CHAPTER 7 – WATER TREATMENT FACILITIES CONDITION ASSESSMENT

7.1 Introduction

A condition assessment of equipment associated with wells, booster stations, and the Ugum Water Treatment Plant was conducted in February and March 2005. The assessment was performed by visiting each of the sites and visually inspecting the equipment. When possible, the equipment was assessed during operation. This chapter summarizes the results of the condition assessment. Selected reservoirs were assessed separately as part of the corrosion assessment and are discussed in Volume 1, Chapter 11 - Corrosion Assessment. Electrical power assets were assessed separately and are discussed in Volume 1, Chapter 12 – Electrical Assessment.

7.2 Assessment Approach

A team consisting of a Brown and Caldwell senior operations specialist and an engineer, together with GWA staff, visited each of the facilities and conducted a qualitative assessment of equipment physical condition and functionality. Physical condition relates to the appearance, including apparent wear and corrosion, as well as operating characteristics such as noise, vibration, and temperature. Functionality relates to the ability of the piece of equipment to accomplish its purpose.

Both physical condition and functionality were given a numeric rating from 0 to 4. Descriptions of these ratings are provided in Table 7-1 and 7-2.

Table 7-1 – Equipment Physical Condition Rating

Rating Scale	Description
0	Not Applicable
1	Equipment integrity severely compromised by corrosion and/wear.
2	Moderate to high risk of failure
3	Visible degradation of equipment, but acceptable
4	Well-maintained, like new condition of equipment

Table 7-2 – Equipment Functionality Rating

Rating Scale	Description
0	Not Applicable (Not operational or abandoned)
1	Equipment is not currently functioning for its intended use.
2	Equipment is in service but function is highly impaired.
3	Equipment functions as intended, maintenance frequencies and tasks as expected for this asset class.
4	Equipment functions as intended, by maintenance frequencies and tasks exceed those expected for this asset class.

7.3 Factors Affecting Condition

There are several factors that affect the condition of equipment of the GWA water system. Some of these factors are controllable and some are not. Several of these factors are described below.

- **Use** – All equipment has a useful or expected life. As the run-time hours increase, the condition of the equipment naturally degrades.
- **Maintenance** – Predictive and preventive maintenance activities are necessary for any equipment to achieve its useful life. These activities can also prolong and even extend the useful life of equipment. Equipment has been historically poorly maintained.
- **Power Quality** – The quality of electrical power supplied by Guam Power Authority (GPA) affects the life of electrical motors. The effect of power quality on motors is being addressed in a separate report.
- **Corrosive Environment** – GWA equipment and facilities are affected by rust and corrosion due to the island's marine air.
- **Vandalism /Theft** – Most of GWA's water facilities are not secure and show indications of vandalism. Though most stationary equipment are not targets of theft, some appurtenant equipment such as emergency generator batteries are. Many of the batteries associated with GWA generators have been removed to prevent their theft. This reduces their functionality since they cannot start automatically.
- **Weather and Natural Disasters** – Guam routinely experiences typhoons and earthquakes. Within the last 10 years two super typhoons with winds exceeding 200 miles per hour hit the island.

There is a lot of synergy among these factors that affect condition. For example, when a piece of equipment fails or is taken out of service, the use of back-up equipment increases. Poor maintenance practices and the corrosive environment place added wear on the back-up equipment, further reducing its useful life.

7.4 Condition Assessment

The discussion of the condition assessment for GWA's water system is organized by wells, booster stations, and the Ugum Water Treatment Plant. An assessment of the emergency generators associated with the wells and boosters stations is also provided. This chapter is intended to summarize the results of the condition assessment. A compact disk is provided in Appendix 2A with all the information collected.

7.5 Wells

GWA wells are identified by an alphanumeric designator. The alphabetic letters designate the areas in which the wells are located, as follows:

- **"A" series** – Located in the Agana region and extend from Adelup-Pago northward to Barrigada.
- **"Y" series** – Located in the Yigo area.
- **"D" series** – Extend north from the village of Dededo along Y-Sengsong Road.
- **"F" series** – Located in Finegayan.

- **"M" series** – Extend from the Naval Communications Station in Barrigada to Dededo-Yigo.
- **Other –** refers to the **"H" series** located in Harmon Village; the **"AG" series** – Located in Machananao (Agafa Gumas); and the **"Mj" series** – Located in the sourthern part of the island near Malojloj.

One hundred ten wells were assessed. Table 7-3 shows the physical condition rating of the wells. Table 7-4 shows the functionality rating of the wells. Tables7-5 and 7-6 show the physical condition rating and functionality rating, respectively, of GWA-owned and -operated emergency generators associated with each well. GWA owns and operates 35 generators associated with the wells.

Almost two-thirds of the 35 emergency generators operated by GWA are not functioning as intended.

Even though GWA uses some part of the buildings associated with the wells, most of the buildings are owned and maintained by GPA. The buildings are subject to vandalism and typhoons. The buildings owned by GPA are in overall better condition than the buildings owned by GWA.

The chlorination pumps associated with the wells are in fair to good condition, but for many, their installation is poor. Some are located indoors and some are located outdoors.

Table 7-3 – GWA Well Pumps Physical Condition Assessment

Wells	Well Series					
	A	Y	D	F	M	Other
Total Number of Wells	26	16	23	17	18	10
Number of Wells with the Physical Condition Rating Below						
0 – Not Applicable[1]	5	3	7	2	3	3
1 – Equipment integrity severely compromised by corrosion and/wear.	8	6	6	7	8	3
2 - Moderate to high risk of failure	9	4	4	8	6	2
3 – Visible degradation of equipment, but acceptable	2	3	6	0	0	2
4 – Well-maintained, like new condition of equipment	0	0	0	0	0	0
Other[2]	2	0	0	0	1	0

1. Hardbroke, removed, or secured.
2. Not visited or too dangerous to access.

Table 7-4 – GWA Well Pumps Functionality Condition Assessment

Wells	Well Series					
	A	Y	D	F	M	Other
Total Number of Wells	26	16	23	17	18	10
Number of Wells with the Functionality Rating Below						
0 – Not Applicable	0	0	0	0	1	0
1 – Equipment is not currently functioning for its intended use.	8	6	6	5	4	3
2 - Equipment is in service but function is highly impaired.	12	7	9	9	11	4
3 – Equipment functions as intended, maintenance frequencies and tasks as expected for this asset class.	4	3	8	3	2	3
4 – Equipment functions as intended, by maintenance frequencies and tasks exceed those expected for this asset class.	0	0	0	0	0	0
Other[1]	2	0	0	0	0	0

1. Not visited or too dangerous to access.

Table 7-5 – GWA Well Generator Physical Condition Assessment

Wells	Well Series					
	A	Y	D	F	M	Other
Total Number of Wells	26	16	23	17	18	10
GWA Generators	6	10	7	3	6	3
GPA Generators	20	6	15	11	12	6
Wells without Generators	0	0	1	3	0	0
Number of GWA Generators with Physical Condition Rating Below						
0 – Not Applicable[1]	5	3	7	2	3	3
1 – Equipment integrity severely compromised by corrosion and/wear.	0	0	0	0	0	0
2 - Moderate to high risk of failure	1	1	0	0	1	0
3 – Visible degradation of equipment, but acceptable	0	4	0	1	2	0
4 – Well-maintained, like new condition of equipment	0	2	0	0	0	0
Other[2]	0	0	0	3	0	0

1. Generator is inoperable, hard broke, or secured.
2. Not visited, too dangerous to access, or unknown.

Table 7-6 – GWA Well Generator Functionality Condition Assessment

Wells	Well Series					
	A	Y	D	F	M	Other
Total Number	26	16	23	17	18	10
GWA Generators	6	10	7	3	6	3
GPA Generators	20	6	15	11	12	6
Wells without Generators	0	0	1	3	0	0
Number of GWA Generators with the Functionality Rating Below						
0 – Not Applicable	0	0	0	0	0	0
1 – Equipment is not currently functioning for its intended use..	5	4	7	2	3	3
2 – Equipment is in service but function is highly impaired.	1	1	0	0	1	0
3 – Equipment functions as intended, maintenance frequencies and tasks as expected for this asset class.	0	4	0	1	2	0
4 – Equipment functions as intended, by maintenance frequencies and tasks exceed those expected for this asset class.	0	1	0	0	0	0
Other[1]	0	0	0	3	0	0

1. Not visited, too dangerous to access, or unknown.

7.6 Booster Stations

The physical condition and functionality ratings for the equipment associated with GWA's water booster stations are provided in Table 7-7. The physical condition and functionality rating for GWA-owned and operated emergency generators are shown in Tables 7-8 and 7-9 respectively.

Overall the booster stations have good functional ratings though the physical condition of many is poor. Failure of a booster station has an immediate result on water delivery to certain service areas.

Only seven of the booster station generators are owned and operated by GWA, and most of them are in poor condition.

Most of the buildings are in fair to good condition. Vandalism, poor maintenance, and typhoons have taken their toll on finishes, windows, doors, and other appurtenances.

Table 7-7 – GWA Booster Station Condition Assessment Summary

Booster Station	Equipment Name	Rating									
		Physical Condition					Functionality				
		0	1	2	3	4	0	1	2	3	4
Agana Heights[1] (Ulloa Untalan)	centrifugal pump above ground, 50 gal surge tank, pressure switch										
Agat/Umatac (Umatac #1)	Pump				x					x	

Table 7-7 – GWA Booster Station Condition Assessment Summary (continued)

Booster Station	Equipment Name	Rating									
		Physical Condition					Functionality				
		0	1	2	3	4	0	1	2	3	4
Santa Ana Upper	Pump 1			x						x	
	Pump 2	x						x			
Santa Ana Lower	Pump			x						x	
Asan Spring	SECURED due to fecal count in spring	x									
	Pump 1				x					x	
	Pump 2				x					x	
	Cl_2 system			x					x		
Barrigada	Pump 1					x					x
	Pump 2				x					x	
Chalan Palauan	Pump 1					x					x
	Pump 2					x					x
	Pump 3					x					x
	Pump 4					x					x
Mangenon Access Road	Pump 1			x						x	
	Pump 2			x				x			
	Pump 3			x						x	
Pago Bay	Pump 1			x					x		
	Pump 2				x					x	
	Pump 3			x					x		
Ugum	Pump			x					x		
Northern	at WWTP – did not assess	x									
Wusstig	abandoned	x									
Malojloj (Malojloj Elevated)	Pump 1				x					x	
	Pump 2				x					x	
	Pump 3	x					x				
Malojloj Line Booster	Pump 1					x					x
	Pump 2					x					x
	Pump 3					x					x
Latte Heights	Pump 1				x					x	
	Pump 2				x					x	
	Pump 3				x					x	
Lower Pigua (Gayos)	Pump		x						x		
Toguan (Umatac #3)	Pump 1		x						x		
	Pump 2		x						x		
Upper Pigua (Pigua)	Pump 1				x					x	
	Pump 2				x					x	
Adawag	Pump				x					x	
Lower Nimitz Hill	Pump 1					x					x
	Pump 2					x					x

Table 7-7 – GWA Booster Station Condition Assessment Summary (continued)

Booster Station	Equipment Name	Rating									
		Physical Condition					Functionality				
		0	1	2	3	4	0	1	2	3	4
Upper Nimitz Hill	SECURED	x									
Santa Rita	Pump 1					x					x
	Pump 2					x					x
	Cl_2 Scale			x				x			
	Cl_2 ejector				x				x		
	Cl_2 Pump			x					x		
Sinifa	Converted to PRV – did not visit										
Truman	Pump 1			x						x	
	Pump 2			x						x	
Sinijana (Pale Kirin)	Pump				x					x	
	50 gal tank				x					x	
Umatac #1	See above Agat/Umatac	x									
Umatac #2	Pump 1	x					x				
	Pump 2					x	x				
	Temporary Pump				x					x	
Umatac #3	See above Toguan										
Gayinero	Pump 1	x					x				
	Pump 2			x					x		
Mataguac	Pump 1				x					x	
	Pump 2	x					x				
	Pump 3				x					x	
	Cl_2 feed pump 1				x					x	
	Cl_2 feed pump 2				x					x	
Santa Rosa	Pump 1	x					x				
	Pump 2				x					x	
Yigo Elevated Tank	Pump 1					x					x
	Pump 2				x					x	
Brigade	Pump 1				x					x	
	Pump 2				x					x	
	Pump 3			x					x		
Camacho's	Pump			x						x	
Windward Hills	Pump 1				x					x	
	Pump 2				x		x				
	Pump 3			x					x		
Yona	SECURED	x									

1. On private property and under litigation; could not evaluate.

Table 7-8 – GWA Booster Station Generator Physical Condition Assessment

Total Number of Booster Stations	36
GWA Generators	7
GPA Generators	14
Booster Stations without Generators	10
Number of GWA Generators with Physical Condition Rating Below	
0 – Not Applicable[1]	0
1 – Equipment integrity severely compromised by corrosion and/wear.	3
2 - Moderate to high risk of failure	2
3 – Visible degradation of equipment, but acceptable	2
4 – Well-maintained, like new condition of equipment	0
Other[2]	0

1. Generator is inoperable, hard broke, or secured.
2. Umatac #1 is served by Agat/Umatac WBPS; Umatac #3 is served by Toguan WBPS.

Table 7-9 – GWA Well Booster Station Functionality Condition Assessment

Total Number of Booster Stations	36
GWA Generators	7
GPA Generators	14
Booster Stations without Generators	10
Number of GWA Generators with the Functionality Rating Below	
0 – Not Applicable	3
1 – Equipment is not currently functioning for its intended use.	0
2 - Equipment is in service but function is highly impaired.	1
3 – Equipment functions as intended, maintenance frequencies and tasks as expected for this asset class.	3
4 – Equipment functions as intended, by maintenance frequencies and tasks exceed those expected for this asset class.	0
Other[1]	0

1. Not visited, too dangerous to access, or unknown.

7.7 Ugum Water Treatment Plant

The physical condition and functionality ratings for equipment associated with the Ugum Water Treatment Plant are provided in Table 7-10. Much of the equipment at the Ugum Water Treatment Plant is in poor physical condition, but is functioning to provide potable water.

Though each of the liquid stream processes is important, chemical feed is critical for continuous operation of the plant. There is little redundancy in the chemical feed equipment to ensure reliable operation.

None of the solids handling facility equipment is operational. Even the thickening tank is simply used as a pass-through basin.

Significant improvements in the reliable operation of the Ugum Water Treatment Plant have been made in the last two years, but the poor equipment condition makes it vulnerable to failure.

Table 7-10 – Ugum WTP Condition Assessment

Process	Equipment Name	Rating									
		Physical Condition					Functionality				
		0	1	2	3	4	0	1	2	3	4
Intake	Pipe			x					x		
	Raw Water Pump 1			x					x		
	Raw Water Pump 2				x		x				
	Raw Water Pump 3			x				x			
	Screening			x					x		
	Tank			x					x		
Flocculation	Tank 1			x					x		
	Tank 2			x					x		
	Tank 3			x					x		
	Tank 4			x					x		
	Mixer, Rapid			x					x		
	Motor, Rapid - see Mixer above			x						x	
Sedimentation	Settling Tank 1			x					x		
	Settling Tank 2			x			x				
	Settling Tank 3			x					x		
	Settling Tank 4			x					x		
Filtration	Backwash Pump 1		x						x		
	Backwash Pump 2		x						x		
	Backwash Tank			x						x	
	Filter Blower			x						x	
	Filter Tank 1		x							x	
	Filter Tank 2		x							x	
	Filter Tank 3		x							x	
	Filter Tank 4		x							x	
Disinfection	Ejector 1				x					x	
	Ejector 2	x					x				
	Ejector 3										
	Scale		x				x				
	cl2 detector		x				x				

Table 7-10 – Ugum WTP Condition Assessment (continued)

Process	Equipment Name	Rating									
		Physical Condition					Functionality				
		0	1	2	3	4	0	1	2	3	4
Clearwell	Clearwell Discharge Pump 1				x					x	
	Clearwell Discharge Pump 2			x					x		
Chemical	Chemical Feeder A			x					x		
	Chemical Feeder B		x						x		
	Chemical Feeder C		x						x		
	Chem Feed Pump Alum			x					x		
	Chem Feed Pump Soda Ash		x				x				
	Chem Feed Pump Carbon		x				x				
	Polymer Feeder										
	vent system	x					x				
	equipment lift		x						x		
Solids Handling	Centrifuge		x				x				
	Centrifuge Feed Pump 1		x				x				
	Centrifuge Feed Pump 2										
	Polymer Feed Pump 1		x				x				
	Polymer Feed Pump 2		x				x				
	Polymer Holding Tank										
	Thickening Feed Pump 1	x					x				
	Thickening Feed Pump 2	x					x				
	Thickening Tank			x					x		
	Sludge Transfer Pump		x				x				