

CHAPTER 8 – WATER DISTRIBUTION SYSTEMS

8.1 Introduction

Due to the absence of water system standards for GWA, the Water System Standards for the State of Hawaii will be used as a guide to determine what water distribution system improvements should be made for GWA’s system. As noted in Volume 2, Chapter 3 – Water Budget, there is a significant amount of unaccounted for water that is being pumped out of the ground or diverted from surface waters that are not reaching GWA’s consumers. As identified in Volume 2, Chapter 4 - Leak Detection, a great deal of water loss can be attributed to leaks in the water system that creates insufficient water service volume and pressure. Some of the water supply and pressure problems reported are also related to waterlines of insufficient size and inadequate layout to provide adequate water service. This Chapter will first provide design criteria that will be used as basis for developing water distribution system improvement, and secondly identify system deficiencies that should be corrected.

8.2 Planning Criteria

Criteria for improving the water distribution system includes waterline sizing to maintain minimum fire flows and pressures, limit maximum velocities, and provide minimum residual pressures for domestic use. The criteria also addresses spacing of fire hydrants based upon land use.

8.2.1 Fire Flow Requirements

Table 8-1 – Fire Flow Requirements

Land Use	Flow (GPM)/Duration (HRS)/Fire Hydrant Spacing (FT)
Rural	1000/2/500
Single Family	1000/2/350
Low-Rise Apartments	1500/2/350
Schools, Neighborhood Businesses, Small Shopping Centers, and High-Rise Apartments	2000/2/250
Light Industry, Downtown Business, Large Shopping Centers and Hospitals	2000/2/250
Heavy Industry, Hotels	2500/2/250

Notes:

1. On dead end streets, the last fire hydrant (F.H.) shall be located at one half the spacing distance for F.H.'s from the last house/unit (frontage property line or to the driveway/access for the property).
2. Spacing of the F.H. shall be measured along the roadway.

8.2.2 Pipeline Sizing

Pipelines should be sized to meet the following requirements:

- Maximum daily flow of 150% of the average daily flow plus fire flow with a residual pressure of 20 psi at critical fire hydrants adjacent to the fire flow.
- Peak hour flow of 300% of the average daily flow with a minimum residual of 40 psi.

- The carrying capacity of the water mains shall be based upon the Hazen-Williams “C” coefficients listed in Table 8-2.
- The maximum velocity in water mains (without fire flows) is six feet per second.
- The maximum velocity in distribution mains with fire flow at maximum day domestic flow is 10 feet per second (fps). The maximum velocity in transmission mains without water services or fire flow is 20 fps.
- The maximum static or pumping pressure, whichever is greater, shall not exceed 125 psi.

Table 8-2 – Water Main “C” Coefficient

Pipe Diameter (Inches)	Hazen-Williams “C” Coefficient
4”, 6”	100
8”, 12”	110
16”, 20”	120
24” and larger	130

8.2.3 Reservoir Capacity

Reservoirs should be sized to meet the following requirements:

- Capacity shall satisfy maximum day consumption. Reservoirs shall be full at beginning of the 24-hour period with no input from groundwater or surface water sources.
- Meet maximum day flow plus fire flow for the duration of the fire (i.e., two hours). Reservoir shall be assumed to be 3/4 full at the start of the fire, with credit for incoming flow from supply pumps feeding the reservoir, with the largest pump in the pump station or well out of service.
- The minimum reservoir size shall be 100,000 gallon. Reservoir size shall be as approved by GWA.
- When two or more reservoirs are available to serve the same distribution system, the combined capacity of the reservoirs shall be taken into account in assessing the level of fire protection capacity for facilities.

8.2.4 Total Pump Capacity

The total pump capacity shall be based on the criterion that yields the maximum pumpage based upon the following:

- Meet maximum day demand with an operating time of 16 hours simultaneously with maximum fire flow required independent of the storage provided by reservoirs. A standby unit may be used to determine the total flow required.
- Meet maximum day demand during the duration of fire plus fire demand without 3/4 of the reservoir storage.
- Meet maximum day demand with an operating time of 16 hours with the largest pumping unit considered to be out of service.

8.3 Water Distribution System Improvements

The first priority of improvements should seek to decrease the high level of leakage in the system, as there is an adequate quantity of water being produced from existing well sources and the Santa Rita Spring. A system-wide leak detection program will aid in determining areas in the water system that has significant leaks that requires replacement of water lines. The replacement of deteriorated or substandard sections of waterlines will improve the quantity of water and available pressure in the distribution system.

The second priority of improvements should provide water mains that are adequately sized to provide fire protection for the designated land use area. Urban areas with a higher congestion of development will require higher fire flow with larger mains, while rural areas with lower densities can generally be supported by eight-inch mains.

8.3.1 Leak Detection Study Results

Based upon the Guam Waterworks Authority - Water Leak Detection Study on All Three Public Water System (Volume 2, Appendix 2B), dated September 12, 2005, an initial leak detection study was performed to identify locations of water loss in the water system. The locations and estimated quantity of water loss is summarized in Chapter 4 – Water Loss Control, Table 4-1 - Water Leak Detection Study Summary. One approach to repairing the leaks or replacing sections of water lines with leaks is to target the locations with the highest estimated water loss. For example, eliminating the leaks in the locations with the 10 highest quantity of water loss (e.g., 28,000 gallons per day (gpd) or greater) would eliminate about 2/3 (378,738 out of 566,302 gallons) of the total water loss estimated. A summary of the water loss reduction that could be achieved is provided in Table 8-3, with the highest estimated water loss listed first.

Table 8-3 – Priority List for Waterline Repair or Replacement

Priority	Location	Type of Leak	Potential Reduction in Water Loss (GPD)
1	Agat Village – North Santa Cruz St & Tomas Rivera St.	Hydrant Lateral	72,000
2	Yona Village – Jota Road across House #386	Main Line	56,000
3	Piti Village	Service Line	38,000
4	Merizo Village – Route 4, In front of House #1145	Service Line	36,000
5	Cabras Area	Miscellaneous	35,858
6	Yona Village – Water Booster Pump Station 25	Pressure Line	28,880
7 (tie)	Piti Main Village	Defective Valve	28,000
7 (tie)	Santa Rita Village – Chalan Kindo, vicinity of House #180B	Waterline Valve	28,000
7 (tie)	Route 4 – Before the bridge after Arriola Beach	Main Line (12" PVC)	28,000
7 (tie)	Yigo Village – Chalan Tun Luis Takano	Main Line	28,000

Note: Refer to Chapter 4 for more information regarding the location of these leaks.

The prioritization of repair should also consider other factors such as ease of access, cost of repair, age and condition of line, cost effectiveness of replacement vs. repair of line and/or valve, upgrades required to support existing or future development, impact to public, and proximity to other repair or replacement work required.

“This is a draft report and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.”

8.3.2 Fire Flow Protection

Fire flow requirements for various land uses are provided in Table 8-1, with the minimum fire flow of 1000 gpm for a duration of two hours. In consideration of the flow velocities from fire plus domestic flows, water mains should be adequately sized so that the maximum velocities with fire flow alone should be kept below 10 feet per second. A summary of flow velocities for standard pipe diameters and varying levels of fire flow is provided in Table 8-4.

Table 8-4 – Fire Flow Velocities

Pipe Velocities (FPS)				
Fire Flow (GPM)	6-Inch	8-Inch	12-Inch	16-Inch
1000	11.35	6.38	2.84	1.60
1500	17.02	9.57	4.26	2.39
2000	22.70	12.77	5.68	3.19
2500	28.37	15.96	7.09	3.99

Note: 1. Reference Table 8-1 for corresponding land use and other fire flow criteria.

In order to prevent excessive velocities during fire flows, the minimum pipe size provided for distribution system mains should be eight inches. As identified in Table 8-4, an eight-inch main can accommodate rural, single family, and low-rise apartment areas that have fire flow requirements in the range of 1000 to 1500 GPM. A 12-inch main would generally be adequate to accommodate fire flow requirements for more developed urban areas of the island that include schools, businesses, shopping centers, high-rise apartments, hotels, and industrial areas. All water distribution lines that are smaller than eight inches and have fire hydrants connected to them should be upgraded to eight inches or larger depending upon the fire flow service level required as identified in Table 8-1. In particular, any areas with older water lines that have been shown to have leaks and inadequate service pressures and flows should be replaced.

8.3.3 Water Distribution System Improvements

Based upon the hydraulic model of the water system, as discussed in Chapter 6 – Water System Hydraulic Modeling, improvements to the water distribution system were identified for the southern, central, and northern systems. In order to meet the fire flow requirements identified earlier in this Chapter, increases in pipes sizes or installation of new segments to provide loops in the water distribution system are required. Tables 8-5, 8-6, and 8-7 summarize the improvements recommended for the water distribution systems in the south, central, and northern systems, respectively.

Table 8-5 – Southern Distribution System Improvements

No.	Area	Description	Length	Comment
1	Malojloj	Increase 6-inch waterline to 8 inches along Fangualoan St. from Malojloj Well St. to S-15 and on to connection to 12-inch waterline along Route 4.	4200	Improve available fire flow in this area
2	Malojloj	Increase 6-inch waterline to 8 inches along Route 4 from end of existing 8-inch near Chotda St. to Malojloj Well St.	1200	Improve available fire flow in this area and further south
3	Inarajan	Complete loop of 6-inch waterline at the ends of Chagamin St. and Y Peca Lane	500	Need to verify if connection between dead-end leg lines is feasible, or if the waterline along Chagamin St. should be extended to Abmam Dr. and connected back to the 12-inch main on Route 4.
4	Inarajan	Increase 6-inch waterline to 8 inches along Route 4 at interconnection of parallel 8-inch and 12-inch lines about 1900 feet south of As Quede St.	200	Improve available fire flow in this area and further to the south and west
5	Umatac	Increase 6-inch waterline to 8 inches from Route 4 south of Mata Ave towards the northeast to Chalan Joseph A. Cruz St.	700	Improve available fire flow in this area
6	Umatac	Increase 6-inch waterline to 8 inches (or larger) along Route 4 from Bile St. to the transition from the 6-inch to 12-inch waterline about 1000 feet south of Jesus A. Quidachay St.	4500	Improve available fire flow in this area
7	Umatac	Increase 6-inch and 4-inch waterlines to 8 inches (or larger) along Route 4 and Route 2, from Jesus A. Quidachay St to Lasafua Reservoir	13,000	Need to verify if there are any segments of 12-inch line along this length of line. Improve available fire flow in this area

Table 8-6 – Central Distribution System Improvements

No.	Area	Description	Length	Comment
1	Talofoyo	Install booster pump station near Windward Hills #2 Reservoir and increase 8-inch waterline to 12 inches along Route 4A southeastward to San Miguel St.	6000	Improve fire flow and pressures in Talofoyo. There is a need to site a dedicated elevated storage tank in Talofoyo to replace the previous one abandoned
2	Talofoyo	Increase 8-inch waterline to 12 inches along Route 4A from San Miguel St. southward to Manual P Mantanona Lane	3800	Evaluate if an elevated storage tank can be placed in this area with a ground elevation of about 382 feet.
3	Talofoyo	Extend 12-inch line from intersection of Route 4A and San Miguel St. eastward along Jose P. Cruz St. to Chalan Kenton Laders	1600	Approximate length of 12-inch line could also be extended to proposed elevated storage tank that will improve both fire flows and pressures in the area
4	Santa Rita	Increase 8-inch waterline to 12 inches along Route 17 from Chalan J. Kindo intersection and eastward along Route 17 to Sinifa Reservoir	3000	Reduce max-day velocities that exceed 6 fps and improve fire flows
5	Agat	Connect dead-end 6-inch line along Route 2 above Agat #1 Reservoir to parallel 16-inch main or replace 6-inch line with a 8-inch (or larger) waterline as needed	2800	Improve substandard fire flow and pressure in this area

“This is a draft report and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.”

Vol 2 Chapter 8
Water Distribution Systems

Table 8-7 – Northern Distribution System Improvements

No.	Area	Description	Length	Comment
1	Santa Rosa*	Extend 6-inch waterline on north end of Tun Thomas Dongo to 12-inch line with an 8-inch waterline.	300	Improve available fire flow in this area
2	Santa Rosa*	Increase 6-inch waterline to 8 inches (or larger) to the east of Santa Rosa Reservoir (not including branched 6 inch lines).	3000	Improve available fire flow in this area
3	Santa Rosa	Increase 6-inch waterline on Tun Luis Tugong and Rosa to 8 inches (or larger).	2300	Improve available fire flow in this area
4	Yigo Elevated*	Increase 8-inch waterline to 12 inches along Chalan Arendo to Chalan Emsley.	4900	Improve available fire flow and pressure in this area
5	Mataguac Zone*	Increase 6-inch waterline to 8 inches along Chalan Maanao from Route 1 (Marine Drive) thru Mataguac BPS to Chalan Aniles.	2300	Improve available fire flow, pressure and velocity in this area.
6	Mataguac Zone*	Increase 6-inch waterline to 8 inches along Evangelista from Route 1 (near Well Y-17).	600	Improve available fire flow, pressure and velocity in this area.
7	Mataguac Zone	Extend 6-inch waterline southward along Chalan Kaskahu until intersection with Chalan Okso. Install PRV where Mataguac and Yigo Zones meet.	1200	Improve available fire flow and pressure in this area.
8	Yigo Zone *	Increase 6-inch waterline on Ton Jose to 8 inches. Install 8-inch waterline along Chalan Paharu, from Well Y-23 to Ton Jose.	1600 and 2800	Improve fire flow in this area.
9	Yigo Zone *	Increase 6-inch waterline to 8 inches along Chalan Langet, from Route 1 to Ree. Install 8-inch waterline on Ree from Chalan Langet to 12-inch line on Aga. (Near lower portion of Route 1, southwest of Well Y-10)	600 and 650	Improve available fire flow in this area.
10	Yigo Zone	Install 8-inch waterline along Aababang from Aapacha to Road K (adjacent to Route 1, north of Wells Y-5 & Y-6)	300	Improve available fire flow in this area.
11	Yigo Zone	Increase 6-inch waterline to 8 inches along Milalak from Marine Drive westward (not including branch lines).	1800	Improve available fire flow in this area.
12	Yigo Zone	Increase section of 8-inch waterline to 12 inches along Highway 15 between 12-inch lines at Road B. Wendy and Gayinero Dr.	3600	Reduce max-day velocities that exceed 6 fps and improve fire flows
13	Yigo Zone *	Increase 8-inch waterline to 12 inches (or larger) on Marine Drive from Well Y-17 northward to Yigo Reservoir.	3800	Improve available fire flow and pressure in this area.
14	Yigo Zone	Increase 6-inch waterline along Chaguian Machananao to 12 inches from Route 9 southward (including only main waterline).	5300	Improve available fire flow in this area.

“This is a draft report and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.”

Table 8-7 – Northern Distribution System Improvements (continued)

No.	Area	Description	Length	Comment
15	Yigo Zone	Extend 6-inch waterline on Chalan San Juan to 8-inch line on Bouganvilla to complete loop. (near top of Route 9)	300	Improve available fire flow in this area.
16	Yigo Zone	Install 6-inch waterline on Entrada to complete looping of 6-inch waterlines along Azud, Amarillo and Apaca Streets. Connect end of 6-inch waterline along Chalan Santa Bernadita to 12-inch line along Route 9.	500 and 400	Improve available fire flow in this area.
17	Yigo Zone	Install 8-inch connection between ends of Quezon and Magsaysay.	500	Improve available fire flow in this area.
18	Astumbo	Install 9-inch waterline on Chiote between Kamute and Chalan A'Abang.	200	Improve available fire flow in this area.
19	Astumbo	Increase 6-inch waterline along Chalan Ibang to 12 inches from Y-Sengsong to S-13 and 8 inches to the end. Increase 6-inch waterline along Chalan Pugue Matchena to 8 inches from Y-Sengsong to Chalan Pakpak. Increase 6-inch lines along S-13 and Chalan Pakpak between Chalan Ubas and Chalan Bongbong to 8 inches.	2200, 2200, and 800	Improve available fire flow and pressure in this area.
20	Astumbo *	Install an additional 16-inch waterline parallel to 12-inch waterline along Swamp and Y-Sengsong, connect to 24-inch along Route 3 and 16-inch waterline exiting Astumbo Reservoir.	9000	Improve velocities and available fire flow and pressure in this area.
21	Kaiser *	Install an additional 12-inch (or larger) parallel line from Well D-10 (on Y-Sengsong) to Kaiser Reservoir. (Interconnect with parallel lines next to it)	5300	Improve available fire flow and pressure in this area.
22	Kaiser	Install an 8-inch waterline along Lada from Adora to connect to the 14-inch line along Ukudo north of Well D-18)	800	Improve available fire flow and pressure in this area.
23	Kaiser	Connect 8-inch waterline left of Ilangilang to 24-inch line along Route 1. (Below Well H-1)	200	Improve available fire flow and pressure in this area.
24	Kaiser	Install 8-inch connection from Fatima to 6-inch waterline along Santa Monica.	800	Improve available fire flow and pressure in this area.
25	Kaiser	Install 14-inch connection along Ukudo from south of Lada to 12-inch line on Santa Monica.	800	Improve available fire flow and pressure in this area.
26	Kaiser	Install 8-inch waterline along Sunrise St. from Route 1 to Route 16	2200	Improve velocities, available fire flow and pressure in this area.

“This is a draft report and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.”

Table 8-7 – Northern Distribution System Improvements (continued)

No.	Area	Description	Length	Comment
27	Kaiser	Install 12-inch waterline along St. John St. and Tun Pedro Cruz St. with connection to the 24-inch waterline on Route 1 and 14-inch waterline on Finegayan St. (labeled as A. Sanchez).	1000	Improve velocities, available fire flow and pressure in this area.
28	Tumon *	Extend 6-inch waterline along Hospital to Pale San Vitores to complete loop.	300	Improve available fire flow in this area.
29	Tumon	Install 8-inch waterline from end of Father San Vitores Street to end of Father Duenas Drive to complete loop along these streets and Gov. Skinner St., Gov. Bradley St. and Father Ramon St.	1500	Improve available fire flow and pressure in this area.
30	Hyundai *	Increase 6-inch waterline along Bello Road to 8 inches from Chalan Villagomez to Duenas (north of Hyundai Reservoir).	1200	Improve available fire flow and pressure in this area.
31	Hyundai *	Install 12-inch connection along Corenso to connect North Sabana Barrigada to South Sabana Barrigada (west of Hyundai Reservoir).	1500	Improve available fire flow and pressure in this area.
32	Hyundai	Extend 12-inch waterline on South Sabana Barrigada from Carinoso to Route 16 (southwest of Hyundai Reservoir).	800	Improve velocities and available fire flow and pressure in this area.
33	Mangilao/Chaot	Extend 6-inch waterline south along Dimas St. to Carlos Lane. Extend 6-inch line south along Juan Muna St. to 8-inch along Corten Torres St. Extend 6-inch line from First St. off of Iglesias St. to East Rojas St. to complete loop (west of Mangilao Reservoir).	750, 300 and 100	Improve available fire flow and pressure in this area.
34	Piti/Agana *	Increase 4- and 8-inch waterline along Luna to 12 inches, which will connect the 12-inch line along Candelaria to the 12-inch line along Route 7A.	1500	Improve available fire flow and pressure in this area.
35	Piti/Agana *	Install 12-inch connection along Chalan Obispo from Route 7A south to Pale Kieran Hickey Dr. and connect up 8-inch along Haiguas Dr.	1100	Improve available fire flow and pressure in this area.
36	Pulantat	Extend 8-inch line on Arterio A. Cruz to 16-inch line on Route 4 (south of Pago Bay booster).	300	Improve available fire flow in this area.
37	Pulantat	Install 8-inch main along Pulantat Road from connection with 12-inch main at Chalan Teleforo intersection to 6-inch line at S-37 intersections to complete loop.	2600	Improve available fire flow in this area.

8.3.4 Pressure Reducing Valve (PRV) Station Improvements

Due to the varied elevation of reservoirs across the island, water pressures in the distribution system will vary depending upon the elevation of the waterline in relation to the water level in the reservoir. A description of the pressure zones established for GWA's system based upon the overflow elevation of reservoirs is described in Chapter 1. In some cases, a reservoir is not available for a pressure zone, but is created from a booster pump station servicing an isolated area of the water distribution system. A review of GWA files and hydraulic modeling of the system indicates that a PRV or closed valve is needed to isolate one pressure zone from another. Figures 8-1 and 8-2, identifies the location of known PRV's or closed valves in the distribution system.

Although a closed valve can effectively isolate one pressure zone from another, it does not allow flow from one pressure zone to another. Thus, the installation of a PRV can be more effective in allowing the transport of water from a higher pressure zone to a lower pressure zone, particularly when water is needed for periods of high demand, such as for fire fighting. A PRV will require the proper downstream settings depending upon the appropriate differential in pressure between the higher and lower pressure zones, and will also require more maintenance to keep it in proper working order. A PRV is required at the boundaries between the pressure zones identified on Figures 8-1a and 8-1b, for each water main that bridges across the pressure zones. A summary of recommended PRV stations is provided in Table 8-8.

Table 8-8 – PRV Station Improvements

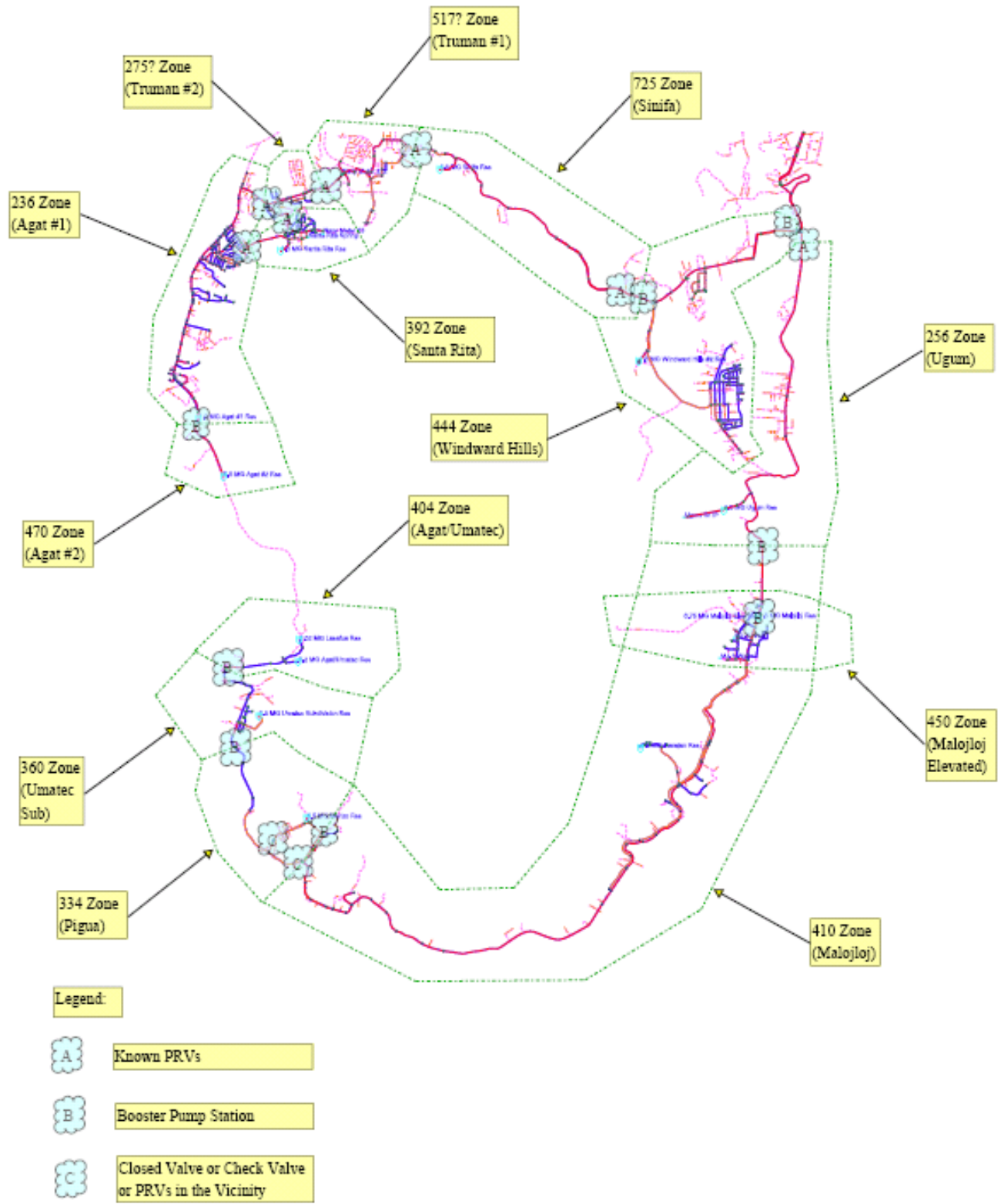
No.	High Pressure Zone	Low Pressure Zone	Street	Waterline Diameter	Comment
1	Yigo	Ysengsong	Install PRV at intersection of Guagna and Chalan Lumasu	12	Shown as assumed PRV in model
2	Yigo	Ysengsong	Install PRV at intersection of Route 3 and Y-sengsong	12	Shown as assumed PRV in model
3	Yigo	Ysengsong	Install PRV at intersection of Route 3 and Y-sengsong	20	Shown as assumed check valve in model
4	Yigo	Ysengsong	Install PRV near intersection of Route 3 and Y-sengsong, along 12" waterline on Y-sengsong (south of Well F-6)	12	Shown as assumed check valve in model
5	Ysengsong	Kaiser	Install PRV along Route 28, between Chalan Lahe and Nevermind (East of Well D-12)	12	Shown as assumed PRV in model
6	Yigo Elevated	Santa Rosa	Install PRV along Chalan Arendo (North of Yigo Elevated Reservoir)	12	Shown as assumed check valve in model
7	Yigo	Kaiser	Install PRV near intersection of Route 1 and Bartolu St., along Route 1 (south of Well Y-12, and east of Kaiser Reservoir)	12	Shown as assumed check valve in model
8	Barrigada	Kaiser	Install PRV near intersection of East Nandez Ave. and China Street (West of Well M-6)	12	Shown as assumed check valve in model
9	Barrigada	Kaiser	Install PRV along Route 26 on west most waterline, between Chalan Galak and Chalan Peskadot	16	Shown as assumed check valve in model
10	Barrigada	Kaiser	Install PRV along Route 26 on east most waterline, between Chalan Galak and Chalan Peskadot	16	Shown as assumed check valve in model
11	Kaiser	Tumon	Install PRV at intersection of Route 16 and Sunrise, along Route 16 (north of Well M-18)	12	Not found in model
12	Kaiser	Tumon	Install PRV at intersection of Route 16 and Taitano Road, along Route 16 (west of Well M-18)	12	Not found in model
13	Kaiser	Tumon	Install PRV at intersection of Route 1 and Carlos, along Route 1	24	Shown as assumed PRV in model
14	Kaiser	Tumon	Install PRV near intersection of Route 1 and Adrian Sanchez Street, along Route 1	12	Shown as assumed PRV in model

"This is a draft report and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report."

Table 8-8 – PRV Station Improvements (continued)

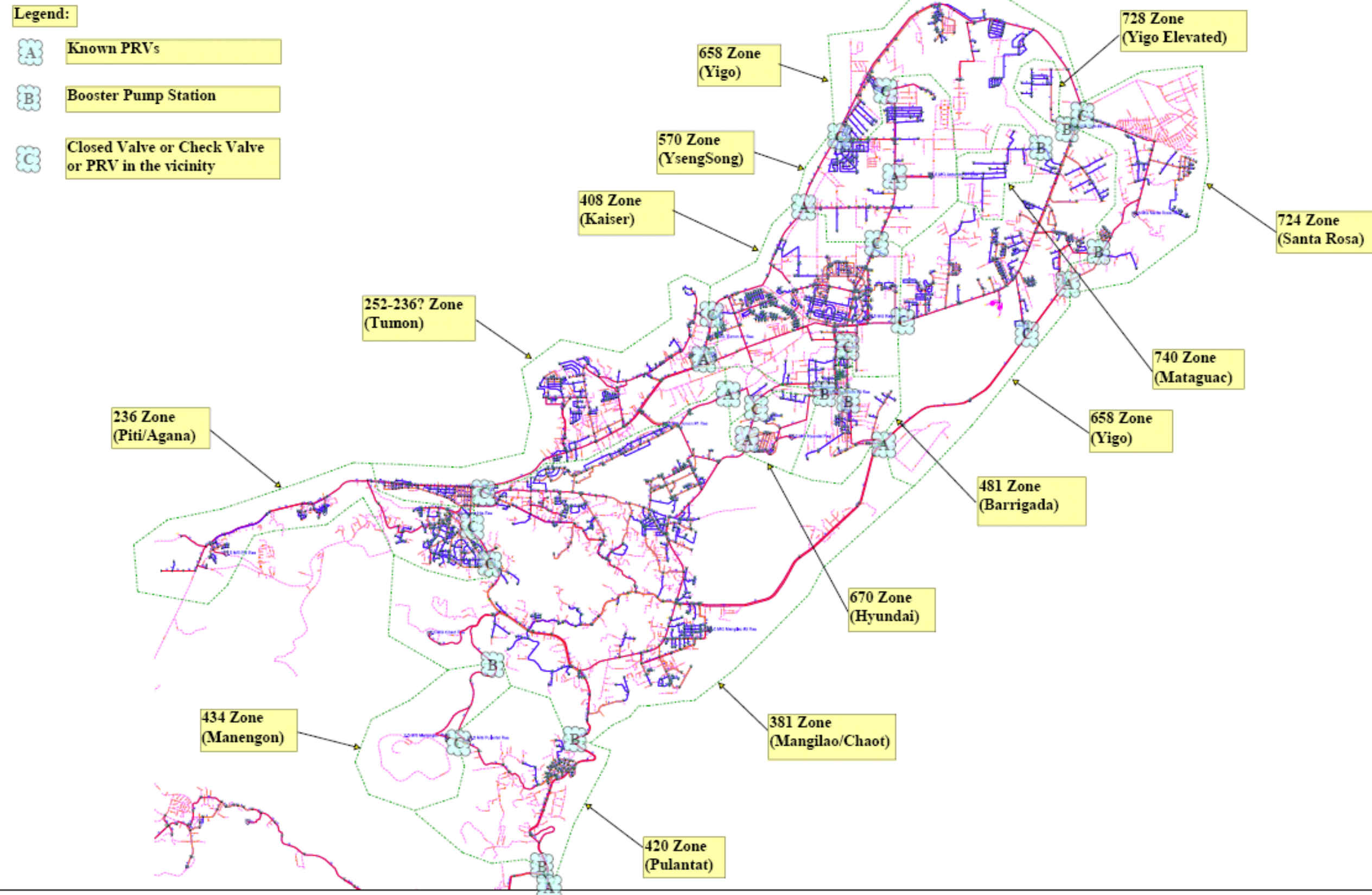
No.	High Pressure Zone	Low Pressure Zone	Street	Waterline Diameter	Comment
15	Kaiser	Tumon	Install PRV near intersection of Route 1 and Adrian Sanchez St., along Adrian Sanchez St.	14	Shown as assumed PRV in model
16	Mangilao/Chaot	Tumon	Install PRV at intersection of Route 4 and O'Brien, along O'Brien	8	Shown as assumed PRV in model
17	Mangilao/Chaot	Tumon	Install PRV near intersection of Route 33 and Route 8	12	Shown as assumed check valve in model
18	Tumon	Piti/Agana	Install PRV at intersection of Route 1 and Route 6, along Route 1 (north of Caldalaria Rd.)	20	Not found in model
19	Mangilao/Chaot	Piti/Agana	Install PRV near intersection of Route 4 and Chalan Canton Tutujan, along Chalan Canton Tutujan	8	Shown as assumed check valve in model
20	Mangilao/Chaot	Piti/Agana	Install PRV along Route 4 just north of Well A-23	12	Shown as assumed check valve in model
21	Manengon	Pulantat	Install PRV along Chalan Teleforo, southwest of Pulantat Reservoir	8	Shown as assumed check valve in model
22	Hyundai	Barrigada	Install PRV at intersection of Route 16 and Perez Coral, northwest of Hyundai Reservoir	16	Shown as assumed PRV in model
23	Malojloj	Pigua	Install PRV at intersection of Route 4 and Espinosa Ave., along 12" line on Route 4	12	Shown as assumed check valve in model
24	Malojloj	Pigua	Install PRV at intersection of Route 4 and Espinosa Ave., along west most waterline on Espinosa Ave.	12	Shown as assumed check valve in model

Figure 8-1 – SS Pressure Zones



"This is a draft report and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report."

Figure 8-2 – NS Pressure Zones



"This is a draft report and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report."