6 WELL SITING, INSTALLATION AND OPERATION RECOMMENDATIONS

6.1 RECOMMENDATIONS

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 noncompliance with the secondary drinking water maximum concentration levels for total 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-inch-diameter, 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-inch-diameter, 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 completion of 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; Doug Roff, PG, CEG, CHg.
- Geology/Hydrogeology Team. Doug Roff, PG, CEG, CHg.
- **Reviewer.** Joe Harrigan, PG.

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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.

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.

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