Final Environmental Impact Statement

Commonwealth of the Northern Mariana Islands Joint Military Training

Appendices M through N

June 2026

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Final Environmental Impact Statement

Commonwealth of the Northern Mariana Islands Joint Military Training

APPENDICES M THROUGH N

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POTABLE WATER STUDY
IN SUPPORT OF THE
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
JOINT MILITARY TRAINING ENVIRONMENTAL IMPACT STATEMENT

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June 2026

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1 INTRODUCTION

1.1 BACKGROUND

The islands of the Commonwealth of the Northern Mariana Islands (CNMI) are strategically located in the United States (U.S.) Department of Defense (DoD) Indo-Pacific area of operations, as shown in Figure 1. Figure 2 shows the Military Lease Area on Tinian where the U.S. military has trained for several decades.

The Proposed Action would support the ongoing and evolving training requirements of U.S. Armed Forces forward deployed to the Western Pacific, and U.S. allies and partners, specifically for distributed operations training within the Military Lease Area on Tinian. Proposed training events would include both ground and aviation training within the Military Lease Area.

Non-live-fire offensive and defensive training actions would continue to be conducted in the Military Lease Area with an increase in existing land-based training events, including both ground and aviation training, which are the same or similar to those currently being conducted on Tinian.

Live-fire training would be conducted at two ranges that would be developed within the Exclusive Military Use Area:

- **Multi-Purpose Maneuver Range.** A live-fire range occupying approximately 200 acres at the northern tip of Tinian to support platoon-size live-fire and maneuver, including three surface radar facilities.
- **Explosives Training Range.** A live-fire range on approximately 2.5 acres for the employment of demolitions and military explosives in support of offensive and defensive training events.

The following are also included in the Proposed Action to support training events:

- Establishment of 13 Landing Zones, areas cleared of vegetation to 6–8 inches, and associated access roads to conduct training events and to provide staging, bivouac, and gathering and rendezvous areas.
- Ground and aviation improvements at North Field, including establishment of a drop zone and the placement of a metal airfield surface.
- Construction and operation of a Base Camp.
- Clearance and improvements of roads within the Military Lease Area.

1.2 PURPOSE

The purpose of this study is to estimate the potable water demand and infrastructure required for the proposed CNMI Joint Military Training Environmental Impact Statement and to recommend potable water solutions to avoid significant impacts. Potable water solutions would be made part of the Proposed Action.

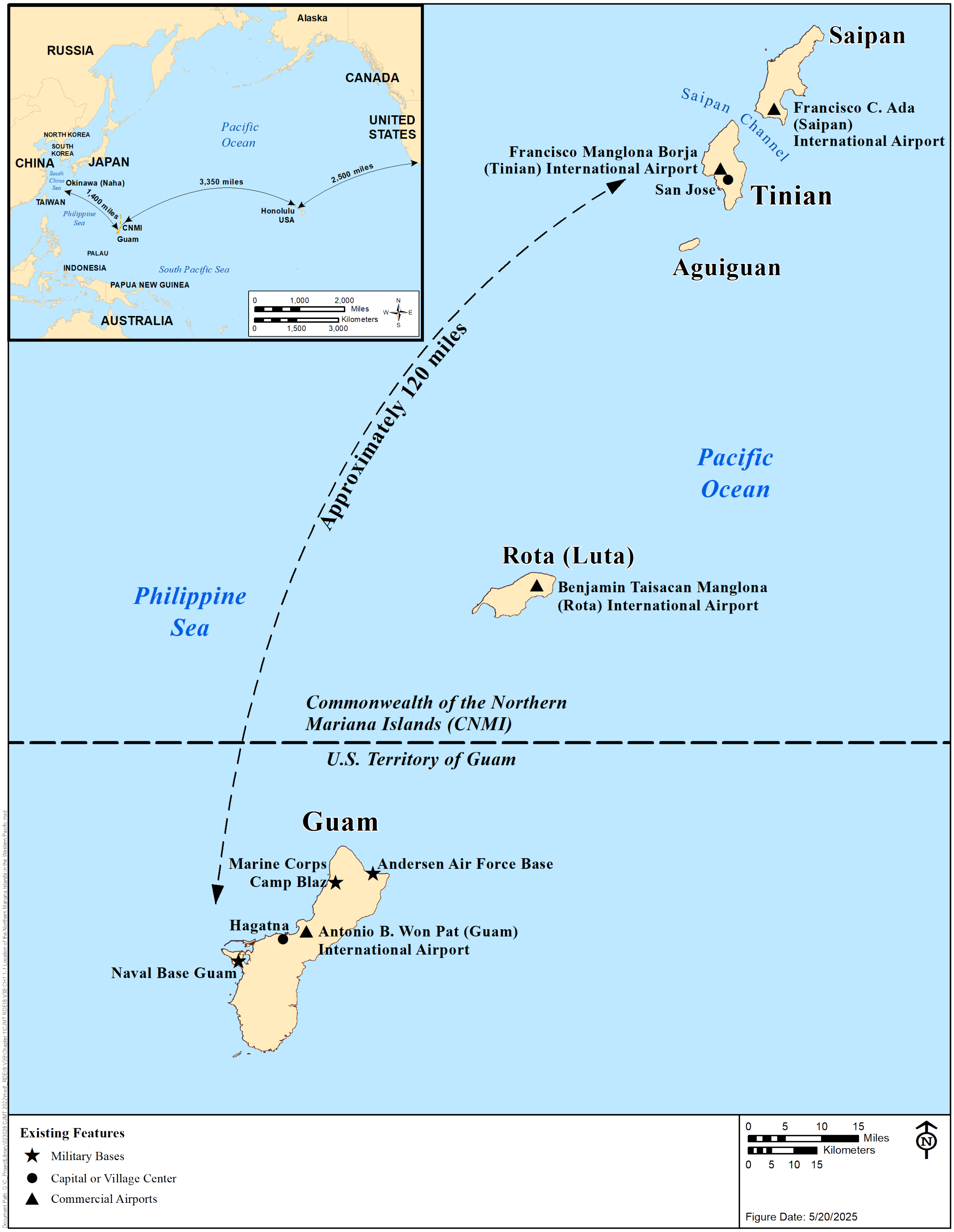

Figure 1 Island of Tinian – Location

Figure 2 Island of Tinian – Military Lease Area Boundaries

1.3 GROUNDWATER SUPPLY

Rainfall is the primary source of fresh groundwater on Tinian. The U.S. Geological Survey estimates the average annual groundwater recharge for Tinian to be approximately 30 inches per year (Gingerich 2002). This translates into approximately 62,000 acre-feet per year of recharge.

The rapid downward percolation of rainwater into porous limestone rock (Doan et al. 1960) recharges Tinian's basal freshwater aquifer. Fresh groundwater on Tinian is primarily classified as basal, which is a body of fresh groundwater that floats on saline groundwater. The portion of the basal freshwater lens that is usable for potable water, which has chloride concentrations less than 250 parts per million, is thickest south and southwest of Mount Lasso and becomes increasingly thinner approaching the coastline (Figure 3).

The groundwater table on Tinian ranges from sea level around the perimeter of the island to over 3 feet above mean sea level in the central portions of the island. Groundwater flows outward from the North Central Highland and the southeastern ridge, and generally seaward around the island (Department of the Navy [DON] 2015). Figure 3 depicts groundwater table elevation contours and the general directions of groundwater flow. Most of the fresh groundwater slowly discharges naturally from springs around the perimeter of the island and submarine coastal springs.

The basal freshwater lens underlying Tinian is the principal source of drinking water and meets the definition of an aquifer in CNMI Title 65, Chapter 65-90-010.

1.4 CNMI BUREAU OF ENVIRONMENTAL AND COASTAL QUALITY

The CNMI Bureau of Environmental and Coastal Quality is the regulatory agency responsible for permitting and enforcement of groundwater, potable water, and non-potable water. The CNMI Bureau of Environmental and Coastal Quality regulates potable water systems per CNMI Drinking Water Regulations, Chapter 65-20. Construction of new wells and operation of existing groundwater wells are subject to an annual permit that limits extraction to protect both availability and quality of groundwater. As part of the permitting process, well owners must conduct the following at each well each year, per CNMI Title 65, Chapter 140:

- Pump test
- Aquifer recovery test
- Water quality testing at a Bureau of Environmental and Coastal Quality-certified laboratory

The maximum quantity of groundwater that can be extracted each month is set by Bureau of Environmental and Coastal Quality in the permit for each well, which must be renewed each year.

1.5 COMMONWEALTH UTILITIES CORPORATION

The Commonwealth Utilities Corporation, a public utility governed by a Board of Directors appointed by the CNMI governor, owns and operates Tinian's only public potable water system. The water system on Tinian consists of approximately 33 miles of pipelines, three aboveground steel reservoirs, and approximately 800 metered service connections (Commonwealth Utilities Corporation 2015a). It is supplied by a single groundwater well (Maui Well No. 2). Figure 4 shows the physical layout of the Commonwealth Utilities Corporation water system.

Figure 3 Tinian Groundwater Wells, Elevation, and Flow Direction

Figure 4 Commonwealth Utilities Corporation Existing Potable Water System

1.5.1 Wells

Maui Well No. 2 is a Maui-style infiltration gallery, which obtains freshwater from the basal lens (Figure 5 and Figure 6) and is the sole source of potable water; there are no redundant or backup supplies. The well is located adjacent to the Marpo wetland area. Maui Well No. 2 is equipped with four 75-horsepower pumps, each capable of pumping approximately 350 gallons per minute. With one pump allowed to be out of service, the pumping capacity is 1.5 million gallons per day.

Figure 5 Maui Well No. 2 Pump House

Figure 6 Maui Well No. 2 Pump Equipment

1.5.2 Storage

The Commonwealth Utilities Corporation water system includes a total of 1.25 million gallons of storage between three existing aboveground reservoirs. Two reservoirs are located adjacent to each other in Carolinas Heights. Each reservoir has a volume of 0.50 million gallons (Figure 7 and Figure 8).

Figure 7 Carolinas Tank 1 (0.50 Million Gallons)

Figure 8 Carolinas Tank 2 (0.50 Million Gallons)

The third reservoir is located in Marpo Heights and has a capacity of 0.25 million gallons (Figure 9). In September 2024, the Marpo Tank appeared to be abandoned. It was surrounded by thick vegetation and not accessible (Figure 10). During this site visit, staff heard the sound of a significant amount of flowing water and speculated that the tank may be overflowing (D. Cronquist, AECOM, Personal Communication, September 9, 2024).

Figure 9 Marpo Tank (0.25 Million Gallons) in 2013

Figure 10 Marpo Tank (0.25 Million Gallons) in 2024

1.5.3 Distribution System

The distribution system consists of approximately 33 miles of water pipelines that vary in diameter from 4 to 12 inches. According to the currently available draft final version of the Commonwealth Utilities Corporation drinking water and wastewater master plan for its facilities on Tinian (Commonwealth Utilities Corporation 2015a), most of the pipelines were constructed of polyvinyl chloride and are in relatively good condition (Commonwealth Utilities Corporation 2015a). Shorter lengths of pipelines were constructed using fiber-reinforced polymer polyvinyl chloride and galvanized iron.

1.6 FRANCISCO MANGLONA BORJA/TINIAN INTERNATIONAL AIRPORT

The Commonwealth Ports Authority owns and operates Francisco Manglona Borja/Tinian International Airport. The airport is a customer of the Commonwealth Utilities Corporation and receives all of its potable water from Maui Well No. 2. Downstream of the Commonwealth Utilities Corporation water meter, the Commonwealth Ports Authority operates its own water system within the airport property. This system includes a 0.2-million-gallon storage reservoir and booster pump station (Figure 11).

Figure 11 Water Tank and Booster Pump Station at Francisco Manglona Borja/Tinian International Airport

1.7 U.S. AGENCY FOR GLOBAL MEDIA

The U.S. Agency for Global Media, formerly International Broadcasting Bureau, operated radio transmitting facilities on Tinian and Saipan. The Tinian facility is not connected to the Commonwealth Utilities Corporation system. Rainwater is captured from a portion of the roof and stored in two aboveground tanks with a total capacity of 8,500 gallons (Figure 12). All water used at the facility is non-potable except for a point-of-use reverse osmosis system that treats water for potable use in the kitchen. Rainwater harvesting provides the majority of water used except during dry months. Approximately 5,000 gallons per year are purchased from Commonwealth Utilities Corporation and trucked in bulk.

Figure 12 Non-potable Water Storage Tank at U.S. Agency for Global Media Facility on Tinian

1.8 TINIAN MAYOR'S OFFICE

The Tinian Mayor's Office owns groundwater and charges a fee for the quantity of water extracted. The Tinian Mayor's Office owns and operates two non-potable water wells: M-21 and M-26 (see Figure 13). Neither well is connected to pipe networks. Both wells are permitted by Bureau of Environmental and Coastal Quality. The wells are described as follows:

- **Well M-21** is primarily used by the construction contractor for the U.S. Air Force's Tinian Divert Infrastructure Improvements at the Francisco Manglona Borja/Tinian International Airport. This well includes a water meter and a 40,000-gallon tank. This well was permitted in 2024 to extract no more than 1.8 million gallons per month (J. Aldieri, NAVFAC Marianas, Personal Communication, September 10, 2024).
- **Well M-26** is primarily used by cattle ranchers and is not metered. For the purposes of this report, it is assumed that the quantity of water used at this well is equal to the permitted extraction of Well M-21.

2 EXISTING WATER SYSTEM

2.1 EXISTING WATER DEMANDS

Table 1 summarizes water production (i.e., extraction) quantities from Maui Well No. 2 as recorded by the Commonwealth Utilities Corporation at the well site. Production includes water delivered into the distribution system, which is inclusive of water billed to customers, unmetered uses, leaks, losses, and overflows.

Table 1. Commonwealth Utilities Corporation Water Production from Maui Well No. 2

Year	*Total Annual (MG)*	*Average Daily (MGD)*
2019	313	0.86
2020	312	0.85
2021	307	0.84
2022	321	0.88
2023	306	0.84
Average		**0.85**

Legend: MG = million gallons; MGD = million gallons per day.
Source: Commonwealth Utilities Corporation 2024b.

Table 2 summarizes billing records for all Commonwealth Utilities Corporation customers combined based on meter readings. All registered connections served by the Commonwealth Utilities Corporation are metered and read monthly.

Table 2. Commonwealth Utilities Corporation Billed Water Demand

Year	*Total Annual (MG)*	*Average Daily (MGD)*
2019	88	0.24
2020	77	0.21
2021	81	0.22
2022	84	0.23
2023	87	0.24
Average		**0.23**

Legend: MG = million gallons; MGD = million gallons per day.
Source: Commonwealth Utilities Corporation 2024c.

The average production at Maui Well No. 2 for the last 5 years was 0.85 million gallons per day.

2.2 WATER QUALITY AND COMPLIANCE WITH REGULATORY STANDARDS

2.2.1 National Primary Drinking Water Standards

The Bureau of Environmental and Coastal Quality has adopted the National Primary Drinking Water Standards, which establish a maximum contaminant level for various constituents in public water systems to protect human health (CNMI Drinking Water Regulations, Chapter 65-20). Compliance with these standards is mandatory and requires the Commonwealth Utilities Corporation to have analytical laboratory testing performed on the water supply. The results of these tests are provided to the public in the form of a water quality report issued annually by the Commonwealth Utilities Corporation. The reports issued between 2012 and 2023 indicate that the Commonwealth Utilities Corporation water system meets the primary drinking water standards

(Commonwealth Utilities Corporation 2013, 2014, 2015b, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024a).

Nitrogen, both nitrate and nitrite, is a common contaminant of concern in areas where wastewater is primarily treated in septic tanks and in agricultural areas. The Commonwealth Utilities Corporation reports that total nitrogen levels are below the maximum contaminant level of 10 milligrams per liter. In 2023, the concentration of total nitrogen was 4.8 milligrams per liter (Commonwealth Utilities Corporation 2024a).

2.2.2 National Secondary Drinking Water Standards

The Bureau of Environmental and Coastal Quality has also adopted the National Secondary Drinking Water Standards, which provide non-mandatory water quality standards for 15 additional contaminants (CNMI Drinking Water Regulations, Chapter 65-20). The secondary standards are established "…as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor" (U.S. Environmental Protection Agency 2018). These contaminants are not considered a risk to public health.

As discussed previously, the freshwater basal lens floats on top of the denser seawater. The transition between freshwater and seawater is gradual, with salt content generally increasing with depth. Chloride concentration is an important secondary standard for Maui Well No. 2 because it has the potential to indicate the quantity of freshwater available at that location. The secondary maximum contaminant level for chloride is 250 milligrams per liter. Table 3 provides chloride concentrations at Maui Well No. 2 between 2012 and 2023.

Table 3. Chloride Concentrations at Maui Well No. 2

Year	*Chloride (ppm)*	
	Average	*Range*
2012	196	175–223
2013	190	172–217
2014	213	212–214
2015	213	212–214
2016	190	184–196
2017	184	184
2018	176	176
2019	146	n/a
2020	145*	n/a
2021	176*	158–176
2022	176*	158–176
2023	177*	n/a

Note: * = Value reported as highest instead of average.
Legend: ppm = part per million; n/a = not available.
Source: Commonwealth Utilities Corporation 2013, 2014, 2015b, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024a.

2.2.3 Treatment

The Commonwealth Utilities Corporation does not treat water produced at Maui Well No. 2 other than disinfection.

3 WATER DEMANDS FOR PROPOSED ACTION

3.1 POTABLE WATER DEMANDS WITHIN THE MILITARY LEASE AREA

The following section estimates the water demands due to the Proposed Action located within the Military Lease Area and outside the existing service area of the Commonwealth Utilities Corporation water system.

3.1.1 Design Population

The maximum number of personnel on island at any one time from the Proposed Action would be 1,070 (estimates for this study used 1,100 to be conservative) and consists of the following types:

- Up to a maximum of 1,000 military personnel participating in training.
- Between 30 and 50 permanent support personnel, who would maintain and operate the facility. It is assumed that 20 individuals would relocate to Tinian and that the on-island local workforce could fill 30 positions.
- Up to 50 construction workers, who are assumed to relocate to Tinian from off-island. Construction would occur in phases over approximately 10 to 15 years.

Dependents are not included in the estimates above based on the experience of other DoD construction projects on Tinian. Potable water used for existing military training and construction projects is already obtained from Commonwealth Utilities Corporation and included in the existing Commonwealth Utilities Corporation water demand data.

3.1.2 Domestic Demands

Domestic demands consist of all water necessary for human consumption, bathing, laundry, food preparation, and other miscellaneous uses that are calculated on a per capita basis. Table 4 summarizes the average day domestic demands located within the Military Lease Area using Unified Facilities Criteria 3-230-03 (DoD 2020) unit demands. The maximum population value was used in these calculations from the design population discussed above.

Table 4. Average Day Domestic Demand Within the Military Lease Area Under Alternative 1

Personnel Type	*Use Category[a]*	*Unit Demand (gpcd)*	*Population*	*Demand (gpd)*
Military Personnel	Military Training Camps	50	1,000	50,000
Construction Workers (8-hour shift)	Nonresident Personnel and Civilian Employees (per 8-hour shift)	30	50	1,500
Permanent Support Personnel (8-hour shift)	Nonresident Personnel and Civilian Employees (per 8-hour shift)	30	50	1,500
			Total	**53,000**

Note: [a]Per UFC 3-230-03 Table 3-1.
Legend: gpcd = gallon per capita per day; gpd = gallon per day; UFC = United Facilities Criteria.

3.1.3 Industrial Demands: Operation

A portable wash rack would be stored at the Base Camp and made available for use at either TNI or North Field in the event cargo/material arrives that does not meet cleanliness standards and for cargo/equipment departing from TNI or North Field. A water truck would supply water to the water bladder attached to the portable wash rack. Washing would be conducted using only water and no soaps or solvents. Wash water would be contained during the washing cycle. Wash water from the portable wash rack would be run through an oil water separator and be discarded in accordance with all applicable laws, regulations and permits. The oil/water separator would be periodically pumped out and disposed of in conformance with CNMI regulations for oily waste.

A new central vehicle wash facility, J609 Embark Facility, was recently constructed at Naval Base Guam. This facility, although larger than the facility proposed for Tinian, provides a reliable estimate of the amount of water that would be required to clean military vehicles in a climate similar to that of Tinian. The central vehicle wash facility on Guam was designed with a demand of 4,800 gallons per day for 230 vehicles per day (DON 2023). This yields approximately 21 gallons per vehicle for a similar climate to the proposed wash facility on Tinian.

The Proposed Action includes a wash capacity for the following vehicles:

- 15 military vehicles
- 30 maintenance and operation vehicles

The maximum water demand is 945 gallons per day. Military vehicles are estimated to be transported by air 4 times per year. Maintenance and operation vehicles are estimated to be washed 3 times per month (36 times per year). This results in an average annual water demand of 23,940 gallons per year.

3.1.4 Industrial Demands: Construction

Industrial demands during construction would include concrete mixing, earthwork compaction, dust control, hydrostatic pressure testing, and cleaning. Non-potable water used for this purpose is proposed to be obtained from Well M-21.

3.1.5 Average Annual Water Demand

The previous tables provided average day demands at the peak training population, which is a maximum potential adverse effect used to size the proposed water infrastructure. Because military training may occur intermittently throughout the year, the water used annually would be significantly lower than the average daily demand.

Table 5 provides the long-term average annual water demand within the Military Lease Area by the Proposed Action under Alternative 1 after construction is complete.

Table 5. Average Annual Water Demands Within the Military Lease Area Under Alternative 1

Description	*Demand*	*Cycles Per Year*	*Persons x Day*	*Unit Water Demand (gpcd)*	*Demand (gallons/year)*
Large Training Group	1,000 persons × 30 days	4	120,000	50	6,000,000
Medium Training Group	250 persons × 14 days	4	14,000	50	700,000
Small Training Group	100 persons × 14 days	10	14,000	50	700,000
Permanent Support Personnel (8-hour shift)	50 persons × 365 days	1	18,250	30	547,500
Portable Vehicle Wash Facility					23,940
				Total	**7,971,440**

Note: These demands represent the maximum of the training durations and personnel per year identified in the final EIS.
Legend: gpcd = gallon per capita per day.

Training tempo under Alternative 2 is 10 percent less than under Alternative 1, which would result in a proportional decrease in water use by 10 percent. As a result, the average annual water demand under Alternative 2 is 7,174,296 gallons per year.

3.2 POTABLE WATER DEMANDS OUTSIDE THE MILITARY LEASE AREA

The following section estimates the water demands due to the Proposed Action located outside the Military Lease Area. This area is within the existing service area of the Commonwealth Utilities Corporation water system. It is anticipated that the Commonwealth Utilities Corporation would meet potable water demands in this area.

3.2.1 Domestic Demands

It is anticipated that construction workers and permanent support personnel would live outside the Military Lease Area in homes, apartments, or hotels. Table 6 summarizes the additional average day domestic demands due to the Proposed Action under Alternative 1 that the Commonwealth Utilities Corporation would meet. Per capita unit demand is estimated using Unified Facilities Criteria 3-230-03 (DoD 2020).

Table 6. Average Day Domestic Demand on Commonwealth Utilities Corporation Water System Under Alternative 1

Personnel Type	*Use Category* [a]	*Unit Demand (gpcd)*	*Population*	*Demand (gpd)*
Construction Workers (24-hour)	Family Housing	125	50	6,250
Permanent Support Personnel (24-hour) [b]	Family Housing	125	20	2,500
			Total	**8,750**

Notes: [a]Per UFC 3-230-03, Table 3-1.
[b]Only personnel relocating from off-island are included here.
Legend: gpcd = gallon per capita per day; gpd = gallon per day; UFC = Unified Facilities Criteria.

3.2.2 Industrial Demands: Operation

The biosecurity facility at the Port of Tinian is proposed to include wash racks. Military vehicles would be washed there as required as part of the biosecurity screening process. The wash racks would be a contained concrete facility where multiple vehicles can be washed simultaneously using cleaning equipment. Washing would be conducted using only water and no soaps or solvents are proposed to be used. Wash water would be contained in a holding tank and recycled through an oil/water separator. Once the wash cycles are complete, wash water would be pumped out and disposed of in conformance with CNMI regulations. The oil/water separator would be periodically pumped out and disposed of in conformance with CNMI regulations for oily waste. No domestic demand is proposed at the Port of Tinian as the biosecurity facility would not have a restroom.

New vehicle wash racks, J609 Embark Facility, was recently constructed at Naval Base Guam. This facility, although larger than the facility proposed for Tinian, provides a reliable estimate of the amount of water that would be required to clean military vehicles in a climate similar to that of Tinian. The central vehicle wash facility on Guam was designed with a demand of 4,800 gallons per day for 230 vehicles per day (DON 2023). This yields approximately 21 gallons per vehicle for a similar climate to the proposed wash facility on Tinian.

The Proposed Action includes a wash capacity of 44 vehicles per day, which is based on 87 total vehicles for a 1,000-person training exercise and a 2-day retrograde period. The prorated industrial demand for the proposed wash facility would be 924 gallons per day.

3.2.3 Industrial Demands: Construction

Industrial demands during construction would include mixing concrete, earthwork compaction, dust control, hydrostatic pressure testing, and cleaning. Non-potable water used for this purpose is proposed to be obtained from Well M-21. No water is proposed to be purchased from the Commonwealth Utilities Corporation for construction purposes.

3.2.4 Average Annual Water Demand

The water demand by the Proposed Action is anticipated to remain consistent and not vary significantly throughout a given year. Because of this, the average annual water demand is the sum of the existing and proposed demands. Table 7 summarizes impacts of the Proposed Action under Alternative 1 on the Commonwealth Utilities Corporation water system.

Table 7. Summary of Existing and Proposed Water Demands on Commonwealth Utilities Corporation Under Alternative 1

Category	*Average Day Demand (MGD)*
Existing CUC Production [a]	0.85
Proposed Additional Domestic Demand	0.0088
Proposed Additional Industrial Demand [b]	0.0009
Total Demand on CUC Water System	**0.86**

Notes: [a]Average of production at Maui Well No. 2 from 2019 to 2023.
[b]Assume one wash per day at the Central Vehicle Wash Facility at the Port of Tinian.
Legend: CUC = Commonwealth Utilities Corporation; MGD = million gallons per day.

The Proposed Action under Alternative 1 is estimated to increase water production at Maui Well No. 2 by 1.14 percent. The water demands on the Commonwealth Utilities Corporation are the same for both Alternative 1 and Alternative 2.

3.3 NON-POTABLE WATER DEMANDS

3.3.1 Construction Water (Well M-21)

Industrial demands during construction would include mixing concrete, earthwork compaction, dust control, hydrostatic pressure testing, and cleaning. The U.S. Air Force is currently constructing the Tinian Divert Infrastructure Improvements at the Francisco Manglona Borja/Tinian International Airport. The contractor purchases all water for that construction from the Tinian Mayor's Office at Well M-21. This well has an extraction capacity of 1.8 million gallons per month in 2024 (J. Aldieri, NAVFAC Marianas, Personal Communication, September 10, 2024), or 21.6 million gallons per year. All water used at this well is used for construction purposes.

The construction employer is responsible for obtaining non-potable water used in construction. Construction of the Tinian Divert Infrastructure Improvements would be completed prior to starting construction of the Proposed Action. It is anticipated that the construction employer for the Proposed Action would make arrangements with the Tinian Mayor's Office to use Well M-21 for construction water.

The Proposed Action is significantly smaller in size and scope than the Tinian Divert Infrastructure Improvements and would use substantially less water during construction. To be conservative, it is assumed that the same quantity of water, 21.6 million gallons per year, would be used in construction of the Proposed Action.

3.3.2 North Field Wells

Non-potable water infrastructure is proposed to be constructed at North Field for firefighting purposes. Water infrastructure at North Field is proposed to be separate from the Base Camp and would not be interconnected. Water would be used for firefighting purposes and would not be operated continuously. Based on wildland firefighting recommendations, it is estimated that the volume of non-potable water used would not exceed 800,000 gallons per year.

3.3.3 U.S. Air Force's Tinian Divert Infrastructure Improvements

The U.S. Air Force has constructed a groundwater well to supply water to the Tinian Divert Infrastructure Improvements at the Francisco Manglona Borja/Tinian International Airport. The primary purpose for this well is to provide water for fire protection purposes. It is estimated this well would use an average of 800,000 gallons per year. This project was permitted separately and is not included in the Proposed Action.

3.3.4 U.S. Air Force's North Field Rehabilitation

The U.S. Air Force is planning to rehabilitate an existing groundwater well or construct a new groundwater in North Field to supply non-potable water for construction of their North Field Rehabilitation project. The U.S. Air Force estimates they would use 12,000 gallons per day for construction, which is 4,380,000 gallons per year. This project was permitted separately and is not included in the Proposed Action.

4 NEW WATER INFRASTRUCTURE

4.1 OPTIONS EVALUATED

The following options were evaluated to supply water in order to meet the needs of the Proposed Action within the Military Lease Area. Water demands outside the Military Lease Area are proposed to be met by the Commonwealth Utilities Corporation.

No construction activities would be conducted at the former U.S. Agency for Global Media site on Saipan and no changes to water use are proposed. Because of this, there is no impact to potable water on Saipan.

4.1.1 Option A, Connection to Commonwealth Utilities Corporation

Under Option A, a pipeline would be constructed to supply water from the Commonwealth Utilities Corporation to meet the needs of the Proposed Action within the Military Lease Area. However, this was not deemed feasible because the Commonwealth Utilities Corporation does not comply with the DoD requirements for water supply as described in Unified Facilities Criteria 3-230-01 (DoD 2020). Unified Facilities Criteria 3-230-01 incorporates the *Ten State Standards* (Great Lakes 2012), which requires a minimum of two sources of groundwater to be provided.

The Commonwealth Utilities Corporation water system on Tinian only has one source of groundwater with no redundancy and does not comply with these requirements.

4.1.2 Option B, Construct Separate Water Infrastructure

Under Option B, new water infrastructure would be constructed that would operate independently of the existing Commonwealth Utilities Corporation water system and avoid impacts to it. The Proposed Action includes construction of new water infrastructure at two different locations:

- Base Camp
- North Field

Water infrastructure at the Base Camp would consist of new groundwater wells, aboveground storage tanks, and distribution piping to meet potable water and fire protection demands. Water infrastructure at North Field would consist of new groundwater wells and aboveground storage tanks for fire protection demand only. Groundwater production from these wells would conform to extraction limitations and requirements stated in the operation permit by the Bureau of Environmental and Coastal Quality. Excess capacity could also be made available for agricultural or other uses approved by the U.S. Marine Corps (USMC).

4.1.3 Option C, Interconnection Between Water Systems

Under Option C, a pipeline would be constructed between the new water infrastructure described in Option B and the Commonwealth Utilities Corporation to provide emergency water supply. However, this was not deemed feasible because the combined system would not comply with the DoD requirements for water supply as described in Unified Facilities Criteria 3-230-01 (DoD 2020). Unified Facilities Criteria 3-230-01 incorporates the *Ten State Standards* (Great Lakes 2012), which requires the total developed groundwater source capacity to equal or exceed the design maximum day demand with the largest producing well out of service.

The groundwater wells proposed in Option B do not have sufficient capacity to meet the needs of the Commonwealth Utilities Corporation water system if the largest producing well, Maui Well No. 2, were out of service and therefore would not comply with these requirements.

4.2 BASE CAMP WATER INFRASTRUCTURE

The Proposed Action includes construction of a Base Camp at the U.S. Agency for Global Media site on Tinian. As envisioned, Administration, Range Control, and Training Support functions proposed in the Base Camp would use the existing operation and administration building, and warehouse requirements would be partially met with the existing warehouse facilities. Other previously disturbed, cleared areas within the site would accommodate other new construction needs of the proposed Base Camp.

The Proposed Action includes construction of new water infrastructure to fully support the USMC's proposed CNMI Joint Military Training and to avoid impacts on the Commonwealth Utilities Corporation water system. This proposed new water infrastructure would supply the domestic, industrial, and fire protection demands of military training activities within the Military Lease Area. This proposed new water infrastructure would comply with the Federal Safe Drinking Water Act and the CNMI Drinking Water Regulations and be operated by USMC with a CNMI-certified water operator. No connection to the Commonwealth Utilities Corporation water system is proposed. Excess capacity could also be made available for agricultural or other uses approved by USMC. The existing non-potable rainwater harvesting system may also be retained for non-potable uses.

Potable water would be supplied to the Base Camp from new groundwater wells at one of the two following locations:

- Wellfield Option A is located east of Broadway at 86th Street.
- Wellfield Option B is located between West End Drive and 8th Avenue at 86th Street.

Wellfield Option B is the preferred option to locate new groundwater wells due to its proximity to the Base Camp. Water pipelines from the well field to the Base Camp would be located in 86th Street and 8th Avenue, or along West End Drive (Figure 13). It is not feasible to construct groundwater wells closer to the former U.S. Agency for Global Media site due to the site geology.

4.2.1 Design Flow

Water demands are calculated in accordance with Unified Facilities Criteria 3-230-03, *Water Treatment* (DoD 2020). Design flow is the greater of peak hourly demand or maximum daily domestic demand plus industrial demand. Maximum daily and peak hourly demands are calculated as the product of the average daily domestic demand and the coefficient "K." The coefficient "K" for maximum daily demand is 2.25 for populations of less than 5,000 people. The coefficient "K" for peak hourly demand is 4.0 for populations of less than 5,000 people.

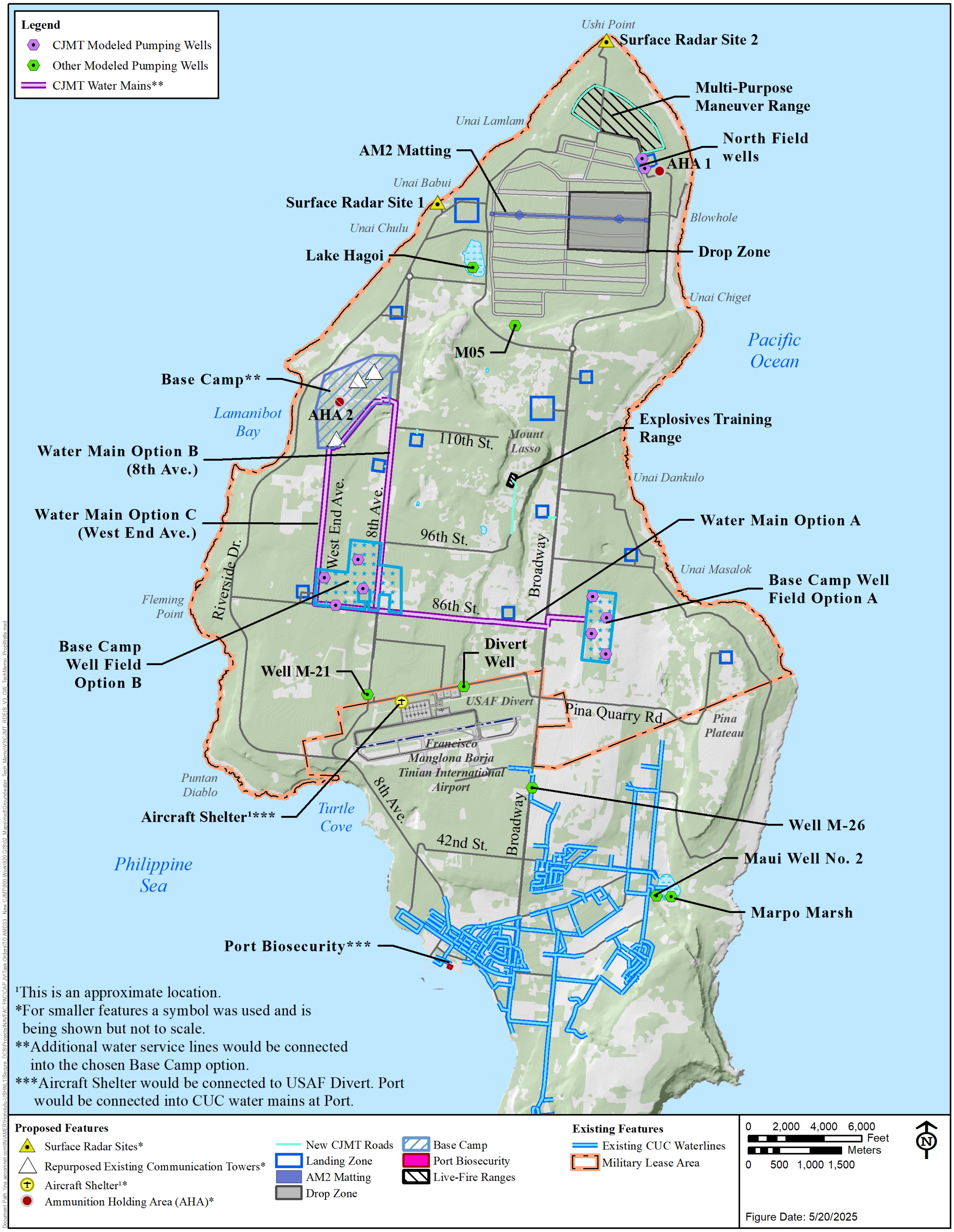

Figure 13 Water Infrastructure Included in Proposed Action

Fire demand requirements are described in Unified Facilities Criteria 3-600-01, *Fire Protection Engineering for Facilities* (DoD 2021a). The fire demand is a minimum of 1,000 gallons per minute for a 2-hour duration at 20 pounds per square inch, which is a volume of 120,000 gallons.

The design flow is then calculated as:

- Peak Hourly Demand = 53,945 gallons per day × 4.0 = 215,780 gallons per day
- Maximum Daily Demand + Fire Flow = 53,945 gallons per day × 2.25 + 120,000 gallons per day = 241,376 gallons per day

The controlling design flow is 241,376 gallons per day and the proposed water infrastructure would be designed to provide this flowrate.

4.2.2 Groundwater Wells

New groundwater wells could be constructed to operate with a capacity of 120 gallons per minute. To reduce impacts to the aquifer, a larger number of wells operating at lower flowrates is proposed. The proposed equipped pumping capacity would be limited to 60 gallons per minute, which is equal to 86,400 gallons per day. Three groundwater wells can provide 259,200 gallons per day, which would meet the design flow of 241,376 gallons per day. *Ten State Standards* (Great Lakes 2012) require a fourth, redundant well to be constructed so that design flow can be met with the largest source of water out of service. It is planned that all four wells would operate on a rotating cycle. The specific location of the wells would be determined as part of engineering design.

Construction and operation of each groundwater well would be subject to an annual permit from Bureau of Environmental and Coastal Quality. Bureau of Environmental and Coastal Quality would determine extraction limitations based on the results of pump tests, aquifer recovery tests, and water quality testing. The extraction limitations would be subject to change each year based on test results.

4.2.3 Water Treatment

Groundwater is not anticipated to require filtration or treatment, other than disinfection, based on the analytical testing results of groundwater performed in 2015 (DON 2015).

4.2.4 Storage Requirements

Water storage requirements are described in Unified Facilities Criteria 3-230-01 (DoD 2021b). The required storage is the sum of the maximum daily demand for 24 hours, which is 121,376 gallons, and fire demand of 120,000 gallons:

- Required Storage Volume = 121,376 gallons + 120,000 gallons = 241,376 gallons

One possible hypothetical tank configuration that would meet this requirement has a diameter of 40 feet and a height of 32 feet with a gross volume of 300,810 gallons and a usable volume of 253,808 gallons. To meet the required storage, two tanks are recommended so that one tank can be removed from service for maintenance and repair while the other is in operation. Additionally, Unified Facilities Criteria 3-600-01 (DoD 2021a) requires that water storage tanks be refilled within 48 hours of normal consumption and within 24 hours if normal consumption is curtailed.

4.2.5 Booster Pump Station

A booster pump station would be required downstream of the storage tanks to pressurize the water infrastructure. Per Unified Facilities Criteria 3-230-01 (DoD 2021b), pumps would be required to maintain a residual pressure of 40 pounds per square inch at average day demand and 30 pounds per square inch during design flow. Minimum residual pressure at fire hydrants must be at least 20 psi while supplying fire flow. It is recommended that the booster pumps be designed to supply both domestic and fire demands. Stand-alone fire demand pumps could fail in an emergency because they do not operate regularly.

The booster pump station and disinfection are proposed to be located inside a 1,200-square-foot pump building.

4.3 NORTH FIELD WATER INFRASTRUCTURE

Non-potable water infrastructure is proposed to be constructed at North Field for firefighting purposes. Water infrastructure at North Field is proposed to be separate from the Base Camp and not interconnected. Water infrastructure is planned to include up to two new or rehabilitated groundwater wells, two 100,000-gallon aboveground water tanks, a booster pump station, and a 900-square-foot pump house. The overall land disturbance for this infrastructure is anticipated to be 100 feet square (10,000 square feet) with approximately 7,000 square feet of impervious or semi-impervious surface. The specific locations would be determined during engineering design.

New groundwater wells could be constructed to operate with a capacity of 120 gallons per minute. To reduce impacts to the aquifer, it is proposed to limit the equipped pumping capacity to 60 gallons per minute, which is equal to 86,400 gallons per day. Water would be used for firefighting purposes and would not be operated continuously. Based on wildland firefighting recommendations, it is estimated that the volume of non-potable water used would not exceed 800,000 gallons per year.

Construction and operation of each groundwater well would be subject to an annual permit from Bureau of Environmental and Coastal Quality. Bureau of Environmental and Coastal Quality would determine extraction limitations based on the results of pump tests, aquifer recovery tests, and water quality testing. The extraction limitations would be subject to change each year based on test results. Even though this is intended as a non-potable water, Bureau of Environmental and Coastal Quality requires that the wells be designed and constructed to potable standards.

4.4 AIRCRAFT SHELTER WATER INFRASTRUCTURE

The proposed aircraft shelter is located at the Tinian Divert Infrastructure Improvements at the Francisco Manglona Borja/Tinian International Airport. Fire protection requirements for the aircraft shelter would be met by the water system being constructed as part of the Tinian Divert Infrastructure Improvements. This water system would include a groundwater well, storage tank, and booster pump for fire protection purposes. A pipeline would be constructed from this water system to the proposed aircraft shelter. No potable water uses are proposed at the aircraft shelter. No changes in demand or usage on this water system are proposed.

5 SUMMARY

5.1 NEW WATER INFRASTRUCTURE

The Proposed Action on Tinian includes construction of potable water infrastructure at the Base Camp that includes new groundwater wells, water storage tanks, and a pipeline distribution system to provide water for military trainees. This action, designed and managed in a manner that would avoid adversely affecting the sustainable yield of the aquifer, would avoid demands on the Commonwealth Utilities Corporation water system. The new water infrastructure would be sized in accordance with government regulations to provide a maximum day demand of 121,376 gallons per day plus fire demand of 120,000 gallons per day.

While the new water infrastructure would be sized to provide the maximum day demand and fire demand occurring simultaneously, the actual water usage during the year would be substantially less. The average annual water demand of the new water infrastructure would be 7,971,440 gallons per year under Alternative 1. The average annual water demands under Alternative 2 would be 7,174,296 gallons per year.

Non-potable water infrastructure is proposed to be constructed at North Field for firefighting purposes. Water infrastructure at North Field is proposed to be separate from the Base Camp and would not be interconnected. It is estimated that 800,000 gallons per year would be used. This demand would be the same under both Alternative 1 and Alternative 2.

Construction and operation of each groundwater well would be subject to an annual permit from Bureau of Environmental and Coastal Quality. Bureau of Environmental and Coastal Quality would determine extraction limitations based on the results of pump tests, aquifer recovery tests, and water quality testing. The extraction limitations would be subject to change each year based on test results to protect the aquifer.

5.2 COMMONWEALTH UTILITIES CORPORATION

Construction workers and permanent support personnel would reside outside the Military Lease Area and become customers of the Commonwealth Utilities Corporation. As customers, they would be responsible for paying all charges and rates adopted by the Commonwealth Utilities Corporation. The Proposed Action under Alternative 1 and Alternative 2 is estimated to increase water production at Maui Well No. 2 by 9,674 gallons per day, which is 1.14 percent.

5.3 GROUNDWATER IMPACTS

Impacts to groundwater availability and quality are evaluated in the Groundwater Modeling Technical Memorandum. Table 8 provides a summary of water demands evaluated in the groundwater model.

Table 8. Summary of Average Annual Water Demands on Tinian

Owner	*Facility*	*Type*	*Average Annual Water Demand* [b] *(gallons per year)*	*No. Wells*
Military	CJMT Base Camp	Potable	7,971,440	4
Military	CJMT North Field	Non-Potable	800,000	2
Military	U.S. Air Force North Field Rehabilitation	Non-Potable	4,380,000	1
Military	Tinian Divert Infrastructure Improvements	Potable	800,000	1
CUC	Maui Well No. 2 [a]	Potable	314,727,702	1
Tinian Mayor's Office	Well M-21 (CJMT Construction)	Non-Potable	21,600,000	1
Tinian Mayor's Office	Well M-26 (Existing Agriculture)	Non-Potable	21,600,000	1

Notes: [a]Average of production at Maui Well No. 2 from 2019 to 2023 and proposed CJMT demands on the CUC water system. [b]Total demand for all the wells.

Legend: CJMT = Commonwealth of the Northern Mariana Islands Joint Military Training; CUC = Commonwealth Utilities Corporation; gpd = gallon per day; U.S. = United States.

6 REFERENCES

CNMI. *CNMI Drinking Water Regulations*. Chapter 65-20.

Commonwealth Utilities Corporation. (2013). "2012 Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2014). "2013 Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2015a). *Draft Final Drinking Water and Wastewater Master Plan – Tinian, Commonwealth of the Northern Mariana Islands*. June.

Commonwealth Utilities Corporation. (2015b). "2014 Water Quality Report." June.

Commonwealth Utilities Corporation. (2016). "2015 Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2017). "2016 Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2018). "2017 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2019). "2018 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2020). "2019 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2021). "2020 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2022). "2021 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2023). "2022 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2024a). "2023 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2024b). "CUC Tinian Water Production Data." July.

Commonwealth Utilities Corporation. (2024c). "CUC Tinian Water Usage for the Period of 2017 - 2024."

Doan, D. B., Burke, H. W., May, H. G., & Stensland, C. H. (1960). Military Geology of Tinian, Mariana Islands. Prepared under the direction of the Chief of Engineers, U.S. Army by the Intelligence Division, Office of the Engineer Headquarters United States Army Pacific with personnel of the United States Geological Survey. Retrieved from https://search.library.cornell.edu/catalog/5099117.

DoD (Department of Defense). (2020). *Unified Facilities Criteria, Water Treatment.* UFC 3-230-03. May.

DoD. (2021a). *Unified Facilities Criteria, Fire Protection Engineering for Facilities*. UFC 3-600-01. May.

DoD. (2021b). *Unified Facilities Criteria, Water Storage and Distribution*. UFC 3-230-01. July.

DON. (2015). *Aquifer Study Technical Memorandum Final in Support of the Commonwealth of the Northern Mariana Islands Joint Military Training*. JBPHH, HI: Prepared for NAVFAC Pacific. November.

DON. (2023).”Vehicle Wash Facility Water Demand.” Personal Communication Form.

Gingerich, S. B. (2002). *Geohydrology and Numerical Simulation of Alternative Pumping Distributions and the Effects of Drought on the Ground-Water Flow System of Tinian, Commonwealth of the Northern Mariana Islands* (No. 02–4077) (p. 46). Honolulu, HI: Prepared by the United States Geological Survey in cooperation with the Commonwealth Utilities Corporation, Commonwealth of the Northern Mariana Islands. Retrieved from http://pubs.usgs.gov/wri/wri02-4077/.

Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. (2012). *Recommended Standards for Water Works.*

U.S. Environmental Protection Agency. (2018). “Secondary Drinking Water Standards: Guidance for Nuisance Chemicals.” *Environmental Protection Agency*. Retrieved January 11, 2018, from https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

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ATTACHMENT A
FEBRUARY 2016 MEETING MINUTES

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Background, Summary, and Follow-up from 03 and 04 February 2016 on Next Steps in Addressing Potable Water and Groundwater Issues on Tinian, Commonwealth of the Northern Mariana Islands (CNMI)

Meeting Locations: Commonwealth Utilities Corporation (CUC) Conference Room Saipan (03 February 2016 Meeting) and CUC Conference Room Tinian and Field (04 February 2016)

Attendees:

CNMI Bureau of Environmental and Coastal Quality (BECQ):
Captain Derek Chambers †
CUC:
James Benevente, Engineer †
John Reigel, Manager*
Winston Omar, Operator**
Environmental Protection Agency (EPA):
Carl Goldstein, Program Manager †
Mike Lee, Water Division †
John McCarroll, Pacific Islands †

Marine Corps Activity Guam:
Gunnery Sergeant Donald McClester †
Major Chris Merrill †

Marine Corps Forces Pacific (MARFORPAC), Defense Policy Review Initiative (DPRI):
Sherri Eng, Environmental †
Tim Robert, Operations †
Martha Spengler, Environmental*
Marine Corps Headquarters
Stephen Wenderoth, Legal Counsel †
Naval Facilities Engineering Command Pacific:
Brian Whitehouse, Project Manager †
Pacific Air Forces:
Mark Petersen, Project Manager †

Joint Venture TEC-AECOM (JV):
Daniel Cronquist, Engineer*
Douglas Roff, Hydrogeologist*

†=attended meetings on 03 February only * = attended meetings on 03 February and 04 February; **= attended meeting on 04 February only

Background: Two meetings were held in the CNMI the first week of February 2016 to discuss the next steps in addressing the EPA's concerns related to potable water and groundwater issues on Tinian. These meetings are a follow-on action related to the EPA's comments on the Draft CNMI Joint Military Training (CJMT) Environmental Impact Statement (EIS)/Overseas EIS (OEIS) (hereinafter referred to as the "DEIS"). The Department of Defense (DoD) released the DEIS in April 2015. After an initial review, the EPA agreed to withhold an adverse rating on the DEIS provided the DoD addresses its concerns related to the CJMT proposed action. These concerns included issues related to potable water and groundwater alternatives on Tinian. The DoD agreed to prepare a Revised DEIS (RDEIS) in order to address the EPA's and others' comments on the DEIS. Towards this end, MARFORPAC and the EPA met in December 2015 and January 2016 to discuss potable water demands, potable water production, sustainable production of groundwater aquifer sub-basins on Tinian, and potential potable water alternatives to be evaluated for possible analysis in the RDEIS.

At the DoD's request, the EPA coordinated a meeting with the CUC and BECQ in the CNMI. The purpose of the meeting on 3 February 2016 was to get the CUC's and BECQ's feedback on assumptions that went into a Water Demands Memo that the JV prepared to estimate potable water production from the CUC System and projected water demands on Tinian through 2027. In addition, the DoD wanted to discuss the sustainable production of fresh groundwater on the island, gain a better understanding of the unaccounted for water (UFW) from the CUC System, and CUC's plans and desires to address UFW and other CUC System issues. The purpose of the 4 February 2016 meeting was for the JV and DoD to meet with CUC operators and to examine key CUC infrastructure and gather data needed to further evaluate potable water and groundwater alternatives on Tinian.

I. Water Demands Memo

Background: DPRI Environmental directed the JV to prepare a Water Demands Memo that outlines the production rate of the CUC's sole freshwater production well on Tinian (Maui Well No. 2) and the various projected water demands on Tinian from the present through 2027. The Water Demands Memo was intended to address EPA comments related to the sustainable production of freshwater on the island, provide a breakdown of the CJMT construction and operation water demands and how those demands and other projected water demands could be met (i.e., potable water and groundwater options/alternatives). Toward that end, the memo memorializes the CUC's daily and annual production pumped from Maui Well No. 2 and metered potable water (i.e., assumed consumption rate of potable water) as reported by the CUC. The memo also provides estimated agricultural water demands on the island, projected CJMT water demands broken down by year of construction through operation, projected Divert water demands, projected Plumeria Resort and Tinian Ocean View Resort water demands, and anticipated water demands from induced population growth. The Water Demands Memo is a starting point in the reevaluation of potable water and groundwater options on Tinian. The DoD shared the draft Water Demands Memo with the EPA in their 14 January 2016 meeting and received feedback on assumptions made in preparing the Water Demands Memo.

Discussion Summary:

- **General Feedback on the Water Demands Memo.** The CUC and BECQ were pleased with the draft Water Demands Memo as it helped them to better understand the water demands on Tinian and the current production rates of Maui Well No. 2. Both agencies would like a copy of the Water Demands Memo once it is finalized.
- **Projected Water Demands on Tinian**
  - **Feed-back on Water Demand Assumptions.** The CUC and BECQ had few comments on the assumptions that went into the projected water demands outlined in the Water Demands Memo except for the following:
    - While they had no formal documentation or permit application, the CUC understands that the proposed Tinian Ocean View Resort intends to meet their operational water demands via reverse osmosis.
    - The CUC and BECQ had no specific knowledge of agricultural water demands on Tinian.
  - **Follow Up on Water Demands.** The JV will follow up with the Tinian Ocean View Resort developers (Alter City Group and Bridge Investment Group, respectively) to confirm that water demands are adequately represented. Plumeria Resort water demands for operation were obtained from the development's Environmental Impact Assessment (EIA). The Tinian Ocean View Resort, which has begun construction, does not have an EIA; thus, all construction and operation water demands were estimated based on descriptions available from the local newspaper. The JV will follow up with the Tinian agricultural extension agent (Lawerence Duponcheel) and with the CNMI Department of Agriculture to get a better sense of the water demands from agriculture off of the Military Lease Area (MLA).
- **Freshwater Production on Tinian**
  - **Sustainable Freshwater Production from Maui Well No. 2.** The CUC agreed with an EPA recommendation that it would be prudent to assume that the CUC sustainable production capacity from Maui Well No. 2 is 1.0 Million Gallons per Day (MGD). The CJMT DEIS had used an average sustainable production capacity of 1.26 MGD in order to assess impacts from the CJMT project, noting that production rate ranges from 1.0 MGD during dry periods to about 1.50 MGD

during wet periods. Based on the discussion, the DoD agreed to use the 1.0 MGD in its impact analysis for the RDEIS (unless further analysis of CUC extraction rates indicates another reasonable value). [Note: CUC operators on Tinian have kept hourly hydraulic head (groundwater levels) from Maui Well No. 2 since its inception along with pump rates.]

- **Sustainable Freshwater Yield on Tinian.** All agreed that the aquifer sub-basins on Tinian could accommodate the projected freshwater pumping demands outlined in the Water Demands Memo provided that the extraction of groundwater was sufficiently dispersed to avoid impacting water quality (i.e., siltation, chloride content).
  - **Maui Well No. 2 Water Quality Issues.** Presently, the CUC System pumps exclusively from the Makpo sub-basin aquifer which is thought to be hydraulically connected to the Makpo Wetland. [Note: Maui Well No. 2 is a horizontal well or "Maui-style infiltration gallery well"]. The CUC confirmed that water quality during periods of heavy rainfall coincided with increased turbidity in the well thought to be due to runoff into the wetland. In their comments on the DEIS, the EPA expressed concern that increasing pump rates to accommodate project CJMT could further affect water quality at Maui Well No. 2. In addition, the chloride content at Maui Well No. 2 is recorded at greater than 200 milligrams per liter (mg/l) which is close to the SDWA Secondary Drinking Water Level of 250 mg/l. As noted in EPA comments and discussions, CUC System customers have registered complaints about water quality/taste. All agreed that pumping from other wells either within the Makpo aquifer sub-basin or other aquifer sub-basins would be one way to avoid impacting water quality at Maui Well No. 2.
  - **Other Potential Production Wells in the Makpo Aquifer Sub-basin.** As described by the U.S. Geological Survey (*Geohydrology and Numerical Simulation of Alternative Pumping Distributions and the Effects of Drought on Ground-Water Flow System of Tinian, Commonwealth of the Northern Mariana Islands*, Gingerich et al 2002) , the CUC had two vertical wells in operation in the Makpo aquifer sub-basin into the 1990s. During the site visit on 4 February 2016, the CUC operators showed the JV and DoD the locations of these inactive wells – both of which were capped and are reportedly in marginal to poor condition. The CUC indicated that the wells were taken off-line because the CUC could not afford to continue to maintain the wells. Reportedly, there are other vertical wells that may tap into the Makpo aquifer sub-basin that may be used for agricultural or other water demands (these are described in the 2002 USGS report).
  - **Potential Freshwater Production from the Masalok Aquifer Sub-basin.** The JV explained why they believe that pumping in the MLA (i.e., primarily in the Masalok aquifer sub-basin), as proposed in the DEIS, would not likely affect the water quality and quantity in the Makpo sub-basin aquifer. The maximum CJMT projected water demands, as described in the DEIS, would be between 0.240 MGD and 0.460 MGD. Mr. Roff explained that the USGS (2002) modeled pumping in both the northern and southern portions of Tinian during drought periods and at pumping rates that are below those projected water demands described in the Water Demands Memo.

II. Impacts to Water Quality from Increased Groundwater Extraction on Tinian

Background. In their comments on the DEIS, the EPA stated that the DEIS did not adequately address the potential for saltwater intrusion on drinking water and the effects on drinking water quality. The DEIS concludes that the additional construction-period and operation-period water demands (off of the MLA) would require increased pumping from the CUC's Maui Well No. 2 and this could result in temporary increased chloride levels as a result of saltwater intrusion. The DEIS concludes that these impacts are less than significant because the limited times this would occur and because of the size and recharge characteristics of the freshwater basal lens. The EPA believes that the information in the DEIS allows for uncertainty regarding the potential for saltwater intrusion in the aquifer. The DEIS conclusions regarding potential salinity increases were based largely on the USGS 2002 groundwater model. This steady-state groundwater flow model is based on pumping data from the late 1990's and, while it was the best available tool for predicting the possible hydrologic effects of additional groundwater withdrawals at that time, more sophisticated models currently exist. The model cannot predict the salinity distribution within the aquifer and it is not capable of predicting the quality of the water pumped from a given well. The model can simulate the location of the freshwater/saltwater interface; however, it cannot simulate local up-coning atpumped wells.

Furthermore, the EPA indicated in their comments that the DEIS does not specifically discuss the combined impacts to the aquifer, during operations, from pumping in the MLA (Masalok aquifer sub-basin) and outside the MLA (Makpo aquifer sub-basin). The EPA is concerned that the two sub-basins have a high degree of connectivity and thus pumping from one sub-basin would lower the freshwater availability in the other sub-basin. The EPA noted that groundwater withdrawal on Tinian and the potential effects it could have on Makpo Wetland are not discussed in the DEIS. Maui Well No. 2, Tinian's sole public water supply well, pumps freshwater from Makpo Wetland's basal groundwater lens. The project water demand would be between 0.033 to 0.058 MGD during the construction period. During the operation period the project water demand would be on average 0.240 MGD and maximum of 0.460 MGD. The DoD System's well field would be within the Masalok sub-watershed, with a small portion located within the Makpo sub-watershed where the CUC System well is located. The EPA believes that the two sub-watersheds are connected (i.e., share the same limestone aquifer and the two basins are connected); thus, the EPA believes that the wells and wetlands in one sub-watershed could be influenced by groundwater withdrawal from wells in the neighboring sub-watershed.

The DoD in subsequent discussions with the EPA responded that structural features, which define the Median Valley, likely result in significant conduit flow to the north and southwest of the MLA. These were not accounted for in the 2002 model.

Discussion Summary:

- **Aquifer Modelling on Tinian.** Following the discussion on the sustainable yield of freshwater on Tinian, Mr. Lee (EPA) indicated that an updated aquifer model could help address the EPA's concerns about water quality as a result of projected and proposed water extraction from the DoD, CUC, and Plumeria Resort on drinking water quality.

III. Unaccounted for Water from the CUC System on Tinian

The EPA in its comments on the DEIS recommended that UFW be targeted for improvement as it would have a beneficial impact by helping the CUC and the municipality. The EPA recommended that options for correcting the deficiencies in the CUC System should be evaluated in the RDEIS as the EPA believes that it represents a reasonable alternative that could reduce potentially significant impacts on the potable water utility (and groundwater aquifer).

Presently, the CUC pumps between 0.890 MGD to 1.32 MGD from Maui Well No. 2; however, they currently bill only 0.320 MGD. This means that approximately 0.570 MGD to 1.00 MGD is UFW lost to the environment or utilized by customers at unmetered or unregistered facilities. The CUC, in response to a Stipulated Order with the EPA, prepared a draft drinking water master plan ("Master Plan"). The Master Plan identified several potential sources of UFW including faulty water meters, over-topping of water storage tanks, leaking pipes, and unmetered/unregistered connections. At the 03 February 2016 meeting, the CUC acknowledged that they do not fully understand the quantities of UFW that can be attributed to various sources. The following provides a summary of the various UFW sources and the CUC's general understanding and identified approach for addressing UFW from these sources:

- **Faulty Water Meters.** The CUC acknowledged that their water meters are not reliable and often undercount the amount of water delivered to service connections resulting in UFW. Often water bills are estimated based upon use when the meters were functional. Sources of inaccuracy, according to the Master Plan, include improper installation and lack of maintenance.
- **Over-Topping of Storage Tanks.** The CUC operates two aboveground water storage tanks, 0.250 million gallon (MG) and 0.500 MG in size. The 0.250 MG tank's flow control system has failed, resulting in UFW of 0.144 to 0.216 MGD according to the Master Plan. Currently the tank is operated manually and the master valve to the tank was closed during our field visit. The 0.500 MG storage tank has a telemetric connection to Maui Well No. 2 which is controls operation of the pumps; however, due to power supply irregularity, the telemetry can be unreliable and thus result in over topping of the tank. The CUC has programmed projects to replace the 0.500 MG tank and telemetry system at the tank. The CUC has not yet programmed a project to address deficiencies at the 0.250 MG tank. The Master Plan recommends that the CUC abandon the 0.250 MG tank.
- **Leaking Transmission and Distribution Pipes.** Leaking pipes are a source of UFW that are exacerbated by non-functional pressure reducing valves (PRVs) which over pressurize portions of the pipeline system. The CUC has programmed a project to replace several of the PRVs in accordance with the Master Plan recommendations. Additionally, CUC has identified pipelines for replacement including the seaport area where the proposed CJMT port operations would be located. The CUC has identified a need to perform leak detection and repair or replacement throughout Tinian – particularly areas of San Jose Village.
- **Unmetered and Unregistered Connections to the CUC System.** Neither unmetered nor unregistered connections have water meters and both contribute to UFW. The primary difference between the two is that unmetered connections are known and authorized by CUC whereas the unregistered connections are not known and are not authorized. CUC has not attempted a comprehensive review of their service area to determine occupied properties without a meter.

IV. CUC System Improvements

In their comments on the DEIS, the EPA noted that it has issued a Stipulated Order to the CUC to bring its drinking water system back into compliance with Safe Drinking Water Act (SDWA). Furthermore, the EPA noted that the CUC is in severe financial distress. In the EPA's comments, they stated that if the DoD action would place an additional financial burden on the CUC, this would be an unacceptable impact to the CUC and could compromise the public's access to drinking water. The EPA recommended that the DoD describe any improvements that the DoD would make to the CUC System in the RDEIS. These improvements could include any additional pumping capacity that would be needed to the CUC System to ensure that sufficient drinking water would be available to the public, nature and extent of CUC System improvements, and an explanation of how the DoD would support CUC in making these improvements.

- **Programmed CUC System Improvements.** The CUC provided the DoD with a list of programmed improvements (i.e., funding has been approved) to the CUC System.
    - PRV replacements. The CUC has a project in place to replace and, in some case, move several PRVs. This project will go a long way in reducing water pressure and help reduce additional pipeline failures.
    - 0.500 MG Storage Tank Replacement. The CUC has a project programmed to replace the existing 0.500 MG storage tank including the liquid control telemetry. This project will help in with the reliability of the CUC System.

- **Unprogrammed CUC System Improvements.** The CUC provided the DoD with a list of potential construction projects in order of importance that they are looking for funding to implement. They believe that one or some combination of projects from this list could be used as mitigation for DoD actions on Tinian. These improvements are not presently programmed.
    - Install altitude valve at the 0.250 MG storage tank. This improvement would reduce leakage by approximately 0.144 MGD to 0.150 MGD when the tank is in operation.
    - Replace 8-inch fiberglass-reinforced pipe (FRP) transmission/distribution line between Maui Well No. 2 and the 0.500 MG storage tank with 10-inch ductile iron pipe for resistance to pressure transients (4,620 linear feet); install dedicated polyvinyl chloride (PVC) distribution pipe from 0.500 MG tank to intersection with Maui Well No. 1 (currently off-line, inactive) (5,370 linear feet), sized to accommodate proposed DoD demand.
    - Replace 6-inch FRP distribution piping between Maui Well No. 1 intersection and the 0.250 MG tank with new PVC sized to accommodate proposed DoD demand (DoD point of connection on this pipeline) (8,270 linear feet).
    - Replace galvanized iron (GI) and cast iron piping in Makpo Valley with new 6-inch PVC (6,000 linear feet).
    - Replace 10-inch FRP distribution piping from 0.500 MGD to San Jose Village (10,720 linear feet) with new PVC, sized to accommodate increased demand.
    - Replace GI pipe to seaport with new PVC sized to accommodate proposed military seaport demand.
    - Perform leak detection and repair throughout Tinian, focus first on FRP distribution piping in San Jose Village.

V. Follow-up Actions

The DPRI provided follow-up actions to the JV following the meetings in the CNMI in order to continue to address the EPA's comments related to potable water and groundwater on Tinian. The following is a summary of those actions which will enable DPRI to have discussions with DoD leadership in Washington D.C. to discuss the potable water/groundwater alternatives/options for Tinian and the studies necessary to make these evaluations. In addition, the JV will provide DPRI with rough order of magnitude costs for the non-programmed CUC System improvements. The intent is to meet with DoD leadership in March followed by a meeting with the EPA later (the same week) in order advise them of the way forward for related to potable water/groundwater issues on Tinian.

1. **Water Demands Memo.** JV to update and finalize the Water Demands Memo to reflect refinements to the projected agricultural water demands, Tinian Ocean View Resort, updates to the CJMT as it relates to potential changes resulting from the "Day-in-the-Life" (i.e., relocation of washracks, any increases in firefighting demands), Divert (based on new information from Mark Petersen), induced growth from DoD and proposed resort development, and existing CUC metering data (i.e., does the existing metering water demand match the Tinian population plus the Tinian Dynasty tourist demands?).
2. **Unaccounted For Water.** JV to provide an outline for assessing UFW including traditional methods of how this could be achieved (e.g., water flow measurements on fire hydrants or other locations) and adaptive methods (e.g., study of the water meters). Provide pros and cons of each including the fact that the CUC has some repair and replacement projects that would change the UFW results in the future.
3. **Aquifer Model.** JV to provide an outline of the objectives of the groundwater modelling, inputs, and outputs, costs, and how this would address the EPA's recommendations.
4. **Potable Water/Groundwater Alternatives/Options to Evaluate.** The JV to provide a write up on the possible potable water/groundwater alternatives or options for possible evaluation.

- **All CUC System.** Based on the updated water demands and the 1.0 MGD water production capacity from Maui Well No. 2, is an "All CUC System" a practicable potable water/groundwater alternative for meeting CJMT demands? JV to provide a discussion of the critical vulnerabilities for an All CUC System. These could include: (1) UFW correction (15% to 25% have been discussed as optimal UFW) and what it would take to get the UFW under control and maintain it (rough costs); (2) the need for redundancy for DoD potable water system; (3) requirements for firefighting (i.e., ability to replenish the water storage tank in base camp within 48 hours in the event of a fire); (4) Groundwater Under the Direct Influence (GUDI) concerns for Maui Well No. 2 (requires back-up wells in the event water quality is not compliant); and (5) memo from Schergardus on water quality requirements for military installations; etc.
- **Potential Hybrid System Options.** JV to identify potential Hybrid System options and rough costs. These could include: (1) DEIS Option which includes a DoD System to meet most demands with improvements to CUC System to meet port improvements and personnel living on the economy (i.e., construction workers and base operations personnel); (2) Connection of a DoD System to the CUC System to allow for DoD to provide potable water in the event the CUC System has a shortfall in meeting their demands; (3) DoD System water trucked down to the port to meet port improvement demands and some improvements or pay assessment fees for personnel living on the economy.
- **All DoD System.** Preliminarily, an "All DoD System" does not appear to be a viable solution as at least some of the CJMT demands – personnel living on the economy – would need to be met by the CUC System.

- **Deadlines.** The JV was tasked to provide items 2 and 4 (UFW and Potable Water/Groundwater Options) in time for meetings with DoD leadership in early March and items 1 and 3 (Water Demands Memo and Aquifer Model) in time for the EPA meeting (mid March).

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ATTACHMENT B
ADDITIONAL UNIFIED FACILITIES CRITERIA DISTRIBUTION SYSTEM REQUIREMENTS

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ADDITIONAL UNIFIED FACILITIES CRITERIA DISTRIBUTION SYSTEM REQUIREMENTS

Unified Facilities Criteria 3-230-01, *Water Storage and Distribution* (Department of Defense [DoD] 2021b):

- Design criteria should be in accordance with the following precedence:
  - State waterworks regulations
  - Utility provider's requirements
  - *Recommended Standards for Water Works*, latest edition
  - Conservation alternatives to meet current DoD conservation policies
- Minimum storage volume required is the sum of 50 percent of the average daily domestic requirements, plus any industrial demand that cannot be reduced during the fire period and the required fire demand.
- Distribution mains should be sized based on maximum hourly demand or the maximum daily demand plus the fire flow requirement, whichever is greater.
- A pipe network should be provided where flow to a single course is available from two or more directions.
- Demand projections should be based on anticipated demand not less than 5 years in the future.
- The Best Practice Documents American Water Works Association Manual M32, *Distribution Network Analysis for Water Utilities*, and Manual M31, *Distribution System Requirements for Fire Protection*, can be consulted for additional guidance.
- Velocities should range from 2–5 feet (8 meters) per second at maximum daily demand and the largest fire flow requirement.
- Minimum ground-level residual pressures at fire hydrants must be at least 40 pounds per square inch during normal flow conditions, 30 pounds per square inch during hourly maximum demand, and 20 pounds per square inch while supplying fire flow and hose-stream demand.
- Areas of excessively high or low pressures require that the system be divided into multiple pressure levels.
- Minimum pipe cover must be 2.5 feet (0.8 meter).
- When distribution is pumped from storage, transmission mains must have capacities equal to maximum day demand plus industrial demand and fire flow requirements.
- Without storage, transmission mains must meet maximum hourly demand.
- Shutoff valve spacing should not exceed 5,000 feet (1,524 meters) on long lines and 15,000 feet (5,572 meters) on loops.
- Velocities should not exceed 5 feet (1.5 meter) per second in transmission mains.

Unified Facilities Criteria 3-230-03, *Water Treatment* (DoD 2020):

- Domestic uses include drinking water, household uses, and household lawn irrigation.
  - Industrial flows include cooling, issues to ships, irrigation, swimming pools, shops, laundries, dining, processing, flushing, air conditioning, vehicle wash racks, rinse racks, and boiler makeup.

Unified Facilities Criteria 3-600-01, *Fire Protection Engineering for Facilities* (DoD 2021a):

- Additional distribution system requirements:
  - Must be sized to accommodate fire flows plus domestic and industrial for flushing demands that cannot be restricted during fires.
  - Must be looped to provide at least 50 percent of the required fire flow in case of a single break.
  - Must be able to support 150 percent of the building fire pump–rated capacity with a minimum pressure of 20 pounds per square inch at the suction side of the pump.
- Hydrant installation requirements:
  - Must be installed adjacent to paved areas, accessible to fire department apparatus.
  - Must not be closer than 3 feet (1 meter) or farther than 7 feet (2 meters) from the roadway, shoulder, or curb line.
  - Must be installed with a minimum 6-inch connection to the supply main and valves at the connection.
  - Must be in accordance with National Fire Protection Association 24, except as modified by the Unified Facilities Criteria.
- Hydrant spacing requirements:
  - All parts of the building must be within 350 feet (107 meters) of a hydrant.
  - At least one hydrant must be located within 150 feet (46 meters) of the fire department connection.
  - Hydrants protecting warehouses must be spaced a maximum of 300 feet (91 meters) apart.
  - Hydrants protecting aircraft hangars must be spaced a maximum of 300 feet (91 meters) apart with at least one hydrant at each corner of the hangar.
  - Hydrants protecting petroleum, oil, and lubricants storage and distribution facilities must be spaced a maximum of 300 feet (91 meters) apart, with a minimum of two hydrants.
  - Hydrants protecting exterior storage must be spaced at 300-foot (91-meter) maximum intervals around the perimeter.
  - Hydrant spacing must not exceed 600 feet (183 meters) for family housing developments without sprinkler protection and must not exceed 1,000 feet (305 meters) for family housing developments with sprinkler protection.

GROUNDWATER MODELING TECHNICAL MEMORANDUM

IN SUPPORT OF THE

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS JOINT MILITARY TRAINING ENVIRONMENTAL IMPACT STATEMENT

Department of the Navy
Naval Facilities Engineering Systems Command, Pacific
258 Makalapa Drive, Suite 100
JBPHH HI 96860-3134

June 2026

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1 INTRODUCTION

1.1 BACKGROUND

The islands of the Commonwealth of the Northern Mariana Islands (CNMI) are strategically located in the United States (U.S.) Department of Defense (DoD) Indo-Pacific area of operations, as shown in Figure 1. Figure 2 shows the Military Lease Area on Tinian where the U.S. military has trained for several decades.

The Proposed Action would support the ongoing and evolving training requirements of U.S. Armed Forces forward deployed to the Western Pacific, and U.S. allies and partners, specifically for distributed operations training within the Military Lease Area on Tinian. Proposed training events would include both ground and aviation training within the Military Lease Area.

Non-live-fire offensive and defensive training actions would continue to be conducted in the Military Lease Area with an increase in existing land-based training events, including both ground and aviation training, which are the same or similar to those currently being conducted on Tinian.

Live-fire training would be conducted at two ranges that would be developed within the Exclusive Military Use Area:

- **Multi-Purpose Maneuver Range.** A live-fire range occupying approximately 200 acres at the northern tip of Tinian to support platoon-size live-fire and maneuver, including three surface radar facilities.
- **Explosives Training Range.** A live-fire range on approximately 2.5 acres for the employment of demolitions and military explosives in support of offensive and defensive training events.

The following are also included in the Proposed Action to support training events:

- Establishment of 13 Landing Zones, areas cleared of vegetation to 6–8 inches, and associated access roads to conduct training events and to provide staging, bivouac, and gathering and rendezvous areas.
- Ground and aviation improvements at North Field, including establishment of a drop zone and the placement of a metal airfield surface.
- Construction and operation of a Base Camp.
- Clearance and improvements of roads within the Military Lease Area.

1.2 PURPOSE

The purpose of this study is to evaluate the potential impact to the groundwater resources on Tinian associated with groundwater extraction to support the proposed CNMI Joint Military Training (CJMT).This study considered groundwater demand, including current and projected demands for all uses (related to the Proposed Action, other DoD, and non-DoD water demands) to evaluate impacts from the Proposed Action. This study supported the determination of impacts associated with the Proposed Action. The Groundwater Modeling Technical Memorandum did not evaluate whether Maui Well No. 2 would be more vulnerable to stresses on the aquifer.

1.3 SCOPE OF STUDY

The goal of this study was to evaluate potential impacts to water quality on Tinian associated with the Proposed Action. The Proposed Action includes the installation of two optional CJMT well fields to provide potable and non-potable water for construction and operation of the proposed Base Camp and CJMT.

The scope of this study is presented below:

- Develop a new groundwater flow model based on the U.S. Geological Survey 2002 model.
- Use available data from Doan et al. 1960, Gingerich and Yeatts (U.S. Geological Survey) 2000, and Gingerich (U.S. Geological Survey) 2002.
- Use data from the CJMT *Aquifer Study Technical Memorandum* (Department of the Navy [DON] 2015).
- Use available head and production data for Maui Well No. 2 provided by the Commonwealth Utilities Corporation.
- Develop model scenarios based on water demands over the course of a typical training year.
- Use the model input sources, calibration, and sensitivity analysis primarily from the U.S. Geological Survey 2002 report. No additional sensitivity analysis will be performed.
- Use model output to evaluate directions of groundwater flow on island.
- Use the model to simulate chloride concentrations under five scenarios.
- Summarize model development, input sources, calibration, sensitivity, model limitations, and modeling results in a *Groundwater Modeling Technical Memorandum*. Include discussion of sea level rise's potential effects on the availability of freshwater via existing and proposed water wells that may assist planners in strategizing future contingency actions.

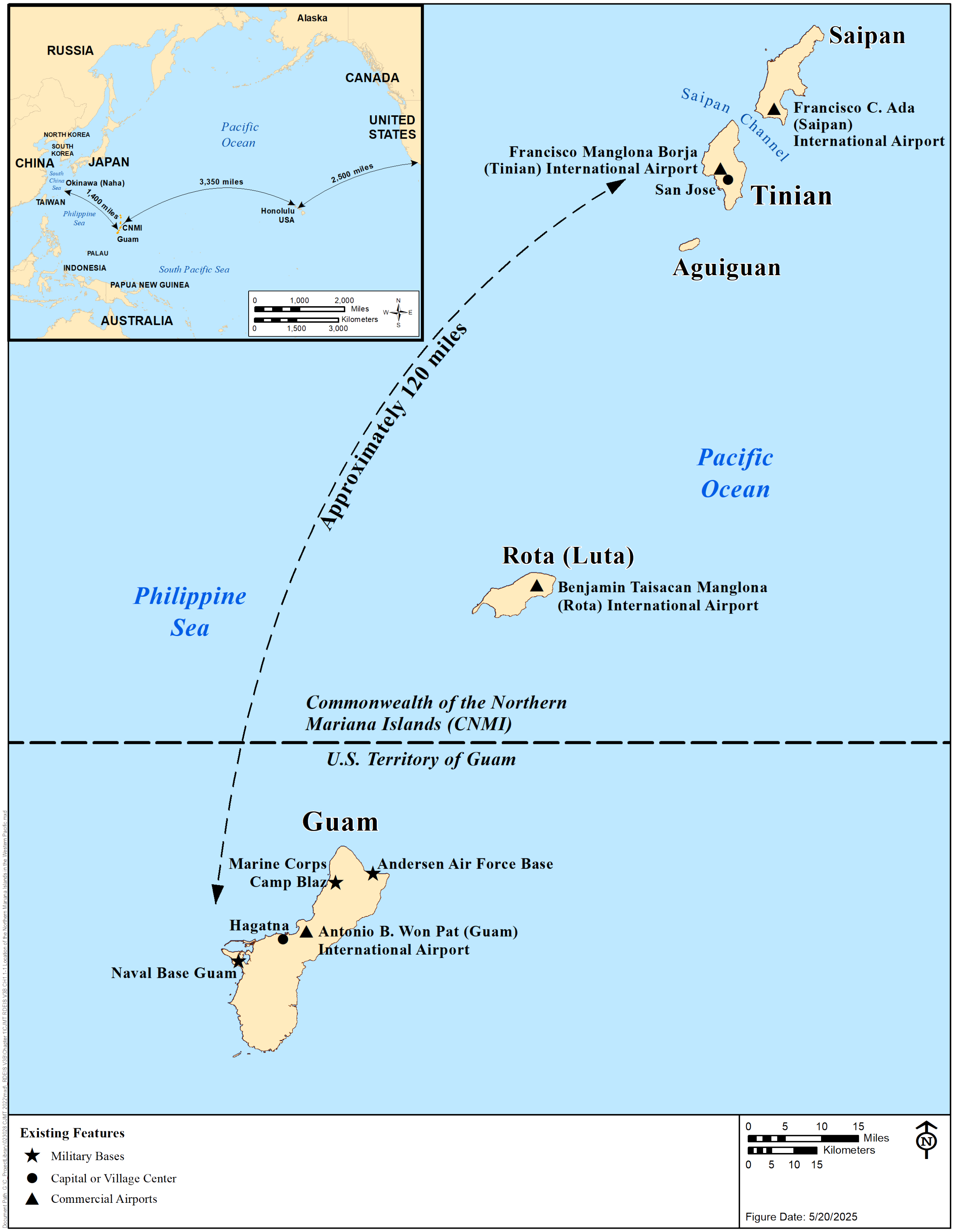

Figure 1 Island of Tinian – Location

Figure 2 Island of Tinian – Military Lease Area Boundaries

2 EXISTING AND PROPOSED WATER SYSTEMS

2.1 EXISTING WELLS

Currently, one potable water well and two groundwater wells are in use on Tinian. The agricultural wells are owned by the CNMI and are provided with electrical power by the Tinian Mayor's Office for the benefit of the cattle ranchers, who can fill potable containers used to provide water to cattle and construction contractors.

2.1.1 Current Potable Supply Wells

The sole supply of potable water on Tinian comes from the Makpo Marsh potential wetland complex's basal groundwater lens. Water is collected from the lens by Maui Well No. 2, discussed below. Tinian's public water system is owned and operated by the Commonwealth Utilities Corporation and serves the southern third of Tinian where the island's entire population resides. The currently operating public system consists of one horizontal Maui well for water supply, three storage tanks, one chlorine injection point, and approximately 38 miles of distribution pipes. A small distribution system serving Francisco Manglona Borja/Tinian International Airport is owned by the Commonwealth Ports Authority. The Commonwealth Ports Authority distribution system consists of a 60,000-gallon (227,100-liter) storage tank and a piping system that receives water from the Commonwealth Utilities Corporation's Maui well subsystem. In the past, additional wells for potable water supply were in operation, but they have since been taken offline and are not maintained in operable condition. Figure 3 shows existing wells on the island.

Maui Well No. 1, also located at the Makpo Marsh potential wetland complex, is currently out of service because the equipment is old and its repair parts have been difficult to obtain. The Maui Well No. 1 pump house was equipped with two 75-horsepower pumps and one 50-horsepower pump, and was originally designed to pump water to the Marpo Heights Tank. Previous plans to refurbish Maui Well No. 1 have been abandoned. Maui Well No. 1 is a Maui-type infiltration gallery constructed in Marpo Marsh within the Median Valley by the U.S. military in 1945. This well is the only well that was not abandoned after World War II; it supplied all of the potable water for Tinian until 1999, when two vertical wells were added to the system. Maui Well No. 1 produced about 1 million gallons per day from the shallow limestone aquifer. The well drew from the upper part of the aquifer over a large area, which tends to maximize the amount of freshwater that can be withdrawn from an area while minimizing upconing of the saltwater.

In 2000–2001, a new 400-foot-long infiltration gallery well (Maui Well No. 2) was constructed near Maui Well No. 1 to replace that well. According to the *2012 Water Quality Report* (Commonwealth Utilities Corporation 2013), Maui Well No. 2 supplied all Commonwealth Utilities Corporation water in 2012. Maui Well No. 2 has four 75-hp pumps, each capable of pumping about 350 gallons per minute for a total of 1,400 gallons per minute to both the Marpo Heights and Carolinas Tanks as well as the Commonwealth Port Authority Airport Tank. Currently, Maui Well No. 2 supplies the Commonwealth Utilities Corporation's entire Tinian water system, operating three of its four pumps almost constantly (Commonwealth Utilities Corporation 2013). Because one pump is kept on standby for maintenance purposes, Maui Well

No. 2 operates at near-full capacity. Additional information on Tinian's potable water system is provided in the *Potable Water Study* (DON 2025).

At various times, other vertical wells (e.g., TH-06 [capable of 60 gallons per minutes] and TH-04 [capable of 50 gallons per minute]) have been in use by the Commonwealth Utilities Corporation. Additional details, including ownership of the individual wells, are included in Attachment A – Known Current and Former Wells.

2.1.2 Existing Non-potable Supply Wells

Well M-21 was previously used by cattle ranchers. Currently, it is used primarily by the construction contractor for the U.S. Air Force Tinian Divert Activities and Exercises (Divert) Infrastructure Improvements at the Francisco Manglona Borja/Tinian International Airport. This well was permitted in 2024 to extract not more than 1.8 million gallons per month (DON 2025).

Well M-26 is primarily used by cattle ranchers and is not metered. Well M-26 agricultural water demand has been estimated at 59,178 gallons per day.

These wells are labeled M-21 and M-26 in Figure 3. Except for these two, no other wells within the Military Lease Area (the northern roughly two-thirds of the island) are known to be in use. During the aquifer study, M-21 and M-26 were used to produce about 25 gallons per minute each to cattle ranchers.

2.1.3 Existing Monitoring Wells

Some of the historical literature suggests that the Japanese military may have dug more than 100 wells during their occupation of Tinian. Most of these were reportedly filled in. The U.S. military constructed approximately 40 (M-series) groundwater wells in 1944 and 1945 on the island for water supply, including Maui Well No. 1. Most of these were reportedly drilled to 10 or 15 feet below mean sea level. The majority of the M-series wells have been inactive since shortly after World War II (Doan et al. 1960).

Between 1993 and 1997, the U.S. Geological Survey rehabilitated 16 of the inactive U.S. military wells. Rehabilitation involved retrieving the original pump and pipe, re-drilling as necessary, cleaning out the hole to near the original depth, and installing new surface casing/well head features, if necessary. In addition, between 1993 and 1997, U.S. Geological Survey drilled 17 new (TH-series) wells for groundwater monitoring in the Median Valley and the adjacent Southeast Ridge and Central Plateau. Of the 17 wells, 12 are open holes and 5 are cased with polyvinyl chloride pipe and screened below the water table. All wells were drilled into the top of the freshwater lens except wells TH-02, TH-04X, TH-08, and TH-09, which were drilled into the transition zone. The freshwater lens thickness and underlying transition zone fluctuate as a result of seasonal rainfall and groundwater withdrawal (U.S. Geological Survey 2000). At least one of the M-series wells (M-29) was deepened through the transition zone (to a depth of 168 feet below mean sea level) and used as a transition zone monitoring well for a period of time. However, no records of this transition zone monitoring have been located despite searches by U.S. Geological Survey staff.

Figure 3 Tinian Existing Wells

In 2012, a hydrogeologic assessment of groundwater conditions was completed at the planned Tinian landfill site and surrounding area (Tetra Tech 2012). The Tinian landfill site was a proposed municipal solid waste landfill northwest of the airport. The scope of work for the assessment included installation of three monitoring wells: WOP-197-01, WOP-197-02, and WOP-197-03. Although the basis for the well nomenclature used by the Bureau of Environmental and Coastal Quality is unknown, it is understood that these three refer to monitoring wells at the proposed landfill.

2.1.4 CJMT Proposed Action Water Wells

Potable and non-potable water for the Proposed Action are expected to come from four new wells located in Well Field A or B located northeast or northwest of the Tinian International Airport, respectively (Figure 4). Groundwater elevations in the area are generally less than 1 to about 2 feet above msl in the notional DoD well field.

Other On-island Wells

Following construction for U.S. Air Force's Tinian Divert Infrastructure Improvements at the Francisco Manglona Borja/Tinian International Airport, U.S. Air Force would use a newly installed firefighting well. The average demand for this well is estimated at 2,192 gpd.

U.S. Air Force plans to rehabilitate an existing well (assumed to be existing well M-05) for construction at North Field. The average demand for this well is estimated at 12,000 gallons per day.

Figure 4 Tinian Future Wells

3 WATER DEMANDS FOR PROPOSED ACTION

The Proposed Action includes construction of new water infrastructure to fully support the U.S. Marine Corps' (USMC) proposed CJMT and to avoid impacts on the Commonwealth Utilities Corporation water system. This proposed new water infrastructure would supply the domestic, industrial, and fire protection demands of military training activities and the majority of water used during construction. This proposed new water infrastructure would be operated by the DoD and would not be connected to the Commonwealth Utilities Corporation water system.

Domestic demand on the Commonwealth Utilities Corporation water system would also increase because of the Proposed Action. Operations staff and construction workers would live outside the Military Lease Area or stay in hotels and become customers of the Commonwealth Utilities Corporation water system.

These future demands are summarized in Table 1.

Table 1. Summary of Average Future Annual Water Demands on Tinian

Owner	*Facility*	*Type*	*Average Annual Water Demand (gallons per year)*	*No. Wells*
Military	CJMT Base Camp [a]	Potable	7,971,440	4
Military	CJMT North Field	Non-Potable	800,000	2
Military	USAF North Field Rehabilitation	Non-Potable	4,380,000	1
Military	Tinian Divert Infrastructure Improvements	Potable	800,000	1
CUC	Maui Well No. 2 [b]	Potable	314,727,702	1
Tinian Mayor's Office	Well M-21 (CJMT Construction)	Non-Potable	21,600,000	1
Tinian Mayor's Office	Well M-26 (Existing Agriculture)	Non-Potable	21,600,000	1

Notes: [a]Total demand for all the wells.
[b]Average of production at Maui Well No. 2 from 2019 to 2023 and proposed CJMT demands on the CUC water system.
Legend: CJMT = Commonwealth of the Northern Mariana Islands Joint Military Training; CUC = Commonwealth Utilities Corporation; gpd = gallon per day; U.S. = United States; USAF = United States Air Force.
Source: *Potable Water Study Update* (DON 2025).

4 GROUNDWATER AND GEOLOGY

4.1 GROUNDWATER SUPPLY

Rainfall is the primary source of fresh groundwater on Tinian. The U.S. Geological Survey estimates the average annual groundwater recharge for Tinian to be approximately 30 inches per year (U.S. Geological Survey 2002). This translates into approximately 62,000 acre-feet per year of recharge. The rapid downward percolation of rainwater into porous limestone rock (Doan et al. 1960) recharges Tinian's basal freshwater aquifer. Fresh groundwater on Tinian is primarily classified as basal, which is a body of fresh groundwater that floats on saline groundwater. The portion of the basal freshwater lens that is usable for potable water, which has chloride concentrations less than 250 milligrams per liter, is thickest south and southwest of Mount Lasso and becomes increasingly thinner approaching the coastline. The groundwater table on Tinian ranges from sea level around the perimeter of the island to over 3 feet above msl in the central portions of the island. Groundwater flows outward from the North Central Highland and the southeastern ridge, and generally seaward around the island (DON 2015). Most of the fresh groundwater slowly discharges naturally from springs around the perimeter of the island and submarine coastal springs. The basal freshwater lens underlying Tinian is the principal source of drinking water and meets the definition of an aquifer found in CNMI Title 65, Chapter 65-90-010, and U.S. Environmental Protection Agency (EPA) regulations.

4.1.1 Physical Environment of Tinian

Physical features relevant to the groundwater modeling include topography, climate, geology, hydrogeology, and the existing well network and water supply systems. These features are detailed in the *Aquifer Study Technical Memorandum* (DON 2015).

4.1.2 Topography

Tinian is about 12 miles long and 6 miles wide. It is separated from Saipan by the approximately 3-mile-wide Tinian Channel. Tinian comprises a series of limestone plateaus separated by steep slopes and cliffs (U.S. Department of Agriculture Soil Conservation Service 1989). The surface landforms (Figure 5) are divided into five major physiographic areas based on topography and spatial relations, as described below (U.S. Geological Survey 1999). These are depicted along with representative spot elevation in Figure 5:

- **Southeastern Ridge.** This land area is the southernmost and highest part of the island, with a maximum elevation of 614 feet at Mount Kastiyu. Steep slopes and cliffs up to 500 feet in height on the southeast characterize this area.
- **Median or Marpo or Makpo Valley.** This land area is a low, broad, elongated depression northwest of the Southeastern Ridge with a maximum elevation of 150 feet. In the valley, the land surface intersects the water table, resulting in a small potential wetland complex known as the Makpo Wetland or Makpo Marsh.
- **Central Plateau.** This land area extends northward from the Makpo Valley and includes central Tinian and portions of northern Tinian. The plateau is broad and gently sloping, with most of the vertical relief at its southern and northern boundaries.

- **North-Central Highland.** This land area is located within the northern part of the Central Plateau and midway between the east and west coasts of the island. The maximum elevation of the highland at Mount Lasso is 545 feet.
- **North Lowland.** This land area is located at the northern tip of Tinian. It is generally flat with an average elevation of approximately 100 feet, except for the Lake Hagoi wetland, where the land elevation is approximately at sea level.

4.1.3 Climate

The seasons on Tinian are defined by distinct differences in rainfall. During the wet season, which occurs between the months of July and October, the island receives roughly 60 percent of its annual precipitation. February through May comprise the dry season, when only about 10 percent of Tinian's annual rainfall occurs. The remaining months (November, December, January, and June) are the transitional months when the island receives the remaining 30 percent of its rainfall. Rainfall from tropical storms and typhoons, in years when they occur, can comprise a significant percentage of the total annual rainfall, and a lack of storms can significantly contribute to drought conditions. Typical temperatures range from 76 degrees Fahrenheit to 88 degrees Fahrenheit (U.S. Geological Survey 2002).

Precipitation averaged about 81 inches per year at the airport weather station from 1988 to 1994 and in 1996, years for which complete daily rainfall records were available. Because the highest point on Tinian is only 614 feet above mean sea level, orographic effects (increased rainfall related to mountain ranges) appear to be minimal. Gingerich and Yeatts measured rainfall at four sites on Tinian from 1993 to 1996, and the measured amounts ranged from 72 to 82 inches across the island (U.S. Geological Survey 2000). Gingerich used an average rainfall of 82 inches per year in the water budget for the numerical groundwater flow model (U.S. Geological Survey 2002).

Figure 5 Tinian Physiographic Areas

4.1.4 Geology

Tinian is a composite carbonate island (Jenson et al. 2006) consisting of geologically young coralline and algal limestone strata overlying an older core of volcanic tuff and breccias, small portions of which crop out at the surface in two small places on the island (Figure 6). The limestone retains substantial primary porosity but also exhibits regional- to local-scale fractures (secondary porosity) associated with regional tectonic stresses and local loading/unloading from uplift-subsidence and deposition-erosion cycles. Regional high-angle normal faults result in offset limestone plateaus that characterize the island (Figure 6). Figure 7 shows geologic cross sections of Tinian.

Tinian comprises the following four major geologic units, shown in Figure 6 (U.S. Geological Survey 2002):

- **Tinian Pyroclastic Rocks.** Tinian Pyroclastic rocks are the oldest rocks exposed on the island (Late Eocene age; about 38 million years old), which likely underlie all other exposed rock units there. These fine- to coarse-grained ash and angular fragments represent explosive volcanic materials ejected from an ancient volcano that formed the core of the island. These rocks are exposed on the North-Central Highland and Southeastern Ridge where they occupy about 2 percent of the surface of Tinian today. Surface exposures are generally highly weathered and typically altered to clay minerals.
- **Tagpochau Limestone.** Of Early Miocene age (approximately 23–20 million years old), Tagpochau Limestone rocks are exposed on about 15 percent of Tinian's surface, generally in the North-Central Highland and the southern part of the Southeastern Ridge. These rocks range up to about 600 feet in thickness. They are composed of fine- to coarse-grained, partially recrystallized broken limestone fragments, and about 5 percent reworked volcanic fragments and clays. Surface exposures are highly weathered, and this unit extends from the unconformity with the volcanic rocks below to the ground surface in the North-Central Highland and the southern part of the Southeastern Ridge, mentioned above. Across most of the island, this unit is capped by the Mariana Limestone.
- **Mariana Limestone.** These Pliocene to Pleistocene age (about 5–3 million years old), Mariana Limestone rocks cover approximately 80 percent of Tinian's surface, forming nearly all of the North Lowland, the Central Plateau, and the Makpo Valley. These rocks range up to about 450 feet in thickness. They are composed of fine- to coarse-grained fragmented limestone, with some fossil and algal remains, and small amounts of clay particles. Small voids and caverns (tertiary porosity) are common in surface exposures. Overall, the Mariana Limestone has a higher coral content than the Tagpochau Limestone.
- **Beach Deposits, Alluvium, and Colluvium.** Shallow Pleistocene to Holocene age (approximately 2 million years old to the present) sediments mantle less than 1 percent of Tinian's surface and range up to approximately 15 feet thick. The deposits consist of poorly consolidated sediments, which are mostly calcareous sand and gravel deposited by waves. However, they also contain clays and silts deposited inland surrounding Lake Hagoi and the Makpo Marsh potential wetland complex. Loose soil and rock material (talus) are found at the base of slopes.

Figure 6 Tinian Generalized Surficial Geology

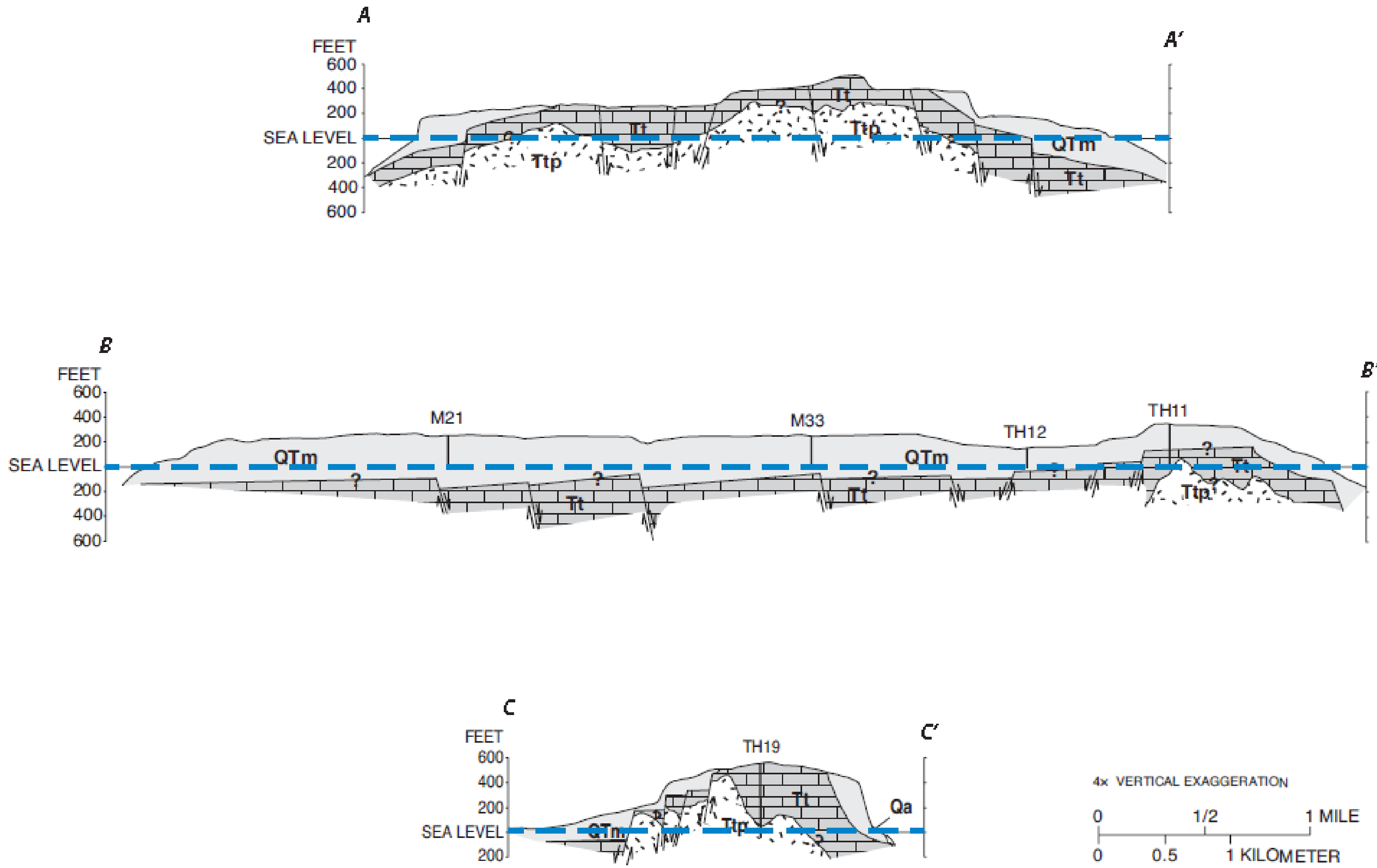

Figure 7 Tinian Geologic Cross Sections

Source: U.S. Geological Survey 2000 (after Doan et al. 1960).

4.2 GROUNDWATER RESOURCES OF TINIAN

4.2.1 Overview

Groundwater is recharged by rainfall infiltration over most of Tinian. Water that recharges the groundwater system flows from zones of higher to lower hydraulic head. Ideally, fresh groundwater (chloride less than 250 milligrams per liter) forms a double-convex lens in a cross section and is underlain by denser saltwater (chloride concentration of 19,000 to 20,000 milligrams per liter); however, the base is distorted where it contacts the relatively impermeable volcanic basement rock. The Ghyben-Herzberg relationship (Baydon-Ghyben 1888–1889, Herzberg 1901) is commonly used to relate the thickness of a freshwater lens in an ocean-island aquifer to the density difference between freshwater and saltwater. A generalized cross section of the freshwater lens is presented in Figure 8. Doan et al. (1960) reports the existence of such a basal freshwater lens in areas near the north end and center portion of the island. The theoretical interface between freshwater and saltwater will be at a depth below sea level about 40 times the height of the water table above sea level. Instead of a sharp freshwater/saltwater interface, however, freshwater is separated from saltwater by a transition zone in which salinity grades from freshwater to saltwater. In many field studies, the theoretical Ghyben-Herzberg interface depth within the transition zone is generally defined as the depth of about a 50 percent mix of freshwater and saltwater (i.e., roughly equal to a chloride concentration of 9,500 to 10,000 milligrams per liter). Under equilibrium flow conditions in permeable aquifer systems, the Ghyben-Herzberg relationship may provide a reasonable estimate of freshwater depth if the transition zone is comparatively thin (U.S. Geological Survey 2002). Pumping freshwater tends to disturb this equilibrium, resulting in a thinner freshwater lens and thicker transition zone. Freshwater lens thickness is affected by aquifer permeability and recharge rates. A reduction in recharge rate or an increase in permeability will reduce the thickness of the freshwater lens.

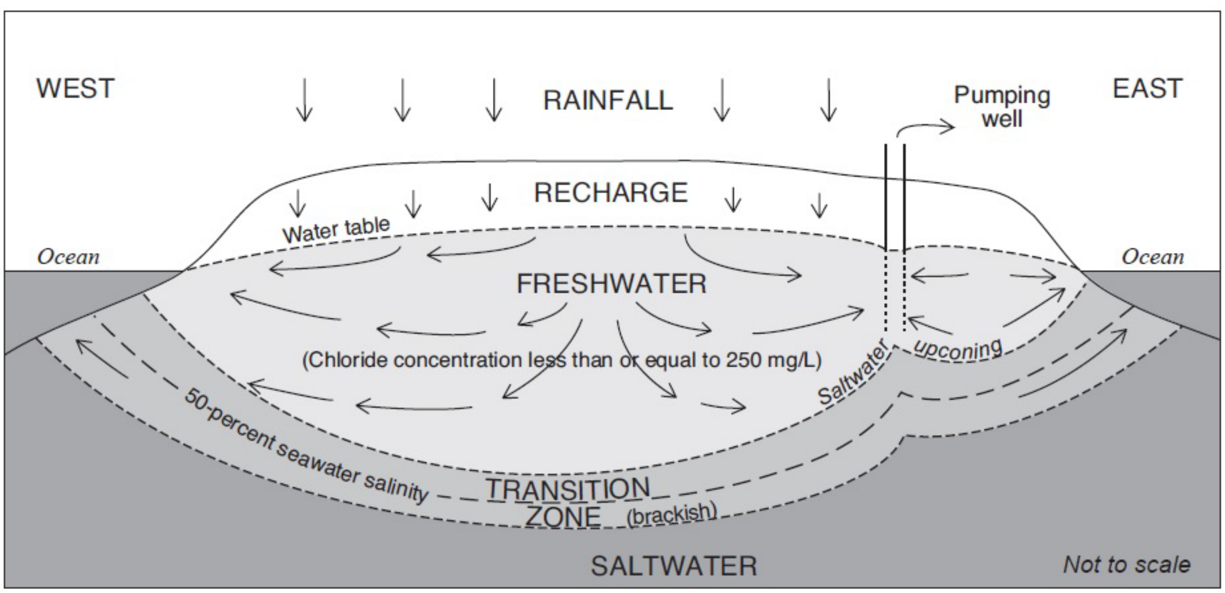

Figure 8 Generalized Depiction of a Freshwater Lens above Saltwater

Source: U.S. Geological Survey 2000.

In very permeable limestone, the water table is no more than a few feet above sea level, and the slope of the water table is nearly flat (U.S. Geological Survey 2002). Based on the Ghyben-Herzberg Principle, the depth to the 50% isochlor on Tinian should vary from a maximum of about 80 feet below mean sea level around the Central Plateau where the groundwater stands about 2 feet above mean sea level, decreasing radially to sea level around the perimeter of the island.

Potable and non-potable water for the proposed action is expected to come from one of two new well fields (Well Fields A and B, shown in Figure 4).

The groundwater surface has been mapped (Doan et al. 1960; USGS 2000) in the notional DoD well field to range from about 0.8 to 1.6 feet above mean sea level. Assuming an ideal freshwater lens, the 50 percent isochlor would vary from about 32 to 64 feet below mean sea level in the center of the island and would thin toward the coast. The portion of the lens that is useful for potable water (i.e., with a chloride concentration of less than 250 milligrams per liter [approximately 1 percent isochlor]) is likely thinner than the theoretical 50 percent isochlor depth.

Most of the fresh groundwater discharges naturally from the aquifer at onshore and submarine coastal springs. Stafford et al. (2004, 2005) documented caves, fractures, and coastal springs on Tinian, which can be locally important for groundwater development. A small amount of groundwater may be lost locally to evaporation and transpiration at the Makpo Marsh potential wetland complex and Hagoi Lake (U.S. Geological Survey 2002).

4.2.2 Hydrogeology

Hydraulic conductivity is a quantitative measure of the capacity of a rock to transmit water. Limestone units tend to have high hydraulic conductivities because of the porous and well-washed character of coral reefs, as well as secondary porosity as a result of dissolution. In contrast, pyroclastic rocks tend to have much lower hydraulic conductivities as a result of poor sorting and the high susceptibility of some volcanic minerals to chemical weathering and alteration to clays (U.S. Geological Survey 2002), as is the case on Tinian.

Tinian, a composite karst island aquifer (Jenson et al. 2006), is a triple-porosity aquifer. The young limestone retains substantial primary (interparticle or matrix) porosity, which makes the dominant contribution to storage and usually local transmission to wells. Regional transmissivity is dominated by widened fractures, which may develop along faults or along tension fractures. Where wells intercept the fracture network, performance can be one or more orders of magnitude higher than for wells that draw their production exclusively from local matrix porosity. The third source of porosity in composite islands is conduits (cave systems) that can develop along the contact between the overlying soluble limestone aquifer and the underlying insoluble volcanic basement. Such conduits can develop along the flanks of the basement rises and ridges where they stand above sea level or have been above sea level during ice-age, sea-level low-stands (Vann et al. 2013). Hydraulic conductivities in carbonate island karst aquifers can range from local values of 1 to 10^3 feet per day to regional values of 10^3 to 10^4 feet per day (Rotzoll et al. 2013).

The Tinian pyroclastic rocks are generally believed to have much lower permeability than limestone because of their texture and density and are essentially considered non–water-bearing for the purposes of this study. The overlying Tagpochau Limestone, where it exists beneath current ocean levels, and the Mariana Limestone that overlies it are both considered viable aquifers in this study. The minor beach deposits, alluvium, and colluvium are not situated in areas or at elevations that make them viable as groundwater resources for the purposes of this study. Doan et al. (1960) reported historical well productions from the military wells ranging from nil to 100 gallons per minute, with the majority being in the 60 to 100 gallons per minute range. The U.S. Geological Survey performed aquifer tests on Tinian between 1994 and 2000 to estimate the hydraulic conductivity of the Tinian aquifers (Tagpochau Limestone and Mariana Limestone). Pumping rates for the tests ranged from 3 to 165 gallons per minute. Resulting estimates of hydraulic conductivity in Tagpochau Limestone and Mariana Limestone on Tinian ranged from 21 to 23,000 feet per day.

The U.S. Geological Survey prepared a groundwater model in *Geohydrology and Numerical Simulation of Alternative Pumping Distributions and the Effects of Drought on the Ground-Water Flow System of Tinian, Commonwealth of the Northern Mariana Islands* (U.S. Geological Survey 2002). For modeling purposes, Tinian was divided into three horizontal hydraulic conductivity zones: (1) highly permeable limestone, (2) less permeable, clay-rich limestone, and (3) lowpermeability- volcanic rocks. The two-dimensional, steady-state groundwater flow model was developed to enhance the understanding of: (1) the distribution of aquifer hydraulic properties, (2) the conceptual framework of the groundwater flow system, and (3) the potential effects of various pumping distributions and drought on water levels and the freshwater/saltwater zones. For the modeling, the U.S. Geological Survey used values of 10,500 feet per day for highly permeable limestone, 800 feet per day for less permeable limestone, and 0.2 feet per day for volcanic rock (U.S. Geological Survey 2002). This 4 to 5 order-of-magnitude contrast is not unusual in composite islands. The U.S. Geological Survey monitored and contoured ambient groundwater elevations for further understanding of the groundwater flow regime (U.S. Geological Survey 2000). Groundwater generally flows radially away from the North Central- Highland and the Southeastern Ridge.

4.3 WATER QUALITY

Chloride concentration is an important secondary standard for Maui Well No. 2 because it has the potential to indicate the quantity of freshwater available at that location. The secondary maximum contaminant level for chloride is 250 milligrams per liter. Table 2 provides chloride concentrations at Maui Well No. 2 between 2012 and 2023.

Table 2. Chloride Concentrations at Maui Well No. 2

Year	Chloride (mg/L)	
	Average	Range
2012	196	175–223
2013	190	172–217
2014	213	212–214
2015	213	212–214
2016	190	184–196
2017	184	184
2018	176	176
2019	146	NA
2020	145 [a]	NA
2021	176 [a]	158–176
2022	176 [a]	158–176
2023	177	NA

Notes: [a]Value revised to highest instead of average.
Legend: mg/L = milligrams per liter; NA = not available; No. = Number.
Source: Commonwealth Utilities Corporation 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024.

U.S. Geological Survey 2002 reported that chloride concentration at the Municipal well [Maui Well No. 1] did not change significantly during 1992–1997, averaging about 180 milligrams per liter, and ranging from 160 to 220 milligrams per liter. The average chloride concentration is about 100 milligrams per liter higher than initially measured during non-pumping conditions after construction in 1945 (Lawlor 1946), and 100 milligrams per liter higher than at other wells in the median valley.

Salinity in a freshwater lens is gradational, consisting of an upper freshwater core through an underlying transition zone to saltwater below. However, depending on aquifer permeability and the strength of tidal influence, the transition from freshwater to saltwater can be gradual or sharp. On small islands, mixing in the transition zone results mainly from tidal fluctuations superimposed on the gravity-driven flow of freshwater toward the shore. In areas near the coast where mixing is thorough, a freshwater lens may not form and brackish water may exist even at the water table. Under conditions of steady recharge, no pumping, and no ocean-level effects, the steady-state lens would have fixed dimensions. In reality, rainfall is episodic and seasonal, and lens volume fluctuates naturally with time. Tidal fluctuations, variable recharge, and episodic pumping all combine to create a thicker transition zone than would be present without these influences (U.S. Geological Survey 2002). Figure 8 shows a generalized graphic depiction of a freshwater lens above a saltwater wedge on a small island.

Based on monitoring performed by the U.S. Geological Survey in the 1990s, the transition zones in wells TH-08 and TH-09 (monitoring wells installed by the U.S. Geological Survey in 1993) varied from approximately 30 to 50 feet thick in 1993 and 1994. Doan et al. (1960) report 20 pre-pumping chloride concentration results ranging from 16 milligrams per liter to 650 milligrams per liter. Two of the samples exceeded the EPA's secondary maximum concentration level for chloride of 250 milligrams per liter. Ten pairs of pre-pumping and post-pumping chloride concentration results are also reported (U.S. Geological Survey 2000). Prior to pumping, 1 of the 20 wells (with pre- and post-pumping data) exceeded the secondary maximum concentration level and, after pumping, 2 to 3 wells exceeded that standard. One of the post-pumping results was simply recorded as "high," but it is assumed this refers to a concentration higher than 250 milligrams per liter. Seven to 8 of 10 wells remained below the secondary maximum concentration level at the end of pumping. The U.S. Air Force commissioned testing of two wells in the North Field area in November 2025. Based on that testing, chloride concentrations at the Ushi and M-10 wells were reported to range between 2,254 to 2,499 mg/L, and 2,058 and 2,499 mg/L, respectively during 36-hour constant rate testing (APEC 2025). Note that these values are an order magnitude higher than the value of 220 mg/L reported by Doan et al 1960 for the Ushi Well measured at the end of pumping (date of measurement is unknown). No values were reported at M-10 or at the beginning of pumping at the Ushi Well. It is possible that the values obtained in November 2025 were influenced by drier-than-normal conditions reported at that time. According to drought.gov "In the Commonwealth of the Northern Mariana Islands (CNMI), southern FSM (Kapingamarangi), and western RMI (Kwajalein), drier-than-normal conditions prevailed during SON" [September to November 2025] (NOAA, 2025). The site describes La Niña conditions with below-normal sea surface temperatures across the central and eastern equatorial Pacific Ocean during that period of time.

Bureau of Environmental and Coastal Quality provided the following information in Captain Brian Bearden's email to Jacqueline Rice from Headquarters, USMC, forwarded to Doug Gilkey on March 3, 2025:

> [Bureau of Environmental and Coastal Quality]'s previous review comments raised a number of concerns with the proposed location near the airport, primarily related to the potential to contaminate valuable groundwater resources. That location was within an area where we have documentation and other data that would support classification as a Class I Aquifer Recharge Area/Groundwater Protection Zone as established or references [sic] in several CNMI regulations. Our primary documentation supporting this concern is the 2000 USGS Water investigations Report 00-4068 which shows the area on the north side of the airport as being within the boundaries of the +1.0 feet groundwater elevation contour, which the CNMI Well Drilling and Well operations regulations (NMIAC [Northern Mariana Islands Administrative Code] § [Section] 65-140-2010) utilize as the boundary of the Class II groundwater protection zones, which also contains the Class I zones which are more loosely defined to include "municipal wellfields" and other resources that are either currently in use for water supply, or meet specific other criteria.
>
> In contrast to this, the IBB [International Broadcasting Bureau] site is in an area that appears to not be within either a Class I or II Aquifer Recharge Area/Groundwater Protection Zone. Even though the USGS report does not show groundwater elevation contours in this particular area due to lack of data, the map contours can be reasonably extrapolated, supported by general knowledge of island freshwater lens hydrology, to strongly suggest that the IBB site is located outside the potential boundaries of any future Class I or II groundwater protection zone designation. Thus, the IBB site would not trigger the same level of concern stated in [the Bureau of Environmental and Coastal Quality]'s previous comments related

to the locations closer to the airport and would be a preferred location to minimize such concerns.

Table 3 summarizes water production (i.e., extraction) quantities from Maui Well No. 2 as recorded by the Commonwealth Utilities Corporation at the well site. Production includes water delivered into the distribution system, which is inclusive of water billed to customers, unmetered uses, leaks, losses, and overflows.

Table 3. Commonwealth Utilities Corporation Water Production from Maui Well No. 2

Year	***Total Annual (MG)***	***Average Daily (MGD)***
2019	313	0.86
2020	312	0.85
2021	307	0.84
2022	321	0.88
2023	306	0.84
2019 to 2023 Average	NA	0.85

Legend: CUC = Commonwealth Utilities Corporation; MG = million gallons; MGD = million gallons per day; NA = not applicable; No. = number.
Source: Commonwealth Utilities Corporation 2024a.

5 MODELING

5.1 MODELING APPROACH

The U.S. Geological Survey developed a groundwater flow model to simulate groundwater conditions on the island, with the results published in a 2002 report. The model was constructed using the quasi-three-dimensional SHARP computer program developed by H. I. Essaid for the U.S. Geological Survey (Essaid 1990). SHARP is a finite difference code that models both fresh and saltwater flow and approximates a sharp interface between the two solutions. In the model, each of the limestone and volcanic rock aquifers is represented by a single model layer, and flow within the layer is assumed to be horizontal.

The 2002 SHARP model has several limitations. It assumes that freshwater and saltwater do not mix, preventing it from predicting salinity distribution within the aquifer or the quality of water pumped from a specific well. While the model can simulate the location of the freshwater/saltwater interface, it cannot accurately predict local drawdown or rise in the interface beneath a pumped well. Additionally, since the groundwater flow model consists of only two relatively thick layers, it lacks the resolution needed to simulate vertical head gradients effectively.

5.1.1 Previous Modeling Effort

The U.S. Geological Survey developed a groundwater flow model to simulate groundwater conditions on the island, with the results published in a 2002 report. The model was constructed using the quasi-3-D SHARP computer program developed by H. I. Essaid for the U.S. Geological Survey (Essaid 1990). SHARP is a finite difference code that models both fresh and saltwater flow and approximates a sharp interface between the two solutions. Each aquifer in the model is represented by a single layer, and flow within the layer is assumed to be horizontal.

5.1.2 Model Selection

Many numerical modeling codes are capable of simulating variable density conditions, and the modeling process is typically approached in a phased manner. Several American Society for Testing and Materials International standards exist to guide the modeling process. American Society for Testing and Materials D6170-17 (2010b) and American Society for Testing and Materials D5447-04 (2010a) contain recommendations for selecting a groundwater modeling code and applying that code to a site-specific problem.

The computer code selected to model groundwater flow was the Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) 2000, a 3-D, cell-centered, finite difference, saturated-flow model developed by the U.S. Geological Survey (originally developed by McDonald and Harbaugh 1988). The Groundwater Modeling System (GMS) provides an interface to the updated version of MODFLOW 2000 (Hill et al. 2000). Based on the information available, the uncertainty associated with site information, and the modeling objective, MODFLOW 2000 was considered an appropriate groundwater flow code.

Chloride transport simulations were conducted using the Modular Three-Dimensional Multispecies Transport Model for Simulation (MT3DMS) groundwater contaminant transport model code (Zheng and Wang 1999). MT3DMS is an improved version of the MT3D model developed in 1990 (Zheng 1990). This model has improved numerical solvers that make it more stable and prevent model-induced numerical oscillations. GMS provides a module that links MODFLOW groundwater flow information to MT3DMS. MT3DMS uses this information to simulate contaminant transport using the MODFLOW -simulated groundwater flow field.

SEAWAT (Version 4, U.S. Geological Survey 2008) was developed to simulate variable density flow resulting from high concentrations of solutes, typically salt. SEAWAT was built on the MT3DMS platform and solves iteratively for flow, transport, and the resulting density variations that impact flow.

The groundwater model software package selected for this effort was GMS (Version 10.8, Aquaveo 2021). GMS is a comprehensive graphical-user interface for performing groundwater simulations and provides various powerful tools for data interpolation and figure generation. The entire GMS consists of a graphical user interface (the GMS program) and a number of analysis codes (e.g., MODFLOW, MODPATH, MT3DMS, RT3D, SEAWAT). GMS was developed by the Environmental Modeling and Research Laboratory in partnership with Waterways Experiment Station and was used as a supplementary tool to assist with preparing and interpolating data, pre- and post-processing, and generating figures (Environmental Modeling and Research Laboratory 2005).

5.1.3 Model Construction

A model grid was created with a domain extent matching that outlined in the 2002 U.S. Geological Survey model document. The original SHARP input files were obtained from the U.S. Geological Survey, and the model layer elevations and properties were extracted for import into the new MODFLOW grid. Although the 2002 U.S. Geological Survey model files provided limited data on aquifer geometry and properties, the model results are deemed reasonable for the intended purposes.

5.2 MODEL DESIGN

The lateral extent of the modeled area is shown in Figure 9. The domain includes the entire island of Tinian, an area offshore extensive enough to minimize boundary interferences with simulated groundwater flow on the island, and the offshore area where fresh groundwater discharges to the ocean (U.S. Geological Survey 2002).

5.2.1 Grid and Layering

The model grid (Figure 9) is non-uniform, composed of 81 rows and 73 columns, and covers an area of approximately 58,400 feet east to west and 92,520 feet north to south. The total modeled area encompasses approximately 194 square miles). Maximum cell dimensions are approximately 2,336 feet by 3,700 feet, and the minimum cell size is 925 feet by 584 feet (localized to the island).

Figure 9 Groundwater Model Domain

The initial U.S. Geological Survey model consisted of two layers that were later subdivided into eight model layers. Layers 1 through 3 represent the karst aquifer materials and some shallower volcanic rocks, while layers 4 through 8 only include volcanic basement material. The original and subdivided model cross sections are shown in Figure 10. To avoid dry cells, the bottom of model layer 1 was set to -15 feet mean sea level across the island, which matches the screen bottom elevation of the proposed four new CJMT water wells. However, in the area near Maui Well No. 2, the bottom of layer 1 was locally set to -2 feet mean sea level to align with the bottom screen elevation of Maui Well No. 2.

5.2.2 Boundary Conditions

Because the 2002 U.S. Geological Survey model layer 1 was divided into three model layers in the new model development, the ocean in model layer 1 was simply represented using a constant-head boundary. In model layers 2 through 8, the four edges of model were also applied to a constant-head boundary (Figure 11).

In the 2002 model, recharge was applied to layer 1 of the model over the island at a uniform rate of 29.7 inches per year. In the AECOM 2025 model, recharge was distributed spatially over the limestone areas, with low-permeability rock areas receiving a minimal recharge rate. This is discussed further in Section 5.3 of this report.

To account for the background chloride component, a concentration of 30 milligrams per liter was assigned to recharge on the island, as detailed in *The Effects of Withdrawals and Drought on Groundwater Availability in the Northern Guam Lens Aquifer, Guam* (U.S. Geological Survey 2013). Conditions in the Northern Guam Lens Aquifer were considered a reasonable analog for Tinian based on similarities in rainfall, temperature, aquifer geology and topography.

The bottom boundary of the model is no-flow. A constant concentration source of 19,000 milligrams per liter of chloride (representing salt) was assigned approximately 1.5 miles offshore of the island in all layers and in layer 8 beneath the island. The 1.5-mile distance was considered sufficient to prevent boundary effects while maintaining the constant concentration source. Constant concentration cells are shown in Figure 11.

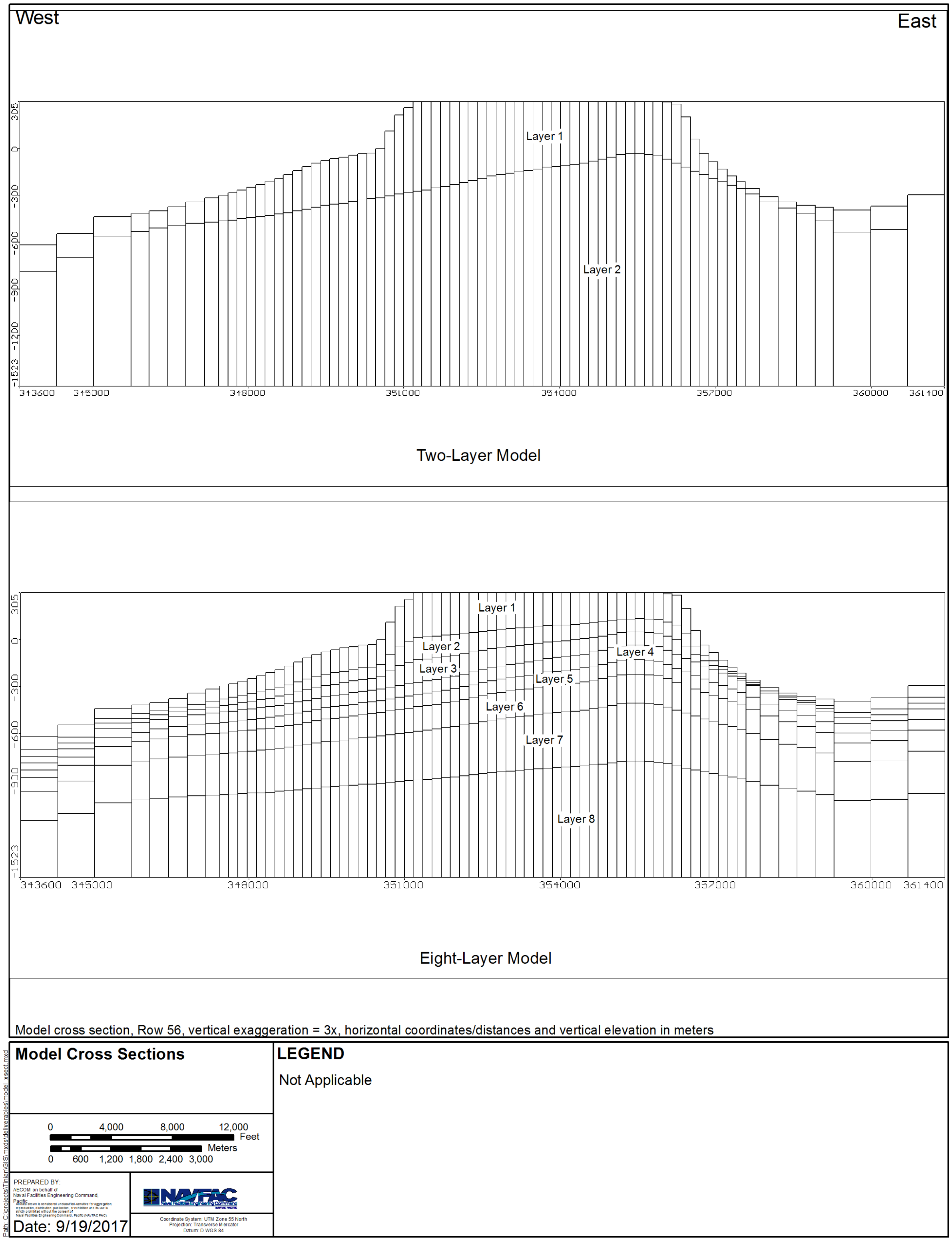

Figure 10 Model Cross Sections

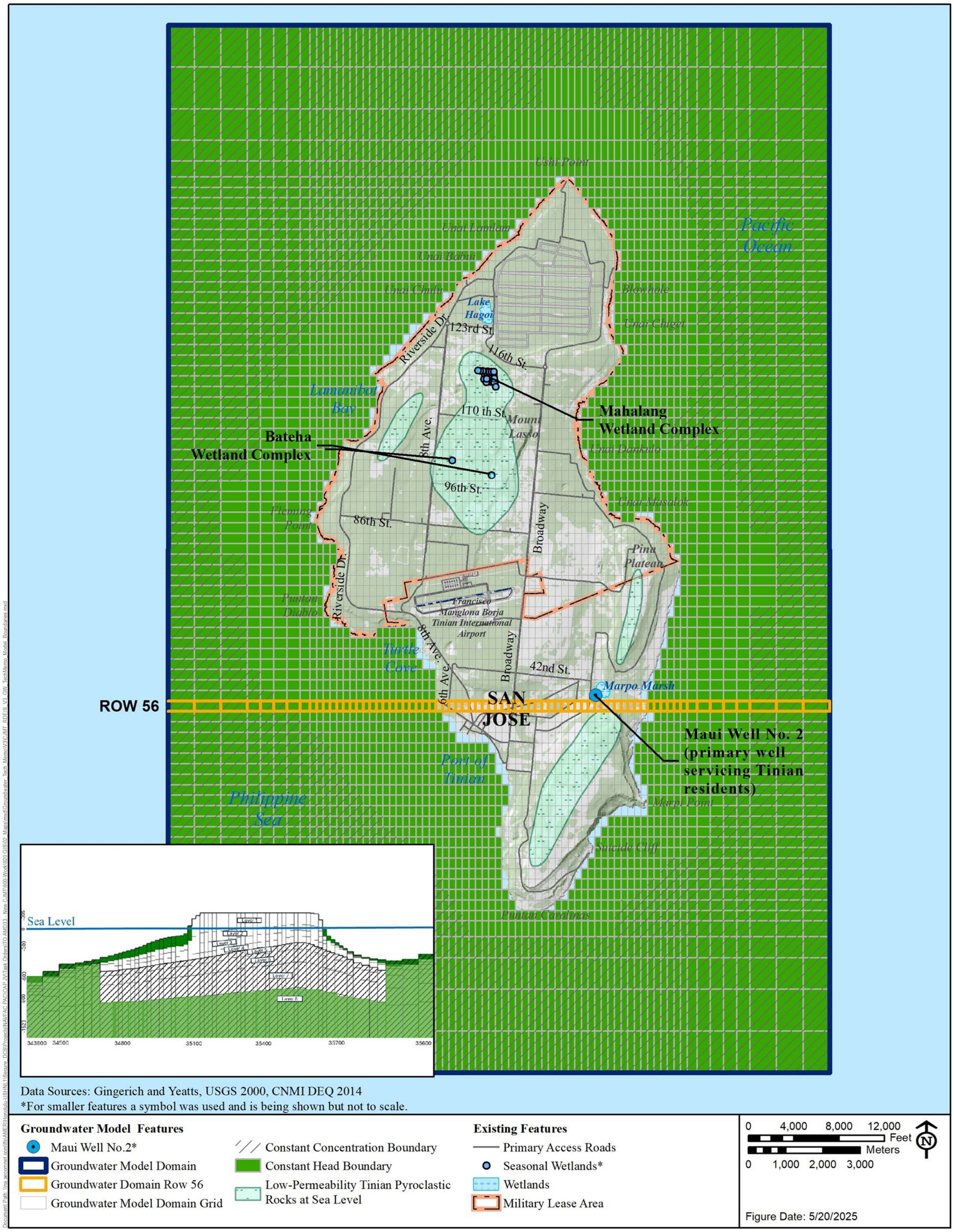

Figure 11 Model Boundaries

5.2.3 Hydraulic Parameters

The hydraulic conductivities used in the 2002 U.S. Geological Survey model are as follows:

- High hydraulic conductivity zone representing limestone: 10,500 feet per day
- Lower hydraulic conductivity zone representing clay-rich limestone: 800 feet per day
- Low permeable zone representing the volcanic rocks: 0.2 feet per day

In the 2025 AECOM model, the hydraulic conductivity values in the high hydraulic conductivity zone representing limestone was distributed spatially, while hydraulic conductivity values in the low hydraulic conductivity zone representing clay-rich limestone and in the low hydraulic conductivity zone representing the volcanic rocks were applied uniformly. The hydraulic conductivity values in the 2002 U.S. Geological Survey model were applied to the new model and used as a starting point for calibration; the final hydraulic conductivity values were determined from model calibration.

5.3 FLOW MODEL CALIBRATION

5.3.1 Overview

Model calibration involves adjusting model parameters to achieve a reasonable match with observed data. Care was taken to avoid assigning unreasonable values to any parameter, preventing unrealistic model results. The goal of calibration is to achieve a match, as close as possible, between simulated and observed heads rather than replicate field conditions exactly. A model is generally considered well calibrated for flow when the normalized root mean squared error is less than 10 percent between modeled and measured groundwater elevations for a set of data.

5.3.2 Steady State

Similar to U.S. Geological Survey 2002 model (two-layer model), the AECOM 2025 model (eight-layer model) was also calibrated to "steady state." The pilot-point interpolation method was used to calibrate the hydraulic conductivity distribution in the high-hydraulic conductivity limestone zone and recharge distribution in all limestone areas. The zonal method was used to calibrate K values in the low- hydraulic conductivity zone representing clay-rich limestone and in low-permeable zone representing the volcanic rocks. Average groundwater levels observed from 1990 to 1999, sourced from the 2002 U.S. Geological Survey model, were used for calibrating AECOM's 2025 model and are presented in Table 5. The USGS modified these water levels to account for tidal influences per the method outlined in the 2002 report. Calibration results of both the 2002 U.S. Geological Survey model and the 2025 AECOM model are shown are in Table 4. The measured and modeled water levels compare favorably. The head residuals of the 2025 AECOM calibration model are shown in Figure 12 and in Table 5. Figure 13 presents a scatter plot of simulated and measured water levels from the 2025 AECOM calibration. The plot shows a similar spread among all the data sets around the best fit line, indicating a strong correlation between simulated and observed values. Calibration statistics show a mean error close to zero, with a normalized error of 8.66 percent (root mean square error divided by the range of observed heads) well within the calibration criterion of 10 percent. Therefore, the 2025 AECOM model is considered to be well-calibrated and adequate for the intended purposes. Model limitations are discussed in Section 5.8. A summary of calibration statistics is presented in Table 6.

Both the 2002 U.S. Geological Survey model and the 2025 AECOM model produced similar calibration statistics and groundwater contours. Some of the discrepancies can be attributed to differences in model code and construction combined with sparse data. From this point forward, only the 2025 AECOM model was used for simulations.

The final calibrated hydraulic conductivity values of the 2025 AECOM model are as follows:

- High hydraulic conductivity zone representing limestone: 164–13,123 feet per day
- Lower hydraulic conductivity zone representing clay-rich limestone: 115 feet per day
- Low permeable zone representing the volcanic rocks: 0.17–0.53 feet per day

These values are presented in Figure 14. The high hydraulic conductivity values for limestone falls into the range of the aquifer test results (U.S. Geological Survey 2002). Transverse and longitudinal hydraulic conductivity were set equal to one another (no horizontal anisotropy). Vertical hydraulic conductivity was set equal to one-tenth horizontal hydraulic conductivity (horizontal to vertical anisotropy equal 10) as with the U.S. Geological Survey 2002 model. Although the calibrated values varied from the 2002 U.S. Geological Survey model, they are still within the range of values reported from aquifer pump testing on the existing wells. While the pump test results may understate regional hydraulic conductivities in a triple porosity system, the goodness of fit for heads indicates these calibrated values are appropriate for their intended purpose.

In the 2025 AECOM model, the uniform recharge rate of 29.7 inches per year used in the U.S. Geological Survey 2002 model was replaced with a spatially distributed recharge rates, with low-permeability rock areas receiving a minimal recharge rate. Using a pilot-point method, the overall recharge distribution was calibrated to maintain the same total annual recharge volume within the island. The final recharge rate distribution was determined through model calibration. The final calibrated recharge distribution is shown in Figure 15. The model used the following values uniformly across the domain: specific storage (1.52E-06 1/foot) and specific yield and effective porosity (28 percent).

Table 4. Measured and Calculated Water Levels

Well	*Measured Water Levels*	*2002 USGS (Two-Layer) Model Calculated Water Level*	*2025 AECOM (Eight-Layer) Model Calculated Water Level*
	ft msl	*ft msl*	*ft msl*
M-02	2.65	2.62	2.81
M-05	0.93	1.07	1.23
M-07	1.38	1.51	1.53
M-08	1.31	1.41	1.52
M-09	1.40	1.36	1.30
M-10	0.84	0.75	0.56
M-11	1.63	1.43	1.52
M-15	1.30	1.19	1.23
M-16	1.26	1.36	1.43
M-19	2.15	2.18	2.14
M-21	1.62	1.65	1.52
M-22	1.38	1.36	1.40
M-25	1.36	1.27	1.27
M-26	1.77	1.39	1.45
M-29	1.64	1.53	1.69
M-33	1.58	1.45	1.51
M-35	2.42	2.58	2.58
M-39	2.02	2.11	1.87
Municipal (a.k.a. Maui Well No. 1)	1.03	1.03	1.28
HagN	1.13	0.9	1.04
HagS	1.17	0.97	1.06
TH-01	1.11	1.29	1.41
TH-02	0.92	0.86	0.85
TH-04	1.30	1.19	1.30
TH-06	1.22	1.3	1.39
TH-07	1.29	1.36	1.45
TH-09	1.25	1.07	1.22
TH-10	1.27	1.29	1.41
TH-12	1.37	1.33	1.33
TH-22	1.25	1.05	1.14
Ushi	0.78	0.72	0.54

Legend: AECOM = AECOM Technical Services, Inc.; ft = foot/feet; msl = mean sea level; No. = Number.
Source: U.S. Geological Survey 2002 DON.

Table 5. Calculated Differences Between Measured and Modeled Results

Well	*Dates of Measurement*	*Number of Measurements*	*2002 USGS (Two-Layer) Model*	*2025 AECOM (Eight-Layer) Model*
M-02	September 25, 1997–April 16, 1999	15,700	0.03	-0.16
M-05	July 31, 1997–October 1, 1997	3	-0.14	-0.30
M-07	July 6, 1995–October 1, 1997	25	-0.13	-0.15
M-08	August 22, 1997–October 3, 1997	3	-0.10	-0.21
M-09	May 4, 1995–October 2, 1997	31	0.04	0.10
M-10	March 31, 1997–December 29, 1997	8	0.09	0.28
M-11	April 13, 1995–December 29, 1997	34	0.20	0.11
M-15	May 29, 1997–December 29, 1997	6	0.11	0.07
M-16	May 4, 1995–December 29, 1997	32	-0.10	-0.17
M-19	June 5, 1997–December 30, 1997	5	-0.03	0.01
M-21	September 30, 1990–February 1, 1996	45,443	-0.03	0.10
M-22	July 4, 1997–December 30, 1997	5	0.02	-0.02
M-25	November 1, 1994–September 5, 1997	28	0.09	0.09
M-26	November 1, 1994–September 5, 1997	20	0.38	0.32
M-29	July 30, 1997–April 16, 1999	14,524	0.11	-0.05
M-33	August 22, 1997–December 30, 1997	4	0.13	0.07
M-35	July 31, 1997–December 30, 1997	4	-0.16	-0.16
M-39	May 15, 1997–December 30, 1997	7	-0.09	0.15
Municipal (Maui Well No. 1)	November 22, 1990–April 16, 1999	67,952	0.00	-0.25
HagN	May 17, 1993–July 4, 1997	39	0.23	0.09
HagS	May 17, 1993–July 4, 1997	38	0.20	0.11
TH-01	September 17, 1996–December 29, 1997	4	-0.18	-0.30
TH-02	April 30, 1997–September 5, 1997	5	0.06	0.07
TH-04	January 10, 1994–December 29, 1997	48	0.11	0.00
TH-06	July 6, 1995–July 31, 1997	27	-0.08	-0.17
TH-07	September 17, 1997–April 16, 1999	9,233	-0.07	-0.16
TH-09	February 9, 1993–December 30, 1997	114	0.18	0.03
TH-10	October 10, 1996–December 29, 1997	18	-0.02	-0.14
TH-12	January 8, 1997–December 29, 1997	10	0.04	0.04
TH-22	October 31, 1996–December 29, 1997	17	0.20	0.11
Ushi	October 1, 1990–July 28, 1997	53,296	0.06	0.24

Legend: AECOM = AECOM Technical Services, Inc.; No. = Number; USGS = United States Geological Survey.

Table 6. Statistics of 2025 AECOM (Eight-Layer) Model

Mean Error	-0.01
Mean Absolute Error	0.14
Root Mean Square Error	0.16
Maximum Observed Head	2.65
Minium Observed Head	0.78
Range of Observed Heads	1.87
Normalized Error (Root Mean Square Error divided by Head Range)	8.66%
Correlation Coefficient between Observed and Modeled Heads	93.58%

Legend: % = percent; AECOM = AECOM Technical Services, Inc.

Figure 12 Model Head Residuals

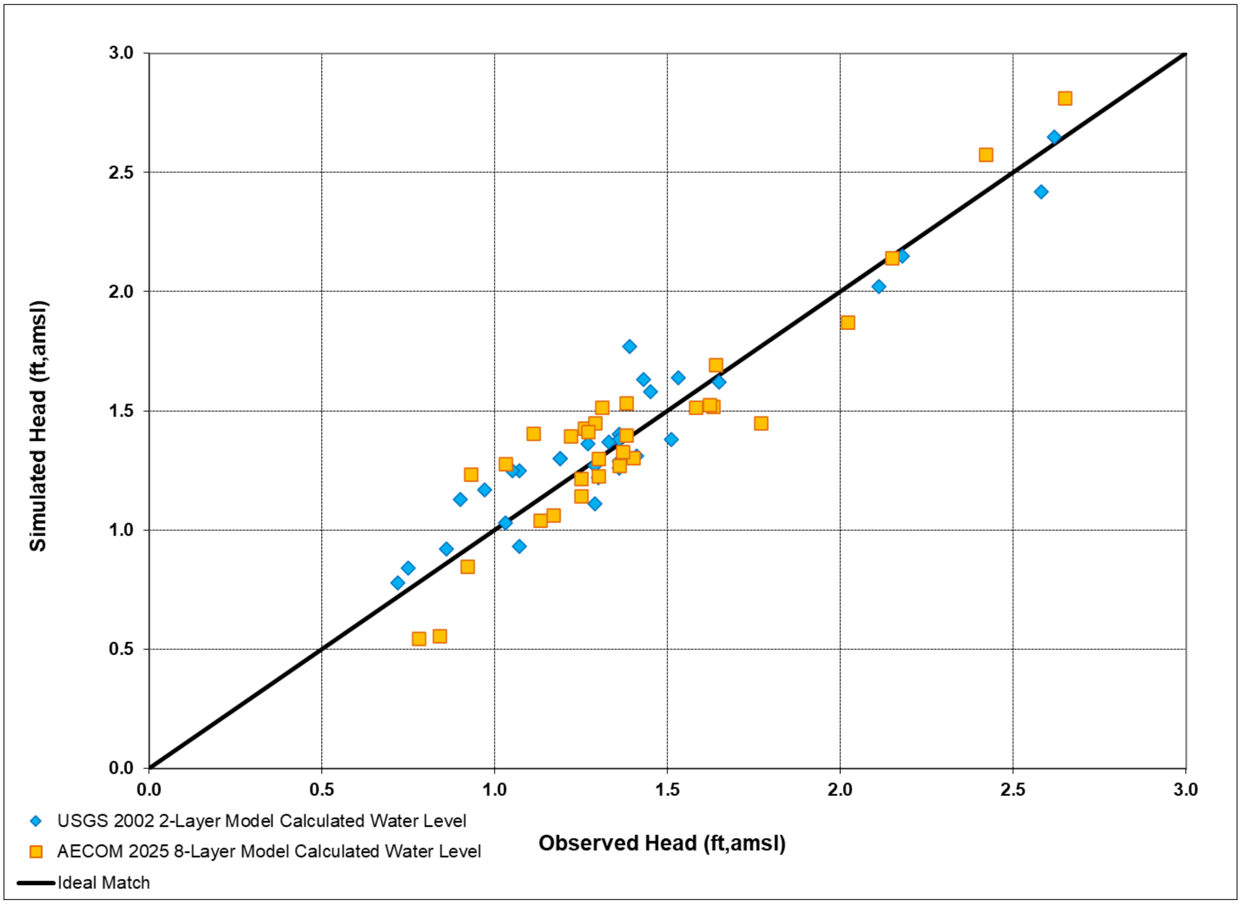

Figure 13 Scatter Plot of Observed Heads vs. Simulated Heads

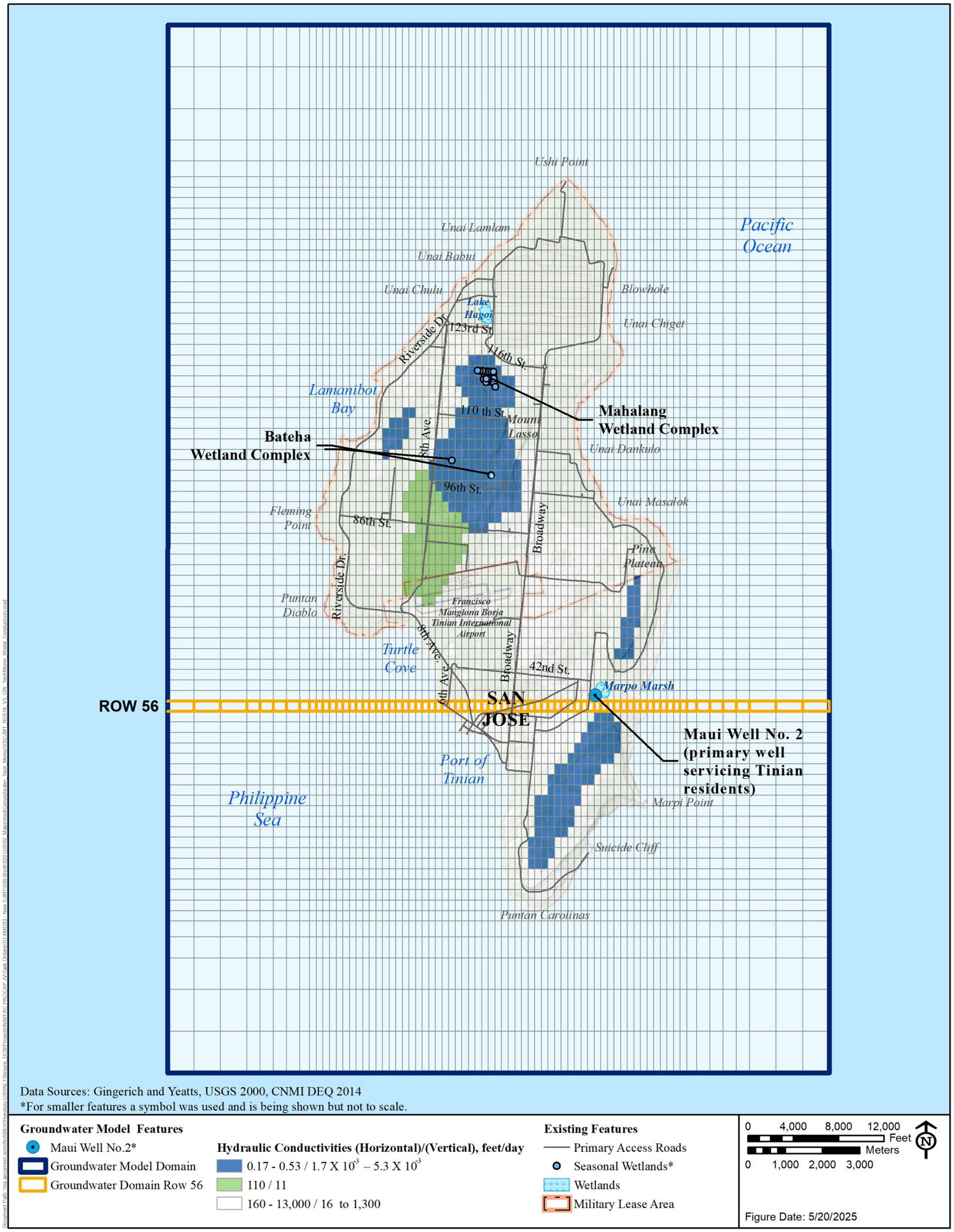

Figure 14 Model Hydraulic Conductivity Values and Distribution in Model Layer 1

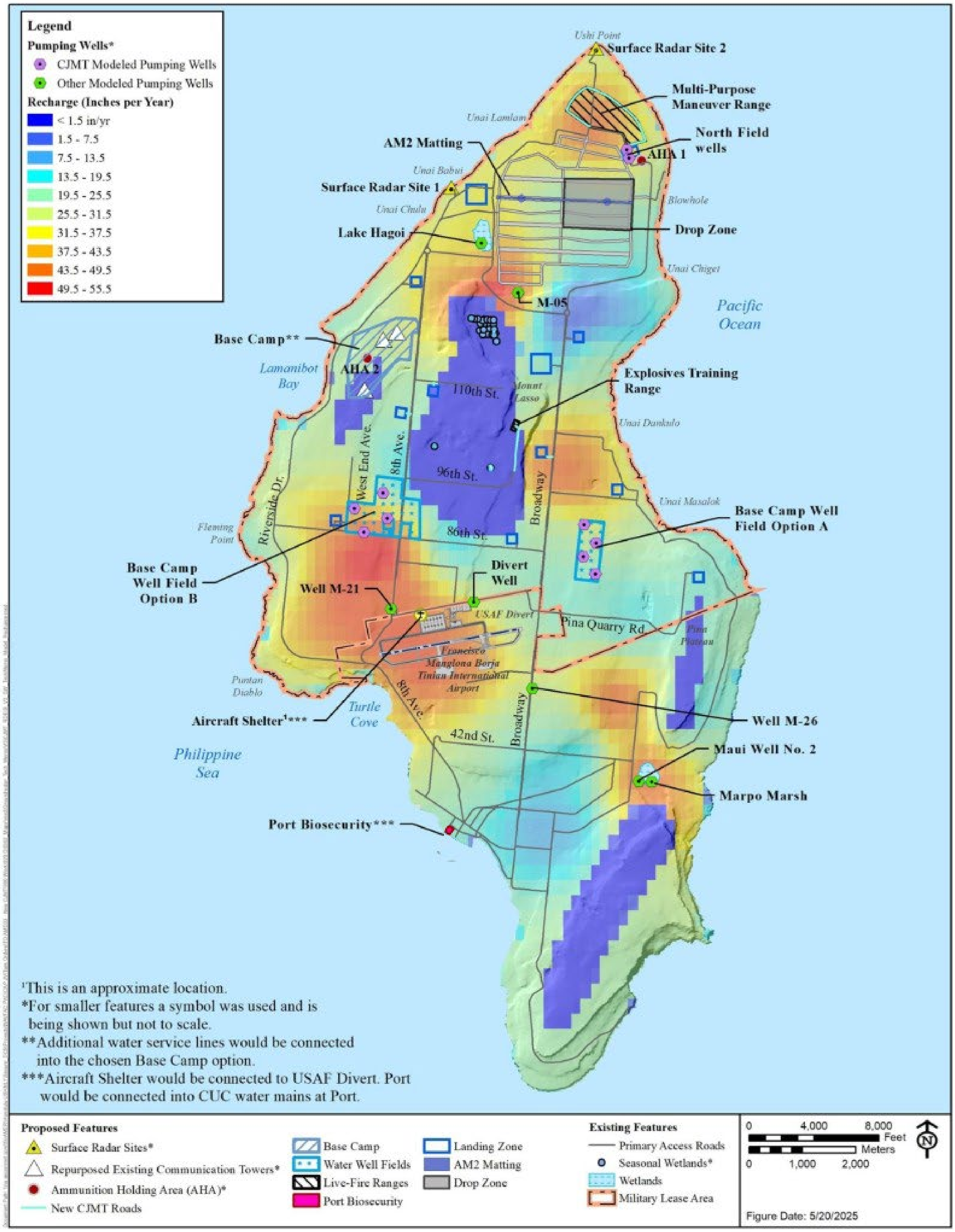

Figure 15 Model Recharge

5.4 MODEL SCENARIOS

The next step in the process was to run the model in a transient state using the SEAWAT module in the GMS modeling platform. An initial model run was conducted to establish steady-state conditions with regard to saltwater distribution. Prior to applying pumping conditions to the model, it is necessary to establish a steady-state baseline. The simulation time typically exceeds 100 years before equilibrium is reached, depending on several factors, including the defined initial concentrations. Steady state in this context refers to a stabilized condition in the flow and transport system, not the model code. The system was deemed to be at "steady state" when the modeled hydraulic heads and concentrations ceased to change over time throughout the model domain. The model was run under baseline conditions for 250 years to approximate steady state. Following this, the model ran for 250 years to simulate each of the scenarios (forward simulations).

The drought scenario was assumed to be two consecutive years of reduced rainfall, represented in the model by a conservative infiltration rate of 10 percent of the modeled normal infiltration rate. Drought conditions were applied for a period of 2 years of reduced recharge during model years 249 and 250. Model results discussed below refer to the end of the 250-year forward simulation periods. In SEAWAT, salt concentrations are modeled at the center of a model cell, unlike the SHARP code that calculates an interface between salt and freshwater with no diffuse concentrations above or below the modeled boundary. Note that model layering is different from aquifer or geologic layering. In this model, the layers are numbered from top to bottom (i.e., layer 1 is the shallowest and layer 8 is the deepest). The top three model layers (layers 1 through 3) represent the limestone aquifer system and the remaining five layers (4 through 8) represent the low-permeability volcanic material. Figure 16 through Figure 20 depict predicted chloride concentrations in model layers 1 through 3. These are the layers containing the existing and proposed well screens. Maui Well No. 2 and the CJMT wells were assigned to model layer 1.

The five scenarios are below; italicized text highlights the differences.

Scenario No. 1 (Baseline)

- Normal rainfall.
- Existing Commonwealth Utilities Corporation Water Demand (Maui Well No. 2) = 853,472 gallons per day (Average 2019–2023).
- Well M-21 using Divert construction water demands based on Bureau of Environmental and Coastal Quality permitted pumping limits per September 2024 field notes = 59,178 gallons per day.
- Well M-26 agricultural water demand = 59,178 gallons per day.

Scenario No. 2 (Proposed Action + Normal Rainfall + Well Field A)

- Normal rainfall.
- Existing Commonwealth Utilities Corporation Water Demand (Maui Well No. 2) = 853,472 gallons per day (taken from average 2019–2023 demand from Commonwealth Utilities Corporation).
- Proposed additional water demand on Commonwealth Utilities Corporation (Maui Well No. 2) due to CJMT = 9,046 gallons per day.

- Well M-21 CJMT construction water demand = 59,178 gallons per day – M-21 to be used for CJMT construction (No Divert and no agricultural at this well).
- Well M-26 agricultural water demand. = 59,178 gallons per day.
- CJMT water demand at *Well Field A* which includes concurrent construction and operational water demands = 21,777 gallons per day.
- Construction water at M-21, *Well Field A* would be 23,340 gallons per day. Will not be separately modeling the post-CJMT-construction demand at the new Well Field A or M-21.
- CJMT water wells at North Field. = 2,192 gallons per day.
- U.S. Air Force North Field construction (M-05) = 12,000 gallons per day.
- Divert Well (firefighting well at Tinian International Airport) = 2,192 gallons per day.

Scenario No. 3 (Proposed Action + Drought Rainfall + Well Field A)

- Drought conditions.
- Existing Commonwealth Utilities Corporation Water Demand (Maui Well No. 2) = 853,472 gallons per day (taken from average 2019 – 2023 demand from Commonwealth Utilities Corporation).
- Proposed additional water demand on Commonwealth Utilities Corporation (Maui Well No. 2) due to CJMT = 9,046 gallons per day.
- Well M-21 CJMT construction water demand = 59,178 gallons per day– M-21 to be used for CJMT construction (No Divert and no agricultural at this well).
- Well M-26 agricultural water demand = 59,178 gallons per day.
- CJMT water demand at *Well Field A* which includes concurrent construction and operational water demands = 21,777 gallons per day.
- Construction water is now at M-21, *Well Field A* would be 23,340 gallons per day. Will not be separately modeling the post-CJMT-construction demand at the new Well Field A or M-21.
- CJMT water wells at North Field = 2,192 gallons per day.
- U.S. Air Force North Field construction (M-05) = 12,000 gallons per day.
- Divert Well (firefighting well at Tinian International Airport) = 2,192 gallons per day.

Scenario No. 4 (Proposed Action + Normal Rainfall + Well Field B)

- Normal rainfall.
- Existing Commonwealth Utilities Corporation Water Demand (Maui Well No. 2) = 853,472 gallons per day (taken from average 2019 – 2023 demand from Commonwealth Utilities Corporation).
- Proposed additional water demand on Commonwealth Utilities Corporation (Maui Well No. 2) due to CJMT = 9,046 gallons per day.
- Well M-21 CJMT construction water demand = 59,178 gallons per day– M-21 to be used for CJMT construction (No Divert and no agricultural at this well).
- Well M-26 agricultural water demand = 59,178 gallons per day.
- CJMT water demand at *Well Field B* which includes concurrent construction and operational water demands = 21,777 gallons per day.

- Construction water is now at M-21, *Well Field B* would be 23,340 gallons per day. Will not be separately modeling the post-CJMT-construction demand at the new Well Field B or M-21.
- CJMT water wells at North Field = 2,192 gallons per day.
- U.S. Air Force North Field construction (M-05) = 12,000 gallons per day.
- Divert Well (firefighting well at Tinian International Airport) = 2,192 gallons per day.

Scenario No. 5 (Proposed Action + Drought Rainfall + Well Field B)

- Drought conditions.
- Existing Commonwealth Utilities Corporation Water Demand (Maui Well No. 2) = 853,472 gallons per day (taken from average 2019 – 2023 demand from Commonwealth Utilities Corporation).
- Proposed additional water demand on Commonwealth Utilities Corporation (Maui Well No. 2) due to CJMT = 9,046 gallons per day.
- Well M-21 CJMT construction water demand = 59,178 gallons per day – M-21 to be used for CJMT construction (No Divert and no agricultural at this well).
- Well M-26 agricultural water demand = 59,178 gallons per day.
- CJMT water demand at *Well Field B* which includes concurrent construction and operational water demands = 21,777 gallons per day.
- Construction water is now at M-21, *Well Field B* would be 23,340 gallons per day. Will not be separately modeling the post-CJMT-construction demand at the new Well Field B or M-21.
- CJMT water wells at North Field = 2,192 gallons per day.
- U.S. Air Force North Field construction (M-05) = 12,000 gallons per day.
- Divert Well (firefighting well at Tinian International Airport) = 2,192 gallons per day.

Pumping and evaporative/evapotranspirative losses from the lake and marsh for each of the scenarios are summarized in Table 7.

Table 7. Pumping Rates for Scenarios 1 through 5

<table>
<tr><th>Well</th><th>Scenario 1
(Baseline)</th><th>Scenario 2</th><th>Scenario 3</th><th>Scenario 4</th><th>Scenario 5</th></tr>
<tr><td>Lake Hagoi</td><td colspan="5">41,739</td></tr>
<tr><td>Makpo Marsh</td><td colspan="5">123,897</td></tr>
<tr><td>Maui Well No. 2</td><td>853,472</td><td>862,518</td><td>862,518</td><td>862,518</td><td>862,518</td></tr>
<tr><td>M-21</td><td>59,178</td><td>59,178</td><td>59,178</td><td>59,178</td><td>59,178</td></tr>
<tr><td>M-26</td><td>59,178</td><td>59,178</td><td>59,178</td><td>59,178</td><td>59,178</td></tr>
<tr><td>M-05</td><td>—</td><td>12,000</td><td>12,000</td><td>12,000</td><td>12,000</td></tr>
<tr><td>Divert Well</td><td>—</td><td>2,192</td><td>2,192</td><td>2,192</td><td>2,192</td></tr>
<tr><td>North Field-01</td><td>—</td><td rowspan="2">2,192</td><td rowspan="2">2,192</td><td rowspan="2">2,192</td><td rowspan="2">2,192</td></tr>
<tr><td>North Field-02</td><td>—</td></tr>
<tr><td>Well Field A-01</td><td>—</td><td rowspan="4">21,777</td><td rowspan="4">21,777</td><td>—</td><td>—</td></tr>
<tr><td>Well Field A-02</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Well Field A-03</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Well Field A-04</td><td>—</td><td>—</td><td>—</td></tr>
</table>

<table>
<tr><th>Well</th><th>Scenario 1 (Baseline)</th><th>Scenario 2</th><th>Scenario 3</th><th>Scenario 4</th><th>Scenario 5</th></tr>
<tr><td>Well Field B-01</td><td>—</td><td>—</td><td>—</td><td rowspan="4">21,777</td><td rowspan="4">21,777</td></tr>
<tr><td>Well Field B-02</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Well Field B-03</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Well Field B-04</td><td>—</td><td>—</td><td>—</td></tr>
</table>

Note: All units in gpd.
Legend: gpd = gallon per day; No. = Number.

5.5 MODEL RESULTS

Modeled pumping for the proposed DoD wells was evenly distributed among the listed wells. Divert construction is expected to be staggered from CJMT construction and is therefore not included. Long-term operational Divert demands are assumed to be incidental at the facility itself. Table 8 summarizes the resulting concentrations in model cells corresponding to the wells of interest, following the figures for each scenario.

Table 8. Predicted Chloride Concentrations for Scenarios 1 through 5

Well	*Scenario 1 (Baseline)*	*Scenario 2*	*Scenario 3*	*Scenario 4*	*Scenario 5*
Maui Well No. 1	32	32	33	32	33
Maui Well No. 2	149	150	168	150	167
M-21	48	48	106	48	107
M-26	32	51	100	51	100
M-05	41	42	70	42	70
Divert Well	32	32	39	32	39
North Field-01	590	590	902	590	902
North Field-02	665	664	1,130	664	1,130
Well Field A-01	37	37	40	37	40
Well Field A-02	35	35	49	35	40
Well Field A-03	32	32	39	32	33
Well Field A-04	34	34	38	34	35
Well Field B-01	30	32	30	30	30
Well Field B-02	30	30	30	30	30
Well Field B-03	30	30	30	30	31
Well Field B-04	30	30	30	30	30

Note: All units in mg/L.
Legend: mg/L = milligram per liter; No. = Number.

Modeled chloride concentrations in model layers 1, 2, and 3 for each scenario are presented in Figure 16 through Figure 20.

Many of these concentrations are not predicted to change or are predicted to change very little as a result of CJMT groundwater extraction. The biggest predicted changes at individual wells are under drought conditions (Scenarios 3 and 5) in M-21, M-26, M-05, North Field-01 and North Field-02, However in all cases wells that currently meet the secondary standard continue to meet that standard. The North Field-01 and North Field-02 are expected to remain non-potable under normal and drought conditions. To evaluate the reasonableness of these results, data from the *Aquifer Study Technical Memorandum* (DON 2015) were reviewed. These included data from U.S. Geological Survey 2000, U.S. Geological Survey 2002, and DON (2015). These are summarized in Table 9 and Table 10. In both data sets, chloride concentrations were measured before and after single-day to multi-day pump tests.

Consistent with the current modeling results, during the 2015 aquifer study, wells M-21, M-25, and M-33 saw little to no change in chloride concentrations before and after pumping (Table 9). Additional data before and after pumping (Table 10) indicate that most locations (nine wells) did not change in chlorides before or after pumping. Two locations decreased in chloride concentrations and four locations increased in chloride concentrations.

Table 9. 2015 Aquifer Study Chloride Concentrations

Well	*Average Pumping Rate (gpm)*	*Maximum Drawdown During Pumping (ft)*	*Pre-Pumping Chloride Concentration (mg/L)*	*Post-Pumping Chloride Concentration (mg/L)*
M-21	31	0.12	220	220
M-25	112	0.25	720	710
M-33	104	1.92	39	44

Legend: ft = foot/feet; gpm = gallon per minute; mg/L = milligram per liter.
Source: DON 2015.

Table 10. Chloride Concentrations Observed Before and After Pumping

Well	*Observed Chlorides Before Pumping (mg/L)*	*Observed Chlorides After Pumping (mg/L)*	*Differences in Chlorides (mg/L)*
Ag30	130	130	0
HagS	148	160	12
M-08	100	600	500
M-15	35	70	35
M-16	106	45	-61
M-21	220	220	0
M-25	720	710	-10
M-33	39	44	5
Maui Well No. 1	100	100	0
Pala	200	200	0
W-1	85	85	0
W-14	40	40	0
W-20	600	600	0
W-4	35	35	0
W-6	100	100	0

Legend: No. = Number; mg/L = part per million.
Source: USGS 2000; DON 2015.

In both data sets (Table 9 and Table 10), many of the wells exhibited little to no chloride concentration change as a result of single-day to multi-day testing.

The Ushi and M-05 wells in the North Field area were pump tested for 36 hours each in November 2025 (APEC 2025). Water quality testing was performed during this pump testing. Water from these wells exceeded primary and secondary drinking water standards (e.g., for chloride, total dissolved solids and coliform bacteria). The water also exceeded the chloride limits for reinforced concrete mixing water. The wells were pumped at 35 to 40 gpm each. Water levels fluctuated up to 0.23 and 0.05 feet in Ushi and M-10, respectively. However, based on the sinusoidal shape of the water level plots, much of this fluctuation may be due to tidal fluctuation. Chloride concentrations were reported to vary between 2,352 and 2,499 mg/L, and 2,058 and 2,499 mg/L for Ushi and M-10, respectively during the tests with no distinct pattern of increase or decrease in either well during pumping. These values are roughly an order of magnitude from the value reported at the end of pumping by Doan et al 1960, indicating large fluctuations over the years. The modeling assumed that groundwater for U.S. Air Force use would come from the M-05 wells farther to south and closer to the center of the island. The modeling assumed CJMT pumping in the North Field area at 2 wells (designated North Field-01 and North Field-02) located southeast of Ushi and M-10. Model results indicate that water at these wells is expected to be brackish and increase in salinity during drought conditions.

The modeling conclusions appear to be reasonable on the whole. However, some locations (especially those with vertical conduits that extend below the saltwater-freshwater interface) may exhibit rapid salinity increases. For that reason, Section 6 includes recommendations for pump testing and water quality testing. If some wells are observed to exhibit rapid salinity increases, those wells should be properly plugged and abandoned under permit from CNMI Bureau of Environmental and Coastal Quality.

5.6 GROUNDWATER FLOW DIRECTIONS

Modeled groundwater heads and groundwater flow directions under current (baseline) conditions (Scenario 1) and the proposed action under drought conditions (Scenarios 3 and 5) are plotted in Figure 21 through Figure 23. The baseline contours differ slightly from the proposed action under drought conditions. There are also slight differences between pumping at Well Field A (Scenario 3) versus pumping at Well Field B (Scenario B) but not enough to noticeably alter contours.

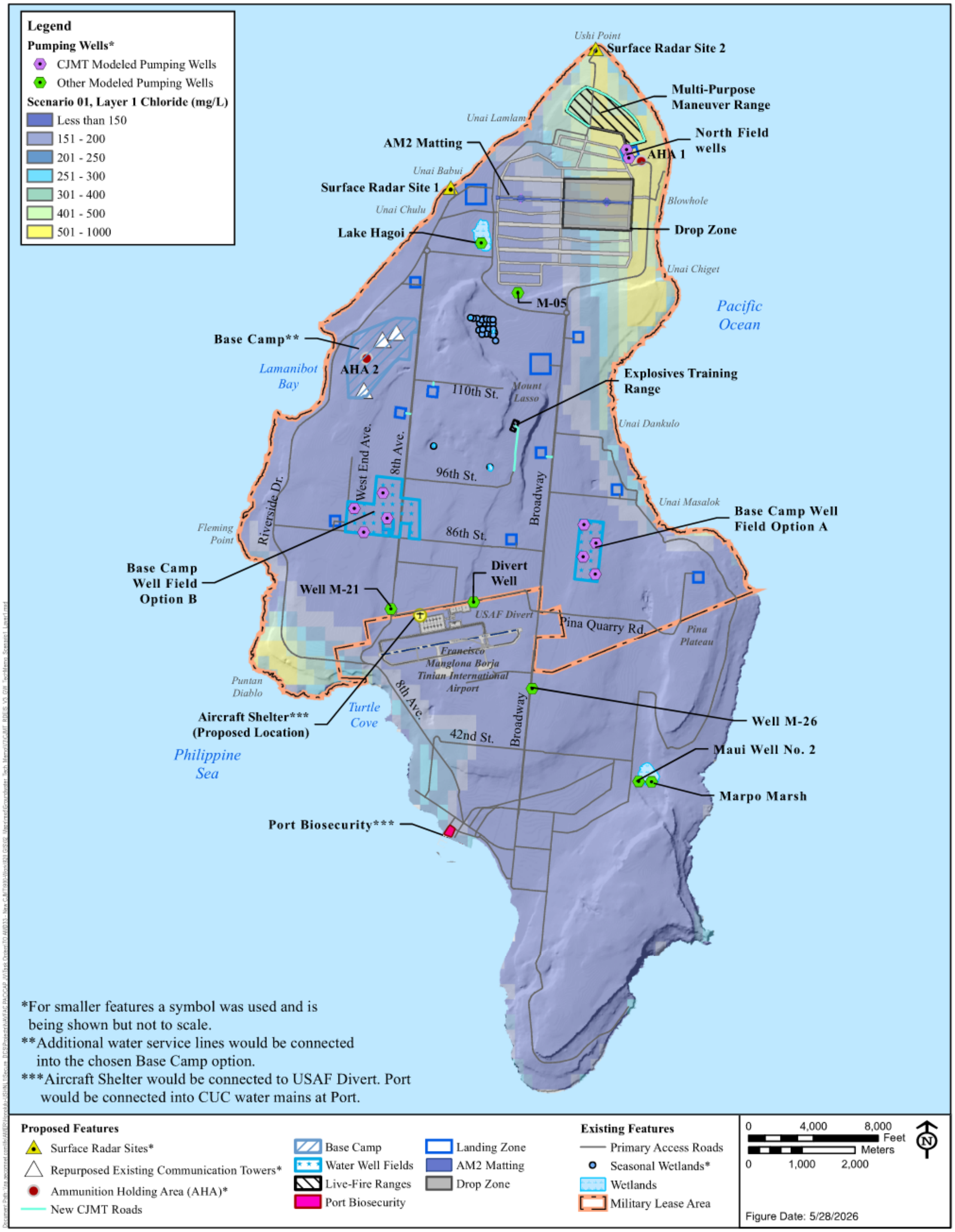

Figure 16.1 Modeled Chloride Concentrations for Layer 1 – Scenario 1

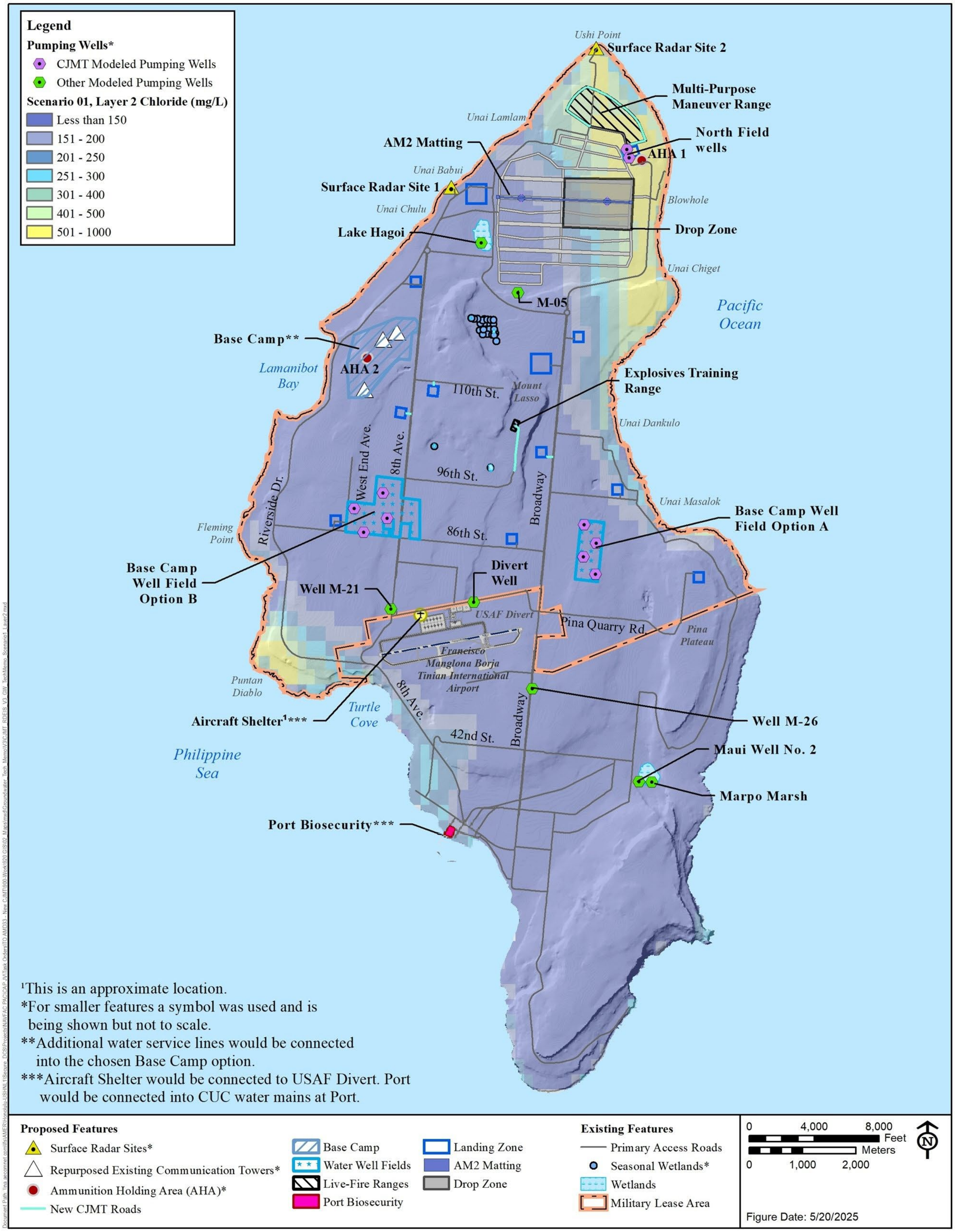

Figure 16.2 Modeled Chloride Concentrations for Layer 2 – Scenario 1

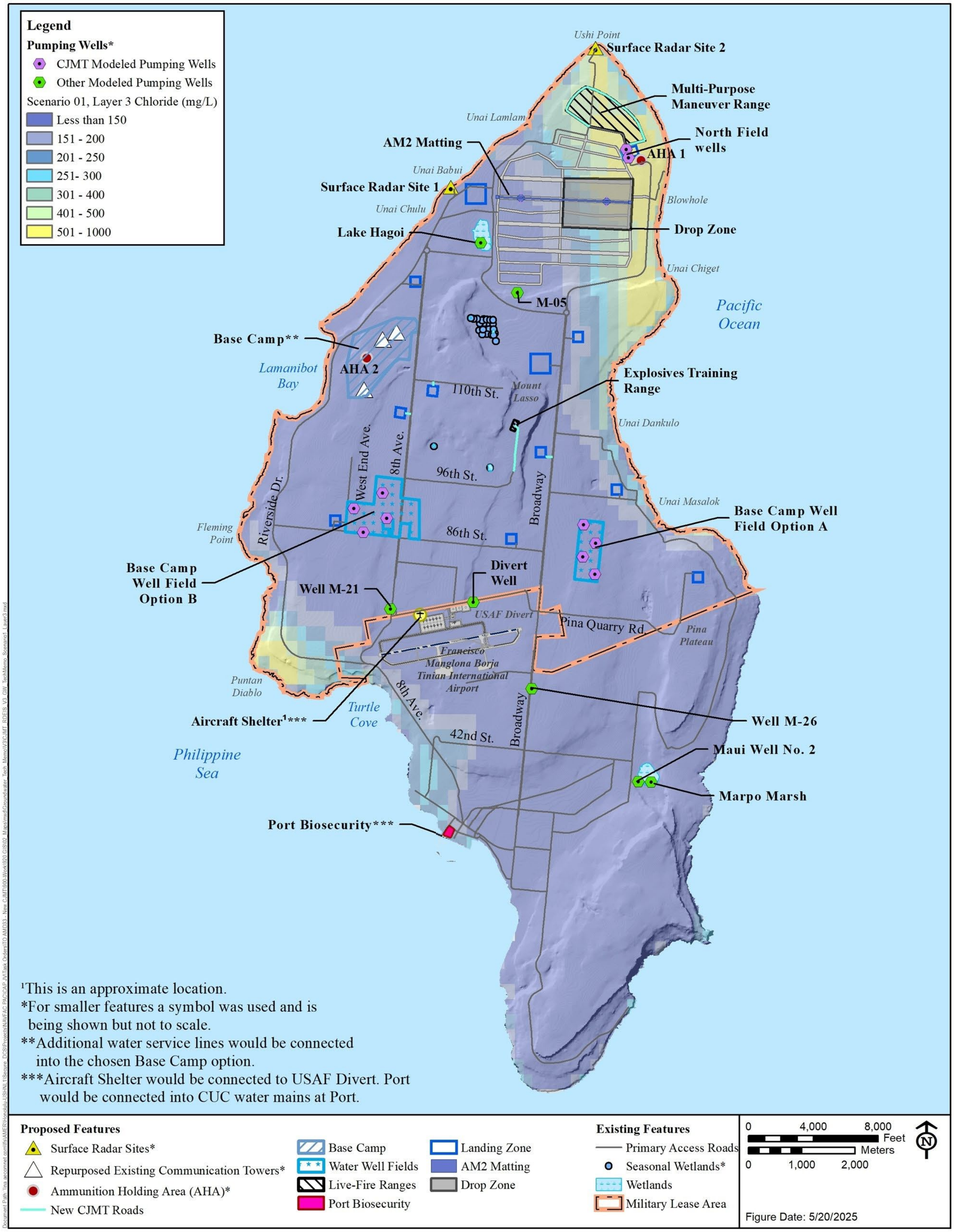

Figure 16.3 Modeled Chloride Concentrations for Layer 3 – Scenario 1

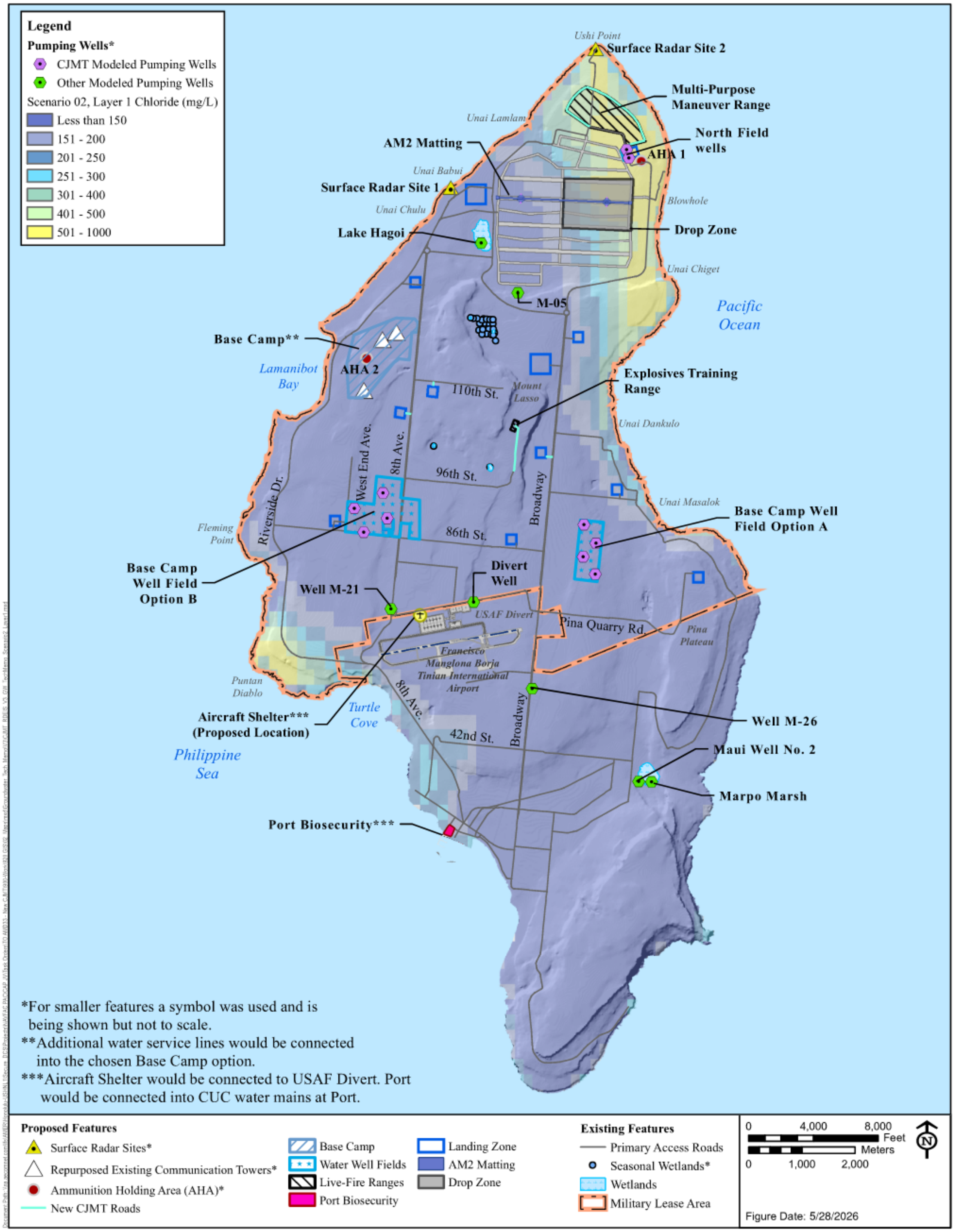

Figure 17.1 Modeled Chloride Concentrations for Layer 1 – Scenario 2

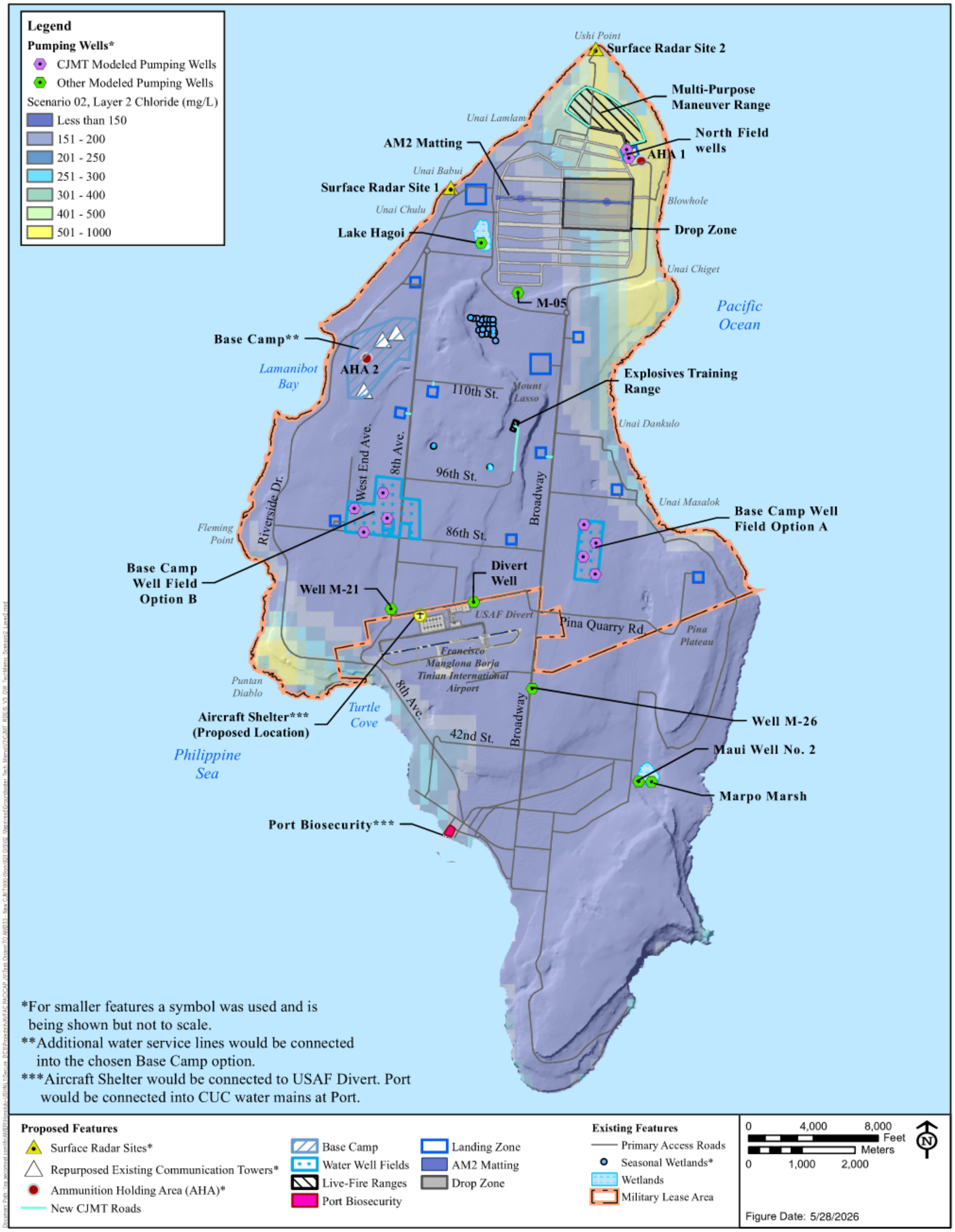

Figure 17.2 Modeled Chloride Concentrations for Layer 2 – Scenario 2

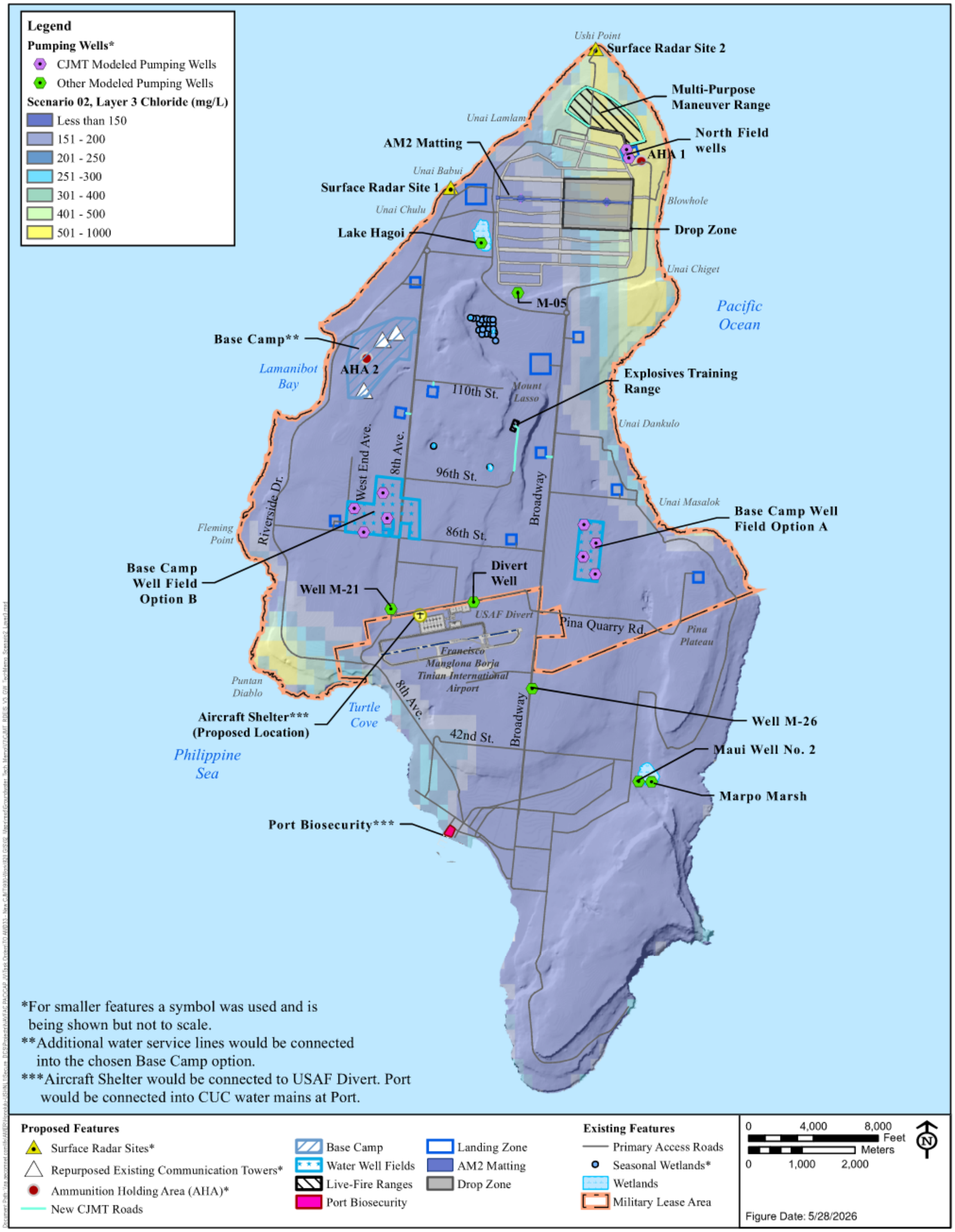

Figure 17.3 Modeled Chloride Concentrations for Layer 3 – Scenario 2

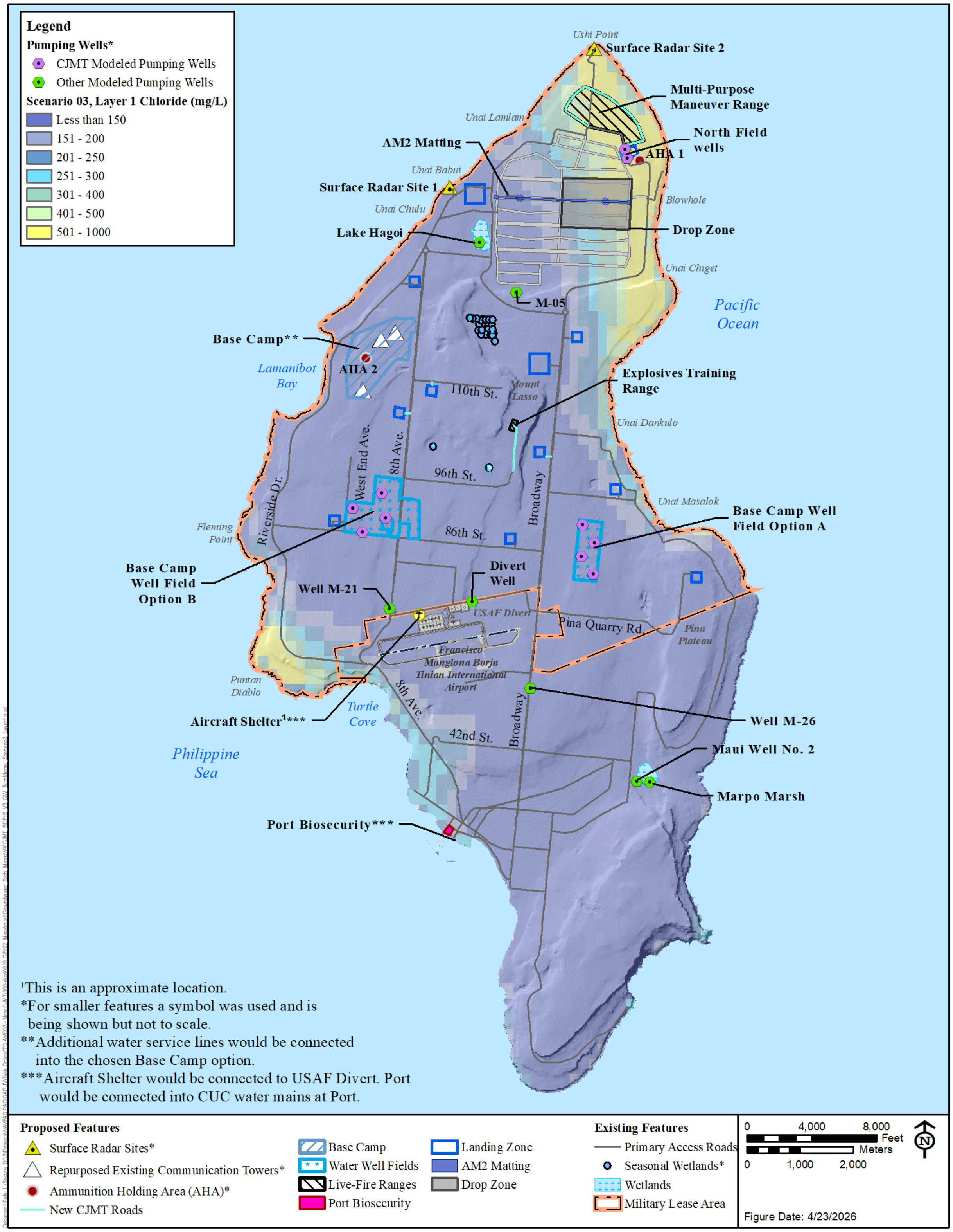

Figure 18.1 Modeled Chloride Concentrations for Layer 1 – Scenario 3

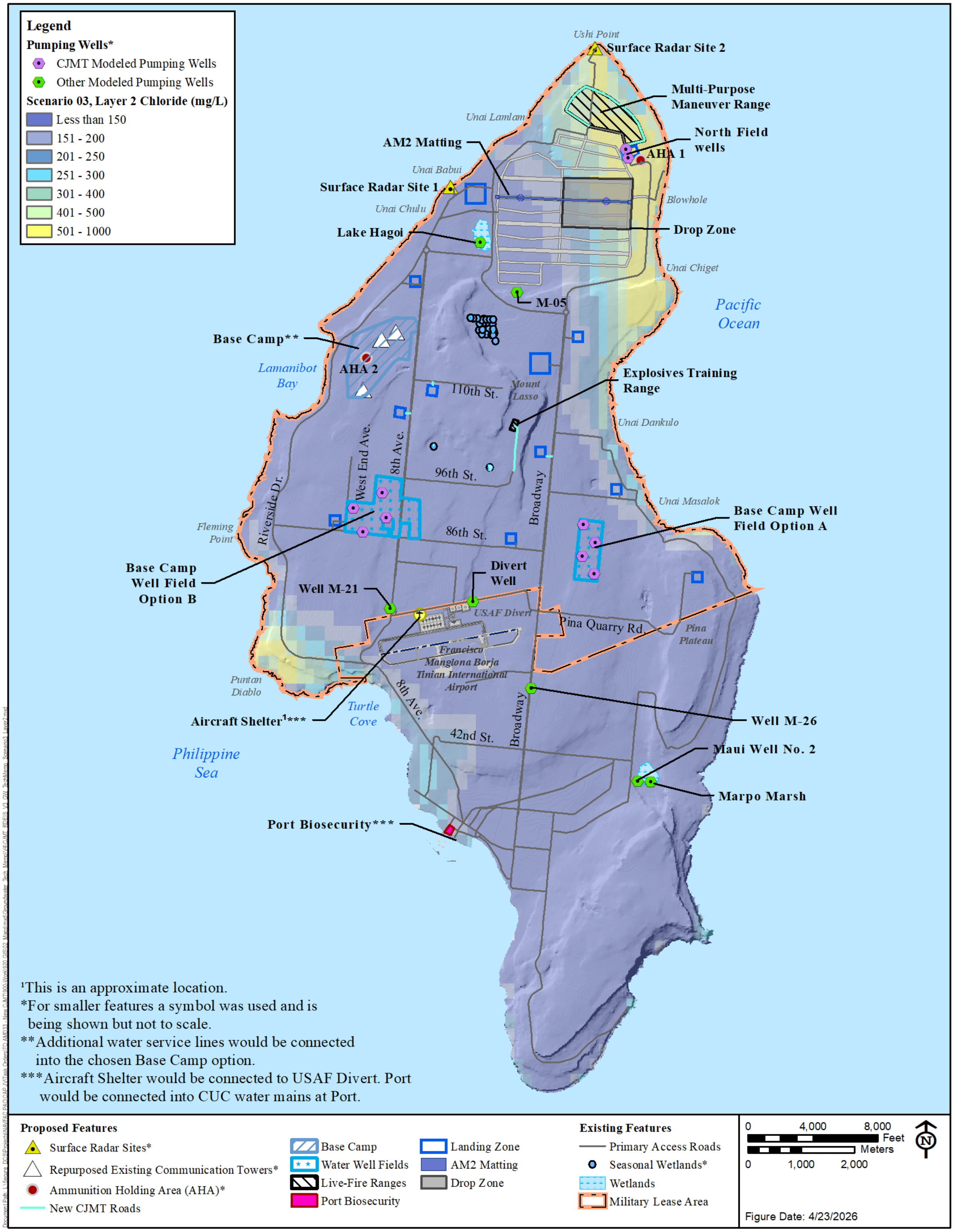

Figure 18.2 Modeled Chloride Concentrations for Layer 2 – Scenario 3

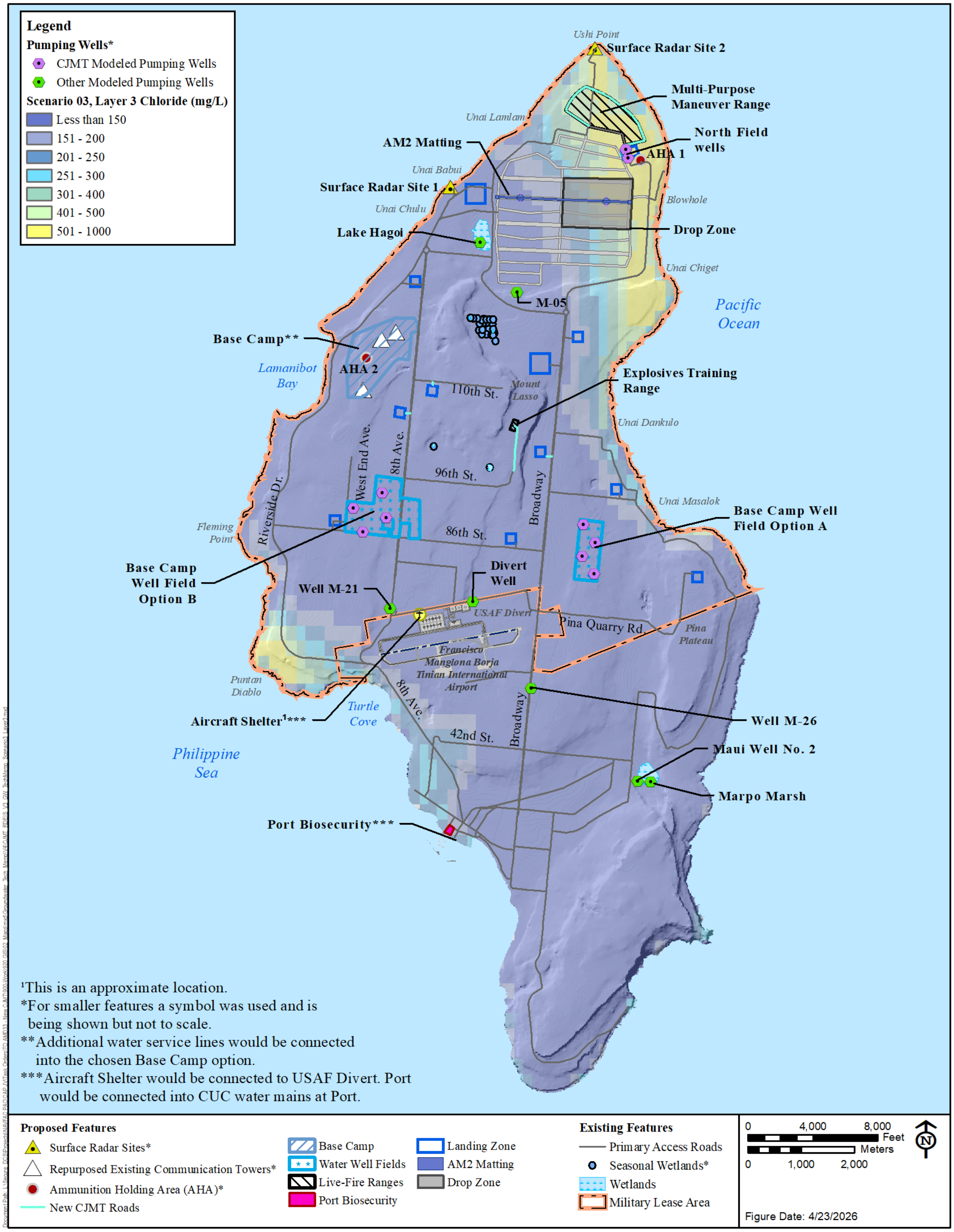

Figure 18.3 Modeled Chloride Concentrations for Layer 3 – Scenario 3

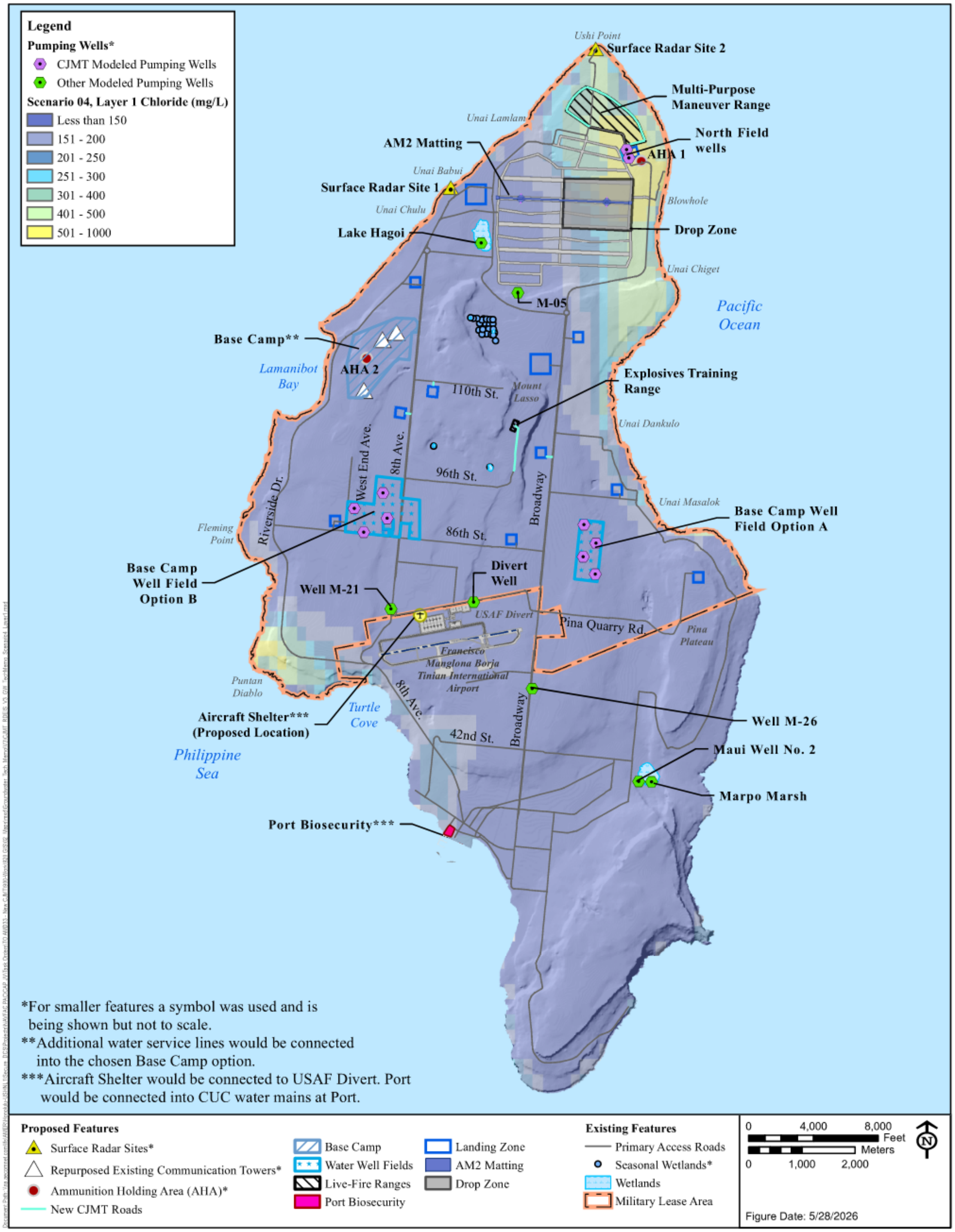

Figure 19.1 Modeled Chloride Concentrations for Layer 1 – Scenario 4

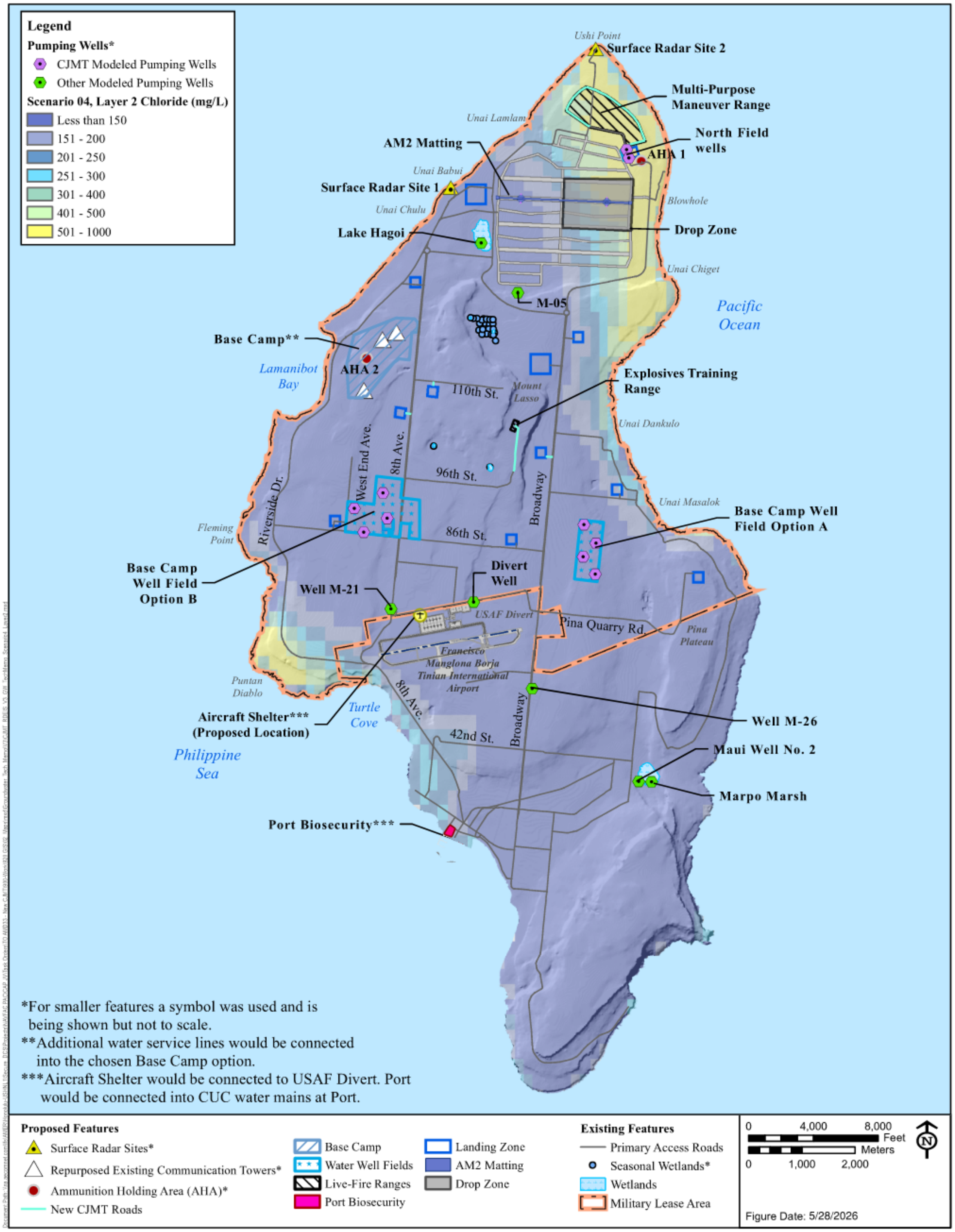

Figure 19.2 Modeled Chloride Concentrations for Layer 2 – Scenario 4

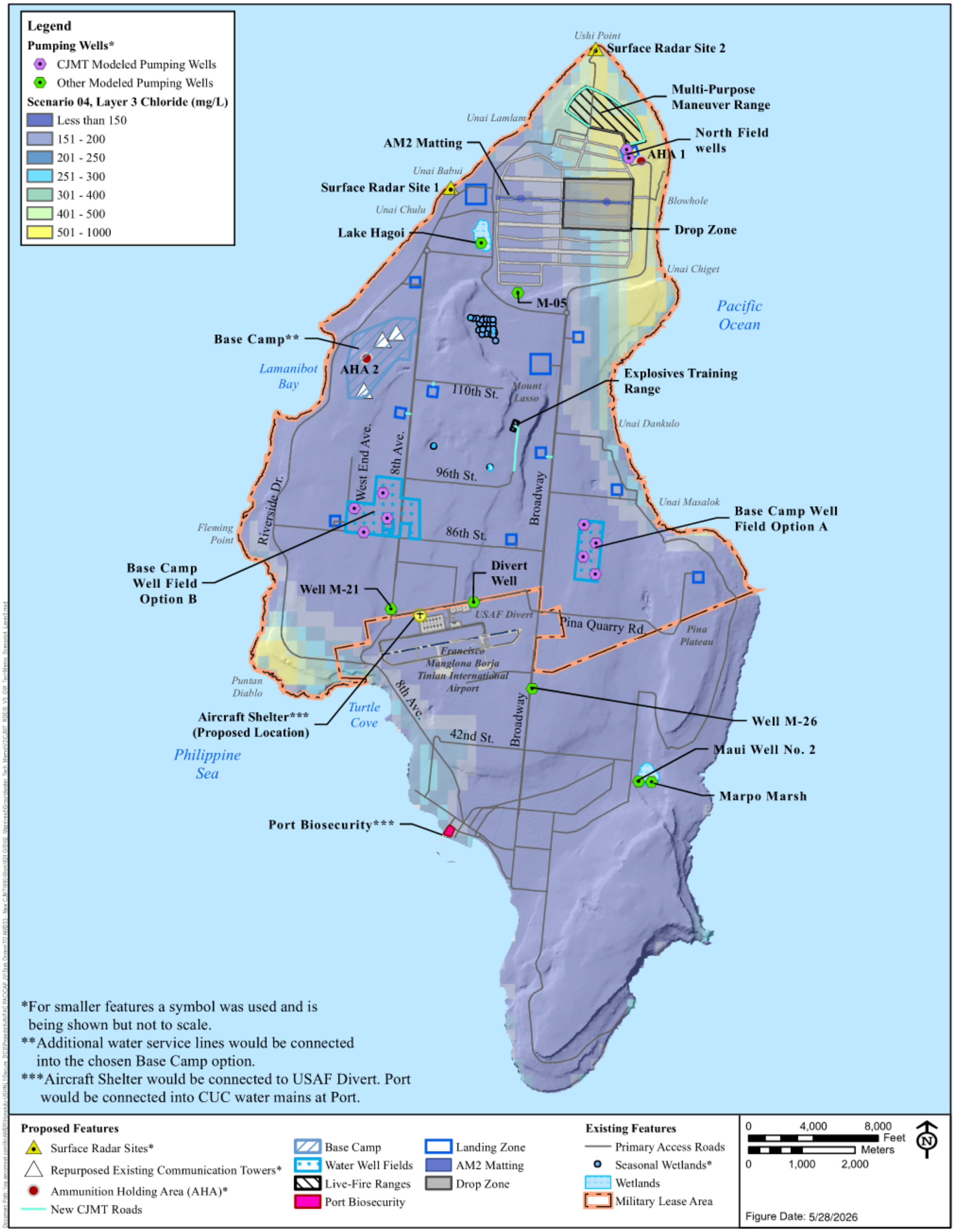

Figure 19.3 Modeled Chloride Concentrations for Layer 3 – Scenario 4

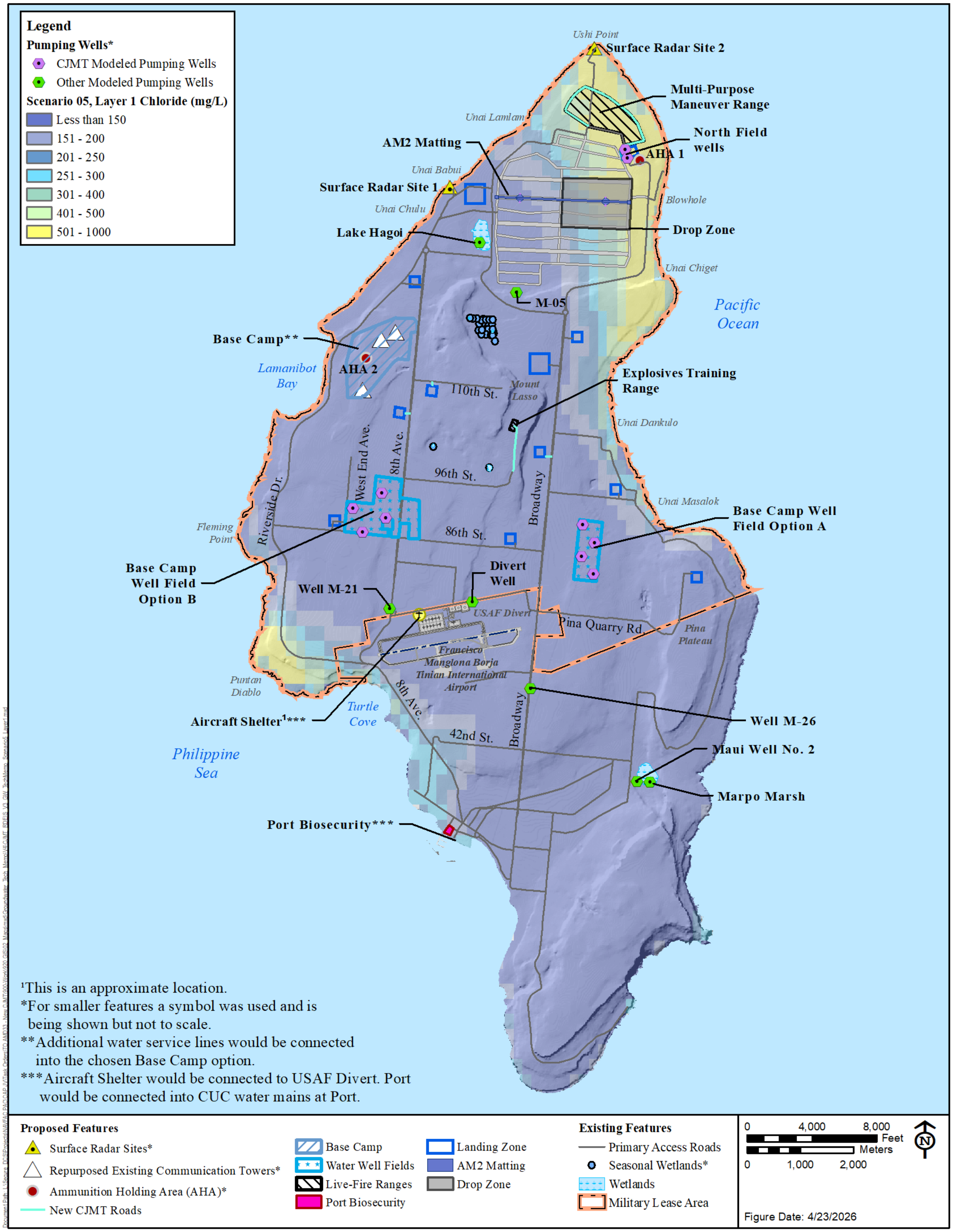

Figure 20.1 Modeled Chloride Concentrations for Layer 1 – Scenario 5

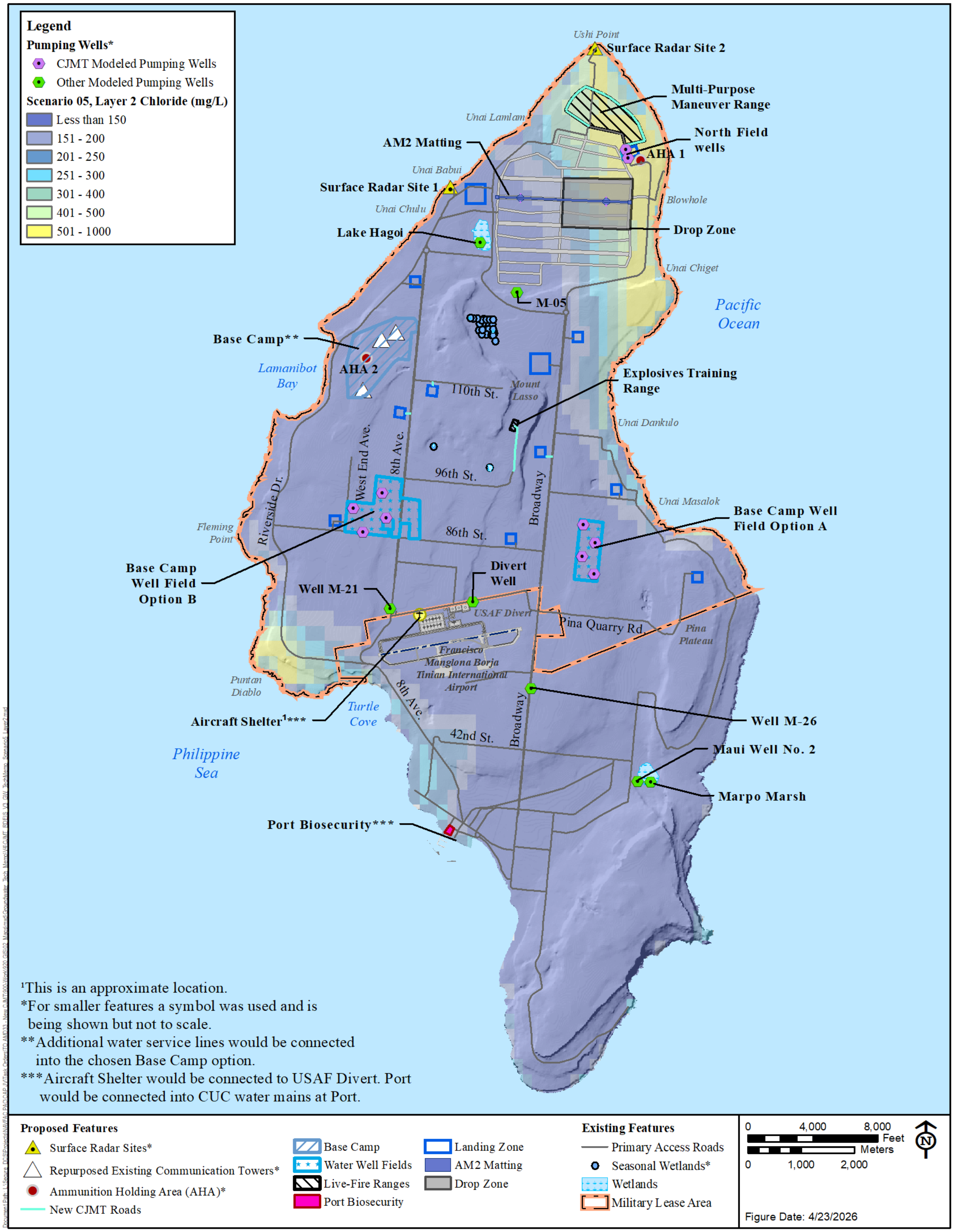

Figure 20.2 Modeled Chloride Concentrations for Layer 2 – Scenario 5

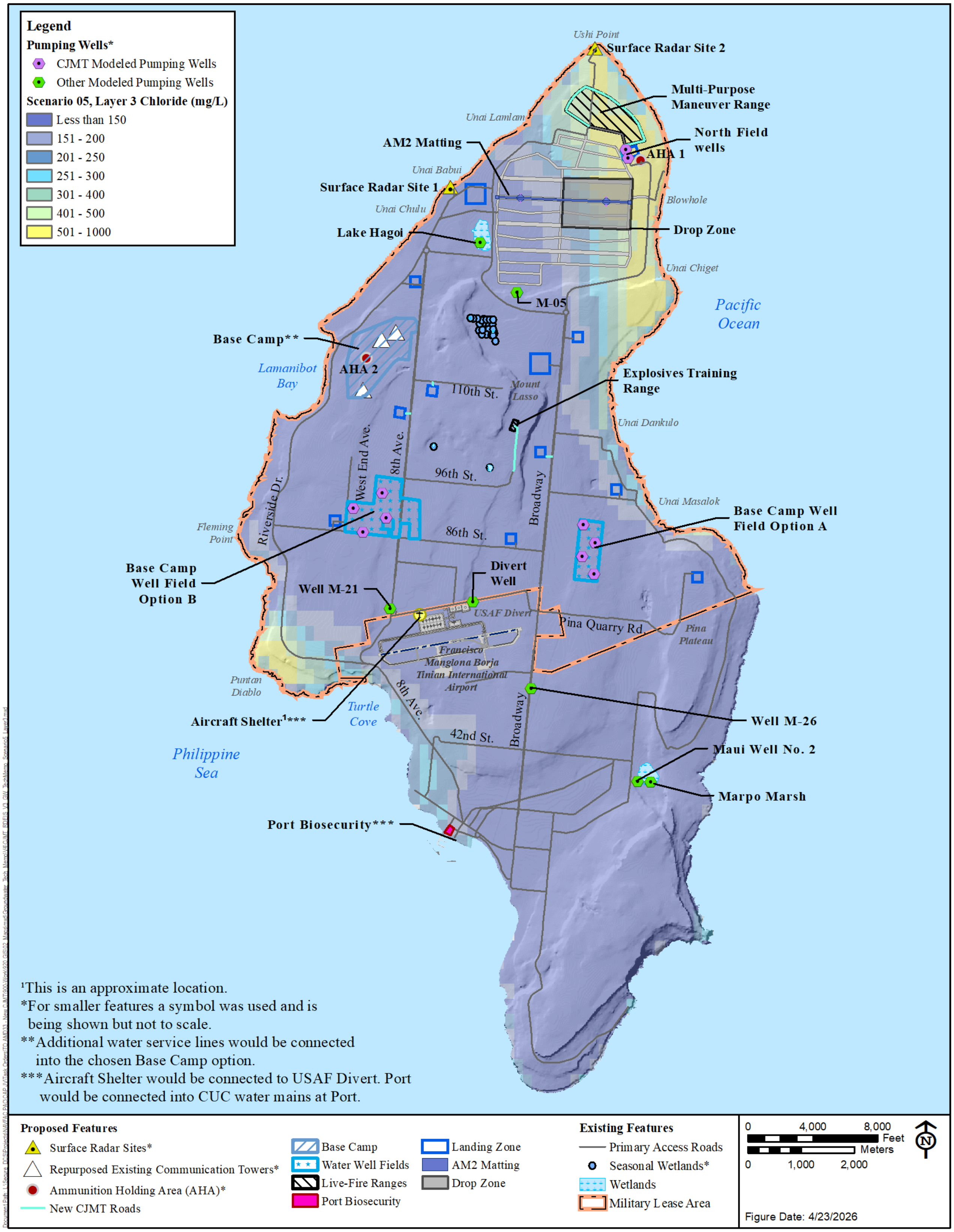

Figure 20.3 Modeled Chloride Concentrations for Layer 3 – Scenario 5

Figure 21 Modeled Groundwater Heads and Groundwater Flow Directions – Scenario 1

Figure 22 Modeled Groundwater Heads and Groundwater Flow Directions – Scenario 3

Figure 23 Modeled Groundwater Heads and Groundwater Flow Directions – Scenario 5

5.7 EFFECTS OF SEA LEVEL RISE

The scope of work for the study also included the following: "Provide technical basis (hydrogeological) for discussion of sea level rise's potential effects on the availability of freshwater via existing and proposed water wells that may assist planners in strategizing future contingency actions." While the groundwater modeling effort evaluated the short-term impact of drought on chloride concentrations, it did not address long-term changes such as sea level rise. In general, it is expected that sea level rise would result in a concomitant rise in the transition and saltwater zones. This phenomenon would not significantly change the amount of freshwater available especially in areas bounded by sea cliffs. However, a significant rise in sea level could necessitate changes in well screen depths. This could require drilling new wells. It is recommended that periodic groundwater samples be collected from the pumping wells and selected monitoring wells to allow for the assessment of fluctuations of both groundwater elevation and chloride concentration.

5.8 SUSTAINABLE YIELD VS. SUSTAINABLE MANAGEMENT OF AQUIFERS

"Sustainable yield" (also sometimes called "Safe Yield") has traditionally been defined as the rate at which groundwater can be continuously withdrawn from an aquifer without impairing the quality or quantity of the pumped water or the environment. On Tinian, specific yield is not related to groundwater quantity. Overextraction (i.e., unsustainable extraction) could reduce the volume of freshwater and induce drawdown, leading to the replacement of freshwater with saltwater from beneath the transition zone and/or the inward migration of saltwater from the coast. Since saltwater from the ocean is effectively infinite, specific yield is not limited by the aquifer size or groundwater volume in storage, as is often the case in inland continental settings. Instead, the sustainable yield limit on Tinian would be the quantity of usable freshwater available without inducing significant salinity increases within the freshwater aquifer. Before groundwater modeling, and in the absence of a reliable model for a specific aquifer, sustainable yield had generally been estimated as a percentage (typically 20–25 percent) of estimated recharge. However, achieving the hypothetically available sustainable yield would require optimized groundwater withdrawal, which usually does not occur. Optimization would require using many small, shallow wells and/or several Maui-style wells distributed relatively uniformly around the island. Because this approach is not feasible nor proposed on Tinian, the full capacity of the aquifer is generally not available for development. In island aquifers, salinity can rise in proportion to the amount of groundwater extracted and as a percentage of recharge. Recognition of these limitations in the sustainable yield concept, along with the advent of new tools and technologies for aquifer management, such as numerical groundwater modeling, remote monitoring of production and water quality, and variable-rate pumps, has led to its supersession by the "sustainable use" or "sustainable management" concept (Alley and Leake 2004).

Reliable models provide useful tools for general estimates of the trade-offs between extraction and water quality. For any given well or well field, however, the most effective management practice involves frequent measurement and tracking of the relationship among water quality, extraction, and recharge, with appropriate adjustments of production as indicated by the data. Therefore, it is crucial for managers to obtain baseline and ongoing data on water quality and well performance.

For the proposed CJMT Base Camp and North Field wells, it is important to maintain running records of water quality, correlated with pumping rates and monthly and annual rainfall. Well fields and individual wells should be constructed so that managers, working with hydrogeologists familiar with the local climate and aquifer properties, can adjust or redistribute the production rates among wells as trends in performance and water quality evolve. Water production, water level and water quality data must be submitted to the CNMI Bureau of Environmental and Coastal Quality upon initial well permitting and annually during re-permitting for operation. Based on that data, Bureau of Environmental and Coastal Quality assigns maximum extraction rates on a well-by-well basis.

The U.S. Geological Survey estimated Tinian's average annual groundwater recharge to be about 30 inches per year, using the bookkeeping method with daily rainfall data from 1987 to 1997 (U.S. Geological Survey 2002). This recharge rate represents approximately 37 percent of the total rainfall and equals to approximately 62,000 acre-feet per year or 55 million gallons per day. Doan et al. (1960) stated there were two air bases and one naval base on the island with a maximum total population of about 250,000 personnel near the end of World War II, and groundwater resources "were adequate" to supply this entire population. Demand at the time was estimated to be approximately 2.3 million gallons per day, which was not thought to be the "maximum exploitable yield." The existing wells at that time provided a maximum supply of 2.5 million gallons per day. It was estimated that a more "ambitious" extraction program (i.e., with additional wells) could yield 3 to 4 million gallons per day. Doan et al. (1960) also referenced a study from Piper (1946) that reported a maximum production of 12 million gallons per day at some unstated date. If this production occurred during World War II, it would represent 48 gallons per person per day with 250,000 personnel on island. No additional information about this report could be found.

The current island demand (including evaporation and evapotranspiration losses) is estimated at approximately 1.1 MGD. Total groundwater consumption, combining civilian use and DoD operations (CJMT, Divert and North Field wells), is estimated at approximately 1.3 MGD. That value represents about 2 percent of the estimated recharge, which is significantly below the theoretical maximum sustainable yield of 20 to 25 percent of recharge mentioned earlier and substantially lower than the 2.3 MGD or 12 MGD reported by Doan et al. (1960) and Piper (1946).

5.9 MODEL LIMITATIONS AND UNCERTAINTIES

A groundwater model is a simplification of the natural environment and inherently has limitations. Consequently, some degree of uncertainty exists in any numerical model's ability to fully predict groundwater flow and contaminant transport. Model output uncertainty arises from uncertainties in the conceptual model, input parameters, and the numerical model's ability to replicate field conditions.

To minimize uncertainty, AECOM used real-world data whenever available and conducted extensive model simulations for calibration. Where data were limited, conservative values were applied to high-uncertainty parameters. Despite these efforts, no warranty, expressed or implied, guarantees that this study accounts for all hydrogeological, hydrological, environmental, or other site-specific characteristics.

The groundwater model developed for this project provides a detailed representation of the subsurface hydrogeology of the island and an extended area beyond the island boundaries. This broader coverage minimizes boundary effects on model results. However, like all numerical models, it has inherent limitations and uncertainties due to data availability, assumptions, and necessary simplifications.

The 2025 AECOM model assumed equivalent porous media. The Tinian aquifer is recognized as a triple-porosity Carbonate Island Karst aquifer where fracture and conduit porosity may be present. Further, the precise locations and hydraulic properties of these features are nearly impossible to document comprehensively in the field and cannot be fully incorporated into current modeling codes, including those used in this study. As a result, salinity responses of individual wells to pumping and contaminant migrations from specific locations may show significant local deviations from the model's prediction. Table 11 summarizes factors that could influence the modeling results and their potential impacts on the results.

Table 11. Model Limitations

Model Limitations	***Potential Impact on Model***
Lack of Detailed Aquifer Data.	a) There are no field test data for specific yield for the limestone (Tagpochau Limestone and/or Mariana Limestone) or volcanic rocks (Tinian Pyroclastic Rock). There was no mention of response to pumping in unpumped observation wells. b) For hydraulic conductivity, there is significant variability (21 feet per day to 23,000 feet per day) in the data from the limestone units and only one pump test in volcanic rocks. c) There are few temporal chloride concentrations. Only one well (Maui Well Number 2) has temporal or recent chloride data. d) There is limited information on spatial distribution of rainfall recharge.
Insufficient Calibration Data: Head and chloride concentration data are spatially and temporally inadequate for calibration.	Limit the model's ability to be well-calibrated, thus reduce reduces confidence in model predictions.
Non-uniqueness Representation of Rock Distribution: Variability in rock extent and distribution introduces uncertainty.	Introduces uncertainty in aquifer properties and model results. Different plausible geologic interpretations yield different hydraulic properties and flow conditions, affecting predicted groundwater movement and solute transport.
Coarse Model Grid: The model grid is relatively coarse, leading to lateral discontinuity in cells that violate the 50% rule of thumb.	Coarse grid may lead to inaccuracies in representing hydrogeologic features (especially near sharp boundaries or abrupt lithologic changes). Lateral discontinuities in cell properties may violate the 50% rule of thumb, potentially distorting hydraulic gradients and solute.
Averaged Chloride Concentrations: Modeled chloride concentrations represent cell-wide averages, which may be too coarse to accurately track specific isochlor (e.g., the 250 mg/L contour).	Localized concentration variations may not be captured. This can lead to smoothed concentration distributions that may not accurately depict isochlors, such as the 250 mg/L contour, affecting the assessment of salinity intrusion.

Model Limitations	***Potential Impact on Model***
Simplified Geological Representation: Geologic features are modeled at a coarse resolution, potentially affecting hydrologic behavior and model accuracy.	May lead to over-simplifications in key hydrostratigraphic features, potentially affect the accuracy of simulated flow paths, aquifer connectivity, leading to inaccurate interpretation of groundwater movement and solute transport.
Conservative Chloride Assumptions: Background and recharge chloride concentrations are likely conservative.	Model results may overestimate chloride impacts, leading to potentially pessimistic projections of salinity intrusion or water quality degradation. While this approach may provide a protective estimate, it could also lead to overly restrictive management decisions.

Legend: % = percent; mg/L = milligram per liter.

As with any groundwater model used to make predictions, achieving more definitive results requires periodically revisiting the model as new data become available and comparing projections with observed conditions. This model in particular was constructed with numerous assumptions due to limited data availability and would benefit from additional data collection. Despite these issues the model results are useful for the purposes intended.

The 2002 USGS model was used as a starting point for developing a 3-D flow and transport model. Combined with the *Aquifer Study Technical Memorandum* (DON 2015) and the more recent Maui Well No. 2 data, this model is considered adequate for environmental evaluation purposes. However, spatial and temporal variation/fluctuation should be anticipated as it is not possible to capture all geologic heterogeneity in a numerical representation of the natural system.

The current model provides conservative projections because where data were limited or unavailable, conservative values were applied to high-uncertainty parameters. For example, relatively low specific yield (or effective porosity) of 28 percent was used in the model, although "the higher values of porosity (30 to 50 percent) seem more likely to be representative of actual aquifer properties (USGS 2002)." The use of a lower specific yield would result in less groundwater in storage, higher groundwater velocities and a shallower freshwater/saltwater interface.

5.10 MODEL SUMMARY

Based on the modeling described herein, the following conclusions are made:

- The Proposed Action (Scenario 2 or 4) is not predicted to increase chloride concentrations at Maui Well No. 2 from 2016 conditions. Under drought conditions (Scenario 3 or 5), the chloride concentration is expected to rise temporarily by less than 20 milligrams per liter and would still meet the secondary maximum concentration level. While the average chloride concentration is not expected to exceed the secondary maximum concentration level on average, seasonal variations in precipitation and pumping, along with analytical variability, could occasionally result in exceedances.
- Under all scenarios, water quality at the proposed Base Camp wells at either Well Field A or Well Field B is expected to meet the secondary chloride maximum concentration level.
- Although the secondary drinking water maximum concentration level does not strictly apply to agricultural, firefighting, or construction wells, the modeling indicates the chloride concentrations at M-21, M-26, M-05, and the Divert well would remain below this

threshold under all scenarios. However, chloride concentrations at the two North Field wells would exceed these standards under normal rainfall and drought conditions.
- The proposed CJMT pumping at either Base Camp well field option plus the new North Field wells is expected to have a less than significant impact on island potable groundwater quality.

This study supports the determination that the Proposed Action would not result in significant impacts to groundwater (short- and long-term availability of water and groundwater quality). Improving the overall resilience of Tinian's aquifer, conducting long term monitoring of the aquifer at large, development of emergency response actions and contingency plans, and assessing the potential vulnerability of the community drinking water system were outside of the scope of this study.

The groundwater model evaluated both drought and normal rainfall scenarios. The model used existing and reasonably foreseeable water demands including Commonwealth Utilities Corporation potable water demand, agricultural demands, U.S. Air Force construction and operational demands, U.S. Air Force operational demands, and USMC construction and operational demands, and USMC operational demands. This analysis conservatively assumed a continuation of construction demands long-term that would actually only be temporary and intermittent.

6 WELL SITING, INSTALLATION AND OPERATION RECOMMENDATIONS

6.1 RECOMMENDATIONS

The USMC will continue to coordinate with the CNMI Bureau of Environmental and Coastal Quality on specific details such as permitting and the locations of wells. Annual CNMI Bureau of Environmental and Coastal Quality permitting requirements include reporting pumping volumes and water quality on a well-by-well basis. Based on this information, the Bureau of Environmental and Coastal Quality determines annually the allowable pumping volume for the following year.

At the request of CNMI, the DoD would fund a one-time hydrogeological study to establish baseline data that could be used to support monitoring of Tinian's aquifer. This study would consist of groundwater sampling at existing well locations, and laboratory testing of water samples. In addition, the DoD would install up to four groundwater monitoring wells at each of the two live-fire ranges, establish a water monitoring plan, and include one year of baseline monitoring before ranges would become operational. The locations of wells would be determined in collaboration with CNMI Bureau of Environmental Quality.

Based on a total borehole depths of approximately 17 feet below msl and completed well screens from roughly msl to 15 feet below msl, it is anticipated that the CJMT wells shown in Figure 4 would provide water that complies with the EPA and CNMI drinking water regulations. These include permits and annual reporting required by Bureau of Environmental and Coastal Quality (Division of Environmental Quality 2005). The practical thickness of the freshwater lens (i.e., depth within which chloride is less than the secondary maximum concentration level of 250 milligrams per liter) is generally much thinner than the theoretical 50% isochlor (chloride concentration equal to approximately 9,700 milligrams per liter). The freshwater lens thickness can also vary seasonally and with change in annual rainfall. Past practice elsewhere on the Mariana Islands has been to screen or leave open wells from the water table down to 40–50 feet below mean sea level. However, accumulated experience with drilling and well development elsewhere on the Mariana Islands (Camp, Dresser and McKee, Inc. 1982), along with more recent developments (Gulley et al. 2012), suggest that most of the production in productive wells comes from the first 15–20 feet below mean sea level due to the preferential development of phreatic caves near the freshwater table. Prospects for saltwater contamination could be reduced by limiting well completion depths. Consistent with the sustainable management concept in the *Aquifer Study Technical Memorandum* (DON 2015), increasing the number of wells, setting them at shallower depths, and operating them at more modest rates than traditionally sought would enhance the water quality while achieving overall production goals.

Based on the specific capacities from the pump tests cited in the *Aquifer Study Technical Memorandum* (DON 2015), it is expected that drawdown associated with pumping approximately 60 gallons per minute could range from about 0.1 to 19 feet. To maintain well performance and water quality, drawdown should not be allowed to exceed approximately 0.5 foot. Therefore, boreholes should be pump tested to confirm adequate specific capacity prior to well completion. Significant seawater intrusion (lateral migration and/or upconing) is not expected to cause dissolved solids and chloride if well screens are set no deeper than 15 feet below msl and pumping rates are limited to produce no more than the drawdown listed above. However, this should be monitored frequently throughout the life of each well, and wells should be constructed with adjustable pumping capabilities to optimize both production and water quality. Given the characteristics of this aquifer, water quality from wells is likely to respond rapidly to changes in pumping rates. Even with conscientious management, occasional increases in salinity may occur in individual wells, particularly during extended dry periods or long-term sea level fluctuations. In such cases, reduced pumping or replacing the affected well may be necessary to maintain water quality.

The CJMT wells should draw water primarily from the Tagpochau Limestone and the Mariana Limestone. Because the limestone may be thinner in some areas (i.e., the basement rock is shallower), lithologic and geophysical logging should be performed at each pilot hole to confirm adequate limestone thickness. Locations outside of well fields A or B were not evaluated. Additional recommendations for well siting, setbacks, installation, testing, and operation are provided in the *Aquifer Study Technical Memorandum* (DON 2015).

6.2 WELL SITING AND INSTALLATION

Prior to finalizing location of any of the exploratory wells at candidate sites the following should be performed:

- Review of the following figures from the *Aquifer Study Technical Memorandum* (DON 2015): Figure 5.7-1 (Analytical Results on Gingerich and Yeatts 2000 Groundwater Levels), Figure 5.7-2 (Hydraulic Head and Groundwater Flow Direction), Figure 5.7-3 (Surface Geology and Proposed Well Network), Figure 5.7-4 (Topography, Hydrology and Depressions on U.S. Navy 2010 Aerial Photo), and Figure 6.1-1 (Proposed Wells on Doan and Other, 1960 Groundwater Resources Map).
- Site reconnaissance before and after vegetation clearing to find any surface debris, tanks, piping, soil discoloration, or collapse features.
- Unexploded ordnance, munitions and explosives of concern, and utility clearance.
- Mapping of any surface geologic exposures collapse features or manmade features.
- Any future wells should be sited within the well fields A or B shown in Figure 4. The wells would be located outside of proposed training constraints, proposed water disposal/infiltration features, biological constraints, cultural constraints, hazardous waste/hazardous materials constraints, fractures, joints, faults, and karst features.
- Step testing and constant-rate pump testing of pilot holes and completed wells. Pilot borings with expected drawdown of 2 feet or more and/or a specific capacity of less than 30 gallons per minute per foot of drawdown should not be completed. Such holes could be considered for monitoring wells by which to observe changes in water levels and quality.
- Water quality testing of a whole water sample collected near the end of pump testing for all Safe Drinking Water Act analytes.
- Periodic samples should also be collected during pilot-hole and completed-well step- and constant-rate pump testing and analyzed in accordance with the CNMI *Well Drilling and Well Operation Regulations* (Department of Environmental Quality 2005). Hourly samples

should be collected throughout the pumping phase for chloride analysis. Transducers that record water level and specific conductivity should be used to augment hourly samples.

- Video-logging of new boreholes and completed wells. Logging of new holes, and archiving of the video, would provide a basis for the hydrogeologist(s) to make informed predictions and diagnoses of well performance, as well as subsequent mitigation decisions regarding causes and appropriate responses to changes in salinity.
- Well field and well design include the following considerations: Wells should be spaced no closer than allowed by the setbacks by Bureau of Environmental and Coastal Quality, and wells should not be placed any closer than 500 feet from each other or karst collapse features.
- Minimum 12-inch-diameter pilot holes should be drilled to no more than 17 feet below sea level.
- Pilot holes should be geologically logged based on cuttings and geophysically logged using tools (i.e., spontaneous potential, resistivity, gamma, guard resistivity, acoustic [sonic] log) to include character of limestone and evidence of faults, joints, fractures, and solution cavities. Tools should selected and positioned to optimize geophysical signals.
- The well screens should extend from sea level to a nominal depth of 15 feet below mean sea level.
- Following geophysical logging, the pilot hole should be reamed to a minimum 18-inch diameter. A caliper log should be performed of the reamed borehole (if the caliper survey shows the hole to be less than the specified diameter at any point, the hole should be re-reamed and resurveyed).
- Completed well borings should be at least 18 inches in diameter.
- Wells should be constructed of 12-inchdiameter, 5/16-inch thick, high-strength, low-alloy casing (ground surface down to 20 feet above mean sea level) and 304L stainless steel casing (20 feet above mean sea level down to mean sea level) connected with a di-electric coupler approximately 20 feet above mean sea level and 12-inchdiameter, 5/16-inch 304L, stainless steel Roscoe Moss Ful Flo screen, and a 2-foot long by 18 5/16-inch stainless steel casing well sump.
- Screen aperture and filter pack/formation stabilizer gradation should be designed by the hydrogeologist and engineer designing the wells.
- The casing should be round, straight, and plumb. The deviation of the casing is measured from a plumb vertical line centered at the top of the inner casing and is calculated as the actual deviation of the well casing from this centerline at the depth of the caging tool. Testing should be conducted to verify the plumbness and alignment of the casing. The completed well should be drilled in such vertical alignment that a line drawn from the center of the well casing at ground surface to the center of the well casing at the bottom depth below ground surface should not deviate from the vertical more than 2/3 of the inside diameter of the well casing per 100 feet of depth (American Water Works Association A100). Two plots of plumbness and alignment of the completed well should be completed in planes oriented at 90 degrees with respect to each other.
- The design flow rate should be no more than 60 gallons per minute per well. To reduce the risk of pump cavitation, provide adequate pump cooling, and accommodate seasonal and decadal ocean water elevation changes, the pump intake should be placed a nominal 14 feet

below mean sea level. Well pumping rates should be modulated to prevent drawdown greater than 0.5 feet in each well.

- It is also assumed that Bureau of Environmental and Coastal Quality would require monitoring wells associated with the new production wells as described in the CNMI *Well Drilling and Well Operations Regulations* (Department of Environmental Quality 2005). Although the final numbers and locations cannot be determined before consultation with Bureau of Environmental and Coastal Quality and possibly additional investigation for planning purposes, it is recommended that at least one deep monitoring well (through the transition zone) at the new CJMT well field be installed to allow profiling of the salinity and tracking of its response to changes in well pumping, rainfall recharge, and ocean water levels.
- Any wells or boreholes not to be used as production or monitoring wells should be properly abandoned under the direction of Bureau of Environmental and Coastal Quality.
- Production wells should include a 3-inch diameter gravel feed tube and 2-inch diameter sounding tube. The filter pack/formation stabilizer and transition sand should be installed. The filter pack/formation stabilizer should be installed a minimum of 15 feet above the top of the screen interval.
- The filter pack/formation stabilizer should be placed by pumping through a tremie pipe extending to the bottom of the casing hole annulus. The tremie pipe should be gradually withdrawn as the filter pack/formation stabilizer is placed. Swabbing and circulating should be continued during placement of the filter pack/formation stabilizer.
- After the filter pack/formation stabilizer has been swabbed into place to the proper depth, the transition sand should be installed a minimum of 10 feet above the top of the filter pack/formation stabilizer.
- The filter pack/formation stabilizer should be disinfected with chlorine during placement as per specifications. The completed well, pumping equipment, and piping should be disinfected in accordance with the CNMI *Well Drilling and Well Operation Regulations* (Department of Environmental Quality 2005).
- After the transition sand is installed, the annular space between the borehole and the well casing should then be filled with cement grout from the top of the filter pack/formation stabilizer to 18 inches below the ground surface.
- A total of 48 hours after the installation of cement-bentonite grout, the well should be carefully swabbed to properly settle the sand pack.
- The completed well should be developed by surge-block-and-air-lift method for a minimum of 6 hours.
- The completed well should be video-logged from top to bottom to document well conditions.
- A submersible or line-shaft turbine test pump should be installed.
- An 8-hour step test should be performed with steps at 50 percent, 75 percent, 100 percent, and 125 percent of design capacity.
- Following review of drilling logs, geophysical logs, video log, and step test data, a 48-hour constant rate test should be performed at a rate determined from the step test.

7 MODELING TEAM

The groundwater team members and team roles are listed below:

- **Groundwater Team Leader.** Doug Roff, PG, CEG, CHg.
- **Modeling Team.** Jim Zhang, PhD, PE (lead); Bianca Mintz, PG, CHg; Doug Roff, PG, CEG, CHg.
- **Geology/Hydrogeology Team.** Doug Roff, PG, CEG, CHg**;** Bianca Mintz, PG, CHg
- **Reviewer.** Joe Harrigan, PG.

8 REFERENCES

Alley, W.M. and Leake, S.A. 2004. The Journey from Safe Yield to Sustainability. *Groundwater*. 42: 12-16. https://doi.org/10.1111/j.1745-6584.2004.tb02446.x

Aquaveo. 2021. *GMS - Groundwater Modeling System v10.8*. https://www.aquaveo.com/software/gms-groundwater-modeling-system-introduction

American Society for Testing and Materials. 2010a. *Standard Guide for Application of a Groundwater Model to a Site-Specific Problem.* ASTM D5447−04.

American Society for Testing and Materials. 2010b. *Standard Guide for Selecting a Groundwater Modeling Code.* ASTM D6170-17.

Allied Pacific Environmental Consulting (APEC). 2025. *Constant-Rate Pumping Test Report, Tinian North Field, CNMI – Ushi & M-10 Wells*. December.

Baydon-Ghyben, W. 1888–1889. *Nota in Verband Met de Voorgenomen Putboring Nabij Amsterdam*. Koninklyk Institute Ingenieurs Tijdschrift. Pages 8–22.

Camp, Dresser and McKee, Inc. 1982. *Northern Guam Lens Study, Groundwater Management Program, Aquifer Yield Report.* Prepared by Camp, Dresser and McKee, Inc. in association with Barrett, Harris & Associates for Guam Environmental Protection Agency.

Commonwealth Utilities Corporation. 2013. "Commonwealth Utilities Corporation 2012 Water Quality Report." *Commonwealth Utility News.* July 1.

Commonwealth Utilities Corporation. (2014). "2013 Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2015). "2014 Water Quality Report." June.

Commonwealth Utilities Corporation. (2016). "2015 Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2017). "2016 Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2018). "2017 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2019). "2018 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2020). "2019 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2021). "2020 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2022). "2021 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2023). "2022 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Commonwealth Utilities Corporation. (2024). "2023 Tinian Water Quality Report." *Commonwealth Utility News*. July.

Department of Environmental Quality. 2005. *Well Drilling and Well Operation Regulations.* Office of the Governor. September.

Doan, D. B., H. W. Burke, H. G. May, and C. H. Stensland. 1960. *Military Geology of Tinian, Mariana Islands*. Prepared under the direction of the Chief of Engineers, U.S. Army by the Intelligence Division, Office of the Engineer Headquarters, United States Army Pacific with personnel of the United States Geological Survey. Available at: http://search.library.cornell.edu/catalog/5099117.

DON. 2015. *Final (Version 3) Commonwealth of the Northern Mariana Islands Joint Military Training Aquifer Study Technical Memorandum.* JBPHH, HI: Prepared for NAVFAC Pacific. November.

DON. 2025. *Potable Water Study Update V2a3 in Support of the Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact.* JBPHH, HI: Prepared for NAVFAC Pacific. April.

EMRL. 2005. Groundwater Modeling System (GMS). Environmental Modeling and Research Laboratory. Brigham Young University. Version 6.0.

Essaid, H. I. 1990. *The Computer Model SHARP, a Quasi-Three-Dimensional Finite-DIFFERENCE model to Simulate Freshwater and Saltwater Flow in Layered Coastal Aquifer Systems*. U.S. Geological Survey, Water-Resources Investigations Report 90-4130.

Gulley, J. D., J. B. Martin, P. J. Moore, and J. Murphy. 2012. *Formation of Phreatic Caves in an Eogenetic Karst Aquifer by CO_2 Enrichment at Lower Water Tables and Subsequent Flooding by Sea Level Rise: Earth Surface Processes and Landforms*. DOI: 10.1002/esp.3358.

Herzberg, A. 1901. "Die Wasserversorgung Einiger Nordseebader*." Journal Gasbeleuchtung und Wasservesorgung* 44:815–819, 842–844.

Hill, M.C., E.R. Banta, A.W. Harbaugh, and E.R. Anderman. 2000. MODFLOW 2000. "The U.S. Geological Survey Modular Ground-Water Model; User Guide to the Observation, Sensitivity, and Parameter-Estimation Processes and Three Post-Processing Programs." Open-File Report 00 184. U.S. Geological Survey. Denver Colorado.

Jenson, J. W., T. M. Keel, J. R. Mylroie, J. E. Mylroie, K. W. Stafford, D. Taborosi, and C. Wexel. 2006. "Karst of the Mariana Islands: The Interaction of Tectonics, Glacio-Eustasy, Fresh-Water/Salt-Water Mixing in Island Carbonates." *Geological Society of America Special Papers* 404:129–138.

Lawlor, J.P. 1946. *Skimming trench solves a coral island water supply problem: Engineering News-Record*, v. 137, p. 993-995.

McDonald, M.G., and A.W. Harbaugh. 1988. "A Modular Three-Dimensional Finite-Difference Ground-water Flow Model." Book 6, Chapter A1. *Techniques of Water-Resources Investigations of the United States Geological Survey.* USGS. Reston, Virginia.

National Oceanic and Atmospheric Administration (NOAA), National Integrated Drought Information System (NIDIS), and partners. 2025. *Pacific Region Climate Impacts and Outlooks: Fall 2025.* Prepared by Simeral, David, in cooperation with NOAA Climate Prediction Center and affiliated Pacific regional partners. Available at: https://www.drought.gov/sites/default/files/2025-12/Pacific%20Fall%202025.pdf

Rotzoll, K., S. B. Gingerich, J. W. Jenson, and A. I. El-Kadi. 2013. "Estimating Hydraulic Properties from Tidal Attenuation in the Northern Guam Lens Aquifer, Territory of Guam, USA." *Hydrogeology Journal* 21(3):643–654.

Stafford, K. W., J. E. Mylroie, and J. W. Jenson. 2004. *Karst Geology of Aguijan and Tinian: CNMI Cave Inventory and Structural Analysis of Development.* WERI Technical Report No. 106.

Stafford, K. W., J. E. Mylroie, D. Taboroši, J. W. Jenson, and J. R. Mylroie. 2005. "Karst Development on Tinian, Commonwealth of the Northern Mariana Islands: Controls on Dissolution in Relation to the Carbonate Island Karst Model." *Journal of Cave and Karst Studies* 67(1):14–27.

Tetra Tech. 2012. *Geotechnical Design Report for the Tinian Landfill, Tinian, MP.* Tamuning, Guam. Prepared for Commonwealth of the Northern Mariana Islands Capital Improvement Program Office/Office of the Governor, Saipan, MP. February.

United States Department of Agriculture, Soil Conservation Service (USDA SCS). 1989. *Soil Survey of the Islands of Aguijan, Rota, Saipan, and Tinian, Commonwealth of the Northern Mariana Islands.* Prepared by Young, Fred, in cooperation with the Commonwealth of the Northern Mariana Islands.

U.S. Geological Survey. 1999. *Topographic Map of the Island of Tinian, Commonwealth of the Northern Mariana Islands.* Available at: http://mappery.com/map-of/Tinian-island-topo-Map.

U.S. Geological Survey. 2000. *Ground-Water Resources of Tinian, Commonwealth of the Northern Mariana Islands* (No. 00-4068). U.S. Geological Survey Water-Resources Investigations Report 00-4068. Prepared by Gingerich, S. B., and D. S. Yeatts. Prepared in cooperation with the Commonwealth Utilities Corporation, Commonwealth of the Northern Mariana Islands. Available at: http://pubs.usgs.gov/wri/2000/4068/.

U.S. Geological Survey. 2002. *Geohydrology and Numerical Simulation of Alternative Pumping Distributions and the Effects of Drought on the Ground-Water Flow System of Tinian, Commonwealth of the Northern Mariana Islands.* U.S. Geological Survey Water-Resources Investigations Report 02-4077. Prepared by Gingerich, S. B. Prepared in cooperation with the Commonwealth Utilities Corporation, Commonwealth of the Northern Mariana Islands.

U.S. Geological Survey. 2008. *SEAWAT Version 4: A Computer Program for Simulation of Multi-Species Solute and Heat Transport.* U.S. Geological Survey Techniques and Methods Book 6, Chapter A22. Prepared by Langevin, C.D., Thorne, D.T., Jr., Dausman, A.M., Sukop, M.C., and G. Weixing.

U.S. Geological Survey. 2013. *The Effects of Withdrawals and Drought on Groundwater Availability in the Northern Guam Lens Aquifer, Guam*. U.S. Geological Survey Scientific Investigations Report 2013-5216. Prepared by Gingerich, S. B. Prepared in cooperation with Headquarters, United States Marine Corps.

Wang, H.F. and M.P. Anderson. 1982. *Introduction to Groundwater Modeling: Finite Difference and Finite Element Methods.* San Diego, CA: Academic Press, Inc., A Division of Harcourt Brace & Company.

Vann, D. T., V. M. Bendixson, D. F. Roff, N. C. Habana, C. A. Simard, R. M. Schumann, and J. W. Jenson. 2013. *Topography of the Basement Rock beneath the Northern Guam Lens Aquifer and Its Implications for Groundwater Exploration and Development.* Technical Report #142. Water & Environmental Research Institute of the Western Pacific, University of Guam.

Zheng, C. 1990. *MT3D, A Modular Three-Dimensional Transport Model for Simulation of Advection, Dispersion and Chemical Reactions of Contaminants in Groundwater Systems.* Report to the U.S. Environmental Protection Agency. Robert S. Kerr Environmental Research Laboratory. Ada, Oklahoma. October.

Zheng, C. and P.P. Wang. 1999. *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion and Chemical Reactions of Contaminants in Groundwater Systems (Release DoD_3.50.A) Documentation and User's Guide.* U.S. Army Corps of Engineers. Contract Report SERDP-99. Tuscaloosa, AL: University of Alabama.

ATTACHMENT A
KNOWN CURRENT AND FORMER WELLS ON THE ISLAND OF TINIAN

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Table A-1. Known Current and Former Wells on the Island of Tinian

Well Name	*Other Well Names*	*Owner*	*Installed By*	*Date Well Drilled*	*Type*	*Wellhead or Measuring Point Elevation (ft)*	*Well Depth Below msl (Negative Values = Above msl)*	*Chloride Content (Various Sources)*		*Water Production (gpm) (Doan et al. 1960)*	*Water Production (gpm) (Various Sources)* [b]	*Original Function*	*Current Status*
						ft	*ft*	*Before Pumping (mg/L)*	*After Pumping (mg/L)*	*gpm*	*gpm*		
Ag-20	W-40B, Small Marpo (Japanese) Well	CNMI government	Japanese military	1930s	Dug, cement-lined trench	7.1	1.0					Watering cattle/ irrigation	Inactive
Ag-30	W-40A, Large Marpo (Japanese) Well	CNMI government	Japanese military	1930s	Dug, cement-lined trench	5.08	5.0	130	130	0	500	Watering cattle/ irrigation	Active agricultural well
Hag-N	W-43, North Hagoi		Japanese military	1930s	Dug, cement-lined trench	4.4	2.0	622				Watering cattle/ irrigation	Inactive
Hag-S	W-44, South Hagoi		Japanese military	1930s	Dug, cement-lined trench	7.54	1.0	148	360			Watering cattle/ irrigation	Inactive
M-02 [c]	W-2, Civilian Affairs Well	CNMI government	U.S. military	8/5/1997	Drilled, 6 in (15 cm) solid steel cased well	264.56	12.0		20	100		Water supply	Inactive
M-05 [c]	W-5, Asiga Well	CNMI government	U.S. military	7/31/1997	Drilled, 6 in (15 cm) solid steel cased well	108.8	13.0		75	75		Water supply	Inactive
M-07 [c]	W-7, W 100 St. Well	CNMI government	U.S. military	5/19/1995	Drilled, 6 in (15 cm) solid steel cased well	241.35	19.0			100	23	Water supply	Inactive
M-08 [c]	W-8, 110 St. Well	CNMI government	U.S. military	8/14/1997	Drilled, 6 in (15 cm) solid steel cased well	266.07	16.0	100	600	100		Water supply	Inactive
M-09 [c]	W-9, NAB #1	CNMI government	U.S. military	4/24/1995	Drilled, 6 in (15 cm) solid steel cased well	265.08	15.0		107		128	Water supply	Inactive
M-10 [c]	W-10	CNMI government	U.S. military	3/20/1997	Drilled, 6 in (15 cm) solid steel cased well	95	14.0		220	60		Water supply	Inactive
M-11 [c]	W-11, NAB #2	CNMI government	U.S. military	3/14/1995	Drilled, 6 in (15 cm) solid steel cased well	292.03	14.0				124	Water supply	Inactive
M-15 [c]	W-15, Broadway Well	CNMI government	U.S. military	5/29/1997	Drilled, 6 in (15 cm) solid steel cased well	193.84	17.0	35	70	70		Water supply	Inactive
M-16 [c]	W-16, 2nd Ave. Well	CNMI government	U.S. military	2/24/1995	Drilled, 8 in (20 cm) solid steel cased well	153.39	14.0	106	45		96	Water supply	Inactive
M-19 [c]	W-19, 8th Ave. Well	CNMI government	U.S. military	6/5/1997	Drilled, 6 in (15 cm) solid steel cased well	247.92	14.0				30	Water supply	Inactive
M-21 [c]	WOP-151/152, W-21, Mendiola Well, 67th St. Well	CNMI government	U.S. military	1/11/1997	Drilled, 6 in (15 cm) solid steel cased well	243.29	17.0	80		60	49	Water supply	Active agricultural well
M-22 [c]	W-22, 90th St. Well	CNMI government	U.S. military	6/30/1997	Drilled, 6 in (15 cm) solid steel cased well	222.73	8.0		150	40		Water supply	Inactive
M-25 [d]	W-25, East Side Well	Unknown	U.S. military	09/19/87?	Drilled, 6 in (15 cm) solid steel cased well	211.94	88.0	196		30		Water supply	Inactive
M-26 [d]	UPW-008, W-26, 59th St. Well	Unknown	U.S. military	1987?	Drilled, 6 in (15 cm) solid steel cased well	340.83	30.0	40		35		Water supply	Active agricultural well
M-29 [c]	W-29, West Field Well	CNMI government	U.S. military	2/12/1997	Drilled, 6 in (15 cm) solid steel cased well	247.04	168.0					Water supply	Inactive
M-33 [c]	W-33, 72nd St. Well	CNMI government	U.S. military	8/20/1997	Drilled, 6 in (15 cm) solid steel cased well	235.63	10.0	50				Water supply	Inactive
M-35 [c]	W-35	CNMI government	U.S. military	7/25/1997	Drilled, 6 in (15 cm) solid steel cased well	257.23	13.0					Water supply	Inactive
M-39 [c]	W-39	CNMI government	U.S. military	5/15/1997	Drilled, 6 in (15 cm) solid steel cased well	238.93	11.0		150			Water supply	Inactive

Well Name	*Other Well Names*	*Owner*	*Installed By*	*Date Well Drilled*	*Type*	*Wellhead or Measuring Point Elevation (ft)*	*Well Depth Below msl (Negative Values = Above msl)*	*Chloride Content (Various Sources)*		*Water Production (gpm) (Doan et al. 1960)*	*Water Production (gpm) (Various Sources)* [b]	*Original Function*	*Current Status*
						ft	*ft*	*Before Pumping (mg/L)*	*After Pumping (mg/L)*	*gpm*	*gpm*		
Maui Well No. 1	W-41, formerly Municipal Well, Marpo Well	CNMI government	U.S. military	1945	Dug, out-of-service municipal water supply well (Maui-type horizontal construction - constructed of 240 steel cylindrical bomb crates joined end to end and perforated)	9.76	-9.8	97	100		780	Drinking water supply well	Out of service
Maui Well No. 2	Municipal Well	CNMI government	CNMI government	2000	Municipal water supply well (Maui-type horizontal construction)						875	Drinking water supply well	Active use
ObsB		Unknown	USGS	2/2/1991	USGS 4 in (10 cm) monitoring piezometer (PVC pipe-cased)	7.45	0.5					Groundwater monitoring well	Unknown
Pala	W-45	Tinian Palacios family	Japanese military	1930s	3 ft (0.9 m) diameter, hand dug well	65	3.0	185	200				Active use
Taga		CNMI government	Ancient Chamorro	Unknown	Shallow-dug well								Unknown
TH-01		CNMI government	USGS	9/17/1996	USGS 12 in (30 cm) monitoring well	117.46	13				165	Groundwater monitoring well	Unknown
TH-02		CNMI government	USGS	4/28/1997	USGS 8 in (20 cm) monitoring well	158.86	94					Groundwater monitoring well	Unknown
TH-03		CNMI government	USGS	10/24/1996	USGS 8 in (20 cm) monitoring well	109.05	22				105	Groundwater monitoring well	Unknown
TH-04		CNMI government	USGS	12/13/1993	USGS 8 in (20 cm) monitoring well	72.18	18				108	Groundwater monitoring well	Unknown
TH-05		CNMI government	USGS	6/21/1995	USGS 8 in (20 cm) monitoring well	120.85	18				92	Groundwater monitoring well	Unknown
TH-06		CNMI government	USGS	3/2/1995	USGS 6 in (15 cm) monitoring well	309.07	13				57	Groundwater monitoring well	Unknown
TH-07		CNMI government	USGS	1/20/1995	USGS 6 in (15 cm) monitoring well	343.84	20				50	Groundwater monitoring well	Unknown
TH-08		CNMI government	USGS	1/29/1993	USGS 4 in (10 cm) monitoring well	8.24	92					Groundwater monitoring well	Unknown
TH-09		CNMI government	USGS	2/3/1993	USGS 4 in (10 cm) monitoring well	6.7	92					Groundwater monitoring well	Unknown
TH-10		CNMI government	USGS	10/9/1996	USGS 8 in (20 cm) monitoring well	163.74	16				68	Groundwater monitoring well	Unknown
TH-11		CNMI government	USGS	2/25/1997	USGS 6 in (15 cm) monitoring well	339.66	19				63	Groundwater monitoring well	Unknown
TH-12		CNMI government	USGS	1/8/1997	USGS 8 in (20 cm) monitoring well	146.41	13				72	Groundwater monitoring well	Unknown
TH1-9		CNMI government	USGS	7/26/1995	USGS 8 in (20 cm) monitoring well	550	29					Groundwater monitoring well	Unknown
TH-1X		CNMI government	USGS	10/1/1996	USGS 6 in (15 cm) monitoring well	116.99	15					Groundwater monitoring well	Unknown
TH-22		CNMI government	USGS	10/16/1996	USGS 8 in (20 cm) monitoring well	96.61	16				110	Groundwater monitoring well	Unknown

Well Name	Other Well Names	Owner	Installed By	Date Well Drilled	Type	Wellhead or Measuring Point Elevation (ft)	Well Depth Below msl (Negative Values = Above msl)	Chloride Content (Various Sources)		Water Production (gpm) (Doan et al. 1960)	Water Production (gpm) (Various Sources) [b]	Original Function	Current Status
						ft	ft	Before Pumping (mg/L)	After Pumping (mg/L)	gpm	gpm		
TH-24		CNMI government	USGS	4/10/1997	USGS 8 in (20 cm) monitoring well		9				3	Groundwater monitoring well	Unknown
TH-4X		CNMI government	USGS	5/5/1994	USGS 8 in (20 cm) monitoring well	71.89	268					Groundwater monitoring well	Unknown
Ushi		U.S. military	U.S. military	9/6/1987	Military water supply well	98.47	19.0					Non-potable water supply well	Unknown
W-1	Masalog	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	255.29	7.2	40	85	55		Water supply	Inactive
W-12	E 100 St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	184.43	14.6	100	High	60		Water supply	Inactive
W-13	Park Row Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	59.96	15.0					Water supply	Inactive
W-14	42nd St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	242.63	12.4	30	40	35		Water supply	Inactive
W-17	86th St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	244	4.0					Water supply	Inactive
W-18A	98th St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	289.3	100.7	38		8		Water supply	Inactive
W-18B	98th St. B Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	285	75.0	35		8		Water supply	Inactive
W-20	New 110th St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	258	10.0		600	10		Water supply	Inactive
W-23	Mil. Gov. #2	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	294.4	-126.4					Water supply	Inactive
W-24	Central Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	247.27	15.7	70				Water supply	Inactive
W-27	Mil. Gov. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	284.5	30.5			0		Water supply	Inactive
W-28	West Side Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	253.75	12.3					Water supply	Inactive
W-3	Lasso	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	202.18	31.3					Water supply	Inactive
W-30	84th St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	255.5	-18.5					Water supply	Inactive
W-31	Hilo Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	257.58	11.4			0		Water supply	Inactive
W-32	113th St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	223	14.0					Water supply	Inactive
W-34 [a]	Island Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	298.24	17.8					Water supply	Inactive
W-36		U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	125	12.0					Water supply	Inactive
W-37		U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	100	14.0					Water supply	Inactive
W-38		U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	277.83	22.2			0		Water supply	Inactive
W-4	Gurgaon	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	225.31	6.7		35	60		Water supply	Inactive
W-46 [a]		U.S. military	U.S. military	WWII Period	Hand-dug well	50	-45.0	650				Water supply	Inactive

Well Name	*Other Well Names*	*Owner*	*Installed By*	*Date Well Drilled*	*Type*	*Wellhead or Measuring Point Elevation (ft)*	*Well Depth Below msl (Negative Values = Above msl)*	*Chloride Content (Various Sources)*		*Water Production (gpm) (Doan et al. 1960)*	*Water Production (gpm) (Various Sources)* [b]	*Original Function*	*Current Status*
						ft	*ft*	*Before Pumping (mg/L)*	*After Pumping (mg/L)*	*gpm*	*gpm*		
W-47 [a]		U.S. military	U.S. military	WWII Period	Hand-dug well	35	-20.0					Water supply	Inactive
W-6	96th St. Well	U.S. military	U.S. military	WWII Period	Drilled, 6 in (15 cm) solid steel cased well	239.41	15.1	16	100	100		Water supply	Inactive
WOP-197-01		CNMI government	Unknown	10/7/2011	4 in (10 cm) Schedule 80 PVC pipe							Groundwater monitoring well (for landfill siting study)	Unknown
WOP-197-02		CNMI government	Unknown	9/24/2011	4 in (10 cm) Schedule 80 PVC pipe						193	Groundwater monitoring well (for landfill siting study)	Unknown
WOP-197-03		CNMI government	Unknown	10/3/2011	Schedule 80 PVC pipe well							Groundwater monitoring well (for landfill siting study)	Unknown

Notes: [a] Present location of this well is unknown.
[b] Rates based on pump test data (mostly USGS 2002). Values do not necessarily represent maximum sustainable rates.
[c] Rehabilitated by USGS.
[d] Rehabilitated by private party.
Blanks = unknown

Legend: cm = centimeter; CNMI = Commonwealth of the Northern Mariana Islands; ft = foot/feet; gpm = gallon per minute; in = inch; lpm = liter per minute; m = meter; msl = mean sea level; NA = not applicable; mg/L = part per million; PVC = polyvinyl chloride; USGS = U.S. Geological Survey; WWII = World War II

Sources USGS 2000, 2002; Doan et al. 1960

WASTEWATER ANALYSIS

IN SUPPORT OF THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS JOINT MILITARY TRAINING FINAL ENVIRONMENTAL IMPACT STATEMENT

Department of the Navy
Naval Facilities Engineering Systems Command, Pacific
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June 2026

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1 PURPOSE

The purpose of this evaluation is to identify existing conditions and estimate the wastewater to be generated with the Proposed Action analyzed in the Commonwealth of the Northern Mariana Islands (CNMI) Joint Military Training Final Environmental Impact Statement (EIS). This assessment evaluates existing wastewater facilities and wastewater treatment facilities resulting from the Proposed Action.

1.1 DESCRIPTION OF PROPOSED WASTEWATER INFRASTRUCTURE

1.1.1 Base Camp

The Proposed Action includes construction of a Base Camp at the United States (U.S.) Agency for Global Media (USAGM) site on Tinian. As envisioned, Administration, Range Control, and Training Support functions proposed in the Base Camp would use the existing operation and administration building, and warehouse requirements would be partially met with the existing warehouse facilities. Other previously disturbed, cleared areas within the site would accommodate other proposed Base Camp new construction needs. Wastewater infrastructure would be constructed at the Base Camp as described in the subsequent sections.

The USAGM site does not appear to be within either a Class I or II Aquifer Recharge Area/Groundwater Protection Zone on Tinian (Captain B. Bearden, U.S. Public Health Service, Personal Communication, March 3, 2025). No changes in wastewater infrastructure are proposed for the USAGM site on Saipan.

1.1.2 Port of Tinian

The biosecurity facility at the Port of Tinian is proposed to include wash racks. Military vehicles would be washed there as required as part of the biosecurity screening process. The wash racks would be a contained concrete facility where multiple vehicles can be washed simultaneously using cleaning equipment. Washing would be conducted using only water and no soaps or solvents are proposed to be used. Wash water would be contained in a holding tank and recycled through an oil/water separator. Once the wash cycles are complete, wash water would be pumped out and disposed of in conformance with CNMI regulations. The oil/water separator would be periodically pumped out and disposed of in conformance with CNMI regulations for oily waste. No domestic demand is proposed at the Port of Tinian as the biosecurity facility would not have a restroom.

1.1.3 Francisco Manglona Borja/Tinian International Airport

The Proposed Action includes construction of an aircraft shelter to be located at Tinian Divert facility at the Francisco Manglona Borja/Tinian International Airport. The shelter would be sized and constructed to provide protection for aircraft from inclement weather, including typhoon force winds. No wastewater infrastructure is proposed at the aircraft shelter.

1.1.4 Other Facilities

The Proposed Action includes construction of various other facilities including ranges, landing zones, and a drop zone. No wastewater infrastructure is proposed for any of these facilities.

Portable toilets may be placed temporarily as required for construction, operation, or training activities.

1.2 COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS WASTEWATER REGULATIONS

The Northern Mariana Islands Administrative Code defines two different types of wastewater treatment systems (Northern Mariana Islands Administrative Code 2017a). The first type is an Individual Wastewater Disposal System, which consists of a septic tank and leach field. An Individual Wastewater Disposal System is typically used for a single residence or business. The second type is an Other Wastewater Treatment System, which includes all treatment methods other than a septic tank.

1.2.1 Individual Wastewater Disposal System Regulations

The following is a summary of the Northern Mariana Islands Administrative Code as it pertains to Individual Wastewater Disposal System design:

- Average daily wastewater flow rates are calculated per Northern Mariana Islands Administrative Code section 65-120-500.
- Septic tank sizing and design are determined per Northern Mariana Islands Administrative Code section 65-120-600.
- Percolation testing is required per Northern Mariana Islands Administrative Code section 65-120-700.
- Leaching field sizing and design are determined per Northern Mariana Islands Administrative Code section 65-120-800.

1.2.2 Other Wastewater Treatment System Regulations

CNMI regulations require construction and operation of an Other Wastewater Treatment System for average daily wastewater flows greater than 5,000 gallons per day (Northern Mariana Islands Administrative Code section 65-120-110). These regulations also state the maximum discharge limits for various effluent constituents, including a total nitrogen limit of 1.0 milligrams per liter (Northern Mariana Islands Administrative Code section 65-120-010). Total nitrogen is removed from wastewater by using bacteria that digest the various forms of nitrogen (e.g., nitrate and nitrite).

1.3 EXISTING WASTEWATER INFRASTRUCTURE

1.3.1 Existing Individual Wastewater Disposal System Infrastructure

Various Public and Private Systems

Tinian has no centralized municipal wastewater collection and treatment system. Residences, businesses, and municipal facilities use Individual Wastewater Disposal Systems that consist of a septic tank and leach field. The Commonwealth Utilities Corporation has awarded a contract to an engineering consultant to prepare a preliminary engineering report for a wastewater treatment plant (Bureau of Environmental and Coastal Quality, Personal Communication, September 12, 2024).

Until such a system is funded and constructed, residents and visitors would continue to rely on Individual Wastewater Disposal Systems.

United States Agency for Global Media

The USAGM, formerly International Broadcasting Bureau, operates an Individual Wastewater Disposal System, constructed in 1997, consisting of a packaged wastewater treatment system for aerobic digestion (Figure 1). Treated wastewater is disposed of in a leach field without a septic tank.

Figure 1 Existing Individual Wastewater Disposal System at USAGM

Camp Tinian

A U.S. military Individual Wastewater Disposal System was constructed on Tinian in 1999 to support military training (Figure 2). The septic tank and leach field system are sized for 6,640 gallons per day (Department of Environmental Quality 1999).

Figure 2 Existing Individual Wastewater Disposal System near Camp Tinian

Commonwealth Utilities Corporation Tinian Power Plant

The Commonwealth Utilities Corporation power plant on Tinian has an Individual Wastewater Disposal System with a small aeration tank similar to the USAGM facility. No information was made available regarding this system (Bureau of Environmental and Coastal Quality, Personal Communication, September 12, 2024).

1.3.2 Existing Other Wastewater Treatment System Infrastructure

Tinian Dynasty Hotel and Casino

The Tinian Dynasty Hotel and Casino operated 500 rooms, a casino, several restaurants, and dwelling units for staff accommodation until it closed in 2016. The hotel had its own Other Wastewater Treatment System, a tertiary treatment plant that was permitted to treat 240,000 gallons per day. The condition of this facility is not known. Figure 3 shows the condition of the entrance to the facility in September 2024; the Other Wastewater Treatment System is not visible through the vegetation.

Figure 3 Entrance to the Tinian Dynasty Hotel and Casino

Note: The Other Wastewater Treatment System is located within the vegetation to the right and was not visible at the time this photo was taken.

Tinian Diamond Hotel and Casino

The Tinian Diamond Hotel and Casino operated a hotel, a casino, and a restaurant until it closed in December 2024. The facility had its own Other Wastewater Treatment System, a tertiary treatment plant that consists of membrane bioreactors with denitrification (Figure 4). The Bureau of Environmental and Coastal Quality stated that the Other Wastewater Treatment System had not operated due to a lack of minimum wastewater flow (Bureau of Environmental and Coastal Quality, Personal Communication, September 12, 2024).

Figure 4 Other Wastewater Treatment System at Tinian Diamond Hotel and Casino

1.4 PROPOSED WASTEWATER DEMAND AND WASTEWATER INFRASTRUCTURE

1.4.1 Design Population

The maximum number of personnel on island at any one time from the Proposed Action would be 1,070 (estimates for this study used 1,100 to be conservative) and consists of the following types:

- Up to a maximum of 1,000 military personnel participating in training.
- Between 30 and 50 permanent support personnel, who would maintain and operate the facility. It is assumed that 20 individuals would relocate to Tinian and that the on-island local workforce could fill 30 positions.
- Up to 50 construction workers, who are assumed to relocate to Tinian from off-island. Construction would occur in phases over approximately 10 to 15 years.

Dependents are not included in the estimates above based on the experience of other U.S. Department of Defense (DoD) construction projects on Tinian.

1.4.2 Portable Vehicle Wash Facility

A portable wash rack would be stored at the Base Camp and made available for use at either TNI or North Field in the event cargo/material arrives that does not meet cleanliness standards and for cargo/equipment departing from TNI or North Field. A water truck would supply water to the water bladder attached to the portable wash rack. Washing would be conducted using only water and no soaps or solvents. Wash water would be contained during the washing cycle. Wash water from the portable wash rack would be run through an oil water separator and discarded in accordance with all applicable laws, regulations and permits. The oil/water separator would be periodically pumped out and disposed of in conformance with CNMI regulations for oily waste.

1.4.3 Proposed Wastewater Demand

Wastewater demand is determined using the requirements of Unified Facilities Criteria 3-240-01 based on population. Wastewater demand for both Alternatives 1 and 2 is the same. Table 1 summarizes the estimated wastewater demands for the Proposed Action.

Table 1. Peak Proposed Wastewater Demand

Personnel Type	*Use Category* [a]	*Unit Flow (gpcd)*	*Population*	*Wastewater Flow (gpd)*
Military Personnel	Military Training Camps	50	1,000	50,000
Construction Workers (8-hour shift)	Nonresident Personnel and Civilian Employees (per 8-hour shift)	30	50	1,500
Permanent Support Personnel (8-hour shift)	Nonresident Personnel and Civilian Employees (per 8-hour shift)	30	50	1,500
			Total	**53,000**

Legend: gpcd = gallon(s) per capita per day; gpd = gallon(s) per day.
Notes: [a] Data per Table 3.1 of Unified Facilities Criteria 3-240-01.

Wastewater infrastructure is designed to accommodate the peak flow. Actual flow will vary significantly between training events and non-training periods. During non-training periods, wastewater flow could be 1,500 gallons per day or less.

1.4.4 Proposed Wastewater Infrastructure

The Proposed Action includes construction of new wastewater infrastructure at the Base Camp, which would be operated and maintained by the U.S. Marine Corps (USMC). The new wastewater infrastructure could include a sanitary sewer collection system, a sewer lift station, and one or more Individual Wastewater Disposal Systems. Individual Wastewater Disposal Systems are proposed because the USAGM site does not appear to be within either a Class I or II Aquifer Recharge Area/Groundwater Protection Zone on Tinian (Captain B. Bearden, U.S. Public Health Service, Personal Communication, March 3, 2025). USMC will continue to coordinate with the CNMI Bureau of Environmental and Coastal Quality on the consideration of additional treatment technologies. At Base Camp, a grease trap with a capacity of at least 1,000 gallons is proposed to be located at the mess tent sewer connection. Grease will be periodically removed and disposed in conformance with CNMI regulations.

Wastewater service outside of the Base Camp would be provided using portable toilets. These portable toilets would be periodically emptied and disposed of at a septage disposal site approved by the CNMI Bureau of Environmental and Coastal Quality per section 65-120-1405 (CNMI Code of Regulations).

Sludge from the CNMI Joint Military Training septic tanks would also be emptied and disposed of at a septage disposal site approved by the Bureau of Environmental and Coastal Quality per Northern Mariana Islands Administrative Code section 65-120-1405.

Septic Tank Size

The following is an estimate of the total volume needed for all the septic tanks in order to estimate sludge removal. Per Northern Mariana Islands Administrative Code section 65-120-605, septic tanks shall be sized using the following equation when the average daily sewer flow is greater than 1,500 gallons per day:

Liquid volume = 1,125 gallons + (75% × Average daily sewage flow in gallons per day)

Liquid volume = 1,125 gallons + (75% × 53,000 gallons per day) = 40,875 gallons

Per Northern Mariana Islands Administrative Code section 65-120-625, the minimum septic tank dimensions are 6 feet in length, 4 feet wide, and 6 feet deep. Tanks are also required to include scum storage for 15 percent of the liquid depth and 1 inch of air space at the top of the tank. Conceptual tank dimensions that would meet these requirements are:

- *Width:* 20 feet
- *Length:* 42 feet
- *Depth:* 8 feet
- *Tank Volume:* 50,272 gallons

The calculation above assumed a single septic system for the Proposed Action. Multiple smaller systems or parallel tanks that provide the same capacity could also be used instead.

Leach Field Size

Leach fields for septic systems are sized based on the percolation rate of the soil per Northern Mariana Islands Administrative Code section 65-120-820, Table 800-1. Below are calculations for the total leach field size using the smallest allowable percolation rate (largest required area) for all septic systems.

Assuming percolation at 0.67 inches per hour:

53,000 gallons per day / 0.5 gallons per square foot per day = 106,000 square feet of leach field = 2.4 acres

Percolation tests would be done per Northern Mariana Islands Administrative Code section 65-120-700 prior to starting engineering design of the leach fields.

1.5 VEHICLE MAINTENANCE

Under the Proposed Action, vehicle maintenance activities would not be conducted at the Base Camp. The training unit would bring on-island all vehicles used during training and remove the vehicles following the completion of training. No drainage or drywells would be constructed or used.

1.6 SUMMARY

Wastewater generated on the Military Lease Area as a result of the Proposed Action can be collected and treated in accordance with Northern Mariana Islands Administrative Code. Below is a summary of the anticipated wastewater system to be constructed at the Base Camp:

- Wastewater Demand: 53,000 gallons per day
- Total Septic Volume: 50,272 gallons
- Leach Field Size: 2.4 acres

Operation and maintenance of the wastewater system in accordance with Unified Facilities Criteria 3-240-03 is anticipated to include the following:

- Maintain vegetation over the leach field by cutting grass and removing trees, shrubs, and larger plants.
- Monitor sludge depth within septic tanks and remove sludge when the system is no longer working efficiently in accordance with the equipment manufacturer's recommendations.
- The quantity and frequency of sludge removal is based on the amount the system is used. Generally, it is expected that a septic tank is pumped every 3 to 5 years. If the tanks are half full of sludge, then removal could consist of 25,000 gallons or approximately 100 tons.

The wastewater generated by new populations residing outside the Military Lease Area in existing housing, including wastewater generated by construction workers and permanent support personnel outside shift hours, would not exceed the capacity of the Individual Wastewater Disposal Systems. Each private property owner is responsible for maintenance and compliance with the CNMI regulations for their Individual Wastewater Disposal System. Thus, no indirect impact is anticipated from the construction workers or permanent support personnel living outside of the Military Lease Area in support of the Proposed Action.

2 REFERENCES

Department of Environmental Quality. 1999. *Individual Wastewater Disposal System Certification for Use of Septic System*. CNMI Department of Environmental Quality. March 10.

Department of Defense, United States (DoD). 2019. *Unified Facilities Criteria (UFC), Operation and Maintenance (O&M): Wastewater Treatment.* UFC 3-240-03. April 1.

Department of Defense, United States (DoD). 2024. *Unified Facilities Criteria (UFC), Wastewater Collection and Treatment*. UFC 3-240-01. October 1.Northern Mariana Islands Administrative Code. 2017a. *Wastewater Treatment and Disposal Rules and Regulations*. Chapter 65-120.

Northern Mariana Islands Administrative Code. 2017b. *Water Quality Standards*. Chapter 65-130.

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SOLID WASTE AND HAZARDOUS WASTE STUDY
IN SUPPORT OF THE
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
JOINT MILITARY TRAINING ENVIRONMENTAL IMPACT STATEMENT

Department of the Navy

Naval Facilities Engineering Command, Pacific

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June 2026

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this study is to present solid and hazardous waste management requirements associated with the construction and operational phases of the Proposed Action presented in the Final Commonwealth of the Northern Mariana Islands (CNMI) Joint Military Training (CJMT) Environmental Impact Statement (EIS).

1.2 STUDY GOALS AND OBJECTIVES

This *Solid and Hazardous Waste Study* was prepared to evaluate waste management and disposal options for all solid and hazardous waste streams generated by the Proposed Action. The study objectives are summarized as follows:

- Identify existing and planned CNMI waste management options.
- Characterize and quantify waste streams of the Proposed Action.
  - Municipal Solid Waste
  - Construction and Demolition Waste
  - Green Waste
  - Hazardous Waste, Non-Hazardous Industrial Wastes, Universal Waste and E-waste
- Evaluate solid and hazardous waste management/disposition options for the Proposed Action.

The Proposed Action anticipates that approximately 30-50 permanent staff will be required to maintain and operate the facility. Table 1 summarizes the facilities to be developed and the anticipated construction timeframe.

Table 1. Proposed Action Project Phasing

Year	*Description*
2026	Helicopter Landing Zones Cleared (1/3 of total area cleared)
	North Field Drop Zone Cleared (1/3 of total area cleared)
	Landing Zones Access Roads Cleared (1/3 of total area cleared)
2027	Helicopter Landing Zones Cleared (1/3 of total area cleared)
	North Field Drop Zone Cleared (1/3 of total area cleared)
	Landing Zones Access Roads Cleared (1/3 of total area cleared)
2028	Helicopter Landing Zones Cleared (1/3 of total area cleared)
	North Field Drop Zone Cleared (1/3 of total area cleared)
	Landing Zones Access Roads Cleared (1/3 of total area cleared)
	Base Camp Potable Water Services Facilities
	Communications Area Distribution Node (ADN)
	Electrical Distribution Building / Switching Station
	Fuel Storage and Distribution Facility
	Potable Water Well Field
	Combined Electrical and Communication Lines Inside and Outside of the Military Lease Area
	Water line from Well Field (final field location TBD; assume largest area disturbed with Option A)
2030	Two Surface Radar Tower
	Base Camp Ammunition Holding Area
	Multi-Purpose Maneuver Range Ammunition Holding Area
	Multi-Purpose Maneuver Range Water Wells and Tanks
	Multi-Purpose Maneuver Range: Center Access Road/UKD Range (vegetation clearing and regular maintenance)
	Multi-Purpose Maneuver Range: Firebreak
	Multi-Purpose Maneuver Range: Perimeter Road and Firebreak
	Multi-Purpose Maneuver Range: Target/Objective Areas
2031	Range Support Maintenance Shop
	Port Biosecurity/Wash Rack
2033	General Purpose Warehouse and Hazardous Materials Storage and Transfer Building
2036	Aircraft Shelter
2038	Camping Concrete Tent Pads
	Base Camp Biosecurity/Wash Rack
	Base Camp Motor Pool
	Base Camp Public Works Shop
	Base Camp Security Fencing
	Base Camp Training Unit Vehicle Parking
2039	Explosives Training Range (ETR)
	Explosives Training Range Access Road
	Wastewater/Restrooms/Showers

2 EXISTING AND PLANNED CNMI WASTE DISPOSAL OPTIONS

The purpose of this section is to evaluate the existing conditions of solid and hazardous waste management infrastructure on Tinian. This section describes the existing solid waste infrastructure, the potential future solid waste management options on Tinian, and the current tonnage of solid waste generated.

In this study, solid waste generation refers to the quantities of solid waste generated that requires management. Management is composed of two parts:

- Diversion/recycling; and
- Disposal – landfilling and incineration.

The solid waste quantities associated with each of these two management components will produce an impact on the existing solid waste infrastructure. Successful implementation of local re-use/diversion/recycling programs will positively impact final disposal facilities by reducing waste quantities requiring management. The Tinian diversion/recycling infrastructure currently consists of the newly constructed Tinian Transfer Station.

The existing CNMI disposal infrastructure consists of the unpermitted and non-compliant Tinian Puntan Diablo disposal facility located on Tinian and the permitted Marpi Landfill located on Saipan. The permitted landfill on Saipan would be utilized to dispose of waste that cannot be diverted from disposal. The estimated solid waste quantities of the Proposed Action are compared to recent CNMI solid waste generation quantities to evaluate the impacts of the Proposed Action on the existing solid waste infrastructure. The recent annual disposal tonnage estimated at the Tinan Puntan Diablo disposal facility, and the Marpi Landfill are discussed in subsequent sections.

To ensure the United States (U.S.) Marine Corps' (USMC's) waste management plans align with the CNMI's local waste management goals and their Integrated Solid Waste Management Plan, the USMC will develop an integrated waste management plan (ISWMP) in accordance with Marine Corps Order (MCO) 5090.2, Volume 17 for the CJMT project, in coordination with the CNMI municipal government. The ISWMP would be developed to address both construction activities and the ongoing training activities, and would be prepared prior to the commencement of construction.

If it is determined that the local solid waste infrastructure is not adequate to permit proper management of the Proposed Action-generated waste, the alternative to transport the waste to one or more off-island facilities where the recyclables could be recovered and the residual waste disposed of in permitted and compliant disposal facilities authorized to accept Department of Defense (DoD) waste.

2.1 TINIAN PUNTAN DIABLO DISPOSAL FACILITY

Solid waste on Tinian is currently transported by residents and business entities to the Tinian Puntan Diablo disposal facility located adjacent to 8th Avenue near San Jose and the southwest coast. The facility is operated by the CNMI Department of Public Works. The existing disposal facility is unlined and not presently in compliance with the design and operating requirements of the Resource Conservation and Recovery Act Subtitle D regulations (40 Code of Federal Regulations [CFR] Part 258) governing municipal solid waste landfills. The facility also does not comply with the CNMI regulations (Title 65, Division of Environmental Quality, Chapter 65-80, Solid Waste Management Regulation), which substantially follow the Subtitle D regulations.

CNMI intends to convert the disposal facility to a permitted landfill by demonstrating compliance with the small community exemption available in Resource Conservation and Recovery Act Subtitle D regulations 40 CFR Part 258.1(f)(1) (CNMI 2023). The anticipated timeline to complete the permitting process is 6 to 12 months. See Section 6.2.1. for a summary of the small community exemption. To receive this permit, the state-owned Small Community Exempt Landfill will still require a Closure and Post-Closure Plan that includes a Final Cover Design developed with Bureau of Environmental and Coastal Quality per 40 CFR 258.60. All components of 40 CFR 258 – Subpart C – Operating Criteria will need to be designed, constructed, and fully operational. The Facility Operations Plan, or other comparable documents, will include the following operating requirements or demonstrations that fully implement the 40 C.F.R. 258 – Subpart C – Operating Criteria:

- Demonstrated compliance with Resource Conservation and Recovery Act Subtitle D Regulation 40 CFR Part 280.1(f)(1)
- Hazardous waste exclusion;
- Landfill cover material requirements;
- Disease vector control;
- Explosive gases control;
- Demonstrate compliance with the Clean Air Act;
- Facility access control requirements;
- Run-On/Run-Off control systems;
- Surface water requirements; and
- Recordkeeping requirements.

Additionally, any future permitted Tinian Puntan Diablo Landfill will require the revised Facility Operations Plan to include other content/requirements so that staff can be trained to operate the facility and maintain compliance with the applicable sections of 40 CFR 258.

Conversion of the disposal facility and operation of the new landfill under the small community exemption would be for 10 years or until a new Atgidon Landfill can be permitted, constructed, and opened (CNMI 2023). The Puntan Diablo landfill will only be utilized to manage CJMT solid waste if the site is permitted and compliant as a landfill and in compliance with Resource Conservation and Recovery Act Subtitle D regulations (40 CFR Part 258) and local regulations. Reference to the Tinian Puntan Diablo Landfill in subsequent Chapters 3 through 5 is to the planned, permitted, and compliant landfill and not the current unpermitted disposal facility.

The Tinan Puntan Diablo disposal facility is operated without scales and, as a result, definitive historical disposal tonnage records are not available. The Integrated Solid Waste Management Plan assumes an average daily waste disposal rate of 3.8 pounds per person for the Tinian population (CNMI 2023). The 2020 population for Tinian is reported as 2,044 in the Integrated Solid Waste Management Plan (CNMI 2023). The 2010 population was reported in the Integrated Solid Waste Management Plan as 3,136, indicating a reduction of approximately 34 percent. For the purposes of estimating the 2023 annual disposal tonnage, it is assumed that the population has remained flat/unchanged since 2020. Table 2 presents the estimated average annual and average daily disposal tonnage at the disposal facility (CNMI 2023).

Table 2. Estimated 2023 Tinian Puntan Diablo Disposal Tonnage

	Disposal Tonnage
Population[a]	2,044
Solid Waste Generation Rate[a] (pound (lb) /Person/Day)	3.8
Annual Solid Waste Generation[a] (Tons/Year)	1,418
Average Daily Generation (Tons/Day)[b]	3.9

Notes: [a] – 2023 CNMI Draft Comprehensive ISWMP.
[b] – Assumes site is open 365 days/year.

2.2 PROPOSED ATGIDON LANDFILL

CNMI is initiating permitting efforts for a new landfill at the Atgidon site, located north of 86th Street and between Riverside Drive and 10th Avenue (CNMI 2023). The CNMI plans to permit this new site under the small community exemption as discussed previously. CNMI anticipates permitting will take 5 years to complete, with site development commencing shortly thereafter to ensure disposal capacity at the new Atgidon Landfill is available prior to cessation of operations at Puntan Diablo (CNMI 2023). The design capacity for this landfill is not known at this time.

2.3 MARPI LANDFILL

The Marpi Landfill is located on the island of Saipan and is the only active disposal facility in Saipan. The Marpi Landfill operating permit was renewed by the Bureau of Environmental and Coastal Quality in 2016, subject to the completion of site upgrades and remedial measures. Per the CNMI Department of Public Works Solid Waste Management Feasibility Study, December 2019 (GHD, Inc./Gershman, Brickner, & Bratton, Inc. 2019), the 26-acre permitted and lined disposal area of the Marpi Landfill had an estimated remaining operational life of approximately 29 years (approximately 2045). Lined disposal Cells 1 and 2 were constructed with an estimated remaining cell life of approximately 6.7 years at the time of the 2019 study. Therefore, the next disposal cell will need to be operational in 2025 to ensure available disposal capacity for continued use, assuming the rate of disposal capacity utilization has remained consistent since the 2019 study. At this time, CJMT has not received formal authorization from CNMI to utilize the Marpi Landfill.

The Marpi Landfill annual disposal tonnage records for the period of 2020 through 2022 is reported in the Integrated Solid Waste Management Plan (CNMI 2023). Annual average disposal tonnage can be calculated from the tonnage reported in the Integrated Solid Waste Management Plan.

According to US Census data, the island of Saipan has experienced a reduction in population between 2010 and 2020. As stated in the Integrated Solid Waste Management Plan, the 2010 population was reported as 48,220 and the 2020 population was 43,385, indicating a reduction of approximately 10 percent. For purposes of estimating the current (2023) annual disposal tonnage disposed of at Marpi Landfill, it is assumed the population has remained unchanged since 2020. Table 3 presents the average annual and average daily disposal tonnage at the Marpi Landfill.

Table 3. Estimated Existing (2023) Marpi Landfill Disposal Tonnage

Year	*2020*	*2021*	*2022*	*Average*
Annual Disposal Tonnage[a]	32,810	30,241	32,206	31,752
Average Daily Disposal Tonnage[b]	90	83	88	87

Notes: [a] – 2023 CNMI Draft Comprehensive ISWMP.
[b] – Assumes site is open 365 days/year.

The operational capacity of the landfill was evaluated to determine whether the landfill has the equipment and personnel required to accept additional waste from the Proposed Action. The term operational capacity refers to the daily landfill operation requirements and not the overall site life capacity of the landfill. The average daily disposal tonnage for the 2020 through 2022 time period is 87 tons/day and ranges between 83 and 90 tons/day (CNMI 2023). It is assumed that the landfill is operating sufficiently within this capacity range.

Based on population data, it is reasonable to assume that past annual and daily average disposal tonnage was higher than current levels due to the population decline of approximately 10 percent between 2010 and 2020. To estimate the upper level of the landfill's operational capacity, an additional 10 percent was added to the current annual disposal rates. The 2010-era annual disposal quantity based on the population at the time would have been approximately 35,000 tons/year (96 tons/day). The 96 tons/day represents a daily operational capacity for the landfill, which is higher than its current operating range. The ability of the landfill to manage larger volumes of waste historically indicates that the landfill may have a daily operational capacity to support solid waste disposal generated by the Proposed Action.

2.4 TINIAN TRANSFER STATION

The Tinian Transfer Station is currently permitted to receive only source-separated recyclable materials such as cardboard/paper, plastic bottles, and aluminum cans (CNMI 2023). These materials are shipped off the island for processing and sale, and the cost of handling and transportation exceeds the revenue generated by the sale of the recyclables.

The facility was originally designed to function as a transfer station to receive municipal solid waste generated on Tinian and package it and transport it to the Marpi Landfill on Saipan (CNMI 2023). If disposal capacity is available on Tinian, the facility will continue its current operational scope of handling source-separated recyclables. If no disposal option is available on Tinian, the transfer station operation could be expanded, with the appropriate solid waste permit modification, to receive, package, and transport both recyclables and municipal solid waste. Municipal solid waste would be transported to Marpi Landfill for disposal.

Currently, there is no historical data available regarding the quantities or composition of materials diverted at the transfer station. Waste hauling contractors take possession of recycled materials collected at the Tinian Transfer Station under a CNMI contract. Details of this contract are not available; it is assumed the recyclables are being transported and sold to off-island industries. At this time, CJMT has not received formal authorization from CNMI to utilize the Tinian Transfer Station.

2.5 CONSTRUCTION AND DEMOLITION WASTE

There is currently no permitted construction and demolition landfill on Tinian or Saipan. There are no current efforts to segregate or divert construction and demolition waste; hence, construction and demolition waste is currently disposed of at the Tinian Puntan Diablo disposal facility.

The CNMI is planning to develop and operate a municipally-owned site to accept construction and demolition waste generated on Tinian. Site assessment and planning stages of development were projected to begin in late 2023 (CNMI 2023). If permitted, compliant and available, this facility will be considered a potential management option for construction and demolition waste generated by the Proposed Action that is not recycled or diverted.

2.6 GREEN WASTE

Green waste generated by residents on Tinian is managed at the Tinian Organics Processing Site operated by the Department of Public Works. The site does not accept green waste from commercial generators. It was permitted in June 2022 for green waste disaster debris. It is equipped with a wheel loader and a chipper for green waste processing and storage. It receives approximately 660 cubic yards per year (CNMI 2023). The Tinian Organics Processing Site will not be evaluated as a solution for green waste diversion for CJMT.

2.7 HAZARDOUS, INDUSTRIAL, UNIVERSAL WASTES AND E-WASTES

There are an estimated 70—80 generators of hazardous waste within the CNMI. It is unknown how many reside on Tinian. The majority of these generators are Resource Conservation and Recovery Act very small quantity generators or small quantity generators. Hazardous waste generators on Tinian contract with certified hazardous waste contractors to meet disposal requirements. Hazardous waste generators must procure disposal services off-island because CNMI does not have a permitted disposal facility for hazardous, industrial, universal, and electronic waste (CNMI 2023).

Hazardous, industrial, and universal wastes and e-waste generated by CJMT activities on Tinian will be disposed of off-island by DoD per applicable U.S. Environmental Protection Agency regulations.

3 PROPOSED ACTION WASTE GENERATION AND CHARACTERIZATION

The CJMT Proposed Action would generate solid waste associated with construction, maintenance, and operational training concurrently because some training would commence upon the Record of Decision. Training would be conducted while improvements are being made to the training infrastructure. Waste generation would be a combination of construction wastes and wastes generated from training activities. The waste generated would vary depending on the level of training and the construction activities for a given year. This chapter only covers waste generated during construction. This section describes the solid waste generation from construction, which includes solid waste, construction and demolition waste, and green waste.

Waste management practices will be developed with an emphasis on source reduction to minimize the generation of waste thereby reducing the dependence on landfill or incineration for final management. The DoD would develop the CJMT Training Manual and other standard operating procedures to implement waste minimization through source reduction, to mandate and enforce segregation and diversion of recyclables from the waste stream to minimize disposal, to include all waste management requirements as outlined in the CNMI integrated waste management plan, and to include waste management policies and procedures that reference the CNMI zero waste proclamation and applicable regulations. The CJMT Training Manual will address the USMC requirement to ensure municipal solid waste is managed in accordance with USMC Environmental Management and Range Sustainability requirements, which are based on applicable laws, rules, and policies which prohibit illegal dumping. The CJMT Training Manual will address identification of hazardous materials and measures and methods to be employed to prevent improper disposal of these materials with the non-hazardous solid waste.

The DoD will comply with all laws, regulations, and executive orders in the management of solid waste as required.

3.1 SOLID WASTE

Under the Proposed Action, the estimated population increase due to off-island construction workers and support staff is projected to be no more than 50 people at any one time.

Solid waste generation is based on the rates cited for Tinian in the CNMI Draft Integrated Solid Waste Management Plan of 3.8 pounds/person/day. Table 4 presents the estimated solid waste generated for the project construction period.

Table 4. Estimated Solid Waste Generation – Construction Phase

	Input	*Total Tonnage*	*Diverted/Recycled*[b]	*Disposal*
Population (estimated construction-related personnel)	50	N/A	N/A	N/A
Solid Waste Generation Rate (lbs/person/day)[a]	3.8			
Daily Solid Waste Generation (tons/day)	N/A	0.10	0.01	0.08
Annual Solid Waste Generation (tons/year)		35	4	31

Notes: [a] – 2023 CNMI Draft Comprehensive ISWMP.
[b] – Assumes site is open 365 days/year.
Legend: N/A = Not Applicable.

3.1.1 Construction Waste

The construction waste would be produced from the construction or renovation of structures and is estimated from the square footage of the proposed pavement and building footprints (i.e., impervious areas). The estimated generation is derived from the total area of impervious surfaces developed, less areas surfaced with asphalt concrete, in the Proposed Action multiplied by the construction generation rate. Asphalt concrete pavement construction generates essentially no debris or waste and therefore is excluded from the impervious areas that will generate construction waste. Proposed developments, representing those impervious surfaces, which will generate construction waste are summarized in Table 3.1-2. Development areas that do not create impervious surfaces and generate no construction waste or negligible construction waste are also summarized in Table 5.

Construction activities are expected to occur during the 2026 through 2039 timeframe. Table 5 presents the construction phasing of the planned facilities and the projected construction waste generation. The construction waste generation for structures/buildings during the period of project construction is estimated to be 4.34 pounds per square foot (21 kilograms per square meter) of structure/building area, multiplied by the total newly created structure/building square footage (U.S. Environmental Protection Agency 2018). Concrete surfaced areas are estimated to generate approximately 1.09 pounds. square foot (5.3 kilograms per square meter), approximately 25 percent of the generation rate for structures/buildings. The total generated construction waste is summarized in Table 3.1-2.

Table 5. Projected Construction Waste Generation

Year	*Description*	*New Impervious Areas*		*Construction Waste Generated (tons)*[e, f]
		New Structure/Building Construction (sf)	*New Concrete Surfacing (sf)*	
2026	Helicopter Landing Zones Cleared (1/3 of total area cleared)[a]	0	0	0
	North Field Drop Zone Cleared (1/3 of total area cleared)[a]	0	0	0

Year	Description	New Impervious Areas		Construction Waste Generated (tons)[e, f]
		New Structure/Building Construction (sf)	New Concrete Surfacing (sf)	
	Landing Zones Access Roads. Cleared (1/3 of total area cleared)[a]	0	0	0
2027	Helicopter Landing Zones Cleared (1/3 of total area cleared)[a]	0	0	0
	North Field Drop Zone Cleared (1/3 of total area cleared)[a]	0	0	0
	Landing Zones Access Roads. Cleared (1/3 of total area cleared)[a]	0	0	0
2028	Helicopter Landing Zones Cleared (1/3 of total area cleared)[a]	0	0	0
	North Field Drop Zone Cleared (1/3 of total area cleared)[a]	0	0	0
	Landing Zones Access Roads. Cleared (1/3 of total area cleared)[a]	0	0	0
	Base Camp Potable Water Services Facilities[b]	7,270	0	16
	Communications Area Distribution Node (ADN)	2,700	0	6
	Electrical Distribution Building / Switching Station	900	0	2
	Fuel Storage and Distribution Facility	0	18,000	10
	Potable Water Well Field	7,200	0	16
	Combined Electrical and Communication Lines Inside and Outside of the Military Lease Area	0	0	0
	Water Line from Well Field (final field location TBD; assume largest area disturbed with Option A)[c]	0	0	0
2030	Two Surface Radar Tower	1,800	0	4
	Base Camp Ammunition Holding Area	0	27,000	15
	Multi-Purpose Maneuver Range Ammunition Holding Area	0	27,000	15
	Multi-Purpose Maneuver Range Water Wells and Tanks[d]	6,210	0	13
	Multi-Purpose Maneuver Range: Center Access Road/UKD Range (vegetation clearing and regular maintenance)	0	0	0
	Multi-Purpose Maneuver Range: Firebreak	0	0	0
	Multi-Purpose Maneuver Range: Perimeter Road and Firebreak	0	0	0
	Multi-Purpose Maneuver Range: Target/Objective Areas	0	0	0
2031	Range Support Maintenance Shop	1,260	0	3
	Port Biosecurity/Wash Rack	0	26,000	14
2033	General Purpose Warehouse and Hazardous Materials Storage and Transfer Building	36,000	0	78
2036	Aircraft Shelter	16,200	40,000	57
2038	Camping Concrete Tent Pads	0	10,120	5
	Base Camp Biosecurity/Wash Rack	0	5,400	3

Year	*Description*	*New Impervious Areas*		*Construction Waste Generated (tons)*[e, f]
		New Structure/Building Construction (sf)	*New Concrete Surfacing (sf)*	
	Base Camp Motor Pool	0	0	0
	Base Camp Public Works Shop	8,700	0	19
	Base Camp Security Fencing	0	0	0
	Base Camp Training Unit Vehicle Parking	0	0	0
2039	Explosives Training Range (ETR)	320	0	1
	Explosives Training Range Access Road	0	0	0
	Wastewater/Restrooms/Showers	*3,200*	*0*	*7*

Notes:
a Assume 1/3 of activities conducted each year (2026-2028).
b New structure/building area includes 2-42' diameter tanks (2,770 sf) and assumed 3,600 sf for other structures.
c Two well field location options currently being considered. For purposes of estimating land clearing waste generation the option with the largest impact (Option A) has been assumed.
d New structure/building area includes 2-33' diameter tanks (1,710 sf) and assumed 3,600 sf for other structures.
e Construction waste generation for new impervious surface areas associated with structure/building construction is estimated to be 4.34 pounds per square foot (21 kilograms per square meter) (USEPA 2003).
f Construction waste generation for new impervious surface areas associated with concrete surfaced areas is estimated to be 1.09 lbs per square foot (5.3 kg per square meter).

Construction and demolition waste will be mainly generated from construction activities associated with new development. Construction and demolition waste associated with new structures/buildings is anticipated to be composed primarily of concrete, wood, drywall/plaster, and smaller quantities of other wastes. The average composition of non-residential construction-related construction and demolition waste is presented in Table 6 (United States Environmental Protection Agency 2018).

Table 6. Estimated Construction and Demolition Composition for New Structures/Buildings – Construction Phase

Material Type	*Estimated Percent*[a]
Concrete	77
Wood Products	10
Drywall and Plasters	10
Steel	-
Brick and Clay Tile	1
Asphalt Shingles	3
Asphalt Concrete	-
Total	**100**

Note: [a] – U.S. Environmental Protection Agency 2018.

New areas of development that will be surfaced with concrete pavement will generate debris consisting primarily of residual concrete and wood used to make concrete forms with negligible quantities of other material types. The composition of the construction debris is based on the percentages of concrete and wood presented in Table 7 with all other waste types removed. The resulting estimated composition of construction debris generated in the construction of new concrete surfaced areas is presented in Table 7.

Table 7. Estimated Construction and Demolition Composition for New Concrete Surfaced Areas – Construction Phase

Material Type	*Estimated Percent*
Concrete	89
Wood	11
Total	**100**

Based on the construction debris material composition presented in Tables 6 and 7, concrete and wood represent 87 percent of the overall construction and demolition waste stream associated with new structures/buildings and 100 percent of construction and demolition waste associated with new concrete paved areas.

For typical construction projects, concrete and wood materials can be diverted from disposal with reasonable efforts by the construction employer. Concrete waste, when properly sized, can be used for structural fill, as road base, and for road surfacing. Wood debris can be chipped, similar to green waste, and used as mulch and ground cover. All construction project contracts should establish requirements for the construction workforce to divert these and other recyclables generated from disposal.

Current DoD Integrated Solid Waste Management policy sets a minimum diversion from landfilling or non-waste to energy incineration of 60 percent for construction and demolition waste (Office of the Assistant Secretary of Defense 2020). Given the majority of construction and demolition is anticipated to be concrete and wood, the mandated diversion rate of 60 percent should be practically and economically achievable if diversion and reuse requirements are included in the construction contracts.

Table 8 presents the estimated annual construction and demolition waste quantities to be generated during the multi-year construction period. Also presented are the estimated recycled/diverted quantities and disposal quantities based on the 60 percent diversion mandate. Generation is assumed to occur over 365 days.

Table 8. Estimated Construction and Demolition Waste Generation, Diversion and Disposal – Construction Phase

Year	*Construction and Demolition Waste*					
	Total Generated		*Total Diverted/Recycled*		*Total Disposal*	
	Annual (tons)	*Daily Average (tons)*	*Annual (tons)*	*Daily Average (tons)*	*Annual (tons)*	*Daily Average (tons)*
2026	0	0	0	0	0	0
2027	0	0	0	0	0	0

Year	Construction and Demolition Waste					
	Total Generated		Total Diverted/Recycled		Total Disposal	
	Annual (tons)	Daily Average (tons)	Annual (tons)	Daily Average (tons)	Annual (tons)	Daily Average (tons)
2028	49	0.13	29	0.08	20	0.05
2030	47	0.13	28	0.08	19	0.05
2031	17	0.05	10	0.03	7	0.02
2033	78	0.21	47	0.13	31	0.09
2036	57	0.16	34	0.09	23	0.06
2038	27	0.07	16	0.04	11	0.03
2039	8	0.02	5	0.01	3	0.01

CJMT will need to obtain CNMI authorization to dispose of construction and demolition waste at the Marpi Landfill, the permitted Tinian Puntan Diablo Landfill, the future/planned Atgidon Landfill, and/or the planned hardfill site.

3.1.2 Green Waste

The construction workforce will clear vegetation during facility construction from the 2026 through 2039 timeframe. The projected quantities of green waste to be generated are presented in Table 9.

Table 9. Projected Green Waste Generation During Construction

Year	Description	Area Cleared (sf)	Green Waste Volume Generated[b] (cy)	Green Waste Tonnage Generated[b] (tons)
2026	Helicopter Landing Zones Cleared (1/3 of total area cleared)[a]	2,280,000	50,667	12,667
	North Field Drop Zone Cleared (1/3 of total area cleared)[a]	1,292,280	28,717	7,179
	Landing Zones Access Roads. Cleared (1/3 of total area cleared)[a]	139,224	3,094	773
2027	Helicopter Landing Zones Cleared (1/3 of total area cleared)[a]	2,280,000	50,667	12,667
	North Field Drop Zone Cleared (1/3 of total area cleared)[a]	1,292,280	28,717	7,179
	Landing Zones Access Roads. Cleared (1/3 of total area cleared)[a]	139,224	3,094	773
2028	Helicopter Landing Zones Cleared (1/3 of total area cleared)[a]	2,280,000	50,667	12,667
	North Field Drop Zone Cleared (1/3 of total area cleared)[a]	1,292,280	28,717	7,179
	Landing Zones Access Roads. Cleared (1/3 of total area cleared)[a]	139,224	3,094	773
	Base Camp Potable Water Services Facilities	0	0	0
	Communications Area Distribution Node (ADN)	0	0	0

Year	*Description*	*Area Cleared (sf)*	*Green Waste Volume Generated[b] (cy)*	*Green Waste Tonnage Generated[b] (tons)*
	Electrical Distribution Building / Switching Station	0	0	0
	Fuel Storage and Distribution Facility	0	0	0
	Potable Water Well Field	412,460	9,166	2,291
	Combined Electrical and Communication Lines Inside and Outside of the Military Lease Area	1,205,820	26,796	6,699
	Water Line from Well Field (final field location TBD; assume largest area disturbed with Option A)	336,000	7,467	1,867
2030	Two Surface Radar Tower	51,200	1,138	284
	Base Camp Ammunition Holding Area	0	0	0
	Multi-Purpose Maneuver Range Ammunition Holding Area	27,000	600	150
	Multi-Purpose Maneuver Range Water Wells and Tanks	65,340	1,452	363
	Multi-Purpose Maneuver Range: Center Access Road/UKD Range (vegetation clearing and regular maintenance)	108,000	2,400	600
	Multi-Purpose Maneuver Range: Firebreak	302,880	6,731	1,683
	Multi-Purpose Maneuver Range: Perimeter Road and Firebreak	504,000	11,200	2,800
	Multi-Purpose Maneuver Range: Target/Objective Areas	531,200	11,804	2,951
2031	Range Support Maintenance Shop	0	0	0
	Port Biosecurity/Wash Rack	0	0	0
2033	General Purpose Warehouse and Hazardous Materials Storage and Transfer Building	0	0	0
2036	Aircraft Shelter	0	0	0
2038	Camping Concrete Tent Pads	0	0	0
	Base Camp Biosecurity/Wash Rack	0	0	0
	Base Camp Motor Pool	0	0	0
	Base Camp Public Works Shop	0	0	0
	Base Camp Security Fencing	313,400	6,964	1,741
	Base Camp Training Unit Vehicle Parking	0	0	0
2039	Explosives Training Range (ETR)	108,900	2,420	605
	Explosives Training Range Access Road	67,200	1,493	373
	Wastewater/Restrooms/Showers	0	0	0

Notes: [a]–Assume 1/3 of activities conducted each year (2026-2028).
[b]–Green Waste Generation: Total square yards of cleared area was multiplied by 2 yards (1.85 meters) (the average height of vegetation); then 10 percent of the volume was used to estimate the amount of green waste generated (based on the site visit to Tinian in December 2013). Average density of green waste is assumed to be 500 pounds per cubic yard (DON 2017).

Table 10 summarizes annual green waste quantities to be generated during the multi-year construction period.

Table 10. Estimated Annual Green Waste Generation - Construction Phase

Year	*Volume* (*cubic yards*)	*Weight* (*tons*)
2026	82,478	20,619
2027	82,478	20,619
2028	125,906	31,477
2030	35,325	8,831
2031	0	0
2033	0	0
2036	0	0
2038	6,964	1,741
2039	3,913	978

Green waste generated during construction will be chipped by the construction employer. The construction employer will be responsible for determining size and location of the chipping area and obtain local permits as required. The construction employer will utilize mulch as needed to complete construction. Mulch remaining after completion of construction will be stockpiled and utilized by facility maintenance managers to control vegetation growth and/or for erosion and dust control. Excess mulch will be made available for use by residents of Tinian for the benefit of enriching the island soils and reducing erosion.

Mulched green waste is widely used as alternative daily cover, in place of soil daily cover, in landfill operations in the continental United States; if permitted, the option of using mulch as alternative daily cover would be available to the operator of the local landfill.

The coconut rhinoceros beetle has been reported to have been found in the CNMI. Inspection of green waste generated during the land clearing phase of the work would be conducted to prevent the spread of this invasive species. If inspection of the work area indicates the presence of coconut rhinoceros beetle, methods to control it would include chipping/grinding which kills the majority of the insects during the mechanical size reduction process. If it is determined that additional control is required, enhanced control can be done by subjecting the mulched material to elevated temperatures for a defined period of time which will kill the insects. Elevated temperatures in excess of 130 degrees F for a period of 15 days have been shown to be effective in destroying coconut rhinoceros beetle. Placing the mulched material, with appropriate moisture levels, in windrows and turning them periodically through the 15 day period will produce the required elevated temperatures. Upon completion of the elevated temperature process, the mulch may be utilized.

3.1.3 Hazardous, Industrial, Universal Wastes and E-Wastes

Hazardous, industrial, universal wastes and e-wastes may be generated during the construction phase of the Proposed Action. Quantities of wastes generated cannot be estimated at this time. The types of wastes generated during the construction phase may consist of, but not be limited to the following:

- Used oil from construction equipment maintenance and operation;
- Antifreeze from construction equipment maintenance and operation;

- Diesel and gasoline; and
- Expired or unused paint and paint-related materials.

All construction-related hazardous, industrial, universal wastes, and e-wastes would be stored, collected, shipped off-island, and managed in accordance with applicable regulations. Transportation of all hazardous wastes would be conducted in compliance with U.S. Department of Transportation regulations and CFR Title 49. Since all generated hazardous wastes would be removed from the island and disposed of according to relevant laws and regulations, the proposed construction activities would have no impact with respect to hazardous waste disposal on Tinian.

4 PROPOSED ACTION WASTE GENERATION AND CHARACTERIZATION—TRAINING OPERATIONS

Training operations will generate solid waste due to the presence of personnel undergoing training and permanent facility staff. Ongoing facility maintenance activities will also result in waste during the training operations period.

This chapter presents the following estimated values:

- Solid waste quantities and composition projected to be generated during training operations;
- Construction waste quantities generated from maintenance activities;
- Green waste generation from ongoing grounds maintenance;
- Quantities of waste that will be diverted/recycled;
- Quantities of waste requiring disposal; and
- Types of hazardous wastes generated.

Training operations will vary from year-to-year due to variations in the number and type (i.e., large, medium, or small) of training events and the number of personnel participating in training events. Solid waste generation estimates present quantities of waste for an estimated average training tempo, representing approximately mid-range of number of events/year and mid-range of minimum and maximum personnel per event, and high-range training tempo representing maximum training events permitted per year with maximum number of permitted participants. The range of waste generation presented provides information necessary for evaluating options and selecting final management methods/facilities to manage wastes generated by the Proposed Action.

Waste management practices will be developed with an emphasis on source reduction to minimize the generation of waste thereby reducing the dependence on landfill or incineration for final management. The USMC will develop the CJMT Training Manual and other standard operating procedures to implement waste minimization through source reduction, to mandate and enforce segregation and diversion of recyclables from the waste stream to minimize disposal, to include all waste management requirements as outlined in the CNMI integrated waste management plan, and to include waste management policies and procedures that reference the CNMI zero waste proclamation and applicable regulations. The Training Manual will address the USMC requirement to ensure municipal solid waste is managed in accordance with USMC Environmental Management and Range Sustainability requirements, which are based on applicable laws, rules, and policies which prohibit illegal dumping. The Training Manual will address identification of hazardous materials and measures and methods to be employed to prevent improper disposal of these materials with the non-hazardous solid waste.

4.1 SOLID WASTE

4.1.1 Solid Waste Generation Rates

This section describes the anticipated solid waste generation rates for two different conditions on Tinian. One condition would be during training periods where both permanent on-island staff are present and training personnel are present. The second condition is in-between training events when only permanent personnel are on island.

Solid waste generated from active training operations is estimated based on documented waste generation data collected over a 6-month period by the Army at the Pohakuloa Training Area (Pohakuloa) in Hawaii County, Hawaii, from November 2013 through April 2014 (Duwall, L., Pohakuloa Solid Waste Contract Program Evaluator 2014). The Pohakuloa operation involves military personnel conducting temporary-duty training similar to that planned for CJMT. The Pohakuloa solid waste generation rate is 7.0 pounds (lbs) per person per day which is higher than the non-training generation rate of 4.9 lbs per person per day described below. During active training periods, CJMT will host personnel undergoing active training in addition to the permanent staff. The number of active training events per year, training event sizes, and training event duration will vary.

Solid waste generation for permanent personnel is expected to be 4.9 lbs per person per day (USEPA 2020). Only permanent staff will be present during non-training periods. The population during these periods will vary little and will be considered the baseline population. Solid waste generated during these periods is very low compared to active training periods.

4.1.2 Solid Waste Composition and Diversion

Waste composition data from US military bases in Guam (NAVFAC Marianas 2013) is a reasonable approximation of the composition of solid waste generated by the Proposed Action because it is based on solid waste data from similar types of activities, climate conditions, and geographical location. Waste composition data is presented in Table 11.

Table 11. Tinian Training Area - Solid Waste Composition During Training

Material Type[a,b]	***Estimated Percent by Weight***[a,b]
Paper/Cardboard	30.4
Glass	4.0
Plastics/Polystyrene	21.0
Metal	6.0
Organics/Food Waste	37.2
Remaining/Composite municipal solid waste	1.4
Total	**100.0**

Notes: [a] NAVFAC Marianas 2013.
[b] Composition modified to remove non-municipal solid waste components of construction and demolition, electronic waste, and hazardous waste.

The current DoD Integrated Solid Waste Management policy sets a minimum diversion from landfilling or non-waste to energy incineration of 40 percent for non-hazardous waste, excluding construction and demolition debris (Office of the Assistant Secretary of Defense 2020). CJMT is unlikely to meet the 40 percent solid waste diversion goal due to the types of waste generated during expeditionary exercises, such as pre-packaged food containers, and its remote location with limited recycling services and no domestic consumption of diverted materials. Additionally, unlike day-to-day operations at a traditional installation, expeditionary training does not regularly include activities that generate certain waste streams, which contain materials that are typically diverted from the landfill (e.g., vehicle maintenance materials, kitchen/mess hall operations). An estimated waste diversion rate for the project has been developed based on the anticipated recovery of recyclable materials present in the waste stream along with the types of materials that can currently be received and processed at the Tinian Transfer Station: source-separated cardboard/paper, plastic bottles, and aluminum cans (CNMI 2023).

As the Tinian Transfer Station accepts only source-segregated recyclable materials, CJMT would be required to segregate cardboard/paper, plastic bottles, and aluminum prior to delivery. Recycling facilities that receive source-separated materials have a low tolerance for unsorted materials and material contamination because they lack material sorting equipment and site capacity for sorting. Contaminated recyclables will likely be rejected by the transfer station, which would necessitate landfill disposal.

The requirement to segregate recyclables with minimal contamination may impact the degree of recovery. Segregation is a labor-intensive process and will be largely dependent upon factors such as providing personnel, space, and materials or equipment dedicated to the sorting/segregation process. Even at established military bases and military housing units observations of recycling and diversion programs have modest to low rates of segregation and capture of recyclable materials with the majority of recyclables being discarded into the waste receptacles rather than the recyclables collection containers. The responsibility for sorting materials falls on the individual generator which, in this case, would largely be the individuals participating in training. Range Control will provide information and oversight to the visiting training units on proper procedures to follow during training in the Military Lease Area, including the requirements for proper waste disposal. Diversion of recyclables would be maximized by this oversight, along with the educational program and provision of recycling receptacles that are clearly labeled and would protect recyclables from contamination.

Estimated recovery rates for the targeted recyclables is based on the 2018 averages for the United States (USEPA 2020) with an adjustment of these rates to reflect the site-specific challenges to recycling, outlined above. A conservative adjustment of 50 percent reduction from the 2018 United States average (USEPA 2020) for the CJMT diversion rates is utilized based on the assumption of CJMT implementing a recycling program for the targeted materials. Table 12 presents the assumed waste composition, the 2018 average diversion rate for the United States, and the adjusted diversion rate for the project.

Table 12. Tinian Training Area – Estimated Recyclable Diversion Rates

Material Type	*Estimated Percent of Total Waste Stream*[a,b]	*2018 US Average Diversion Percentage*[c]	*Adjusted CJMT Diversion Percentage*	*Overall CJMT Diversion Percentage*
Paper/Cardboard	30.4	64	32	10
Glass	4.0	N/A	N/A	N/A
Plastics/Polystyrene	21.0	14	7	1
Metal	6.0	35	17	1
Organics	37.2	N/A	N/A	N/A
Remaining/Composite municipal solid waste	1.4	N/A	N/A	N/A
Total	100.0			12

Notes: [a] NAVFAC Marianas 2013.
[b] Composition modified to remove non-municipal solid waste components of construction and demolition, electronic waste, and hazardous waste.
[c] USEPA 2020.

Based on the above outlined assumptions, the overall aggregate diversion rate for the solid waste stream is estimated to be 12 percent.

These modest diversion rates for the individual material types are based on assumed low levels of diversion due to the following reasons:

- Frequent turnover of participating personnel can result in difficulty implementing an effective segregation program;
- Potential contamination of paper products due to food residue and other contamination; and
- Portions of the plastics, polystyrene, and metal categories cannot be recycled at the Tinian Transfer Station.

The following sections use a 12 percent diversion rate to estimate the overall municipal solid waste diversion for the project.

4.1.3 Solid Waste Quantities

The quantities of solid waste generated are dependent upon the frequency of training events, total personnel participating in the training, the presence of construction workers, as well as the permanent facility staff. Table 13 presents Alternative 1, which entails the highest expected training intensity, with the projected training frequencies, the expected population of various sizes of training sessions, and the anticipated population of permanent staff and construction workers.

Table 13. Alternative 1 Training Events, Duration, Frequency and Projected Headcount

Description	*Projected Personnel Headcount*	*Event Duration*	*Estimated Training Frequency*
Permanent Staff	50	365	
Construction Workers	50	365	
Training Events			
Small Training Events	up to 100	1-2 Weeks	Routinely occurring throughout the year
Medium Training Events	up to 250	1-2 Weeks	Once per quarter
Large Training Events	up to 1,000	2-4 Weeks	2-4 times per year

Notes: [1] 30 of the 50 permanent staff positions area expected to be filled by Tinian residents, with the balance being filled by off-island personnel. For estimation solid waste impacts, only the additional 20 off-island positions will be considered.
[2] For estimation of solid waste impacts associated with small training events, and annual total number 12 of events is assumed (average of one event per month, year round).
[3] Maximum personnel participating in training at any one time is 1,000.

Permanent staff is projected to be 50 persons with approximately 30 of those positions to be filled by current Tinian residents. Solid waste generation projections for the project will include the 20 additional positions that will be filled by personnel not presently residing on Tinian.

The range of training frequency, total training days, and personnel headcount is presented in Table 14.

Table 14. Training Event Frequency and Personnel Headcount

Activity Description	*Personnel Headcount/Event*		*Event Frequency (events/year)*		*Event Duration (days)*		*Total Maximum Training Days/Year*	*Personnel Days/Year*
	Event Size Range	*Maximum Headcount*	*Frequency Range*	*Maximum*	*Duration Range*	*Maximum*		*Maximum*
Permanent Staff		20			365			7,300
Construction Workers		50			365			18,250
Training Personnel								
Small Training Events	up to 100	100	12	12	7-14	14	168	16,800
Medium Training Events	up to 250	250	4	4	7-14	14	56	14,000
Large Training Events	up to 1,000	1,000	2-4	4	14-28	28	112	112,000
Total Training Personnel				20		56	336	142,800
Average Training Personnel Headcount/Training Day (Training Personnel Days/Year, Maximum ÷ Total Maximum Training Days/Year)								425

Notes: [1] Assumed small training event frequency to be 12 events/year (average of one per month, year round).
[2] Maximum personnel participating in training at any one time is 1,000.

The maximum personnel participating in training at any one time is 1,000. For the maximum projected annual training events under Alternative 1, the average number of personnel participating in training throughout the course of the training year, total personnel days averaged over the maximum number of training days, is 425, which is shown in Table 14.

The maximum estimated annual solid waste generation is calculated using the estimated personnel days per year, the estimated solid waste generation rates, and estimated diversion rate. Table 15 presents this range.

Table 15. Maximum Solid Waste Generation (per year)

Description	***Solid Waste Generation Rate (lbs/person/day)[a,b]***	***Personnel Days/Year***	***Solid Waste Generated (tons/year)***
Permanent Staff	4.9	7,300	18
Construction Workers	4.9	18,250	45
Small Training Events	7.0	16,800	59
Medium Training Events	7.0	14,000	49
Large Training Events	7.0	112,000	392
Solid Waste Generated/Year			562
Solid Waste Diverted/Year[c]			67
Solid Waste Disposal/Year			495

Notes: [a] SW generation rate for permanent staff and construction workers = 4.9 pounds/person/day.
[b] SW generation rate for training personnel = 7.0 pounds/person/day.
[c] Estimated 12 percent diversion rate.

The solid waste generation rates of 4.9 lbs/person/day for permanent staff and construction workers and 7.0 lbs/person/day for training participants were applied to the headcount ranges representative of three population conditions that estimate the range of solid waste generation and associated diversion and disposal occurring over the course of a training year:

1) Minimum daily waste generation – periods during which no training is occurring, and only permanent staff and construction workers are present;
2) Maximum daily waste generation - periods when the maximum training population of 1,000 is present with the permanent staff and construction workers; and
3) Average daily waste generation – represents an overall average disposal tonnage per day for the entire training year under Alternative 1. Average training population over the course of the training year is noted in Table 14 and is used to estimate solid waste generation in the training population which is added to that generated by the permanent staff and construction workers.

The daily solid waste generation, solid waste diversion, and disposal tonnage for these 3 conditions are presented in Table 16.

Table 16. Solid Waste Generation (per day)

Description	*Permanent Staff*[a]	*Construction Workers*[a]	*Training Personnel*[b]	*Daily Solid Waste Tonnage*
Solid Waste Generation (lbs/person/day)	4.9	4.9	7.0	
Minimum Daily Waste Generation	20	50	0	
Solid Waste Generation (tons/day)	0.05	0.12	0.00	0.17
Solid Waste Diversion (tons/day)[c]	0.01	0.01	0.00	0.02
Solid Waste Disposal (tons/day)	0.04	0.11	0.00	0.15
Average Daily Waste Generation	20	50	425	
Solid Waste Generation (tons/day)	0.05	0.12	1.49	1.66
Solid Waste Diversion (tons/day)[c]	0.01	0.01	0.18	0.20
Solid Waste Disposal (tons/day)	0.04	0.11	1.31	1.46
Maximum Daily Waste Generation	20	50	1,000	
Solid Waste Generation (tons/day)	0.05	0.12	3.50	3.67
Solid Waste Diversion (tons/day)[c]	0.01	0.01	0.42	0.44
Solid Waste Disposal (tons/day)	0.04	0.11	3.08	3.23

Notes: [a] SW generation rate for permanent staff and construction workers = 4.9 pounds/person/day.
[b] SW generation rate for training personnel = 7.0 pounds/person/day.
[c] Estimated 12 percent diversion rate.

Solid waste tonnage estimates for the three population conditions, outlined above, are summarized in Table 17. Average and maximum training period estimates provide a reasonable range of solid waste generation per day during the varying training periods during the training year. The average daily generation rate can be viewed as the typical average anticipated waste loading over the entire training year, and the maximum generation rate can be viewed as the highest anticipated daily waste loading during training periods with the maximum participating headcount (1,000 persons). The maximum daily condition represents the highest impact on recycling and final disposal facilities utilized. While the average daily solid waste generation rate based on the average training day population is useful in assessing the average daily impact to the local solid waste management infrastructure, it is not used to estimate the annual loading as that is based on the maximum personnel training days for the entire year.

Table 17. Solid Waste Generation

Description	*Permanent Staff and Construction Workers*[a]	*Maximum Training Population Generation*[b]	*Estimate Annual Solid Waste Generation*
Solid Waste Generation (tons/day)[c]	0.17	3.67	
Solid Waste Diversion (tons/day)[d]	0.02	0.44	
Solid Waste Disposal (tons/day)	0.15	3.23	
Annualized MSW Generation, Diversion, and Disposal			
Solid Waste Generation (tons/year)[c]	63	500	562
Solid Waste Diversion (tons/year)[d]	8	60	67
Solid Waste Disposal (tons/year)	55	440	495

Notes: [a] SW generation rate for permanent staff and construction workers = 4.9 pounds/person/day.
[b] SW generation rate for training personnel = 7.0 pounds/person/day.
[c] Estimated 12 percent diversion rate.

Expended ammunition casing metals, aluminum, and brass are projected to be generated in the amount of 1.45 lbs/person/day during active training, and quantities are presented in Table 18 (NAVFAC Marianas 2013).

Table 18. Expended Ammunition Casing Metals

	Average Daily Waste Quantity (tons/day)	*High-Range Daily Waste Quantity (tons/day)*	*Average Annual Tonnage (tons/year)*	*High-Range Annual Tonnage (tons/year)*
Expended Aluminum & Brass Cartridges [a]	0.49	0.72	25	75

Notes: [a] Estimated aluminum and expended brass cartridges occur during training - 1.45 pounds/person/day of training.

Solid waste generation at the ranges is expected to be minimal during operation. Collection bins would be provided at appropriate locations and periodically emptied, with solid waste taken to the most convenient transfer station or recycling center for processing and transfer to the appropriate disposal or recycling facility.

All expended ammunition casings will be collected by training units and returned to be recycled off island, per USMC MCO 4400.201-V7, and not be managed at CNMI municipal recycling or disposal sites.

4.1.4 Construction Waste

During training operations, construction waste would be produced from capital improvements and regular maintenance of the facilities. Documented operational conditions at bases on Guam indicate construction and demolition waste is generated each year by regular maintenance of facilities (NAVFAC Marianas 2013) and has been found to average approximately 5.6 percent of the annual solid waste tonnage. The estimated construction and demolition waste generated through facility maintenance for Alternative 1 is calculated by applying this generation rate to the estimated annual solid waste tonnage. The results of this calculation for the Tinian facility are presented in Table 19.

Table 19. Projected Construction and Demolition Waste Generation During Training Operations

Annual Solid Waste (tons/year)	*Operational C&D Waste*	
	Annual (tons/year)	*Daily (tons/day)*
562	31.5	0.09
C&D Tons Diverted (60%)	18.9	0.05
C&D Tons Disposed (40%)	12.6	0.03

Notes: [1] C&D waste generation as a percentage of overall annual solid waste = 5.60%, NAVVFAC Marianas 2013.

4.1.5 Green Waste

Green waste resulting from the ongoing grounds maintenance of the training facilities will be minimal. Areas cleared of vegetation during the construction will be maintained by regular mowing with the cuttings being left on the ground to decompose with no appreciable quantities of green waste generated. Through regular mowing, vegetative growth will be limited to grasses, and re-establishment of larger woody shrubs and trees will be prevented.

4.1.6 Hazardous Waste, Industrial, Universal Wastes, and E-Wastes

Hazardous, industrial, and universal wastes and e-waste may be generated during the training operations. Quantities of wastes generated cannot be estimated based on the information known at this time. The types of wastes generated during the construction phase may consist of, but not be limited to, the following:

- Used oil and grease from equipment maintenance and operation;
- Antifreeze from equipment maintenance and operation;
- Off-spec or contaminated diesel and gasoline;
- Expired, unused, or off-spec paint and paint-related materials;
- E-wastes;
- Mercury-containing equipment;
- Batteries; and
- Fluorescent light bulbs.

Operational-related hazardous wastes, universal wastes (i.e., fluorescent lamps, mercury-containing instruments, batteries), electronic waste (e.g., computer equipment, monitors, televisions, etc.), and non-hazardous industrial waste (i.e., oil, and paint, antifreeze, expired commercial chemical products, etc.) would be collected and transported off the island in accordance with applicable laws and regulations. These wastes would also be managed and stored in accordance with applicable regulations. The proposed operational activities would have no impact with respect to hazardous waste disposal on Tinian.

5 SOLID AND HAZARDOUS WASTE MANAGEMENT DISPOSAL OPTIONS

This chapter discusses the three proposed solid waste disposal options and the proposed management method for non-hazardous solid waste being considered for the Proposed Action, which are summarized as follows:

1. Landfill Disposal in the future Tinian Puntan Diablo Landfill, then Future Atgidon Landfill

   The CNMI intends to permit the existing Tinian Puntan Diablo disposal facility by demonstrating compliance with the small community exemption available in Resource Conservation and Recovery Act Subtitle D regulations (40 CFR Part 258.1(f)(1)). Once permitted and compliant, the Tinian Puntan Diablo Landfill would qualify as an acceptable disposal site for the Proposed Action.

   The CNMI recognizes the permitted Tinian Puntan Diablo Landfill is not a long-term solution for ensuring ongoing local solid waste disposal. As a result, CNMI intends to proceed with permitting and constructing a replacement landfill at the Atgidon site, located north of 86th Street, between Riverside Drive and 10th Avenue. The CNMI plans to permit this new site under the small community exemption (40 CFR Part 258.1(f)(1)). CNMI anticipates permitting the Atgidon Landfill will take up to 5 years to complete, with site development commencing shortly thereafter. Once operational, the landfill at Atgidon would be an acceptable disposal site for the Proposed Action.

   At this time, CJMT has not received formal authorization to use either of the future permitted landfills on Tinian.

2. Marpi Landfill, Saipan

   In the event landfill disposal is not available on Tinian, the Marpi Landfill on Saipan could be used if approved by CNMI and would require a solid waste accumulation, storage, and transfer facility on Tinian. The Tinian Transfer Station, if permitted and equipped to function as a solid waste transfer operation as opposed to its current limited operation as a recycling accumulation facility, would be one possible option for a transfer facility. At this time, CJMT has not received formal authorization to use the Tinian Transfer Station. Alternatively, a facility to accumulate and containerize solid waste generated by the Proposed Action for transfer to the Marpi Landfill could be developed and operated within the CJMT facilities. In either option, the filled refuse transfer containers would be transported to the Tinian port facility for transfer to Saipan and the Marpi Landfill.

3. Incineration

   The final option being considered for the management of CJMT solid waste is the use of an incinerator in the event a local landfill is not available, or if it is determined solid waste volumes need to be further minimized prior to being landfilled. If an incinerator is ultimately selected, it would be a decision by the DoD to manage all DoD solid waste, excluding construction and demolition and green waste, generated on Tinian. Incineration typically decreases the volume of solid waste by 80 to 90 percent.

DoD Integrated Solid Waste Management policy establishes a hierarchy of preferred methods for solid waste management with incineration of waste preferred over land disposal because of the significant volume reduction.

The incinerator residual/ash will be accumulated in sealed storage containers and periodically transported to the Marpi Landfill, or other permitted and compliant Resource Conservation and Recovery Act Subtitle D landfill for final disposal. Based on the anticipated composition of the solid waste, the ash would be expected to be non-hazardous. Ash residue would be required to be periodically sampled and analyzed prior to disposal, and would be managed as hazardous waste in compliance with appropriate regulations if necessary.

If it is determined that use of an incinerator on Tinian is the best solution for management of residual waste, the incinerator will be one which is permitted and approved by the U.S. Environmental Protection Agency and the CNMI in accordance with applicable regulations. The incinerator unit will be tested as required to demonstrate its compliance with all operational and emissions standards.

5.1 SOLID WASTE MANAGEMENT REQUIREMENTS

This section summarizes the estimated daily solid waste management requirements for the construction period and the operational period. Solid waste management facilities supporting diversion/recycling and final disposal used for the Proposed Action must have the capacity to efficiently receive, process, and/or dispose of this range of materials on a daily basis in addition to any other quantities of waste received from other sources not associated with the Proposed Action. The following was estimated with the solid waste data analysis for the Proposed Action:

- The maximum daily solid waste generated under Alternative 1, including solid waste associated with operational training, permanent staff, and construction workers (3.67 tons/day), and the highest average daily construction and demolition waste (0.21 tons/day), is 3.89 tons/day.
- After diversion, the maximum daily solid waste disposal tonnage under Alternative 1 is projected to be 3.32 tons/day. The average daily solid waste tonnage is projected to be 1.46 tons (Table 16).
- Maximum daily solid waste recycling for the Alternative 1 operational period to achieve 12 percent diversion is 0.44 tons. The average daily solid waste recycling/diversion is 0.2 tons (Table 16).
- Required average daily construction and demolition waste recycling to achieve 60 percent diversion is 0.13 tons/day.

Recycling of construction and demolition waste primarily is conducted by the construction employer and does not significantly impact local recycling facilities. Small amounts of paper/cardboard, plastics, and aluminum cans may be processed through the Tinian Transfer Station.

5.2 IMPACTS TO EXISTING AND PLANNED SOLID WASTE MANAGEMENT FACILITIES

The above-outlined disposal and diversion/recycling requirements for the construction period and operational period of the Proposed Action can be used to evaluate the impact on the existing and planned solid waste facilities and their capacity to absorb such quantities.

Table 20 presents the current daily disposal at the local landfills and the estimated past daily disposal during recent periods of higher population.

Table 20. Existing Disposal Capacity vs. Required Capacity

Landfill	*Current Daily Disposal (tons)*	*Past Estimated Daily Disposal (tons)*	*Assumed Excess Daily Capacity (tons)*	*Project Required Maximum Daily Disposal (tons)*	*Capacity Excess/(Deficit) – Maximum Daily Disposal (tons)*	*Projected Required Average Daily Disposal (tons)*	*Capacity Excess / (Deficit) Average Daily Disposal (tons)*
Tinian	3.9	5.2	1.4	3.32	(1.96)	1.46	(0.06)
Marpi	87.0	95.7	8.7		5.38		7.24

5.2.1 Tinian Puntan Diablo Landfill

The Puntan Diablo Landfill operation may require additional operational assets, equipment and personnel, to supplement the existing daily operational capacity and ensure the facility is capable of efficiently managing the additional disposal tonnage from the Proposed Action. The additional disposal tonnage from the Proposed Action represents an increase of approximately 85 percent over the current average daily disposal tonnage and would be expected to result in a decrease of remaining operational life.

According to the Integrated Solid Waste Management Plan, the remaining disposal capacity at Tinian Puntan Diablo Landfill, once permitted, will be 10 years. The proposed Atgidon Landfill daily operational capacity and permitted disposal capacity should be designed in anticipation of the additional disposal needs presented in this study.

The projected maximum daily solid waste generation of 3.67 tons/day, before any reduction through recycling and diversion, when added to the current average daily disposal tonnage at the Puntan Diablo disposal facility of 3.9 tons results in a total daily disposal tonnage of 7.57 tons. The projected average daily solid waste generation after the projected 12% diversion of recyclables is 1.46 tons/day. When added to the current average daily disposal tonnage at the Puntan Diablo disposal facility of 3.9 tons, the projected average daily total disposal at this facility would be 5.36 tons.

The small community exemption, under which the CNMI plans to permit the Puntan Diablo facility, limits daily average disposal tonnage to less than 20 tons. The combined Proposed Action waste tonnage and the average daily disposal tonnage at Puntan Diablo of 5.36 tons is significantly below this threshold.

5.2.2 Marpi Landfill

The Marpi Landfill operation has more than adequate daily operational capacity to absorb the additional disposal tonnage from the Proposed Action.

The remaining operational life of the landfill, as previously noted, is approximately 26 years at current disposal rates (GHD, Inc./Gershman, Brickner, & Bratton, Inc. December 2019). The additional average daily disposal tonnage from the Proposed Action, if accepted at Marpi, represents an increase of approximately 1.7 percent and would be expected to result in a decrease of remaining operational life by approximately 0.5 years from approximately 26 years to 25.5 years.

5.2.3 Tinian Transfer Station

The Tinian Transfer Station will be impacted in different ways depending on the landfill utilized for disposal. Regardless of which landfill may be used for disposal, only acceptable recyclable materials and municipal solid waste would be processed through the Tinian Transfer Station. If the Tinian/Atgidon Landfill option is utilized, the transfer station could receive up to 0.44 tons/day of additional recyclables generated by the Proposed Action.

If the Marpi Landfill option is utilized, and the CNMI and CJMT negotiate the use of the Tinian Transfer Station for processing of all solid waste from the Proposed Action, the facility would be required to be re-permitted to operate as a transfer station and acquire additional equipment and waste transport containers to receive, store, and transport up to 3.32 tons/day of solid waste. The station would also receive up to 0.44 tons/day of additional recyclables.

Additionally, utilization of the Tinian Transfer Station to enable use of the Marpi Landfill for disposal needs will require logistical coordination and equipment for the following tasks associated with the transfer of filled waste containers to the landfill and return of empty containers from the landfill back to Tinian:

- Transport trucks to move filled waste containers to the port of Tinian for loading onto barges/ships outbound to Port of Saipan;
- Barge/ship service to transport the containers to Port of Saipan:
- Transport trucks to receive waste containers at the Port of Saipan and transfer them to the Marpi Landfill;
- Equipment at the landfill to unload the incoming waste containers from the transfer trucks and to load up outgoing empty containers to be returned to Tinian; and
- Trucks and equipment at the landfill to discharge waste at the active landfill face.

5.3 INCINERATION

Development and operation of a new landfill on Tinian has been proposed in the past and to date has not yet been successfully implemented. Uncertainty about adequate funding sources and the adequacy of CNMI government resources to support the planning, design, construction and operation of a new landfill continues. If landfill disposal is not available to support the Proposed Action, an on-site incinerator may be utilized as the method for solid waste disposal which will minimize the volumes of waste requiring landfill disposal. Residual ash volume will be 80 to 90 percent less than the original volume of waste, thus landfill disposal volume required will be reduced by 80 to 90 percent as well.

The incinerator would be sized to process the anticipated daily disposal tonnage (3.32 tons/day), and additional or redundant capacity may be required to accommodate all solid waste estimated to be generated (3.89 tons/day) in the event of a disruption in diversion of solid waste. This may entail the facility being designed with two incinerators to provide the desired capacity and to provide operational flexibility when lower quantities of waste are being generated. The projected daily tonnage is the same as those estimated for landfill disposal and assume 12 percent diversion/recycling of solid waste before incineration.

The quantities of solid waste will often be less than the maximum daily for which the incinerator will be sized because the maximum daily tonnage will only be generated during peak training activities. As a result, during periods of lower waste generation, the incinerator will not be operated regularly. During periods of lower waste generation, waste will be received on a daily basis and will be stored in sealed containers (to control vectors and odors) until adequate quantity is accumulated to operate the incinerator.

The typical waste incinerator will be composed of a waste in-feed system, closed combustion chamber(s), exhaust/air pollution control system, and ash handling system. Small scale waste incinerators typically require supplemental fuel to start up and to supplement the basal thermal unit-value of the waste to maintain minimum and stable combustion temperatures.

The incinerator facility will be an enclosed or partially enclosed building to shelter the incinerator equipment from the elements. The waste-receiving portion of the building should be sized to receive and store several days of incoming waste in the event of incinerator downtime. The waste handling area will require rolling-stock equipment capable of handling the incoming waste, placing the waste into the incinerator feed system, and placing the waste into storage containers. The facility will need an all-weather access road and staging area for the waste storage containers. The building will require a concrete floor capable of supporting the incoming waste collection vehicles and the rolling-stock operational equipment; the floor should be water-tight and equipped with a sump to collect and manage liquids seeping from the waste.

An on-site incinerator will require local land use and environmental permits issued by the governing CNMI agencies. The incineration and air pollution control equipment design will be required to satisfy the applicable environmental regulations. Ash residue generated by the incinerator will be collected, stored and periodically transported to a lined Resource Conservation and Recovery Act Subtitle D landfill permitted to accept solid waste incinerator ash. If the incinerator ash tests positive for hazardous constituents, it will be managed as hazardous waste and disposed of at an U.S. Environmental Protection Agency permitted hazardous waste disposal facility.

5.4 HAZARDOUS, INDUSTRIAL, UNIVERSAL, AND ELECTRONIC WASTE

Hazardous wastes, non-hazardous industrial wastes, universal wastes (i.e., fluorescent lamps, mercury-containing instruments, batteries), and electronic waste (e.g., computer equipment, monitors, televisions, etc.) will be collected, shipped off the island, and managed in accordance with applicable regulations.

Training will be implemented to address identification of hazardous materials and measures and methods to be employed to prevent improper disposal of these materials with the non-hazardous solid waste.

6 REGULATORY SETTING

Solid waste management on Tinian is governed by several federal and CNMI regulations and agencies, as described below.

6.1 COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

6.1.1 Bureau of Environmental and Coastal Quality

The Bureau of Environmental and Coastal Quality is the lead regulatory agency for solid waste management within the CNMI. Solid waste management regulations have been promulgated and are found in Title 65 Chapter 80 of the CNMI Administrative Code. In this documentation, the municipal solid waste disposal requirements, presented in Part 201, state that the following regulations apply:

- Section 65-80-201, "Municipal Solid Waste Criteria."
- Section 65-10, "Air Pollution"
- 40 CFR section 258 (1999), which is adopted by reference in its entirety and attached as Appendix I to Title 65 Chapter 80. All municipal solid waste Landfills must comply with the provisions of 40 CFR section 258 (1999).

The purpose of the regulations is to establish requirements and criteria for new and existing solid waste management activities and facilities, including municipal solid waste landfills and other landfilling operations, incineration, solid waste collection and transfer, recycling, composting, and salvage. The Solid Waste Management Regulations further require a municipal solid waste landfill to comply with Part 258 ("Criteria for Municipal Solid Waste Landfills") of Title 40 CFR, which the Solid Waste Management Regulations (Northern Mariana Islands Administrative Code 2004) have adopted and incorporated by reference.

6.1.2 Coastal Resources Management

The Bureau of Environmental and Coastal Quality promotes the conservation and wise development of coastal resources. One of the Bureau of Environmental and Coastal Quality functions is to coordinate the site selection permit process, thereby ensuring that permit decisions are consistent with Coastal Resource Management regulations.

A site selection permit process occurs when any proposed project has the potential to affect coastal resources directly and significantly. In accordance with CNMI Administrative Code Title 15, Chapter 10, "Coastal Resources Management Rules and Regulations," the selection of a municipal solid waste landfill site would fall within the purview of this regulation.

An Area of Particular Concern is a geographically delineated area with special management requirements enforced by the Coastal Resource Management Office. There are five areas of particular concern:

- *Shoreline:* The area between the mean high-water mark and 150 feet [46 meters] inland.
- *Lagoon and reef:* The area extending seaward from the mean high-water mark to the outer slope of the reef.

- *Wetlands and mangroves:* Areas that are permanently or periodically covered with water and where wetland or mangrove vegetation can be found.
- *Port and industrial:* Land and water areas surrounding the commercial ports of Saipan, Tinian, and Rota.
- *Coastal hazards:* Areas identified as coastal flood hazard zones.

When siting any on-island municipal solid waste facilities, the Municipality of Tinian must avoid areas of particular concern or, if these areas are unavoidable, must ensure that proposed facilities situated within an Area of Particular Concern would comply with the requirements of the Coastal Resource Management coastal permit.

6.1.3 Division of Fish and Wildlife

The CNMI Division of Fish and Wildlife is one of several agencies within the CNMI Department of Land and Natural Resources tasked with ensuring the long-term survival and sustainability of the CNMI's natural resources. Department of Fish and Wildlife reviews development proposals submitted to the Bureau of Environmental and Coastal Quality (e.g., applications for major site location permits and associated environmental assessments) to ensure that the proposed developments would minimize, mitigate, or avoid negative impacts on endangered or threatened species. Additionally, Department of Fish and Wildlife consults with the U.S. Fish and Wildlife Service pursuant to the federal Endangered Species Act (16 U.S. Code [U.S.C.] section 1536) as warranted.

6.1.4 Historic Preservation Office

The CNMI Historic Preservation Office was established by the Commonwealth Historic Preservation Act of 1982 (Northern Mariana Islands Administrative Code 1982) to identify and protect significant archaeological, historic, and cultural resources in the CNMI. Under Public Law 3-39, the Historic Preservation Office is mandated to review proposed developments pursuant to Section 106 of the National Historic Preservation Act of 1982 (Northern Mariana Islands Administrative Code 1982). A Section 106 review must be performed for projects that involve a direct, indirect, or an adverse impact on a property that is included or eligible for inclusion in the National Register of Historic Places. The proponent of a Proposed Action is responsible for initiating and ensuring completion of the Section 106 review. The Historic Preservation Office assists the Coastal Resource Management Office in evaluating applications for major site location permits as well as environmental assessments.

The Historic Preservation Office's input is intended to ensure either that significant prehistoric, historic, and cultural resources at or near a proposed municipal solid waste landfill would be protected from damage, or that sufficient site data would be compiled before such resources are altered or destroyed. The proponent of a Proposed Action may also be required to complete an Application for Historic Preservation Review to include construction plans and location maps.

6.2 UNITED STATES GOVERNMENT

6.2.1 United States Environmental Protection Agency

Subtitle D of the Resource Conservation and Recovery Act, incorporated into the CNMI Solid Waste Management Regulations by reference, uses a combination of design and performance standards for regulating municipal solid waste landfills and solid waste management facilities in general. It also establishes facility design and operating standards, groundwater monitoring, corrective action measures, and conditions, including financial requirements, for landfill closure and post-closure care as enforced by the United States Environmental Protection Agency.

Owners/operators that dispose of less than 20 tons/day based on an annual average, are exempt from subparts D and E of 40 CFR 258, so long as the requirements of 40 CFR 258.1(f) are met. Subpart D -provides liner design criteria where the requirement for a composite liner and leachate collection/removal system is found and Subpart E - provides groundwater monitoring and corrective action requirements. The exemption provided by 40 CFR 258.1(f) is available under the following conditions:

- There is no evidence of groundwater contamination from the landfill, and either of the following is satisfied:
  - 2.a. The community served by the landfill experiences annual interruptions of at least 3 consecutive months of surface transportation that prevent access to a regional waste management facility or
  - 2.b. The community has no practical waste management alternative, and the landfill unit is located in an area that annually receives less than or equal to 25 inches of precipitation.

Other Resource Conservation and Recovery Act regulations that apply for management of potential waste streams are as follows:

- Hazardous wastes must be managed per Resource Conservation and Recovery Act regulations are contained in title 40 of the C.F.R. parts 260 through 273.
- Standards for the management of used oil are contained in 40 C.F.R. 279.
- Guidelines for the thermal processing of solid wastes in 40 C.F.R. 240 will be applicable if waste is incinerated.

The management of solid waste through an incinerator will be subject to air pollution emission limitations, air pollution control equipment, and operating permits as required by the Clean Air Act as implemented through 40 C.F.R. Subchapter C.

6.2.2 Federal Aviation Administration

Improved reporting, studies, documentation, and statistics clearly show that aircraft collisions with birds and other wildlife are a serious economic and public safety problem. Section 503 of the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (U.S. Congress 2000), enacted in April 2000, addresses this hazard. This law prohibits construction or establishment of a new municipal solid waste landfill within 6 miles (9.7 kilometers) of certain public-use airports, as measured between the property lines of the airport and the landfill. Federal Aviation

Administration Advisory Circular AC No.: 150/5200-34A provides compliance guidance with this law.

In its National Plan of Integrated Airport Systems (2001–2005) (Department of Transportation 2002), the Federal Aviation Administration lists Francisco Manglona Borja / Tinian International Airport as a primary commercial service facility, thus requiring compliance with the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (U.S. Congress 2000, 49 U.S.C. Section 44718).

Advisory Circular AC No.: 150/5200-34A, Section 7 provides the following statement in regard to landfills that would be located within 6 miles of an airport:

> "If it is determined that a new municipal solid waste landfill would be located within six miles of such a public airport, then either the municipal solid waste landfill should be planned for an alternate location more than 6 miles from the airport, or the municipal solid waste landfill proponent should request the appropriate state aviation agency to file a petition for an exemption from the statutory restriction. Presumably, the CNMI aviation agency would be responsible and assist in the preparation and submittal of the required exemption request."

7 REFERENCES

CNMI. 2023. *DRAFT Comprehensive Integrated Solid Waste Management Plan for the Commonwealth of the Northern Mariana Islands.*

Department of Environmental quality . 2010. *Cease and Desist/Administrative Order.* Prohibition of Burning of Wastes and Requirement to Maintain Landfill Cover at the Tinian Dump. CASE NO. DEQ SWM 2010-01.

DoN. 2018. *Solid Waste Study Update V2a1 Final in Support of the Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact Statement/Overseas Environmental Impact Statement.* JBPHH, HI: Prepared for NAVFAC Pacific. April.

GHD, Inc./Gershman, Brickner, & Bratton, Inc. December 2019. *CNMI Department of Public Works Solid Waste Management Feasibility Study.*

NMIAC. 1982. *Commonwealth Historic Preservation Act of 1982.* Public Law 3-39. December.

Office of the Assistant Secretary of Defense, 2020. *Memorandum for Deputy Assistant Secretary of the Army (Energy and Sustainability) Deputy Assistant Secretary of the Navy (Installations and Facilities) Deputy assistant Secretary of the Air Force (Environment, Safety and Infrastructure) Staff Director, Defense Logistics Agency (Environmental Management). Subject: Revision to the Department of Defense Integrated Solid Waste Management Metrics.* March 16, 2020.

U.S. Army. 2014. Email from Ms. Lisa Duwall, Pohakuloa Training Area (PTA) Solid Waste Contract Program Evaluator, Solid Waste Generation Rate at PTA. 22 May 2014.

U.S. Congress. 2000. *Wendell H. Ford Aviation Investment and Reform Act for the 21st Century.* 49 U.S.C. Section 44718.

USEPA 2003. *Estimating Building-Related Construction and Demolition Material Amounts.*

USEPA 2018. *Construction and Demolition Generation in the United States.*

USEPA 2020. *Advancing Sustainable Materials Management: 2018 Fact Sheet.*

STORMWATER STUDY
IN SUPPORT OF THE
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
JOINT MILITARY TRAINING ENVIRONMENTAL IMPACT STATEMENT

Department of the Navy
Naval Facilities Engineering Systems Command, Pacific
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1 INTRODUCTION

1.1 PURPOSE

The purpose of this study is to provide planning-level concepts for stormwater management in support of the Commonwealth of the Northern Mariana Islands (CNMI) Joint Military Training (CJMT) Environmental Impact Statement. This comprehensive assessment encompasses existing site hydrology and hydraulics and potential impacts of the Proposed Action. Cut and fill required for construction activities would be balanced on each site, eliminating the need for import or export of soil. Mitigation includes Low Impact Development (LID) integrated management practices to manage stormwater. This analysis is based on applicable United States (U.S.) and local regulations governing the collection, conveyance, storage, treatment, infiltration, and/or disposal of stormwater.

The following design storms are analyzed in this study:

- 1-year recurrence interval, 24-hour storm event
- 25-year recurrence interval, 24-hour storm event
- 24-hour detention time, including sediment storage volume
- 95th percentile storm event

2 REGULATORY FRAMEWORK

This chapter provides a brief overview of the pertinent regulations that apply to the Proposed Action and discusses how each is used in the stormwater study.

2.1 ENERGY INDEPENDENCE AND SECURITY ACT OF 2007 SECTION 438

The Energy Independence and Security Act of 2007 requires “the sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.” This statutory requirement promotes the use of sustainable stormwater management strategies—such as green infrastructure and Low Impact Development to reduce runoff impacts from federal projects.

Section 438 was previously supported and reinforced by Executive Order 13693, *Planning for Federal Sustainability in the Next Decade* (signed in 2015). However, Executive Order 13693 was revoked by Executive Order 13834 in 2018. Despite these changes in Executive Orders, the requirements of Section 438 remain in effect as federal law and continue to guide agency compliance related to stormwater management on federal properties.

Technical guidance issued by the United States (U.S.) Environmental Protection Agency for implementing Section 438 remains applicable and is still used by federal agencies to inform project planning and design in accordance with the law

2.2 TECHNICAL GUIDANCE FOR THE ENERGY INDEPENDENCE AND SECURITY ACT SECTION 438 IMPLEMENTATION

This document recommends that projects reduce hydrologic impacts by implementing green infrastructure or Low Impact Development techniques designed to either retain the 95th percentile storm event on-site or maintain pre-development runoff conditions through site-specific hydrologic analysis (U.S. Environmental Protection Agency 2009). The 95th percentile storm event is used as a design criterion, as discussed in Chapter 5.

2.3 DEPARTMENT OF THE NAVY LOW IMPACT DEVELOPMENT POLICY FOR STORMWATER MANAGEMENT

This policy document aligns with federal mandates on Efficient Federal Operations, emphasizing stormwater management through a Low Impact Development approach. The goal is to prevent any net increase in stormwater volume, sediment, or nutrient loading from major renovation and construction projects. To achieve this, the policy mandates that Low Impact Development be incorporated into the design of all projects with a stormwater management component (Department of Defense [DoD] Unified Facilities Criteria 3-210-10, 2023).

This requirement is also based on the Department of the Navy’s 2007 Low Impact Development Policy for Stormwater Management, issued by the Assistant Secretary of the Navy (Installations and Environment), which mandates no net increase in stormwater volume, sediment, or nutrient loading from construction and major renovation activities

This policy provides guidance for reviewing and selecting Low Impact Development strategies for proposed stormwater management systems, ensuring compliance with the Energy Independence and Security Act Section 438 and Executive Order on Efficient Federal Operations. Further details are included in Chapter 6.

2.4 DEPARTMENT OF DEFENSE IMPLEMENTATION OF STORM WATER REQUIREMENTS UNDER THE ENERGY INDEPENDENCE AND SECURITY ACT SECTION 438

This DoD requirement is the overall design objective for each project and should maintain pre-development hydrology and prevent any net increase in stormwater runoff. The design requirement further states if this design objective cannot be met within the project footprint, Low Impact Development measures may be applied at nearby locations on DoD land. (DoD 2023). This policy further supports the evaluation of Low Impact Development, as described in Chapter 6.

2.5 UNIFIED FACILITIES CRITERIA 3-201-01, CIVIL ENGINEERING

This document provides requirements for all aspects of civil site development for proposed U.S. military facilities, including grading and drainage (DoD 2022).

2.6 UNIFIED FACILITIES CRITERIA 3-210-10, LOW IMPACT DEVELOPMENT

This document provides guidelines for planning, designing, constructing, and maintaining Low Impact Development strategies for stormwater management. The manual presents basic guidance for Low Impact Development design with an overview of the associated operation, cost, and maintenance considerations (DoD 2023).

2.7 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT ADMINISTRATION

The U.S. Environmental Protection Agency (EPA) Region 9 retains primary responsibility for administering and enforcing the National Pollutant Discharge Elimination System (NPDES) permit program in the CNMI. While CNMI agencies may assist in permit compliance activities, the EPA is the permitting authority and has ultimate oversight over all NPDES permitting and enforcement actions in the territory.

2.8 CNMI AND GUAM STORMWATER MANAGEMENT MANUAL

The *CNMI and Guam Stormwater Management Manual* (Horsley Witten Group, Inc. 2006) provides additional stormwater guidance and standards. Applicable standards for CJMT include:

- **Standard 1.** Site designers shall strive to reduce the generation of stormwater runoff and use pervious areas for stormwater treatment. For development sites over 1 acre, impervious cover shall not exceed 70 percent of the total site area. Impervious areas are hard surfaces that prevent water from infiltrating into the ground and include paved and coral surfaces such as roads, driveways, parking lots, and yards, as well as rooftops.

- **Standard 2.** Stormwater management shall be provided through a combination of structural and non-structural practices.
- **Standard 3.** All stormwater runoff generated from new development shall be adequately treated prior to discharging into jurisdictional wetlands or inland and coastal waters of CNMI and Guam.
- **Standard 4.** Pre-development annual groundwater recharge rates and runoff rates to coastal waters shall be maintained by promoting infiltration using structural and non-structural methods.
- **Standard 5.** New development shall use structural best management practices designed to remove 80 percent of the average annual post-development total suspended solids load and match or exceed pre-development infiltration rates, as possible. It is presumed a best management practice complies with the standard if it is:
  - Sized to capture the prescribed water quality volume.
  - Designed to match or exceed pre-development infiltration rates.
  - Designed according to the specific performance criteria outlined in the *CNMI and Guam Stormwater Management Manual* (Horsley Witten Group, Inc. 2006).
  - Constructed properly.
  - Maintained regularly.
- **Standard 6.** The post-development peak discharge rate frequency shall not exceed the pre-development peak discharge rate for the 25-year frequency storm event.
- **Standard 7.** To protect stream channels from degradation, channel protection shall be provided by means of 24 hours of extended detention storage for the 1-year frequency storm event.
- **Standard 8.** Stormwater discharges to critical areas with sensitive resources (i.e., coral reefs, swimming beaches, wellhead protection areas, designated sensitive ecosystems) would be subject to additional performance criteria, and would need the use or restriction of certain best management practices.
- **Standard 9.** All best management practices shall have an enforceable operation and maintenance agreement to ensure the system functions as designed. In addition, every best management practice shall have an acceptable form of water quality pretreatment.
- **Standard 10.** Redevelopment projects are governed by special stormwater sizing criteria depending on the amount of increase or decrease in impervious area created by the redevelopment. Redevelopment projects that reduce impervious cover (from existing conditions) by at least 40 percent are deemed to meet both the recharge and water quality requirements (Standards 4 and 5, above). Where site conditions prevent the reduction in impervious cover, stormwater management practices shall be implemented to provide stormwater controls for at least 40 percent of the site's impervious area. When a combination of impervious area reduction and stormwater management practice implementation is used for redevelopment projects, the combination of impervious area reduction and the area controlled by a stormwater management practice shall equal or exceed 40 percent.

- **Standard 11.** For sites meeting the definition of an "infill development project," the stormwater management requirements would be the same as for other new development projects with the important distinctions that the applicant can meet those requirements either on-site or at an approved off-site location and that the 70 percent impervious cover requirement may be waived. An approved off-site location must be identified in accordance with CNMI/Guam review. The applicant must also demonstrate that no downstream drainage or flooding impacts would occur as a result of not providing on-site management. The intent of this provision is to allow flexibility to meet the goals of improved water quality and channel protection to receiving waters while still promoting infill development.
- **Standard 12.** Certain industrial sites are required to prepare and implement a stormwater pollution prevention plan. All sites with disturbance over 1 acre are required to prepare and implement a stormwater pollution prevention plan in accordance with the National Pollutant Discharge Elimination System Phase II Stormwater Program.
- **Standard 13.** Stormwater discharges from land uses or activities with higher potential pollutant loadings, defined as hotspots, are required to use specific structural best management practices and pollution prevention practices. In addition, stormwater from a hotspot land use may not be recharged to groundwater without pretreatment of 100 percent of the water quality volume or the recharge volume, whichever is greater.

2.9 RANGE ENVIRONMENTAL VULNERABILITY ASSESSMENT

The Range Environmental Vulnerability Assessment program is a proactive and comprehensive initiative that serves as a baseline assessment of operational ranges across U.S. Marine Corps installations. The Range Environmental Vulnerability Assessment program operates outside of regulatory requirements, aiming to proactively address potential environmental concerns and to promote sustainable range practices. This aligns with the DoD Instruction 4715.14, *Operational Range Assessments*, which outlines key requirements for responsible range management.

3 EXISTING CONDITIONS

3.1 TOPOGRAPHY

Tinian consists of a series of limestone plateaus separated by steep slopes and cliffs. The major plateaus are generally level. Tinian consists of four major surface geologic units (physiographic regions) (Gingerich 2002) (Figure 1):

- **Tinian Pyroclastic (Volcanic) Rock.** These fine-grained to coarse-grained ash and angular fragments represent explosive materials ejected from an ancient volcano that forms the core of the island. These rocks are exposed on the North-central Highland and Southeastern Ridge and cover approximately 2 percent of the surface of the island. These materials generally appear to be highly weathered and altered in surface exposures. This rock unit has low permeability due to its texture and density.
- **Tagpochau Limestone.** These highly weathered rocks are exposed on about 15 percent of the island's surface and are generally located in the North-central Highland and the southern part of the Southeastern Ridge. These rocks reach up to 600 feet in thickness. Surface exposures are composed of fine- to coarse-grained, partially recrystallized broken limestone fragments, and about 5 percent are reworked volcanic fragments and clays. This unit consists of highly permeable and fractured material.
- **Mariana Limestone.** These rocks cover approximately 80 percent of the island's surface forming nearly all of the North Lowlands, the Central Plateau, and the Marpo Valley. These rocks reach up to 450 feet in thickness and are composed of fine- to coarse-grained fragmented limestone, with some fossil and algal remains and small amounts of clay particles. Small voids and caverns are common in surface exposures. The Mariana Limestone has a higher coral content than the Tagpochau Limestone; however, is also highly permeable.
- **Beach Deposits, Alluvium, and Colluvium.** These deposits cover less than 1 percent of the island's surface and reach up to 15 feet in thickness. The deposits consist of poorly consolidated sediments, mostly sand and gravel deposited by waves; however, they contain clays and silt deposited inland beside Lake Hagoi and Makpo Marsh as well as loose soil and rock material at the base of slopes.

3.2 EXISTING SLOPE

Much of the relatively flat land across the Military Lease Area was previously used for agriculture and then for military facilities during World War II. Steeper-graded areas are primarily limited to coastal bluffs, native limestone forests, and a few steep areas in and around localized depressions.

Figure 1 Island of Tinian – Physiographic Regions

3.3 SOILS

Soils are divided into four different hydrologic soil groups (Hydrologic Soil Groups A through D) based on a soil's runoff potential and infiltration capabilities. Generally, soils composed of limestone upland soils in relatively flat areas are classified as Hydrologic Soil Group A and infiltrate well, resulting in less runoff. Hydrologic Soil Group B is classified as soils having moderate infiltration rates when thoroughly wetted. Soils that belong to the Hydrologic Soil Group C have a moderate potential for runoff when they are completely wet and include silt loam, sandy clay loam, clay loam, and silty clay loam. Soils composed of basalt are classified as Hydrologic Soil Group D and infiltrate poorly, resulting in greater runoff. Soils in the project area are entirely Hydrologic Soil Group B. The Hydrologic Soil Group regions are shown in Figure 2.

The U.S. Department of Agriculture Soil Conservation Service identified soil classes across Tinian in 1985 (U.S. Department of Agriculture Soil Conservation Service 1989).

3.4 CLIMATE AND HYDROLOGY

Rainfall on Tinian averages 83 inches per year, based on the 50-year rainfall database (Lander and Guard 2003). The wet season, which typically occurs between July and November, receives 65 percent of the annual precipitation, while 16 percent typically occurs during the dry season from January to April (Lander and Guard 2003). The remaining transitional months (November, December, January, May, and June) receive approximately 19 percent of the rainfall (Carruth 2008). Tropical storms comprise a significant percentage of the total annual rainfall. Most of the precipitation on Tinian evaporates, transpires, or percolates into openings in the limestone and volcanic rock beneath the thin soil surface (Gingerich 2002).

The surface hydrology on Tinian includes minimal overland flow, except during intense rainfall events. The drainage is primarily groundwater transport with precipitation percolating quickly into porous rock. As a result, there are no permanent streams or major overland conveyance systems, and no particular drainage problems (Doan et al. 1960).

Figure 2 Island of Tinian – Hydrologic Soil Groups

4 STORMWATER CONSIDERATIONS

This chapter describes the design assumptions including grading, drainage, and Low Impact Development, as well as existing physical conditions, used in evaluating stormwater quantity.

4.1 ASSUMPTIONS

- Comply with Unified Facilities Criteria 03-201-01, *Civil Engineering* (DoD 2022) for minimum and maximum grading slopes.
- Apply Low Impact Development Integrated Management Practices in accordance with Unified Facilities Criteria 3-210-10 (DoD 2023).
- Comply with design-level guidance for grading and drainage systems in accordance with Unified Facilities Criteria 03-201-01 (DoD 2022).
- Use Section 3 of Unified Facilities Criteria 03-201-01, *Civil Engineering* (DoD 2022), for storm drainage system design criteria.
- Convey drainage primarily via overland sheet and channelized flow; avoid the use of culverts and gray infrastructure (pipes and inlets), if feasible.
- Avoid/minimize impacts to depressional areas and karst/fractured surface geology due to the potential for conduits for stormwater flow and contamination of freshwater lens.
- Avoid/minimize impacts to wellhead protection areas and associated buffers.
- Avoid/minimize impacts to ecologically sensitive areas (marine environments, wetlands, and protected habitat) and associated buffers.
- Avoid/reduce impacts to culturally sensitive areas and areas of historical significance.
- Avoid downstream impacts on existing non-DoD areas.
- Avoid/minimize impacts to existing operational facilities and associated utilities, including any communications sites, Francisco Manglona Borja/Tinian International Airport, and other facilities, as applicable.
- Expand the existing stormwater berm on the east, north, and south sides of the main transmitter building to increase runoff containment and peak flow reduction. The scope also includes a new berm along the northern edge of the support facilities area to redirect offsite water flows eastward, away from the warehouse and maintenance facility. Modifications include an increase in crest elevation and possibly additional armoring for erosion protection.
- Expand engineered stormwater berms to prevent external runoff from impacting the project area along the perimeter of key training areas, such as the Multi-Purpose Maneuver Range and Explosives Training Range. These berms would redirect off-site flows away from operational areas, ensuring that runoff modeling focuses solely on project-specific impervious area increases. Additionally, channelized flow systems would be integrated in identified high-concentration drainage pathways to reduce erosion and peak discharge rates.

4.2 DEPRESSIONAL AREAS

Landlocked and/or isolated depressional areas potentially contain direct conduits to the underlying freshwater lens aquifer. As a result of the high soil porosity and karst, fractured surface geology, these depressions are believed to facilitate rapid stormwater infiltration, preventing stormwater from staging up and spilling downstream. The specific history of geologic creation of these depressions is unknown, but they are believed to be manmade. The depressions are treated as closed basins/sinkholes with respect to stormwater, and these depressional areas should be avoided. Preliminary analysis indicates that stormwater would not have any detrimental impact on depressional areas.

4.3 PROTECTED SURFACE WATERS

All new development projects must treat stormwater runoff properly before discharging it into CNMI and Guam waters or wetlands, per Standard 3 (*CNMI and Guam Stormwater Management Manual*). For stormwater management purposes, surface waters in freshwater areas, ephemeral ponds, potential wetlands, or non-delineated wetlands are considered wetlands. Any potential impacts on these areas, such as those caused by grading, drainage, disturbance, or stormwater conveyance elements, should be avoided or minimized. Three potential wetland areas in Hagoi, the Mahalang Complex, and Bateha would fall under this protection. Stormwater runoff would be captured and treated before reaching these wetland habitats of Tinian to avoid any adverse effects.

4.4 FAULT LINES

Fault lines may act as direct conduits for surface water runoff to drain directly to the freshwater lens aquifer. For this reason, fault lines would be buffered and proposed stormwater management facilities would be kept a reasonable distance away. Typically, best management practices for setbacks include 150 feet for stormwater ponds and infiltration devices and 250 feet for permanent, critical facilities.

5 WATER QUANTITY ANALYSIS

To simulate stormwater runoff within the representative sub-basins, the analysis followed the *CNMI and Guam Stormwater Management Manual* (Horsley Witten Group, Inc. 2006) and used HydroCAD Version 10.00-20 stormwater modeling software published by HydroCAD Software Solutions LLC. The HydroCAD model was used to determine peak discharge rates and preliminarily size various types of surface, subsurface, and conveyance best management practices. Using the Natural Resources Conservation Service Technical Release No. 20: Project Formulation – Hydrology procedures, the model provided hydrograph generation and routing for a given rainfall event. Runoff hydrographs were developed from rainfall using the dimensionless unit hydrograph, drainage areas, times of concentration, and Natural Resources Conservation Service runoff curve numbers.

The initial runoff analysis used the third quartile 24-hour storm event based on National Oceanic and Atmospheric Administration Atlas 14 (2011) assuming soil type Hydrologic Soil Group B. Natural Resources Conservation Service curve number values were selected based on soil group and land use category. The soil groups and land uses were categorized for each sub-basin in the project area.

5.1 DIGITAL ELEVATION MODEL DEVELOPMENT

A digital elevation model is a grid of geospatially referenced coordinates used to create three-dimensional representations of the earth's surface. The software ArcGIS version 10.8.1 by Esri, Inc., was used to create a grid with 3.28-foot on-center spacing using the 5-foot contour interval topographic survey (Geodatabase V1).

The following steps were involved in the development of the digital elevation model:

1. Shapefiles for the 5-foot and 50-foot contours were extracted from the geodatabase.
2. An elevation of 0 was not found in either the 5-foot or 50-foot contours. To resolve this issue, a boundary line was used to separate the gap zone where the 50-foot contours were applied. Everywhere else, the 5-foot elevation line was extended by 5 feet and designated an elevation value of 0. This method ensures there is no overlap between the 5-foot and 0-foot values.
3. Once all the lines were cleaned and ready, a triangulated irregular network was created using the 5-foot contours, 50-foot contours (tied in), and boundary line (the new boundary from the 5-foot contour buffer set to 0-foot elevation) as the elevation data. The new boundary line was converted to a polygon and was used as a hard clip.
4. The triangulated irregular network was converted to a digital elevation model and the cell size was set to 1 meter.
5. For the proposed conditional analysis, a modified digital elevation model was generated by integrating a balanced cut-and-fill analysis with the existing conditions digital elevation model. This combined raster represents the proposed post-project topography.

5.2 FLOW PATH DETERMINATION AND SUB-BASIN DELINEATION

Arc Hydro was used to perform ponding analysis, flow path analysis, and sub-basin area delineation. Arc Hydro typically uses a "fill sinks" approach to identify drainage flow paths. In this approach, flow paths are created by analyzing the elevation of each 1-meter-square digital elevation model cell compared to its eight neighboring cells in the grid and the direction established toward the lowest cell. Because of the karst geology and expansive ponding areas, disabling the "fill sinks" feature in Arc Hydro and establishing unobstructed drainage routes for water to collect and flow toward the location was practical. Ponding and flow path identification does not identify underground conduits or infiltration.

For accurate runoff modeling, two scenarios were considered: (1) assuming off-site flows bypass the study area via engineered berms, and (2) considering off-site contributions where natural depressions and uncontained drainage patterns allow infiltration. Off-site runoff contributions were excluded from primary sub-basin calculations given engineered berm placements along perimeter zones. Consequently, curve number values in Section 5.4 reflect post-development conditions only for on-site impervious areas, aligning with CNMI and Naval Facilities Engineering Systems Command guidelines. The analysis accounted for both pre- and post-development conditions, incorporating expanded impervious areas, revised outflow points, and updated detention storage to optimize stormwater control and to minimize impacts to adjacent areas.

5.3 LAND USE AND LAND COVER

According to the U.S. Forest Service's vegetation mapping of Tinian, updated by the U.S. Fish and Wildlife Service, approximately 90 percent of the island is covered in vegetation. The exceptions are developed areas in San Jose, the Port of Tinian, the airport, roads, and small sections of rock outcroppings, sand, and soil. Most of this vegetation includes non-native tangantangan (*Leucaena leucocephala*), mixed introduced forest, native limestone forest, and herbaceous-scrub. Other vegetation types, wetland habitats, and agricultural areas comprise the remainder. This report focuses on land use cover to understand current and future stormwater flows. Areas with dense vegetation cover are called mixed forest, including tangantangan trees and other species with dense cover, while areas without trees are called shrubs and grassland. Figure 3 shows the general land cover on Tinian.

Figure 3 Land Cover on the Island of Tinian

5.4 TINIAN CURVE NUMBER VALUES

The CNMI Stormwater Management Manual and Naval Facilities Engineering Systems Command guidance guided curve number selection. Pre-development curve numbers were assigned based on Hydrologic Soil Group B, with a base curve number of 22 for undisturbed pervious areas, the lowest possible curve number on Tinian, which is typically associated with Hydrologic Soil Group A, ensuring a conservative pre-development estimate that assumes high infiltration capacity even though Tinian's soils are primarily classified as Hydrologic Soil Group B. Post-development curve numbers for impervious areas used a worst-case value of 98, reflecting new hardscapes. Because off-site flow was explicitly bypassed, external drainage areas were excluded from the composite curve number calculation. This ensures that runoff projections reflect project-specific modifications without artificially inflating results. Post-project sub-basins were included in the composite curve number calculations (Attachment A). Table 1 displays the curve number values selected for Hydrologic Soil Group B and land use cover identification.

Table 1. Curve Numbers Used for Post-project Land Cover and Soil on Tinian

Land Cover ID	*Hydrologic Soil Group B*
Barren	75.6
Other Scrub/Grassland	51.1
Scrub/Shrub	38.5
Leucaena Forest	45.2
Limestone Degraded Forest	45.2
Limestone Native Forest	45.2
Wetland Herbaceous	81.6
Wetland Shrub-Herb	81.6
Developed	98.0

Legend: ID = identification.
Source: AECOM 2014.

5.5 INITIAL ABSTRACTION/STORAGE

The Natural Resources Conservation Service methodology estimates precipitation excess as a function of cumulative precipitation, soil cover, land use, and antecedent moisture content. The maximum retention and the initial abstraction are related through an intermediate parameter, the curve number. The calculation of runoff amount in HydroCAD was completed using Table 2-2 (U.S. Department of Agricultural Soil Conservation Service 1986), which takes into account factors such as soil type, land use, and curve number.

5.6 TIME OF CONCENTRATION

The time of concentration of a watershed is defined as the time required for a drop of water to travel from the most hydraulically distant part of a watershed to the point of discharge or outlet. Time of concentration is computed by summing all the travel times for consecutive drainage system components. The time of concentration for each sub-basin was developed using the TR-55 equations (U.S. Department of Agricultural Soil Conservation Service 1986).

For sheet flow of fewer than 300 feet, Manning's kinematic solution (Overton and Meadows 1976) is used to compute travel time. After 300 feet, sheet flow usually becomes a shallow, concentrated flow. The average velocity for this flow can be determined from the equation shown below, in which average velocity is a function of the watercourse slope and type of cover.

$$T(t) = \frac{L}{60\, k\sqrt{S}}$$

Where:

$T(t)$ = Travel time for open channel flow segments

L = Length of flow segment

k = Intercept coefficient per Table 3-3 of the Federal Highway Administration Hydraulic Engineering Circular No. 22, Third Edition (Federal Highway Administration 2009)

S = Slope of the ground surface as a percentage

5.7 DESIGN STORM FREQUENCY

Pre- and post-development hydrology were analyzed for the following design storm events:

- 1-year and 25-year recurrences, 24-hour storm events
- 95th percentile storm event

These storm events were selected to meet the design requirements established in the *CNMI and Guam Stormwater Management Manual* (Horsley Witten Group, Inc. 2006).

5.8 DESIGN RAINFALL DEPTHS AND DISTRIBUTION

The *Rainfall Data Verification Memorandum*, prepared by the University of Guam, U.S. Department of Agriculture, and National Oceanic and Atmospheric Administration, summarizes precipitation data, distribution curves, and intensity duration frequency curves for Tinian (National Oceanic and Atmospheric Administration 2011). No additional applicable rainfall data that would supersede these values have been published since the *Rainfall Data Verification Memorandum*. Table 2 provides design storm event rainfall depths.

Table 2. Rainfall Data per Design Storm

Location	*Mean Annual Rainfall (in)*	*Water Quality Storm Events*	*24-Hour Rainfall (in) per Recurrence Interval (years)*	
		95th Percentile	*1 yr*	*25 yr*
Tinian	83.4	2.2	4.25	14.88

Legend: in = inch; yr = year.
Source: Lander and Guard 2003.

Temporal distributions of precipitation are provided with precipitation frequency estimates from the National Oceanic and Atmospheric Administration Atlas 14 Volume 5 (National Oceanic and Atmospheric Administration 2011) for the 6-hour, 12-hour, 24-hour, and 96-hour durations. The temporal distributions are expressed in probability as cumulative percentages of precipitation totals at various time steps. For this study, the third quartile 24-hour duration rainfall distribution curve was selected based on data indicating that third quartile distribution occurs most frequently with 24-hour storm events.

5.9 RESULTS OF ANALYSIS

Following the mapping and calculation of baseline hydrologic conditions, the proposed conditions were evaluated to assess the impact of changes in impervious surfaces, land use, and curve numbers. The analysis encompassed the proposed Base Camp (former U.S. Agency for Global Media site), Ammunition Holding Area, Explosives Training Range, and supporting infrastructure, including roads and utility corridors. Stormwater runoff was modeled for the 1-year, 25-year, and 95th percentile storm events to determine changes in runoff volume, peak flow rates, and time of concentration.

The hydrologic model was structured to reflect distinct drainage basins within the Base Camp footprint, accounting for variations in topography, soil permeability, and flow paths. The Base Camp area was delineated based on drainage direction and existing stormwater infrastructure. Each sub-basin was assigned updated curve numbers to reflect the expansion of impervious surfaces, new detention areas, and the revised stormwater berm configuration.

HydroCAD modeling outputs were generated to analyze changes in peak flows and runoff volumes under post-development conditions. The results, summarized in Table 3, highlight adjustments to stormwater parameters based on updated land use classifications, while Table 4 details the pre- and post-development peak discharge rates and runoff volume changes for each design storm event. The purpose of these analyses is to define stormwater routing, detention capacity, and best management practice implementation, aligning with regulatory requirements and site-specific hydrologic conditions.

The drastic decrease in time of concentration is primarily due to the increase in impervious area, which reduced infiltration and accelerated runoff. The replacement of dense vegetation with paved surfaces substantially lowered surface roughness, increasing flow velocity. Additionally, the introduction of engineered drainage features, steeper slopes, and channelized flow paths further expedited runoff travel time. These changes are typical in developed areas, where stormwater moves much faster compared to natural landscapes.

The drainage areas summarized in Table 3 and Table 4 reflect total acreages with potential off-site runoff contributions removed, ensuring that the analysis only considers site-generated stormwater flows. The ETR was explicitly modeled using conservative screening-level assumptions, including representation as 100 percent impervious, to avoid understating potential runoff. Modeling results demonstrated that the ETR contribution to overall runoff volumes and peak flows is negligible relative to Base Camp and MPMR; therefore, ETR results are documented in the appendix but were screened out of the main report and summary tables.

The Surface Radar Site was screened out of quantitative modeling due to its remote location and very small impervious footprint (< 0.05 acre), which is below the CNMI Stormwater Management Manual threshold for detailed analysis and results in a de minimis runoff contribution.

The Ammunition Holding Area, supporting roads, and utility corridors are included in the composite curve number and HydroCAD models due to their larger impervious footprint and hydraulic connectivity to the site drainage network.

Although the ETR contribution was de minimis at the watershed scale, its unique operational characteristics warrant consideration of localized stormwater management measures during final design to address potential runoff concentration and water quality impacts within training areas, consistent with CNMI planning-level guidance.

The HydroCAD software has a built-in function that rounds curve numbers to the nearest whole number. This information is displayed in the table provided in the HydroCAD output.

Table 3. HydroCAD Stormwater Parameters

Parameter	*Base Camp*		*MPMR*	
	Existing	*Proposed*	*Existing*	*Proposed*
95th Percentile Rainfall Depth (in)	2.2		2.2	
1-yr 24-yr Rainfall Depth (in)	4.25		4.25	
25-yr 24-hr Rainfall Depth (in)	14.88		14.88	
Area (ac)	12.63		0.78	
Curve Number	22.5	98	22.5	98
Flow length (ft)	842		233	
Time of Concentration (min)	86.9	7.1	66.7	2.9

Legend: ac = acre; ft = foot or feet; hr = hour; in = inch; min = minute; MPMR = Multi-Purpose Maneuver Range; yr = year.

Table 4. HydroCAD Stormwater Results

Parameter		*Base Camp*			*MPMR*		
		Existing	*Proposed*	*Change*	*Existing*	*Proposed*	*Change*
95th % Water Quality Storm	Runoff Volume (acre-ft)	0.00	2.08	2.08	0.00	0.13	0.13
	Peak Flow (cfs)	0.00	3.29	3.29	0.00	0.20	0.20
1-yr 24-hr	Runoff Volume (acre-ft)	0.00	4.22	4.22	0.00	0.26	0.26
	Peak Flow (cfs)	0.00	6.46	6.46	0.00	0.40	0.40
25-yr 24-hr	Runoff Volume (acre-ft)	1.69	15.40	13.71	0.11	0.95	0.85
	Peak Flow (cfs)	4.13	22.73	18.60	0.26	1.41	1.15

Legend: % = percent; acre-ft = acre-foot or acre-feet; cfs = cubic feet per second; hr = hour; MPMR = Multi-Purpose Maneuver Range; yr = year.

6 STORMWATER BEST MANAGEMENT PRACTICES/INTEGRATED MANAGEMENT PRACTICES

6.1 STORMWATER MANAGEMENT PRACTICES

This chapter identifies stormwater quantity management alternatives for the Proposed Action and explains the application of Low Impact Development, best management practices, and integrated management practices within the stormwater management strategy. Low Impact Development, best management practices, and integrated management practices for the Proposed Action are summarized as follows:

- Low Impact Development focuses on minimizing runoff and promoting infiltration by integrating stormwater controls into the natural landscape through measures such as bioretention basins, vegetated swales, and permeable pavements. Low Impact Development is primarily used to restore pre-development hydrology by reducing runoff at the source and enhancing groundwater recharge.
- Best management practices serve as standardized stormwater control measures that reduce pollution, manage runoff flow, and prevent erosion. Best management practices include detention basins, hydrodynamic separators, sediment traps, and vegetation buffers, which help maintain compliance with environmental standards and prevent sediment transport into water bodies.
- Integrated management practices combine both Low Impact Development and best management practice components to create site-specific stormwater solutions. Integrated management practices are applied in areas with complex stormwater challenges, such as training ranges, and refueling areas, , where standard best management practices alone may not be sufficient. These solutions are designed to accommodate operational constraints while maximizing stormwater treatment efficiency.

This report applies all three approaches of Low Impact Development for runoff reduction, best management practices for pollution control, and integrated management practices for site-specific integration to create a comprehensive, adaptive stormwater management plan at the Base Camp and Multi-Purpose Maneuver Range.

6.2 WATER QUALITY/LOW IMPACT DEVELOPMENT

Conceptual-level stormwater management capabilities were assessed by quantifying various treatment components based on approximate Low Impact Development, best management practice, and integrated management practice footprints. The estimated stormwater capture volume potential was compared to anticipated post-development runoff to determine the most effective treatment solutions. Low Impact Development placement prioritizes on-site stormwater retention, ensuring that infiltration areas do not interfere with critical infrastructure or military operations. By integrating Low Impact Development-based infiltration and structural best management practices, the design balances water quality improvement, groundwater recharge, and flood control, particularly in the high-rainfall CNMI region.

The high-rainfall CNMI region necessitates an approach that balances water quality improvement, groundwater recharge, and peak flow attenuation. Low Impact Development measures would be strategically positioned in high-infiltration areas to promote on-site runoff absorption, while best management practices would be employed to regulate stormwater movement and to prevent excessive flow velocities. In areas with high pollutant loads, such as ammunition holding and refueling zones, integrated management practices would be used to integrate advanced filtration and containment systems to capture contaminants like heavy metals and hydrocarbons before runoff enters natural waterways.

Balancing water quality, groundwater recharge, and 25-year design storm event management necessitates a dual approach that combines integrated management practices with traditional detention basins. While detention basins are necessary for peak flow reduction, integrated management practices ensure that stormwater in high-risk areas receives adequate filtration and pollutant removal. By incorporating these strategies, the project achieves a resilient stormwater management plan that meets operational and environmental requirements.

6.3 WATER QUALITY AND RECHARGE VOLUMES

To determine the appropriate size for the facilities and treatment, the Unified Stormwater Sizing Criteria in the *CNMI and Guam Stormwater Management Manual* (Horsley Witten Group, Inc. 2006) recommends the use of the 95th percentile storm event to calculate the water quality and recharge volumes (Table 5). The water quality volume is intended to improve water quality by capturing and treating 90 percent of the average annual storm events for high-quality resource areas and hotspots and 80 percent for land uses that drain to moderate-quality resource areas. The recharge volume must be achieved through a structural practice like infiltration, bioretention, or filters. According to the *CNMI and Guam Stormwater Management Manual*, any infiltration facility must have a sedimentation basin containing 25 percent of the water quality volume must be provided for sediment. Among the available options, a grass channel or stilling basin would be the most advisable choice depending on the location and preferences. The equation for water quality volume is as follows:

$$WQ_V = \frac{(P)(A)(I)}{12}$$

Where:

WQ_v = Water quality volume in acre-feet

P = 90 percent rainfall event (1.5 inches) for hotspots/high-quality resource areas; 80 percent rainfall event (0.8 inches) for moderate-quality resource areas

A = Site area in acres

I = Impervious area percentage of site area as a decimal

A minimum water quality volume value of 0.0167 feet × total area in acres (also referred to as 0.2 watershed inches) is required to fully treat the runoff from pervious surfaces. Because both the Base Camp drainage unit (≈ 96 percent impervious) and the MPMR pad (≈ 100 percent impervious) exceed the 80-percent impervious threshold described in Section 4-4 of the CNMI

& Guam Stormwater Management Manual, the impervious fraction (I) was conservatively set to 1.0 for sizing Water-Quality (WQv) and Recharge (Rev) volumes.

Table 5. Water Quality Volumes

Water Quality Criteria, WQ_v	*90% of Average Annual Storm Events – High-quality Resource Areas and Hotspots*	
Precipitation (in), P	1.5	1.5
Parameters	***Basecamp***	***MPMR***
Area (acres), A	12.63	0.78
Impervious area (acres)	12.63	0.78
Impervious area (decimal percent), I	1.00	1.00
WQ_v (90%) (acre-ft)	1.58	0.10
min WQ_v (acre-ft)	0.21	0.01
Sedimentation Volume (acre-ft)	0.40	0.03

Legend: % = percent; acre-ft = acre-foot or acre-feet; in = inch; min = minimum; MPMR = Multi-Purpose Maneuver Range; N/A = not applicable; WQ_v =water quality volume limestone dominated areas.

$$Re_V = \frac{(P)(A)(I)}{12}$$

Where:

Re_v = Recharge volume in acre-feet

P = 90 percent rainfall event (1.5 inches)

A = Site area in acres

I = Impervious area percentage of site area as a decimal

This criterion applies primarily to limestone-dominated recharge areas within the Base Camp footprint, except for locations where soil profiles extend at least 3 feet below the bottom of proposed stormwater facilities. Recharge volume calculations have been updated to account for the full extent of impervious areas due to the increased development footprint and the proximity of potential hotspot locations. Given the reduced extent of pervious surfaces, the entire site has been incorporated into the recharge volume analysis to ensure compliance with stormwater management requirements and to maintain effective infiltration and runoff mitigation strategies.

Table 6 presents these calculations, incorporating changes based on the revised site layout and stormwater management strategy. The impervious surface analysis accounts for new facility footprints, vehicle access routes, and structural best management practices, affecting infiltration potential and runoff patterns. The stormwater infiltration system has been updated to align with these modifications, incorporating engineered recharge zones and additional bioretention basins to support stormwater absorption and groundwater recharge capacity.

The Base Camp stormwater plan incorporates detention and infiltration strategies suited to site-specific hydrology and land use changes.

Table 6. Recharge Volumes

Recharge Criteria, Re_v	*Criterion for Limestone Regions of CNMI Requiring Infiltration of 1.50 Inches of Rainfall*	
Precipitation (in), P	1.5	
Parameters	***Base Camp***	***MPMR***
Area (acres), A	12.63	0.78
Impervious area (acres)	12.63	0.78
Impervious area (decimal percent), I	1.00	1.00
Recharge criteria, Re_v (acre-ft)	1.58	0.10

Legend: acre-ft = acre-foot or acre-feet; in = inch; MPMR = Multi-Purpose Maneuver Range; Re_v = recharge volume.

6.4 LOW IMPACT DEVELOPMENT APPLICATION

Improving drainage in the proposed areas requires creating conceptual integrated management practices for its basins. Drainage basins were identified and conceptual integrated management practices were developed for each. Roof downspout runoff is directed to flow to dry conveyance swales. These swales lead to bioretention cells or dry wells before entering perimeter swales (where applicable). The final design phase should finalize the capture/conveyance scheme of the perimeter swales.

6.5 INTEGRATED MANAGEMENT PRACTICES

Recommendations in this section are adapted from the *CNMI and Guam Stormwater Management Manual* (Horsley Witten Group, Inc. 2006). This discussion explores integrated management practices tailored to address the specific challenges of treating stormwater for an operational Base Camp.

6.6 BASE CAMP TREATMENT OPTIONS

Stormwater management at the Base Camp is designed to reduce runoff impacts, enhance on-site infiltration, and can reduce pollutant loadings.

Key Stormwater Treatment Components:

- **Erosion Control Measures (Best Management Practices).** Vegetative buffers, reinforced swales, and sediment traps would stabilize disturbed areas and prevent sediment transport.
- Stormwater Diversion and Containment (Integrated Management Practices and Best Management Practices).
- Engineered drainage swales and perimeter berms to control velocity and route flows to treatment areas.
- **Detention and Infiltration Basins (Low Impact Development and Best Management Practices).** Shallow detention basins would be strategically placed to capture peak storm events, store runoff temporarily, and allow gradual infiltration, preventing erosion and excessive flow velocities.

- **Hydrodynamic Separators and Filtration Systems (Best Management Practices).** These would be installed at key discharge points to capture suspended solids, hydrocarbons, and other pollutants before runoff enters receiving environments.
- **Permeable Ground Surface Integration (Low Impact Development and Integrated Management Practices).** Selective use of permeable surfaces in high-impact areas would enhance infiltration, reduce runoff velocity, and limit sediment transport.
- **Stormwater Berm Expansion (Integrated Management Practices and Best Management Practices).** Raise and extend the existing berm on the north, south, and east flanks of the transmitter building, plus a new berm along the northern edge of support facilities to redirect flows eastward toward controlled treatment corridors.
- **Operational controls for vehicle refueling & equipment maintenance (BMP**) Conduct refueling ≥ 120 ft from water bodies or stormwater pathways. Perform routine equipment leak inspections; repair before entering storm-sensitive areas. Provide drip pans, spill-response kits, and secondary containment at all fueling areas.
- **Adaptive Management (Best Management Practices and Integrated Management Practices).** Routine visual inspections of LID structures would be conducted after major storm events to confirm performance; corrective maintenance would follow CNMI SW Manual guidelines.

Best Management Practices for Vehicle Refueling and Equipment Maintenance:

To further reduce stormwater contamination risks from training vehicles and equipment, additional best management practices would be enforced, including:

- **Vehicle and equipment refueling** would occur at least 120 feet from water sources or designated stormwater pathways, following established military environmental protection guidelines.
- **Routine equipment inspections** would be conducted to identify leaks of hydraulic fluid, oil, and lubricants, with corrective actions taken before vehicles enter stormwater-sensitive areas.
- **Secondary containment measures** such as drip pans and spill response kits would be deployed at fueling areas to contain accidental leaks and prevent stormwater contamination.

The stormwater management strategy for the Base Camp incorporates a hybrid approach that combines best management practices, Low Impact Development-based infiltration strategies, and site-specific integrated management practices. By expanding the existing stormwater berm, integrating natural drainage features, and using cost-effective stormwater treatment solutions, these measures collectively support a resilient, effective, and low-maintenance stormwater management plan, safeguarding water quality and environmental integrity at the Base Camp.

6.6.1 Multi-Purpose Maneuver Range and Explosives Training Range Treatment

The Multi-Purpose Maneuver Range and Explosives Training Range require an effective stormwater management strategy that minimizes runoff, controls erosion, and prevents potential contamination from training activities. Given the site's unique operational and environmental challenges, the most cost-effective and efficient solution is a hybrid approach that integrates natural drainage features with targeted treatment measures to ensure effective stormwater control with minimal maintenance and cost.

Key Stormwater Treatment Components:

- **Vegetated Swales and Permeable Surfaces (Low Impact Development and Integrated Management Practices).** Grass-lined swales would be used along drainage paths to slow runoff, encourage infiltration, and reduce erosion. Permeable surfaces (e.g., gravel-based training areas) would minimize direct runoff and sediment transport while maintaining operational flexibility**.**
- **Detention Basins (Best Management Practices and Low Impact Development).** Shallow, strategically placed dry detention basins would capture peak storm events, temporarily store runoff, and allow gradual infiltration, reducing flow velocity and preventing downstream erosion without excessive maintenance.
- **Hydrodynamic Separators at High-Risk Areas (Best Management Practices and Integrated Management Practices).** Pretreatment separators would be installed at key outfalls near ammunition impact zones to filter out suspended solids, sediment, and heavy metals before runoff enters receiving environments.
- **Minimal Grading and Firebreak Integration (Integrated Management Practices).** Drainage solutions would be aligned with existing terrain features to minimize earthwork costs while using firebreaks. Firebreaks would serve a dual purpose by acting as linear infiltration zones, slowing runoff and reducing sediment transport while maintaining wildfire prevention capabilities.
- **Targeted Monitoring and Compliance (Best Management Practices and Integrated Management Practices).** Regular inspection and adaptive management would ensure stormwater quality aligns with military environmental protection standards while allowing for adjustments based on site performance.

By integrating best management practices for erosion control with Low Impact Development-based infiltration strategies, the Multi-Purpose Maneuver Range and Explosives Training Range stormwater plan would optimize water management while ensuring cost-effectiveness and ease of implementation. The stormwater berm extension, combined with vegetated swales, detention basins, and hydrodynamic separators, would provide a comprehensive solution that minimizes long-term maintenance requirements, mitigates potential contamination risks, and supports uninterrupted training operations and environmental best practices. This multi-layered approach would help to manage stormwater effectively and sustainably, reducing environmental impact while maintaining training functionality.

7 CONCLUSIONS

The Proposed Action incorporates stormwater management strategies to mitigate the effects of increased impervious surfaces while maintaining pre-development hydrology. The expanded stormwater berm, detention basins, and integrated best management practices would effectively manage runoff by capturing and regulating peak storm events, diverting and containing stormwater, and preventing sediment transport through vegetative buffers and swales. Water quality protection measures, such as hydrodynamic separators and oil-water separators at fueling areas, would help remove contaminants before discharge, while bioswales, bioretention basins, and permeable surfaces would enhance infiltration and groundwater recharge. These measures would collectively support effective stormwater control, reduce runoff velocity, and protect depressional areas, nearshore waters, and wetlands from potential impacts.

8 REFERENCES

AECOM. (2014). *CJMT Task 11M Stormwater – Design Criteria Revised*.

Assistant Secretary of the Navy (Installations and Environment). (2007). *Department of the Navy low impact development (LID) policy for stormwater management.* Memorandum, November 16.

Carruth, Robert L. (2008). *Ground-Water Resources of Saipan, Commonwealth of the Northern Mariana Islands*. U.S. Geological Survey Water-Resources Investigations Report 03-4178. Honolulu, HI.

DoD. (2013). *Instruction 4715.14, Operational range assessments.* Department of Defense, Under Secretary of Defense for Acquisition, Technology, and Logistics. November 15.

DoD. (2022). *Unified Facilities Criteria (UFC), Civil Engineering*. UFC 3-201-01. December 20.

DoD. (2023). *Unified Facilities Criteria (UFC), Low Impact Development*. UFC 3-210-10. June 1, 2015. Change 3, August 1, 2023.

Doan, D.B., H.W. Burke, H.G. May, and C.H. Stensland. (1960). *Military Geology of Tinian, Mariana Islands*. Prepared under the direction of the Chief of Engineers, U.S. Army by the Intelligence Division, Office of the Engineer Headquarters United States Army Pacific with personnel of the United States Geological Survey.

DON. (2010). *Capital Improvements, Engineering, and Construction Bulletin*. Vol. Issue No. 2011-01. Naval Facilities Engineering Command.

Federal Highway Administration. (2009). *Federal Highway Administration Hydraulic Engineering Circular No. 22, Third Edition*. FHWA-NHI-10-009, Department of Transportation.

Gingerich, S. B. (2002). "Geohydrology and Numerical Simulation of Alternative Pumping Distributions and the Effects of Drought on the Ground-Water Flow System of Tinian, Commonwealth of the Northern Mariana Islands." Report 2002–4077. Water-Resources Investigations Report. USGS Publications Warehouse.

Horsley Witten Group, Inc., Horsley Witten Group, Inc. (2006). *CNMI and Guam Stormwater Management Manual*. Volumes I & II. Prepared for Commonwealth of the Northern Mariana Islands and the Territory of Guam. October.

Lander, Mark A., and Charles P. Guard. (2003). *Creation of a 50-Year Rainfall Database, Annual Rainfall Climatology, and Annual Rainfall Distribution Map for Guam*. WERI Technical Report No. 102. Mangilao, GU: Water and Energy Research Institute of the Western Pacific (WERI), University of Guam. June.

National Oceanic and Atmospheric Administration. (2011). *Precipitation-Frequency Atlas of the United States*. Vol. Volume 5 Version 3.0: Selected Pacific Islands. NOAA Atlas 14. Silver Spring, MD: 2009, Revised 2011.

Overton, D. E., and M. E. Meadows. (1976). *Storm Water Modeling*. New York, NY: Academic Press.

U.S. Department of Agriculture Soil Conservation Service. (1986). *Urban Hydrology for Small Watersheds*. Technical Release 55. Washington, DC. June.

U.S. Department of Agriculture Soil Conservation Service. (1989). *Soil Survey of the Islands of Aguijan, Rota, Saipan, and Tinian, Commonwealth of the Northern Mariana Islands*. Prepared by Fred J. Young in cooperation with the Commonwealth of the Northern Mariana Islands. July.

U.S. Environmental Protection Agency. (2009). *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*. EPA 841-B-09-001. Washington, DC: Office of Water. December.

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ATTACHMENT A
SUPPORTING CALCULATIONS

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ATTACHMENT A.1
BASE CAMP HYDROCAD RESULTS

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1S
Base Camp Analysis 2
Existing
2S
Base Camp Analysis 2
Proposed
Subcat
Reach
Pond
Link
Routing Diagram for CJMT_Tinian_BaseCamp
Prepared by AECOM, Printed 3/12/2025
HydroCAD® 10.20-6a s/n 01723 © 2024 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	Tinian 1 year 24 hour	Tinian 1 year 24 hour		Default	24.00	1	4.25	2
2	Tinian 25 year 24 hour	Tinian 25 year 24 hour		Default	24.00	1	14.88	2
3	Tinian 95th percentile	Tinian 95th percentile		Default	24.00	1	2.20	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
12.626	23	(1S)
12.626	98	(2S)
25.252	**61**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
25.252	Other	1S, 2S
25.252		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	25.252	25.252		1S, 2S
0.000	**0.000**	**0.000**	**0.000**	**25.252**	**25.252**	**TOTAL AREA**	

Time span=1.00-40.00 hrs, dt=0.01 hrs, 3901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Base Camp Analysis 2 Runoff Area=12.626 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=842' Tc=86.9 min CN=23 Runoff=0.00 cfs 0.000 af

Subcatchment 2S: Base Camp Analysis Runoff Area=12.626 ac 100.00% Impervious Runoff Depth=4.01"
Flow Length=892' Tc=7.1 min CN=98 Runoff=6.46 cfs 4.224 af

Total Runoff Area = 25.252 ac Runoff Volume = 4.224 af Average Runoff Depth = 2.01"
50.00% Pervious = 12.626 ac 50.00% Impervious = 12.626 ac

Summary for Subcatchment 1S: Base Camp Analysis 2 Existing

[45] Hint: Runoff=Zero

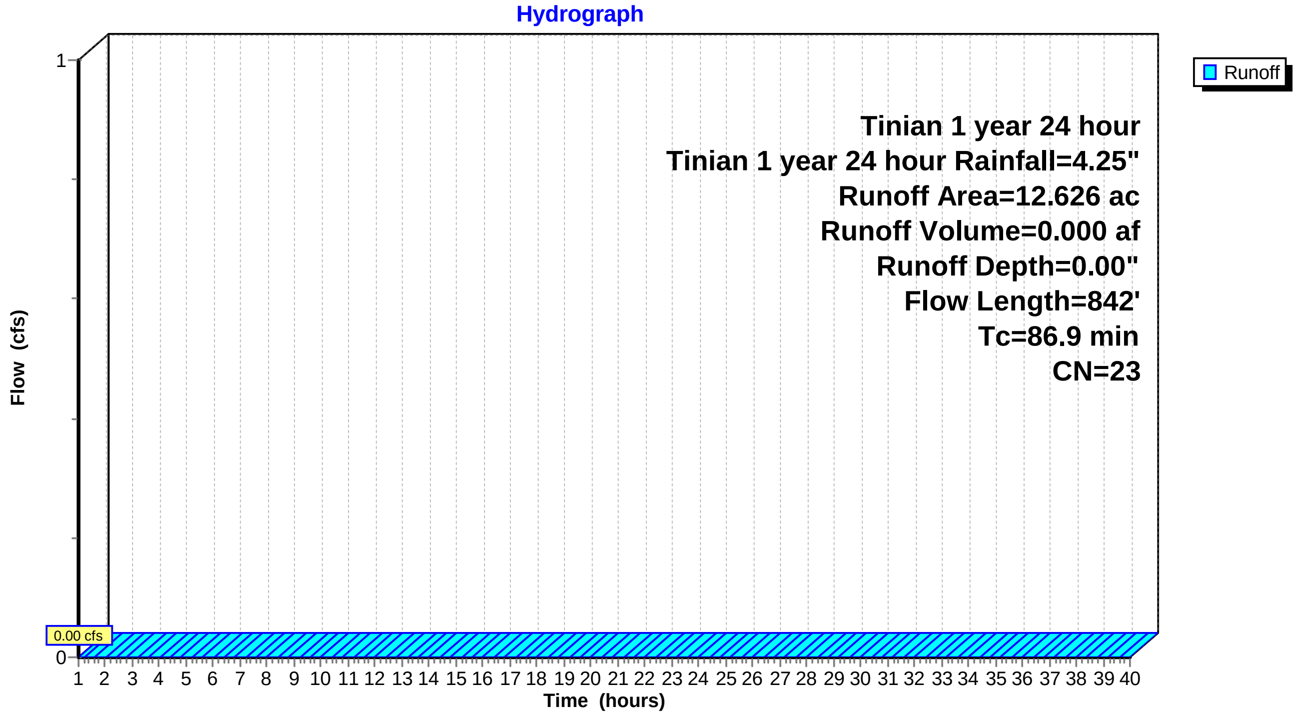
Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-40.00 hrs, dt= 0.01 hrs
Tinian 1 year 24 hour Tinian 1 year 24 hour Rainfall=4.25"

	Area (ac)	CN	Description
*	12.626	23	
	12.626		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.9	150	0.0120	0.06		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
44.0	692	0.0110	0.26		**Shallow Concentrated Flow, Shallow Concentrated Flow Proposed** Forest w/Heavy Litter Kv= 2.5 fps
86.9	842	Total			

Subcatchment 1S: Base Camp Analysis 2 Existing



Summary for Subcatchment 2S: Base Camp Analysis 2 Proposed

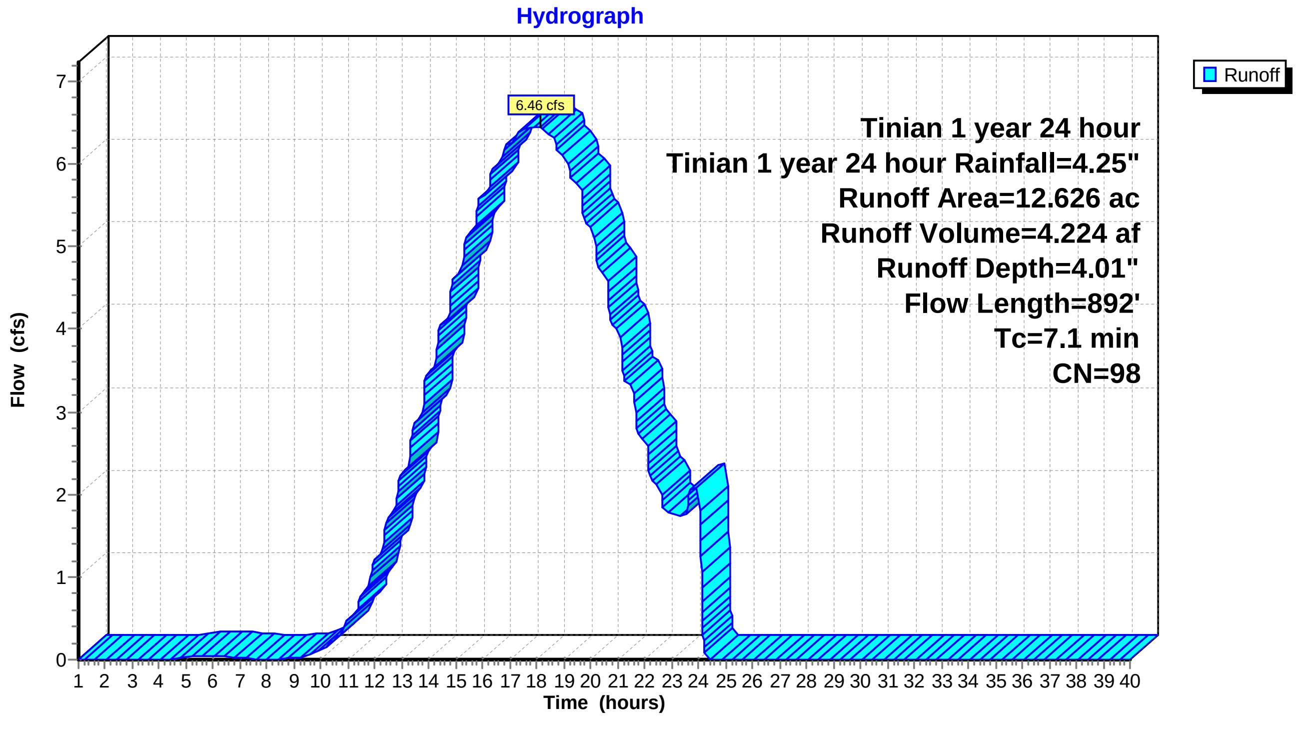
Runoff = 6.46 cfs @ 18.12 hrs, Volume= 4.224 af, Depth= 4.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-40.00 hrs, dt= 0.01 hrs
Tinian 1 year 24 hour Tinian 1 year 24 hour Rainfall=4.25"

	Area (ac)	CN	Description
*	12.626	98	
	12.626		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	150	0.0100	1.67		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
5.6	742	0.0120	2.22		**Shallow Concentrated Flow, Shallow Concentrated Flow Proposed** Paved Kv= 20.3 fps
7.1	892	Total			

Subcatchment 2S: Base Camp Analysis 2 Proposed



Time span=1.00-40.00 hrs, dt=0.01 hrs, 3901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Base Camp Analysis 2 Runoff Area=12.626 ac 0.00% Impervious Runoff Depth=1.61"
Flow Length=842' Tc=86.9 min CN=23 Runoff=4.13 cfs 1.692 af

Subcatchment 2S: Base Camp Analysis Runoff Area=12.626 ac 100.00% Impervious Runoff Depth>14.64"
Flow Length=892' Tc=7.1 min CN=98 Runoff=22.73 cfs 15.401 af

Total Runoff Area = 25.252 ac Runoff Volume = 17.093 af Average Runoff Depth = 8.12"
50.00% Pervious = 12.626 ac 50.00% Impervious = 12.626 ac

Summary for Subcatchment 1S: Base Camp Analysis 2 Existing

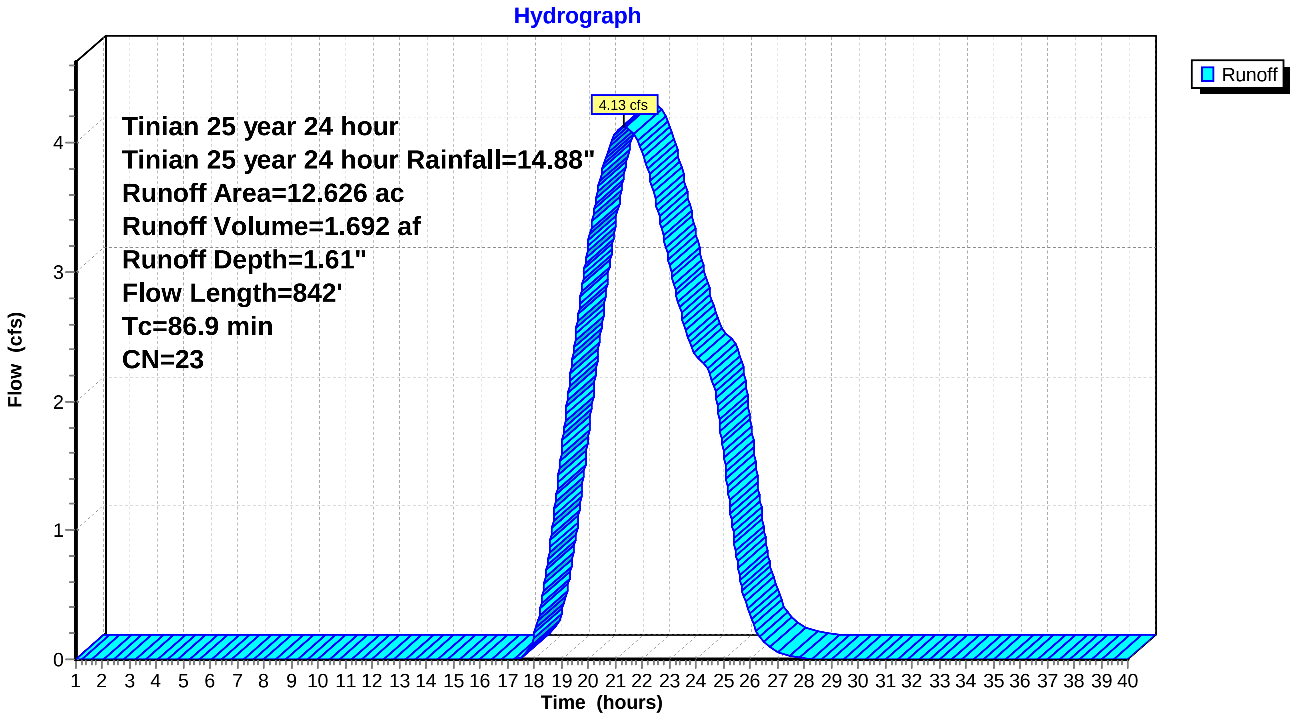
Runoff = 4.13 cfs @ 21.34 hrs, Volume= 1.692 af, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-40.00 hrs, dt= 0.01 hrs
Tinian 25 year 24 hour Tinian 25 year 24 hour Rainfall=14.88"

	Area (ac)	CN	Description
*	12.626	23	
	12.626		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.9	150	0.0120	0.06		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
44.0	692	0.0110	0.26		**Shallow Concentrated Flow, Shallow Concentrated Flow Proposed** Forest w/Heavy Litter Kv= 2.5 fps
86.9	842	Total			

Subcatchment 1S: Base Camp Analysis 2 Existing



Summary for Subcatchment 2S: Base Camp Analysis 2 Proposed

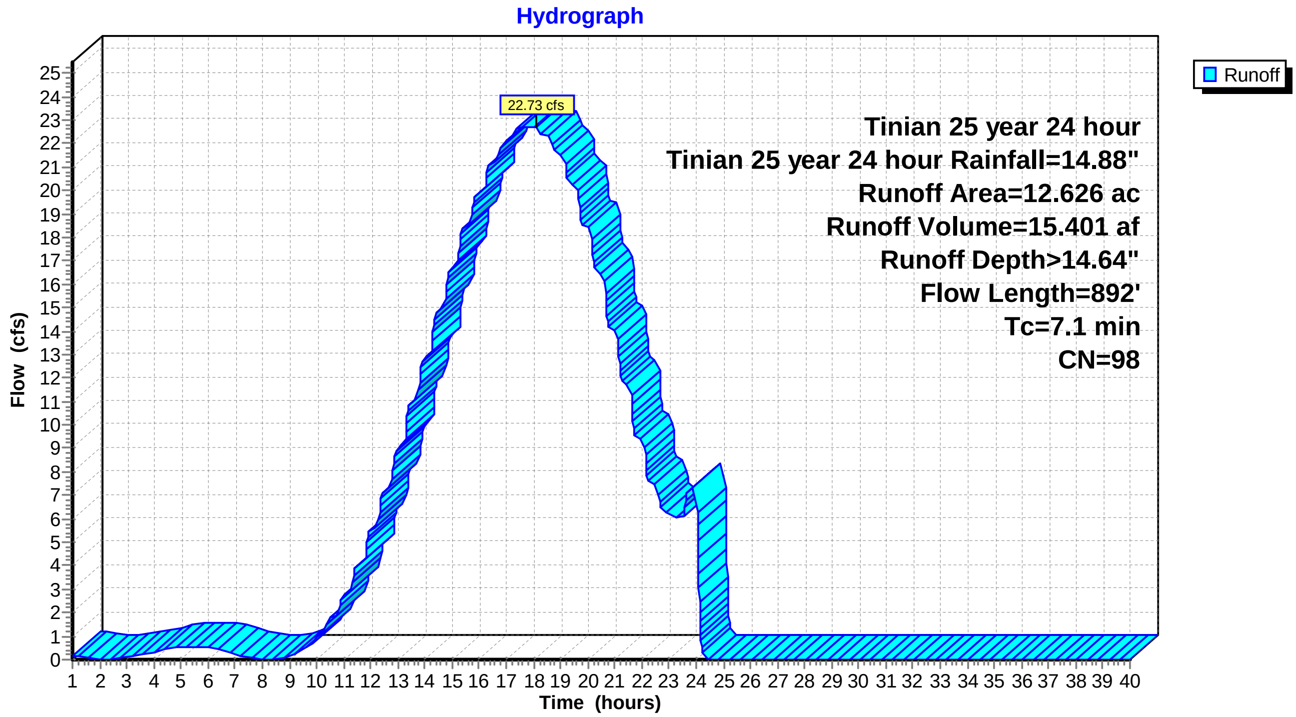
Runoff = 22.73 cfs @ 18.12 hrs, Volume= 15.401 af, Depth>14.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-40.00 hrs, dt= 0.01 hrs
Tinian 25 year 24 hour Tinian 25 year 24 hour Rainfall=14.88"

	Area (ac)	CN	Description
*	12.626	98	
	12.626		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	150	0.0100	1.67		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
5.6	742	0.0120	2.22		**Shallow Concentrated Flow, Shallow Concentrated Flow Proposed** Paved Kv= 20.3 fps
7.1	892	Total			

Subcatchment 2S: Base Camp Analysis 2 Proposed



Time span=1.00-40.00 hrs, dt=0.01 hrs, 3901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Base Camp Analysis 2 Runoff Area=12.626 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=842' Tc=86.9 min CN=23 Runoff=0.00 cfs 0.000 af

Subcatchment 2S: Base Camp Analysis Runoff Area=12.626 ac 100.00% Impervious Runoff Depth=1.97"
Flow Length=892' Tc=7.1 min CN=98 Runoff=3.29 cfs 2.076 af

Total Runoff Area = 25.252 ac Runoff Volume = 2.076 af Average Runoff Depth = 0.99"
50.00% Pervious = 12.626 ac 50.00% Impervious = 12.626 ac

Summary for Subcatchment 1S: Base Camp Analysis 2 Existing

[45] Hint: Runoff=Zero

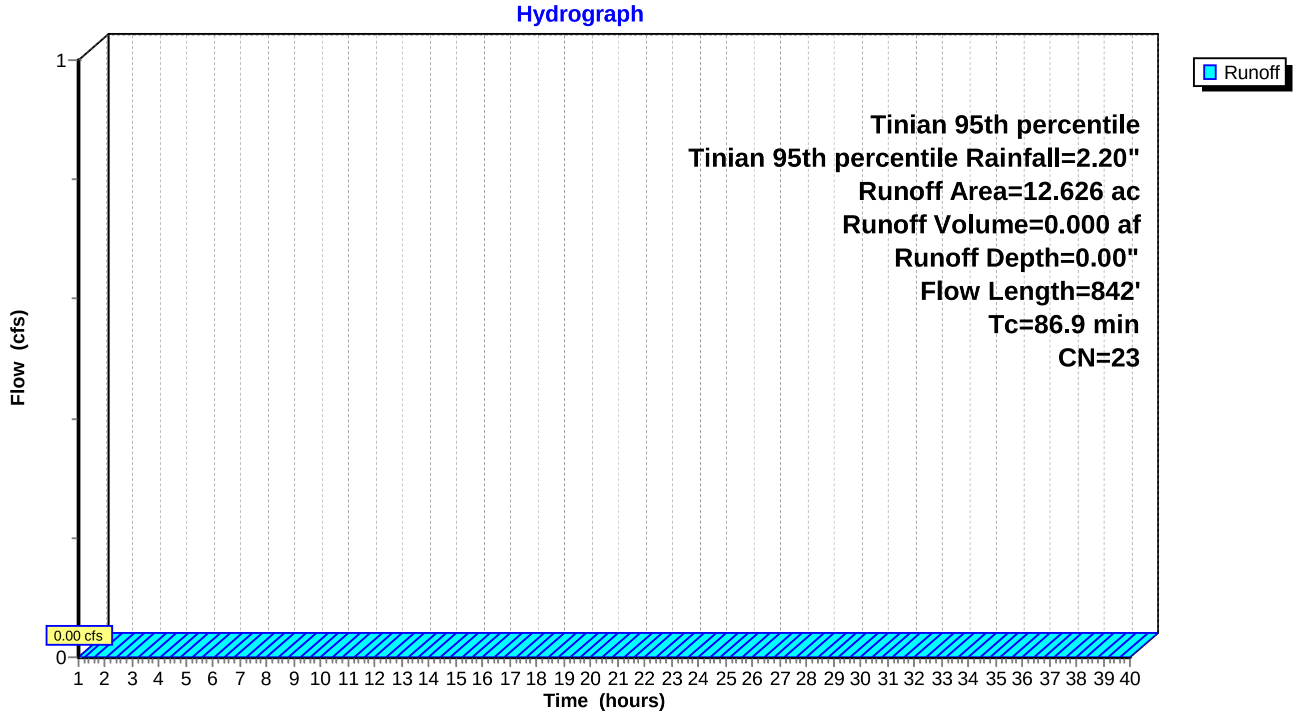
Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-40.00 hrs, dt= 0.01 hrs
Tinian 95th percentile Tinian 95th percentile Rainfall=2.20"

	Area (ac)	CN	Description
*	12.626	23	
	12.626		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
42.9	150	0.0120	0.06		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
44.0	692	0.0110	0.26		**Shallow Concentrated Flow, Shallow Concentrated Flow Proposed** Forest w/Heavy Litter Kv= 2.5 fps
86.9	842	Total			

Subcatchment 1S: Base Camp Analysis 2 Existing



Summary for Subcatchment 2S: Base Camp Analysis 2 Proposed

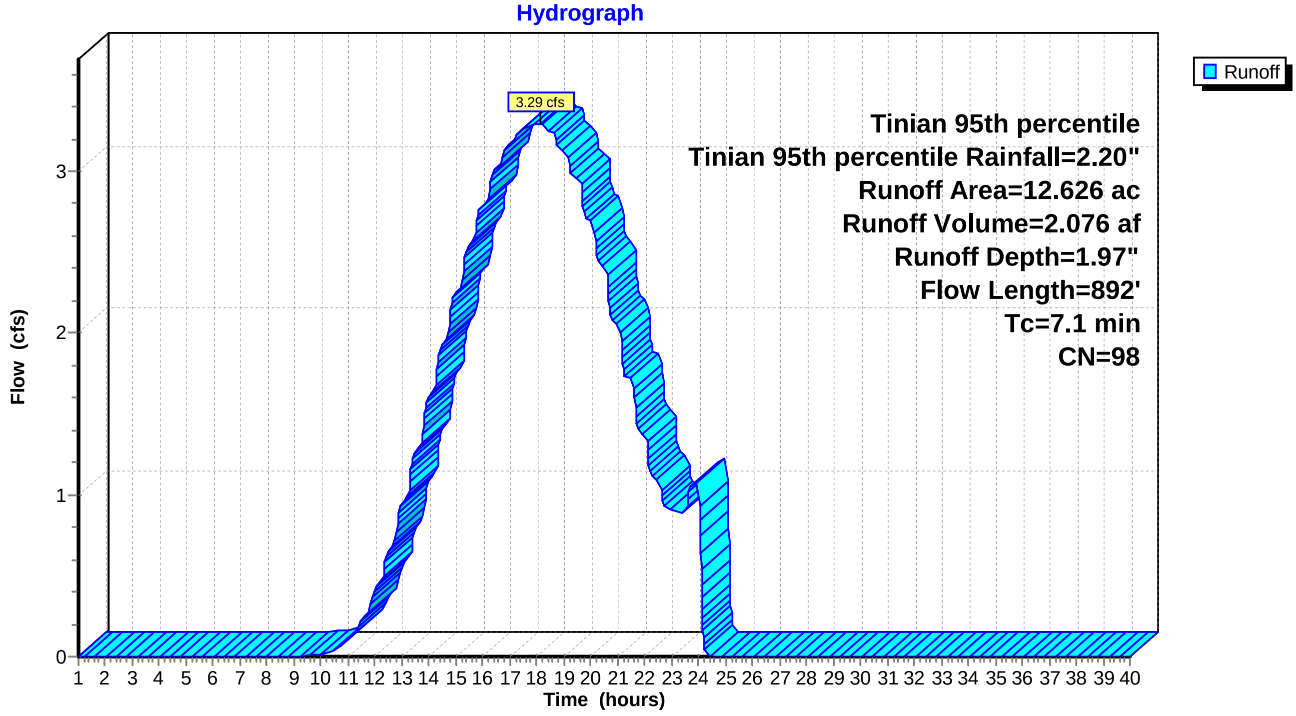
Runoff = 3.29 cfs @ 18.12 hrs, Volume= 2.076 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-40.00 hrs, dt= 0.01 hrs
Tinian 95th percentile Tinian 95th percentile Rainfall=2.20"

	Area (ac)	CN	Description
*	12.626	98	
	12.626		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	150	0.0100	1.67		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
5.6	742	0.0120	2.22		**Shallow Concentrated Flow, Shallow Concentrated Flow Proposed** Paved Kv= 20.3 fps
7.1	892	Total			

Subcatchment 2S: Base Camp Analysis 2 Proposed



ATTACHMENT A.2
ETR AND MPMR HYDROCAD RESULTS

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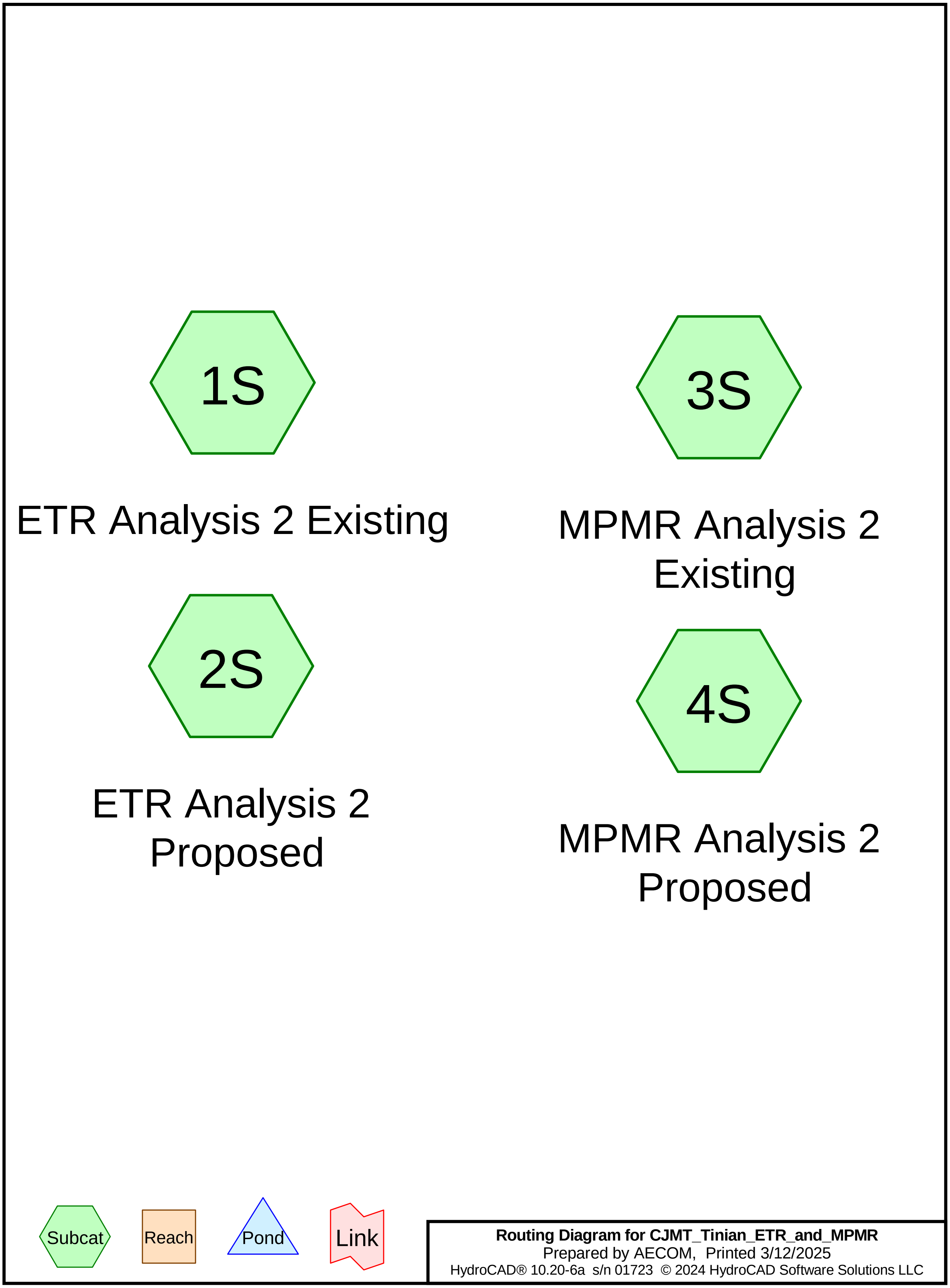

Routing Diagram for CJMT_Tinian_ETR_and_MPMR
Prepared by AECOM, Printed 3/12/2025
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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	Tinian 1 year 24 hour	Tinian 1 year 24 hour		Default	24.00	1	4.25	2
2	Tinian 25 year 24 hour	Tinian 25 year 24 hour		Default	24.00	1	14.88	2
3	Tinian 95th Percentile	Tinian 95th percentile		Default	24.00	1	2.20	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.181	23	(1S, 3S)
3.181	98	(2S, 4S)
6.362	**61**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
6.362	Other	1S, 2S, 3S, 4S
6.362		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	6.362	6.362		1S, 2S, 3S, 4S
0.000	**0.000**	**0.000**	**0.000**	**6.362**	**6.362**	**TOTAL AREA**	

Time span=1.00-60.00 hrs, dt=0.01 hrs, 5901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: ETR Analysis 2 Existing Runoff Area=2.400 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=402' Tc=59.1 min CN=23 Runoff=0.00 cfs 0.000 af

Subcatchment 2S: ETR Analysis 2 Runoff Area=2.400 ac 100.00% Impervious Runoff Depth=4.01"
Flow Length=402' Tc=3.7 min CN=98 Runoff=1.23 cfs 0.803 af

Subcatchment 3S: MPMR Analysis 2 Existing Runoff Area=0.781 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=233' Tc=66.7 min CN=23 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: MPMR Analysis 2 Runoff Area=0.781 ac 100.00% Impervious Runoff Depth=4.01"
Flow Length=233' Slope=0.0050 '/' Tc=2.9 min CN=98 Runoff=0.40 cfs 0.261 af

Total Runoff Area = 6.362 ac Runoff Volume = 1.064 af Average Runoff Depth = 2.01"
50.00% Pervious = 3.181 ac 50.00% Impervious = 3.181 ac

Summary for Subcatchment 1S: ETR Analysis 2 Existing

[45] Hint: Runoff=Zero

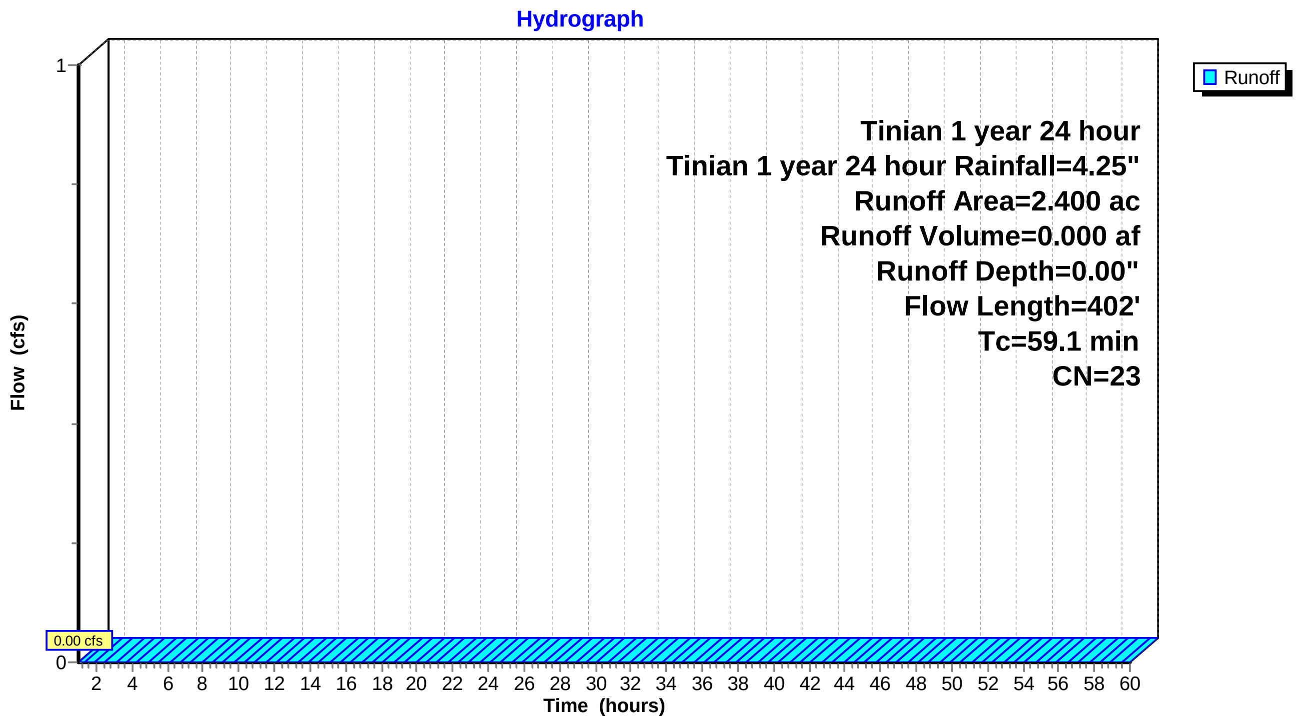
Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 1 year 24 hour Tinian 1 year 24 hour Rainfall=4.25"

	Area (ac)	CN	Description
*	2.400	23	
	2.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.3	150	0.0140	0.06		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
18.8	252	0.0080	0.22		**Shallow Concentrated Flow, Shalloe Concentrated Flow Existing** Forest w/Heavy Litter Kv= 2.5 fps
59.1	402	Total			

Subcatchment 1S: ETR Analysis 2 Existing



Summary for Subcatchment 2S: ETR Analysis 2 Proposed

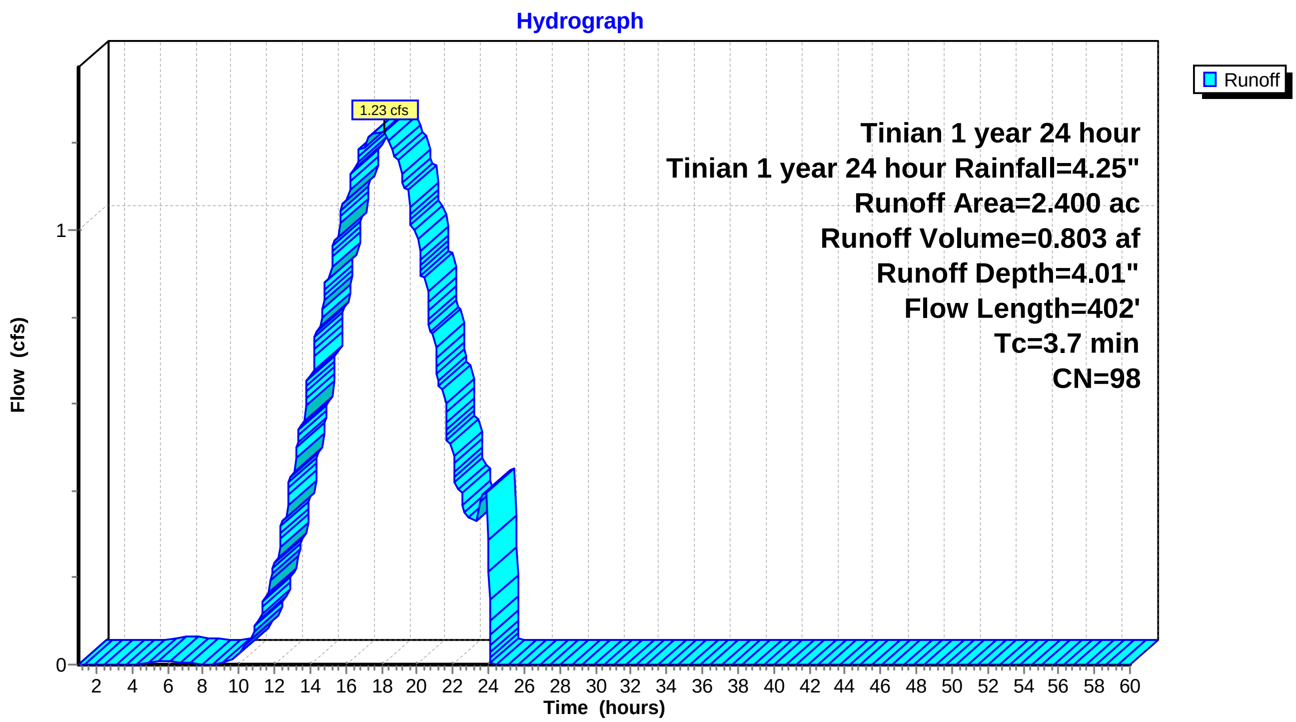
Runoff = 1.23 cfs @ 18.13 hrs, Volume= 0.803 af, Depth= 4.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 1 year 24 hour Tinian 1 year 24 hour Rainfall=4.25"

	Area (ac)	CN	Description
*	2.400	98	
	2.400		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0170	1.91		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
2.8	302	0.0080	1.82		**Shallow Concentrated Flow, Shalloe Concentrated Flow Proposed** Paved Kv= 20.3 fps
3.7	402	Total			

Subcatchment 2S: ETR Analysis 2 Proposed



Summary for Subcatchment 3S: MPMR Analysis 2 Existing

[45] Hint: Runoff=Zero

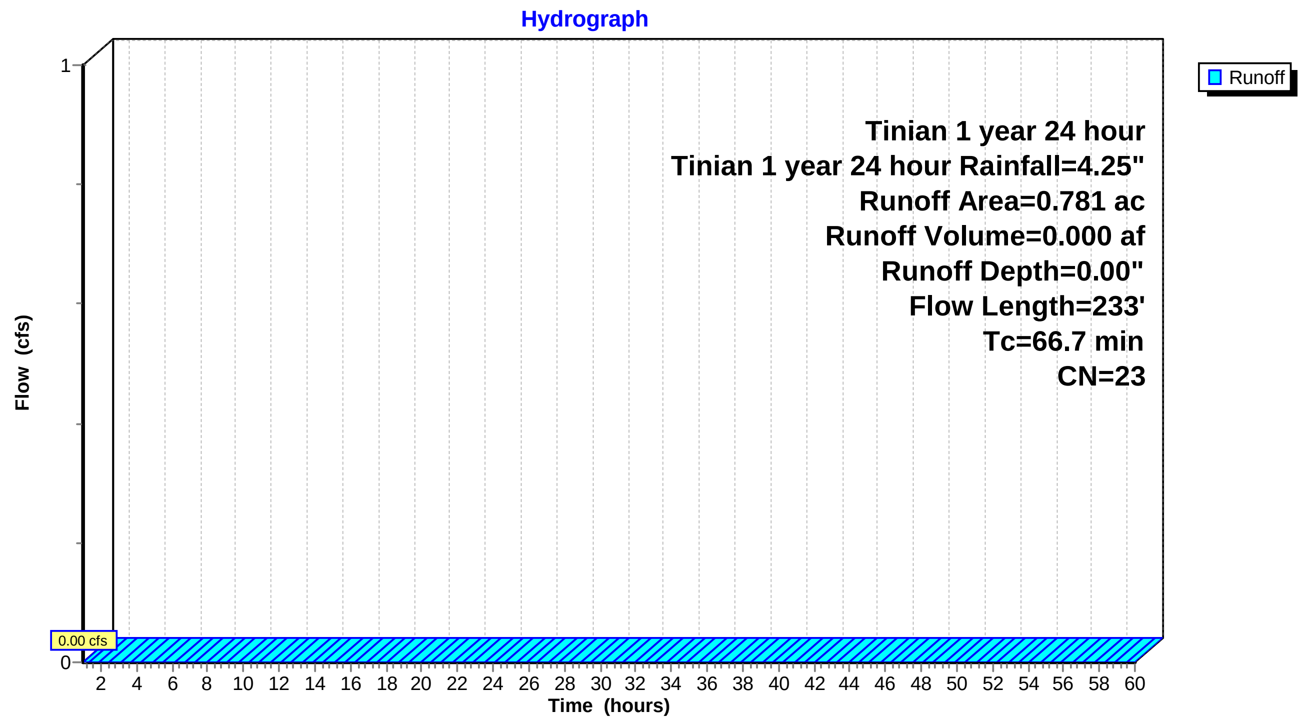
Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 1 year 24 hour Tinian 1 year 24 hour Rainfall=4.25"

	Area (ac)	CN	Description
*	0.781	23	
	0.781		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
56.6	150	0.0060	0.04		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
10.1	83	0.0030	0.14		**Shallow Concentrated Flow, Shallow Concentrated Flow** Forest w/Heavy Litter Kv= 2.5 fps
66.7	233	Total			

Subcatchment 3S: MPMR Analysis 2 Existing



Summary for Subcatchment 4S: MPMR Analysis 2 Proposed

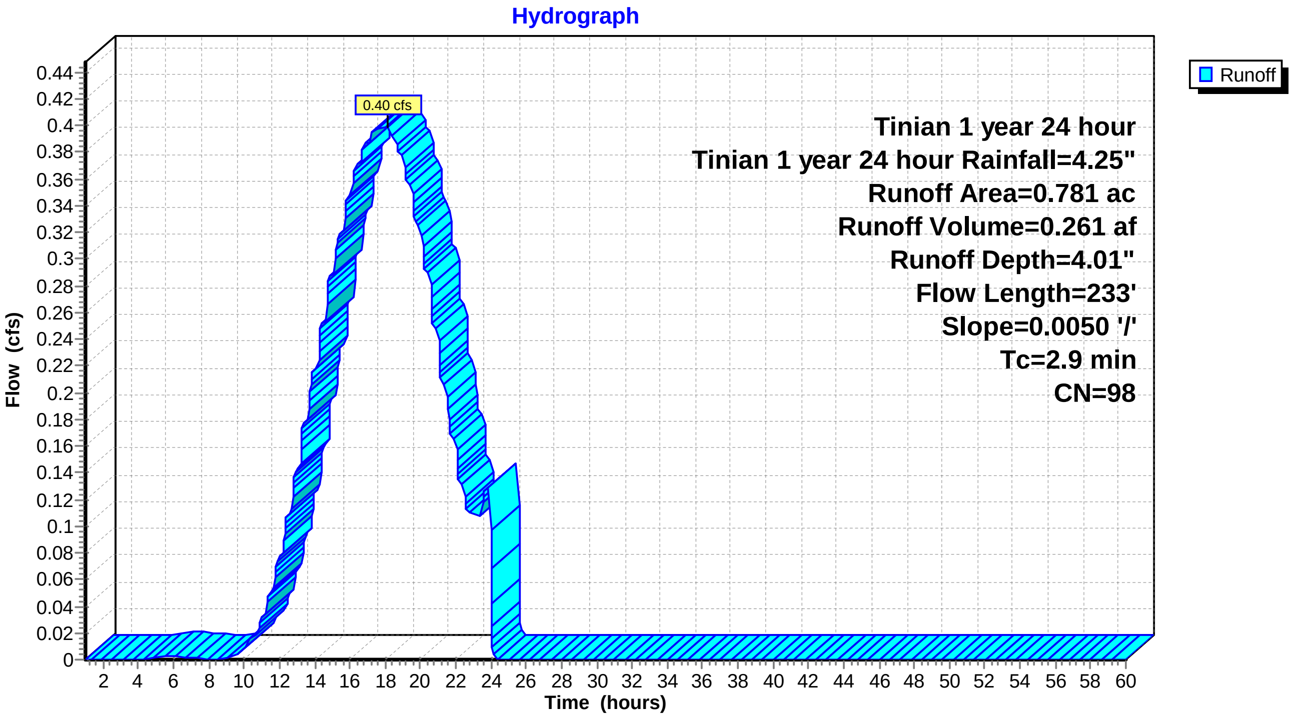
Runoff = 0.40 cfs @ 18.09 hrs, Volume= 0.261 af, Depth= 4.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 1 year 24 hour Tinian 1 year 24 hour Rainfall=4.25"

	Area (ac)	CN	Description
*	0.781	98	
	0.781		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0050	1.17		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
1.5	133	0.0050	1.44		**Shallow Concentrated Flow, Shalloe Concentrated Flow Proposed** Paved Kv= 20.3 fps
2.9	233	Total			

Subcatchment 4S: MPMR Analysis 2 Proposed



Time span=1.00-60.00 hrs, dt=0.01 hrs, 5901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: ETR Analysis 2 Existing Runoff Area=2.400 ac 0.00% Impervious Runoff Depth=1.61"
Flow Length=402' Tc=59.1 min CN=23 Runoff=0.81 cfs 0.322 af

Subcatchment 2S: ETR Analysis 2 Runoff Area=2.400 ac 100.00% Impervious Runoff Depth>14.64"
Flow Length=402' Tc=3.7 min CN=98 Runoff=4.32 cfs 2.927 af

Subcatchment 3S: MPMR Analysis 2 Existing Runoff Area=0.781 ac 0.00% Impervious Runoff Depth=1.61"
Flow Length=233' Tc=66.7 min CN=23 Runoff=0.26 cfs 0.105 af

Subcatchment 4S: MPMR Analysis 2 Runoff Area=0.781 ac 100.00% Impervious Runoff Depth>14.64"
Flow Length=233' Slope=0.0050 '/' Tc=2.9 min CN=98 Runoff=1.41 cfs 0.953 af

Total Runoff Area = 6.362 ac Runoff Volume = 4.306 af Average Runoff Depth = 8.12"
50.00% Pervious = 3.181 ac 50.00% Impervious = 3.181 ac

Summary for Subcatchment 1S: ETR Analysis 2 Existing

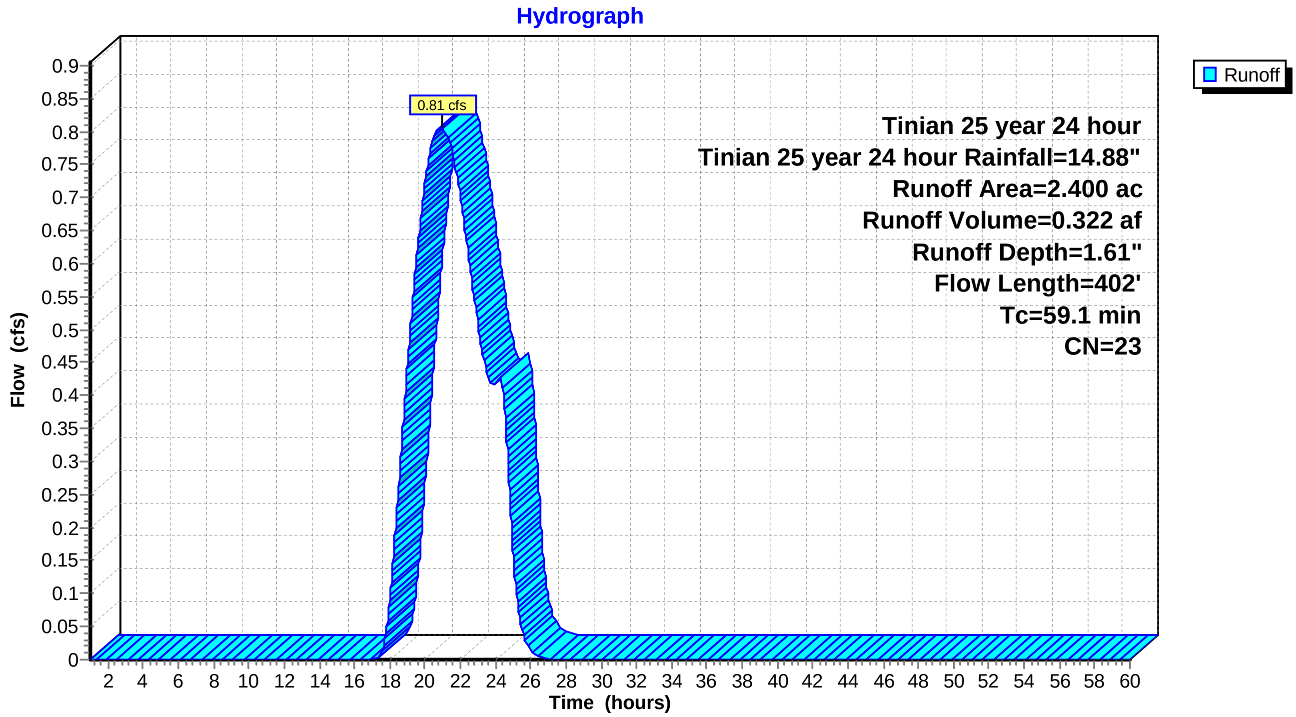
Runoff = 0.81 cfs @ 20.95 hrs, Volume= 0.322 af, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 25 year 24 hour Tinian 25 year 24 hour Rainfall=14.88"

	Area (ac)	CN	Description
*	2.400	23	
	2.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.3	150	0.0140	0.06		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
18.8	252	0.0080	0.22		**Shallow Concentrated Flow, Shalloe Concentrated Flow Existing** Forest w/Heavy Litter Kv= 2.5 fps
59.1	402	Total			

Subcatchment 1S: ETR Analysis 2 Existing



Summary for Subcatchment 2S: ETR Analysis 2 Proposed

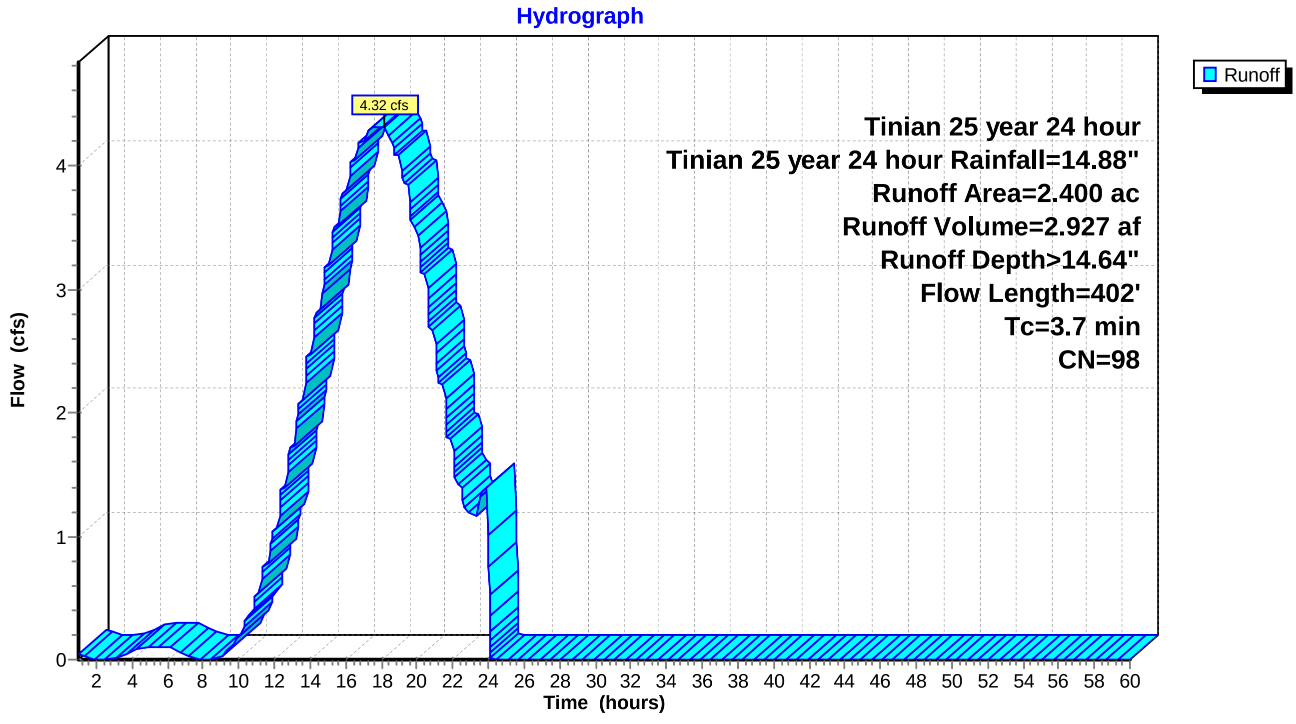
Runoff = 4.32 cfs @ 18.13 hrs, Volume= 2.927 af, Depth>14.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 25 year 24 hour Tinian 25 year 24 hour Rainfall=14.88"

	Area (ac)	CN	Description
*	2.400	98	
	2.400		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0170	1.91		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
2.8	302	0.0080	1.82		**Shallow Concentrated Flow, Shalloe Concentrated Flow Proposed** Paved Kv= 20.3 fps
3.7	402	Total			

Subcatchment 2S: ETR Analysis 2 Proposed



Summary for Subcatchment 3S: MPMR Analysis 2 Existing

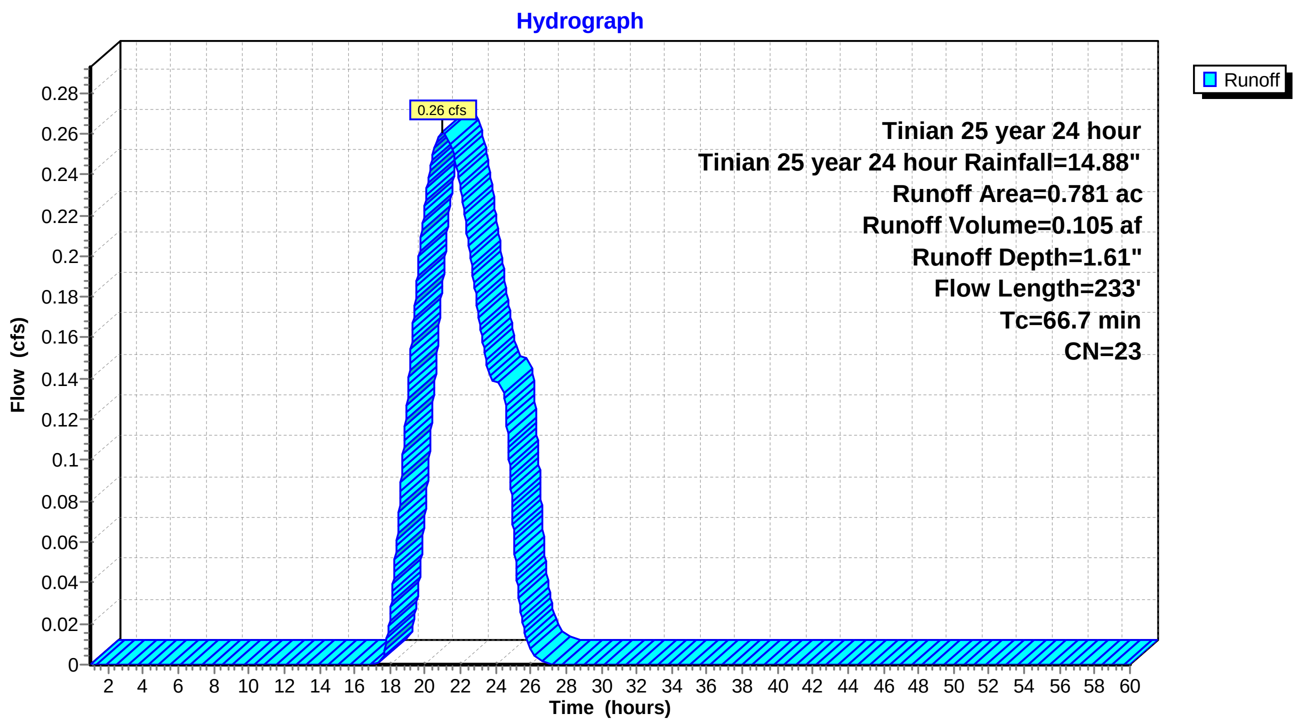
Runoff = 0.26 cfs @ 20.98 hrs, Volume= 0.105 af, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 25 year 24 hour Tinian 25 year 24 hour Rainfall=14.88"

	Area (ac)	CN	Description
*	0.781	23	
	0.781		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
56.6	150	0.0060	0.04		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
10.1	83	0.0030	0.14		**Shallow Concentrated Flow, Shallow Concentrated Flow** Forest w/Heavy Litter Kv= 2.5 fps
66.7	233	Total			

Subcatchment 3S: MPMR Analysis 2 Existing



Summary for Subcatchment 4S: MPMR Analysis 2 Proposed

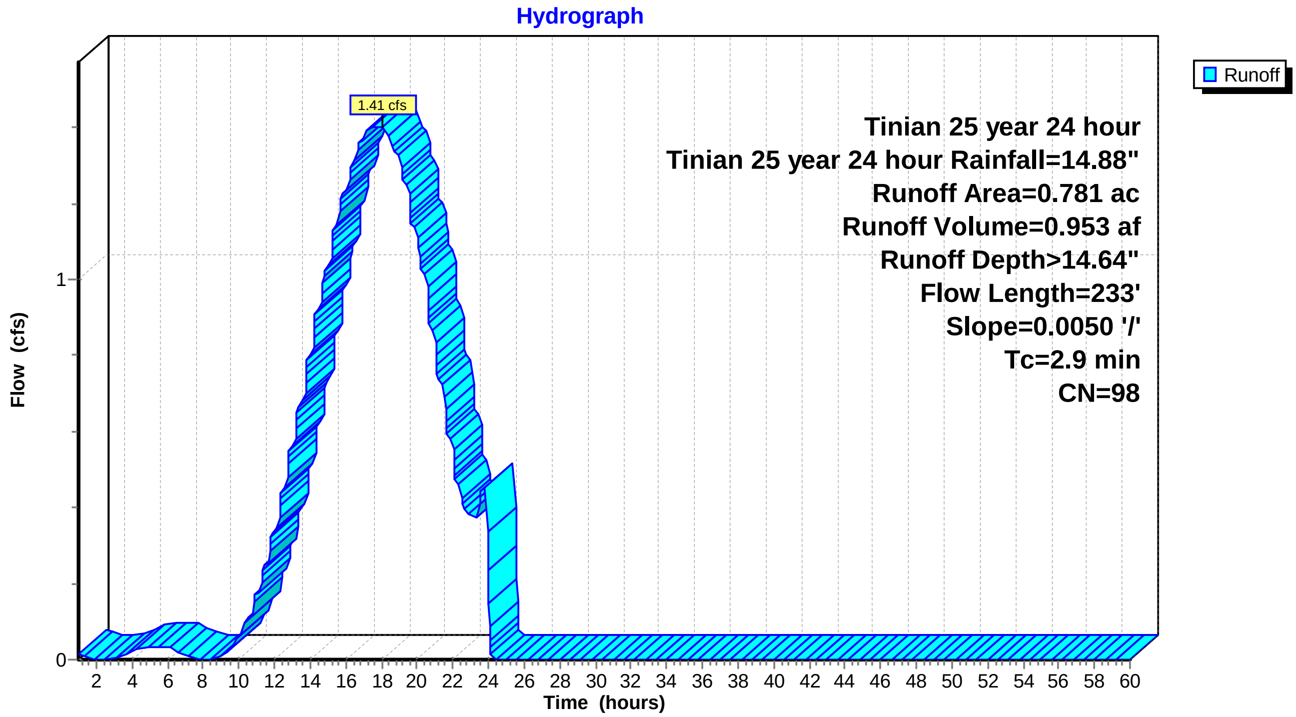
Runoff = 1.41 cfs @ 18.07 hrs, Volume= 0.953 af, Depth>14.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 25 year 24 hour Tinian 25 year 24 hour Rainfall=14.88"

	Area (ac)	CN	Description
*	0.781	98	
	0.781		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0050	1.17		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
1.5	133	0.0050	1.44		**Shallow Concentrated Flow, Shalloe Concentrated Flow Proposed** Paved Kv= 20.3 fps
2.9	233	Total			

Subcatchment 4S: MPMR Analysis 2 Proposed



Time span=1.00-60.00 hrs, dt=0.01 hrs, 5901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: ETR Analysis 2 Existing Runoff Area=2.400 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=402' Tc=59.1 min CN=23 Runoff=0.00 cfs 0.000 af

Subcatchment 2S: ETR Analysis 2 Runoff Area=2.400 ac 100.00% Impervious Runoff Depth=1.97"
Flow Length=402' Tc=3.7 min CN=98 Runoff=0.63 cfs 0.395 af

Subcatchment 3S: MPMR Analysis 2 Existing Runoff Area=0.781 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=233' Tc=66.7 min CN=23 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: MPMR Analysis 2 Runoff Area=0.781 ac 100.00% Impervious Runoff Depth=1.97"
Flow Length=233' Slope=0.0050 '/' Tc=2.9 min CN=98 Runoff=0.20 cfs 0.128 af

Total Runoff Area = 6.362 ac Runoff Volume = 0.523 af Average Runoff Depth = 0.99"
50.00% Pervious = 3.181 ac 50.00% Impervious = 3.181 ac

Summary for Subcatchment 1S: ETR Analysis 2 Existing

[45] Hint: Runoff=Zero

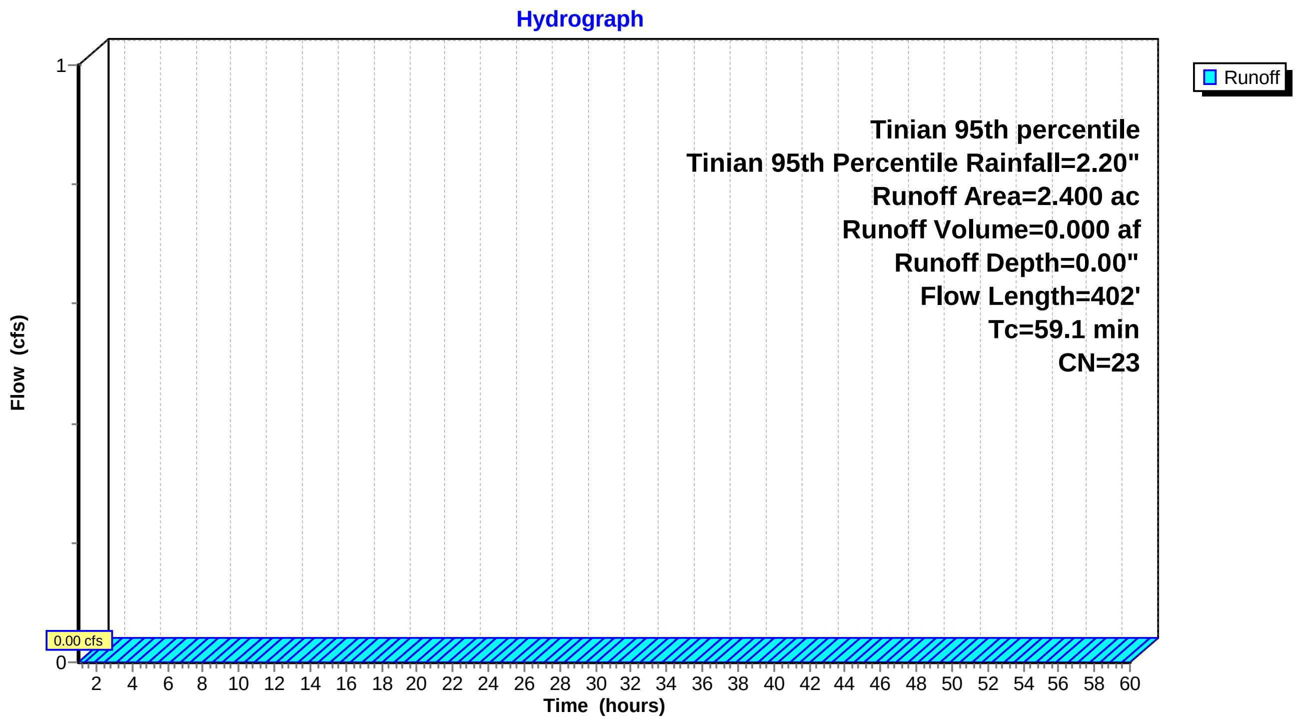
Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 95th percentile Tinian 95th Percentile Rainfall=2.20"

	Area (ac)	CN	Description
*	2.400	23	
	2.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.3	150	0.0140	0.06		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
18.8	252	0.0080	0.22		**Shallow Concentrated Flow, Shalloe Concentrated Flow Existing** Forest w/Heavy Litter Kv= 2.5 fps
59.1	402	Total			

Subcatchment 1S: ETR Analysis 2 Existing



Summary for Subcatchment 2S: ETR Analysis 2 Proposed

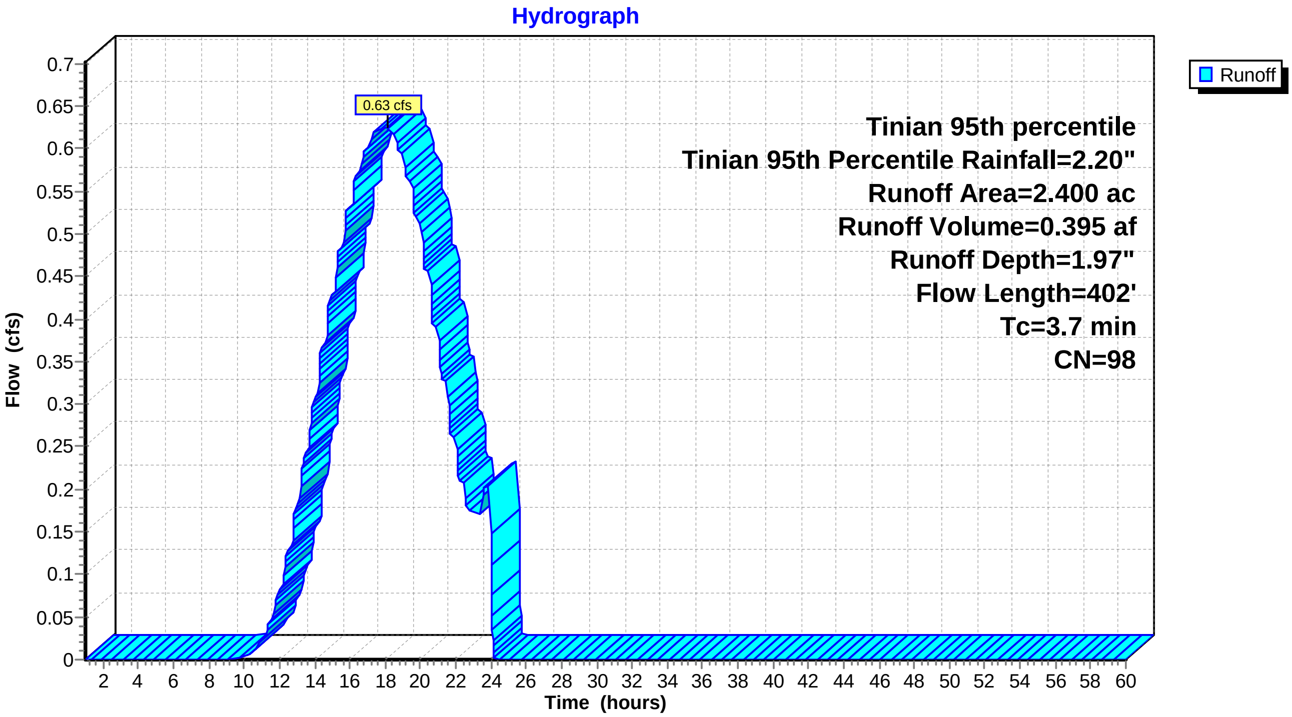
Runoff = 0.63 cfs @ 18.13 hrs, Volume= 0.395 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 95th percentile Tinian 95th Percentile Rainfall=2.20"

	Area (ac)	CN	Description
*	2.400	98	
	2.400		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	100	0.0170	1.91		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
2.8	302	0.0080	1.82		**Shallow Concentrated Flow, Shalloe Concentrated Flow Proposed** Paved Kv= 20.3 fps
3.7	402	Total			

Subcatchment 2S: ETR Analysis 2 Proposed



Summary for Subcatchment 3S: MPMR Analysis 2 Existing

[45] Hint: Runoff=Zero

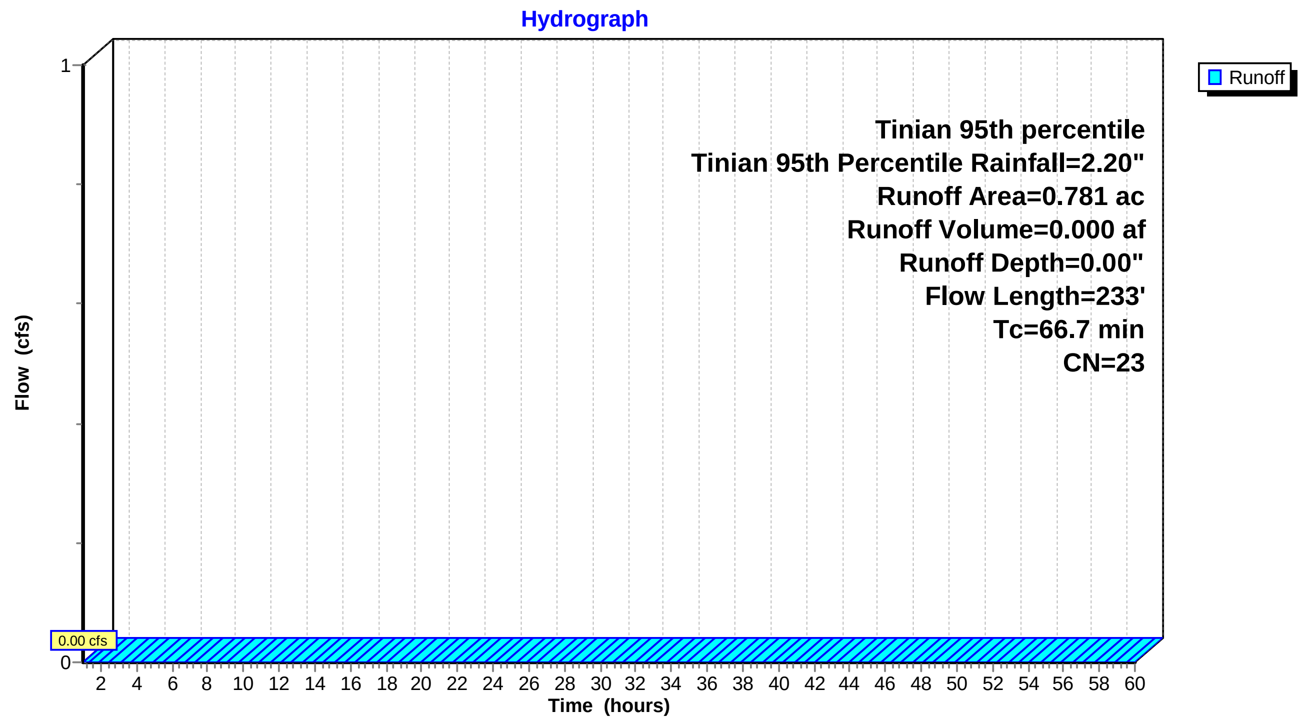
Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 95th percentile Tinian 95th Percentile Rainfall=2.20"

	Area (ac)	CN	Description
*	0.781	23	
	0.781		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
56.6	150	0.0060	0.04		**Sheet Flow, Sheet Flow Existing** Woods: Dense underbrush n= 0.800 P2= 7.00"
10.1	83	0.0030	0.14		**Shallow Concentrated Flow, Shallow Concentrated Flow** Forest w/Heavy Litter Kv= 2.5 fps
66.7	233	Total			

Subcatchment 3S: MPMR Analysis 2 Existing



Summary for Subcatchment 4S: MPMR Analysis 2 Proposed

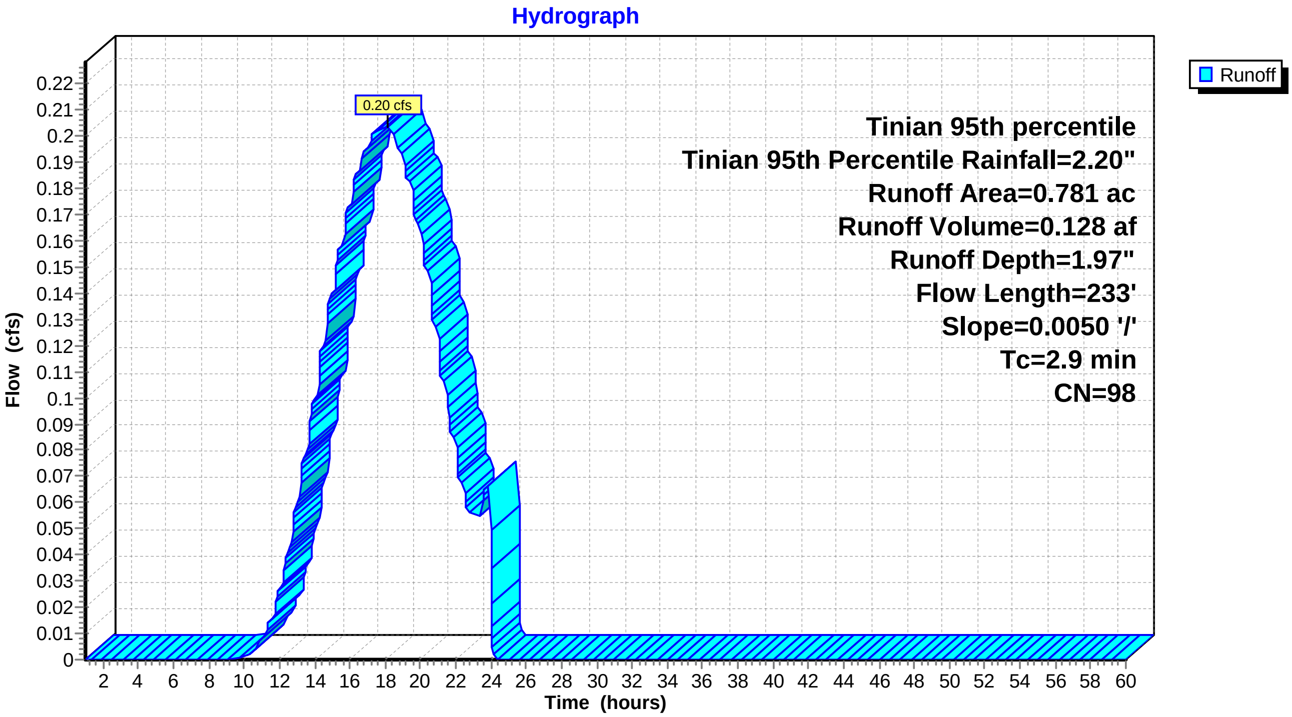
Runoff = 0.20 cfs @ 18.11 hrs, Volume= 0.128 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-60.00 hrs, dt= 0.01 hrs
Tinian 95th percentile Tinian 95th Percentile Rainfall=2.20"

	Area (ac)	CN	Description
*	0.781	98	
	0.781		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0050	1.17		**Sheet Flow, Sheet Flow Proposed** Smooth surfaces n= 0.011 P2= 7.00"
1.5	133	0.0050	1.44		**Shallow Concentrated Flow, Shalloe Concentrated Flow Proposed** Paved Kv= 20.3 fps
2.9	233	Total			

Subcatchment 4S: MPMR Analysis 2 Proposed



ATTACHMENT A.3
CALCULATIONS

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Base Camp Hydrologic Parameters and Assumptions

Planning-Level Flow Path, Curve Number, and Impervious Area Inputs

Time of Concentration and Flow Path Parameters

Parameter	Units	Existing	Proposed	Notes
Length of longest sheet flow path	ft	150.00	100.00	CNMI max limits
Elevation at U/S of sheet flow	ft	74.03	74.03	—
Elevation at D/S of sheet flow	ft	72.21	73.05	—
Sheet flow slope	ft/ft	-0.01	-0.01	Derived
Length of longest shallow concentrated flow path	ft	691.83	741.83	Forested
Elevation at U/S of shallow concentrated flow	ft	72.21	73.05	—
Elevation at D/S of shallow concentrated flow	ft	64.44	64.44	—
Shallow concentrated flow slope	ft/ft	-0.01	-0.01	Derived

Land Use and Curve Number Assumptions

Parameter	Existing	Proposed
Land Use	Forested	Developed
Curve Number (CN)	22.50	98.00

Impervious Area Summary (Proposed Condition)

Parameter	Value
Total Impervious Area	549,980 sq ft
Total Impervious Area	**12.63 acres**

Reference Curve Number Table

Land Use	A	B	C	D
Bare Ground	68.20	75.60	85.70	90.30
Grassland	30.10	51.10	64.90	71.60
Scrub	23.30	38.50	55.30	61.60
Mixed Forest	22.50	45.20	60.60	68.20
Native Forest	22.50	45.20	60.60	68.20
Wetland	72.8	81.6	85.7	88.8
Commercial	98.00	98.00	98.00	98.00

Source: Stormwater Design Criteria Revised Memorandum (Appendix A.4)

Notes:

1. Time of concentration parameters were developed in accordance with CNMI Stormwater Management Manual criteria, including maximum sheet flow lengths for existing and proposed conditions.

2. The proposed condition was conservatively represented as developed (CN = 98) for planning-level evaluation to bound runoff response.

3. Impervious area represents anticipated MPMR footprint used consistently across runoff, water quality, and recharge calculations.

4. Parameters shown here support the combined stormwater modeling described in the main narrative and summarized in Appendix A.

MPMR Hydrologic Parameters and Assumptions

Planning-Level Flow Path, Curve Number, and Impervious Area Inputs

Time of Concentration and Flow Path Parameters

Parameter	Units	Existing	Proposed	Notes
Length of longest sheet flow path	ft	150.00	100.00	CNMI max limits
Elevation at U/S of sheet flow	ft	22.57	22.57	—
Elevation at D/S of sheet flow	ft	21.71	22.10	—
Sheet flow slope	ft/ft	-0.01	-0.01	Derived
Length of longest shallow concentrated flow path	ft	83.27	133.27	Forested
Elevation at U/S of shallow concentrated flow	ft	21.71	22.1	—
Elevation at D/S of shallow concentrated flow	ft	21.42	21.42	—
Shallow concentrated flow slope	ft/ft	0.00	-0.01	Derived

Land Use and Curve Number Assumptions

Parameter	Existing	Proposed
Land Use	Forested	Developed
Curve Number (CN)	22.50	98.00

Impervious Area Summary (Proposed Condition)

Parameter	Value
Total Impervious Area	34,000 sq ft
Total Impervious Area	0.78 acres

Notes:

1. Time of concentration parameters were developed in accordance with CNMI Stormwater Management Manual criteria, including maximum sheet flow lengths for existing and proposed conditions.

2. The proposed condition was conservatively represented as developed (CN = 98) for planning-level evaluation to bound runoff response.

3. Impervious area represents anticipated MPMR footprint used consistently across runoff, water quality, and recharge calculations.

4. Parameters shown here support the combined stormwater modeling described in the main narrative and summarized in Appendix A.

Source: *CNMI Stormwater Management Manual, Volume 1 (Final)*

Summary of Combined Stormwater Analysis Results

Base Camp and MPMR – Existing and Proposed Conditions

HydroCAD Modeling Inputs

Parameter	Units	Base Camp Existing	Base Camp Proposed	MPMR Existing	MPMR Proposed
95th-Percentile Water Quality Storm	in	2.20	2.20	2.20	2.20
1-yr, 24-hr Rainfall Depth	in	4.25	4.25	4.25	4.25
25-yr, 24-hr Rainfall Depth	in	14.88	14.88	14.88	14.88
Drainage Area	acres	12.63	12.63	0.78	0.78
Weighted Curve Number	—	**22.50**	**98.00**	**22.50**	**98.00**
Flow Length	ft	842.0	842.0	233.0	233.0
Time of Concentration (Tc)	min	86.90	7.10	66.7	2.9

Runoff Results – 95th-Percentile Water Quality Storm

Metric	Units	Base Camp Existing	Base Camp Proposed	Change	MPMR Existing	MPMR Proposed	Change
Runoff Volume	ac-ft	0.00	2.08	2.08	0.00	0.13	**0.13**
Runoff Depth	in	0.00	1.97	1.97	0	1.97	**1.97**
Peak Flow	cfs	0.00	3.29	3.29	0	0.20	**0.20**

Runoff Results – 1-Year, 24-Hour Storm

Metric	Units	Base Camp Existing	Base Camp Proposed	Change	MPMR Existing	MPMR Proposed	Change
Runoff Volume	ac-ft	0.00	4.22	4.22	0.00	0.26	**0.26**
Runoff Depth	in	0.00	4.01	4.01	0	4.01	**4.01**
Peak Flow	cfs	0.00	6.46	6.46	0	0.40	**0.40**

Runoff Results – 25-Year, 24-Hour Storm

Metric	Units	Base Camp Existing	Base Camp Proposed	Change	MPMR Existing	MPMR Proposed	Change
Runoff Volume	ac-ft	1.69	15.40	13.71	0.11	0.95	**0.85**
Runoff Depth	in	1.61	14.64	13.03	1.61	14.64	**13.03**
Peak Flow	cfs	4.13	22.73	18.6	0.26	1.41	**1.15**

Rainfall depths used in the stormwater analysis were based on CNMI Stormwater Management criteria for Tinian, as summarized in Table 1.4, Summary of Data for Use on Tinian and Pagan (Referenced Values for Use in CJMT Task 11m Study). The 95th-percentile water quality storm (2.20 inches) and the 1-year and 25-year, 24-hour rainfall depths (4.25 inches and 14.88 inches, respectively) were applied consistently across the Base Camp and MPMR analyses.

The 25-year, 24-hour storm event was also used for comparison with applicable overbank flood control criteria, which specify that post-development peak discharge rates should not exceed pre-development peak discharge rates for the 25-year event, consistent with CNMI guidance.

Source:

CNMI Stormwater Management Manual; Table 1.4 – Summary of Data for Use on Tinian and Pagan; Stormwater Design Criteria Revised Memorandum (Appendix A.4).

Water Quality Volume (WQv) Calculations

90% of Average Annual Storm – High Quality Resource Areas / Hotspots

Parameter	Units	Base Camp (E)	MPMR
Precipitation, P	in	1.50	1.50
Drainage Area, A	acres	12.63	0.78
Impervious Area	acres	12.63	0.78
Impervious Fraction, I	–	1.00	1.00
Water Quality Volume, WQv (90%)	acre-ft	1.58	0.10
Minimum WQv	acre-ft	0.21	0.01
Sedimentation Volume	acre-ft	0.40	0.03

Source: CNMI Stormwater Management Manual, Volume 1 (Final)

Notes:

1. WQv values were used to inform planning-level water quality and sedimentation storage requirements and are not intended to represent final design sizing.

2. Impervious fraction (I) was conservatively assumed as 1.00 for planning-level evaluation, consistent with bounding assumptions used elsewhere in the combined stormwater analysis.

3. The 90-percent average annual storm depth of 1.5 inches was applied in accordance with CNMI stormwater criteria for high-quality resource areas and hotspots.

The following equation can be used to determine the water quality storage volume WQ_v (in acre-feet of storage):

$$WQ_v = (P)(A)(I) / 12$$

where:

WQ_v = water quality volume (in acre-feet)
P = 90% Rainfall Event (1.5 inches) for high quality resource areas
80% Rainfall Event (0.8 inches) for moderate quality resource areas
A = site area in acres
I = impervious area percentage of site area (decimal)

A minimum WQ_v value of 0.0167 ft * total area in acres (also referred to as 0.2 watershed inches) is required to fully treat the runoff from pervious surfaces on sites with low impervious cover.

Recharge Volume (Re_v) Calculations

CNMI Recharge Criteria – Planning-Level Evaluation

Recharge Volume Summary

Parameter	Units	Base Camp (E)	MPMR
Precipitation, P	in	1.50	1.50
Drainage Area, A	acres	12.63	0.78
Impervious Area	acres	12.63	0.78
Impervious Fraction, I	–	1.00	1.00
Recharge Volume, Re_v	**acre-ft**	**1.58**	**0.10**

Notes:

1. Recharge volumes were calculated in accordance with the CNMI Stormwater Management Manual (Volume 1) for limestone-dominated conditions..

2. Impervious fraction (I) was conservatively assumed as 1.00 for planning-level evaluation to bound recharge requirements.

3. The precipitation depth of 1.5 inches represents the CNMI recharge criterion for limestone-dominated areas; volcanic-dominated criteria do not apply.

Recharge Methodology (CNMI Stormwater Manual)

Limestone-Dominated Areas

The criterion specific to the limestone-dominated regions of CNMI and Guam requires infiltration of 1.5 inches of precipitation from all impervious surfaces. The equation is as follows:

$$Re_v = (P)(A)(I)/12$$

Where:
- Re_v = Recharge volume (acre-feet)
- P = Precipitation (1.5 inches)
- A = Site area in acres
- I = Site imperviousness (expressed as a decimal)
- 12 = Conversion from inches to feet

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ELECTRICAL SYSTEM ANALYSIS
IN SUPPORT OF THE
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
JOINT MILITARY TRAINING ENVIRONMENTAL IMPACT STATEMENT

Department of the Navy
Naval Facilities Engineering Systems Command, Pacific
258 Makalapa Drive, Suite 100
JBPHH HI 96860-3134

June 2026

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1 PURPOSE

The purpose of this memorandum is to provide technical background and analysis of power distribution in support of the Commonwealth of the Northern Mariana Islands (CNMI) Joint Military Training Final Environmental Impact Statement (EIS).

1.1 BACKGROUND

The islands of the CNMI are strategically located in the United States (U.S.) Department of Defense (DoD) Indo-Pacific area of operations, as shown in Figure 1. Figure 2 shows the Military Lease Area on Tinian where the U.S. military has trained for several decades.

The Proposed Action would support the ongoing and evolving training requirements of U.S. Armed Forces forward deployed to the Western Pacific, and of U.S. allies and partners, specifically for distributed operations training within the Military Lease Area on Tinian. Proposed training events would include both ground and aviation training within the Military Lease Area.

Non-live-fire offensive and defensive training actions would continue to be conducted in the Military Lease Area with an increase in existing land-based training events, including both ground and aviation training, which are the same or similar to those currently being conducted on Tinian.

Live-fire training would be conducted at two ranges that would be developed within the Exclusive Military Use Area:

- **Multi-Purpose Maneuver Range.** A live-fire range occupying approximately 200 acres at the northern tip of Tinian to support platoon-size live-fire and maneuver, including three surface radar facilities.
- **Explosives Training Range.** A live-fire range on approximately 2.5 acres for the employment of demolitions and military explosives in support of offensive and defensive training events.

The following are also included in the Proposed Action to support training events:

- Establishment of 13 Landing Zones, areas cleared of vegetation to 6–8 inches, and associated access roads to conduct training events and to provide staging, bivouac, and gathering and rendezvous areas.
- Ground and aviation improvements at North Field, including establishment of a drop zone and the placement of a metal airfield surface.
- Construction and operation of a Base Camp.
- Clearance and improvements of roads within the Military Lease Area.

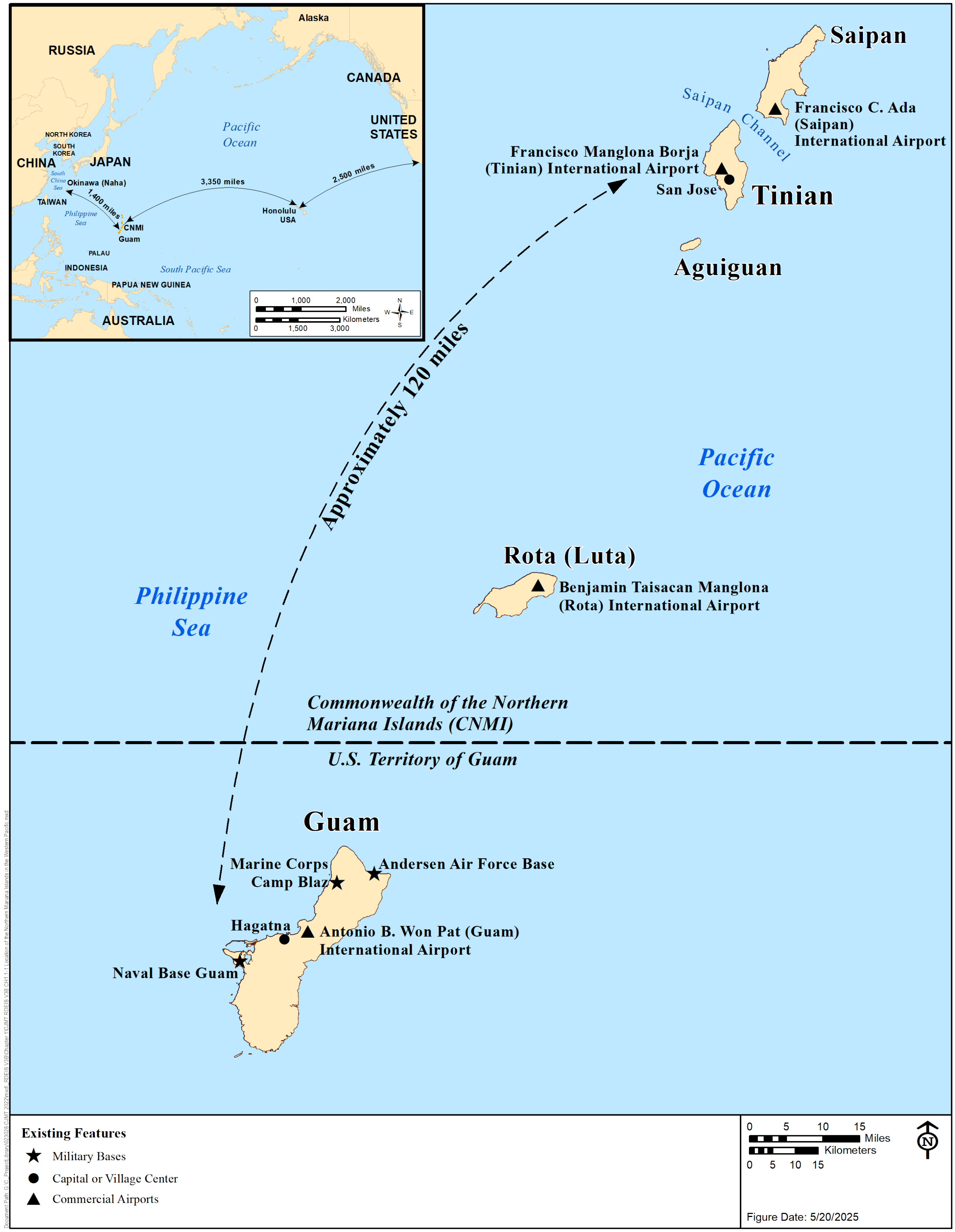

Figure 1 Island of Tinian – Location

Figure 2 Island of Tinian – Military Lease Area Boundaries

2 EXISTING ELECTRICAL SYSTEM ON TINIAN

2.1 COMMONWEALTH UTILITIES CORPORATION ISLAND-WIDE SYSTEM

The Commonwealth Utilities Corporation, a public corporation, owns the existing island-wide electrical distribution system on Tinian . Telesource CNMI, Inc., operates and maintains the system under an Independent Power Provider agreement with the Commonwealth Utilities Corporation. The status of the agreement and whether the Commonwealth Utilities Corporation would inherit the workforce and take over operations, has yet to be confirmed. This would still allow the Commonwealth Utilities Corporation to have flexibility to continue contracting certain items from Telesource CNMI, Inc., if needed. This existing system includes several electrical generation units and distribution infrastructure, which consists of overhead and underground distribution lines, power poles, utility holes, transformers, substations, and meters used to provide and measure power to island customers (Information cited in Cardno GS).

The existing electrical generation system at the powerplant consists of the following components:

- Four 4.16 kilovolt, 2.5 megawatt diesel generators
- Two 4.16 kilovolt, 5.5 megawatt diesel generators
- Two exhaust stacks:
- One 90-foot tall stack to service four 2.5 megawatt generators
- One 175-foot tall stack to service two 5.5 megawatt generators
- An aboveground fuel delivery pipeline from the existing diesel fuel storage tank at the Port of Tinian to a diesel storage tank, which is adjacent to the power plant facility
- Expansion capability for two additional 5.5 megawatt diesel generators (including space inside the existing generator building and tie-in points to the existing exhaust stack)

Data collected in the field indicated an installation date of 1999 for the generators.

The location, configuration, and electrical capacity are essential details for the evaluation of the Tinian Power Plant. The Tinian Power Plant is a single generation facility near the coast outside of San Jose at 25 feet above mean sea level. The powerplant has a total generator operating capacity of 18.2 megawatt with available capacity of 12.70 megawatt considering the maintenance scenario of the largest generator to accommodate additional loads. The powerplant's capacity could be expanded because it has space for two additional 5.5 megawatt generators that would provide an additional 11 megawatt to the system capacity, if installed; this would provide a total generator operating capacity of 29.2 megawatt and an available capacity of 24.7 megawatt. The 4,160-volt output from each of the six diesel generators feed the 1200A synchronizing switchgear that in turn feeds step-up transformers.

The step-up transformers increase the 4,160 volt up to 13.8 kilovolt for power distribution, except for Feeder 2, which distributes power at 4,160 volt. This feeder was anticipated to be upgraded from 4,160 volt to 13.8 kilovolt by 2024, and its current status is unknown. The island-wide electrical distribution consists of four medium voltage feeders that originate from the Commonwealth Utilities Corporation plant. Feeder 1 was identified as offline and loads transferred to Feeder 2. Feeders 2 and 3 support most of the island. Feeder 4 is a dedicated feeder that serves the former U.S. Agency for Global Media (USAGM) facility (Department of the Navy [DON] 2018).

See Figure 3 for existing feeder distribution and designations.

Much of the existing island-wide electrical distribution system is overhead except for lines within the vicinity of the airfield runways. The existing overhead power distribution on the island has been replaced with concrete poles after impacts from Typhoon Yutu in 2018. The extent of how much of the overhead line distribution has been replaced to date has yet to be determined.

A 2017 Tinian Unscheduled Power Outages report received during the site investigation, revealed the following outages:

- 2015 – 11 Emergency Outages
- 2016 – 6 Emergency Outages

No additional information as to the cause of the outage events is known.

3 ESTIMATED ELECTRICAL DEMAND AND PROPOSED ELECTRICAL INFRASTRUCTURE WITH CJMT ACTION

3.1 POWER DEMAND

The existing system capacity at the Tinian power shall not exceed 12.70 MW. Proposed operations would add an estimated 0.146 megawatt of peak electricity demand to operate facilities and supporting infrastructure and equipment. The additional electrical demand loads on the proposed operations include the three surface radar facilities, which may alternatively be powered by temporary or permanent generators. This increase in peak demand accounts for 1.15 percent of total island-wide/Commonwealth Utilities Corporation system capacity. Table 1 provides a summary of existing and proposed electrical demands relative to the existing electrical system capacity. With this added electrical demand, the system maintains a 9.55 megawatt capacity reserve, which is 75.2 percent of the total system capacity (see Attachment A for calculation details). The existing island-wide power generation facility is capable of meeting the increased power demand during the proposed operations; therefore, the impacts would be less than significant.

Table 1. Electrical Power System Peak Demand and Capacity

Item	*MW of Electricity*	*% of System Capacity*
Tinian Power Plant Effective Design Capacity	12.70	100
Peak Electrical Demand from Existing Customers	3.00	23.5
Additional Peak Electrical Demand from Proposed Facilities	0.146	1.15
Total Electrical Demand with Proposed Facilities	**3.146**	**24.8**
Remaining Electrical Generating Capacity with Proposed Action	**9.51**	**75.2**

Legend: % = percent; MW = megawatt.

Multiple interconnection points to the grid exist. However, a spare breaker is available that could be used for the U.S. Marine Corps (USMC) and, based on peak demand load information received for 2016 and 2017, it is recommended that the USMC be tied to the existing Feeder 4 with the former USAGM infrastructure. Further analysis and investigations and data gathering on peak demand readings are required to validate this recommendation.

Demand load information indicated a peak demand load of 1.4 megawatt on Feeder 4; the demand from the proposed facilities is approximately 0.146 megawatt. The addition of the 0.146 megawatt load on Feeder 4 is insignificant and would not require the installation of a dedicated feeder.

Figure 3 Existing Electrical Distribution System

3.2 MEDIUM VOLTAGE POWER DISTRIBUTION

Power and communications would be required at the proposed facilities, surface radars, and communications towers. Power would originate from the existing Commonwealth Utilities Corporation powerplant. Feeder taps on the existing 13.8-kilovolt USAGM overhead Feeder 4 would be required to support the facilities, surface radars, and communications towers.

Communications would originate from the Tinian commercial internet service provider hub, east of the Commonwealth Utilities Corporation power plant.

The electrical feeder and communications lines would be routed to the proposed facilities and surface radar towers via underground distribution. Surface radar towers supported via underground feeders would provide less maintenance, increased reliability and less cost in operating than if were supported by generators. However, initial cost of using generators would be substantially less. The underground distribution would include concrete-encased duct banks and medium-voltage utility holes. Utility holes would be installed at each change in direction and spaced not greater than 400 feet on straight runs as indicated per Unified Facilities Criteria 3-550-01 (DoD 2019). Where tapped from the existing overhead line, additional overhead power equipment and a riser would be required for the proposed distribution. Additional coordination with Commonwealth Utilities Corporation would be required for any outages during cutover of the 13.8-kilovolt feeder to the proposed operations.

Figure 4 reflects the proposed routing of the underground distribution for both power and communications. Further site investigation is required to verify the exact routing of the underground duct bank and utility hole locations to support the proposed operations. Duct bank configurations, utility hole sizes, and exact cable termination points would be deferred and determined during the detailed design effort.

3.2.1 Electrical Distribution System

The existing 13.8-kilovolt Commonwealth Utilities Corporation overhead line running north along 8th Street would be tapped at the power poles to provide underground lateral feeds to the proposed operations, except for the Base Camp and the communications towers.

The demobilization of the former USAGM facilities would allow reuse of the existing medium voltage distribution to support the Base Camp. An existing medium voltage switchgear would remain in place to be used from site electrical distribution. It was noted that the existing switchgear requires repair to the existing bus. The extent of the repair to the switchgear is currently unknown.

The feeder and communications lines would continue underground to the north approximately 2,000 feet east of Runway Baker to feed the two surface radar locations, the Multi-Purpose Maneuver Range, AHA1, and wells.

The feeder would also branch at 86th Street due west to support Base Camp Well Field – Option A or due east towards Base Camp Well Field – Option B, the preferred option.

A recently installed extension of Feeder 4 located north of the Francisco Manglona Borja/Tinian International Airport as part of the Tinian Divert Infrastructure Improvements would be tapped and routed underground to feed the proposed aircraft shelter.

Figure 4 Proposed Electrical Distribution System

3.3 QUANTITIES – UNDERGROUND DISTRIBUTION

Below is a summary of the anticipated quantities of utility holes, trenching, and backfill for both the electrical and communications underground distribution systems.

This underground distribution includes approximately 85,665 linear feet of underground duct bank with 121 electrical utility holes and 221 communication utility holes. Table 2 provides the estimated quantity of duct bank (excavation, backfill, and concrete).

Table 2. Duct Bank Quantities

Type	*Total + 15% Contingency (Cubic Yards)*
Excavation	36,037
Concrete	14,299
Backfill	18,818

Legend: % = percent.

Impacts to the existing electrical and communication systems on the neighboring Island of Saipan have been explored for training activities. No training activities would be conducted at the USAGM site on Saipan. Military traffic would be limited to occasional inspection and maintenance of the communication antenna. Replacement of the existing high-powered shortwave transmission station tower with lower-powered Radio Frequency antennas would either offset or result in a net increase of the existing electrical distribution capacity. Consequently, there would be no impact to the electrical distribution at this site on Saipan.

4 REFERENCES

DON. 2018. *Electrical Study Update V2a1 Final in Support of the Commonwealth of the Northern Mariana Islands Joint Military Training Environmental Impact Statement/Overseas Environmental Impact Statement.* JBPHH, HI. Prepared for NAVFAC Pacific.

DoD. 2019. *Unified Facilities Criteria (UFC), Exterior Electrical Power Distribution.* UFC 3-550-01. Including Change 3. November 1.

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ATTACHMENT A
CALCULATIONS

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Base Camp Load Schedule

Tinian Base Camp Structures

Facility Name	*Unit of Measure*	*Quantity / Size*	*Watt/ SF*	*Watt/ EA*	*Calculated (kW)*	*Calculated (kVA)*	*Total kVA inc. 25% spare*	*Xfmr size (kVA)*	*Total Demand (kVA)*	*Assumption & Notes*
Outdoor Services										
Ammunition Holding Area (AHA-1)	SF	100	2.19		0.22	0.27	0.34	7.5		
Bivouac Concrete Pad	SF	1	0		0.00	0.00	0.00	0		Electrical needs provided by generators
Biosecurity/Washrack	SF	5,400	0.15		0.81	1.01	1.27	7.5		
Facilities										
Administration/HQ Building	SF	2,115	24		50.76	63.45	79.31	112.5		
Range Control Building (Admin)	SF	4,155	7.5		31.16	38.95	48.69	75		
Base Camp	SF	1	0		0.00	0.00	0.00	0		Electrical needs provided by existing USAGM service
Warehouse	SF	18,000	2		36.00	45.00	56.25	75		
Exercise Control (Training Unit Operational Facility)	SF	1,000	6		6.00	7.50	9.38	15		
Restroom/Showers	SF	5,700	2		11.40	14.25	17.81	25		
Miscellaneous Facilities										
Surface Radar 1	EA	1		12500.00	12.50	15.63	19.53	25		
Surface Radar 2	EA	1		12500.00	12.50	15.63	19.53	25		
Communications Towers	EA	3	0		0.00	0.00	0.00	0		Electrical needs provided by existing USAGM service
Hardened Aircraft Shelter	SF	20,020	6		120.12	150.15	187.69	225		
Well Field Monitor	EA	2		750.00	1.50	1.88	2.34	7.5		(2) Sensor, (1) Data Logger, Aux. Equip., Lighting
Fueling/Fuel Tanks	SF	1,500	0.5		0.75	0.94	1.17	7.5		
								607.5	182.25	Demand kVA based on 30% of the sum of all transformer ratings
									145.8	Demand kW with 0.8 PF

Legend: % = percent; Admin = administration; USAGM = United States Agency for Global Media; Aux. = auxiliary; EA = each; HQ = headquarters; kVA = kilovolt ampere; kW = kilowatt; PF = power factor; SF = square foot; Xfmr = transformer.

Duct Bank - Quantities

		L (FT.)	*W (FT.)*	*D (FT.)*	*Cross Section Area (FT.)*	*CU. FT.*	*CU. YD*
Power/Comm	Excavation	53138.56	3.50	3.83	13.41	712322.34	26382.31
	Concrete	53138.56	3.50	1.83	5.30	281678.63	10432.54
	Backfill	53138.56	3.50	2.00	7.00	371969.89	13776.66
Comm	Excavation	45376.48	1.50	3.83	5.75	260687.89	9655.11
	Concrete	45376.48	1.50	1.83	2.30	104391.12	3866.34
	Backfill	45376.48	1.50	2.00	3.00	136129.44	5041.83

All Conduit Areas	
sqin.	Sqft.
95.00	0.66
64.00	0.44
159.00	1.10

Comm Conduit Areas	
sqin.	Sqft.
64.00	0.44
64.00	0.44

TOTALS		
		CUBIC YARDS
Total + 15% Contingency	Excavation	**36037.42**
	Concrete	**14298.88**
	Backfill	**18818.49**

Legend: % = percent; Comm = communications; CU. FT. = cubic foot; CU. YD = cubic yard; D = depth; FT. = foot or feet; L = length; squin. = square inch; Sqft. = square foot; W = width.

Electrical Distribution System – Quantities

Route Segments	*Connecting Segment Numbers*	*Route Description*	*Routing Type*	*Length (Feet)*	*Number of Poles @135' Spacing*	*Number of Manholes @400' Spacing*	*Length (Meters)*	*Notes*
Segment 1	A to B	Existing OH electrical to Tinian Powerplant	Existing Electrical (OH)	9,823			2,994	Tinian Powerplant to Airport, existing poles.
Segment 2	B to C	Existing UG electrical to Tinian Powerplant	Existing Electrical (UG)	2,810		8	856	West of Tinian International Airport clearance zone (west), required to be underground.
Segment 3	C to D	Existing OH electrical to USAGM	Existing Electrical (OH), Proposed Comm (OH)	17,392			5,301	Existing USAGM Feeder from Airport to Base Camp would connect wells in Well Option A Site. Comm installed on existing OH poles.
Segment 4	E to F	Proposed UG electrical and comm lines	Proposed Elec/Comm (UG)	11,205		29	3,415	Base Camp to Surface Radar Site 1.
Segment 5	G to H	Proposed UG electrical and comm lines	Proposed Elec/Comm (UG)	13,381		34	4,079	Unai Chulu Road to Ushi Point Road.
Segment 6	H to J	Proposed UG electrical and comm lines	Proposed Elec/Comm (UG)	5,260		14	1,603	Proposed UG from 8th Avenue To North Comm Tower.
Segment 7	H to K	Proposed UG electrical and comm lines	Proposed Elec/Comm (UG)	4,763		13	1,452	Ushi Point Road to AHA 1 (lighting, comms), also connects MPMR water tanks/wells.
Segment 8	L to M	Proposed UG electrical and comm lines	Proposed Elec/Comm (UG)	11,599		30	3,535	Proposed UG elec/comm from 8th Avenue to Well Field Option B (connects wells).
Segment 9	L to O	Proposed UG comm lines	Proposed Comm (UG)	26,236		67	7,997	Base Camp to Broadway (inside MLA Boundary).
Segment 10	N to P	Proposed UG comm lines	Proposed Comm (UG)	13,222		34	4,030	Broadway MLA to Commercial Internet Service Provider (San Jose).

Total Comm OH Poles	0
Total Elec OH Poles	0
Total # Poles	**0**
Total Comm Manholes	221
Total Elec Manholes	121
Total # of Manholes	**342**
MH Spacing	400
Pole Spacing	135

Legend: ADN = area distribution node; AHA = Ammunition Holding Area; Comm = communications; Elec = electrical; MLA = Military Lease Area; MPMR = Multi-Purpose Maneuver Range; OH = overhead; UG = underground; USAGM = United States Agency for Global Media.

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APPENDIX N
CZMA FEDERAL CONSISTENCY DETERMINATION

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Commonwealth of the Northern Mariana Islands
OFFICE OF THE GOVERNOR
Bureau of Environmental and Coastal Quality
Division of Coastal Resources Management
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Floyd R. Masga
Administrator

COASTAL RESOURCES MANAGEMENT
Agnes M. Sablan
Director, DCRM

April 9, 2026

ADM26-083

Sent via email: <jacqueline.rice@usmc.mil>

Mr. Todd Armsworth
DPRI/Pacific Posture Branch Chief
Marine Corps Installations Command
Department of Navy
3000 Marine Corps Pentagon
Washington, DC 20350-3000

Re: CZMA Consistency Determination for the Commonwealth of the Northern Mariana Islands Joint Military Training (Ref. 3000 DPRI/PP)

Dear Mr. Armsworth,

The Commonwealth of the Northern Mariana Islands (CNMI) Division of Coastal Resources Management (DCRM) has reviewed the Coastal Zone Management Act (CZMA) federal consistency determination (CD) from the United States Marine Corps (USMC) for the proposed land-based military training and the construction of associated infrastructure on the island of Tinian in the CNMI. DCRM received your CD on March 5, 2026. As stated in the February 2026 CNMI Joint Military Training (CJMT) CD, the proposed action is to accommodate the proposed training by creating physical and virtual training environment within the Military Lease Area (MLA). Moreover, the proposed action as described and assessed in the CJMT Revised Draft Environmental Impact Statement (EIS) would have direct and significant impacts with spillover effects on areas subject to the CNMI's Coastal Resources Management Program (CRMP) but could have minor direct effects. Furthermore, the proposed military training and associated infrastructure construction would be consistent to the maximum extent practicable with the CNMI Coastal Resources Program. Additional supporting information dated March 11, 2026 was provided to DCRM on March 12, 2026.

DCRM concurs that this action is consistent to the maximum extent practicable with the enforceable policies of the CNMI CMP. Thank you for coordinating with our office. If you have any questions or need additional information, please contact me at (670) 664-8300 or at fedcon@dcrm.gov.mp or ssablan@dcrm.gov.mp.

Sincerely,

Agnes M. Sablan
Director
Division of Coastal Resources Management

cc : BECQ Administrator; Special Assistant for CBMA; Art Charfauros

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