

CHAPTER 1 – WATER SYSTEM DESCRIPTION

1.1 Introduction

Guam Waterworks Authority (GWA) operates and maintains over 200 water facilities on Guam. Table 1-1 identifies these facilities by system, type, and population served. The facility types can generally be classified as sources, reservoirs, and water booster pumping stations.

GWA is comprised of three public water systems. The Northern (GU00000006) and Central (GU00000003) Public Water Systems are designated “Large” and the Southern (GU00000001) Public Water System is designated “Small”. These are “Distribution” system classifications established by Guam EPA and are based on the population served.

Table 1-1 – Guam Waterworks Authority Facilities

System	Wells	Springs	Reservoirs	Booster Stations	Treatment Plants	Population Served
Northern	119 ¹	0	17	13	0	146,050
Central	0	1	8	14	0	22,000
Southern	2	4	15	9	1	5,504
Total	121	5	40	36	1	173,554

¹ 10 Wells are owned and operated by EarthTech

² Current populations values are 133,600; 15,700; and 7,400, for the Northern, Central, and Southern Systems, respectively.

The public water system boundaries do not offer exact delineations, but the general boundaries are shown in Figure 1-1 and are discussed below. Figure 1-2 shows where potential overlaps of water service among the systems occurs.

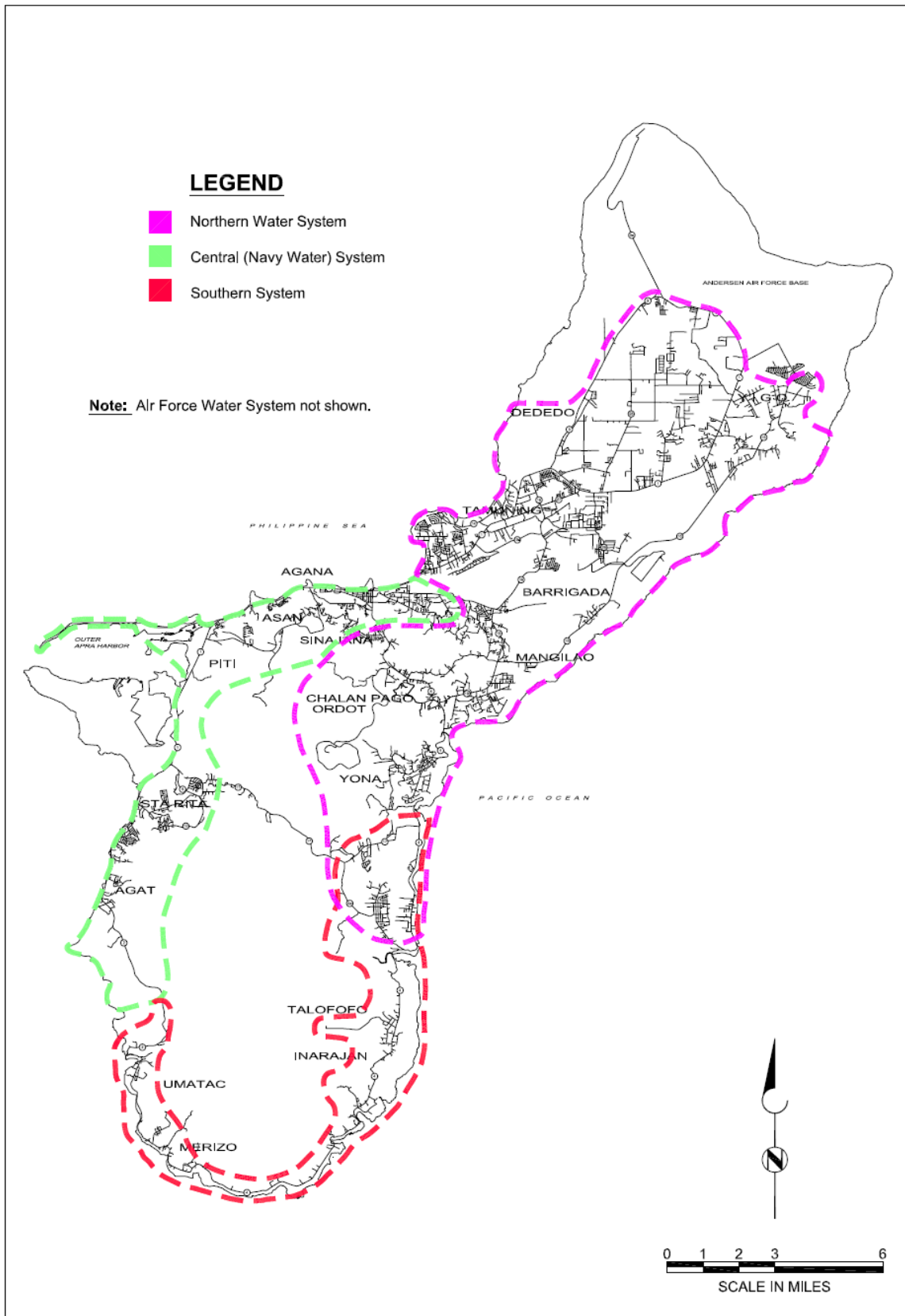
1.1.1 Northern Public Water System

The Northern Public Water System is bounded on the north by Anderson Air Force Base. It includes the remaining northern half of Guam. It extends along the east side of Guam to Route 17. It overlaps the Southern System in the area of Windward Hills along Route 4a. All wells except MJ-series are located in the northern system. Most of the wells are located north of Route 4, before it turns south.

1.1.2 Central Public Water System

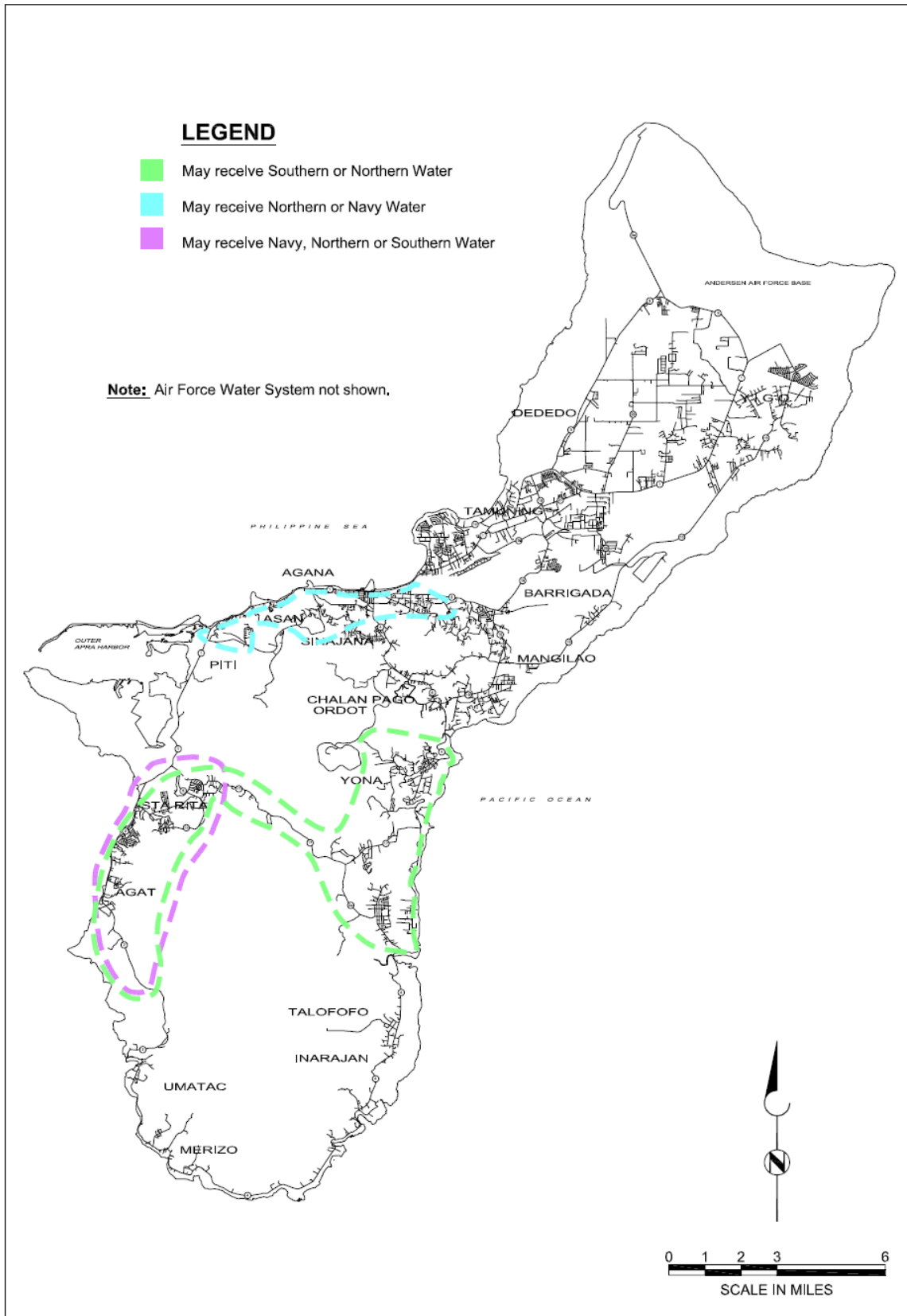
The Central Public Water System extends along the west side of Guam from Mongmong-Toto-Maite south to Agat. The system extends inland to Sinajana and roughly follows the western borders of Chalan Pago and Yona to Route 17, and then the western border of Talofofo to Agat. The main source of water for this area is the U.S. Navy’s Fena Water Treatment Plant, which is discussed below. Northern water can be fed to the Central System in the areas of Mongmong-Toto-Maite, Hatgana, Asan, Sinajana, and parts of Piti. Northern water can also be supplied to Apra Heights, Santa Rita, and Agat through water mains that run along Route 17.

Figure 1-1 – Water System Boundaries



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Figure 1-2 – Water System Overlaps



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1.1.2.1 US Navy Fena Water Treatment Plant

The US Navy operates a surface water treatment plant at Fena Reservoir along Route 5 in Santa Rita. GWA purchases water from the Navy to serve customers in the Central System. However, the water can be conveyed to customers in portions of the Northern and Southern Systems as shown in Figure 1-2.

Fena Reservoir was constructed by the US Navy in 1951 to supply its military operations on Guam. The reservoir has a 6-square mile water shed and a capacity of approximately 2.3 billion gallons (7,050 acre-feet). Fena Dam is approximately 85 feet high and 1,050 feet long. Water is pumped from the reservoir to the Fena Water Treatment Plant where the raw water is treated by coagulation, sedimentation, and filtration. The treatment plant can produce approximately 13.5 mgd.

There are 54 connections between the US Navy’s Fena Water Treatment Plant water supply and GWA’s system. Thirty-nine of these connections are active, and 15 are inactive. The active connections are shown in Table 1-2. The area served by this supply extends from the Sinifa Reservoir in Santa Rita to the Agat Reservoir along Route 2 in Northern Umatac to the Guam International Airport.

A 1956, agreement between the US Government and the Government of Guam commits 4.25 million gallons per day of Navy water. The distribution of this water is outlined in the agreement as follows:

- 0.75 mgd served from the portion of the Navy’s system south of the junction of Routes 1 and 2A;
- 2.50 mgd served from the portion of the Navy’s system north of the junction of Routes 1 and 2A; and
- 1.00 mgd from Agana Springs.

A memorandum of understanding in 1991, increased the Navy’s commitment to 4.39 mgd.

Since the original agreement, the Agana Springs system was abandoned by the Navy and rehabilitated by GWA’s predecessor, PUAG. This source now comprises wells A-29 and A-30.

Table 1-2 – Largest Connections for Supplying GWA from the Navy’s Water System

Customer Name	Route Number	Name	Line Size Connection	Volume, Gallons ¹
GWA	56	Agat Rizal Beach	2-inch	0
GWA	62	Route 5 Apra Area	2-inch	130,700
GWA	69	Agat/Santa Rita	10-inch	67,229,000
GWA	74	Route 2A Ching Hueng	2-inch	806,300
GWA	75	Orchid Taco Bell Front of Naval Station	1-1/2-inch	297,200
GWA	76	Uncle Bob Beer Garden	1-inch	2,000
GWA	81	Palai Housing	2-inch	155,200

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Table 1-2 – Largest Connections for Supplying GWA from the Navy’s Water System (continued)

Customer Name	Route Number	Name	Line Size Connection	Volume, Gallons ¹
GWA	87	Route 2 A Shell Inc	10-inch	5,130,100
GWA	91	Piti Veterans Cemetary	6-inch	11,000
GWA	92	Piti Middle School	3-inch	116,000
GWA	93	Piti GWA/GSA Warehouse	8-inch	174,000
GWA	98	GWA GORCO Fuel Tank	4-inch	1,072,000
GWA	98F	GOVGUAM GORCO Fuel Tank	8-inch	0
GWA	106	Piti Village	6- inch	6,108,100
GOVGUAM	109	NimHill Johnston Res	2-inch	787,400
GOVGUAM	110	Larson Road, Nimitz Hill	6-inch	13,209,000
GOVGUAM	114	Maina Housing	1-1/2-inch	430,800
GOVGUAM	115	Maina Housing Upper	1-1/2-inch	85,900
GOVGUAM	116	Maina Panam Housing	1-1/2-inch	2,499,400
GOVGUAM	117	Maina Housing Lower	4-inch	34,100
GWA	120	Hansen- Snake Road Adelup/Agana Hts	2-inch	967,700
GOVGUAM	124	Agana Heights Route 7	10-inch	0
GWA	125	Route 33 Mongmong Village	4-inch	0
GWA	126	GOVGUAM Agana Power Plant	2-inch	0
GWA	127	Route 8 Maite Village/Tajmahal Apartments	8-inch	17,348,000
GWA	132H/L	Old MCB1 Area High	6-inch	0
GWA	137	Route 8 Barrigada Across Mormon Church	8-inch	5,777,000
GWA	138	Barrigada Area 1	6-inch	0
GWA	154H/L	Agana Mazda Auto City	10-inch	0
GWA	155	Adelup Point	6-inch	1,104,000
GWA	156H/L	Agana Kings Auto Shop High	6-inch	0
GWA	157H/L	Agana Chamorro Village High	6-inch	0
GWA	159	Route 3 NCTS STP	3-inch	1,043,400
GWA	164	Route 3 NCTS STP Bypass	2-inch	0
GWA	169	Piti Laguas Bridge	2-inch	76,300
GWA	173	Agat School Bus Pool	2-inch	18,300
GWA	201	Asan Village	6-inch	0
GWA	222	Sinifa Area	4-inch	14,606,000
GOVGUAM	229	Port Authority Beach	1-1/2-inch	11,100
GWA	232	National Park Service	2-inch	10,600
GWA	235	Cabras Island Master/Commercial Port	10-inch	22,426,000

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Table 1-2 – Largest Connections for Supplying GWA from the Navy’s Water System (continued)

Customer Name	Route Number	Name	Line Size Connection	Volume, Gallons ¹
GWA	236	Cabras Island Bypass/Commercial Port	8-inch	0
GOVGUAM	284	Osir Yacht Club	2-inch	8,400
GOVGUAM	285	Rt. 3 GOVGUAM Supply	8-inch	-0
--	309	NAVACTS GTA Tel Exchange	1-inch	0
--	311	Tiyan #1 Old Main Gate	10-inch	0
GWA	315	Micronesia Hotel Route 8	6-inch that feeds a 12-inch line	8,202,000
Inactive	351	Tiyan #2 New Main Gate	12-inch	0
Inactive	353	Tiyan #3 Fury Road	16-inch	0
GWA	356	Tiyan #4 Security Road AUW Area	16-inch	0
GOVGUAM	365	GWA USDA Plantation	2-inch	0
GWA	367	Two Lovers Point	2-inch	88,000
GWA	398	Route 2A Sewer Plant Master	8-inch	0
GWA	399	Route 2A Sewer Plant Bypass	4-inch	0
GWA	427	Piti GSA	2-inch	7,800
GWA	458	2000 Liberation Day Carnival	Unknown	0
--	462	Harbor of Refuge	Unknown	0
GWA	477	Murray Road Nimitz Hill	Unknown	300
GWA	479	Murray Road Nimitz Hill	Unknown	0
NFM	480	QA Spruance Drive Nimitz Hill	Unknown	0
Total				169,973,100

¹. Period from December 20, 2005 through January 19, 2006

1.1.3 Southern Public Water System

The Southern Public Water System roughly extends south of Route 17, around the southern tip of Guam to Umatac. Southern water can also be supplied to parts of Yona and Chalan Pago in the Northern System, as well as Santa Rita and Agat in the Central System. There are five water sources that serve the southern system: Ugum Water Treatment Plant; Malojloj Wells; Aalatgue (Laelae) Spring; Geus Spring, and Siligan Spring. The sources are described in the following sections.

1.1.3.1 Ugum Water Treatment Plant

The Ugum Water Treatment Plant draws and treats raw water from the Ugum River for use in the Southern Public Water System. The plant generally supplies potable water south along Route 4, terminating at the Umatac-Agat Reservoir along Route 2. The plant can provide water north to the Windward Hills area through the operation of the pressure reducing valves near the intersection of Routes 4 and 17, but this area is normally supplied from the Northern Public Water System wells.

1.1.3.2 Malojloj Wells

These two wells are located along Route 4 in Northern Inarajan. The wells have very low production and are not currently in service for providing potable water.

1.1.3.3 Laelae Spring

Laelae Spring is located in the southern part of Umatac and is inactive.

1.1.3.4 Geus Spring

Geus Spring is located in Merizo and is inactive.

1.1.3.5 Siligan Spring

Siligan Spring is located in Merizo and is inactive.

1.2 GWA Water Sources

The sources of water supply include wells, springs, and surface water. This section describes each of these sources:

1.2.1 Wells

The GWA wells are identified by a geographical classification system. In the classification system, one or more capital letters, followed by a number refers to the general geographical location and the order of drilling. A summary of the geographical locations is provided below. All wells except the two wells with “MJ” designations are located in the Northern Public Water Supply System.

- The “A” series wells are located in the Agana region and extend from the Adelup-Pago contact to Barrigada.
- The “M” series wells extend from the Naval Communications Station in Barrigada to Dededo-Yigo.
- The “D” series wells run north from the village of Dededo along Y-Sengsong Road. They are part of the Northern Public Water System. Four of these wells are owned and operated by Earth Tech, from which GWA purchases water.
- The “Y” series wells are in the Yigo area. Two of these wells are owned and operated by Earth Tech, from which GWA purchases water.
- The “F”, “H”, and “AG” series wells are located in the Finegayan, Harman Village, and Machananao (Agafa Gumás) areas, respectively. Four of the Y-series wells are owned and operated by Earth Tech, from which GWA purchases water.
- The two “MJ” wells are in the Malojloj area and are the only two wells located in the Southern Public Water System.

A list of the GWA wells is provided in Table 1-3. The location of GWA wells is shown in Figure 1-3.

Discharge piping and controls for the wells are essentially the same. There are differences in configuration required to fit each specific site. Multi-stage submersible pumps are used to pump from the well into the distribution system.

Each well site consists of the well, the well head, an air relief valve, a check valve, a bypass line with valve, and a flow meter. A typical well site is shown in Figure 1-4. During start-up the valve on the bypass line opens and the pump to the ground on a timed basis. The purpose of this is to minimize the head on the pump and motor during start-up, and to minimize the discharge of excessive sediment (turbidity) into the distribution system. After a pre-set time, the bypass line valve closes and the well discharge enters the distribution system. The automatic feature of the bypass valve is not operational, so well pumps are started and controlled manually.

Buildings on the well site are used to house the emergency generator and in most cases, chlorination facilities. The buildings are owned either by Guam Power Authority (GPA), GWA, or others, depending on generator ownership. Table 1-3 shows generator ownership for each well. Recently, GWA has begun contracting with GPA for generator maintenance. GWA provides the parts, and GWA provides the labor. Electrical issues associated with power and the emergency generators are discussed in more detail in Volume 1, Chapter 12 – Electrical Assessment.

Most well sites are equipped with chlorination facilities in order to meet the requirements of the Safe Drinking Water Act (SDWA) and its amendments. Except for three wells (A-8, F-8, and NAS-01) which have granular activated carbon for organic contaminant removal, chlorination is the sole means of treatment for the Northern System drinking water. Table 1-3 shows the type of treatment, if provided, at each well site.

The chlorination system typically includes a chlorine scale for two 150-pound containers of chlorine, a cylinder-mounted chlorinator, and an injection pump. Three well sites, D-12, M-8, and M-12, use direct injection of chlorine rather than a pump. Chlorine cylinders have been removed from those sites that are out-of-service. In the case where chlorine leak detection systems are located at facilities, they are typically inoperable. Figure 1-5 shows a typical indoor chlorination system installation at a well site. Though most systems are located indoors, some are located out-of-doors as shown in Figure 1-6.

Figure 1-4 – Typical Well Site

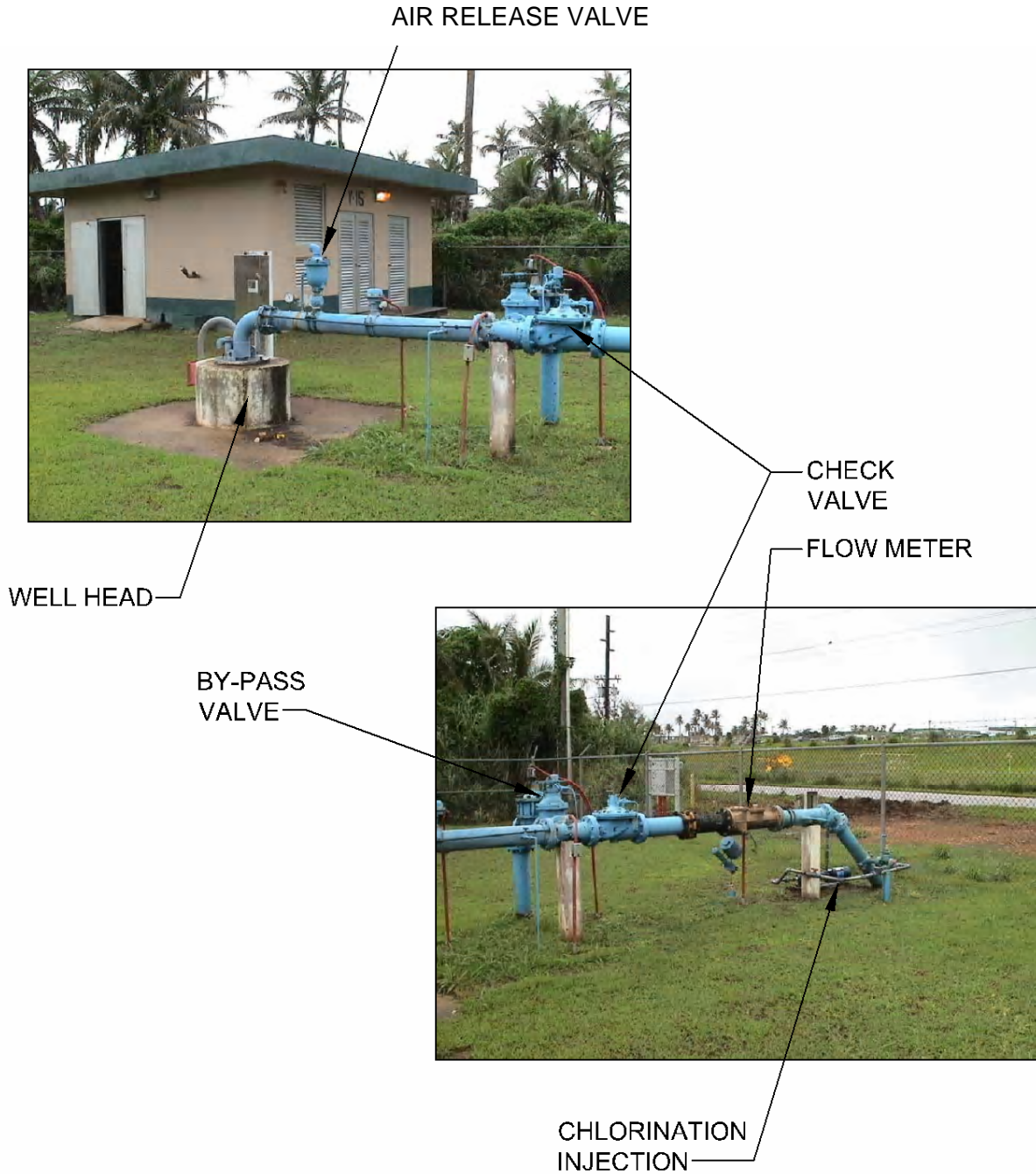


Figure 1-5 – Typical Well Indoor Chlorination System Installation



Figure 1-6 – Outdoor Chlorination System Installation



Table 1-3 – GWA Wells

Name	Municipality	EPA Permit, gpm	30-Day Average gpm ¹	Emergency Generators	Treatment ²	Comments
Northern System						
A-01	Chalan Pago-Ordot	216	298	GPA	Chlorination	Active
A-02	Chalan Pago-Ordot	241	252	GPA	None	Active
A-03	Chalan Pago-Ordot	180	301	GPA	Chlorination	Active
A-04	Chalan Pago-Ordot	244	310	GPA	Chlorination	Active
A-05	Sinajana	269	250	GPA	Chlorination ^{3,4}	Active
A-06	Sinajana	241	306	GPA	Chlorination ³	Active
A-07	Chalan Pago-Ordot	113	0	GPA	None	Inactive
A-08	Chalan Pago-Ordot	206	246	GPA	Chlorination/GAC	Active
A-09	Mangilao	230	314	GPA	Chlorination ³	Active
A-10	Mangilao	233	303	GPA	Chlorination ³	Active
A-12	Chalan Pago-Ordot	235	208	GPA	Chlorination ³	Active
A-13	Mangilao	237	313	GPA	Chlorination ³	Active
A-14	Mangilao	147	306	GPA	Chlorination	Active
A-15	Barrigada	231	310	GPA	Chlorination ³	Active
A-17	Mangilao	180	269	GPA	Chlorination	Active
A-18	Mangilao	229	308	GPA	Chlorination	Active
A-19	Mangilao	138	195	GPA	Chlorination	Active
A-21	Mangilao	213	283	GPA	Chlorination ³	Active
A-23	Agana	317	359	GPA	Chlorination ³	Active
A-25	Agana	245	350	GPA	Chlorination ³	Active
A-26	Mongmong-Toto-Maite	50	0	GPA	None	Inactive
A-28	Barrigada	223	0	GPA	Chlorination	Secured
A-29	Sinajana	403	0	GPA	None	Secured
A-30	Sinajana	755	812	GWA	Chlorination ³	Active
A-31	Agana Heights	293	354	GPA	Chlorination ³	Active
A-32	Agana Heights	173	0	GPA	Chlorination	Secured
AG-01	Yigo	173	0	GPA	Chlorination ³	Secured
AG-02	Yigo	480	600	GWA	Chlorination	Active
D-01	Dededo	257	130	None	Chlorination	Active
D-02	Dededo	187	0	GPA	Chlorination	Secured
D-03	Dededo	149	0	GPA	None	Inactive
D-04	Dededo	172	290	GPA	Chlorination	Active
D-05	Dededo	166	158	GPA	None	Active

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Table 1-3 – GWA Wells (continued)

Name	Municipality	EPA Permit, gpm	30-day Average gpm ¹	Emergency Generators	Other Treatment	Comments
D-06	Dededo	189	285	GPA	Chlorination	Active
D-07	Dededo	198	237	GPA	Chlorination	Active
D-08	Dededo	185	5	GPA	Chlorination	Active
D-09	Dededo	196	258	GPA	Chlorination	Active
D-10	Dededo	351	240	GPA	Chlorination	Active
D-11	Dededo	226	248	GPA	Chlorination	Active
D-12	Dededo	188	198	GPA	Chlorination	Active
D-13	Dededo	200	5	GPA	Chlorination	Active
D-14	Dededo	200	268	GPA	Chlorination	Active
D-15	Dededo	202	261	GPA	Chlorination	Active
D-16	Dededo	161	238	GPA	Chlorination	Active
D-17	Dededo	161	0	GPA	None	Inactive
D-18	Dededo	180	0	None	None	Inactive
D-19	Dededo	227	220	GPA	Chlorination	Active
D-20	Dededo	207	217	GPA	Chlorination	Active
D-21	Dededo	157	231	GPA	Chlorination	Active
D-22	Dededo	200	198	GPA	Chlorination	Active
D-23	Dededo	0	0	None	None	Inactive
D-24	Dededo	180	0	GPA	None	Inactive
D-25	Dededo	400	No Data	Earth Tech	Chlorination	Earth Tech Well
D-26	Dededo	200	No Data	Earth Tech	Chlorination	Earth Tech Well
D-27	Dededo	400	No Data	Earth Tech	Chlorination	Earth Tech Well
D-28	Dededo	200	No Data	Earth Tech	Chlorination	Earth Tech Well
EX-05A	Dededo	254	323	GPA	Chlorination	Active
EX-11	Barrigada	210	214	GPA	Chlorination	Active
F-01	Dededo	140	174	GPA	Chlorination	Active
F-02	Dededo	121	191	GPA	Chlorination ³	Active
F-03	Dededo	142	158	GPA	Chlorination	Active
F-04	Dededo	137	164	GPA	Chlorination	Active
F-05	Dededo	145	189	GPA	Chlorination	Inactive
F-06	Dededo	151	225	GPA	Chlorination	Active
F-07	Dededo	170	5	GPA	Chlorination	Active
F-08	Dededo	149	0	GPA	GAC	Secured
F-09	Dededo	140	200	GPA	Chlorination	Active
F-10	Dededo	142	229	GPA	Chlorination ³	Active

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Table 1-3 – GWA Wells (continued)

Name	Municipality	EPA Permit, gpm	30-day Average gpm ¹	Emergency Generators	Treatment	Comments
F-11	Dededo	142	194	GPA	Chlorination ³	Active
F-12	Dededo	148	204	GPA	Chlorination	Active
F-13	Dededo	380	5	GWA	Chlorination	Active
F-15	Dededo	440	221	GWA	Chlorination ³	Active
F-16	Dededo	230	359	GWA	Chlorination	Active
F-17	Dededo	240	222	GWA	Chlorination ³	Active
F-18	Dededo	240	356	GWA	Chlorination	Active
F-19	Dededo	200	No Data	Earth Tech	Chlorination	Earth Tech Well
F-20	Dededo	200	No Data	Earth Tech	Chlorination	Earth Tech Well
G-501	Dededo	183	148	GPA	Chlorination	Active
H-01	Tumon	288	299	GPA	Chlorination	Active
HGC-02	Dededo	444	585	None	Chlorination	Active
M-01	Barrigada	109	249	GPA	Chlorination	Active
M-02	Barrigada	184	199	GPA	Chlorination	Active
M-03	Barrigada	177	226	GPA	Chlorination	Active
M-04	Barrigada	138	149	GPA	Chlorination ³	Active
M-05	Barrigada	176	226	GPA	Chlorination	Active
M-06	Barrigada	168	238	GPA	Chlorination	Active
M-07	Dededo	175	250	GPA	Chlorination	Active
M-08	Barrigada	158	224	GPA	Chlorination ³	Active
M-09	Barrigada	162	5	GPA	Chlorination	Active
M-12	Dededo	104	0	GPA	Chlorination	Inactive
M-14	Dededo	239	0	GPA	Chlorination	Secured
M-15	Dededo	172	258	GPA	Chlorination	Active
M-17A	Barrigada	202	0	GPA	None	Inactive
M-17B	Barrigada	153	306	GPA	Chlorination	Active
M-18	Barrigada	325	307	GPA	Chlorination	Active
M-20A	Barrigada	400	300	GPA	Chlorination	Active
M-21	Airport Road DW	250	5	GIAA	Chlorination	Active
M-23	Barrigada	225	264	None	Chlorination	Active
NAS-01	Tiyan	200	0	None	Chlorination/GAC	Secured
Y-01	Yigo	141	168	GPA	Chlorination	Active
Y-02	Yigo	161	240	GPA	Chlorination ³	Active
Y-03	Yigo	138	227	GPA	Chlorination ³	Active
Y-04A	Yigo	220	0	GPA	None	Inactive

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Table 1-3 – GWA Wells (continued)

Name	Municipality	EPA Permit, gpm	30-day Average gpm ¹	Emergency Generators	Treatment	Comments
Y-05	Yigo	148	159	GPA	Chlorination ³	Active
Y-06	Yigo	136	251	GPA	Chlorination ³	Active
Y-07	Yigo	514	0	GPA	None	Inactive
Y-09	Yigo	472	401	GPA	Chlorination ³	Active
Y-10	Yigo	250	279	GWA	Chlorination	Inactive
Y-12	Yigo	235	313	GWA	Chlorination	Active
Y-14	Yigo	400	0	GWA (Vandalized)	None	Inactive
Y-15	Yigo	600	522	GWA	Chlorination ³	Active
Y-16	Yigo	250	328	GWA	Chlorination	Active
Y-17	Yigo	350	336	GWA	Chlorination ³	Active
Y-18	Yigo	250	No Data	Earth Tech	Chlorination	Earth Tech Well
Y-19	Yigo	500	No Data	Earth Tech	Chlorination	Earth Tech Well
Y-20	Dededo	500	No Data	Earth Tech	Chlorination	Earth Tech Well
Y-21	Yigo	350	238	GWA	Chlorination	Active
Y-22	Dededo	300	No Data	Earth Tech	Chlorination	Earth Tech Well
Y-23	Yigo	380	323	GWA	Chlorination	Active
Central System						
None	--	--	--	--	--	--
Southern System						
MJ-01	Malojloj	56	0	GPA	None	Secured
MJ-05	Malojloj	58	0	None	None	Secured

1. From February 2006, Deepwell Production Report
2. Treatment consists of chlorination, granular activated carbon (GAC), or none.
3. These facilities have automatic switchover chlorination systems. The remaining facilities have single chlorinator systems.
4. Chlorination is by direct injection due to insufficient contact time before the first residence.
5. Defective water meter

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1.2.2 Springs

There are five springs that are serving or have served as sources in the southern system. All springs except Asan and Santa Rita Springs are located in the Central System. All other springs are located in the Southern System. Only Santa Rita Spring is providing potable water currently. A list of the springs is provided in Table 1-4. The location of GWA springs is shown in Figure 1-7.

Table 1-4 – GWA Springs

Spring	Location	Production, gpm	Area/System Served	Status
Asan Spring	Asan	298	Asan, Piti	Inactive
Santa Rita	Santa Rita	165	Santa Rita Reservoir	Active
Laelae	Umatac	37	Umatac	Inactive
Siligin	Merizo	10	Merizo	Inactive
Geus	Merizo	53	Merizo	Inactive

1.2.3 Surface Water

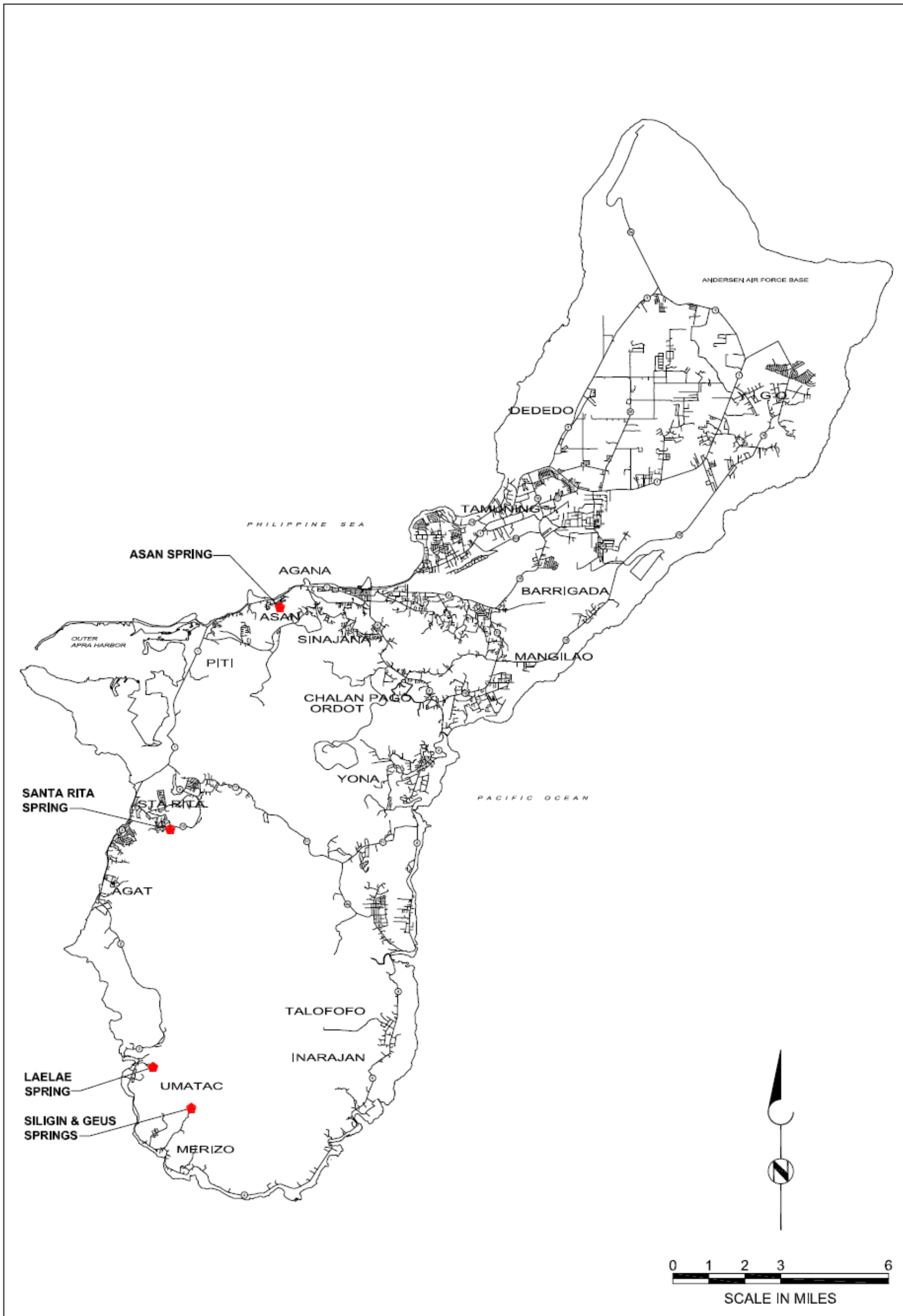
Two surface water treatment plants provide water to customers in GWA’s service area. The U.S. Navy’s Fena Water Treatment Plant serves customers in the Central System and was discussed in Section 1.2.2.1. The Ugum Water Treatment Plant (WTP) serves customers in the Southern System and is discussed below.

The Ugum WTP is the major source of water supply for the Southern Public Water System and the only surface water treatment plant owned and operated by GWA. The plant draws raw water from the Ugum River near its confluence with the Talofofu River. Withdrawal is contingent upon maintaining minimum stream flows to support aquatic life. The minimum stream flows are 1.3 mgd (2 cubic feet per second) during the dry season and 4.5 mgd (7 cubic feet per second) during the wet season.

The Ugum Watershed covers an area of approximately 19 square kilometers (7.3 square miles). The Ugum Watershed includes the Bubulao and Ugum River systems and their tributaries, and stretches from the top of Mount Bolanos to the mouth of the Ugum River where it meets the Talofofu River about 0.8 kilometer from the coast (Ugum Watershed Best Management Practices, Demonstration Project, March 1998).

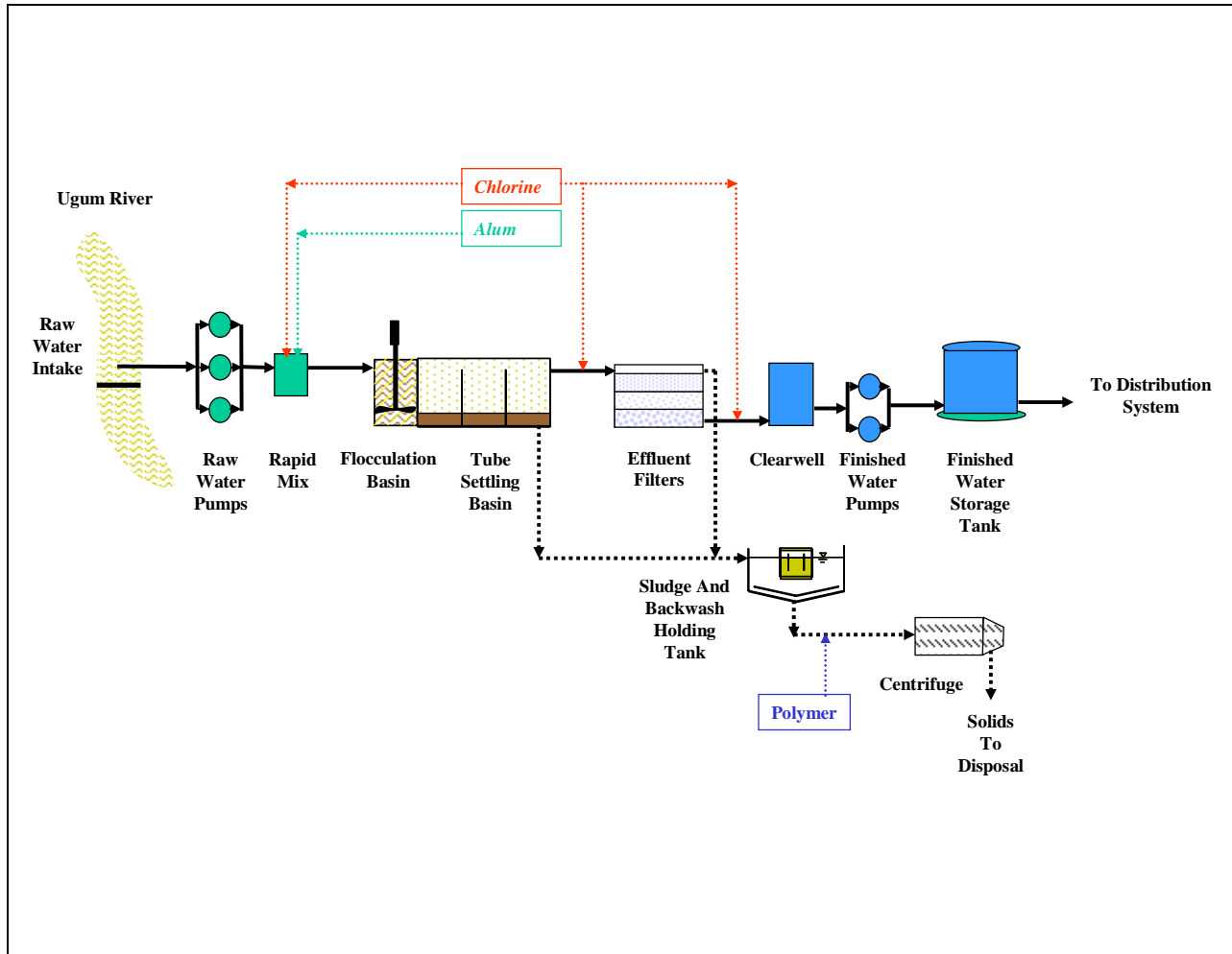
A diversion was created in the Ugum River in 1992 to provide a shallow pool from which the Ugum WTP can draw up a 2 million gallon per day drinking water source from runoff and spring discharge from the watershed. The Ugum WTP was constructed near the near the diversion site and was designed to process 4 million gallons of water per day. The surface water treatment plant’s treatment processes include chemical coagulation, sedimentation, filtration, and disinfection. A process schematic is shown in Figure 1-8. Design data are presented in Table 1-5.

Figure 1-7 – GWA Spring Locations



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Figure 1-8 – Ugum Water Treatment Plant Process Schematic



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Table 1-5 – Ugum Water Treatment Plant Design Data

Unit Process	Design Data
Flow	Average daily, mgd 4.0
	Peak daily, mgd 6.0
Raw Water Intake	Capacity, mgd 2.0
Raw Water Pumping Station	Pumps 3
	Capacity, gpm each 1,800
Rapid Mix	Type In-line mechanical mixer
	Coagulant Alum
Flocculation Basins	Number 4
	Type Two-stage mechanical
	Dimensions
	Length, feet 12.0
	Width, feet 12.0
Depth, feet 9.8	
Sedimentation Basins	Number 4
	Type Rectangular with 60° Tube Settlers
	Basin Dimensions
	Length, feet 45.0
	Width, feet 12.0
	Depth, feet 11.7
	Tube Settler Dimensions
	Length, feet 30.0
Width, feet 12.0	
Depth, feet 11.7	
Filters	Number 4
	Type Dual media (anthracite and silica sand) rapid gravity
	Dimensions
	Length, feet 13.0
Width, feet 13.0	
Clearwell	Number 1
	Minimum Operating Depth, feet 5.1
	Maximum Operating Depth, feet 9.0
	Dimensions
	Length, feet 33.0
Width, feet 17.0	
Disinfection	Disinfectant Elemental chlorine
	Application Points Raw water, settled water, filtered water
Finished Water Storage	Minimum Operating Volume, MG 1.0
	Maximum Operating Volume, MG 2.0

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In 2001, a Comprehensive Performance Evaluation (CPE) was conducted for the Ugum Water Treatment Plant (*Comprehensive Performance Evaluation of the Ugum Water Treatment Plant*, Belanger & Associates, May 2001). The CPE is a methodology developed by the USEPA for assessing performance of water and wastewater treatment facilities. The evaluation identified administration, staffing, financial, design, and operation and maintenance limitations for optimum performance.

Performance standards for the Ugum WTP include:

- Settled water turbidity of less than 2 NTU, 95% of the time;
- Individual filter turbidity less than 0.1 NTU, 95% of the time, excluding 15-minute period immediately following filter backwash;
- Individual filter turbidity less than 0.3 NTU for 15-minute period immediately following filter backwash; and
- Disinfectant concentration-Contact time (CT) values to meet primary drinking water standards for microorganisms (outlined in Chapter 2 – Water Regulatory Issues).

A key finding in the evaluation was the inability of the Ugum WTP to respond to and treat high turbidity source water from the Ugum River. Data showed that raw water turbidity ranged as high as 76 NTU as a result of rainfall and erosion in the watershed. The 95th percentile for settled water turbidity was 4.2 NTU, and the 95th percentile for filter water was 1.2 NTU. An operating policy prior to the CPE was to “secure the plant when raw water turbidity exceeds to NTU.” In other words, water treatment was suspended. From January through December 2000, water treatment was suspended on 26 different occasions.

From 2000 through 2002, several violations of the surface water treatment rules occurred. In late 2003, polymer addition was initiated to supplement alum coagulation. Since that time, the Ugum WTP has not been “secured” due to variable raw water turbidity and has consistently met regulatory requirements.

Key design limitations that were identified during the CPE include:

- Siltation occurs in intake structure and transfer pipe
- Lack of pre-sedimentation basin to remove readily settleable silt in the treatment plant before coagulation and sedimentation
- Interruption of disinfection due to lack of automatic chlorine container switchover
- Discharge of recycle flows downstream of coagulation when process is in operation
- Integrated operation of flocculation and sedimentation basins
- Poor instrumentation for turbidity and chlorine residual
- Lack of redundant coagulant feed equipment
- Lack of alarm system for high raw water turbidity, filtered water turbidity, or low chlorine residual
- Inadequate laboratory space.

A capacity assessment was also performed as part of the CPE. Table 1-6 shows the capacity of each unit process with all treatment trains in service and with only three treatment trains in service. One of the filters is off-line due to structural damage caused by an earthquake.

Table 1-6 – 2001 Comprehensive Performance Evaluation Capacity Assessment

Unit Process	Capacity with 3 of 4 trains in service, mgd	Capacity with 4 of 4 trains in service, mgd
Flocculation	5.89	7.86
Sedimentation	2.59	3.45
Filtration	2.92	3.89
Pre- and Post-Disinfection	15.02	16.52
Post-Disinfection	10.51	10.51

Despite the limiting factors identified in the CPE, plant performance has improved tremendously since 2002, when coagulation chemicals were placed in use on a more consistent basis. The Ugum WTP has not failed to meet surface water treatment rules pertaining to water quality since this time, though there have been some administrative violations. Chapter 2 - Water Regulatory Issues, section 2-2 discusses regulatory compliance.

The Ugum WTP is scheduled to be converted from a dual media filtration plant to a membrane filter plant by the end of 2006.

1.3 Transmission and Distribution

The GWA distribution system is a collection of legacy systems beginning with the first Navy installations prior to the Second World War, some changes during the Japanese invasion, and further installations after Guam’s liberation, during and after the war. The constructed distribution systems were turned over to the Government of Guam to operate for the civilian population.

GWA’s water system network does not have a separate water transmission system that conveys water to storage and then from storage through the distribution system. Transmission and distribution are combined into a common network at GWA. Water supply sources feed the same pipes to which service connections are made. The installed system provides severe challenges to GWA in attempting to meet the SDWA disinfection requirements because some of the customer connections are adjacent to the wells. This shortcoming is one of the high priority CIP projects that must be pursued by GWA to enhance the integrity and reliability of its potable water system.

The main water distribution/transmission pipes roughly follow the major transportation routes around the island. Parallel lines run the length of Route 15, most of Route 1, and Route 16 to serve the most populated areas in the northern and central systems. At the intersection of Routes 4 and 17, where the southern system begins, a single transmission/distribution line extends south around the island to its terminus in Umatac.

The island water system is highly integrated. Valve boxes and pressure reducing valves are used to ensure water supply reaches customers throughout the island. The southern system is the most vulnerable to water loss. Historical failures of the Ugum Water Treatment Plant have resulted in significant water shortages in the southern system. Though water from the well fields in the northern and central systems can serve the southern system, demand and loss limits this capability.

A summary of piping material associated with GWA’s distribution system is presented in Tables 1-7, 1-8, and 1-9. NOTE: The quantities presented in these tables have discrepancies that are being addressed currently, and might change in the final WRMP.

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Table 1-7 – Distribution Piping Material, Age, and Length by Village

Village	Pipe Material	Pipe Age, years	Pipe Length, feet
Agat	Asbestos Concrete	21 – 30	105
		Unknown	3,290
	Cast Iron	11 – 20	241
	Ductile Iron	6 – 10	2,124
		11 - 20	5,204
	Polyvinyl Chloride	0 – 5	642
		6 – 10	5,901
11 – 20		48,314	
21 – 30		1,202	
Unknown		14,121	
Unknown	31 - 40	22	
Asan	Ductile Iron	21 – 30	305
	Polyvinyl Chloride	11 – 20	20,511
		21 – 30	9,743
		31 – 40	1,058
Unknown		1,410	
Barrigada	Cast Iron	21 – 30	8,389
		Unknown	2,199
	Ductile Iron	21 – 30	218
		Polyvinyl Chloride	6 – 10
	11 – 20		9,100
	21 – 30		24,149
31 – 40	15,805		
Unknown	12,678		
Chalan Pago-Ordot	Cast Iron	11 – 20	7
		21 – 30	4,956
		Unknown	1,018
	Ductile Iron	11 – 20	824
		Unknown	3,807
	Poly Vinyl Chloride	11 – 20	5,714
		21 – 30	7,150
31 – 40		13,063	
Unknown		3,487	
Dededo	Asbestos Concrete	21 – 30	4,006
	Cast Iron	21 – 30	4,612
		40+	12,857
		Unknown	9,047
	Ductile Iron	6 – 10	80
		11 – 20	1,190
		21 – 30	544
	Polyvinyl Chloride	0 – 5	207
		6 – 10	18,559
		11 – 20	109,217
21 – 30		68,477	
31 – 40		12,454	
40+		5,655	
Unknown		55,234	
Unknown	21 - 30	710	

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Table 1-7 – Distribution Piping Material, Age, and Length by Village (continued)

Village	Pipe Material	Pipe Age, years	Pipe Length, feet	
Hagatna	Cast Iron	21 – 30	13,517	
		11 – 20	2,536	
	Polyvinyl Chloride	11 -20	15,225	
		21 – 30	2,571	
		31 – 40	6,597	
	Unknown	26,157		
Inarajan	Asbestos Concrete	21 – 30	31,334	
		31 – 40	2,877	
	Cast Iron	21 – 30	12	
		Polyvinyl Chloride	11 – 20	47,333
			21 – 30	32,041
	31 – 40	3,556		
	Unknown	3,694		
Mangilao	Asbestos Concrete	21 - 30	5,893	
		Unknown	35	
	Cast Iron	Unknown	377	
		Ductile Iron	11 – 20	5,498
	21 – 30		1,230	
Polyvinyl Chloride	0 – 5		155	
	6 – 10	54		
	11 – 20	80,390		
	21 – 30	24,576		
	31 – 40	37,289		
	Unknown	16,143		
Merizo	Polyvinyl Chloride	21 – 30	1,465	
		31 - 40	355	
Mongmong-Toto-Maite	Asbestos Concrete	31 – 40	3,196	
		Cast Iron	21 – 30	41,969
			Unknown	227
	Polyvinyl Chloride	11 – 20	1,193	
		21 – 30	37,920	
31 – 40		4,170		
	Unknown	17,343		
Piti	Polyvinyl Chloride	11 – 20	8,504	
		21 – 30	2,724	
		31 – 40	13,778	
		Unknown	17,583	
Santa Rita	Cast Iron	40+	1,940	
		Unknown	38	
	Ductile Iron	11 -20	823	
		Polyvinyl Chloride	6 – 10	1,977
			11 – 20	37,068
		21 – 30	8,850	
	31 – 40	4,285		
	Unknown	5,525		
Unknown	Unknown	21 – 30	1,627	
		31 - 40	971	

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Table 1-7 – Distribution Piping Material, Age, and Length by Village (continued)

Village	Pipe Material	Pipe Age, years	Pipe Length, feet
Sinajana	Asbestos Concrete	31 – 40	5,133
	Cast Iron	21 – 30	145
	Polyvinyl Chloride	21 – 30	305
		31 – 40	508
Unknown		7,930	
Talofofo	Asbestos Concrete	11 – 20	1,883
		Unknown	247
	Cast Iron	40+	0
	Polyvinyl Chloride	0 – 5	1,249
		6 – 10	2,037
		11 – 20	29,123
		31 – 40	1,343
Unknown		5,660	
Tamuning	Cast Iron	11 – 20	1,646
		40+	9,305
	Ductile Iron	11 – 20	10,616
		Unknown	4,409
	Polyvinyl Chloride	6 – 10	1,584
		11 – 20	28,378
		21 – 30	9,555
		31 – 40	6,705
		40+	2,332
		Unknown	23,716
Umatac	Asbestos Cement	21 – 30	2,169
	Ductile Iron	11 – 20	161
		21 – 30	166
	Polyvinyl Chloride	21 – 30	546
		31 – 40	3,805
Unknown		14,034	
Yigo	Cast Iron	11 – 20	677
		21 – 30	2,654
	Ductile Iron	6 – 10	1,477
		11 – 20	16,513
		Polyvinyl Chloride	0 – 5
	6 – 10		75,121
	11 -20		128,949
	21 – 30		32,644
	31 – 40		36,835
	Unknown	63,149	
Unknown	21 - 30	2,777	

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Table 1-7 – Distribution Piping Material, Age, and Length by Village (continued)

Village	Pipe Material	Pipe Age, years	Pipe Length, feet
Yona	Cast Iron	21 – 30	226
		6 – 10	281
	Ductile Iron	11 – 20	1,286
		Unknown	8,480
	Polyvinyl Chloride	0 – 5	2,389
		6 – 10	427
		11 – 20	31,082
		21 – 30	23,693
		31 – 40	14,824
		Unknown	84,621
Unknown	Asbestos Concrete	21 – 30	189
	Cast Iron	21 – 30	383
		Unknown	26
	Ductile Iron	11 – 20	3,805
	Polyvinyl Chloride	6 - 10	67
		11 - 20	51,757
		21 – 30	3,598
		31 – 40	347
		Unknown	317,331
	Wood	6 – 10	9
	Unknown	6 – 10	7,429
		11 – 20	600
21 – 30		6,067	
31 – 40		4,469	

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Table 1-8 – Water Distribution Pipe Type and Length

Village	Pipe Length, feet				
	Asbestos Concrete	Cast Iron	Ductile Iron	Polyvinyl Chloride	Unknown
Agat	3,395	241	7,328	70,181	22
Asan	0	0	305	32,721	0
Barrigada	0	10,588	218	61,773	0
Chalan Pago-Ordot	0	5,981	4,631	29,413	0
Dededo	4,006	26,516	1,814	269,803	710
Hagatna	0	13,517	2,536	50,550	0
Inarajan	34,210	12	0	86,623	5,893
Mangilao	35	377	6,727	158,608	0
Merizo	0	0	0	1,820	0
Mongmong-Toto-Maite	3,196	42,196	0	60,626	0
Piti	0	0	0	42,589	0
Santa Rita	0	1,978	823	57,705	2,598
Sinajana	5,133	145	0	8,743	0
Talofofu	2,130	0	0	39,411	0
Tamuning	0	10,951	15,025	72,269	0
Umatac	2,169	0	327	18,385	0
Yigo	0	3,331	17,989	346,573	2,777
Yona	0	226	10,048	157,035	0
Unknown	189	409	3,805	373,099	18,566
Total	54,463	116,468	71,576	1,937,927	30,566

Table 1-9 – Water Distribution Pipe Length by Diameter

Village	Pipe Length, feet										
	<=2	4	6	8	10	12	14	16	18	20	24
Agat	31	0	32,622	12,874	105	13,720	0	21,814	0	0	0
Asan	0	0	7,585	2,984	0	10,484	329	3,307	0	8,338	0
Barrigada	23	0	26,274	6,407	5,635	6,324	63	16,850	2,069	6,862	2,072
Chalan Pago-Ordot	37	232	9,135	2,784	6	20,093	0	7,739	0	0	0
Dededo	5,755	4,747	118,962	52,392	8,551	88,847	13,747	7,442	0	41	2,362
Hagatna	727	0	18,018	18,323	5	15,147	0	3,459	5,532	5,392	0
Inarajan	311	6	24,617	32,527	2,111	64,348	0	2,819	0	0	0
Mangilao	47	0	20,087	17,743	0	67,522	0	39,579	20,586	0	0
Merizo	4	0	1,465	22	0	329	0	0	0	0	0
Mongmong-Toto-Maite	0	91	25,536	23,857	16,630	32,178	0	4,827	2,039	0	0
Piti	8	1	13,450	61	0	9,294	0	19,775	0	0	0
Santa Rita	594	59	19,945	12,220	0	23,088	0	5,277	0	0	1,922
Sinajana	0	1,915	7,678	4,122	0	307	0	0	0	0	0
Talofofo	17	5,200	26,966	4,822	0	4,269	0	82	184	0	0
Tamuning	0	0	24,031	8,872	490	22,352	14,663	4,456	7,856	4,435	11,090
Umatac	0	11	12,685	2,128	8	6,049	0	0	0	0	0
Yigo	4,265	0	150,957	52,138	0	139,726	0	17,402	0	6,184	0
Yona	17	61	30,095	11,972	0	92,640	0	32,525	0	0	0
Unknown	10,675	275	25,213	9,719	42	326,684	0	23,121	338	11	0
Total	22,511	12,602	595,327	275,975	33,593	943,413	28,816	210,490	38,622	31,283	17,470

1.4 Water Booster Pumping Stations

There are 36 water booster pumping stations. These booster stations are listed in Table 1-10 and shown in Figure 1-9. The water booster pumping stations help maintain in-line pressure, fill reservoirs, and serve small communities where a reservoir is not available.

Many of the booster stations have diesel-powered, emergency generators on-site. Most of the emergency generators are the responsibility of Guam Power Authority (GPA), but some are operated and maintained by GWA. Generators operated by GPA have outside diesel fuel storage, whereas those operated by GWA have inside diesel storage.

Table 1-10 – GWA Water Booster Pumping Stations

Name	Water Source	Capacity				Areas Served
		Qty Pumps	Capacity per pump, gpm	HP	TDH, feet	
Northern System						
Hyundai Booster	M- and D-Series Wells	2	600	50	260	Barrigada Reservoir #1
Chalan Palauan Booster (Same as Astumbo Booster)	Astumbo 1.0 M.G. Reservoir	1	5	1.5		Chalan Palauan Area
Gayinero Booster	Y-series wells	2	350	15	120	Boost water through a 12-inch waterline to 1.0 M.G. Santa Rosa Reservoir
Latte Heights Booster	Barrigada #1 and #2 Reservoirs	3	550	15	60	Mangilao #1 and #2 Reservoirs
Mataguac Booster (New)	Y-Series Wells	3	300	25	210	Chalan Maanao to upper portion of Wusstig area
Mataguac Booster (Old)	Out-of-Service	--	--	--	--	--
Northern Treatment Plant Booster	Well H-1 (Harmon)	1	25	15		Northern WWTP and NCS Beach
Santa Rosa Booster	Y-15 Well	2	85	10	230	Upper Santa Rosa area.
Wusstig Booster	Y-Series Wells	1	125	15	90	Upper Wusstig area.
Yigo Elevated Tank Booster	Yigo #2 Reservoir	2	100	5	120	Chalan Emsley area through the 2.0 M.G. elevated tank.
Central System						
Adawag Booster	A-Series and Navy Source	1	15	7		Upper Adawag area.
Ulloa/Untalan Booster	Agana Heights Reservoir.	1	5	1.5	140	Ulloa Residence at high elevation.
Asan Spring Booster (Standby)	Asan Springs	3	280	10	85	Asan Village
Camacho's Booster	Northern Wells through Windward Hills #2 Rsvr.	1	40	3	140	Camacho's Compound.
Manengon Access Road Booster	A- and M-Series Wells.	3	450	40	160	Manengon 1.0 Reservoir
Nimitz Hill Booster (Lower)	Navy water supply.	1	50	15	295	Nimitz Hill Lower Reservoir.

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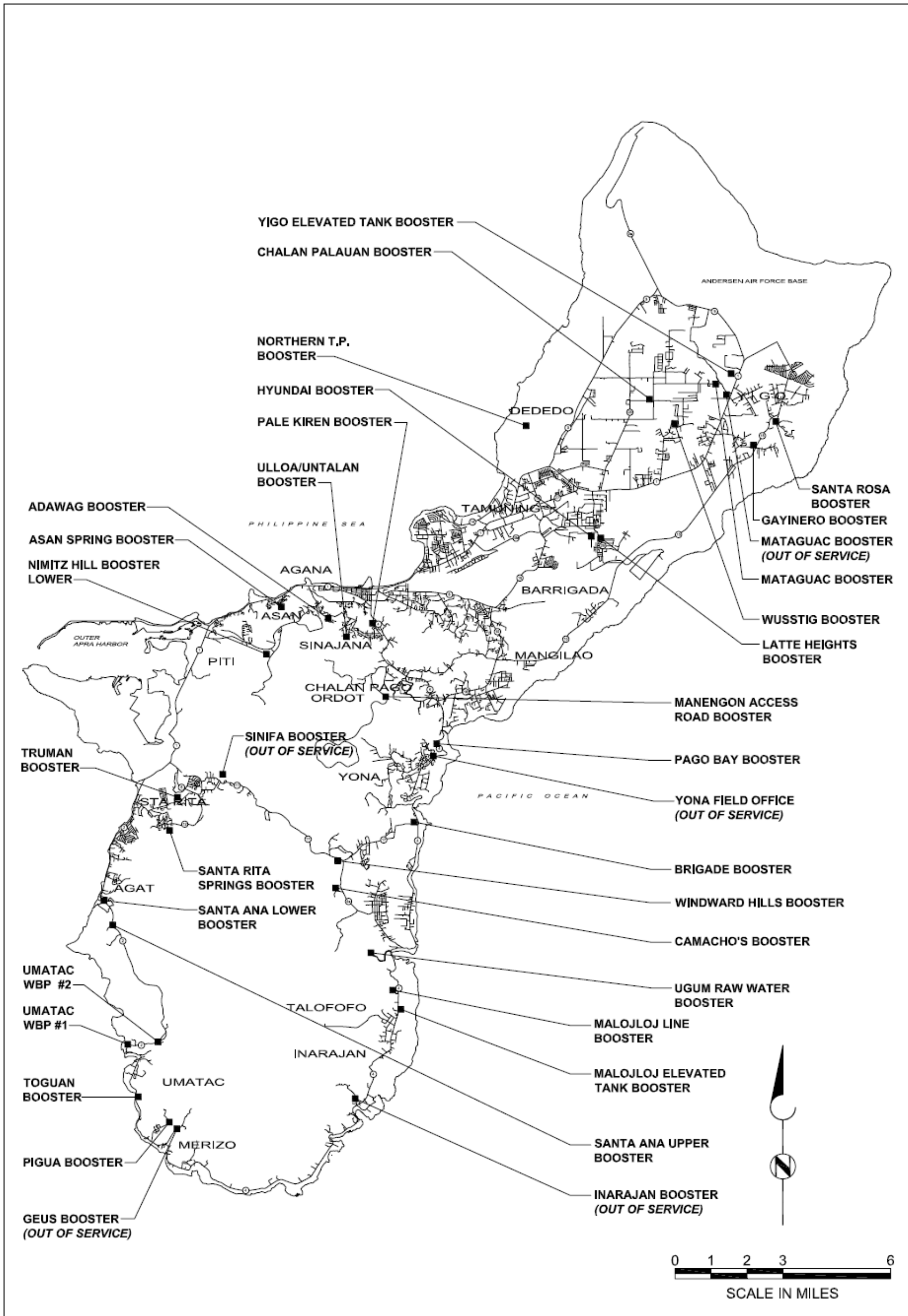
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Table 1-10 – GWA Water Booster Pumping Stations (continued)

Name	Water Source	Capacity				Areas Served
		Qty Pumps	Capacity per pump, gpm	HP	TDH, feet	
Nimitz Hill Booster (Upper) (Out-of-Service)	Navy water supply from the Lower Nimitz Reservoir.	1	No Data	No Data	No Data	Nimitz Hill Upper Reservoir.
Pale Kiren Booster	A-Series Wells	1	130	5	67	Sinajana High Elevation area.
T&D Field Office Yona Booster (Out-of-Service)	Northern Wells through Pago Booster	3	--	--	--	Yona Reservoir
Southern System						
Santa Ana Upper Booster	Navy water supply.	3	350	50	376	Agat #2 Reservoir.
Brigade Booster	Northern Wells or dual source with Ugum WTP.	3	800	100	310	Windward Hills #2 Reservoir and Windward Booster
Inarajan Booster (Out-of-Service)	Ugum WTP	--	--	--	--	Inarajan Reservoir.
Lower Pigua Booster (Geus Booster)	Ugum WTP	3	400	40	185	Upper Pigua area and 0.5 M.G. Reservoir
Malojloj Line Booster	Ugum Water Treatment Plant	2 1	540 200	40 20	190	Malojloj 1.0 M.G. Reservoir
Malojloj Elevated Tank Booster	Ugum WTP through Malojloj Booster	No Data				Boosts water to the 0.1 M.G. Malojloj Elevated Reservoir
Pago Bay Booster	Northern Wells	3	1,100	75	240	Portion of Yona area and Brigade Booster Pump.
Santa Ana Lower Booster	Navy water supply.	1	20	7.5	375	Upper Agat area.
Santa Rita Springs Booster.	Navy water supply and Santa Rita Spring.	2	650	40	185	Santa Rita Reservoir.
Sinifa Booster (Converted to PRV, Out-of Service)	Navy water supply through Truman/Lower Apra Heights Booster.	2	130	10	290	Sinifa Reservoir.
Truman Booster	Navy water supply.	1 1 1	180 200 400	20 30 50	430 430 430	Sinifa Booster Pump Station.
WBP #1 Booster	Ugum WTP	No Data	--	--	--	Not in Use.
WBP #2 Booster	Ugum WTP	2	250			Umatac Reservoir #1 and Agat Elevated Reservoir.
Toguan #3 Booster	Ugum WTP	2	350			Umatac Reservoir #2.
Pigua Booster	Ugum WTP	1	80	5	150	Pigua Subdivision and Land for the Landless
Windward Hills Booster	Northern water wells, Windward Hills #2 Reservoir, and Brigade Booster.	3	400	60	475	Sinifa Reservoir.

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Figure 1-9 – Booster Pumps



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1.5 Reservoirs

Reservoirs consist of ground-level and elevated tanks. The elevated tanks have on-site booster stations to supply water. A list of the GWA's reservoirs is provided in Table 1-11 and shown in Figure 1-10.

Table 1-11 – GWA Reservoirs

Reservoir Name	Capacity, million gallons	Height, feet	Overflow elevation, feet	Floor elevation, feet
Northern System				
Astumbo #1 (Ysengsong #1)	1.0	40.0	570.00	530.00
Astumbo #2 (Ysengsong #2)	2.0	40.0	570.00	530.00
Barrigada #2	2.0	40.0	497.80	457.80
Barrigada #3	3.0	40.0	497.80	457.80
Hyundai	1.0	40.0	497.80	457.80
Kaiser Dededo	2.5	40.0	408.00	368.00
Mangilao #1	1.0	40.0	381.60	341.60
Mangilao #2	2.0	40.0	381.60	341.60
Santa Rosa	1.0	40.0	724.00	684.00
Tumon #1	1.0	40.0	236.00	196.00
Tumon #2	1.0	40.0	252.60	212.60
Yigo #1	1.0	40.0	658.00	618.00
Yigo #2	2.0	40.0	658.00	618.00
Yigo Elevated	0.1	--	728.75	704.75
Central System				
Agana Heights	1.0	40.0	236.00	196.00
Asan Spring	0.1	10.7	146.70	136.70
Chaot	1.0	32.0	381.50	341.50
Manengon	2.0	40.0	434.50	394.50
Nimitz, Lower	0.005	<i>No Data</i>		
Nimitz, Upper	0.010	<i>No Data</i>		
Piti	1.0	40.0	236.00	196.00
Pulantat	1.0	65.0	420.00	355.00
Southern System				
Agat #1	1.0	40.0	236.00	196.00
Agat #2	0.5	40.0	470.00	430.00
Santa Ana Elevated	0.02	7.0	No Data	No Data
Inarajan	0.2	24.0	297.50	273.50
La Safua	0.03	16.0	100.00	84.00
Malojloj	1.0	40.0	410.70	370.70
Malojloj Elevated	0.75	--	450.75	370.75
Pigua	0.5	40.0	334.00	294.00
Santa Rita	1.0	40.0	392.00	352.00
Santa Rita Spring	0.104	Not Applicable	300.00	293.00
Sinifa	1.0	40.0	725.00	685.00
Ugum	2.0	40.0	256.00	216.00
Agat-Umatac	0.2	24.0	404.75	380.75
Umatac Subdivision	0.5	40.0	360.00	320.00
Windward Hills #2	1.0	40.0	444.00	404.00

Figure 1-10 – Reservoir Locations

