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Section 1.0
Executive Summary

1.1 Introduction

The City of Riviera Beach Utility District (CRBUD) is responsible for producing and distributing safe drinking water and sewage collection throughout its service area. The CRBUD owns, operates, and maintains water and wastewater facilities that serve the corporate limits of the City of Riviera Beach, the Town of Palm Beach Shores, a portion of the City of West Palm Beach, and unincorporated Palm Beach County land in the Gramercy Park area. The CRBUD's water facilities include raw water supply wells, the water treatment plant (WTP), the distribution system, and storage and re-pumping facilities. The CRBUD currently supplies drinking water to a population of approximately 40,000. The CRBUD also owns, operates and maintains wastewater facilities in generally the same service area as the water distribution system. The CRBUD's wastewater facilities include a gravity sewer collection system, manholes, wastewater pumping stations, and wastewater transmission piping. The CRBUD's wastewater is conveyed to the East Central Regional Water Reclamation Facility (ECRWRF) for treatment. The CRBUD receives wastewater from the Town of Mangonia Beach, which the CRBUD also conveys to the ECRWRF. The ECRWRF is operated by West Palm Beach but owned by the City of West Palm Beach, the City of Lake Worth, the City of Riviera Beach, the Town of Palm Beach, and Palm Beach County.

The CRBUD water and wastewater infrastructure is aging; much of the infrastructure was constructed in the 1950s and 1960s. Certain critical components of the system are at the end of their expected useful life. Recognizing that certain aging infrastructure would need rehabilitation and replacement over the next 20 years, the CRBUD decided to develop a master plan to identify capital improvement needs relative to maintaining the reliability of its water and wastewater systems.

Additionally, water quality sampling conducted by the Palm Beach County Health Department (PBCHD) in the summer of 2010 found low total chlorine residual (less than 0.6 mg/L) in the Gramercy Park region of the water distribution system, which resulted in a consent order from the PBCHD for noncompliance with Rule 62-555.350(6) of the Florida Administrative Code (FAC). Among other things, the consent order requires the CRBUD to prepare a hydraulic model of the water distribution system. Hence, the CRBUD decided that this Master Plan should include development of a hydraulic model of the water distribution system to aid in assessing potential distribution system chlorine residual improvements.

1.1.1 Planning Area and Period

The planning area for this Master Plan consists of the CRBUD water and wastewater service area depicted in **Figure 1-1**. The wastewater service area is generally the same as the water service area, with the exception that the CRBUD's wastewater service area also includes the Town of Mangonia Park. The CRBUD conveys wastewater to the ECRWRF. The CRBUD sells neither raw water nor drinking water to other public water systems. It is noted that the CRBUD's water distribution system is interconnected with the City of West Palm Beach at two locations and Seacoast Utilities at one location.

The planning period for this study is 20 years extending to the year 2032.

1.1.2 Capital Improvement Planning Flexibility

There are a number of unavoidable uncertainties that affect water and wastewater master planning. Given the limitations on master planning certainty, the CRBUD should build flexibility into the implementation of the Master Plan recommendations to offset the consequences of unexpected events, such as an equipment failure in advance of the replacement timeframe recommended in this report. Additionally, the CRBUD should plan for taking advantage of economic downturns since this condition would likely result in highly competitive bids, enhancing the value of the CRBUD's infrastructure investment.

1.2. Existing Facilities

1.2.1 Water System

The principal water infrastructure serving the CRBUD's customers includes the following:

- Water Supply System
- Water Treatment Plant
- Water Distribution System
- Water Storage and Repump Facilities

1.2.1.1 Water Supply System

The CRBUD obtains all of its raw water supply from the surficial Biscayne Aquifer system via two active wellfields (the "Eastern Wellfield" and the "Western Wellfield") permitted under Water Use Permit No. 50-00460-W, issued by the South Florida Water Management District (SFWMD) on February 27, 2012.

The Eastern Wellfield includes 17 existing wells. The Western Wellfield includes 11 existing wells. The CRBUD reports that the wells are operated in rotation to reduce

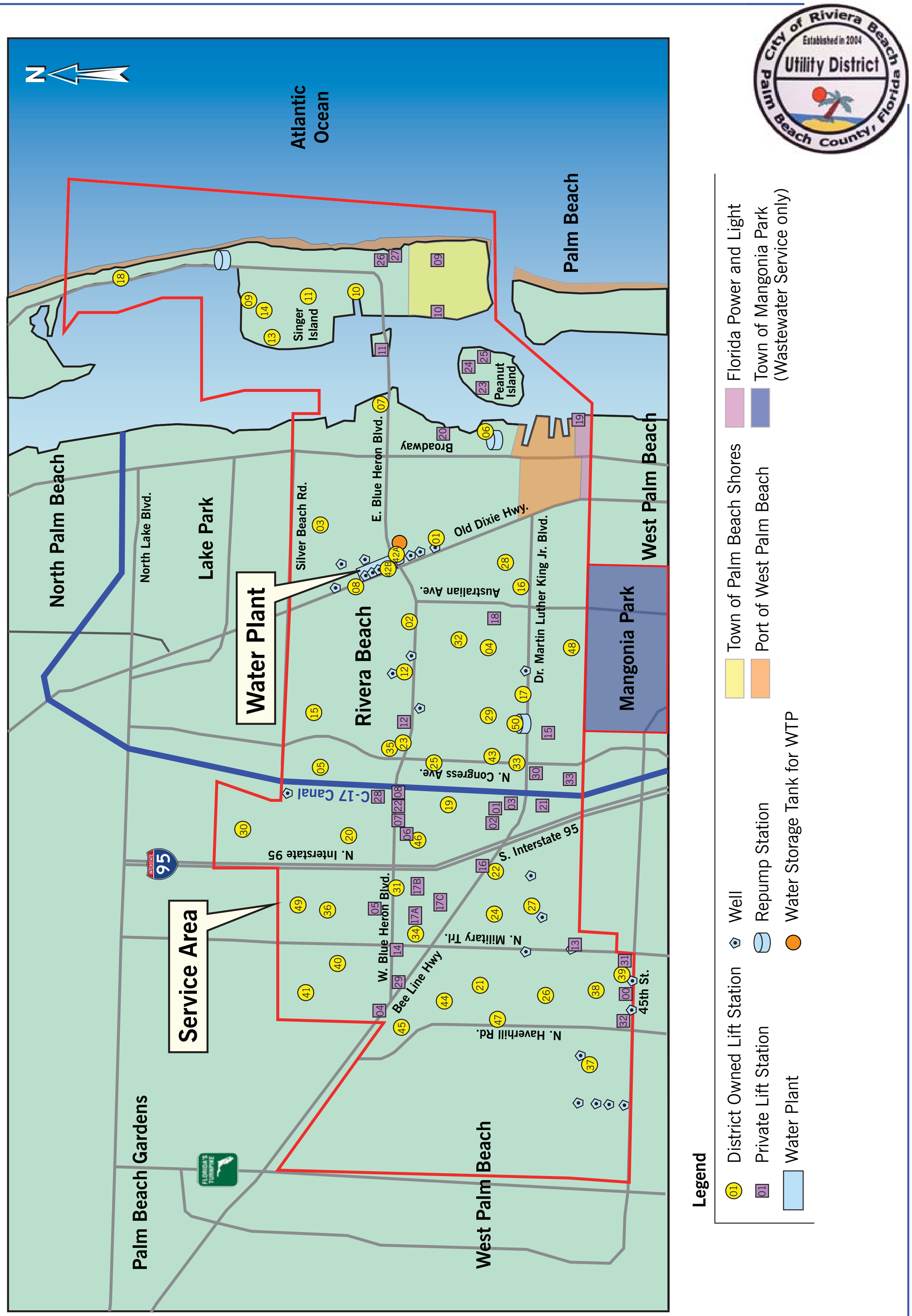

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Figure 1-1
Service Area

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eastern well withdrawals to minimize salt water intrusion in the aquifer. The existing wells were constructed from the 1960's through 2004. Two (future) proposed wells are also permitted for construction. The CRBUD's wellfield also includes three monitor wells. The CRBUD raw water quality is similar to other Biscayne Aquifer raw water sources in South Florida.

Raw water from the wellfields is pumped to the Water Treatment Plant (WTP) via approximately 58,000 feet of raw water transmission system piping, which ranges from 6-inch to 36-inch in diameter.

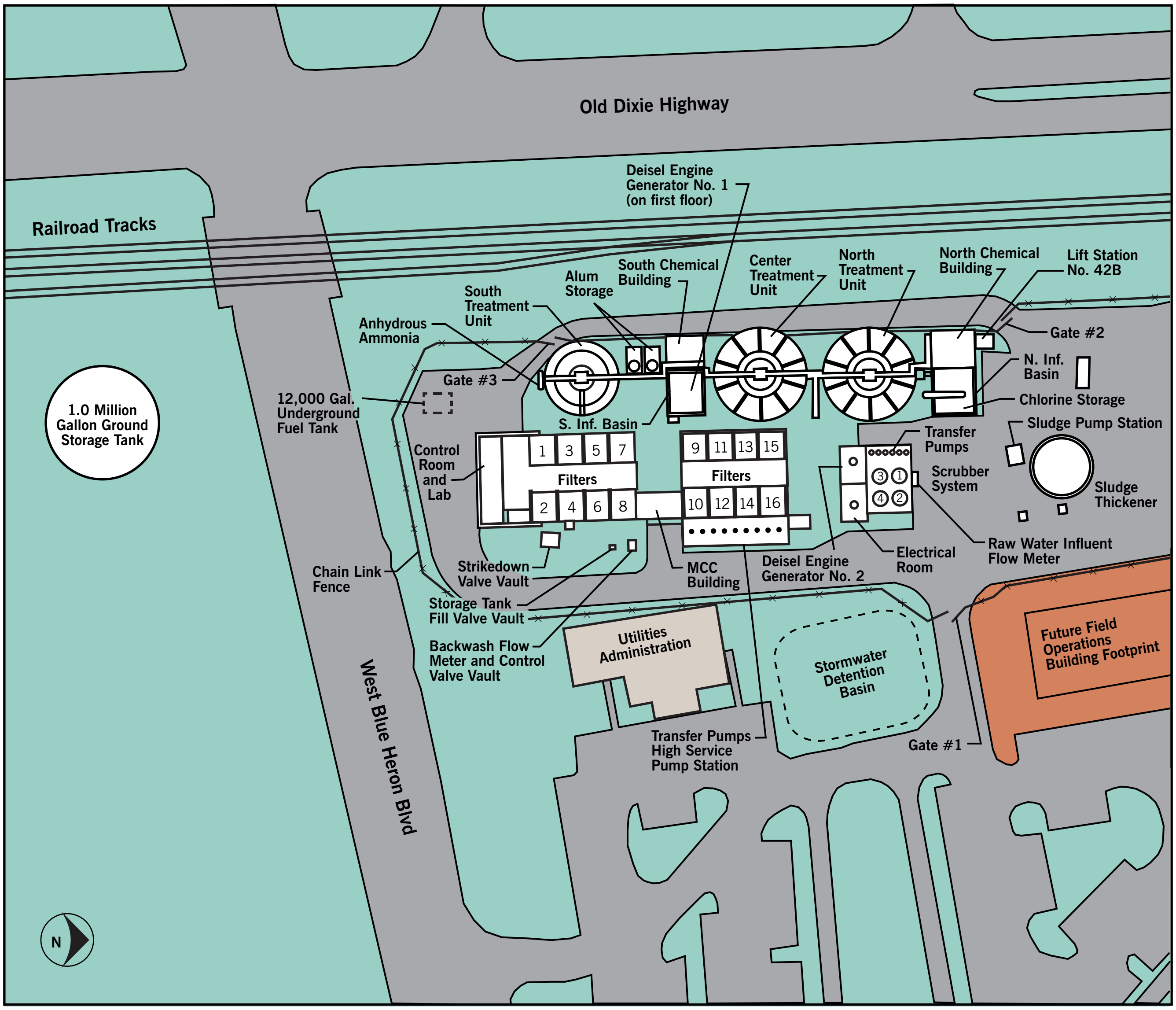
1.2.1.2 Water Treatment Facilities

The existing CRBUD Water Treatment Plant (WTP), originally constructed in 1958, consists of four packed tower scrubbers, two aeration basins, three lime softening treatment units, sixteen filters divided into two filter banks, two interconnected clearwells, two vertical turbine pumps used for backwash and transferring water to storage, and seven vertical turbine high service pumps to convey treated water to the distribution system. A site plan of the treatment facility is depicted on **Figures 1-2 and 1-3**.

The facility (located at 800 West Blue Heron Boulevard, Riviera Beach, Florida 33404) is permitted by the Florida Department of Environmental Protection (FDEP) as a community type Public Water System (PWS) system with a capacity currently permitted at 17.5 mgd.

Additional key elements of the WTP include:

- Onsite Storage - Finished water from the water treatment plant is stored in a one million gallon prestressed concrete ground storage tank located at the Wells Recreation Center located south of Blue Heron Boulevard.
- Lime Storage and Feed - There are four lime storage silos at the WTP.
- Disinfection - Water is currently disinfected using chloramines. Free chlorine is supplied by a gaseous chlorination system and mixed with free ammonia injected from an anhydrous ammonia system.
- Alum (along with polymer) is currently added upstream of the treatment units to act as a coagulant to reduce settled water turbidity.
- Lime solids generated in the softeners are currently periodically blown down via a timer system and conveyed via gravity to the two save all basins. CRBUD staff pump the supernatant back to the treatment process and the lime solids are removed and stock-piled in the northwest portion of the site.



Legend

Area Reserved for Future Utility Field Operations Building

Approximate Scale: 1” = 120’

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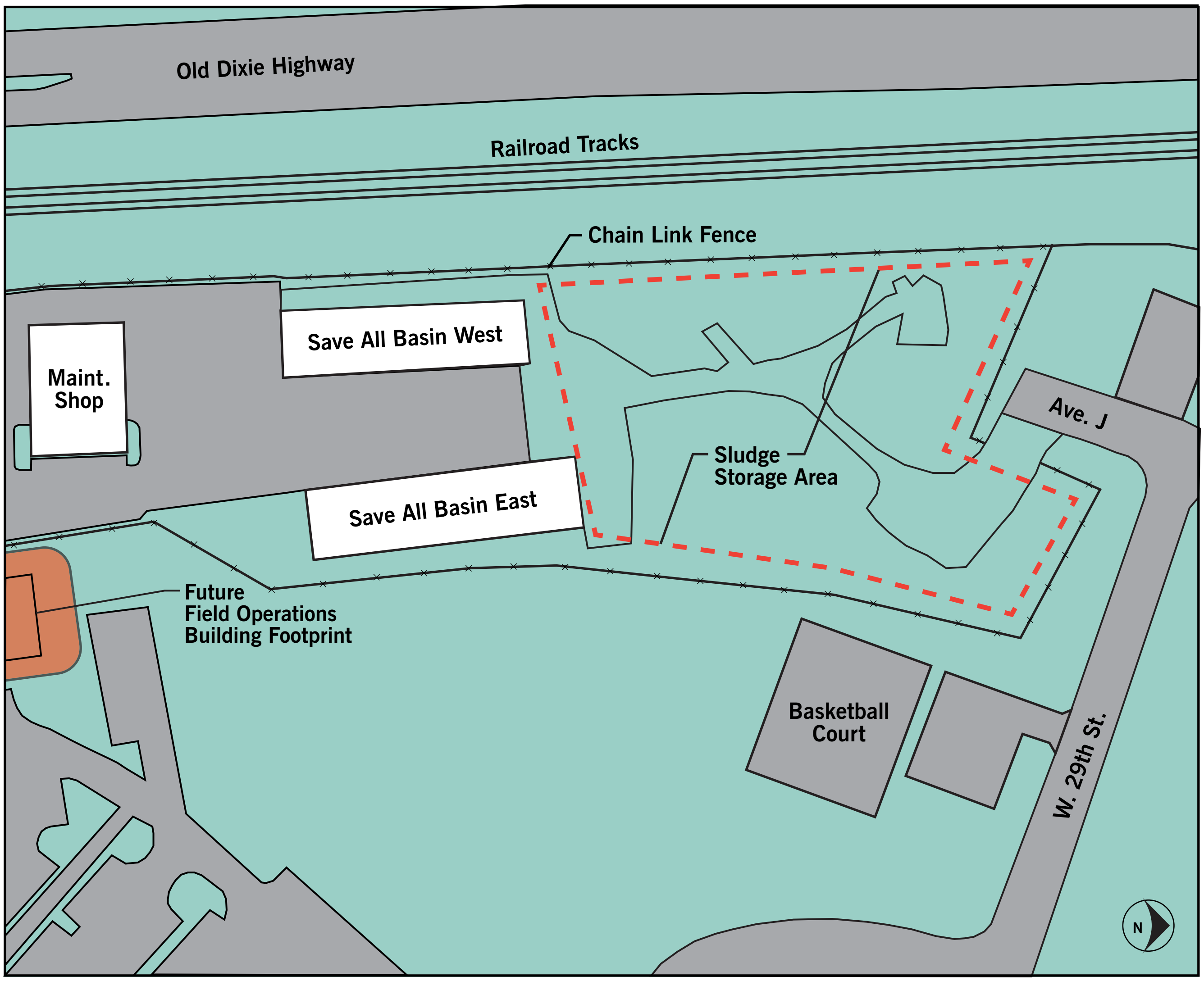
Figure 1-2
Water Treatment Plant – Existing Site Plan South



Approximate Scale: 1” = 120’

Legend

Area Reserved for Future Utility Field Operations Building

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Figure 1-3
Water Treatment Plant – Existing Site Plan North

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- Emergency Power - Emergency power for the WTP is provided by one 1,000 kW diesel engine generator (generator 1) located within the first floor of the south chemical building and one 250kW diesel engine generator (generator 2) located in a building south of the scrubbers.

- Motor Control Centers - The WTP has three sets of motor control centers (MCCs).

- Control System - Seven PLCs are installed in various locations within the WTP for automation of electromechanical processes.

1.2.1.3 Water Distribution System

The CRBUD's water distribution system consists of approximately 186 miles of pipe, ranging from 1 to 30-inch diameter, which conveys the finished water from the treatment plant to the individual customers. In general, the larger diameter transmission mains radiate from the treatment plant and decrease in size as they extend throughout the service area. The piping is comprised of a variety of materials, including cast iron, ductile iron, galvanized steel, asbestos cement, high density polyethylene (HDPE), and polyvinyl chloride (PVC). The system also includes appurtenances such as fire hydrants (approximately 1,100) and water meters (approximately 16,000). Aging of the system is a concern, as some of the elements were constructed over 50 years ago. The CRBUD's water distribution system has three interconnections with two adjacent utilities (Seacoast and West Palm Beach).

CRBUD received a consent order from the PBCHD in a letter dated December 23, 2010 for a failure to maintain a minimum combined chlorine residual of 0.6 mg/L throughout the drinking water distribution system per Rule 62-555.350(6) of the Florida Administrative Code (FAC). Under this consent order the CRBUD is required to prepare and submit the results of the following:

1. A semi-annual chlorine burn in the system
2. A hydraulic study of the system
3. Surveillance monitoring to include weekly total coliform samples in the troubled areas
4. Additional flushing within the system in troubled areas

1.2.1.4 Water Storage and Repump Facilities

There are three existing water storage tank and repump stations within the CRBUD service area. Each repump station is equipped with backup power via a diesel engine generator. The repump stations are designated as follows:

- North Singer Island (NSI) Repump Station
- Avenue C Repump Station
- Avenue U Repump Station

1.2.2 Wastewater System

The CRBUD owns and operates a wastewater collection and transmission system within its service area. The wastewater collection system includes piping (approximately 169 miles) and manholes (approximately 2,600) that convey wastewater via gravity from connections with houses, businesses, etc. to lift stations that are owned by the CRBUD. There are 51 CRBUD owned wastewater lift stations within the service area. The wastewater lift stations convey the wastewater (via force mains) further downstream in the system until it ultimately reaches the ECRWRF for treatment. The ECRWRF is owned by its five contributing local governments and operated by the City of West Palm Beach.

The CRBUD's wastewater collection and transmission system receives wastewater from the City of Riviera Beach, Town of Palm Beach Shores, the Town of Mangonia Park, the Port of Palm Beach and Florida Power and Light.

1.2.3 ECRWRF Biosolids Upgrades

The ECRWRF currently treats biosolids through partial stabilization at the treatment plant via aerobic digestion, dewatering, and then further stabilizes the biosolids at an off-site regional composting facility under a service contract with the Solid Waste Authority of Palm Beach County (SWAPBC). The existing composting facility service contract with the SWAPBC expires on September 30, 2014. As a result, the ECRWRF biosolids will need to be handled in a different manner. The CRBUD will be responsible for certain funding relative to the planned ECRWRF biosolids capital improvement.

The ECRWRF has recently completed a study titled "*Engineering Report for Biosolids Treatment and Management*" that recommended as series of improvements at the ECRWRF to sustain long term biosolids disposal at a 70 million gallon per day facility rating.

It is recommended that the CRBUD adjust the wastewater rates to recover the increased ECRWRF treatment costs that will be passed on to the CRBUD by the ECR Board. Refer to Subsection 1.7 for additional details regarding recommended rate adjustments.

1.3 Evaluations and Assessments

For purposes of this Master Plan, the following evaluations/assessments were conducted to help identify the needs of CRBUD relative to maintaining a reliable/sustainable utility:

- reviewing the findings of previously prepared documents
- development and utilization of a hydraulic model of the water transmission/distribution system
- development and utilization of a hydraulic model of the wastewater transmission system
- field reconnaissance to assess aboveground infrastructure condition and desktop analyses to estimate infrastructure age
- bench scale testing at the WTP
- regulatory review and compliance assessment

1.4 Findings Relative to Project Needs

Based on the evaluations and assessments noted above, projects (i.e., capital improvements) were recommended to maintain the sustainability of the CRBUD water and wastewater infrastructure over the next 20 years. These recommended projects were categorized based on the primary driver for the respective project, as described below:

1. Regulatory: Regulatory driven projects are improvements that are considered necessary for compliance with current and possible future regulations. The CRBUD has an ongoing issue with maintaining chlorine residual in the Gramercy Park area of its water distribution system. Regulatory driven projects related to the water distribution system are recommended to aid the CRBUD achieve regulatory compliance relative to distribution system chlorine residual.

2. Capacity: Capacity driven projects are improvements that increase the capacity of the water distribution and wastewater pumping and transmission systems to meet the needs of current customers as well meeting the needs for forecasted population growth. Based on the CRBUD's Water Use Permitting efforts prior to the initiation of this Master Plan, the CRBUD determined that capacity improvements to the water supply and water treatment facilities were not needed. Consequently, capacity assessments of the CRBUD's water supply and water treatment facilities are not included in this Master Plan.

3. Renewal and Replacement: The CRBUD's water and wastewater infrastructure is relatively old and certain elements have reached the end of their useful life.

R&R projects are intended to either rehabilitate (i.e., renew) or replace infrastructure that is at the end of its useful life and maintain the reliability of the existing infrastructure at current capacity.

4. Water Quality: Projects categorized as “water quality” are intended to enhance water treatment plant operational effectiveness resulting in improved drinking water quality.

5. Water System Security: Projects identified as security related are intended to improve the security of the water treatment plant and repump stations.

6. Facility Improvement: Facility improvement projects were projects identified by the CRBUD staff to enhance operational effectiveness. Additionally, the CRBUD identified adding fluoridation at the WTP as a facility improvement type project.

Projects were also identified by the primary infrastructure area to which they belong, as follows:

- Water Supply Projects
- Water Treatment Projects
- Water Distribution System Projects
- Water System Security Projects
- Wastewater Collection System Projects
- Wastewater Lift Station Projects
- Wastewater Force Main Projects

1.5 Opinion of Probable Project Costs

For each project identified, an opinion of probable costs has been prepared based upon master plan level information. Because of the level of scope development at this stage the opinion of probable project costs are “Order Of Magnitude” estimates as defined by the Association for the Advancement of Cost Engineering International (AACE). The expected range of accuracy for this type of opinion is +100 percent to -50 percent. These opinions of probable cost have been prepared for guidance in project evaluation and implementation from the information available at this stage of the estimate. The final costs of the projects will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions. As a result, the final project costs will vary from the opinions presented herein.

The cost opinions are "project costs" and are inclusive of: construction costs; contractor overhead and profit; estimated allowance for permit application fees; 20 percent estimated allowance for engineering and administrative services during the design, permitting, construction and startup of the project; along with a 30 percent contingency. The costs are based upon year 2012 dollars and do not include escalation for inflation.

Various summaries of project costs are presented in the **Tables 1.1 through 1.5**. It is noted that a capital cost for the ECR Biosolids Upgrade project is not included in these tables. Rather, a cost for this project is included in the financial model (described in Section 14 titled "Financial Considerations") as a debt service.

Table 1.1
Opinion of Probable Projects Costs
Summarized by Category and Improvement Type

Category – Improvement Type	Project Cost (Year 2012 $)
Water Supply – Regulatory	$2,580,000
Water Supply – R&R	$15,814,000
Water Treatment Plant – Water Quality	$6,730,000
Water Treatment Plant – Regulatory	$930,000
Water Treatment Plant – R&R	$23,250,000
Water Treatment Plant – Facility Improvement	$1,500,000
Water Distribution System – Capacity	$11,140,000
Water Distribution System – Regulatory	$2,065,000
Water Distribution System – R&R	$93,700,000
Water System Security	$1,010,000
Wastewater – Regulatory	$50,000
Wastewater – R&R	$54,821,000
Wastewater – Capacity	$800,000
Total	**$214,390,000**

Table 1.2
Summary of Water Project Costs

Infrastructure Area	Project Cost (Year 2012 $)
Water Supply	$18,394,000
Water Treatment	$32,410,000
Water Distribution	$106,905,000
Water System Security	$1,010,000
Total - Water	**$158,719,000**

Table 1.3
Summary of Wastewater Project Costs

Infrastructure Area	Project Cost (Year 2012 $)
Wastewater Collection	$22,291,000
Wastewater Lift Stations	$19,530,000
Wastewater Force Mains	$13,850,000
Total - Wastewater	**$55,671,000**

Table 1.4
Summary of Costs by Improvement Type

Improvement Type	Project Cost (Year 2012 $)
Regulatory	$5,625,000
Renewal and Replacement	$187,585,000
Water Quality	$6,730,000
Facilities	$1,500,000
Capacity	$11,940,000
Water System Security	$1,010,000
Total	**$214,390,000**

Table 1.5
Overall Cost Summary

Infrastructure	Project Cost (Year 2012 $)
Water	$158,719,000
Wastewater	$ 55,671,000
Total	$214,390,000

1.6 Prioritization and Implementation Plan

Once project needs were identified, there was a need to prioritize them and develop a reasonable and fundable plan for implementation. Based on the type of project being evaluated, one of two prioritization methodologies was utilized, as follows:

- Prioritization Methodology 1: Projects related to renewal and replacement (R&R) of existing infrastructure were prioritized using methodology 1, which factored in the condition, estimated remaining useful life, and the consequence of failure to assess the risk of failure of the existing infrastructure.

- Prioritization Methodology 2: Projects not related to R&R of existing infrastructure were prioritized using methodology 2, which assessed the consequences of not implementing the project relative to certain qualitative (criticality) parameters.

Based on the ranking, the prioritized projects were placed into one of the following implementation timeframes: 1) urgent, 2) high, 3) medium, 4) low, and 5) programmatic. In certain cases, the CRBUD staff decided to rank projects higher than determined via the initial scoring methodology to account for qualitative issues associated with a particular project.

1.6.1 Project Implementation Timeframes

The ranked projects were grouped into implementation timeframes as indicated in **Table 1.6**. The ranking, grouping and implementation timeframes presented below are not intended to take into account the feasibility to fund the projects. Rather, the ranking, grouping and implementation timeframes are presented as an idealized goal based upon the project team's judgment of infrastructure needs. Given limitations on available funding, the CRBUD should use the rankings as a basis for making investment decisions.

Table 1.6
Implementation Timeframes

Group	Description	Implementation Timeframe Fiscal Year
1	Urgent Priority: High likelihood of asset failure with severe consequences if asset fails for R&R type project (or severe consequences for non-implementation of non-R&R projects).	2013 to 2015
2	High Priority: Medium to high likelihood of asset failure with medium to high consequences if asset fails for R&R type project (or medium to high consequences for non-implementation of non-R&R projects).	2016 to 2020
3	Medium Priority: Low to medium likelihood asset failure with low to medium severity of consequences if asset fails for R&R type projects (or low to medium consequences for non-implementation of non-R&R projects).	2021 to 2025
4	Low Priority: Low likelihood of asset failure and low consequences if asset fails for R&R type project (or low consequences for non-implementation of non-R&R projects).	2026 and beyond
P	Programmatic: Certain types of projects lend themselves to implementation on an annual (or otherwise recurring) basis, such as annual fire hydrant replacement. These types of projects were categorized as programmatic.	Annually

Actual timeframes for implementation of projects depends upon budget limitations.

1.6.2 Budget Limitations

Table 1.7 presents a summary of the expenditure timeframe based upon the rankings and "idealized" implementation timeframes presented above. The "idealized" implementation timeframes do not consider the feasibility of project funding.

Table 1.7
Capital Improvement Program Expenditure Summary
Based on Idealized Implementation Timeframes

Category	FY 2013 to 2015	FY 2016 to 2020	FY 2021 to 2025	FY 2026 and beyond	Total
Water	$23,765,000	$26,110,000	$34,409,000	$74,435,000	$158,719,000
Wastewater	$8,241,000	$20,744,000	$10,866,000	$15,820,000	$55,671,000
Total	**$32,006,000**	**$46,854,000**	**$45,275,000**	**$90,255,000**	**$214,390,000**

***Legend**: FY: Fiscal Year.*

Based upon financial modeling, it was determined that the above expenditure timeframes would require significant near term rate increases, above those already planned by the CRBUD prior to initiating this report. Hence, financial analyses were performed, as described below, to assess a plausible (likely fundable) expenditure schedule for the first 11 years of the CRBUD capital improvement program.

1.7 Financial Considerations

A detailed analysis of the CRBUD financial condition was performed by the specialty firm Public Resources Management Group in order to determine the feasibility of funding the projects recommended in this Master Plan. Based upon financial modeling, the CRBUD staff (with advice from the consultants) decided that for the first 11 years (i.e., fiscal years 2013 to 2023) of the capital improvement program, expenditures would need to be limited to urgent and high priority capital improvements, based upon the assumptions listed below, to maintain rate increases at an acceptable level:

- Group 1 and the vast majority of Group 2 (i.e., urgent priority ranking) projects would be included in the capital improvement program and the costs would be spread out from fiscal year 2013 to 2023;
- Group 3 and 4 projects (and approximately $2.35M of Group 2 projects) would not be included in the first 11 years of the capital improvement program and would be implemented sometime after fiscal year 2023; and
- Programmatic type wastewater projects would be funded at approximately 36 percent of the estimated need for the first 11 years with the balance of the improvement needs being delayed until after fiscal year 2023.
- Programmatic type water projects would be funded at approximately 25 percent of the estimated need for the first 11 years with the balance of the improvement needs being delayed until after fiscal year 2023.

Based on the assumptions above, a plausible expenditure schedule for the capital improvement program is presented in **Table 1.8**.

Table 1.8
Capital Improvement Program Expenditure Schedule

Category	FY 2013 to 2017	FY 2018 to 2023	FY 2024 and Beyond	Total
Water	$30,185,000	$35,525,000	$ 96,009,000	$158,719,000
Wastewater	$16,270,000	$12,948,000	$ 26,453,000	$ 55,671,000
Total	**$46,455,000**	**$45,473,000**	**$122,462,000**	**$214,390,000**

Legend: *FY: Fiscal Year*

Note: *Costs are in 2012 dollars.*

The CRBUD has approved a series of rate adjustments through Fiscal Year 2019 that were developed based upon a rate study prepared during Fiscal Year 2008 ("Approved Rates"). The expenditure scenario in **Table 1.8** would likely be fundable through fiscal year 2023 if the following were implemented:

- Implement the approved rates adjustments through 2019;
- Increase the wastewater rates at the beginning of Fiscal Year 2014 by an additional 13.0% to recover costs associated with the ECRWRF biosolids project;
- Increase the wastewater rates at the beginning of Fiscal Year 2015 by an additional 8.0% to recover costs associated with the ECRWRF biosolids project;
- Additional annual rate adjustments for water and irrigation of 2.0% in Fiscal Year 2014, 3.0% in Fiscal Year 2015 through 2019, and 4.5% per year from Fiscal Year 2020 through 2023.
- Additional annual rate adjustments for wastewater of 4.0% in Fiscal Year 2016 through 2019, and 4.5% per year from Fiscal Year 2020 through 2023.

Assessment of funding feasibility beyond fiscal year 2023 was beyond the scope of this project. **Table 1.9** reflects the rate adjustments described above.

The above described capital improvement program was recommended in this Master Plan since it: 1) produces a reasonable (responsible) rate increase over the 11 year timeframe from fiscal year 2013 through 2023; 2) allows for the funding of all Group 1 and the majority of Group 2 projects (which the project team identified as the highest implementation priority); 3) begins the initiation of the annual funding for programmatic type projects from operations (although not at the level which may be necessary in the long-term); and 4) provides the ability to leverage water and wastewater revenues in the future (i.e., issuance of additional bonds) to fund the projects at the lowest initial cost to the customer.

Table 1.9
Recommended Water, Wastewater, and Irrigation Rates

Year	Rate Percentage (%)								
	Water			Wastewater			Irrigation		
	Approved	Additional Increase	Total	Approved	Additional Increase	Total	Approved	Additional Increase	Total
2013	2.00	0.00	2.00	5.38	0.00	5.38	2.00	0.00	2.00
2014	2.04	2.00	4.08	4.14	13.00	17.68	2.04	2.00	4.08
2015	2.00	3.00	5.06	1.99	8.00	10.15	2.00	3.00	5.06
2016	2.04	3.00	5.10	5.15	4.00	9.36	2.04	3.00	5.10
2017	2.00	3.00	5.06	2.07	4.00	6.15	2.00	3.00	5.06
2018	2.03	3.00	5.09	3.63	4.00	7.78	2.03	3.00	5.09
2019	1.99	3.00	5.05	3.60	4.00	7.74	1.99	3.00	5.05
2020	-	4.50	4.50	-	4.50	4.50	-	4.50	4.50
2021	-	4.50	4.50	-	4.50	4.50	-	4.50	4.50
2022	-	4.50	4.50	-	4.50	4.50	-	4.50	4.50
2023	-	4.50	4.50	-	4.50	4.50	-	4.50	4.50

Note: *In order to calculate the actual realized rate increase that a customer will see on their new bill you must calculate the total rate increase the following way; for example FY 2013 has an approved rate index of 4.14% and a proposed rate increase of 13%. In order to calculate what the total rate increase would be for FY 2013 you would do the following; 1.0414 * 1.13 = 1.176782 which would equal the 17.68% rate increase as presented on Table 1-9.*

1.8 Future Planning

It is recommended that the CRBUD update this Master Plan on a five year cycle and reassess the ranking of the projects, financial forecast and associated capital improvement program expenditure schedule.

Section 2.0
Introduction

2.1 Background

The City of Riviera Beach Utility District (CRBUD) is responsible for producing and distributing safe drinking water and sewage collection throughout its service area. The CRBUD owns, operates, and maintains water and wastewater facilities that serve the corporate limits of the City of Riviera Beach, the Town of Palm Beach Shores, a portion of the City of West Palm Beach, and unincorporated Palm Beach County land in the Gramercy Park area. The CRBUD's water facilities include raw water supply wells, the water treatment plant (WTP), the distribution system, and storage and re-pumping facilities. The CRBUD currently supplies drinking water to a population of approximately 40,000. The CRBUD also owns, operates and maintains wastewater facilities in generally the same service area as the water distribution system. The CRBUD's wastewater facilities include a gravity sewer collection system, manholes, wastewater pumping stations, and wastewater transmission piping. The CRBUD's wastewater is conveyed to the East Central Regional Water Reclamation Facility (ECRWRF) for treatment. The CRBUD receives wastewater from the Town of Mangonia Beach, which the CRBUD also conveys to the ECRWRF. The ECRWRF is operated by West Palm Beach but owned by the City of West Palm Beach, the City of Lake Worth, the City of Riviera Beach, the Town of Palm Beach, and Palm Beach County.

The CRBUD water and wastewater infrastructure is aging; much of the infrastructure was constructed in the 1950s and 1960s. Certain critical components of the system are at the end of their expected useful life. Recognizing that certain aging infrastructure would need rehabilitation and replacement over the next 20 years, the CRBUD decided to develop a master plan to identify capital improvement needs relative to maintaining the reliability of its water and wastewater systems.

Additionally, water quality sampling conducted by the Palm Beach County Health Department (PBCHD) in the summer of 2010 found low total chlorine residual (less than 0.6 mg/L) in the Gramercy Park region of the water distribution system, which resulted in a consent order from the PBCHD for noncompliance with Rule 62-555.350(6) of the Florida Administrative Code (FAC). Among other things, the consent order requires the CRBUD to prepare a hydraulic model of the water distribution system. Hence, the CRBUD decided that this master plan should include development of a hydraulic model of the water distribution system to aid in assessing potential distribution system chlorine residual improvements.

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The section below provides a general overview of the scope of this master plan.

2.2 Scope of Work

This master plan scope of work involves planning level efforts to identify water and wastewater capital improvement needs over the next 20 years, including the following major elements:

- Plan (based upon documents provided by the CRBUD) capital improvements to maintain the reliability of the existing water supply system;
- Plan (based on equipment age and site observations) capital improvements to maintain the reliability of the existing water treatment plant infrastructure;
- Bench-scale testing of certain water quality impacts if the CRBUD switches to sodium hypochlorite disinfectant along with an assessment of non-capacity type capital improvements for improving drinking water quality utilizing existing infrastructure;
- Prepare and utilize a water distribution system model to identify and plan water storage and distribution system capacity improvements to meet forecasted population growth;
- Plan (based on pipe age) capital improvements to maintain the reliability of the existing water distribution system infrastructure;
- Plan water facility security needs;
- Prepare and utilize a wastewater transmission system model to identify and plan wastewater lift station and conveyance piping capacity improvements to meet forecasted population growth;
- Plan (based on pipe age) capital improvements to maintain the reliability of the existing wastewater transmission system infrastructure;
- Plan capital improvements needed for compliance with existing and anticipated future regulations related to the design, operation, and maintenance of water and wastewater infrastructure;
- Development of opinions of probable cost for the planned improvements;
- Ranking of the planned improvements (based on certain qualitative criteria) to aid the CRBUD prioritize infrastructure investment decisions; and

- Develop a ten-year financial forecast to assist the CRBUD evaluate its ability to fund the planned capital improvements.

The master plan scope of work did not include planning for certain water and wastewater infrastructure elements as described below.

The CRBUD was issued a Water Use Permit (WUP) from the South Florida Water Management District (SFWMD) on February 27, 2012. The permit number is 50-00460. The WUP allows the CRBUD to withdraw a maximum of 3,313 million gallons per year from the surficial Biscayne Aquifer through February 27, 2032. Based upon population and water demand forecasting prepared by the CRBUD's WUP consultant, the WUP supply allocation appears adequate to meet demand through the year 2032. Hence, raw water supply capacity improvements were not considered necessary by the CRBUD staff and are not addressed in this report. However, this report does address the addition of two water supply wells mandated by the WUP specific conditions.

Based upon the CRBUD's experience with operating its gravity sewer collection system, the CRBUD elected to not include an assessment of the capital improvement needs of the gravity sewer collection system from a capacity and reliability perspective. Additionally, this master plan did not include planning of wastewater scalping to produce reclaimed water. Wastewater scalping requires a costly investment; planning of wastewater scalping was not deemed warranted given that Biscayne Aquifer water supply allocation appears adequate to meet demand through the year 2032.

2.3 Planning Area

The planning area for this master plan consists of the CRBUD water and wastewater service area depicted in **Figure 2-1**. The wastewater service area is generally the same as the water service area, with the exception that the CRBUD's wastewater service area also includes the Town of Mangonia Park. The CRBUD conveys wastewater to the ECRWRF. The CRBUD sells neither raw water nor drinking water to public water systems. It is noted that the CRBUD's water distribution system is interconnected with the City of West Palm Beach at two locations and Seacoast Utilities at one location.

2.4 Planning Period

The planning period for this study is 20 years, extending to the year 2032.

2.5 Capital Improvement Planning Flexibility

There are a number of uncertainties that are unavoidable that affect water and wastewater master planning. Certain factors that may result in master planning uncertainty include, but are not limited to, the following:

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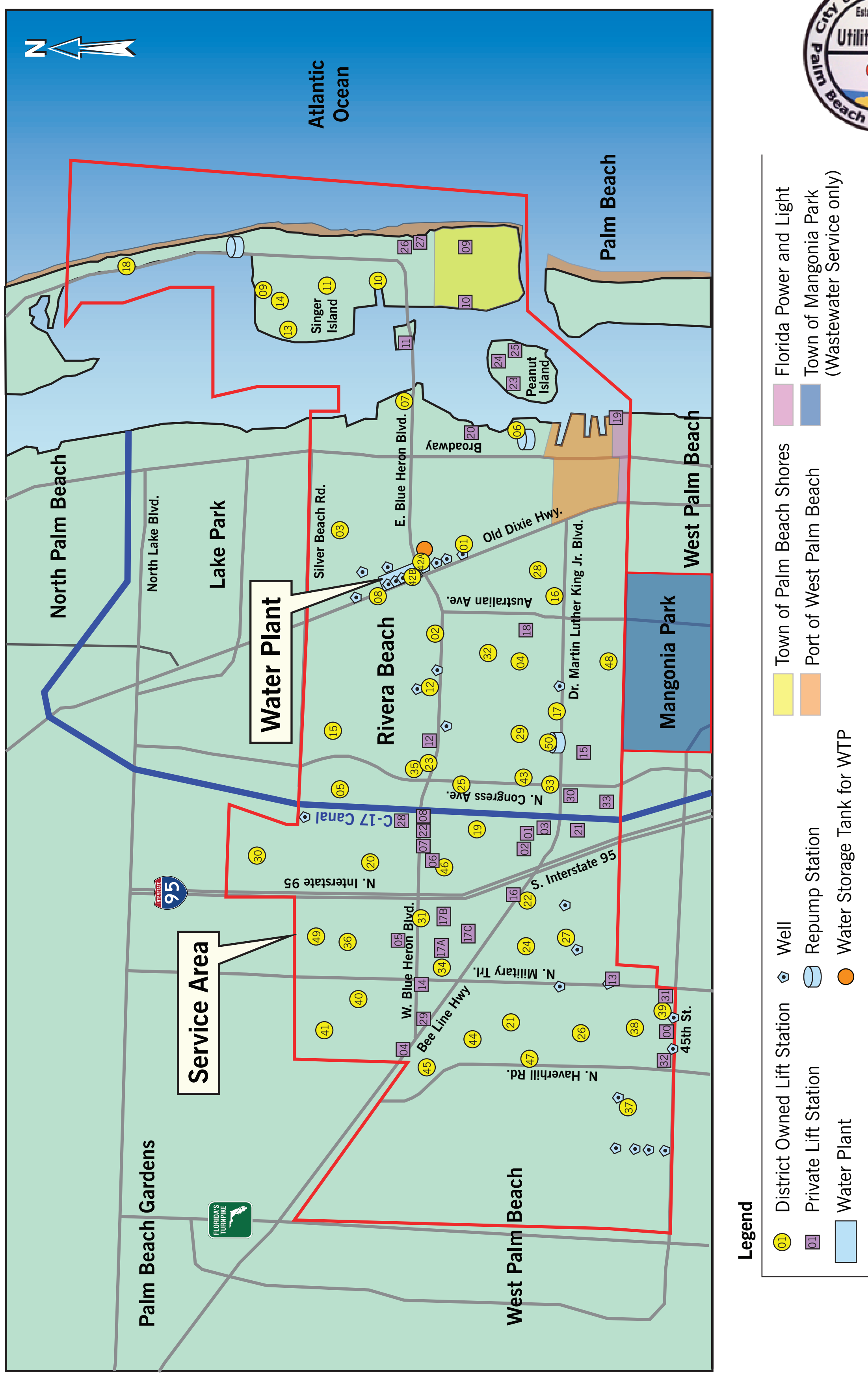

Figure 2-1
Service Area

- Accuracy of population forecast assumptions;
- Prediction of likely timeframe of infrastructure failure;
- Accuracy of available record data;
- Absence of record data for existing infrastructure;
- Accuracy of forecasted enterprise fund revenue; and
- Economic conditions.

Given the above limitations on master planning certainty, the CRBUD should build flexibility into the implementation of the master plan recommendations to offset the consequences of unexpected events, such as an equipment failure in advance of the replacement timeframe recommended in this report. Additionally, the CRBUD should plan for taking advantage of economic downturns since this condition likely result in highly competitive bids, enhancing the value of the CRBUD's infrastructure investment.

Section 3.0
Summary of Existing Facilities

3.1 Introduction

This section provides a brief summary of the City of Riviera Beach Utility District's (CRBUD's) existing water and wastewater utility infrastructure. The principal water infrastructure serving the CRBUD's customers include the following:

- Water Supply System
- Water Treatment Plant
- Water Distribution System
- Water Storage and Repump Facilities

The principal wastewater infrastructure serving the CRBUD's customers include the following:

- Wastewater Collection System
- Wastewater Transmission System

The following subsections describe the major features of the existing water and wastewater utility infrastructure.

3.2 Water Supply System

3.2.1 Introduction

The CRBUD obtains all of its raw water supply from the surficial Biscayne Aquifer system via two active wellfields. The wellfields are designated the "Eastern Wellfield" and the "Western Wellfield". Withdrawal of water from the wellfields is permitted by Water Use Permit No. 50-00460-W, issued by the South Florida Water Management District (SFWMD) on February 27, 2012. This subsection briefly describes the following major water supply related elements:

- Water Supply Wells
- Raw Water Quality
- Raw Water Transmission System

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3.2.2 Water Supply Wells

The CRBUD obtains all of its raw water supply from the surficial Biscayne Aquifer system via two active wellfields. The wellfields are designated the "Eastern Wellfield" and the "Western Wellfield". The Eastern Wellfield includes 17 existing wells. The Western Wellfield includes 11 existing wells. The CRBUD reports that the wells are operated in rotation to reduce eastern well withdrawals to minimize salt water intrusion in the aquifer.

Figure 3-1 illustrates the locations of the 28 existing water supply wells. The existing wells were constructed from the 1960's through 2004. Two proposed wells are permitted for construction (wells A and B). **Table 3.1** summarizes certain critical information on the construction of the existing wells based upon data contained in the Water Use Permit.

Table 3.1
Water Supply Wells

Well No.	Wellfield	Year Drilled	Casing Diameter (inches)	Total Depth (feet)	Cased Depth (feet)	Pump Type	Pump Intake Depth (feet)	Use
1	Eastern	1967	12	224	186	S	84	P
4	Eastern	1967	8	220	210	S	65	P
5A	Eastern	1977	12	198	185	S	65	P
6	Eastern	1967	12	236	198	S	84	P
7	Eastern	1965	12	210	180	S	73	P
9A	Eastern	1978	12	180	160	S	84	P
10A	Eastern	1978	12	230	180	S	84	P
12A	Eastern	1985	12	220	160	S	64	P
13	Eastern	1988	12	240	175	S	84	P
14	Eastern	1967	12	220	181	S	70	P
15	Eastern	1977	12	230	187	S	75	P
16	Eastern	1969	10	224	185	S	65	P
17	Eastern	1967	10	245	205	T	65	SB
18	Eastern	1989	10	230	180	S	76	P
21	Eastern	1977	12	205	165	S	73	P
2004	Eastern	2004	10	175	130	S	U	P
A	Eastern	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
B	Eastern	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1

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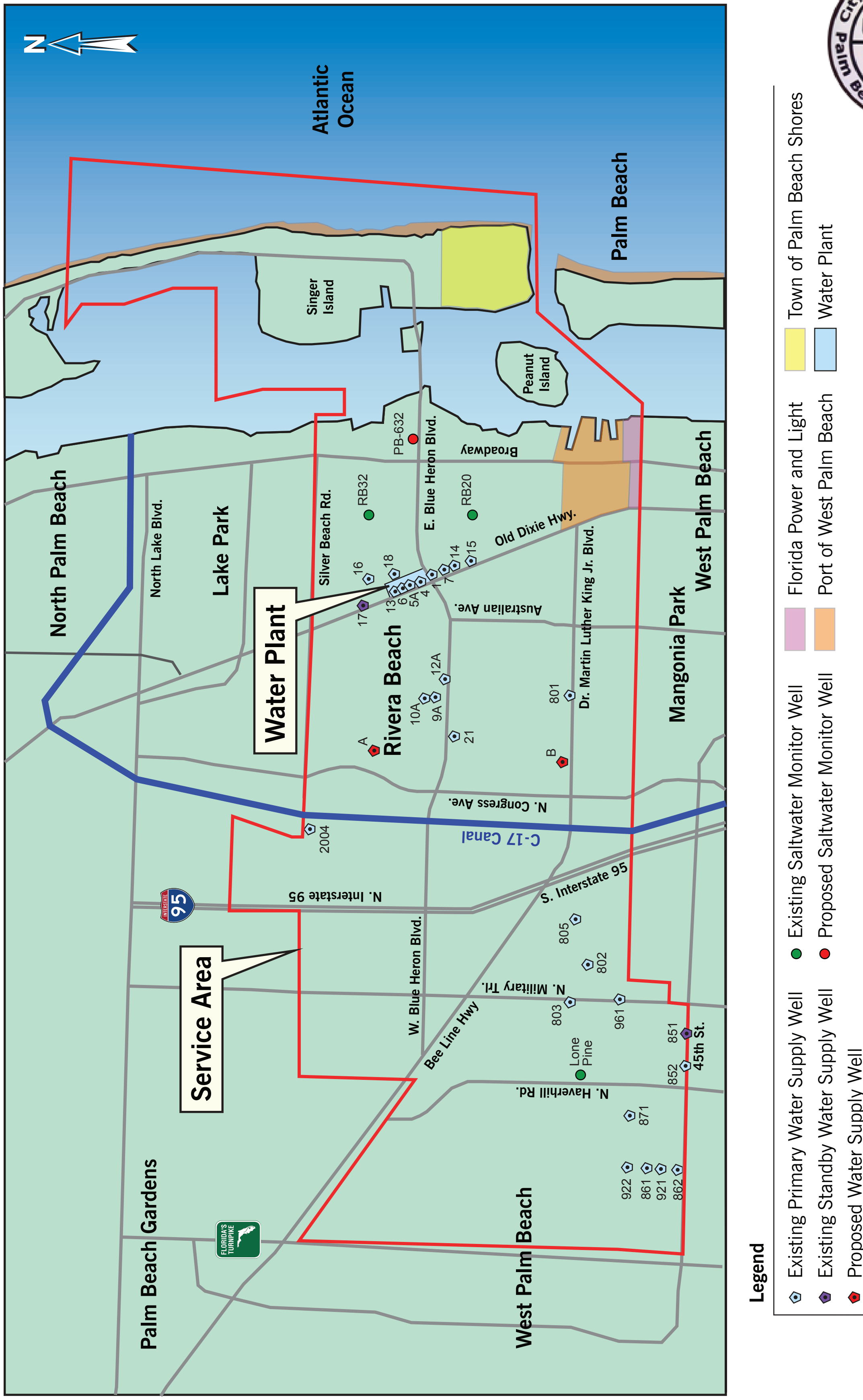

City of Riviera Beach Utility District

Figure 3-1
Water Supply Wells

Table 3.1 (Continued)
Water Supply Wells

Well No.	Wellfield	Year Drilled	Casing Diameter (inches)	Total Depth (feet)	Cased Depth (feet)	Pump Type	Pump Intake Depth (feet)	Use
801	Eastern	1984	12	230	125	S	75	P
802	Western	1984	14	200	109	S	75	P
803	Western	1984	14	155	95	T	75	P
805	Western	1984	14	190	122	S	75	P
851	Western	1985	14	160	75	S	64	SB
852	Western	1985	12	160	100	S	64	P
861	Western	1987	14	115	55	S	51	P
862	Western	1987	14	142	53	S	51	P
871	Western	1988	14	130	70	S	65	P
921	Western	1993	14	120	55	S	63	P
922	Western	1993	14	120	55	S	51	P
961	Western	1996	14	155	83	S		P

Note 1: *Wells A and B are proposed wells.*

Legend:

P: Primary Well (i.e., a well that is typically used for water supply)
S: Submersible Pump
SB: Standby Well (i.e., a well that is only used under certain permit conditions)
T: Turbine Pump
U: Unknown

The CRBUD's wellfield also includes three monitor wells. The monitor wells do not include pumps. **Table 3.2** summarizes certain construction information regarding these monitor wells.

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Table 3.2
Monitor Wells

Well No.	Wellfield	Year Drilled	Casing Diameter (inches)	Total Depth (feet)	Cased Depth (feet)	Pump Type	Pump Intake Depth (feet)	Use
RB20	Eastern	unknown	unknown	270	265	NA	NA	MW
RB32	Eastern	unknown	unknown	270	265	NA	NA	MW
Lone Pine	Western	unknown	2	223	218	NA	NA	MW

Legend:
MW: Monitor Well
NA: Not Applicable

The CRBUD monitors water level and chloride concentrations in monitor wells RB20, RB32, and Lone Pine, along with production wells 4, 15, 16, 802, 805, 861, 921, 922, and 2004 on monthly basis in accordance with Limiting Condition 28 of the Water User Permit.

The monitor wells RB20 and RB32 are located east of the Eastern Wellfield and west of Lake Worth Lagoon. Historically, the water surface elevations observed in these monitors wells has ranged from about 3 to 12 feet as measured in National Geodetic Vertical Datum (NGVD) of 1929. The South Florida Water Management (SFWMD) reports that these levels indicate the existence of a substantial mound of fresh water between the wellfield and the saline source. The CRBUD reports that chloride concentrations in these two monitor wells have ranged between 7 to 38 mg/L during operation of the Eastern Wellfield. The Water Use Permit indicates that there were brief chloride spikes of 65 mg/L in RB32 in December 2001. The SFWMD has limited the Eastern Wellfield withdrawal to six million gallons per day to lessen the potential for saline water instruction.

The Western Wellfield includes one monitor well designated at “Lone Pine”. The CRBUD reports that the chloride concentrations observed in this well have historically ranged between 240 to 365 mg/L. This is indicative of connate saline water in the vicinity of the wellfield, per the SFWMD. The Water Use Permit indicates that chloride concentrations in this monitor well have historically remained stable.

The CRBUD is modifying its wellfield operation program to shift some pumping from the Western Wellfield to the Eastern Wellfield to lessen the potential for the upconing of saline water in the Western Wellfield.

3.2.3 Raw Water Quality

Table 3.3 summarizes average raw water quality measured in 2011 by the CRBUD staff via daily composite samples at the WTP.

Table 3.3
Average Raw Water Quality for 2011

Parameter	Value
M. Alkalinity (mg/L as $CaCO_3$)	250
Total Hardness (mg/L as $CaCO_3$)	270
Calcium Hardness (mg/L as $CaCO_3$)	258
Magnesium Hardness (mg/L as $CaCO_3$)	12
Iron (mg/L)	0.29
pH	7.1
Color (NTU)	49

The CRBUD raw water quality is similar to other Biscayne Aquifer raw water sources in South Florida.

3.2.4 Raw Water Transmission System

The raw water from the wellfield is pumped to the WTP via the raw water transmission system piping. The pipe diameter ranges from 6-inch to 36-inch. There is roughly 58,000 feet of raw water transmission system piping, as indicated in **Table 3.4**.

Table 3.4
Raw Water Transmission System Pipe Diameters

Diameter (in)	Approximate Length (feet)
6	1,393
8	3,238
10	5,363
12	16,376
14	13
16	1,405
18	379
20	217
24	3,325
30	26,203
36	169
Total	**58,080**

Table 3.5 summarizes the distribution of raw water transmission system piping by materials. Roughly 80 percent of the raw water pipe is ductile iron, 18 percent is reported to be asbestos cement pipe and the balance is either unknown or plastic pipe.

Table 3.5
Raw Water Transmission System Pipe Materials

Material	Approximate Length (feet)
Unknown	1,206
Asbestos Cement (AC)	10,495
Cast Iron (CI)	1,120
Ductile Iron (DI)	45,003
High Density Polyethylene (HDPE)	132
Polyvinyl Chloride (PVC)	125
Total	58,080

3.3 Water Treatment Facilities

3.3.1 Introduction

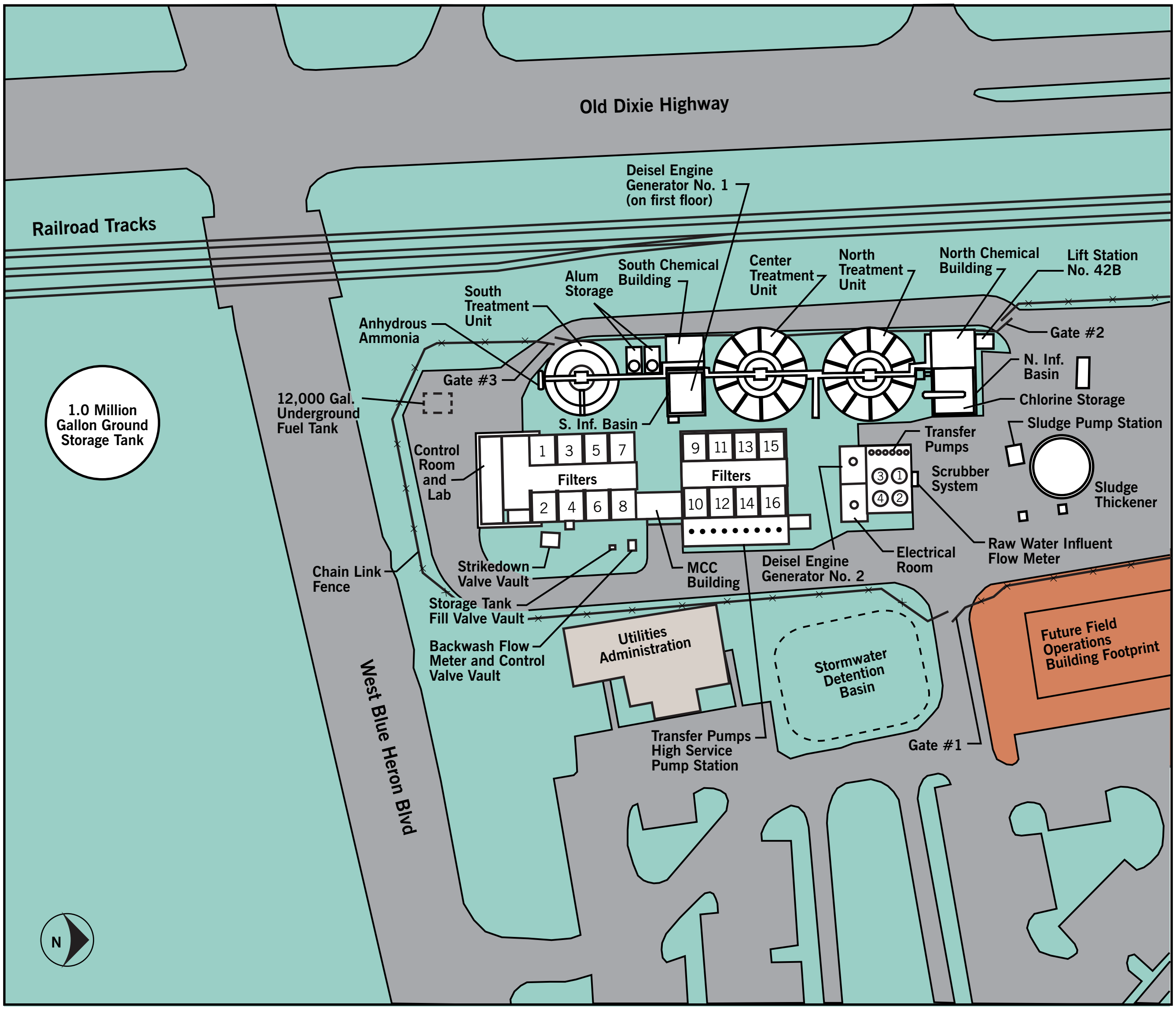
The existing CRBUD Water Treatment Plant (WTP), originally constructed in 1958, consists of four packed tower scrubbers, two aeration basins, three lime softening treatment units, sixteen filters divided into two filter banks, two interconnected clearwells, two vertical turbine pumps used for backwash and transferring water storage, and seven vertical turbine high service pumps to convey treated water to the distribution system. A site plan of the treatment facility is depicted on **Figures 3-2** and **3-3**.

The CRBUD WTP capacity is currently permitted at 17.5 mgd. The facility is permitted by the Florida Department of Environmental Protection (FDEP) as a community type Public Water System (PWS) system with PWS identification number of 4501229.

The WTP is located at 800 West Blue Heron Boulevard, Riviera Beach, Florida 33404. The Palm Beach County Property Appraiser lists the property identification number for the site as: 56434228000007000.

3.3.2 Scrubber System

Raw water is pumped from the production water wells into four packed tower scrubbers. The scrubber system was installed in 1986 for removal of volatile organic compound (VOC) contamination detected in the Eastern Wellfield since the late 1960s. Sampling of the raw water influent by the EPA in 2008 did not show the presence of VOCs above



Legend

Area Reserved for Future Utility Field Operations Building

Approximate Scale: 1" = 120'

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Figure 3-2
Water Treatment Plant – Existing Site Plan South

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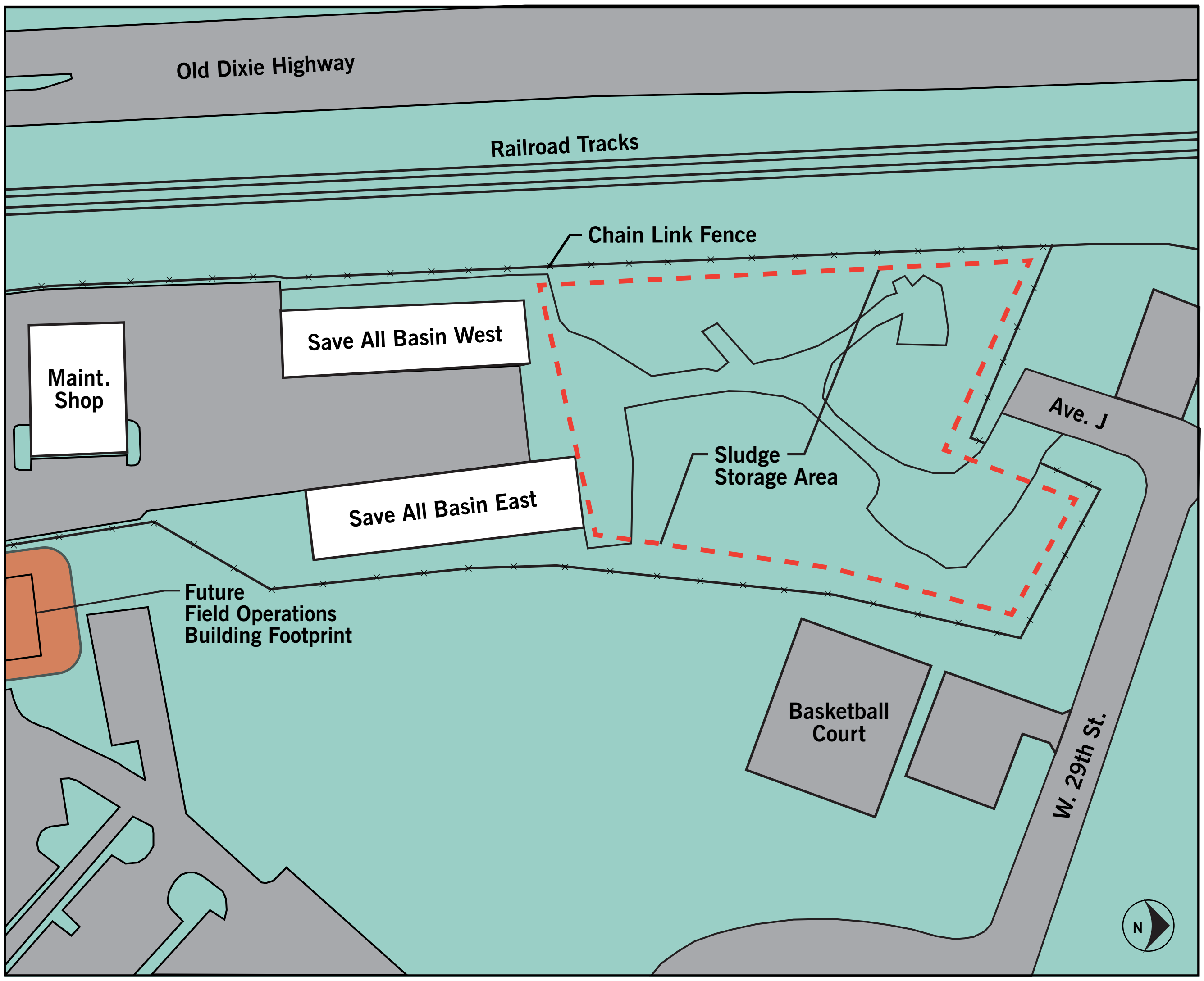
Environmental Engineers & Scientists



Approximate Scale: 1" = 120'

Legend

Area Reserved for Future Utility Field Operations Building

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Figure 3-3
Water Treatment Plant – Existing Site Plan North

federal nor state drinking water standards. The CRBUD continues to operate the air stripping system as a precautionary measure.

3.3.3 Raw Water Transfer Pumps

The scrubber system clearwell is equipped with six vertical turbine transfer pumps to convey the raw water to the north and south influent basins. **Table 3.6** summarizes information on the raw water transfer pumps.

Table 3.6
Raw Water Transfer Pumps

Pump No.	Pump Manufacturer	Drive Info	Speed Control	Pump Design Point	Drive Horsepower and Nominal RPM	Year Installed
1A	Ingersoll-Rand	Type: Electric Manuf.: US Motors	constant speed	7,000 gpm at 36 ft TDH	HP: 75 RPM: 900	1988
2A	Ingersoll-Rand	Type: Electric Manuf.: US Motors	VFD	4,700 gpm at 40 ft TDH	HP: 60 RPM: 900	1988
3A	Ingersoll-Rand	Type: Electric Manuf.: US Motors	constant speed	2,300 gpm at 40 ft TDH	HP: 30 RPM: 1,200	1988
1B	Ingersoll-Rand	Type: Electric Manuf.: US Motors	VFD	5,000 gpm at 36 ft TDH	HP: 60 RPM: 900	1988
2B	Ingersoll-Rand	Type: Electric Manuf.: US Motors	constant speed	3,600 gpm at 36 ft TDH	HP: 50 RPM: 900	1988
3B	Ingersoll-Rand	Type: Electric Manuf.: US Motors	constant speed	1,700 gpm at 36 ft TDH	HP: 20 RPM: 1,200	1988

Legend:

VFD: Variable frequency drive

Raw water transfer pumps 1A, 2A, and 3A convey water to the south influent basin. Raw water transfer pumps 1B, 2B, and 3B convey water to the north influent basin. No cross-connection exists to allow pumping to an alternate raw water influent basin. The north influent basin feeds the northern-most clarifier while the south influent basin feeds the remaining two clarifiers.

3.3.4 Softeners

The CRBUD WTP uses three upflow conventional lime softening treatment units (a.k.a., softeners). The softeners are designated: south treatment unit, center treatment unit and north treatment unit. The capacity of each softener, as indicated in the CRBUD files, is summarized in **Table 3.7**. This table also indicates the year the softener was first placed into service.

Table 3.7
Softeners

Softener	Approximate Year the Facility was Placed in Service	Capacity (mgd)
South Treatment Unit	1957	3.5
Center Treatment Unit	1964	6.5
North Treatment Unit	1979	7.5
	Total	**17.5**

The CRBUD staff reported that their finished water total hardness goal as 110 to 150 mg/L as $CaCO_3$. Water with a total hardness in this range is typically considered hard based upon the United States Geological Survey classification system of water hardness presented in **Table 3.8**.

Table 3.8
Hardness Classification

Classification	Total Hardness as $CaCO_3$
Soft	0 to 60
Moderately Hard	61 to 120
Hard	121 to 180
Very Hard	Greater than 180

Hard water is water that contains high levels of dissolved calcium, magnesium, and other mineral salts, such as iron (Fe^{3+}), strontium (Sr^{2+}), zinc (Zn^{2+}) and manganese (Mn^{2+}). The greater the amount of dissolved minerals in the water, the harder it is. The term “hard water” results from the fact that calcium and magnesium ions in water combine with soap molecules, making it “hard” to form soap bubbles.

Total hardness is defined as the sum of the calcium and magnesium hardness, in mg/L as calcium carbonate ($CaCO_3$). Even though iron, strontium, zinc and manganese may contribute to water hardness, their levels are typically much less than calcium and magnesium. Consequently, the levels of iron, strontium, zinc and manganese are usually not included in total hardness measurements.

The CRBUD’s finished water total hardness goal 110 to 150 mg/L as $CaCO_3$ is relatively high in comparison to the general industry range of 80 to 100 mg/L as $CaCO_3$. The general use of synthetic detergents has reduced the importance of hardness for soap consumption. Consequently, CRBUD’s softened water total hardness goal of 110 to 150 mg/L as $CaCO_3$ is likely a feasible practice for reducing overall water treatment plant chemical consumption and reducing lime sludge production.

Hard water is not a health concern. However, high levels of total hardness can cause excessive build-up of scale inside of water pipes (especially those carrying hot water) resulting in reduced water heater efficiency and clogging household pipes.

3.3.5 Filters

The filtration system at the water treatment plant consists of sixteen filters divided into two filter banks. The south filter bank includes Filters 1 through 8. The north filter bank includes Filters 9 through 16. All filters are the same size. A clearwell underneath the filters is used for filtered water storage. The filters are equipped with Leopold under drains, dual media (sand and anthracite), and a media wash system. The north filter bank utilizes a rotating surface wash water jet system; the south filter bank utilizes upflow water wash with air scour. Filter backwash water is transferred via gravity to the save all basins. Water from the filter clearwells is conveyed by gravity to the high service pump station.

Filters 1 through 4 were constructed in 1957, Filters 5 through 8 were constructed in 1964, and Filters 9 through 16 were constructed in 1979. Filters 1 - 8 were restored in 1996 including: the installation of new media, new Leopold underdrains, and the replacement of surface wash with air scour (blower installed). Filters 9 - 16 were refurbished with new valves and valve actuators in 2009; this refurbishment also included the cleaning of the filter media. New local computer screen control panels were added for all filters in 2010.

3.3.6 High Service and Transfer Pumps

Finished water high service pumping at the CRBUD WTP is accomplished using seven vertical turbine high service pumps. **Table 3.9** summarizes manufacturer, capacity and year installed for the high service pumps.

Table 3.9
High Service Pumps

Pump No.	Pump Info	Drive Info	Speed Control	Pump Design Point	Drive Horsepower and Nominal RPM	Year Installed or Replaced
1	Layne/Verti-Line Impeller: 9G15 Bowl: 18GM Stages: 2	Type: Electric Manuf.: US Motors	VFD (note 1)	4,000 gpm at 200 ft TDH	HP: 250 RPM: 1,800	1990
2	Byron Jackson	Type: Electric Manuf.: US Motors	constant speed	3,000 gpm at 150 ft TDH	HP: 150 RPM: 1,800	1979
3	J-Line	Type: Electric Manuf.: US Motors	constant speed	3,000 gpm at 150 ft TDH	HP: 150 RPM: 1,800	1979
4	unknown	Type: Electric Manuf.: US Motors	constant speed	3,500 gpm at 180 ft TDH	HP: 200 RPM: 1,800	1979
5	unknown	Type: Electric Manuf.: US Motors	constant speed	3,500 gpm at 180 ft TDH	HP: 200 RPM: 1,800	1979
6	Layne/Verti-Line Serial# 110894	Type: Electric Manuf.: US Motors	VFD (note 1)	4,000 gpm at 200 ft TDH	HP: 250 RPM: 1,800	1990
7	J-Line Model: N16KC3 Serial# 37368	Type: Electric Manuf.: US Motors	VFD (note 1)	4,000 gpm at 200 ft TDH	HP: 250 RPM: 1,800	1990

Note 1: *Variable frequency drives (VFDs) were added to these pumps in 2002.*

As indicated above, the total pumping capacity of the high service pump station is 25,000 gpm with all pumps in service. The firm pumping capacity with the single largest pump out of service is 21,000 gpm.

The high service pump station is also equipped with two vertical turbine transfer pumps that convey finished water from the clearwell to the water storage tank located south of Blue Heron Boulevard. **Table 3.10** summarizes certain data relative to the transfer pumps.

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Table 3.10
Finished Water Transfer Pumps

Pump No.	Pump Make and Model	Drive Info	Speed Control	Pump Design Point	Drive Horsepower and Nominal RPM	Year Replaced
1	Byron Jackson Size: 15HQH-1 Serial # 96ER1616	Type: Electric Manuf.: US Motors	constant speed	4,250 gpm at 78 ft TDH	HP: 100 RPM: 1,800	1996
2	Byron Jackson Size: 18KXL Serial # 96ER7270	Type: Electric Manuf.: US Motors	constant speed	1,500 gpm at 70 ft TDH	HP: 40 RPM: 1,800	1996

As indicated above the total transfer pumping capacity is 5,750 gpm with both transfer pumps in service.

3.3.7 On-Site Storage

Finished water from the water treatment plant is stored in a one million gallon prestressed concrete ground storage tank located at the Wells Recreation Center located south of Blue Heron Boulevard. This storage tank is interconnected with the clearwell system. The plant control system will automatically open a valve to allow water from this tank to flow back into the clearwell via gravity if the clearwell water level drops below a setpoint level (set in the plant control system). **Table 3.11** summarizes certain key information for this tank based upon available records.

Table 3.11
Blue Heron Boulevard Tank Information

Parameter	Value
Year Installed	1965
Tank Diameter (feet)	72
Approximate Tank Floor Elevation (NGVD29)	Unknown
Tank Sidewall Height (ft)	Unknown
Low Tank Water Depth Alarm Setpoint (ft)	Unknown
Tank Overflow Depth (ft)	Unknown

The DFS system monitors the water level in this tank. The WTP operators can operate valves via the plant control system to fill this tank.

3.3.8 Lime Storage and Feed

There are four lime storage silos at the WTP. One is located in the north chemical building and the others are located in the south chemical building. Each silo feeds one lime slaker located on the second floor of the chemical buildings. There are four total slakers. The south chemical building, along with its associated lime storage silos were constructed in 1964. The north chemical building, along with its associated lime storage silos were constructed in 1979. The slakers in south chemical building were replaced with new slakers in 2002. The slakers in the north chemical building were replaced with one new slaker in 2002 and one new slaker in 2004. Lime slurry is conveyed by gravity to the lime softening treatment units using a plastic piping open channel delivery system.

3.3.9 Disinfection

Water is currently disinfected using chloramines. Free chlorine is supplied by a gaseous chlorination system and mixed with free ammonia injected from an anhydrous ammonia system.

Chlorine is stored in one-ton chlorine cylinders located outdoors on the non-enclosed first floor of the north chemical building. Chlorine is transferred under vacuum from the chlorine cylinders to the chlorinators; the chlorinators control the gas feed rate to the injection points. The chlorinators are located on the second floor of the north chemical building. Currently, five primary chlorine injection points are utilized: one in each of the three softeners and one in each of the raw water influent pipes into both the north and south influent basins. Additionally, a secondary chlorine injection point is utilized in the finished water clearwell. The chlorination system was constructed in 1979 and is at the end of its estimated useful life.

Anhydrous ammonia is stored in a 1,000 gallon tank located directly south of south softener. The ammoniators (used to control the feed rate of the ammonia gas) are located on the second floor of the south chemical building. Ammonia is currently transferred in a gaseous state (pressurized) to the injection points located in the raw water influent pipes that feed the south and north influent basins. The ammoniators were originally constructed in 1983 and replaced in 1995. The ammoniators are at the end of their estimated useful lives. The anhydrous ammonia storage tank was constructed in 1983 and is at the end of its estimated useful life.

3.3.10 Alum

Alum (along with polymer) is currently added upstream of the treatment units to act as a coagulant to reduce settled water turbidity. The CRBUD currently adds about 1.5 mg/L of alum (a.k.a., aluminum sulfate) at three injection points. One alum injection point is located at the north influent basin (which feeds the north treatment unit). Two injection points are located at the south influent basin (which feeds the south and center treatment unit).

The alum system includes one 10,000 gallon glass lined steel alum storage tank. The tank was installed in 1979. The tank is located on the south side of the south chemical building. There are four alum feed pumps (one dedicated to each treatment unit plus a fourth for standby), located on the first floor of the south chemical building. The alum feed pumps were installed in 2009. Another glass lined steel storage tank sits directly south of the alum storage tank and is out of service. It was originally used to store activated silica.

3.3.11 Polymer

Polymers are typically added at a water treatment plant to help control effluent turbidity in the softeners. There is a polymer feed system located on the first floor of the north chemical building. The polymer system consist of five US Filter Polyblend M Series polymer feed system (Model M240), and two polymer drum scales with digital weight indicators. Polymer is stored in 55 gallon drums outside of the north chemical building. POL-E-Z ® 692 Plus by Nalco is currently added within the primary mixing zone of each softener. Based upon the low maximum allowable dosage (under the NSF International certification for this product) of 1 mg/L, the District has determined that it wants to replace this product with an alternative polymer. The polymer feed system was installed in 2010.

3.3.12 Solids Handling

Lime solids generated in the softeners are currently periodically blown down via a timer system and conveyed via gravity to the two save all basins. The save all basins were constructed in 1964. Filter backwash water is also conveyed to the save all basins. The solids in the save all basins is allowed to settle, whereupon the CRBUD staff pump the supernatant back to the treatment process and the lime solids are dug out and stock-piled in the northwest portion of the site. The return water pumps and associated equipment were last replaced in 1994. The CRBUD is currently attempting to retain a contractor to remove the stockpiled sludge. The CRBUD staff report that they are satisfied with this current solids handling practice.

There is also a non-functional solid handling system at the facility composed of a gravity thickener located to the east of the north chemical building and a vacuum filter located on the second floor of the north chemical building. The gravity thickener and vacuum filter were constructed in 1979. The gravity thickener and vacuum filter are reported by CRBUD staff to be non-functional since about 1997.

3.3.13 Emergency Power

Emergency power for the WTP is provided by one 1,000 kW diesel engine generator (generator 1) located within the first floor of the south chemical building and one 250kW diesel engine generator (generator 2) located in a building south of the scrubbers.

Generator 1 was originally installed in 1979 and was replaced in 1992. Generator 1 provides backup power for all water treatment processes apart from the scrubbers and raw water transfer pumps. Generator 2 was installed in 1988 with the construction of the scrubbers and provides emergency power for the scrubbers and raw water transfer pumps. A 12,000 gallon underground diesel fuel storage tank, located south of the south treatment unit, supplies fuel to both generators

3.3.14 Motor Control Centers

The WTP has three sets of motor control centers (MCCs). **Table 3.12** summarizes certain information about the MCCs.

Table 3.12
Motor Control Centers

MCC No.	Location	Air Conditioned?	Year Installed	Usage
MCC 1	MCC building located between the south and north filter banks	Yes	1979	High service pumps and finished water transfer pumps, south softener, center softener, and certain water supply wells
MCC 2	MCC room located in the electrical room south of the scrubbers	Yes	1988	Scrubber system and raw water transfer pumps
MCC 3	MCC room located on the second floor of the north chemical building	No	1979	Gravity thickener, vacuum filter, north softener, lift station for north chemical building, wells 4, 5 & 6, and maintenance shop

3.3.15 Control System

Programmable logic controllers (PLCs) are digital computers used for automation of electromechanical processes in an industrial environment such as a water treatment plant. Seven PLCs are installed in various locations within the water treatment plant as summarized in **Table 3.13**.

Table 3.13
Programmable Logic Controllers

PLC No.	Location	Year Installed	Manufacturer
PLC 1	MCC Building	1999	Allen Bradley SLC 5/04
PLC 2	Scrubber Electrical Room	1999	Allen Bradley SLC 5/04
PLC 3	South Chemical Building First Floor	1999	Allen Bradley SLC 5/04
PLC 4	North Chemical Building Second Floor MCC Room	1999	Allen Bradley SLC 5/04
PLC 5	South Filter Bank (Filters 1-8) Control Console Room	1996	Control Logix
PLC 6	North Filter Bank (Filters 9-16) Control Console Room	2010	Control Logix
PLC 7	Main Control Room	1999	Allen Bradley SLC 5/04

The PLCs communicate with the plant control system at the main control room. The main control room houses the main control panel, control console, and the data flow system (DFS) telemetry system. The front of the main control panel is equipped with indicator lights, switches, digital displays, and an alarm enunciator. The main control panel provides remote monitoring and control of various plant processes. The manufacturer and model of the PLC and remote input/output (I/O) inside the main control panel are Allen Bradley PLC 5. The PLC and remote I/O rack were installed in the main control panel in 1999. The control room console includes four human machine interface (HMI) workstation computers that were installed in 2007. The HMI software is GE iFix version 4.0 and currently uses 1505 active tags. The console also contains one computer dedicated for offsite monitoring and control using the DFS telemetry system, one computer for the WTP gate access control, one computer for security camera monitoring, one computer for weather monitoring, and one computer for access to the Utility District's billing system. The computer systems are connected to servers in the administration building for data backup.

3.4 Water Distribution System

3.4.1 Introduction

This subsection provides a brief overview of the main features of the existing CRBUD water distribution system. **Figure 3-4** illustrates the water distribution piping. This figure is based upon the Geographical Information System (GIS) shape files provided by the CRBUD. Pipe diameters are not shown for clarity.

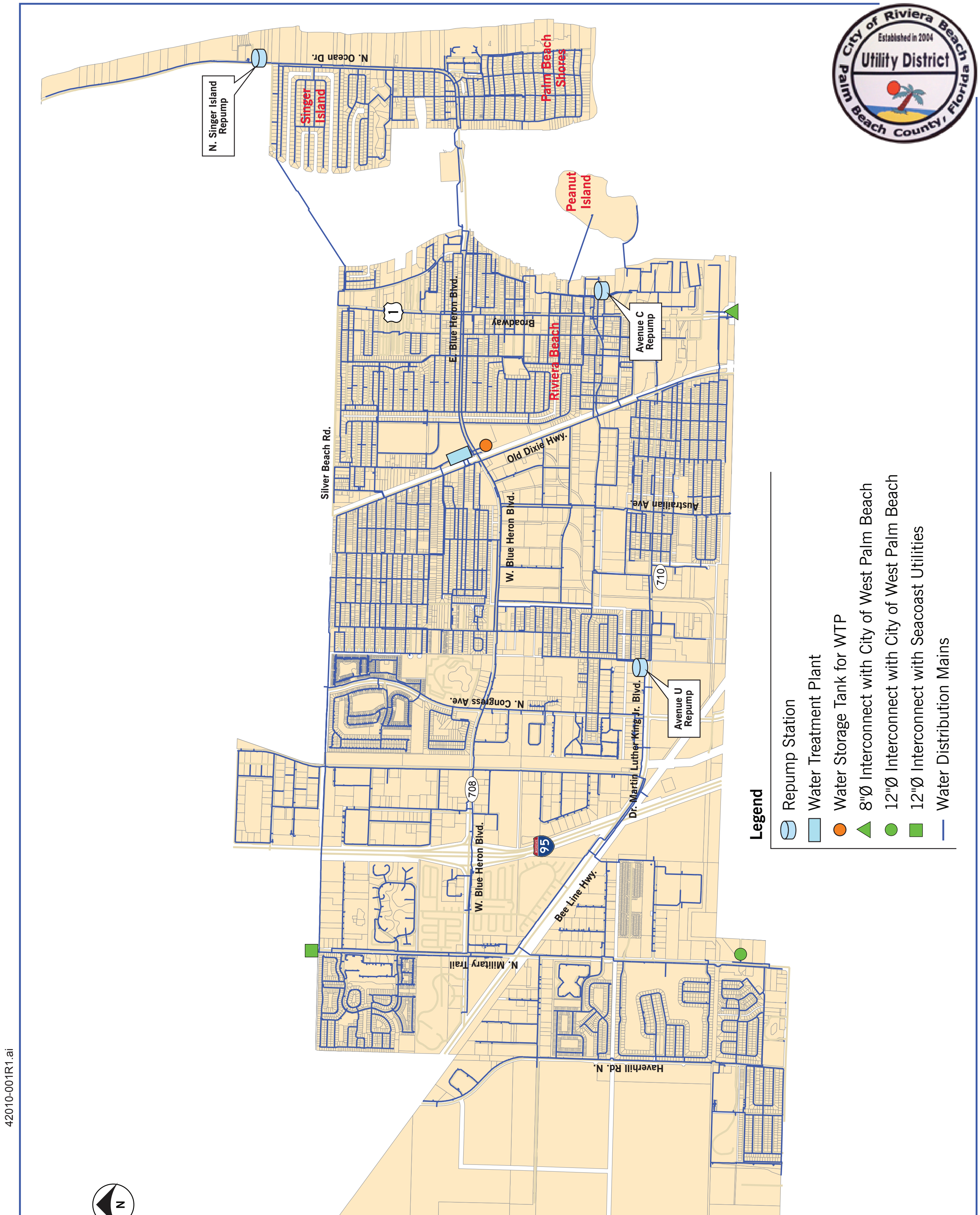

Figure 3-4
Existing Water Distribution System

3.4.2 Interconnects with Adjacent Utilities

The CRBUD's water distribution system has three interconnections with two adjacent utilities. Interconnects are as follows:

- 8-inch diameter interconnect with the City of West Palm Beach
- 12-inch diameter interconnect with the City of West Palm Beach
- 12-inch diameter interconnect with the Seacoast Utilities

Figure 3-4 illustrates the approximate location of these interconnects. These interconnects are closed under normal operations.

3.4.3 Water Piping Material and Diameter Distribution

The CRBUD's water distribution system consists of about 186 miles of pipe ranging from 1 to 30-inch diameter water mains that convey the finished water from the treatment plant to the individual customers. In general, the larger diameter transmission mains radiate from the treatment plant and decrease in size as they extend throughout the service area. The piping is comprised of a variety of materials, including cast iron, ductile iron, galvanized steel, asbestos cement, high density polyethylene (HDPE), and polyvinyl chloride (PVC). **Table 3.14** provides a distribution of the length of water piping by diameter and material.

Table 3.14
Water Distribution System Pipe Material and Diameter Distribution

DIA. (in)	Approximate Pipe Length (feet) By Material										
	U	CA	CI	DI	DIP	GI	GS	HDP	PVC	WS	Total
U	20,561			16					4,030		24,607
1	343	117	235	2		113	228		715		1,753
2	1,030	11,466	749	1,981		1,694	9,884		3,888		30,693
3	2	48,482	118	172					144		48,919
4	96	86,679	2,047	4,772					2,405		95,999
6	593	260,659	17,316	5,994	73		525		31,214		316,373
8	60	56,844	2,068	44,512	71				111,838	53	215,394
10	1,118	78,938	4,322	17,484					14,075		115,937
12	74	19,095	4,492	49,303	590			258	8,523		82,336
14		10,993	563	6,537							18,094
16	553	3,441	4,026	15,692				257			23,969
18			22								22
20	418		25	6,080							6,523
26		29									29
30		320	53	53							426
Total	**24,848**	**577,064**	**36,037**	**152,599**	**735**	**1,806**	**10,637**	**515**	**176,832**	**53**	**981,073**

Legend:

CA - Asbestos Cement

CI - Cast Iron

DI - Ductile Iron

DIP - Ductile Iron

GI - Galvanized Steel

GS - Galvanized Steel

HDP - High-density polyethylene

PVC - Polyvinyl chloride

U – Unknown

WS – Water Supply (material is unknown)

3.4.4 Pipe Age

Figure 3-5 provides a map of the water distribution piping with shading that identifies the approximate age of the piping. **Table 3.15** summarizes the age range of the water distribution system piping in the CRBUD system.

Table 3.15
Water Distribution System Pipe Age – All Materials

DIA. (in)	Approximate Linear Feet of Installed Water Main By Decade (All Materials)						
	Total Length (feet)	**Unknown**	**1951 - 1960**	**1961 - 1970**	**1971 - 1980**	**1981 - 1990**	**1991 - Current**
Unknown	24,607	11,181	673	821	2,714	2,441	6,778
1	1,753	124	465	473	48	65	578
2	30,693	862	18,461	5,508	1,721	2,396	1,744
3	48,919	15,121	22,392	11,224	21	160	-
4	95,999	1,935	46,052	38,737	5,262	2,947	1,066
6	316,373	25,132	145,742	88,357	42,994	10,317	3,833
8	215,394	29,252	23,054	25,815	54,030	22,878	60,364
10	115,937	12,025	33,841	35,368	18,079	6,768	9,856
12	82,336	15,684	18,611	6,437	14,594	20,442	6,568
14	18,094	403	12,194	1,769	1,324	2,404	-
16	23,969	5,901	6,087	4,623	284	-	7,074
18	22	-	22	-	-	-	-
20	6,523	-	1,422	5,083	-	-	17
26	29	-	29	-	-	-	-
30	426	9	373	7	37	-	-
Total	**981,073**	**117,629**	**329,419**	**224,222**	**141,107**	**70,818**	**97,879**

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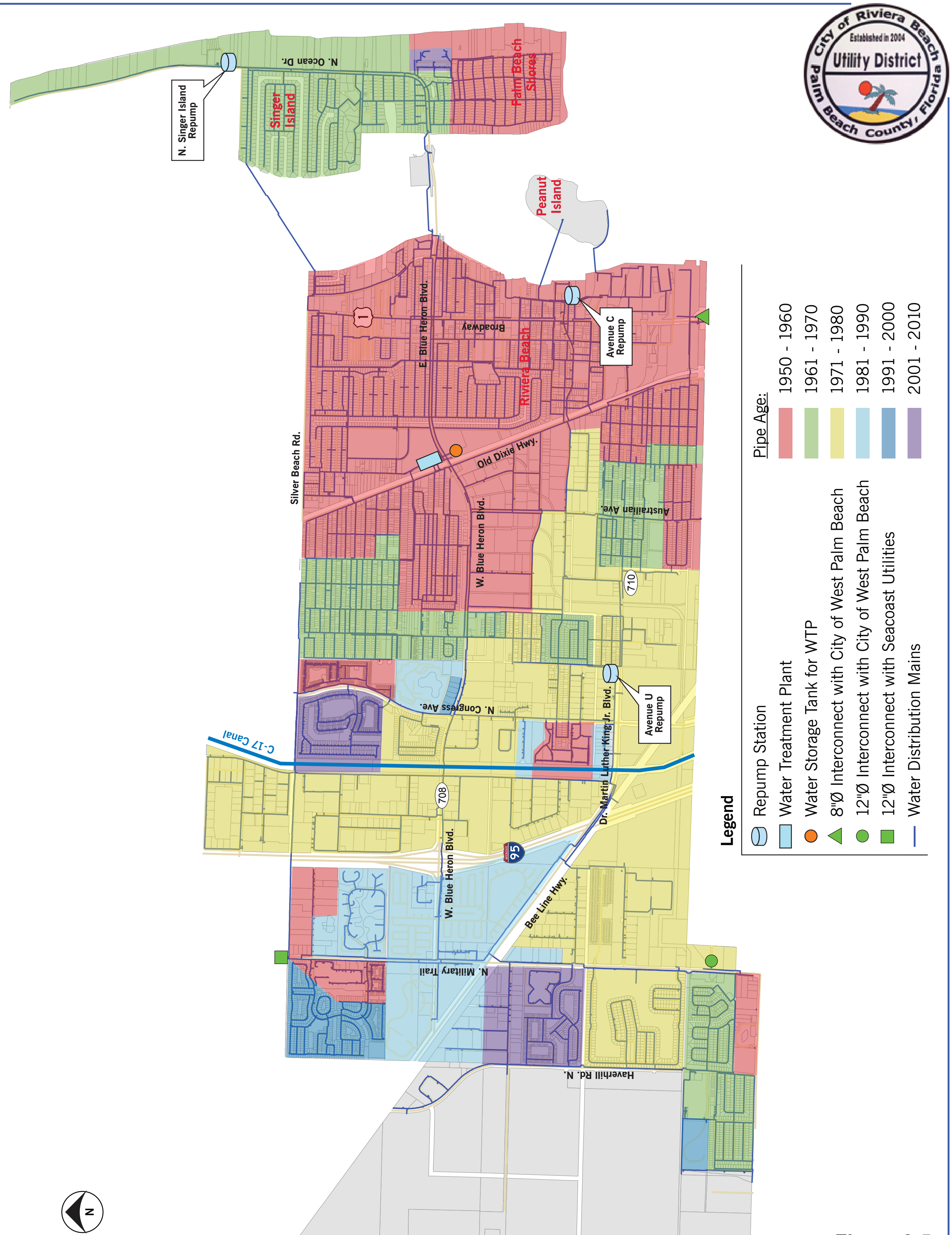

Figure 3-5
Existing Water Distribution Pipe Age Map

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Table 3.16 summarizes the age range of the water distribution system piping of unknown material.

Table 3.16
Water Distribution System Pipe Age – Unknown Material

DIA. (in)	Approximate Linear Feet of Unknown Material Water Main Installed By Decade						
	Total Length (feet)	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - Current
Unknown	20,561	11,074	673	805	2,711	2,441	2,858
1	343	-	-	277	-	65	-
2	1,030	387	131	246	-	108	158
3	2	-	-	2	-	-	-
4	96	40	-	45	10	-	-
6	593	194	58	188	-	93	60
8	60	-	7	-	-	-	53
10	1,118	11	-	6	3	1,098	-
12	74	-	74	-	-	-	-
16	553	-	547	-	6	-	-
20	418	-	418	-	-	-	-
Total	**24,848**	**11,706**	**1,908**	**1,570**	**2,730**	**3,805**	**3,129**

Table 3.17 summarizes the age range of the asbestos cement water distribution system piping.

Table 3.17
Water Distribution System Pipe Age – Asbestos Cement

DIA. (in)	Approximate Linear Feet of Asbestos Cement Water Main Installed By Decade						
	Total Length (feet)	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - Current
1	117	-	117	-	-	-	-
2	11,466	-	6,124	4,548	733	-	60
3	48,482	15,121	22,275	11,086	-	-	-
4	86,679	1,204	43,427	37,587	4,060	-	401
6	260,659	21,231	131,343	79,598	25,455	1,631	1,402
8	56,844	1,446	17,461	19,801	16,506	253	1,376
10	78,938	5,500	24,493	28,647	14,709	3,535	2,054
12	19,095	1,676	6,048	4,028	7,131	212	-
14	10,993	7	7,628	183	910	2,264	-
16	3,441	751	2,405	285	-	-	-
26	29	-	29	-	-	-	-
30	320	-	320	-	-	-	-
Total	**577,064**	**46,937**	**261,670**	**185,764**	**69,505**	**7,895**	**5,293**

Table 3.18 summarizes the age range of the cast iron water distribution system piping.

Table 3.18
Water Distribution System Pipe Age – Cast Iron

DIA. (in)	Approximate Linear Feet of Cast Iron Water Main Installed By Decade						
	Total Length (feet)	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - Current
1	235	-	119	83	33	-	-
2	749	21	686	42	-	-	-
3	118	-	102	16	-	-	-
4	2,047	171	687	1,083	-	-	107
6	17,316	159	8,219	4,395	4,461	82	-
8	2,068	-	904	209	305	430	220
10	4,322	169	2,262	1,321	132	415	22
12	4,492	501	2,513	538	939	-	-
14	563	396	4	163	-	-	-
16	4,026	-	2,560	1,466	-	-	-
18	22	-	22	-	-	-	-
20	25	-	6	19	-	-	-
30	53	-	53	-	-	-	-
Total	**36,037**	**1,418**	**18,138**	**9,335**	**5,871**	**927**	**349**

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Table 3.19 summarizes the age range of the ductile iron water distribution system piping.

Table 3.19
Water Distribution System Pipe Age – Ductile Iron

DIA. (in)	Approximate Linear Feet of Ductile Iron Water Main Installed By Decade						
	Total Length (feet)	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - Current
Unknown	16	-	-	-	-	-	16
1	2	-	-	-	-	-	-
2	1,981	37	774	-	92	1,051	28
3	172	-	16	-	6	150	-
4	4,772	197	1,937	23	57	2,558	-
6	6,068	153	411	601	1,853	2,625	424
8	44,583	4,677	4,214	3,933	12,765	7,747	11,247
10	17,484	2,137	6,872	4,342	1,094	996	2,044
12	49,894	9,806	7,097	1,870	6,524	18,128	6,469
14	6,537	-	4,562	1,423	414	139	-
16	15,692	5,150	575	2,873	277	-	6,817
20	6,080	-	997	5,065	-	-	17
30	53	9	-	7	37	-	-
Total	**153,334**	**22,165**	**27,455**	**20,136**	**23,122**	**33,393**	**27,063**

Table 3.20 summarizes the age range of the galvanized steel water distribution system piping.

Table 3.20
Water Distribution System Pipe Age – Galvanized Steel

DIA. (in)	Approximate Linear Feet of Galvanized Steel Water Main Installed By Decade						
	Total Length (feet)	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - Current
1	341	-	228	113	-	-	-
2	11,568	113	10,514	451	151	115	225
6	535	-	535	-	-	-	-
Total	**12,444**	**113**	**11,277**	**563**	**151**	**115**	**225**

Table 3.21 summarizes the age range of the HDPE water distribution system piping.

Table 3.21
Water Distribution System Pipe Age – HDPE

DIA. (in)	Approximate Linear Feet of High-Density Polyethylene Water Main Installed By Decade						
	Total Length (feet)	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - Current
12	258	-	258	-	-	-	-
16	257	-	-	-	-	-	257
Total	**515**	**-**	**258**	**-**	**-**	**-**	**257**

Table 3.22 summarizes the age range of the PVC water distribution system piping.

Table 3.22
Water Distribution System Pipe Age – PVC

DIA. (in)	Approximate Linear Feet of Polyvinyl Chloride Water Main Installed By Decade						
	Total Length (feet)	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - Current
unknown	4,030	108	-	16	3	-	3,904
1	715	124	-	-	13	-	578
2	3,888	305	232	211	745	1,122	1,273
3	144	-	-	120	14	10	-
4	2,405	323	-	-	1,134	389	559
6	31,214	3,395	5,187	3,575	11,224	5,886	1,947
8	111,838	23,129	469	1,871	24,453	14,448	47,468
10	14,075	4,206	215	1,052	2,141	725	5,737
12	8,523	3,701	2,620	-	-	2,103	98
Total	**176,832**	**35,291**	**8,722**	**6,845**	**39,728**	**24,683**	**61,563**

3.4.5 Fire Hydrants

Table 3.23 summarizes the available GIS data on the fire hydrants in the water distribution system. **Table 3.23** indicates that there are about 1,092 fire hydrants in the water distribution system.

Table 3.23
Fire Hydrants Distributed by Age and Manufacturer

Manufacturer	Approximate Number of Hydrants					
	Unknown	1928 - 1949	1950 - 1969	1970 - 1989	1990 - 2010	Total
Unknown	326	0	0	1	2	329
Albertville	0	0	0	0	2	2
American	1	1	14	61	19	96
Anniston	0	0	0	2	0	2
Clow	4	0	0	35	71	110
Dresser	1	0	1	28	0	30
Eddy	0	0	0	5	0	5
Iowa	0	8	0	0	0	8
Kennedy	1	0	3	57	7	68
Mathews	0	0	1	0	0	1
MH	0	5	73	121	1	200
Muller	0	0	20	55	67	142
RD Wood	3	6	79	1	0	89
US	1	0	2	1	0	4
WA	0	0	0	6	0	6
Total	337	20	193	373	169	1,092

3.4.6 Water Meters

The CRBUD staff informed Hazen and Sawyer that the information on the water meters contained in the CRBUD's GIS system is likely not accurate and should not be used for planning purposes relative to estimating the number and age of the existing water meters.

The CRBUD reported that there are approximately 16,000 water meters in its water distribution system. The CRBUD indicated that the residential water meters (two inch diameter and less) were replaced in 2007 through 2008. The residential meters were manufactured by Neptune and are Automatic Meter Reading (AMR) fixed network type.

The CRBUD indicated that all commercial meters 4-inch and larger need to be replaced with AMR type meters. There are no data available to the project team to determine the number and location of the commercial meters 4-inch and larger.

3.4.7 Automatic Flushing Devices

There are currently five automatic flushing devices installed on fire hydrants in the CRBUD's water distribution system. The approximate locations of the flushing devices are summarized in **Table 3.24**.

Table 3.24
Location of Automatic Flushing Devices

Flusher No.	Approximate Location
1	5662 Parke Ave. Gramercy Park
2	5101 Caribbean Blvd Gramercy Park
3	4761 Lake Arjaro Dr. & 45th St Gramercy Park
4	Beeline Hwy. & West of I-95 *(Note: Behind Palm Lakes Co-Op.)*
5	7392 N. Haverhill Rd

The flushing devices were installed in about 2010.

Design criteria listing the flushing device manufacturer, capacity and controller set points are listed in **Table 3.25**.

Table 3.25
Automatic Flushing Devices Design Criteria

Manufacturer	Kupferle Foundry Company
Model No.	9700
Flush Cycle Adjustability	9 flushing cycles per day at up to 4 hours of flush time per cycle
Maximum Flushing Rate	200 gallons per minute
Current Flushing Controller Settings (typical for all devices)	On at 11:00pm Off at 12:00am (One hour flushing) On at 2:00am Off at 3:00am (One hour flushing) On at 5:00am Off at 6:00am (One hour flushing)

3.4.8 Pressure Monitoring Stations

The CRBUD currently operates 17 water distribution system pressure monitoring stations in its water distribution system. The pressure monitors are connected to the DFS remote telemetry system. The plant control system maintains historical data from these monitoring stations. The pressure monitoring instrumentation is typically connected to a hose bibb located at a CRBUD wastewater lift station or at the water storage tank re-pumping stations. **Table 3.26** lists the general location of the water distribution system pressure monitoring stations.

Table 3.26
Water Distribution System Pressure Monitoring Stations

Pressure Monitor Serving	Location
WTP High Service Pump Station	Water Treatment Plant
Lift Station 12	Avenue R and W 23rd St
North Singer Is. Repump Station	North Singer Island Repump Station
Lift Station 16	Avenue L between 8th St and 9th St
Lift Station 18	N. Ocean Dr. Seadunes Condo (Singer Island)
Lift Station 19	Garden Rd. and Interstate Park Rd. N
Lift Station 20	Central Industrial Dr.
Lift Station 22	Westroads Dr. East End
Raw Water Well Lone Pine #3	Lochmore Rd (Lone Pine Estates)
Lift Station 31	W Blue Heron Blvd (South Side Across from Super 8)
Lift Station 37	Gramercy Park, Main Station
Lift Station 39	SY Fine, 45th St.
Lift Station 40	Woodbine Tr.
Lift Station 23	Blue Heron east of National Village
Lift Station 47	Haverhill Rd N and Dyer Blvd.
Ave U Repump	Avenue U Repump Station Discharge
Ave C Repump	Avenue C Repump Station Discharge

3.4.9 Port of Palm Beach

The Port of Palm Beach (Port) is supplied with potable water by the CRBUD as a wholesale customer. The Port is located in the southeast corner of the CRBUD service area. Water is supplied to the Port through six water master meter stations. The water master meters include check valves that allow the water to enter the Port's water piping system and not flow back out into the CRBUD system. The Port owns the water distribution system piping downstream of the CRBUD's water meters.

Based upon discussion with the Deputy Port Director and Director of Engineering, Port of Palm Beach:

- The Port's estimated working population in 2004 was 1,468. The Port predicts an estimated working population of approximately 2,100 by the year 2019. This forecast is presented in the Port's 2006 Master Plan. The Deputy Port Director and Director of Engineering confirmed that the projection is reasonable.

- The Deputy Port Director and Director of Engineering report that the Port's water distribution system has some pipes that are 40 to 50 years old.

- The Port water system does not have its own PWS identification number. The Deputy Port Director and Director of Engineering report that the Port's water system is not designated as a consecutive system.

- The Port took over the water distribution system piping within Port property when CRBUD's master meters were installed approximately 1998.

- The CRBUD and the Port do not monitor the water quality within the Port's water distribution system as part of routine monitoring for Lead and Copper Rule (LCR) compliance; the CRBUD regularly monitors water quality upstream of the master meters for LCR compliance.

- Port staff has done some grab sample measurements of chlorine residual in the Port system and used to have some issues with low chlorine residual before they started flushing the water distribution system at certain fire hydrants.

- Deputy Port Director and Director of Engineering report that certain fire hydrants within the Port's water distribution system are flushed approximately once every 6 months.

Table 3.27 summarizes meter size and identification number for the CRBUD's water meters that measure the potable water entering the Port.

Table 3.27
Port of Palm Beach Master Meters

Master Meter Station	Meter Size and ID No.	Location
1	10-inch, ID No.: 14503961966 1.5-inch, ID No.: 1470959588	North of E 11th St. on Ave. C
2	6-inch, ID No.: 1450018678 1.5-inch, ID No.: 1470198276	North of E 11th St. on Ave. C
3	8-inch, ID No.: 1410102594 1.5-inch, ID No.: 1450320546	W 10th St. and Avenue E
4	8-inch, ID No.: 1470975014 1.5-inch, ID No.: 1450322296	W 10th St., east of Commercial St.
5	4-inch, ID No.: 1470293066 1.5-inch, ID No.: 1450321360	South of MLK Blvd and East of Old Dixie Hwy.
6	8-inch, ID No.: 1820490673 2-inch, ID No.: 1820515020	SW corner of the Port near W 2nd St.

3.4.10 Known Pressure Concerns

3.4.10.1 Introduction

The following is a summary of anecdotal evidence – provided by the CRBUD staff – of low water distribution system pressure concerns.

3.4.10.2 Gramercy Park

The CRBUD staff indicated that the Gramercy Park area (located in the southwest corner of the CRBUD service area) has experienced low water pressure based on complaints from residents. Up until about the early 1980s, the Gramercy Park area was supplied with potable water from a developer owned lime softening water treatment plant known as “System 2”. The System 2 water treatment plant was demolished after the Gramercy Park area began being supplied with potable water by the CRBUD's water distribution system.

The CRBUD staff report significant reduction in the functional diameter of the Gramercy Park water service lines due to the accumulation of scale. This is based upon anecdotal evidence from field staff. The CRBUD staff report that field measurements of water pressure in the water distribution piping is adequate. The CRBUD speculate that that the operator of the System 2 water treatment plant supplied potable water with a high calcium carbonate precipitation potential resulting in scale formation.

3.4.10.3 Port of Palm Beach

The CRBUD staff report that the Port staff have periodically experienced low water pressure within the Port. The CRBUD staff report that pressure monitoring within the vicinity of the Port's service area – particularly at Avenue C Repump Station – indicates that the water pressure on the CRBUD's side of the Port master meters is adequate.

3.4.11 Known Quality Concerns

Two key water quality concerns were identified by the CRBUD. The first is low chlorine residual in the Gramercy Park area of the service area which resulted in a consent order. This issue is summarized in the next subsection. The second water quality concern identified by the CRBUD staff is low chlorine residual in its water storage tanks. The CRBUD is currently obtaining certain water quality data to assess this concern.

3.4.12 Consent Order

The CRBUD uses chloramine for disinfection of the water distribution system. Historical total chlorine residual data (from 2006 to 2010) measured at 40 locations throughout the service area indicated that the required minimum total chlorine residual (i.e., 0.6 mg/L) is maintained throughout the system. However, sampling conducted by the Palm Beach County Health Department (PBCHD) in the summer of 2010 found low total chlorine residual (less than 0.6 mg/L) in the Gramercy Park region of the service area. Follow-up sampling by the PBCHD indicated continued low total chlorine residuals at the Gramercy Park area. Chlorine residual testing at the WTP indicates total chlorine residual at the entry point to the distribution system in the 3.1 to 3.9 mg/L range. These data indicate that there is a chlorine demand within the distribution system, possibly caused by nitrification.

CRBUD received a consent order from the PBCHD in a letter dated December 23, 2010 for a failure to maintain a minimum combined chlorine residual of 0.6 mg/L throughout the drinking water distribution system per Rule 62-555.350(6) of the Florida Administrative Code (FAC).

Under this consent order the CRBUD is required to prepare and submit the results of the following:

1. A semi-annual chlorine burn in the system
2. A hydraulic study of the system
3. Surveillance monitoring to include weekly total coliform samples in the troubled areas
4. Additional flushing within the system in troubled areas

The CRBUD has been working to resolve low chlorine residual issues and currently performs three hours of nightly flushing at three fire hydrants within Gramercy Park and has increased superchlorination (i.e., switching to free chlorine while flushing hydrants over a two week period) of the distribution system to semi-annually. Additionally, the CRBUD has moved to update its secondary disinfection system at the Avenue U Repump Station. Preparation of the hydraulic model of the water distribution system has been completed as part of this Master Plan.

3.5 Water Repump Stations

3.5.1 Introduction

There are three existing water storage tank and repump stations within the CRBUD service area. Each repump station is equipped with backup power diesel engine generator. The repump stations are designated as follows:

- North Singer Island (NSI) Repump Station
- Avenue C Repump Station
- Avenue U Repump Station

The locations of these repump stations are summarized in **Table 3.28**.

Table 3.28
Repump Stations Location Information

Repump Station Name	Address	Palm Beach Property Appraiser Parcel Identification Number
NSI	5010 N Ocean Dr	56434222010000011
Avenue C	200 E 13th St	56434233060270030
Avenue U	909 Avenue U	56434231160000010

3.5.2 Tank Information

Each repump station includes a one million gallon pre-stressed concrete ground storage tank. The tanks are remotely monitored and controlled manually at the WTP control room. Under normal operations, the WTP operator manually opens the repump station altitude valve to begin tank filling. The altitude valve automatically throttles to maintain distribution system at about 40 psi. The altitude valve will automatically close when the water depth reaches the high water depth. **Table 3.29** summarizes certain information on each tank.

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Table 3.29
Repump Stations Tank Information

Repump Station Name	Year Installed	Tank Diam. (ft)	Approx. Tank Floor Elev. (NGVD 29)	Tank Sidewall Height (ft)	Low Tank Water Depth Alarm Setpoint (ft)	Water Depth that Closes Altitude Valve (ft)
NSI	1967	90	5.0	Unknown	5.0	26
Avenue C	1980	75	9.0	26	5.0	19
Avenue U	1980	85	Unknown	Unknown	5.0	28

3.5.3 Pump Information

Each repump station includes two single stage horizontal split case (HSC) water pumps. The pumps are controllable remotely from the WTP control system. Under normal operations the CRBUD staff turn the pumps on and off from the WTP control room based upon the need to maintain pressure in the distribution system. **Table 3.30** summarizes certain information on the pumps at each repump station.

Table 3.30
Repump Stations Pump Information

Station	Pump Info	Drive Info	Speed Control	Pump Design Point	Drive Horsepower and Nominal RPM	Year Installed
NSI	Type: HSC Qty: 2 Manuf.: Aurora Model: 411-BF Size: 6 x 8 x 18A Impeller: 15.356"	Type: Electric Manuf.: TECO Westinghouse	VFD	2,200 gpm at 210 ft TDH	HP: 200 RPM: 1,800	2010
Ave C	Type: HSC Qty: 2 Manuf.: Fairbanks Morse Model: 2800 Size: 4"2873A Impeller: 7.05"	Type: Electric Manuf.: US Motors	constant speed	900 gpm at 154 ft TDH	HP: 60 RPM: 3,600	1997
Ave U	Type: HSC Qty: 2 Manuf.: Crane Deming Model: 5063 Size: 8x6x14.5 Impeller: 13.75"	Type: Electric Manuf.: US Motors	constant speed	2,000 gpm at 120 ft TDH	HP: 100 RPM: 1,800	1997

3.5.4 Agreement with Sysco

Sysco Southeast Florida (Sysco) owns and operates a food distribution warehouse south of the Avenue U Repump Station. The warehouse is located at: 1999 Martin Luther King Boulevard, Riviera Beach, Florida, 33404. The fire suppression system at the Sysco warehouse is interconnected with the Avenue U Repump Station. Based upon a 1996 agreement between Sysco and the City of Riviera Beach, if the Sysco fire suppression system activates, it will also automatically start a pump at the Avenue U Repump Station. When Sysco conducts testing of its fire suppression system they coordinate with the CRBUD. A copy of this 1996 agreement could not be found by the CRBUD staff.

3.6 Wastewater System

3.6.1 Introduction

The CRBUD owns and operates a wastewater collection system along with a wastewater transmission system within its service area. Wastewater is conveyed by gravity from the wastewater collection system to lift stations. The lift stations convey the wastewater to the master lift stations via force mains. The master lift stations pump the wastewater through a 36-inch diameter force main to the East Central Regional Water Reclamation Facility (ECRWRF). The ECRWR is owned and operated by the City of West Palm Beach. Additionally, the CRBUD's 36-inch force main is interconnected with a force main from the Town of Mangonia Park. The CRBUD owns a master meter that is read daily to determine the amount of wastewater flow conveyed by Mangonia Park into the CRBUD's 36-inch diameter force main. Additionally, the CRBUD receives wastewater from the Town of Palm Beach Shores (via two private lift stations owned by the Town of Palm Beach Shores), the Port of Palm Beach and Florida Power and Light. The CRBUD **Figure 3-6** illustrates the wastewater collection system, wastewater lift stations and force mains.

3.6.2 Gravity Collection System

The sewage collection system includes piping and manholes that convey wastewater via gravity from connections with houses, businesses, etc. to lift stations that are owned by the CRBUD. **Table 3.31** provides a distribution of the length of wastewater collection system gravity piping by diameter and material.

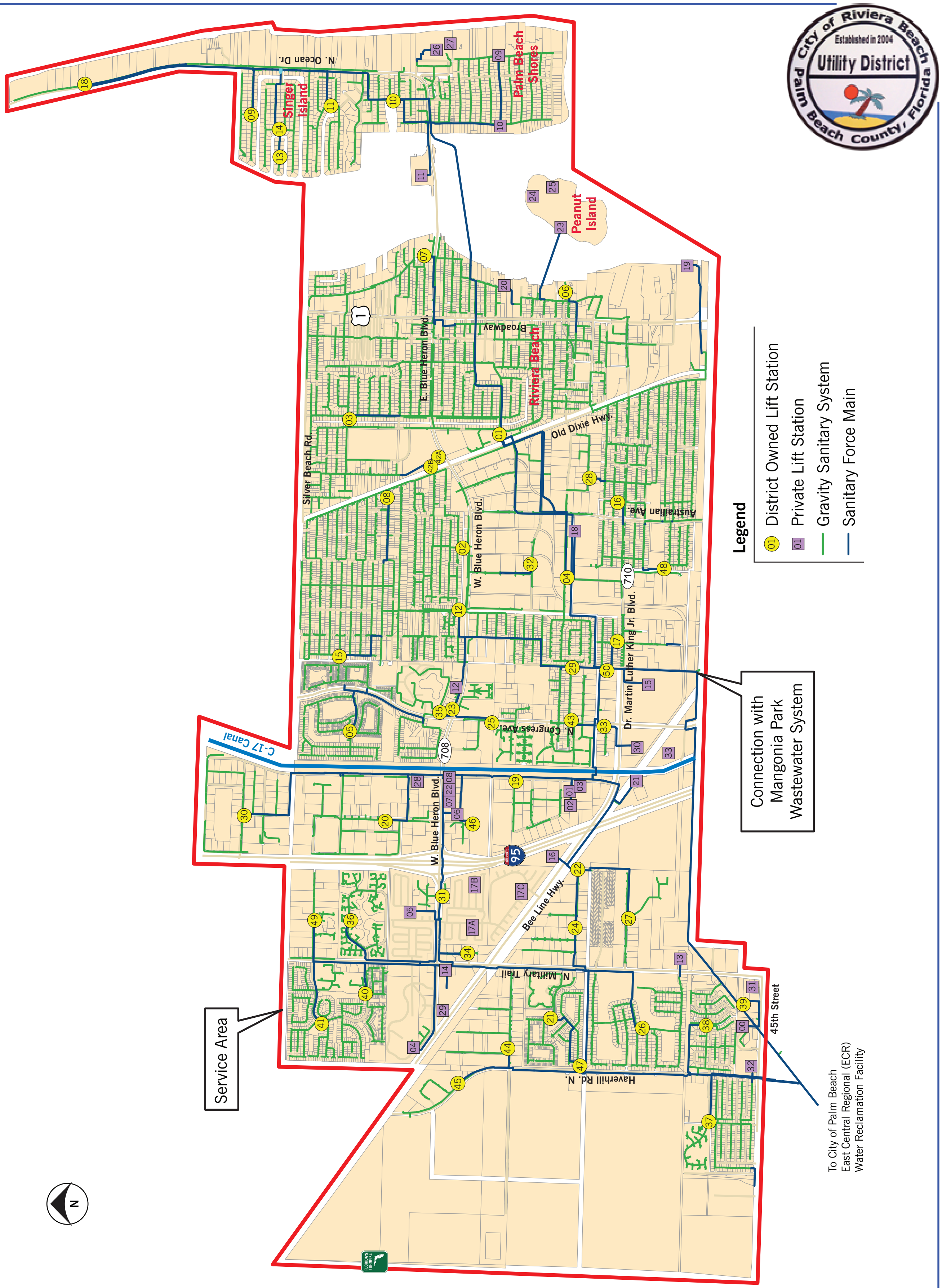

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Figure 3-6

Wastewater Collection and Transmission System

Table 3.31
Wastewater Collection System Pipe Material and Diameter Distribution

DIA. (in)	Approximate Pipe Length (feet) By Material				
	CI	DI	PVC	VCP	Total
Unknown			4,887	3,161	8,048
2			8	806	814
4	435		206	242,000	242,641
5				4	4
6			1,239	16,495	17,733
8		823	12,557	549,216	562,596
10			1,441	32,652	34,093
12		758		11,187	11,945
14				548	548
15				4,234	4,234
16				138	138
18				2,845	2,845
20				369	369
24				3,457	3,457
30				2,661	2,661
Total	435	1,582	20,337	869,772	892,126

Legend:

CI - Cast Iron

DI - Ductile Iron

PVC - Polyvinyl chloride

VCP – Vitrified clay pipe

As indicated in **Table 3.31**, there are approximately 892,000 feet (equivalent to 169 miles) of gravity sewer pipes in the wastewater system. Roughly 165 miles of the gravity sewer piping is composed of vitrified clay piping with the balance composed of other materials. The GIS system indicated that there are 2653 manholes in the gravity collection system with about 1,700 manholes installed in 1970 or earlier.

3.6.3 Force Mains

The force mains consists of pipes, shutoff valves, air release valves and accessories that convey wastewater from the lift stations to lift stations further down stream in the system and ultimately to the ECRWRF. **Table 3.32** provides a distribution of the length of wastewater force main piping by diameter and material.

Table 3.32
Wastewater Force Main Pipe Material and Diameter Distribution

	Approximate Pipe Length (feet) By Material						
DIA (in)	**Unknown**	**CA**	**CI**	**DI**	**PVC**	**VCP**	**Total**
Unknown						16	16
2	72				1,710	17	1,798
3			178		141		320
4	1,892		5,059	10,755	12,897	671	31,274
6			13,116	10,442	11,152	167	34,878
8	8	6,216	9,294	5,253	8,971		29,743
10			6,485	4,376	382	24	11,267
12	20		5,021	11,332	673	1,120	18,167
14				5,448			5,448
16	15		8,025	13,858	4,796		26,694
18	46		4	9,306			9,357
20				6,138			6,138
24	36			32			69
30				14,917			14,917
36				7,552			7,552
Total	**2,091**	**6,216**	**47,183**	**99,410**	**40,723**	**2,015**	**197,637**

Legend:
CA – Asbestos Cement
CI – Cast Iron
DI – Ductile Iron
PVC – Polyvinyl chloride
VCP – Vitrified clay pipe

It is noted that about 2,000 feet of wastewater force main is coded as vitrified clay pipe in the GIS system. Vitrified clay pipe is typically not used in pressure applications. Hence, the material code for this pipe may not reflect field conditions. It is recommended that the CRBUD investigate this issue and update its GIS shape files accordingly.

Table 3.33 summarizes the estimated age range of all of the wastewater force main piping in the CRBUD system.

Table 3.33
Wastewater Force Main Pipe Age

DIA (in)	Approximate Linear Feet of Wastewater Force Main By Decade (All Materials)						
	Unknown	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1990 - Current	Total
Unknown	16						16
2	72	523	62	481		659	1,798
3		141	178				320
4	7,628	4,422	3,710	7,001	7,651	861	31,274
6	1,734	1,653	10,128	8,142	7,844	5,378	34,878
8	6,085	1,290	7,770	6,071	3,782	4,745	29,743
10	26	2,909	6,300	2,031			11,267
12		6,267	7,938	1,207	1,973	781	18,167
14		383	2,498	523	2,044		5,448
16	10,285	2,557	3,381	4,566	4,044	1,860	26,694
18		9,050		307			9,357
20			3,171	2,791		176	6,138
24				69			69
30	7,390		1,831	4,424	1,271		14,917
36			7,552				7,552
Total	33,236	29,196	54,521	37,615	28,610	14,460	197,637

The above tables indicate that there are approximately 198,000 feet (equivalent to 37 miles) of force mains in the CRBUD's wastewater transmission system.

3.6.4 CRBUD Owned Wastewater Lift Stations

The wastewater lift stations receive the wastewater from gravity collection system and convey it further downstream in the system until it ultimately is conveyed to the ECRWRF. There are 51 CRBUD owned wastewater lift stations within the service area. **Table 3.34** provides certain data relative to the CRBUD owned lift stations.

Table 3.34
CRBUD Owned Lift Stations

Lift Sta. No.	Address	Year Inst. or rehabed	Type	Pump Manufacturer	Pump Model	No. of Pumps	GPM	TDH	Motor HP	Speed Control	Discharge To
1A	6522 Avenue "H" West	2004	DPS	Fygt	3312	2	U	U	250	VFD	FM
2	2251 Avenue "O"	1996	S	Flygt	CP3140	2	U	U	15	CS	G
3	501 West 34th Street	1960	S	Flygt	NP 3153 HT	1	650	41	15	CS	G
4A	1270 Avenue "P"	2009	S	Flygt	NP 3153 HT	2	650	41	15	CS	FM
5	West of 2124 Center Stone	2003	S	Flygt	CP3152	2	520	52	15	CS	G
6	200 E 13th Street @ Newcomb Hall	1960	CAN	Smith & Loveless	34G57646459A8	2	550	30	7.5	CS	G
7	2700 Avenue "A" Lake Shore Dr	2004	S	Flygt	NP3171	2	1,128	62	25	CS	G
8	1036 30th Street, West of Old Dixie	1996	S	Flygt	CP3127	2	400	45	10	CS	G
9	1134 Gulfstream Way (Singer Island)	1961	S	Enpo Cornell	400R5-GT11H-001	2	100	29	5	CS	FM
10	2801 Park Avenue	1993	S	Fairbanks Morse	5434M	2	2,000	55	50	CS	FM
11	3650 Ardmore Way (Singer Island)	1996	CAN	Smith & Loveless	Unknown	2	200	23	3	CS	FM
12	1441 W. 23rd Street	1993	S	Fairbanks Morse	4N5433M	2	900	100	40	CS	FM
13	1065 Grand Bahama (Singer Island)	1965	CAN	Smith & Loveless	4B2	2	100	25	5	CS	G
14	3900 Sunset Lane	1965	CAN	Smith & Loveless	256UP2	2	250	35	7.5	CS	FM
15	3344 Avenue "T"	2005	S	Flygt	FLA40/FLA39	2	U	U	15	CS	G
16	851 Avenue L	1965	CAN	Fairbanks Morse	5442B	2	225	26	5	CS	G
17	850 Avenue S	1965	S	BJM	Unknown	2	300	50	15	CS	FM
18	5390 N. Ocean Drive	1985	S	Homa Pump	6A100-240E / 40AC	2	1,100	70	40	CS	FM

Table 3.34
CRBUD Owned Lift Stations

Lift Sta. No.	Address	Year Inst. or rehabed	Type	Pump Manufacturer	Pump Model	No. of Pumps	GPM	TDH	Motor HP	Speed Control	Discharge To
19	6841 Garden Drive	1970	CAN	Smith & Loveless	4B2A	2	350	75	15	CS	FM
20	7525 Central Industrial Drive	1970	S	EMU	KRTUK100-315/224	2	600	105	30	CS	FM
21	South of 102 Crossing Rock	2001	S	Flygt	CP3140	2	471	69	15	CS	G
22	3895 West Road Drive	2008	S	2 - Scan	KRTUK100-251/54	2	300	40	10	CS	FM
23	1950 Blue Heron Blvd	2008	S	Flygt	NP3153	2	900	60	20	CS	FM
24	4261 West Road Drive	1980	S	Gormann Rupp	Unknown	2	90	22	5	CS	G
25	2001 Congress Avenue	1986	S	Homa Pump	A100-240E20/4B	2	1,000	95	20	CS	FM
26	214 Lockmore Drive	1977	S	Flygt	3152	2	U	U	20	CS	FM
27	2459 Fort West Blvd	1981	S	Flygt	3065	2	60	30	2	CS	FM
28	951 West 13th Street	1979	S	Flygt	CP3085-438	2	60	22	2	CS	G
29	1199 Avenue "U" & 12th Street	1979	S	Flygt	CP3126 126-461	2	330	57	10	CS	FM
30	3800 Investment Lane	1985	S	Flygt	3101	2	U	U	5	CS	FM
31	4134 West Blue Heron Blvd	1984	S	Flygt	3126-140-16-01704	2	57	75	10	CS	FM
32	1300 West 15th Street	1970	S	Flygt	CP3085	2	U	U	2	CS	G
33	1950 West 9th Street & Congress	1983	S	Reliance	P18G2701KRU	2	80	50	5	CS	FM
34	7148 Military Trail & Derons Road	1983	S	Reliance	4VH100M4-23	2	80	81	10	CS	FM
35	2550 Congress Avenue	1987	S	Homa Pump	240538	2	390	27	5	CS	G
36	400 Mediterian Drive	1983	S	Homa	Unknown	2	20	99	25	CS	FM

Table 3.34
CRBUD Owned Lift Stations

Lift Sta. No.	Address	Year Inst. or rehabed	Type	Pump Manufacturer	Pump Model	No. of Pumps	GPM	TDH	Motor HP	Speed Control	Discharge To
37	SW of 5145 Caribbean Blvd	1984	S	EMU EBARA	FK2024022	2	U	U	25	CS	FM
38	Behind 5900 Bimini Cir East	1996	S	Flygt / EBARA	3127.180298	2	U	U	7.5	CS	FM
39	4601 45th Street	1980	S	Stacon / Flygt	3126	2	U	30	10	CS	FM
40	2555 Woodbine Trail	2010	S	Flygt	3170180-6105	2	U	U	30	CS	FM
41	Across from 7050 Woodbine	1993	S	Homa Pump	AM644-280/45	2	U	U	50	CS	FM
42A	Water Plant, South (Admin Bldg.)	1960	S	Flygt	Unknown	2	U	U	2	CS	G
42B	Water Plant, North Chemical Bldg.	1960	S	Unknown	Unknown	U	U	U	U	CS	G
43	1180 Congress Ave & 12th Street	1987	S	KSB	KRTUFKK100-251/74	2	440	48	10	CS	FM
44	4881 Dyer Boulevard	1991	S	KSB	KRTUK100-251/54	2	190	56	10	CS	FM
45	4700 Haverhill Road	1991	S	KSB	KRTUK100-200/44	2	100	45	7.5	CS	FM
46	700 Central Industrial Dr. South	1982	S	Flygt	CP 3126	2	85	72	10	CS	FM
47	Unknown	1992	S	Homa	AM376164 H/AKX1266-425	2	4,300	80	150	VFD	FM
		1992	S	Homa	76000	1	U	U	125	CS	FM
48	1360 West 3rd Street	1995	S	Flygt	CP3102	2	183	32	5	CS	G
49	4300 Leo Lane	1995	S	Flygt	CP3127	2	150	78	10	CS	FM
50	909 Avenue "U"	1966	DPS	Allis Chalmers	NSWV 250	4	150	78	10	Note 1	FM

Legend:

CAN: "Can" type lift station

DPS: Dry-pit submersible type lift station

S: Submersible pump in wet well type lift station

If a large capacity lift stations failed, it would have a large negative impact on the CRBUD being able to meet basic services. For the purpose of this report, large capacity lift stations – critical to CRBUD operations – have been categorized as a master lift station or a sub-master lift station. The CRBUD staff has also identified "sub-master" lift stations that serve as critical repumping stations for substantial portions of the service area. The sub-master lift stations are Lift Stations 1A, 10, 12 and 22. **Table 3.35** identifies the master and sub-master lift stations.

Table 3.35
Master and Sub-Master Lift Stations

Lift Station No.	Category	Comments
1A	Sub-Master	Lift Station 1A can pump to Lift Station 50 or directly to the force main going to ECRWRF. It is currently configured to pump directly to the ECRWRF.
10	Sub-Master	All wastewater from Singer Island is repumped by Lift Station 10 to Lift Station 1A
12	Sub-Master	Repump flows to Lift Station 50
22	Sub-Master	
47	Master	Generally repumps all wastewater west of the C-17 canal to the ECRWRF
50	Master	Generally repumps all wastewater east of the C-17 canal to the ECRWRF

Lift Stations 47 and 50 are the master lift stations in the system; all wastewater collected in the CRBUD service area is repumped by one of these stations to the ECRWRF. Lift Station 47 essentially repumps all wastewater collected west of the C17 canal to the ECRWF, although, a small portion of this wastewater west of the C17 canal can be redirected to Lift Station 50. Lift Station 50 essentially repumps all wastewater collected east of the C17 canal to the ECRWRF; although, a small portion of this wastewater can be redirected to Lift Station 47 if needed. Currently, CRBUD is redirecting all the flow possible to Lift Station 47 and Lift Station 1A is configured to pump directly to the ECRWRF in lieu of into the wetwell of Lift Station 50.

3.6.5 Private Lift Stations

There are 35 privately owned and operated wastewater lift stations within the CRBUD's service area. **Table 3.36** lists the private owned lift stations.

Table 3.36
Private Lift Stations

Private Lift Station No.	Address (or location description)	Service	Comments
0	4845 Lake Arjaro Drive	Lake Arjaro Apartment Complex	Residential Apartments (57 units). Lift Station has a 4" force main that discharges to the CRBUD owned Lift Station 39.
1	6553 Garden Road	Coca-Cola Bottling Company Distribution Center & offices	Warehouse/Distribution Center. No production facilities. Office Area. 4 bathrooms.
2	6555 Garden Road and Private Road	Warehouses / Laundry Operation / Offices	Interstate Commerce Park: Several Warehouses and Offices. One Laundry with 20 washing machines. Lift Station has a 3" force main to CRBUD force main.
3	6470 Garden Road	Printing Shop and Tire Supply Store	3,000 square foot print shop, one service bay plus two bathrooms. Lift Station has a 3" force main going to a 6" gravity line.
4	7305 Military Trail	Veteran Affairs Medical Center Hospital	Hospital Building has 8 floors with 250 beds. Cooling towers, Laundry, etc. Lift Station has 6" force main going to a 8" CRBUD force main.
5	Palm Lakes Co-Op Estates, N 73th Ct	Trailer Park On North Side of Road	Palm Lake Co-Op trailer park with 350 units. Complex has one Lift Station with a 4" force main going to a 8" CRBUD force main.
6	3561 Blue Heron Blvd	Buildrer On Site (Old World Décor Building) Offices	Lumber yard. Assumed office area = 4,000 square feet & warehouse = 36,000 square feet. Lift Station has a 4" force main that connects with a CRBUD force main.
7	3651 Blue Heron Blvd	Travel Lodge Motel	Hotel - 115 rooms, 1 pool, 1 Laundry Facility. Lift Station has 6" force main going to CRBUD force main.
8	7289 Garden Road N Blue Heron	Palm Beach County Health Dept. Offices and Bank	Two floor building with an estimated 24,000 square feet of office area. Lift Station has a 6 " force main.

Table 3.36
Private Lift Stations

Private Lift Station No.	Address (or location description)	Service	Comments
9	Across From 1101 South Ocean Ave N. Edwards Lane	Town of Palm Beach Shores	Single-family Homes = 75 units Multiple Family Condos = 580 units Hotel Rooms = 1700 units Lift Station has a 4" force main going to Lake Drive Lift Station.
10	142 Lake Drive N. Edwards Lane	Town of Palm Beach Shores	Single-family Homes = 305 units. Multiple Family Condos = 425 units Lift Station has a 4" force main going to a force main on Blue Heron Blvd
11	900 E Blue Heron Blvd	Phil Foster Park	Two Public Restrooms x 2 (Men & Woman) (3 sinks, 2 urinal Lift Station, 3 toilets). One maintenance area (2 bathrooms). Lift Station has a 4" force main going to a CRBUD force main on Blue heron Blvd
12	1900 Blue Heron Blvd	CITCO GAS STATION Restroom, Pizza Shop, Donut Shop, Laundry	Laundro Mart (8 Machines). Dunkin Donuts and Quiznos (2 bathrooms, each) Citgo (3 bathrooms). No carwash. Lift Station has a 3" force main going to CRBUD Lift Station 23
13	6000 N. Military Trail	Splash Grill Restaurant	Lift Station has a 3" force main going to gravity. The business is abandoned.
14	4501 Military Trail	PB Gas Station - Restaurant And Restroom	Gas station. 3 bathrooms. No carwash. Lift Station has a 3" force main going to CRBUD force main
15	1999 W Martin Luther King Blvd	Sisco Distribution Warehouse	Office area = 30,000 square feet Warehouse = 270,000 square feet. Lift Station has a 4" force main going to gravity.
16	3933 Dr Martin Luther King Jr Blvd	Nortrax Equipment Company - Office (John Deere)	Office area = 6,000 square feet. Auto repair area (10 service bay + 6 water closets). Lift Station has a 4" force main going to a CRBUD force main.
17A 17B 17C	Palm Lakes Co-Op Estates, N 42nd Way	Trailer Park, Club House and Pool Area Restroom	Palm Lake Co-Op complex has three Lift Stations. There are 570 single family residential units. The lift station has a 3"

Table 3.36
Private Lift Stations

Private Lift Station No.	Address (or location description)	Service	Comments
			force main going to an 8" CRBUD force main.
18	1160 Australian Ave	Lincoln Elementary School	Large School. Estimated number of students = 500. Private Lift Station 18 has a 4" force main going to CRBUD Lift Station 4.
19	200 Broadway Ave	FPL Energy Center	FPL demolished entire complex. Currently building a new power plant. FPL used to have 3 private lift stations on site.
20	1801 Broadway	Jim Barry Light Harbor Park	1 public restroom x 2 (Men & Woman) (3 sinks, 2 urinal Lift Station, 3 toilets). Lift Station has 4" force main going to gravity.
21	1 Cheney way	C-B-I Distribution.	Warehouse/office area (3 floors). Office area = 28,000 square feet Warehouse = 252,000 square feet Lift Station has a 4" force main going to a CRBUD 8" force main.
22	3621 Blue Heron Blvd	Enterprise Rental Car Offices And Breakroom	Office, including lunch room plus 2 bathrooms and 1 kitchen sink. Estimated building area = 1300 square ft Lift Station has a 3" force main.
23	Peanut Island	Not visited	Unknown
24	Peanut Island	Not visited	Unknown
25	Peanut Island	Not visited	Unknown
26	N. Ocean Dr	Singer Island Beach North	1 public restroom x 2 (Men & Woman) (3 sinks, 2 urinal Lift Station, 3 toilets). 2 bathrooms at Life Guard Building. Lift Station has 3" force main going to gravity
27	N Ocean Dr	Singer Island Beach South	1 public restroom x 2 (Men & Woman) (3 sinks, 2 urinal Lift Station, 3 toilets). Lift Station has 3" force main going to gravity

Table 3.36
Private Lift Stations

Private Lift Station No.	Address (or location description)	Service	Comments
28	7305 Garden Road	Pepsi Distribution Center	Flows include process waste. CRBUD monitors pH and have flow records. Lift Station has a 6" force main going to 8" gravity to CRBUD Lift Station 20
29	5555 W. Blue Heron Blvd	Kindred Medical Facility	Office area = 5,400 square feet 70 Hospital Beds, 1 laundry with 4 Machines, Lift Station has a 6" force main going to a CRBUD force main.
30	Port of Commerce Center at 1961 W 9th Street	Offices and Warehouse Building	Office area = 60,000 square feet Warehouse area = 55,000 square feet Laundry machines = 10 Lift Station has a 6" force main going to CRBUD Lift Station 33.
31	4501 Military Trail (5635 N Military Trail)	Stop & Shop Store - Restrooms	1 bathroom/1 sink. Store area = 2,000 square feet. Lift Station has a 3" force main going to CRBUD Lift Station 39.
32	5710 Haverhill Road Baptist Church	Cross Roads Baptist Church - Restrooms, Offices And Dining Hall	Church - 6 bathrooms. Break room - 2 sinks. Estimated number of seats = 300. Lift Station has a 3" force main going to CRBUD force main.
33	The Old 84 Lumber Yard On 5 Cheney Way	Warehouse	Office area = 7,700 square feet Warehouse = 69,300 square feet. Lift Station has a 4" force main going to the private Lift Station at the Port Commerce.

Section 4.0
Population Forecast

4.1 Introduction

This section of the Master Plan summarizes the population forecast within the City of Riviera Beach Utility District's (CRBUD's) water service area through the year 2030. The population forecast is based upon data in the November 2011 Update of the Palm Beach County Population Allocation Model published by the Palm Beach County Planning Division which utilizes data prepared by the Bureau of Economic and Business Research (BEBR) at the University of Florida.

4.2 Population Forecast

Table 4.1 presents the population forecast through the year 2030 broken down by Traffic Analysis Zones (TAZs) within the CRBUD's service area.

Table 4.1
Population Forecast by Traffic Analysis Zone (TAZ)

TAZ	2011	2015	2020	2025	2030
76	991	1049	1061	1121	1196
77	900	970	985	989	993
78	1422	1499	1525	1551	1580
79	1421	1521	1608	1669	1745
111	2736	2837	2845	2845	2845
112	1185	1213	1737	2260	2926
113	0	0	0	0	0
114	489	518	569	632	711
115	44	46	46	47	48
116	3037	3166	3180	3211	3251
117	0	0	0	0	0
118	2343	2398	2410	2439	2475
119	1142	1160	1169	1178	1190
126	1184	1285	1382	1579	1879
127	1134	1185	1327	1586	1705

Table 4.1 (Continued)
Population Forecast by Traffic Analysis Zone (TAZ)

TAZ	2011	2015	2020	2025	2030
128	2159	2312	2381	2495	2555
129	4723	5004	5276	5723	6316
132	3883	4106	4151	4375	4655
133	0	0	0	0	0
134	2749	2921	2980	3114	3275
135	0	0	0	0	0
136	0	0	0	0	0
137	1629	1747	1836	1994	2225
138	657	683	686	689	694
140	1051	1135	1367	1741	1803
141	307	332	340	348	357
143	0	0	0	0	0
144	200	219	247	321	455
145	2281	2440	2584	2823	3153
146	333	358	389	429	486
147	24	16	16	16	33
148	0	0	0	0	0
872	455	489	492	507	526
898	520	573	638	750	928
899	209	224	233	247	260
900	550	579	589	606	620
Total	**39,757**	**41,984**	**44,049**	**47,285**	**50,885**

As indicated in **Table 4.1** the population in the year 2011 was 39,757; and is forecasted to grow to 50,885 by the year 2030. The population growth is estimated at an average of approximately 638 persons per year.

4.3 Comparison with Prior Population Forecast

A population forecast was prepared for the Water Use Permit (WUP) application (prepared by Barnes, Ferland and Associates, Inc.) which was submitted to the South Florida Water Management District in 2010. The population forecast for the WUP application utilized data from the November 2010 Update of the Palm Beach County

Population Allocation Model. The population in the year 2030 in the forecast above is 50,885. The population in the year 2030 in the forecast used for the WUP was 51,066. The difference between these two population forecasts is not significant; and it is also consistent with population forecasts for other South Florida utilities.

Section 5.0
Water Demand Forecast

5.1 Introduction

This section of the Master Plan summarizes forecasts of the water demand within the City of Riviera Beach Utility District's (CRBUD's) water service area through the year 2030. The forecast is based upon the population forecast presented in Section 4 (titled "Population Forecast").

5.2 Water Demand Forecast

Table 5.1 presents historical annual average day flow (AADF) produced at the water treatment plant (WTP) along with water consumed as reflected by the customer billing data for the years 2005 through 2010. These data, along with the population forecast presented in Section 4 (titled "Population Forecast"), are used to forecast the water demand within the CRBUD's water service area from the year 2011 through 2030. The forecasted water demands are also presented in **Table 5.1**. The historical data were obtained from the CRBUD's application for its recently approved Water Use Permit issued by the South Florida Water Management District.

Table 5.1
Water Demand Forecast
Annual Average Day Flow (AADF)

Year	Population	Per Capita WTP Production (gpd/person)	WTP Production AADF (mgd)	Unaccounted for Water (%)	Water Consumption Measured by Customer Meters (mgd)
2005	38,000	198	7.53	10.2%	6.77
2006	38,345	198	7.60	8.9%	6.93
2007	39,524	172	6.79	6.8%	6.33
2008	40,350	158	6.36	7.0%	5.91
2009	40,123	165	6.61	6.7%	6.17
2010	39,897	163	6.52	7.2%	6.05
2011	39,757	171	6.80	7.3%	6.30
2012	40,314	171	6.89	7.3%	6.39
2013	40,870	171	6.99	7.3%	6.48
2014	41,427	171	7.08	7.3%	6.57

Table 5.1 (Continued)
Water Demand Forecast
Annual Average Day Flow (AADF)

Year	Population	Per Capita WTP Production (gpd/person)	WTP Production AADF (mgd)	Unaccounted for Water (%)	Water Consumption Measured by Customer Meters (mgd)
2015	41,984	171	7.18	7.3%	6.66
2016	42,397	171	7.25	7.3%	6.72
2017	42,810	171	7.32	7.3%	6.79
2018	43,223	171	7.39	7.3%	6.85
2019	43,636	171	7.46	7.3%	6.92
2020	44,049	171	7.53	7.3%	6.98
2021	44,696	171	7.64	7.3%	7.09
2022	45,343	171	7.75	7.3%	7.19
2023	45,991	171	7.86	7.3%	7.29
2024	46,638	171	7.98	7.3%	7.39
2025	47,285	171	8.09	7.3%	7.50
2026	48,005	171	8.21	7.3%	7.61
2027	48,725	171	8.33	7.3%	7.72
2028	49,445	171	8.46	7.3%	7.84
2029	50,165	171	8.58	7.3%	7.95
2030	50,885	171	8.70	7.3%	8.07

The difference between the WTP production and the water consumption measured by the customer meters is commonly referred to as unaccounted for water (a.k.a., non-revenue water). The unaccounted for water averaged 7.3 percent of WTP production for the years 2006 through 2010. The WTP production averaged 171 gallons per day per person for the years 2006 through 2010. Therefore, for forecasting purposes, a per capita water production rate of 171 gallons per day per person was utilized for future projections. **Figure 5-1** illustrates the above data graphically.

5.3 Maximum Day Flow Peaking Factor

Knowledge of variations in water demand is important for assessing the capacity utilization of existing facilities and sizing of proposed improvements. Variations in historical flow are expressed in terms of ratios to the AADF. Historical water flow data were evaluated to determine the historical maximum day flow (MDF) and associated peaking factors (PFs) for the years 2008 through 2011. The maximum day flow peaking

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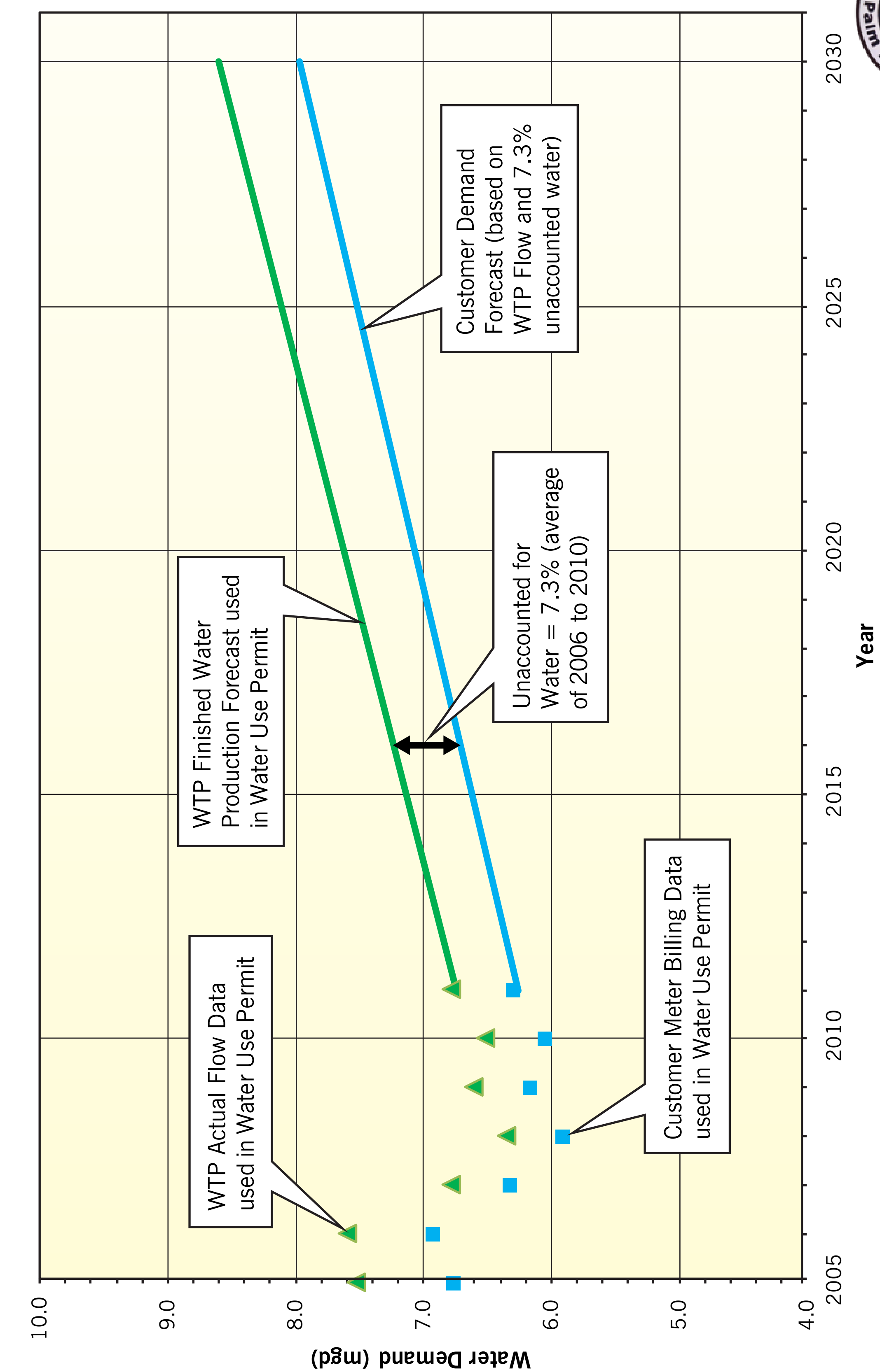

Figure 5-1
Water Demand Forecast

factor is defined as the MDF divided by the AADF (i.e., MDF PF = MDF/AADF). **Table 5.2** summarizes the historical maximum day peaking factors for the CRBUD service area.

Table 5.2
Historical WTP Production and Peaking Factors

Year	AADF (mgd)	MDF (mgd)	MDF/AADF
2008	6.4	8.3	1.3
2009	6.6	7.7	1.2
2010	6.5	8.5	1.3
2011	6.8	9.1	1.3
Average	**6.6**	**8.4**	**1.3**

The MDF PF averaged 1.3 for the period 2008 to 2011, which is a typical maximum day peaking factor based upon analysis of numerous South Florida municipal water systems. The MDF PF of 1.3 is used for planning and analysis in this Master Plan.

5.4 Overall Demand Pattern

In addition to seasonal variations, water demand also varies throughout the day. Typically, there is a consistent pattern of daily variations in demand. The project team reviewed available historical flow meter data from 2010 through 2011 and identified a demand pattern that is representative of the overall water distribution system. This demand pattern is presented in **Figure 5-2**.

The demand pattern is presented as a dimensionless multiplier over a one-day hourly time scale. The pattern illustrates that water demand is lower than average from 11:00 p.m. to 5:00 a.m., approximately. Demand rises in the morning and reaches a peak of about 1.32 times the daily average around 11:00 a.m. (the rise toward the peak is reflective of lawn irrigation as well as domestic customer uses such as meals, bathing, etc.) and then drops off to about average flow between about 3:00 p.m. to 4:00 p.m. After 4:00 p.m. the water demand rises again to a second peak of about 1.20 times the daily average (this second peak is reflective of typical domestic customer evening usages) between 6:00 p.m. to 8:00 p.m. whereupon demand declines again until the following day. This demand pattern is typical of other utilities.

Given the demand pattern presented in **Figure 5-2**, the peak hour (PH) water demand occurred around 11:00 a.m. The PH PF at that time was 1.7. For the purpose of assessing the sizing of equipment on a peak hour basis, a PH PF of 1.7 was used in this Master Plan.

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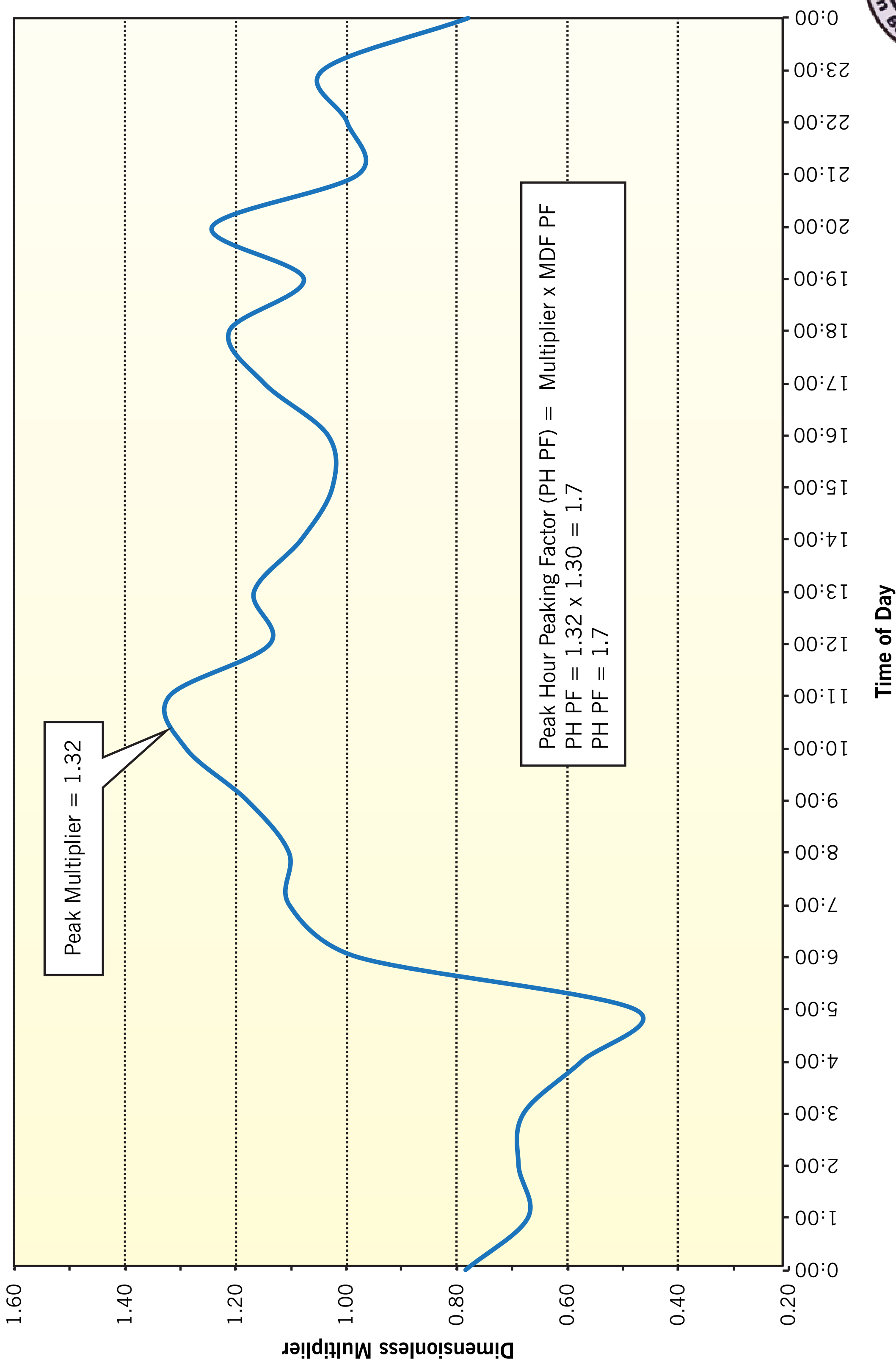

Figure 5-2
Overall Water Demand Pattern

Section 6.0
Wastewater Flow Forecast

6.1 Introduction

The CRBUD collects wastewater generated within its water service area. The wastewater is then conveyed to the East Central Regional Water Reclamation Facility (ECRWRF) via a 36-inch force main that is owned by the CRBUD. Additionally, the Town of Mangonia Park (Town) contributes flow to the CRBUD's force main that conveys the wastewater to the ECRWRF.

This section provides an analysis of the historical wastewater flows from the CRBUD and Town of Mangonia Park for the period from 2006 through 2011. Additionally, this section provides an evaluation of flow variability and peaking factors within the CRBUD's service area.

The forecast of the wastewater flow from the CRBUD service area through the year 2030 is also presented. The wastewater forecast presented herein is based upon the population forecast presented in Section 4 (titled "Population Forecast") and provides the basis for development of the wastewater hydraulic model.

6.2 Historical Wastewater Flows

Table 6.1 summarizes historical wastewater flow from the CRBUD along with the Town of Mangonia Park as measured by the ECRWRF flow meter for the period from 2006 through 2011.

Table 6.1
Historical Monthly Average Daily Flow From CRBUD and Town of Mangonia Park to the ECRWRF (mgd)

Month	2006	2007	2008	2009	2010	2011
January	4.50	4.28	4.52	4.71	5.62	4.65
February	4.47	4.24	4.77	4.42	5.34	4.71
March	4.48	4.21	4.69	4.54	5.03	4.74
April	4.46	4.39	4.48	4.51	4.67	4.85
May	4.30	4.10	4.13	4.66	4.29	5.16
June	4.63	4.67	4.43	4.78	4.40	4.61
July	4.80	5.14	4.58	4.68	4.44	4.80

Table 6.1 (Continued)
Historical Monthly Average Daily Flow From CRBUD and Town of Mangonia Park to the ECRWRF (mgd)

Month	2006	2007	2008	2009	2010	2011
August	4.92	4.88	5.13	4.75	4.63	5.31
September	5.01	4.58	5.53	4.93	4.76	5.17
October	4.22	5.20	6.59	5.33	4.72	5.30
November	4.09	4.51	4.73	4.44	4.60	3.90
December	4.54	4.46	5.20	4.73	4.56	4.74
Average	**4.53**	**4.55**	**4.90**	**4.71**	**4.75**	**4.81**

The wastewater flow being conveyed to the ECRWRF from the CRBUD and the Town has averaged about 4.7 mgd over the last six years.

6.3 Wastewater Flow Forecast

This subsection presents the methodology used to estimate the theoretical wastewater generated from the CRBUD service area.

The wastewater flow forecast was derived using 2011 historical monthly customer water meter billing records as the base flow year. The customer water meter billing records were coded as either a general use account, irrigation use account or hydrant use account. Water meter billing records coded as irrigation and fire hydrant (presumable for construction related activities) accounts were excluded from the analysis since they do not contribute to sewer flows. The balance of the water meter billing data was assumed to contribute to sewer flow. The sum of these water meter data amounted to 4.96 mgd. The wastewater flow measured at the ECRWRF for the same period averaged 4.81 mgd. The ratio of these two values (i.e., 4.96/4.81 = 1.03) was then used to convert the water demand into wastewater flow at each of the customer water meters. This water to wastewater ratio captures the impacts on wastewater flow of both irrigation uses and collection system inflow and infiltration (I/I). The water meter data, converted to wastewater flow, was then spatialized (using the customer water meter addresses in the GIS system) to determine which lift station would receive the wastewater flow based upon the location of the water meter within the gravity sewer collection system basins. The change in potable water demand was calculated based upon the projected percent change in population for the traffic analysis zones within the service area for 2015, 2020, 2025 and 2030. These percentage changes in populations by TAZ – along with the above described water to wastewater ratio – were applied to the base year flow (2011) to forecast wastewater flow to the wastewater lift stations.

The overall wastewater flow forecast (on an AADF basis) is presented in **Table 6.2.**

Table 6.2
Annual Average Day
Forecasted Wastewater Flow

Year	Flow (mgd)
2015	5.00
2020	5.18
2025	5.45
2030	5.91

Table 6.3 summarizes the forecasted wastewater gravity flows (on an AADF basis) to the various CRBUD lift stations, privately owned lift stations and from the Town of Mangonia Park.

Table 6.3
Annual Average Day
Forecasted Wastewater Gravity Flow to CRBUD Lift Stations,
Private Lift Stations and Town of Mangonia Park

Lift Station	Wastewater Flow (gpm)				Comments
	2015	2020	2025	2030	
LS-01	211	224	245	273	
LS-02	86	90	98	108	
LS-03	180	186	195	200	
LS-04	60	60	60	60	
LS-05	59	60	63	67	
LS-06	77	77	79	160	
LS-07	93	100	114	136	
LS-08	47	50	54	60	
LS-09	32	33	33	34	
LS-10	379	386	392	400	
LS-11	65	66	67	68	
LS-12	62	66	71	79	
LS-13	11	11	11	11	
LS-14	72	73	75	76	
LS-15	170	179	194	214	
LS-16	118	132	155	192	
LS-17	67	68	71	75	
LS-18	99	100	105	113	
LS-19	6.6	6.6	6.6	6.6	

Table 6.3
Annual Average Day
Forecasted Wastewater Gravity Flow to CRBUD Lift Stations,
Private Lift Stations and Town of Mangonia Park

Lift Station	Wastewater Flow (gpm)				Comments
	2015	2020	2025	2030	
LS-20	119	119	119	119	
LS-21	94	94	95	97	
LS-22	6.8	6.8	7.0	7.2	
LS-23	135	137	144	153	
LS-24	4.0	4.0	4.1	4.2	
LS-25	34	35	37	38	
LS-26	65	65	66	67	
LS-27	33	33	34	35	
LS-28	5.9	5.9	5.9	5.9	
LS-29	38	39	41	43	
LS-30	16	16	16	16	
LS-31	9	10	11	13	
LS-32	14	14	14	14	
LS-33	21	21	22	23	
LS-34	2.1	2.3	2.5	2.8	
LS-36	8	12	15	20	
LS-37	103	103	104	106	
LS-38	36	37	37	37	
LS-39	2.3	2.3	2.3	2.3	
LS-40	38	38	38	38	
LS-41	62	62	62	62	
LS-43	40	40	42	44	
LS-44	8.0	8.0	8.1	8.2	
LS-45	16	16	16	16	
LS-46	10	10	10	10	
LS-47	1.6	1.6	1.6	1.6	
LS-48	19	19	20	20	
LS-49	35	50	65	84	
LS-50	0.2	0.2	0.3	0.3	
LS-TMP	139	142	145	149	
LS-P00	3.8	3.9	3.9	3.9	
LS-P01	3.4	3.4	3.4	3.4	
LS-P02	0.5	0.5	0.5	0.5	

Table 6.3
Annual Average Day
Forecasted Wastewater Gravity Flow to CRBUD Lift Stations, Private Lift Stations and Town of Mangonia Park

Lift Station	Wastewater Flow (gpm)				Comments
	2015	2020	2025	2030	
LS-P03	1.7	1.7	1.7	1.7	
LS-P04	96	96	96	96	
LS-P05	18	25	33	42	
LS-P06	1.1	1.1	1.1	1.1	
LS-P07	2.8	2.8	2.8	2.8	
LS-P08	0.8	0.8	0.8	0.8	
LS-P09	182	192	199	208	
LS-P10	88	93	97	101	
LS-P11	2.2	2.3	2.3	2.3	
LS-P12	Note 1	Note 1	Note 1	Note 1	All flows to LS-23
LS-P13	0	0	0	0	Abandoned Splash Grill Restaurant
LS-P14	0.5	0.5	0.5	0.5	
LS-P15	19	20	20	20	
LS-P16	3.6	3.9	4.4	4.9	
LS-P17	Note 1	Note 1	Note 1	Note 1	All flows to LS-31
LS-P18	Note 1	Note 1	Note 1	Note 1	All flows to LS-04
LS-P19	0	0	0	0	FPL Complex, LS demolished
LS-P20	Note 1	Note 1	Note 1	Note 1	All flows to LS-06
LS-P21	22	22	22	23	
LS-P22	0.1	0.1	0.1	0.1	
LS-P23	Note 1	Note 1	Note 1	Note 1	All flows to LS-06
LS-P24	Note 1	Note 1	Note 1	Note 1	All flows to LS-06
LS-P25	Note 1	Note 1	Note 1	Note 1	All flows to LS-06
LS-P26	Note 1	Note 1	Note 1	Note 1	All flows to LS-10
LS-P27	Note 1	Note 1	Note 1	Note 1	All flows to LS-10
LS-P28	Note 1	Note 1	Note 1	Note 1	All flows to LS-20
LS-P29	1.5	1.5	1.5	1.5	
LS-P30	Note 1	Note 1	Note 1	Note 1	All flows to LS-33
LS-P31	18	18	18	18	
LS-P32	0.1	0.1	0.1	0.1	
LS-P33	Note 1	Note 1	Note 1	Note 1	All flows to LS-30
Total	**3,475**	**3,600**	**3,784**	**4,101**	

***Note 1:** The wastewater influent flow for this private lift station was accounted for as inflow to the noted CRBUD owned lift station.*

Legend:

CRBUD owned lift stations are designated as LS-XX

Privately owned lift stations are designated as LS-PXX

LS = Lift Station

TMP = Town of Mangonia Park

6.4 Historical Wastewater Flow Variation

Knowledge of variations in wastewater flows is important for assessing the capacity utilization of existing facilities and sizing of new ones. Variations in historical flow are expressed in terms of ratios to the annual average day flow (AADF). Historical wastewater flow data were evaluated to determine the historical maximum day flow (MDF) and the peak hour flow (PHF) and their associated peaking factors (PFs) for 2010 and 2011. The maximum day flow peaking factor is defined as the MDF divided by the AADF (i.e., MDF PF = MDF/AADF). The peak hour flow peaking factor is defined as the PHF divided by the AADF (i.e., PHF PF = PHF/AADF). **Table 6.4** summarizes the historical peak hour and maximum day peaking factors for the CRBUD service area.

Table 6.4
Historical Wastewater Flows and Peaking Factors

Year	AADF (mgd)	MDF (mgd)	MDF/AADF	PHF (mgd)	PHF/AADF
2010	4.8	7.1	1.5	11.3	2.4
2011	4.8	6.9	1.4	12.1	2.5
Average	**4.8**	**7.0**	**1.45**	**11.7**	**2.45**

For this Master Plan, the average MDF PF and PHF PF for the period 2010 to 2011 of 1.45 and 2.45, respectively. The MDF PF of 1.45 was used for master planning. The PHF PF of 2.45 is presented for reference.

6.5 Overall Wastewater Flow Pattern

Wastewater flow also varies throughout the day. Typically, there is a consistent pattern of daily variations in wastewater flow. The project team reviewed available ECRWRF historical flow meter data from 2010 through 2011 and identified a wastewater flow pattern that is representative of the overall wastewater transmission system. This wastewater flow pattern is presented in **Figure 6-1**.

The wastewater flow pattern is presented as a dimensionless multiplier over a one-day hourly time scale. It is noted that this same pattern was used in the development of the

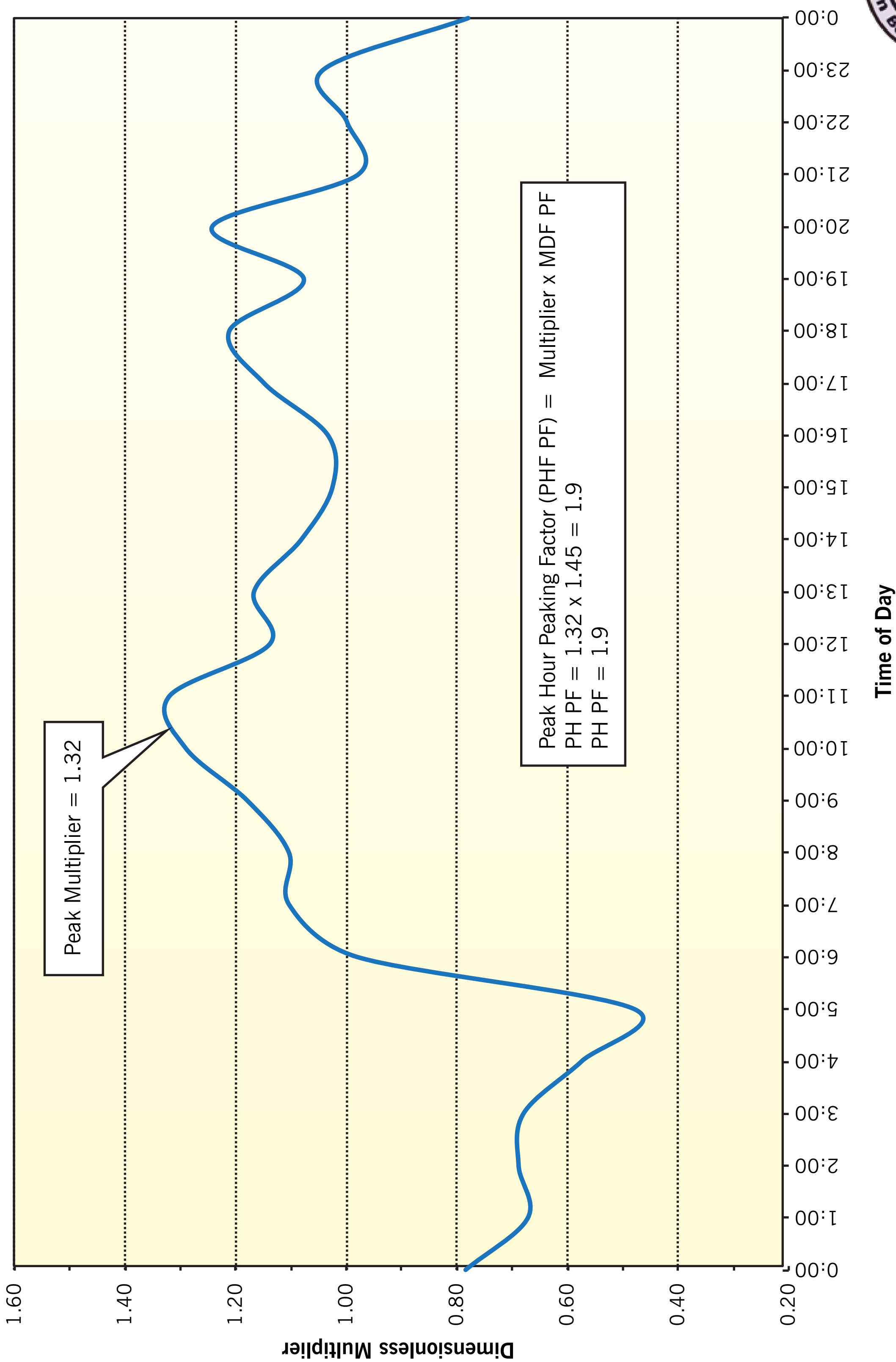

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Figure 6-1
Overall Wastewater Flow Pattern

water distribution system hydraulic model as described in Section 5 (titled "Water Demand Forecast") of this Master Plan. This pattern was input into the model to simulate how wastewater flow to the ECRWRF varies throughout a 24 hour period.

Given the wastewater flow pattern presented in **Figure 6-1**, the wastewater peak hour flow (PHF) occurred around 11:00 a.m. The PHF PF at that time was 1.9. The PHF PF determined using the demand pattern curve is about 20 percent lower than that predicted using the historical data presented in Subsection 6.4. This difference is expected since the wastewater flow pattern was based on ECRWRF flow data for a particular day whereas the data presented in Subsection 6.4 were based on daily records over an entire year.

Section 7.0
Water Supply System

7.1 Introduction

For this Master Plan, evaluation of the water supply system was limited to reviewing the findings of previously prepared documents submitted as part of the City of Riviera Beach Utility District (CRBUD) Water Use Permit (WUP) application along with the WUP issued by the South Florida Water Management District (SFWMD). Based upon a review of these documents, this section summarizes the likely capital improvement needs relative to water supply through the year 2030.

7.2 Water Use Permit

7.2.1 Raw Water Supply Needs

The CRBUD obtains all of its raw water supply from the surficial Biscayne Aquifer system via two active wellfields. The wellfields are designated the "Eastern Wellfield" and the "Western Wellfield". The Eastern Wellfield includes 17 existing wells. The Western Wellfield includes 11 existing wells. The CRBUD reports that the wells are operated in rotation to reduce eastern well withdrawals to minimize salt water intrusion in the aquifer. Certain key information on the construction of the existing wells is summarized in Section 3 (titled "Summary of Existing Facilities") of this report.

Withdrawal of water from the wellfields is permitted by WUP No. 50-00460-W, issued by the SFWMD on February 27, 2012. The water use permit expires on February 27, 2032. The WUP limits annual overall (i.e., both wellfields) raw water withdrawal to 3,313 million gallons which is equivalent to 9.08 mgd on an annual average basis. The Eastern Wellfield is limited to 2,190 million gallons annually and the Western Wellfield is limited to 1,190 million gallons annually.

The WUP also limits the western wellfield to 131.3 million gallons per month (equivalent to 4.3 mgd) and the eastern wellfield to 186 million gallons per month (equivalent to 6.1 mgd). The maximum month withdrawal limitation on the eastern wellfield is based upon reducing the potential for movement of saline water and contaminants. The maximum month withdrawal limitation on the western wellfield is based upon minimizing impacts on wetlands, regional water bodies and potential sources of contamination. The WUP does not include a limitation on maximum day raw water withdrawals.

However, the WUP staff report indicates that pumpage in the Eastern Wellfield should be limited to 6 mgd to limit the potential for movement of saline water and contaminants. Although this limitation does not appear in the WUP, it is likely prudent to operate the wellfield to meet this maximum day pumping limitation for the Eastern Wellfield. The CRBUD should consider obtaining a clarification relative to this discrepancy between the WUP and the water use staff report.

The WUP application documents indicate that the raw water demand is forecasted to equal about 9 mgd in the year 2032 on an annual average day basis. Thus, the available water supply appears to be adequate to meet demand through the year 2032 on an annual average day basis. Hence, raw water supply capacity improvements were not considered necessary by the CRBUD staff and are not included in this Master Plan. Given the available supply and the demand forecast, this is likely a reasonable decision.

The maximum day raw water demand is expected to be 1.3 times the annual average day demand. The WUP does not restrict raw water pumping on a maximum day basis. Hence, it is believed that the limitation set forth in the WUP will allow the District to meet maximum day demand forecast through the year 2032.

Given that capacity improvements relative to water supply are likely not required over the next 20 years, the remainder of this Section focuses on renewal and replacement (i.e., improvements needed to maintain the reliability of the existing infrastructure) and regulatory driven improvement needs. The following paragraphs summarize the capital improvements identified in the WUP.

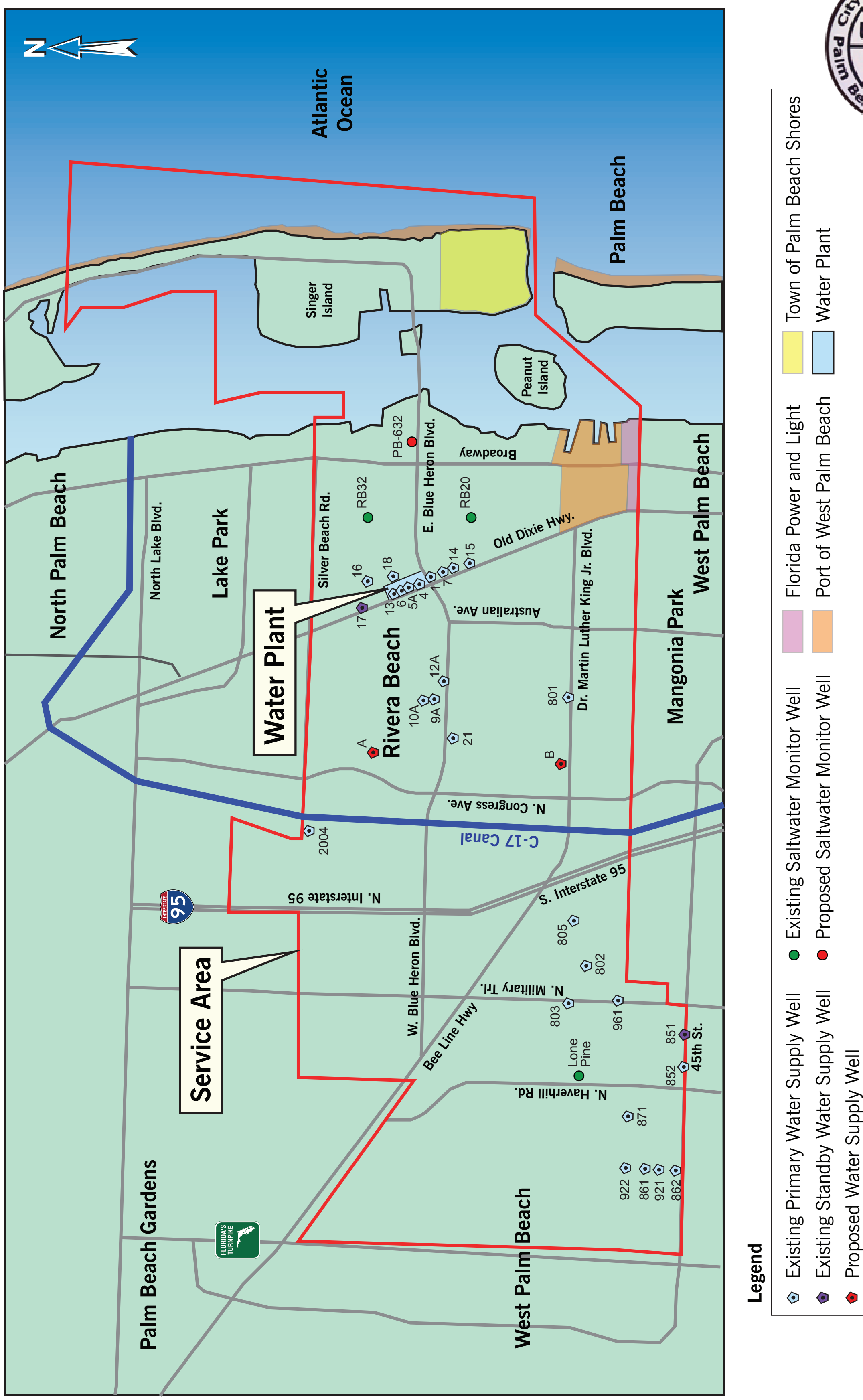
7.2.2 Proposed Monitor Well

The WUP identifies construction of one proposed saltwater monitor well in the eastern wellfield. The proposed monitor well is designated PB-632. The WUP indicated that the proposed saltwater monitor well would be 2-inch diameter, drilled to 275 feet below land surface and cased with polyvinyl chloride (PVC) casing. The general location of the proposed saltwater monitor well is illustrated in **Figure 7-1**. The actual location would be determined during detailed design.

7.2.3 Proposed Water Supply Wells A and B

The WUP identifies construction of two new water supply wells. The wells are designated as proposed wells A and B in Exhibit 5, Table A of the water use staff report. The WUP indicated that the purpose of the proposed wells A and B is to shift a certain amount of raw water withdrawal from the western wellfield (by reducing pumpage from wells 862 and 921) to the proposed eastern wells to lessen the impact on wetlands located is the western portion of the service area.

The proposed wells are located in the eastern wellfield and are illustrated in **Figure 7-1**.



City of Riviera Beach Utility District, Established in 2004, Palm Beach County, Florida

42010-001R1.ai

Figure 7-1
Water Supply Wells

HAZEN AND SAWYER
Environmental Engineers & Scientists

The actual locations would be determined during detailed design. It is recommended that the CRBUD conduct a well site selection study that identifies easement needs and/or property acquisition needs prior to initiating detailed design of the proposed wells.

Per the WUP, the proposed wells would be 20-inch diameter, drilled to 175 feet below land surface and cased with polyvinyl chloride (PVC) casing to a depth of 130 feet. The estimated capacity of these wells would be 500 gpm per the WUP. For the purpose of this Master Plan it assumed that each well would include a submersible turbine pump, slab on grade, above ground piping and valves, a chain-link fence around the surface equipment, 400 feet (per well) of 8-inch diameter underground raw water piping to connect a well to the existing raw water transmission system, power supply via overhead power to a pole mounted transformer and three phase 480 volt service drop, a six foot by ten foot concrete masonry structure with cast-in-place roof to house electrical panel and control panel. Assessment of easement needs and/or property acquisition was not conducted.

7.3 Findings of Previous Studies

7.3.1 Introduction

The CRBUD retained Barnes, Ferland and Associates, Inc. (BFA) to evaluate the condition of the CRBUD's water supply wells. The scope of services provided by BFA included:

- Evaluating well yield and water quality records provided by the CRBUD;
- Field inspections of active wells to assess general conditions and collect recent water quality and yield/drawdown data;
- Recommend and identify wells for repair/rehabilitation to restore service and improve their performance;
- Recommend and identify wells to abandon and replace at the same location;
- Recommend potential new well locations;
- Recommend procedures and criteria for the distribution of withdrawals; and
- Recommend operations to minimize wetland and surface water drawdown impacts.

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7.3.2 Findings

The findings of the evaluation were documented in a report titled "City of Riviera Beach - Well Field Operational Plan Draft" dated October 12, 2010. The project team's interpretation of the key findings and recommendations of the "Well Field Operational Plan Draft" report are as follows:

- Wells 802, 805, 861, 921, 922 and 2004 have elevated specific conductivity, chloride and total dissolved solids (TDS) concentrations. Raw water from these wells was above the TDS maximum drinking water standard (MCL) of 500 mg/L. Raw water from Well 2004 was above the chloride MCL of 250 mg/L.

- Based on three sampling events in 2010, volatile organic compounds (VOCs) were detected in six of the CRBUD's eastern supply wells (Wells 4, 5A, 6, 13, 14, 16). The VOCs were below the MCLs.

- Three wells (9, 10, 12) have previously been plugged and abandoned and replaced at new locations. The replacement wells are designated 9A, 10A and 12A. The replacement wells are deeper than the wells they were replacing. Replacement well 12A has detected VOC intermittently.

- The drawdown magnitude is likely greater at Wells 4, 5A, 6 and 13 (relative to wells 14 and 16) and continuous pumping of these wells might cause an increase in VOC concentrations. It is noted that the CRBUD has several wells tested semi-annually for VOCs and the CRBUD water treatment plant includes air strippers for VOC removal. Composite raw water entering the treatment plant is also tested for VOCs which have not been detected.

- Field assessments were conducted during 2010 on 27 wetlands located within one mile of CRBUD wells by Sustainable Ecosystems International, Inc. Sustainable Ecosystems International, Inc. concluded that CRBUD wells 862, 921, 861, and 922 are relatively shallow and that pumping contributed to wetland drawdown impacts within the vicinity of these wells. Reducing or shifting pumpage from these wells is a mitigation option the City may consider.

- Pump/Motor Out of Service (OOS): Twelve wells (1, 7, 9A, 10A, 12A, 14, 801, 805, 851, 852, 861, and 871) were OOS during November 2010, generally related to mechanical problems with well pumps/motors. Loss of use of these wells requires almost continuous pumping of the remaining wells and may cause excessive localized aquifer drawdowns and related impacts.

- Electrical Problems: Supply wells 851 and 852 have "electrical problems" causing these wells to be OOS. The “electrical problems” were not described in the BFA report.

- Specific capacity testing performed in November 2010 indicated that nine wells (wells 10A, 18, 21, 802, 803, 862, 871, 922, and 961) had drawdowns greater than 40 feet. A well rehabilitation program was recommended to improve capacity and reduce drawdowns. The rehabilitation program should include video logging, chemical/mechanical treatment, and redevelopment.

- The backpressure on the transmission main that receives raw water from Well 14 appears to be higher than the pump discharge pressure. Hence, a larger size pump head capacity may be needed to resolve this issue.

- Three supply wells were not equipped with meters (Wells 803, 871, and 921) and rates can only be estimated from pump curves. Flow meters should be installed during rehabilitation.

- Plugging and abandoning existing wells 5A, 6, 10A, 12A, 13, 861, 862, and 922 and replacing them with new wells was recommended within the next 10 years.

7.3.3 Recommendations

Based upon review of the above referenced study, this Master Plan offers the recommendations summarized in **Table 7.1**.

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Table 7.1
Wellfield Improvement Recommendations

Well No.	Wellfield	Recommendations							
		Annual Specific Capacity Testing	Add New Flow Meter	Replace Pump / Motor, Control Panel and Electrical	Redevelop Well	Reduce Pumpage	Stop Pumping & Convert to Monitor Well	Plug and Abandon	Drill and Equip New Replacement Well (at same location)
1	Eastern	X	X	X	X				
4	Eastern	X			X				
5A	Eastern	X			X			X	X
6	Eastern	X			X			X	X
7	Eastern	X	X	X	X				
9A	Eastern	X	X	X	X				
10A	Eastern	X			X			X	X
12A	Eastern	X			X			X	X
13	Eastern	X			X			X	X
14	Eastern	X	X	X	X				
15	Eastern	X			X				
16	Eastern	X			X				
17	Eastern	X			X				
18	Eastern	X			X				
21	Eastern	X			X				
2004	Eastern	X			X				
A	Eastern	X			X				Note 1
B	Eastern	X			X				Note 1
801	Eastern	X	X	X	X				
802	Western	X			X				
803	Western	X	X		X				
805	Western	X	X	X	X				
851	Western	X	X	X	X				
852	Western	X	X	X	X				
861	Western				X		X		
862	Western	X			X	X		X	X
871	Western	X	X	X	X				
921	Western	X	X		X	X			
922	Western				X		X		
961	Western	X			X				

***Note 1**: Wells A and B are proposed wells to shift a certain amount of raw water withdrawal to the Eastern Wellfield.*

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The above list of recommendations would all be categorized as renewal and replacement type projects. The above recommendations are consolidated into a series of projects in Subsection 7.9.

7.4 Raw Water Transmission System Piping Needs

The CRBUD decided that buried infrastructure and piping condition would not be physically evaluated as part of this Master Plan. There is not sufficient record information on the raw water piping to make a determination about the age of the pipe. However, the CRBUD has determined that roughly 10,700 feet of existing raw water transmission system piping is asbestos cement. The quantity of existing asbestos cement piping (broken down by diameter) in the raw water transmission system is roughly as follows:

- About 1,000 feet of 6-inch diameter piping
- About 1,600 feet of 8-inch diameter piping
- About 4,400 feet of 10-inch diameter piping
- About 3,700 feet of 12-inch diameter piping

It is speculated that the asbestos cement piping was installed in the 1950s and 1960s. The Chrysotile Institute in the article titled "*Asbestos-Cement Pipe: A Special Report*" suggest that the lifespan of asbestos cement piping is 70 years; the actual service life depends on numerous factors (such as installation methods, loading, etc.). Given this suggested lifespan it is recommended that the CRBUD consider replacing the asbestos cement piping within the next 10 years.

7.5 Contamination Issues

The WUP staff report indicates that there are three ongoing contamination issues related to: 1) Trans Circuits superfund site, 2) the Solitron (a.k.a., Honeywell) site and 3) Solid Waste Authority of Palm Beach County. The background and analysis on these issues can be found in the WUP application along with the WUP staff report and are not repeated herein. Neither the WUP staff report nor the "Well Field Operational Plan Draft" report recommended capital improvements in addition to those identified in Subsection 7.3.

7.6 Capacity Improvement Needs

As indicated in Subsection 7.2.1 the raw water supply appears to be adequate to meet demand on an annual average day basis and maximum day basis through the year 2032. Hence, raw water supply capacity improvements were not considered necessary by the CRBUD staff. Consequently, the scope of work for this Master Plan did not include an evaluation of water supply capacity improvement needs.

7.7 Ground Water Rule Compliance

The CRBUD decided that the scope of work for this Master Plan did not require an assessment relative to water supply regulatory driven improvement needs. However, an opinion on the feasibility of federal Ground Water Rule (GWR) 4-log virus treatment compliance via changes in disinfection strategy is included in the scope of work for this Master Plan. It is noted that the GWR was promulgated on November 8, 2006. The capital improvement and operation changes that would be required for GWR 4-log virus treatment compliance are related to treatment rather than supply. Consequently, the feasibility of GWR 4-log virus treatment compliance and related capital improvement needs are described in Section 8 (titled "Water Treatment Facilities" of this report.

The GWR requires that the State conduct a sanitary survey of a ground water system every three years. In Riviera Beach, the Palm Beach County Health Department is the agency that performs the sanitary surveys. A sanitary survey is an on-site review of how a ground water system is designed, maintained, and operated. The reviewer will look at equipment (wells, pumps, aboveground piping, etc.), facilities, and treatment to identify any significant deficiencies. A significant deficiency is any design, operation, or maintenance defect, or any source, treatment, storage, or distribution facility failure or malfunction, that Palm Beach County Health Department determines is causing, or has potential to cause, contamination of water delivered to customers.

To facilitate an understanding of what the Palm Beach County Health Department would consider a significant deficiency, typical examples (based upon a recent presentation by the Florida Department of Environmental Protection) are listed as follows:

- Top of well casing is not elevated to prevent contamination from flooding, or well is vulnerable to surface water runoff;
- Well casing is cracked;
- Well does not have proper sanitary seal;
- Vent for well is not screened and turned downward;
- Well is not secure and is susceptible to vandalism and tampering;
- Well is cross-connected to storm sewer, sanitary sewer, or surface water body;
- Lack of redundant treatment components;
- Lack of treatment process monitoring, failure alarms, or automatic process shutdown;

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- Standby power is not available at the WTP;
- Required disinfectant residual levels are not maintained at WTP;
- Disinfectant residual monitoring at WTP is inadequate;
- There is high leakage rate in the distribution system;
- Separation between water mains & other pipelines is inadequate;
- There are numerous consumer complaints about colored and/or odorous water;
- Storage tank drain or overflow is subject to flooding;
- Storage tank access manhole is not watertight; and
- Storage tank access manhole or access ladder is not secure and is susceptible to vandalism and tampering.

If the Palm Beach County Health Department identifies a significant deficiency they will issue a written "Notification of Significant Deficiencies" to the CRBUD. The "Notification of Significant Deficiencies" may specify corrective actions and deadlines for completion of corrective actions or allow the utility to determine the corrective action.

Based on our understanding of the implementation status of the GWR, the first sanitary surveys are currently underway throughout the State by the local health departments. The project team was informed that the first GWR sanitary survey has not yet been conducted for the CRBUD's water supply system.

Once the Palm Beach County Health Department conducts the sanitary survey, they may identify certain significant deficiencies under the GWR. As a result, the CRBUD may be required to implement capital improvements to correct the deficiencies identified during the sanitary survey.

It is recommended that the CRBUD establish a "placeholder" budget for implementing corrective actions in the event that a future GWR sanitary survey identifies a significant deficiency. Based on the list of example significant deficiencies listed above, the cost to implement corrective actions prescribed by the Palm Beach County Health Department could range widely. Since a sanitary survey has yet to be performed for the CRBUD water system, providing an opinion on an appropriate budget to establish to implement currently unknown corrective actions is highly speculative. Nevertheless, prudent planning warrants proceeding with an assumption, with an understanding that significant modification may be necessary. For the purpose of this Master Plan, the CRBUD decided to use $50,000 every three years as a placeholder budget implementing improvements identified during the GWR sanitary survey.

7.8 Regulatory Driven Improvement Needs

The major water supply related regulatory improvement needs are described in the subsections above. **Table 7.2** aggregates the regulatory driven type improvement recommendations presented above into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

Table 7.2
Regulatory Driven Improvement Projects
Water Supply System

Project No.	Project Name	Project Description
WELLREG001	Proposed Wells A and B	Drill proposed water supply wells A and B. Equip the wells with pumps, motors, power, controls, etc.
WELLREG002	Proposed Salt Water Monitor Well	Construct the proposed saltwater monitor well identified in the water use permit.
WELLREG003	GWR Sanitary Survey Improvements (every 3 years)	Implement corrective actions on an as-needed basis to address deficiencies identified by the Palm Beach County Health Department during performance of Ground Water Rule (GWR) sanitary surveys.

7.9 Renewal and Replacement Improvement Needs

Infrastructure that is nearing (or at) the end of its useful life should be renewed (i.e., rehabilitated or otherwise refurbished) to extend its useful life (e.g., slip lining a pipe) or replaced in its entirety. Infrastructure improvement needs that fall into this category are referred to as "renewal and replacement" improvements in this Master Plan.

The major water supply related renewal and replacement improvement needs are described in the subsections above. **Table 7.3** aggregates the renewal and replacement type improvement recommendations presented above into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

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Table 7.3
Renewal and Replacement Projects
Water Supply System

Project No.	Project Name	Project Description
WELLRR001	Annual Specific Capacity Testing	Retain the service of a contractor to conduct specific capacity testing of the wells on an annual basis.
WELLRR002	Well Pump Replacement	Redevelop the well and replace the pump, motor, control panel, flow meter, and electrical equipment at the following wells: 1, 7, 9A, 14, 801, 805, 851, 852, 871. Additionally, modify the piping, electrical and controls at wells 803 and 921 to include flow meters at the wellhead.
WELLRR003	Rehabilitation of Raw Water Wells	Prepare contract documents for well rehabilitation. The rehabilitation would include logging and redevelopment. Based on CRBUD Capital Plan assume $100,000 per year.
WELLRR004	Convert Production Well to Monitor Well	The BFA report titled "Well Field Operational Plan Draft" dated October 12, 2010, recommended replacing wells 861 and 922 with new wells at the same location. In lieu of this recommendation consider stopping pumping these wells (if feasible) and using them for monitoring wells.
WELLRR005	Drill and Equip New Replacement Wells – Phase 1	Plug and abandon the following existing wells and replace them with a new well at the same location: • Well 5A • Well 6 • Well 10A • Well 12A
WELLRR006	Drill and Equip New Replacement Wells – Phase 2	Plug and abandon the following existing wells and replace them with a new well at the same location: • Well 13 • Well 861 (if Project No. WELLRR004 is not implemented) • Well 862 • Well 922 (if Project No. WELLRR004 is not implemented)
WELLRR007	Raw Water Asbestos Cement Piping Replacement	Replace asbestos cement piping: • About 1,000 feet of 6-inch diameter piping • About 1,600 feet of 8-inch diameter piping • About 4,400 feet of 10-inch diameter piping • About 3,700 feet of 12-inch diameter piping

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7.10 Opinion of Probable Project Costs

The opinions of probable cost for all of the above projects are presented in Section 12 (titled "Opinion of Probable Project Costs") of this report.

Section 8.0
Water Treatment Facilities

8.1 Introduction

This section provides a description of the improvements recommended for the City of Riviera Beach Utility District's (CRBUD's) water treatment plant (WTP).

8.2 Historical Finished Water Quality

8.2.1 Total Hardness

Total hardness is defined as the sum of the calcium and magnesium hardness, in mg/L as calcium carbonate ($CaCO_3$). **Figure 8-1** illustrates total hardness of CRBUD's raw and finished water. It indicates that the raw water total hardness averages about 270 mg/L as $CaCO_3$ and the finished water averages about 143 mg/L as $CaCO_3$. Finished water with a total hardness in the range of 121 to 180 mg/L as $CaCO_3$ is typically considered hard based upon the United States Geological Survey classification system of water hardness, presented in **Table 8.1**.

Table 8.1
Hardness Classification

Classification	Total Hardness as $CaCO_3$
Soft	0 to 60
Moderately Hard	61 to 120
Hard	121 to 180
Very Hard	Greater than 180

Hard water contains high levels of dissolved calcium and magnesium; the greater the amount of dissolved minerals in the water, the harder it is. The term "hard water" results from the fact that calcium and magnesium ions in water combine with soap molecules, making it "hard" to form soap bubbles.

As indicated in Subsection 8.3, the CRBUD's finished water total hardness goal of 110 to 150 mg/L as $CaCO_3$ is relatively high in comparison to the general industry range of 80 to 100 mg/L as $CaCO_3$. The general use of synthetic detergents has reduced the importance of hardness for soap consumption. Consequently, CRBUD's softened water total hardness goal of 110 to 150 mg/L as $CaCO_3$ is likely a feasible practice for

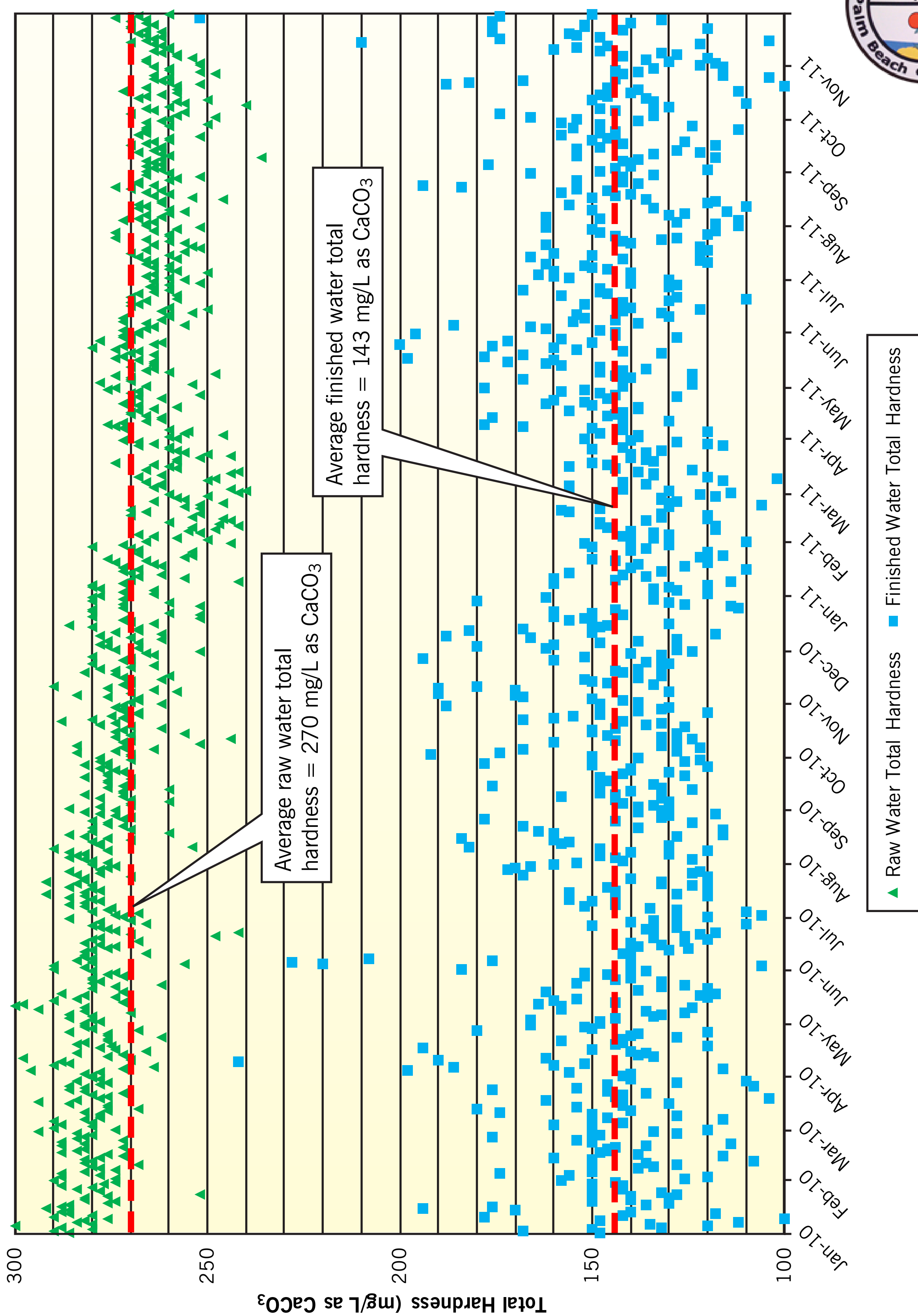

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Figure 8-1
Total Hardness

reducing overall water treatment plant chemical consumption and reducing lime sludge production.

Hard water is not a health concern. However, high levels of total hardness can cause excessive build-up of scale inside of water pipes (especially those carrying hot water) resulting in reduced water heater efficiency and clogging household pipes.

8.2.2 pH

pH is a measure of the hydrogen ion content of water. It indicates whether the water is acidic (pH less than 7), basic (pH greater than 7 and up to 14) or neutral (pH of 7). There is no health based standard range for pH. However, the United States Environmental Protection Agency (USEPA) has established a Secondary Drinking Water Regulation for pH of 6.5 to 8.5. Secondary Drinking Water Regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic effects or aesthetic effects in drinking water. Per Florida Administrative Code (FAC) 62-550.520(1) a lime softening plant is allowed to produced finished water with a pH of 6.5 to 9.0. It is noted that producing a finished water with a pH above 9.0, but less than or equal to 10.0, is allowable under FAC 62-550.520(1) under certain conditions that are likely not applicable to the CRBUD.

Figure 8-2 illustrates historical settled water pH (measured after softening and before final chlorine addition) data from 2010 to 2011. The settled water pH averages 8.2. **Figure 8-3** illustrates historical finished water pH data from 2010 to 2011 after the application of chlorine, which tends to depress pH. The finished water pH averages 8.1. These data are highly variable, which is likely indicative of an inability to control the lime feed rates to the treatment units. These data indicate that about 99 percent of the finished water pH values are less than 8.5 and did not exceed the maximum allowable of 9.0.

8.2.3 Langelier Saturation Index

The Langelier saturation index (LSI) is an equilibrium model derived from the theoretical concept of saturation and provides an indicator of the degree of saturation of water with respect to calcium carbonate. LSI is calculated from a series of equations based on measured values of total alkalinity (mg/L as $CaCO_3$), calcium hardness (mg/L Ca^{2+} as $CaCO_3$), total dissolved solids (mg/L), pH, and the temperature of the water (degrees Celsius). LSI indicates whether the water will tend to precipitate, dissolve, or be in equilibrium with calcium carbonate, as follows:

- If LSI is less than zero: water is under saturated and will tend to dissolve $CaCO_3$
- If LSI is greater than zero: water is super saturated and $CaCO_3$ tends to precipitate and form a scale layer on the pipe wall

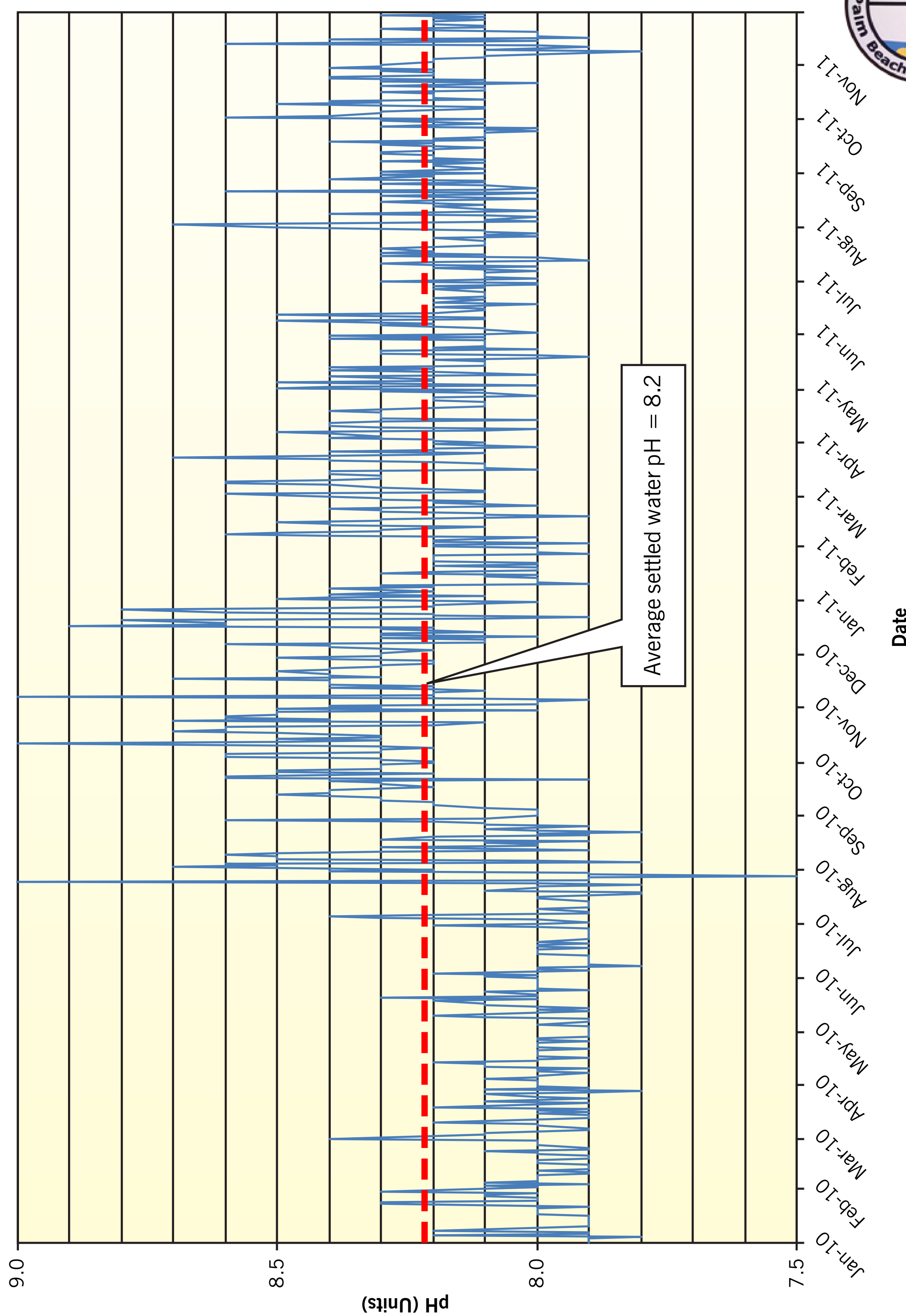

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Figure 8-2
Settled Water pH

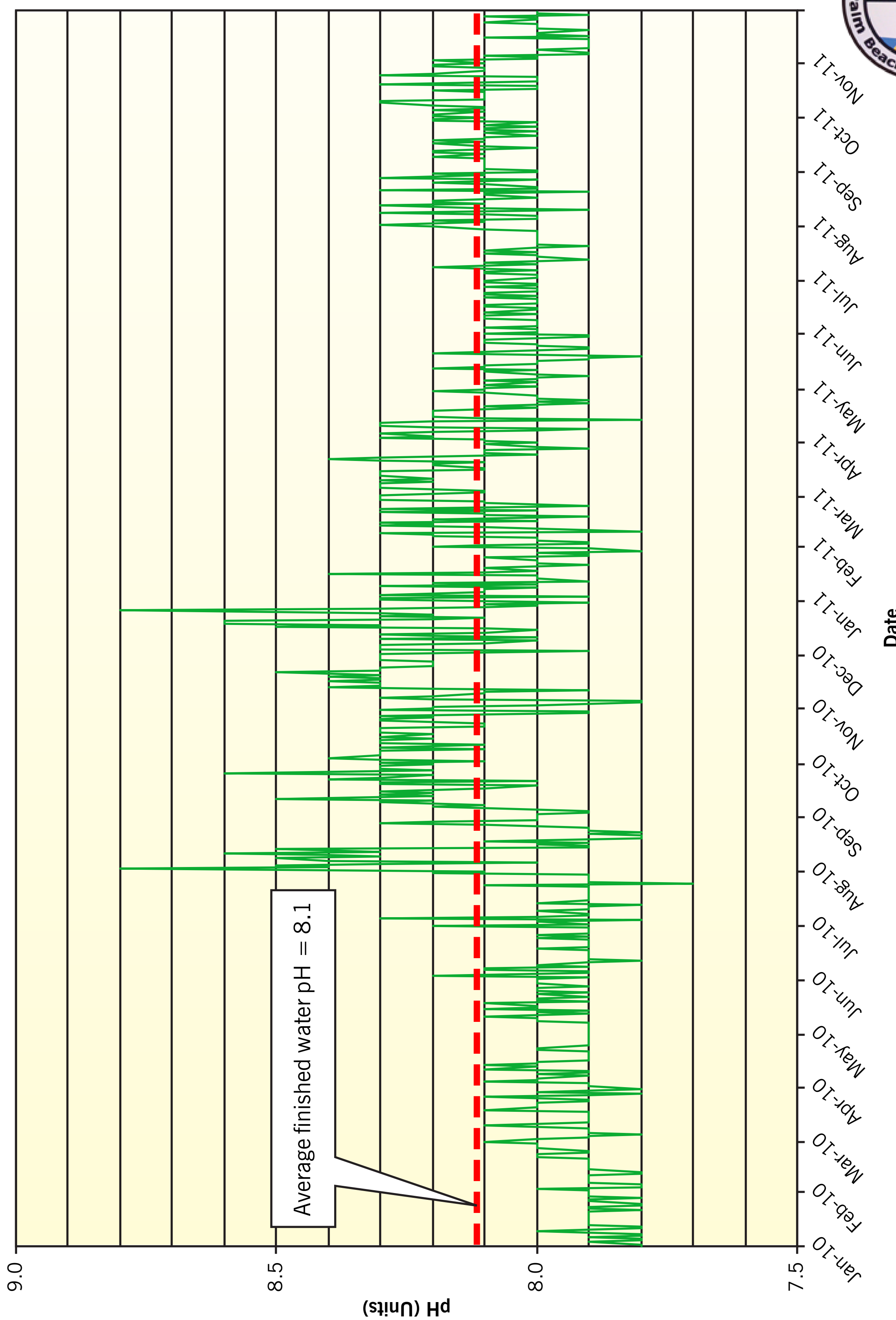

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Figure 8-3
Finished Water pH

- If LSI is equal to zero: water is saturated (in equilibrium) with $CaCO_3$. A scale layer of $CaCO_3$ is neither precipitated nor dissolved

In practice, water with an LSI between -0.5 and +0.5 will likely not display enhanced mineral dissolving or scale forming properties. Water with an LSI below -0.5 tends to exhibit noticeably increased calcium carbonate dissolving abilities while water with an LSI above +0.5 tends to exhibit noticeably increased scale forming properties.

Figure 8-4 illustrates historical finished water LSI data from 2010 through 2011. The data averaged about 0.3 and is highly variable. The high variability in the data is likely indicative of an inability to control the feed rates of lime to the treatment units resulting in poor ability to control finished water pH. Consequently, improving the control of the lime feed rates to the treatment units is recommended.

8.2.4 WTP Finished Water Chlorine and Total Ammonia

The CRBUD adds chlorine and ammonia at the WTP to form a chloramine residual (with the goal of achieving monochloramine as the predominant chloramine species). **Table 8.2** presents the results of testing chlorine residual and total ammonia as nitrogen (as N) at the point the water from the WTP enters the distribution system.

Table 8.2
Chlorine and Ammonia at the Point of Entry in the Distribution System

Date	Free Chlorine as Cl2 (mg/L)	Total Chlorine as Cl2 (mg/L)	Total Ammonia as N (mg/L)	Total Chlorine as Cl2 to Total Ammonia as N Ratio
5/7/12	2.6	3.3	1.36	2.4
5/8/12	2.5	3.3	0.98	3.4
5/9/12	1.7	3.4	0.46	7.4
5/10/12	2.4	3.1	0.81	3.8
5/15/12	3.2	3.9	0.16	24
5/16/12	2.8	3.2	0.32	10
5/17/12	4.0	4.7	0.13	36

The free and total chlorine residual were measured using USEPA accepted colorimetric N, N-diethyl-p-phenylenediamine (DPD) method. Monochloramine (and other constituents) interferes with DPD free chlorine analysis resulting in a false-positive (i.e., a "phantom reading"). Although monochloramine was not measured it can be inferred based upon the CRBUD's existing chlorination strategy. Hence, the free chlorine residual data are considered false positives.

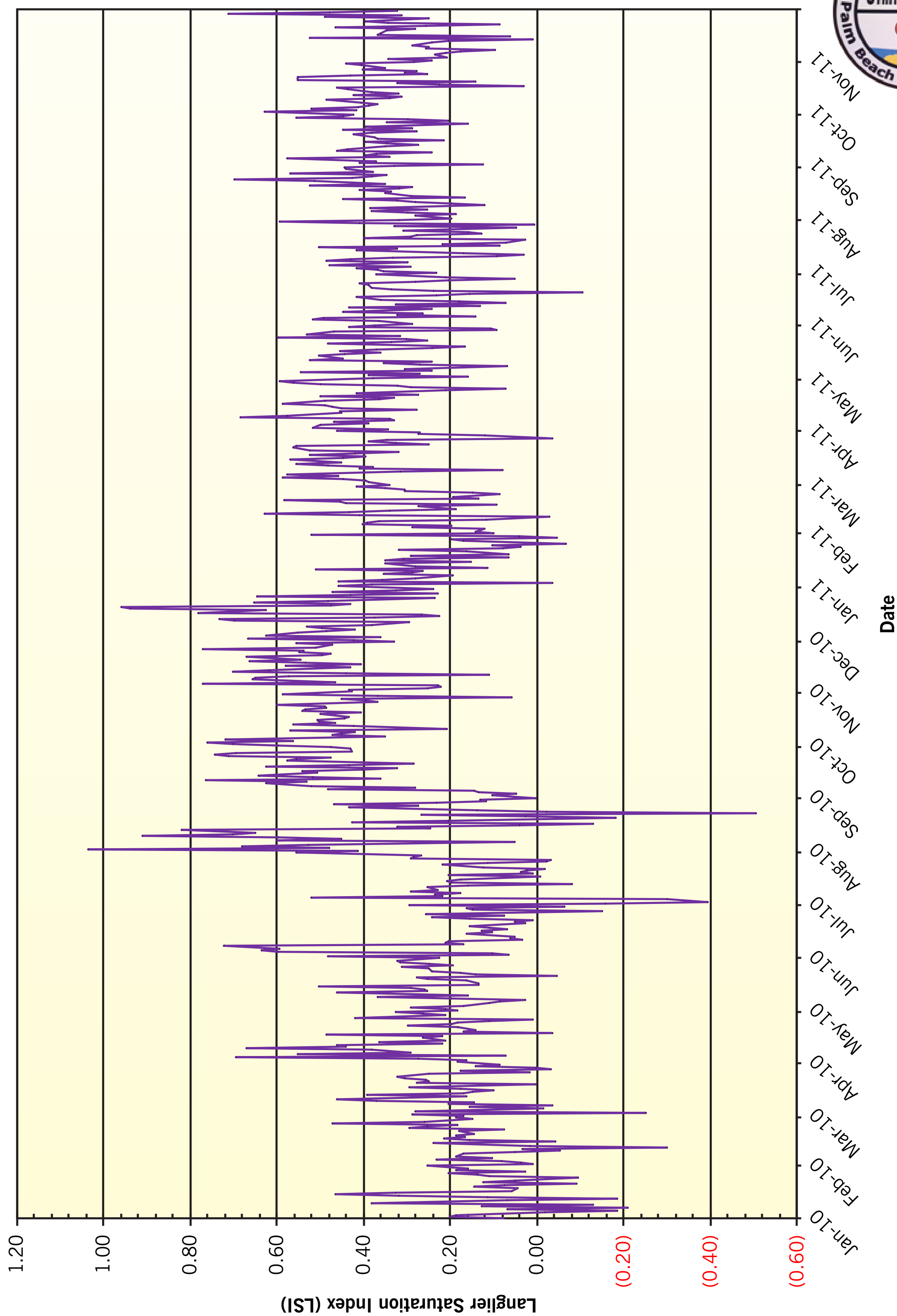

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Figure 8-4
Langelier Saturation Index

Ideally, the measured total chlorine to total ammonia as N ratio (by weight) should be approximately 4:1 to 5:1. Values lower than this ratio result in free ammonia entering the distribution system which would contribute to nitrification. Values in the range of 5:1 to 10:1, likely result in formation of dichloramine and trichloramine which cause taste and odor issues. Values greater than 10:1 result in breakpoint chlorination.

As indicated in **Table 8.2** (above), the measured total chlorine to total ammonia as N ratio varied from 2.4 to 36 during the testing. This is likely indicative of poor controllability of the chlorine and ammonia feed system. It could also be indicative of variability of ammonia in the raw water depending which wells are pumped. The apparently unstable operation of the disinfection system at the WTP (as indicated by the high variation in measured total chlorine to total ammonia as N ratio) is likely contributing to the reduced total chlorine residual in the Gramercy Park area as noted in Section 3 (titled "Summary of Existing Facilities") of this report.

To facilitate improved operation of the chlorine system moving forward, it is recommended that the CRBUD conduct hourly monitoring of the following at the high service pump station discharge:

- Free ammonia (as N)
- Total ammonia (as N)
- Monochloramine
- Total chlorine

8.3 Water Quality Goals

The plant is currently operating at an annual average daily flow rate of approximately 7 mgd. Aluminum sulfate (a.k.a., alum) is currently injected into the influent receiving basins and lime, polymer and chlorine are dosed at the influent to the softeners. Typically aluminum sulfate is dosed at 1.5 mg/L and lime is dosed at 60 mg/L (as product). The staff reports a target softening pH of approximately 8.6 units, a finished water pH of 8.0 to 8.2 (after chlorine addition) and a finished water total hardness goal of approximately 110 to 150 mg/L as $CaCO_3$. The CRBUD has set a filter water turbidity goal of 1 nephelometric turbidity units (NTU) maximum. It is noted that WTP typically produces filtered water of less than 0.1 NTU.

8.4 Recent Capital Improvements

There have been no significant capital improvements at the water treatment plant within the last five years.

8.5 Bench-Scale Testing

8.5.1 Introduction

Bench-scale testing of filter media, lime dosages, polymers, and disinfectants was conducted on-site at the CRBUD's WTP from January 22, 2012 through February 3, 2012. The following subsections present the findings of the bench-scale testing.

8.5.2 Bench-Scale Testing Setup

Raw water for the bench scale testing was obtained from a location on the discharge side of the transfer pumps after the air strippers and before any chemical additions.

Bench-scale testing was performed using Phipps and Bird 6-gang mixers, with 2-liter square jars equipped with sample taps located at a fixed depth. Prepared chemical stock solutions were added to the test jars using biological syringes for accuracy.

Samples collected and prepared to determine disinfection byproducts, total organic carbon, chloride, chlorate, bromate, perchlorate and sodium were forwarded to Test America for analyses. All other testing and analyses were performed by Hazen and Sawyer staff, using a Hazen and Sawyer mobile laboratory.

To simulate the full-scale plant in the jars, a test strategy that has been previously utilized to evaluate softeners was used. The jar test simulation parameters are presented in **Table 8.3** and are generally representative of softener performances.

Table 8.3
Jar Test Simulation Parameters

Treatment Stage	Parameter	Value
Initial Mixing	Mixing Speed (rpm)	100
Initial Mixing	Mixing Duration (minutes)	30
1st Stage Flocculation	Mixing Speed (rpm)	45
1st Stage Flocculation	Mixing Duration (minutes)	45
Settling	Settling Time (minutes)	6

8.5.3 Raw Water Quality

The CRBUD obtains all of its raw water supply from the surficial Biscayne Aquifer system via two active wellfields. The wellfields are designated the "Eastern Wellfield" and the "Western Wellfield". The Eastern Wellfield includes 17 existing wells. The Western Wellfield includes 11 existing wells. The CRBUD reports that the wells are operated in rotation to reduce eastern well withdrawals to minimize salt water intrusion in the aquifer.

Raw water quality is somewhat variable depending on which wells are in service. Samples were obtained from the effluent of the air stripping towers to determine certain raw water quality parameters. The results of the raw water quality testing are presented in **Table 8.4**. **Table 8.4** also includes the effluent water quality from the south softener for comparison purposes.

During bench scale testing, samples were routinely collected from all test jars and analyzed for pH, turbidity, alkalinity and UV-Absorbance at 254 nanometers (nm). The UV-Absorbance measurement is used as a surrogate indicator to determine the relative concentration of naturally occurring organic precursors that react with disinfectants to form trihalomethanes (THM's) and other disinfection byproducts (DBPs). The UV-Absorbance readings can then be compared to determine the relative efficiency of a process strategy in removing DBP precursors.

Relative total organic carbon (TOC) levels are also well indicated by UV-Absorbance results. UV-Absorbance measurements are used instead of direct measurements of THMs, TOC, and DBPs due to the complexity and costs of testing for these compounds.

Table 8.4
Raw Water Quality

Parameter	Raw Water 1/25/12	Raw Water 1/27/12	Raw Water 1/30/12	South Softener Effluent 1/30/12
pH (Units)	8.06	8.11	8.13	8.15
UV-254 (1/cm)	0.287	0.211	0.266	0.224
Turbidity (NTU)	1.89	1.64	2.12	5.14
Temperature ^{0}C	24.7	26	23.3	23.3
Total Hardness (mg/L as $CaCO_3$)	196	202	182	170
Alkalinity (mg/L as $CaCO_3$)	230	234	202	190
Calcium (mg/L)	61	58	67	69

Treatment strategies that can optimize TOC removal in the treatment step – thus minimizing TOC prior to chlorine (or sodium hypochlorite) application – will help to reduce chlorine demand and reduce overall DBP formation.

As shown, raw water quality is variable, depending on the wells that are in service. UV Absorbance values were collected as a surrogate for raw water organic carbon levels. Based on the sample results UV can vary as much as 30 percent.

8.5.4 Lime Dosage Evaluation

The CRBUD's current practice is to dose lime at approximately 60 mg/L (as product). To evaluate the different hardness values that would result from different lime doses, jar testing was conducted using lime doses of 50 to 100 mg/L (90 percent active lime). The results are presented in **Figure 8-5**.

Only lime was added to the test jars for these tests; no other chemicals were added. **Figure 8-5** indicates that increasing lime dosage from 50 to 60 mg/L provides increasing hardness removal. Lime doses of 70 to 100 mg/L show basically no change in total hardness levels with lime dose. It appears that significantly higher doses are needed to remove additional hardness; however, this would increase chemical costs and significantly increase lime sludge handling requirements.

Based on these results it appears that the 60 mg/L lime dosage is the lowest dosage that resulted in an appreciable improvement in finished water total hardness. Hence, it is recommended that the CRBUD continue their current target lime dosage of 60 mg/L.

8.5.5 Polymer Testing

Polymers are used to help control effluent turbidity in the softeners, and depending on their charge, may also help to reduce dissolved organics. Dissolved organics react with chlorine and form DBPs (i.e., trihalomethanes and haloacetic acids). Dissolved organic carbon has a slight negative charge (anionic), and polymers or coagulants with a positive charge (cationic) can help remove organic carbon by charge neutralization. Polymers without charge (nonionic) can help with removals by increasing particle sizes and promoting settling.

POL-E-Z ® 692 Plus by Nalco is currently added within the primary mixing zone of the softeners. Based upon the low maximum allowable dosage (under the NSF International certification for this product) of 1 mg/L, the CRBUD has determined that it wants to replace this product with an alternative polymer.

Accordingly, polymers from several different manufacturers were jar tested. The polymers that were tested are presented in **Table 8.5**.

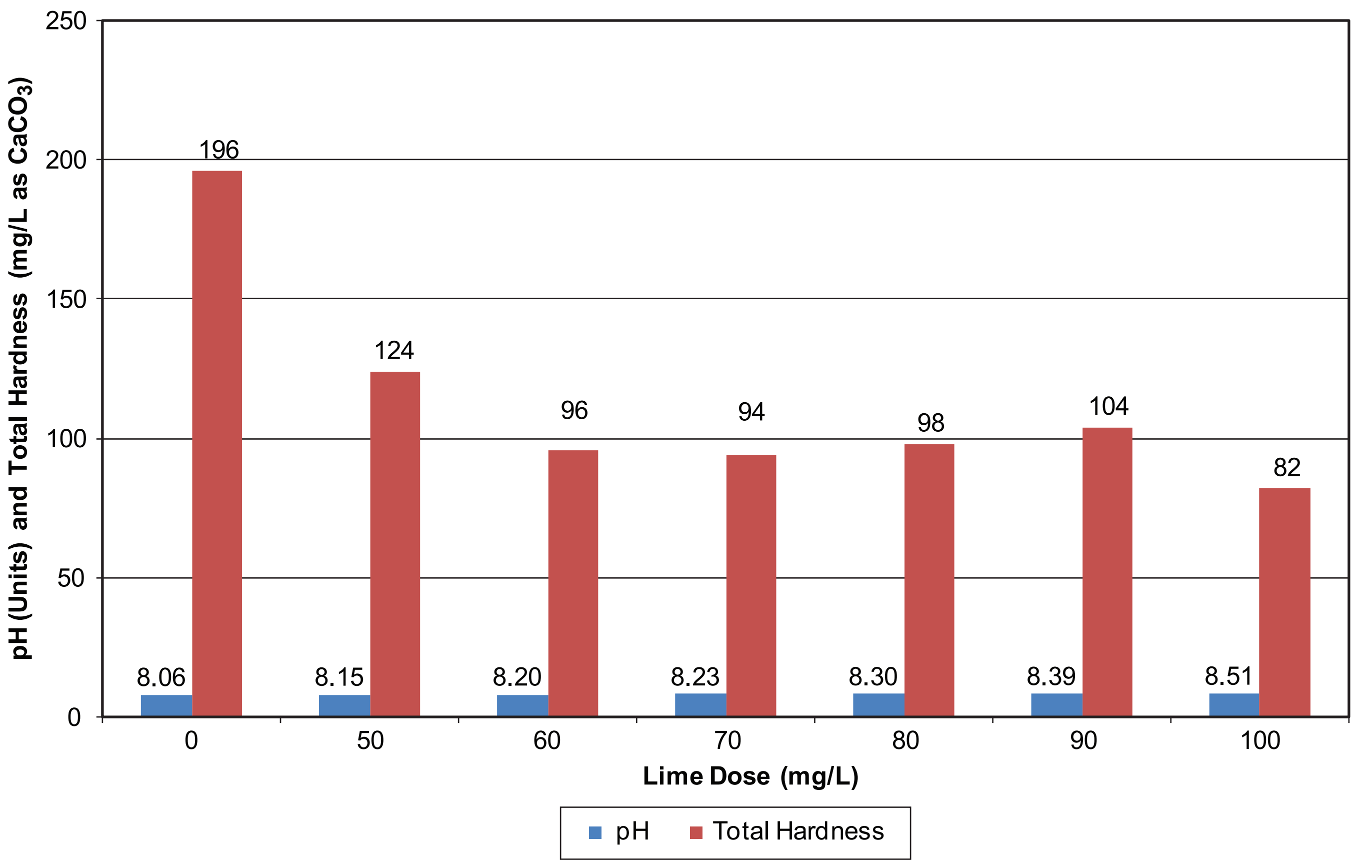

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Figure 8-5
Lime Dose Screen – Total Hardness and pH

Table 8.5
Polymers Bench-Scale Tested at the Riviera Beach WTP

Supplier	Formulation	Type
BASF Corp.; Suffolk, Virginia	LT20	Nonionic
	LT22	Cationic
	LT22s	Cationic
Kemira Chemicals; Atlanta, Georgia	C-1598	Cationic
	N-1986	Nonionic
Nalco; Naperville, Illinois	POL-E-Z ® 692 Plus	Anionic

To determine if any of the polymers would help reduce dissolved organic carbon and help with softener effluent turbidity, all the polymers were tested with a 60 mg/L lime dose. In addition, the polymers were tested at different dosages to help evaluate their performances. The results are presented in **Figure 8-6**.

As shown in **Figure 8-6**, none of the polymers tested, at any dose, provided acceptable settled water turbidity values of 5 NTU or less. The best performance was obtained with C-1598, a Kemira cationic polymer, with the lowest settled water turbidity (23 NTU) and the lowest UV Absorbance (0.200/cm). However, a settled water turbidity value of 23 NTU is still unacceptable. The current plant polymer, Nalco POL-E-Z ® 692 Plus, also did not provide acceptable settled water turbidity values, and at doses of 0.2, 0.5 and 1 mg/L, all the results were more than 100 NTU. In addition, the Nalco POL-E-Z ® 692 Plus did not provide any organics removals; the UV Absorbance for the Nalco POL-E-Z ® 692 Plus was slightly higher than the raw water UV reading. Based on these results none of the polymers tested are recommended for full scale use.

The full-scale plant uses Nalco POL-E-Z ® 692 Plus and achieves lower settled water turbidity values (5 to 15 NTU), but the full-scale plant adds approximately 1.5 mg/L aluminum sulfate to the raw water before lime and polymer addition. Based on our experience, it does not seem likely that such a low dose could provide any benefit; however, it appears that the combination of a low dose of aluminum sulfate to the raw water, followed by the anionic polymer helps with settling. Bench-scale tests with Nalco POL-E-Z ® 692 Plus without aluminum sulfate show unacceptable settled water turbidity values greater than 100 NTU.

8.5.6 Aluminum Sulfate

Aluminum sulfate is currently injected into the influent receiving basins at about 1.5 mg/L. Aluminum sulfate is an approved drinking water coagulant and when added to water, it forms aluminum hydroxide floc that can help reduce settled water turbidity. Aluminum hydroxide can form at pH values from 5.8 to approximately 8.0. At a pH

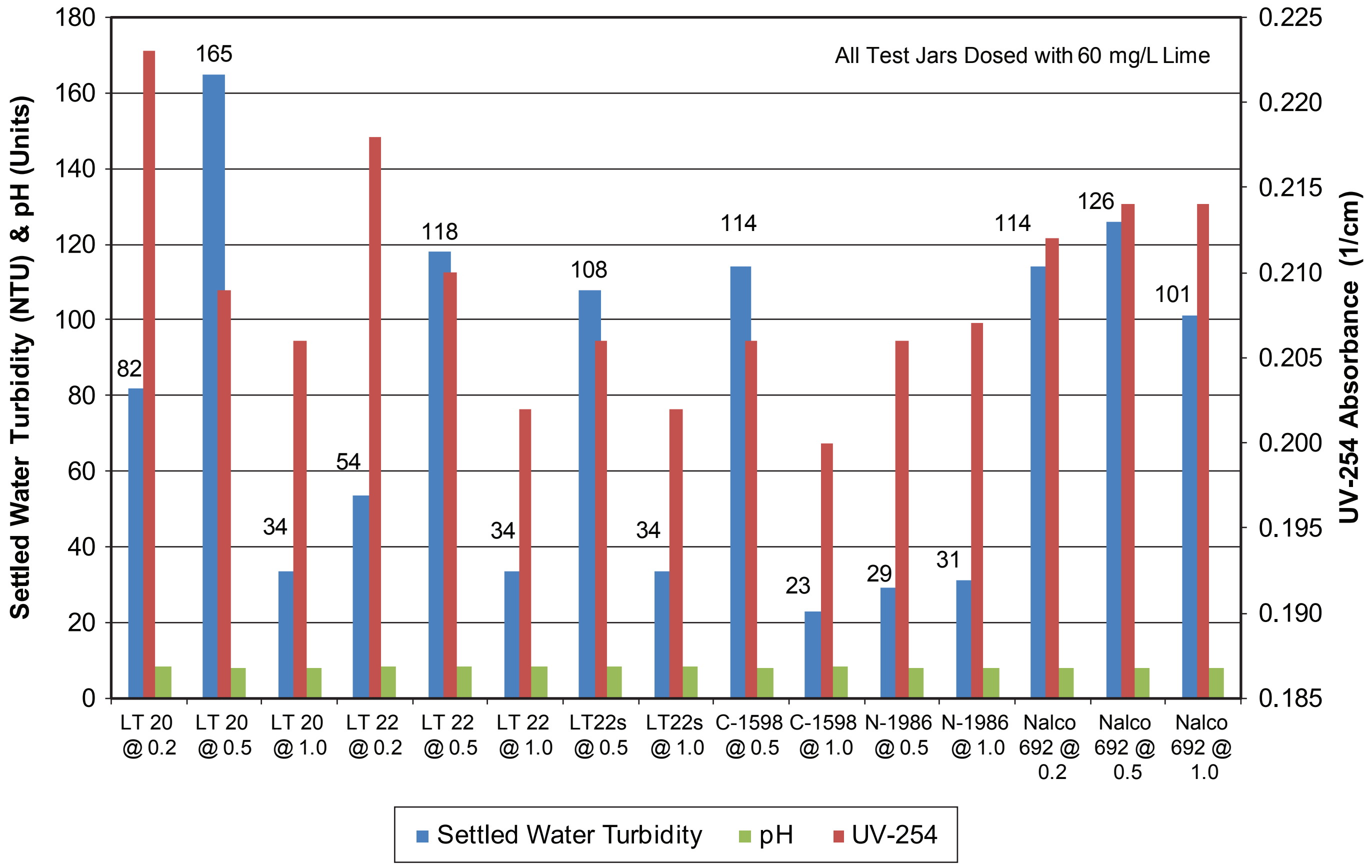

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Figure 8-6
Polymer Screening

above or below these values free residual aluminum ion (Al^{+3}) can be formed. Currently, the State of Florida regulates aluminum as a secondary drinking water standard with a maximum contaminant level (MCL) of 0.2 mg/L per FAC 62-550. The USEPA regulates aluminum as secondary drinking water standard with a MCL of 0.05 to 0.2 mg/L. Because the plant operates at softening pH values of 8.3 to over 9.0 units and these pH values could promote excess aluminum levels in the drinking water, aluminum sulfate was not included in the bench scale testing. Aluminum sulfate is not recommended for use in a ground water softening plant operating at these pH values.

On May 3, 2012 two samples of finished water were obtained from the WTP high service pump station discharge. The samples were sent to Test America for aluminum analysis. The analyses indicated that the finished water aluminum was 0.1 mg/L for both samples. These results tend to indicate that the finished water aluminum likely does not exceed the State of Florida MCL of 0.2 mg/L under current operating practice. However, the lower range of the USEPA MCL for aluminum was exceeded.

Due to the exceedance of the lower range of the USEPA MCL for aluminum, aluminum sulfate is not recommended for use in the CRBUD's WTP

8.5.7 Ferric Testing

None of the polymers tested provided an acceptable settling aid. Furthermore, it is recommended that aluminum sulfate be discontinued. Consequently, bench-scale testing was conducted using ferric sulfate and ferric chloride as a replacement for aluminum sulfate. Ferric sulfate and ferric chloride are approved drinking water coagulants for doses up to 250 mg/L by NSF International (the primary organization that certifies product safety for use in drinking water). One of the advantages ferric coagulants have is that they can form ferric hydroxide flocs at pH values from less than 5 to more than 11 pH Units. Ferric sulfate and ferric chloride were tested to determine settled water and UV-254 performances. The results are shown in **Figure 8-7**.

As shown in **Figure 8-7**, ferric sulfate and ferric chloride were tested at doses of 20 to 40 mg/L. Ferric chloride dosed at 30 mg/L had the lowest settled water turbidity (3.7 NTU) and UV (0.161/cm) values, with 24 percent reduction in UV-254. Additional finished water quality improvements might be gained by the addition of a polymer with the ferric chloride. This issue should be explored during full-scale testing. Based on these results, ferric chloride is recommended for full-scale testing. The addition of ferric chloride may change the dewatering characteristics of the sludge. Hence, the full-scale testing should include assessing dewatering aid polymers along with methods of sludge dewatering.

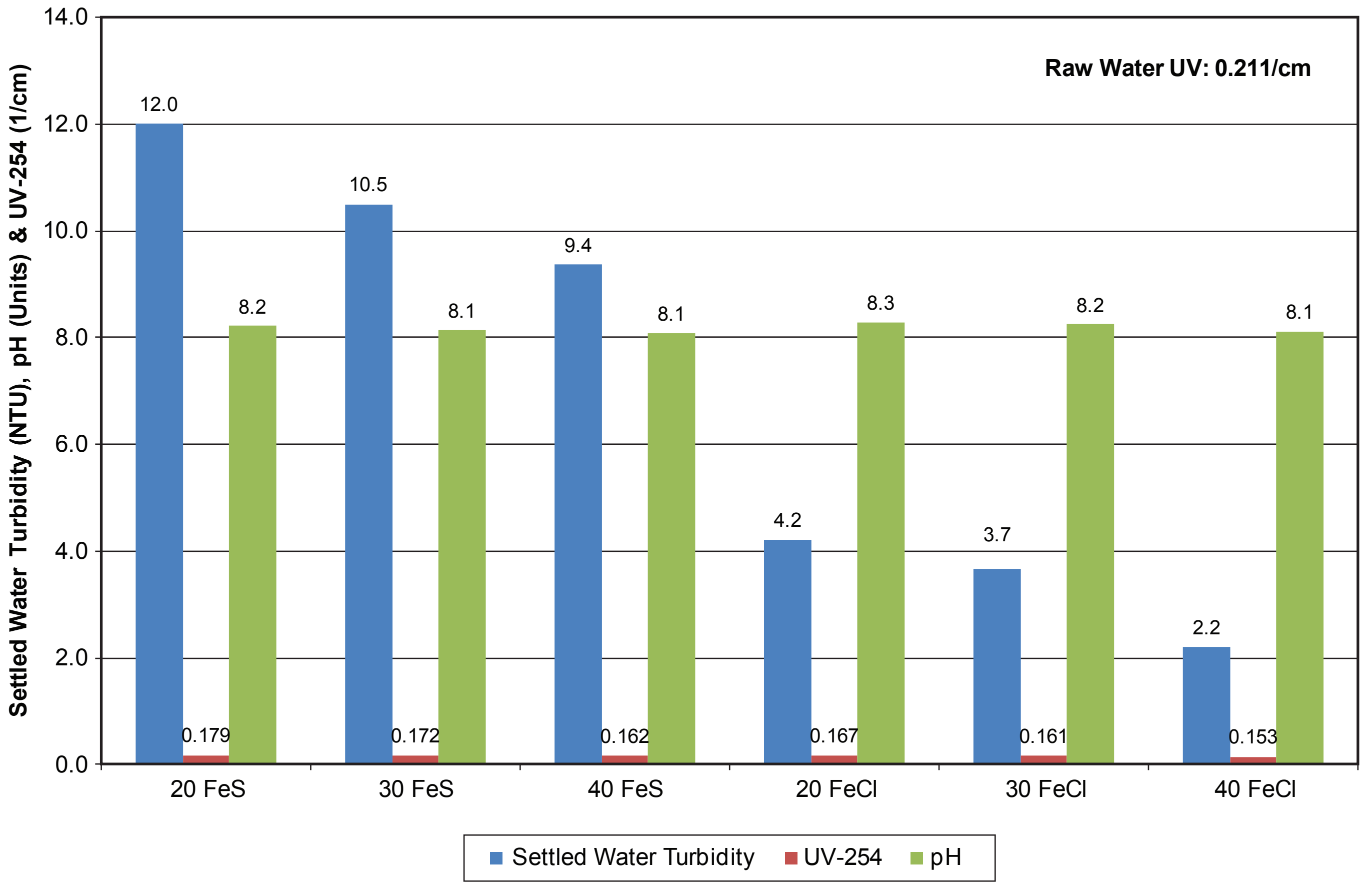

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Figure 8-7
Ferric Sulfate and Ferric Chloride Comparison

8.5.8 Treatment Improvement Recommendations

Based upon the bench-scale testing results, it is recommended that the full-scale testing be performed to assess the following potential treatment changes:

- Stop using aluminum sulfate
- Stop using POL-E-Z ® 692 Plus polymer
- Replace the above aluminum sulfate and polymer systems with a ferric chloride storage and feed system designed for a 30 mg/L dosage rate
- Continue the current lime dosage of 60 mg/L

It is estimated that full-scale ferric chloride testing could be performed for roughly $260,000 inclusive of purchasing ferric chloride, storage tank rental, metering pump, piping and valves, and engineering services to oversee the testing, water quality testing and documenting the findings (including a 30 percent contingency). It is assumed that the CRBUD would provide the assistance of a pipe fitter and an electrician, along with conduit and wiring, to provide power to the pilot unit and assist in installing the pilot unit.

The CRBUD is considering changing from chlorine gas to sodium hypochlorite. This change to sodium hypochlorite will tend to increase the finished water pH. To control finished water pH within its current normal range, the sodium hypochlorite system would include a carbon dioxide system to maintain finished water pH in a range to prevent scaling in the distribution system. Based on September 19, 2012 discussion with the CRBUD staff, the proposed sodium hypochlorite system be constructed and full-scale testing of sodium hypochlorite and full-scale ferric chloride testing would conducted in parallel.

The addition of ferric chloride and lime in close proximity may tend to interfere with softening due to the competing pH affect of the chemicals; ferric chloride will tend to decrease pH and lime increases pH. Injecting the lime upstream of the ferric injection point is likely advisable to minimize interference. This issued should be evaluated during full-scale ferric chloride testing.

As described in a Subsection 8.5.12, lime is currently fed from the slakers to the softeners via open channel troughs; open channel troughs cannot accurately control the feed rate of lime to the softeners. Subsection 8.5.12 recommends implementing a lime-slurry feed system to provide positive control over the feed rate of lime to the treatment system. It is recommended that the lime-slurry feed system recommended in Subsection 8.5.12 be implemented prior to performing the full-scale ferric chloride testing. Additionally, the proposed lime-slurry feed system should provide flexibility in the lime feed point by providing multiple feed points (such as upstream of the treatment unit as well as at the current feed point at the treatment unit reaction zone) to assess how lime feed location mitigates softening interference due to ferric chloride addition. The full-scale test should assess ability to continue to meet the 110 to 150 mg/L as $CaCO_3$ total hardness goal.

It is noted that for solids contact clarifiers, such as the CRBUD's Accelators, a high concentration of solids is maintained in suspension as chemicals are applied. Jars used for bench-scale testing do not have solids in them at the initiation of the testing. As a result, full-scale testing can behave differently than jar testing. Due to this unpredictability, the full-scale testing plan should remain flexible. Therefore, it is recommended that ferric sulfate also be considered during development of the full-scale testing plan.

Full-scale testing of ferric at lime softening plants for other utilities indicated that higher sludge blow down rates may be required relative to the current treatment strategy. Additionally, these historical tests at ferric dosages above 15 to 20 mg/L have indicated that sludge settling in the treatment unit may be inhibited. Therefore, the full-scale test should assess the use of polymer in conjunction with ferric to enhance settling. Furthermore, the dewatering characteristics of the sludge may be impacted by the proposed process changes. Accordingly, the full-scale testing should assess the impact on the CRBUD's existing sludge handling system.

If the full-scale testing proves successful, then design and construction of a new ferric chloride storage and feed system would be recommended.

A new ferric chloride storage and feed system would be required to implement the above strategy. It is roughly estimated that about 13,000 gallons of ferric chloride would be needed to maintain a 30 day supply at average flow and dosage. Hence, two 13,000 gallon storage tanks are recommended. The storage tanks would be in a concrete secondary containment area. Four metering pumps with local panels are proposed, one for each application point at the softeners plus one backup pump. The project implementation cost (including construction cost, engineering services during design and construction along with a 30 percent contingency) is roughly estimated at $950,000. This is an "order-of-magnitude" estimate with an expected accuracy range of +100% to -50%.

The average daily chemical cost for the current treatment strategy of lime, polymer, and aluminum sulfate is roughly estimated at $580 per day (based upon current chemical dosages). The average daily chemical cost for the proposed treatment strategy of lime and ferric chloride is $870 per day. Hence, chemical costs would increase by $290 per day which amounts to about $106,000 on an annual basis.

8.5.9 Filter Evaluation

8.5.9.1 Introduction

The CRBUD WTP has 16 sand and anthracite dual media filters. The filtration system at the water treatment plant consists of sixteen filters divided into two filter banks. The south filter bank includes Filters 1 through 8. The north filter bank includes Filters 9 through 16. All filters are the same size. The filters are equipped with Leopold underdrains and a media wash system. Filters 1 through 8 utilize upflow water wash with air scour media wash system. Filters 9 through 16 utilize a rotating surface wash water jet system to wash the media.

Three filters were selected by CRBUD staff to conduct certain evaluations in accordance with the American Water Works Association (AWWA) document titled "*Filter Evaluation Procedures for Granular Media"*. The results are presented in this subsection.

8.5.9.2 Filter Run Hours Analysis

The CRBUD records filter run hours on their WTP control system and also maintain a separate hand written log of filter run hours. The CRBUD reports that the filter run hours in the computer control system are not reliable due to an error in the computer control strategy. The CRBUD provided H&S with its hand written logs for filter run times for the year 2011. These data are presented in **Figure 8-8**. The figure indicates that certain filters ran more hours that there are hours in a year. Hence, it is concluded that the hand written filter run hour log contains errors and may not be meaningful. It is recommended that the CRBUD modify its computer control system so that historical filter run hours can be tracked automatically.

8.5.9.3 Sieve Testing

Media samples were collected from filters 4, 8 and 15. To collect the media samples, plant staff drained down each filter and collected five samples from different areas of each filter. The five samples from each filter were collected in a single container and thoroughly mixed to obtain a "representative" sample of media.

The composite media samples were first dried and then mechanically sieved to separate the media into separate sand and anthracite samples. Final separation was accomplished manually.

Sieve analyses were performed on the separate sand and anthracite samples collected from each filter. Tests were conducted in accordance with AWWA Standard B100 and ASTM C136 procedures. Sieves with different standard size openings were stacked with sieves having the largest openings on top. A pan was placed at the bottom of the sieves to catch any of the filter fines.

After separating the sand and anthracite, 200 gram samples of sand and 200 gram samples of anthracite were mechanically sieved to determine the media size distributions. Sieves were mechanically shaken for approximately fifteen minutes in accordance with standard procedures. The amount of material retained on each sieve was weighed and the results recorded in **Tables 8.6**, **8.7** and **8.8**.

Table 8.6
Sieve Analysis Data for Filter 4

Sieve Size (mm)	Anthracite Retained (grams)	% Retained	% Pass	Sieve Size (mm)	Sand Retained (grams)	% Retained	% Pass
0	3.91	1.96	0.00	0	0.43	0.22	7.89
0.425	23	11.52	1.96	0.180	0.96	0.48	8.10
0.600	49.85	24.97	13.51	0.300	1.03	0.52	8.58
0.850	13.81	6.92	38.53	0.425	27.34	13.70	9.10
1.000	47	23.55	45.46	0.600	100.78	50.49	22.78
1.400	49.74	24.92	69.06	0.850	31.22	15.64	73.21
1.700	11.9	5.96	94.03	1.000	22.31	11.18	88.84
				1.400	15.76	7.90	92.11
Weight Recovered (g)		199.21		Weight Recovered (g)		199.83	
% Recovered		99.60		% Recovered		99.91	

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Table 8.7
Sieve Analysis Data for Filter 8

Sieve Size (mm)	Anthracite Retained (grams)	% Retained	% Pass	Sieve Size (mm)	Sand Retained (grams)	% Retained	% Pass
0	1.98	0.99	0.00	0	0.65	0.33	12.20
0.425	4.67	2.34	0.99	0.180	0.51	0.26	12.52
0.600	46.54	23.32	3.33	0.300	1.54	0.77	12.78
0.850	7.82	3.92	26.60	0.425	41.14	20.61	13.55
1.000	66.61	33.37	30.51	0.600	102.27	51.23	34.12
1.400	55.46	27.79	63.77	0.850	5.54	2.78	85.25
1.700	16.86	8.45	91.57	1.000	23.95	12.00	88.02
				1.400	24.39	12.22	87.80
Weight Recovered (g)		199.94		Weight Recovered (g)		199.99	
% Recovered		99.97		% Recovered		99.99	

Table 8.8
Sieve Analysis Data for Filter 15

Sieve Size (mm)	Anthracite Retained (grams)	% Retained	% Pass	Sieve Size (mm)	Sand Retained (grams)	% Retained	% Pass
0	1.83	0.92	0.00	0	0.83	0.42	5.21
0.425	7.99	4.00	0.92	0.180	1.08	0.54	5.63
0.600	10.74	5.38	4.92	0.300	1.81	0.91	6.17
0.850	14.14	7.08	10.30	0.425	41.18	20.63	7.18
1.000	85.75	42.96	17.38	0.600	135.73	67.99	27.71
1.400	69.41	34.77	60.35	0.850	3.54	1.77	95.70
1.700	9.74	4.88	95.12	1.000	5.04	2.52	97.48
				1.400	10.41	5.21	94.79
Weight Recovered (g)		199.60		Weight Recovered (g)		199.62	
% Recovered		99.80		% Recovered		99.81	

As shown in **Tables 8.6**, **8.7** and **8.8**, each sample was initially weighed out at approximately 200 grams. After sieving, the material retained in each sieve was weighed and the total weight compared to the initial weight to determine percent recovery, as some material could be retained in the sieve screen or lost (or gained) in transfer to the scale for weighing. Recovery rates ranged from 99.61% to 99.99%.

After sieving, the results were plotted out on a semi-log graph to determine the effective size (ES) and the uniformity coefficient (UC). The ES is equal to the D10 size, where 10 percent by weight (of the media) is finer than this size. The D60 size is larger than 60 percent of the sample by weight. The UC is the ratio of the D60 size to the D10 size. The sieve plots for determining the D10 and D60 sizes are presented in **Figures 8-9**, **8-10** and **8-11**.

Table 8.9 includes the ES and the UC for Filters 4, 8 and 15 and compares them with the original specification.

Table 8.9
Effective Size (ES) and Uniformity Coefficient for Filters 4, 8, and 15

	Sand		Anthracite	
Item	**ES**	**UC**	**ES**	**UC**
Original Specification	0.45 to 0.55	1.60	0.95 to 1.05	1.50
Filter 4	0.44	1.77	0.55	2.45
Filter 8	0.40	1.80	0.68	2.18
Filter 15	0.45	1.55	0.85	1.76

Based upon the above data, it is concluded that the sand for Filters 4 and 8 is slightly out of specification. The sand within Filter 15 is within specification. The anthracite in filters 4 and 8 does not meet specification. The anthracite in Filter 15 is reasonably close to the specification.

The CRBUD staff report that the underdrains for Filters 1 through 8 were installed in 1996 with high density polyethylene type underdrains by Leopold. These underdrains would likely be at the end of their useful life by 2016.

The following improvements are recommended:

- Replace the filter media for Filters 1 through 8;
- Replace the underdrains for Filters 1 through 8 at the same time the filter media is replaced; and
- Establish an annual filter media evaluation program to assess media condition of each filter.

8.5.9.4 Acid Solubility Testing

Acid solubility testing was conducted to determine if the media was accumulating calcium carbonate. To conduct this testing, filter media was dried and then weighed.

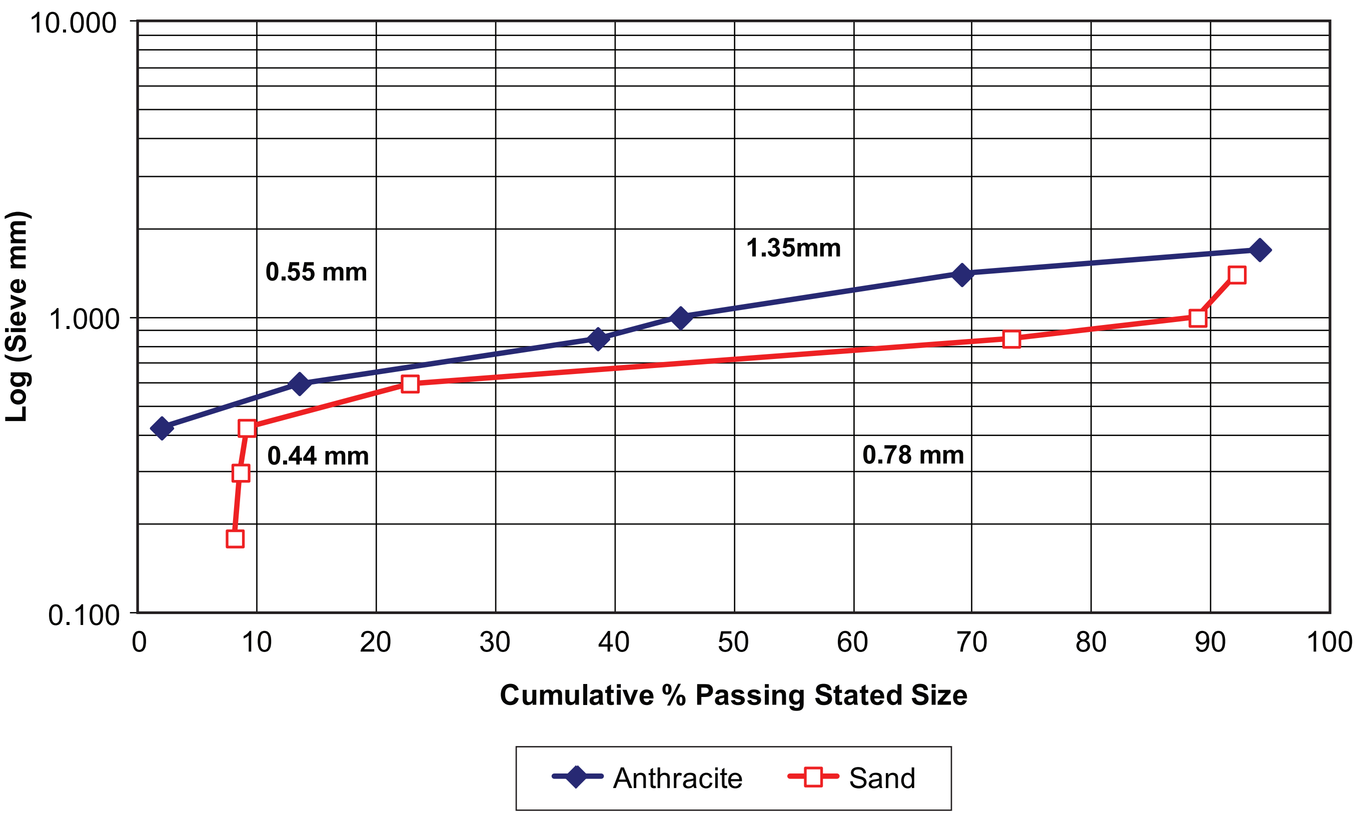

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Figure 8-9
Filter Media Evaluation – Filter 4

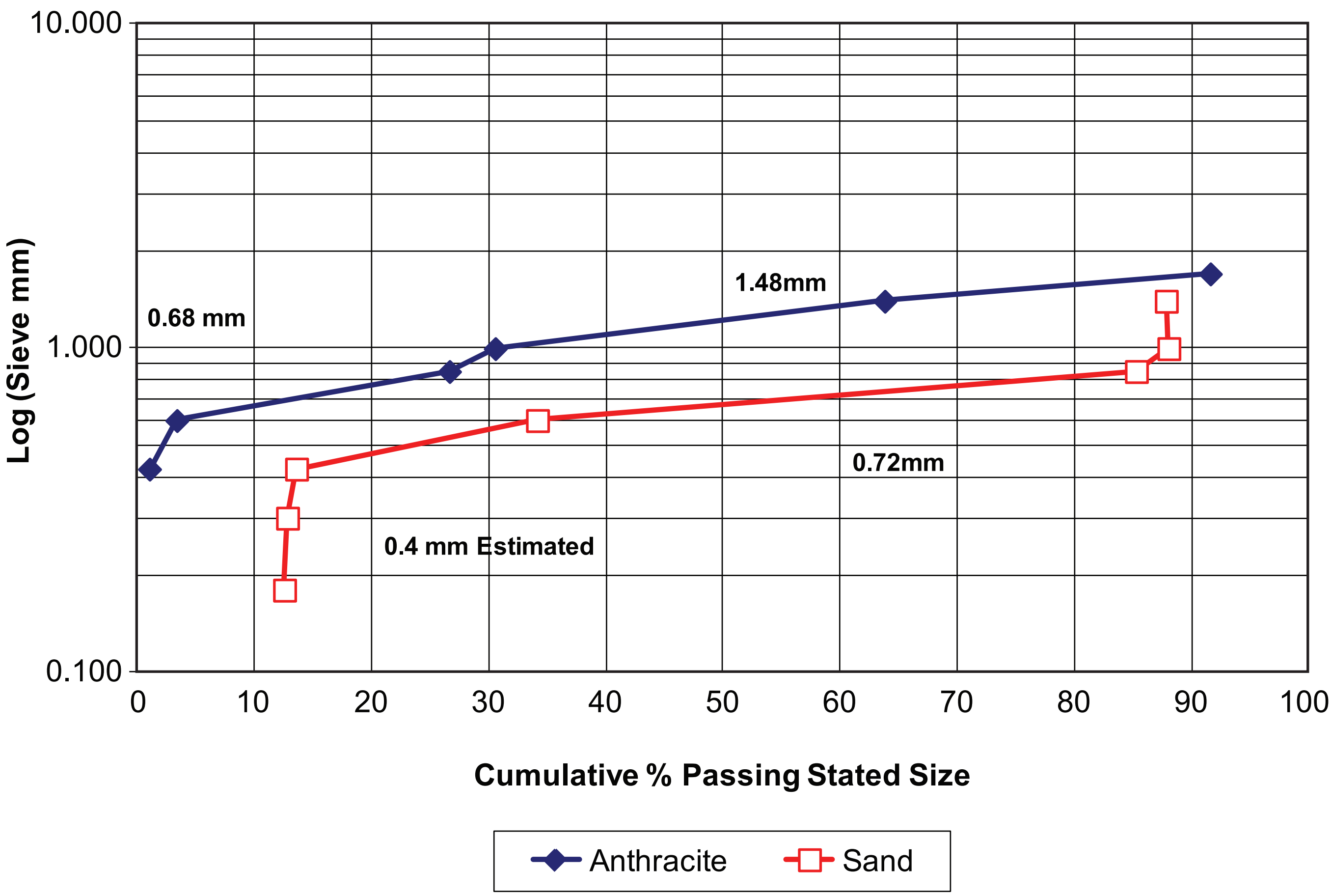

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Figure 8-10
Filter Media Evaluation – Filter 8
D10 and D60 Sizes

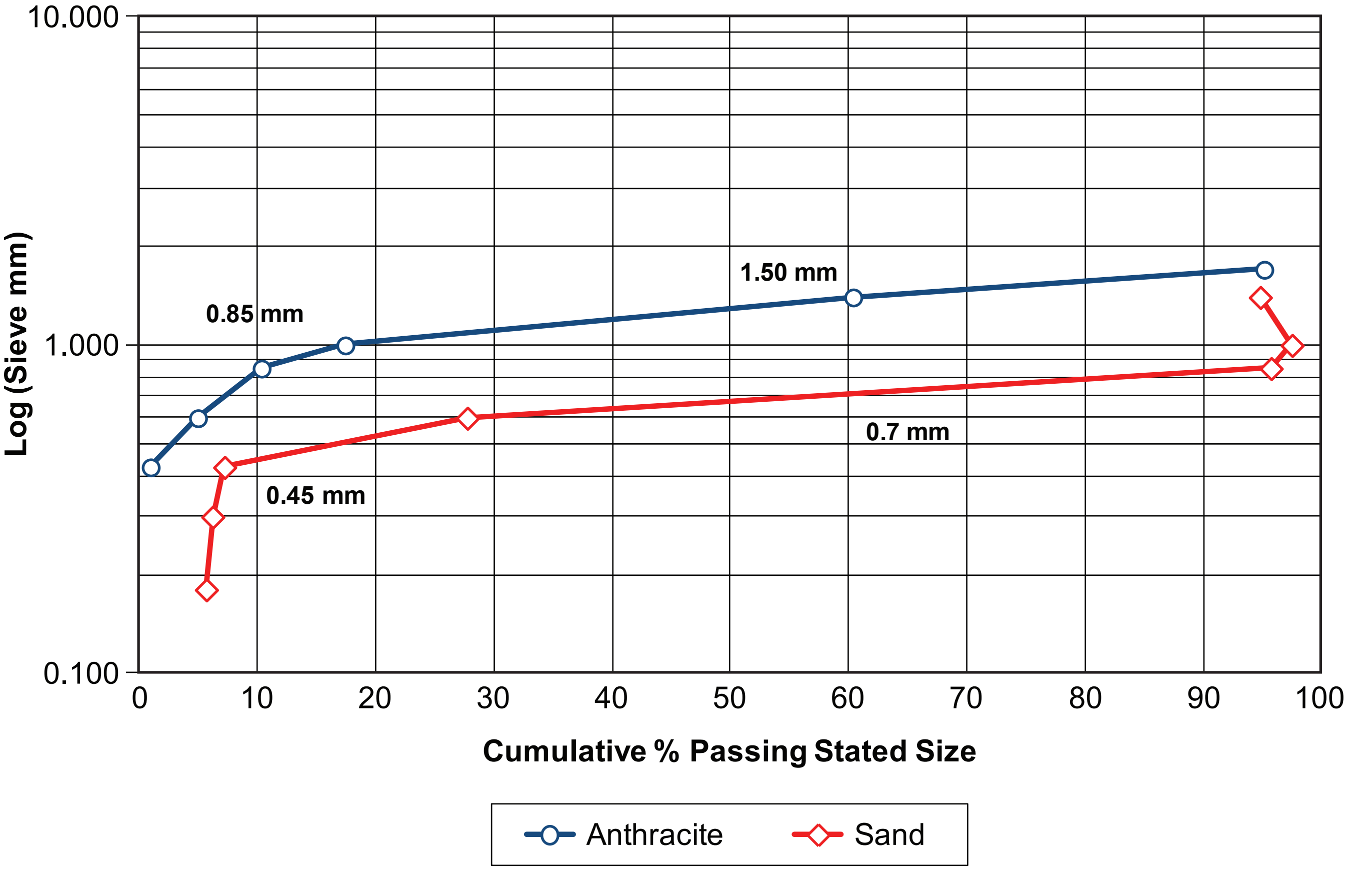

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Figure 8-11
Filter Media Evaluation – Filter 15
D10 and D60 Sizes

The media was then acid washed with concentrated sulfuric acid, washed, dried and then re-weighed. The difference in the weights was the acid soluble fraction. The original media specifications allowed up to 5 percent acid solubility as acceptable. The results of the acid solubility testing are presented in **Table 8.10**.

Table 8.10
Acid Solubility Test Results

Filter No.	Sand	Anthracite
4	6.26%	8.36%
8	9.44%	11.96%
15	1.66%	0.9%

Based on the acid solubility testing, the media from Filter 15 was acceptable and within original specifications; the media for Filters 4 and 8 did not meet the original acid solubility specification. The media in Filters 4 and 8 should be scheduled for change out. Based upon visual observation, the condition of the media for Filters 1, 2, 3, 5, 6 and 7 appear to be similar to Filters 4 and 8. Hence, it is recommended that the media for Filters 1 through 8 be replaced as soon as possible. All of the remaining filters should be tested individually to determine their condition within the next 12 months.

Calcium deposition in the filter media is common in lime softening treatment due to the positive Langelier Saturation Index (LSI) utilized to control corrosion in the distribution system. It is recommended that the CRBUD design, permit and construct a calcium sequesterant system to reduce calcium scale deposition in the filter media. Many lime softening plants add a phosphate product (a.k.a., corrosion inhibitor) to the effluent of the softening reactors to prevent filter cementing. Staff at Miami-Dade indicated that CARUS K-5 has been used successfully in this application for a number of years at the Miami-Dade Preston WTP. Phosphate is added as a corrosion inhibitor for compliance with the Lead and Copper Rule in certain treatment applications. It can also be added as a "sequesterant", keeping calcium in solution, thus preventing calcium deposition in the filter media.

We recommend installing chemical storage, piping and metering pump facilities to inject CARUS K-5 into the softeners effluent to minimize filter media cementing. This chemical is NSF Standard 60 certified. It is delivered as a clear liquid. The dosage rate would be about 1 mg/L as product. Assuming an average day flow of approximately 7 mgd and a specific gravity of 1.37 for the chemical, the CRBUD's WTP would need to feed about 5 gallons per day of chemical. The unit cost of this chemical is roughly $1.50 per pound. The chemical cost is roughly $100 per day, which amounts to about $37,000 per year.

A calcium sequesterant storage and feed system would be required to implement the above strategy. It is recommended that the sequesterant be delivered and fed from 55 gallon drums. A new storage and feed area composed of a 500 square foot slab on grade with a storage shed to house the drums and the chemical metering pumps is recommended. Four metering pumps with local panels are proposed, one for each application point at the softeners, effluent plus one backup pump. The project implementation cost (including construction cost, engineering during design and construction along with a 30 percent contingency) is roughly estimated at $150,000. This is an “order-of-magnitude” estimate with an expected accuracy range of +100% to – 50%.

The CRBUD staff believes that the rotating surface wash water jet system for Filters 9 through 16 provides more thorough washing than the air scour system utilized by Filters 1 through 8. Consequently, as an alternative to the calcium sequesterant system, replacing the air scour system with a rotating surface wash water jet system for Filters 1 through 8 may prove beneficial. The project implementation cost for retrofitting Filters 1 through 8 with a rotating surface wash jet system (including construction cost, engineering during design and construction along with a 30 percent contingency) is roughly estimated at $450,000. This is an “order-of-magnitude” estimate with an expected accuracy range of +100% to – 50%.

8.5.9.5 Physical Observations

Physical observations relative to the media for Filters 4, 8, and 15 are presented in this subsection. The media in Filters 4 and 8 had significant quantities of calcium carbonate mudballs and calcium chips as illustrated in the photograph in **Figure 8-12**. The anthracite for Filters 4 and 8 was also coated in calcium which gave the media a whitish appearance. Based upon visual observation, the condition of the media for Filters 1, 2, 3, 5, 6 and 7 appeared to be similar to Filters 4 and 8.

Figure 8-13 illustrates a side by side comparison of the filter anthracite for Filters 8 and 15. The anthracite for Filter 15 showed no evidence of mudballs or calcium chips. The filter media for Filter 15 was black in appearance, which is indicative of not having accumulated a coating of calcium. Based on the observations of the other filters, it is speculated that the media in Filters 9 through 14 and 16 are similar to the media in Filter 15. It is recommended that this speculation be confirmed through establishment of an annual filter media evaluation program to assess media condition of each filter.

8.5.9.6 Backwash Observations

Backwashes were observed for Filters 4, 8 and 15 during the bench-scale testing. The following summarize the key observations for Filters 4, 8 and 15.

- Filters 1 through 8 utilize upflow water wash with air scour media wash system. Filters 9 through 16 utilize a rotating surface wash water jet system to wash the media.

Figure 8-12
Mudballs and Calcium Chips
Typical of Filters 4 and 8

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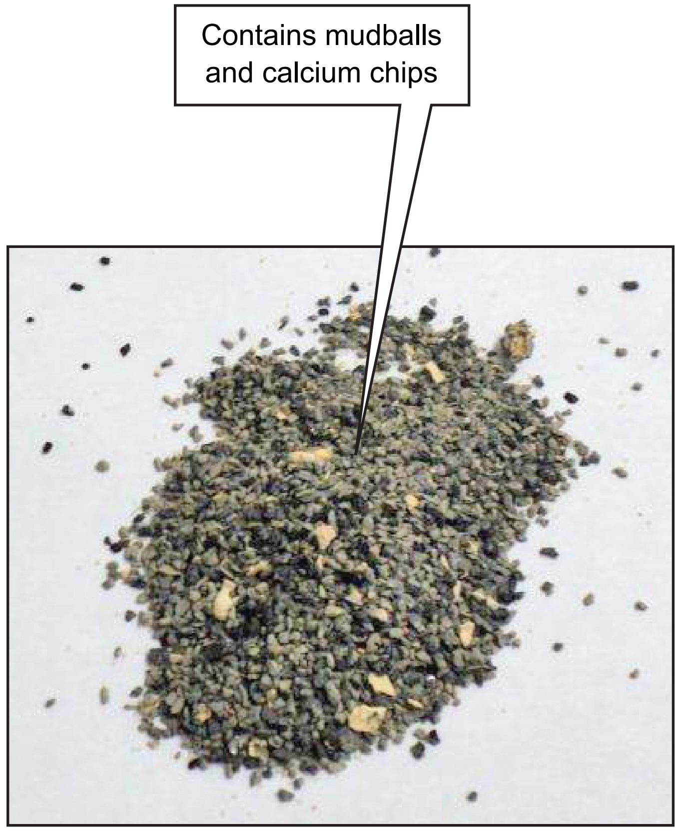
Media for Filter 15



Media for Filter 8

Figure 8-13
Comparison of Media for Filters 8 and 15

- Prior to backwashing the filters appeared to have a coating of calcium carbonate lime sludge on top of Filters 4 and 8;
- "Channeling" through the filter media was observed in Filters 4 and 8;
- Filter backwashing rate appeared adequate for Filters 4, 8 and 15;
- No media carryover was observed during backwashing for Filters 4, 8 and 15;
- The surface wash and air scour systems were operational for Filters 4, 8 and 15;

Filter media "channeling" (observed in Filters 4 and 8) is indicative of poor media condition. When water enters the filter it essentially passes through the channel without passing through the filter media. The water essentially bypasses filtration.

Based upon discussion with the CRBUD WTP operations staff, they believe that the surface wash type system provides better media washing than does the air scour type system. The CRBUD requested that a project be included in this Master Plan to replace the air scour system for Filters 1 through 8 with a surface was system as described in Subsection 8.5.9.4.

8.5.9.7 Turbidity Analysis

Turbidity is a measure of the cloudiness (due to solid phase particles) of water after filtration. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Turbidity has no health effects, but can interfere with disinfection and provide a medium for microbial growth. Turbidity may indicate the presence of disease-causing organisms. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.

There is no filter effluent turbidity limitation for ground water that is not under the direct influence of a surface water. The CRBUD reports that their ground water source is not under the direct influence of a surface water. Consequently, there is no filter effluent turbidity limitation for the CRBUD's WTP. The CRBUD has set a filter water turbidity goal of 1 NTU maximum. The filters were observed to be operated to meet this goal.

8.5.9.8 Mudball Analysis

Mudballs are an indication of inadequate backwashing and/or improper operation of the secondary wash system. Mudballs tend to occur when the filter backwash does not wash out the heavier mud particles near the top of the filter media. Mud particles tend to form spherical shapes adhering to the sand around them and normally range from one to two inches or more as the mudball initially emerges. Mudballs can grow in size over time. If not removed they can become large enough to sink to the bottom of the filter.

Large mudballs in the filter cause the filter to have areas that do not function properly. Continual deposition of mudballs can lead to complete solidification of the filter media.

Mudballs up to one inch were observed in Filters 4 and 8. No mudballs were observed in Filter 15.

It is speculated that the channelization and calcification of the media observed in Filters 4 and 8 may contribute to less than adequate backwash performance. It is also speculated that once the filter media changeout recommended above is completed, it will likely resolve the mudball formation issue. It is recommended that the CRBUD staff conduct mudball analysis on all of the filters on an annual basis in accordance with the AWWA document titled "*Filter Evaluation Procedures for Granular Media*".

8.5.10 Disinfection Strategy Testing

8.5.10.1 Introduction

The purpose of this subsection is to assess the feasibility of compliance with the 4-log virus treatment requirements of the federal Ground Water Rule (GWR) via changes to current disinfection strategy.

8.5.10.2 Current Disinfection Strategy

Chlorine can be injected at the raw water influent main feeding the elevated influent basins (i.e., the old aerators), at the softener collection launder and at the finished water prior to the high service pump station clearwell. The injection points that are currently used are the softener collection launders for operating softeners and the injection point prior to the high service pumps. Ammonia injection points are currently located just upstream of the chlorine injection points on the raw water influent main feeding the elevated influent basins (i.e., the old aerators). Chlorine and ammonia are added to form a chloramine residual in the WTP.

It is noted that a chlorine injection point for algae control exists at the top of both raw water influent basins. CRBUD staff reported that these injection points are not currently utilized. Current practice observed during the bench-scale testing indicated that total chlorine dosed was approximately 6.8 mg/L. Finished water pH was observed to be reduced from the softening pH to approximately 8.2 units in the clearwell via the addition of chlorine.

After completion of the bench-scale testing, analysis of the monthly operating reports indicated that the chlorine dosage averaged about 11 mg/L based on the weight of chlorine consumed over from the beginning of 2008 through the end of 2011.

8.5.10.3 Ground Water Rule Certification Status

The treatment plant is not currently certified for 4-log virus treatment under the federal GWR. It is noted that obtaining 4-log virus treatment certification under the federal GWR and the Florida Administrative Code is not required. Obtaining 4-log virus treatment certification is optional and at the discretion of the CRBUD. If the CRBUD chooses to obtain 4-log virus treatment certification then it will become exempt from triggered source water monitoring in the event of a positive coliform sample in the distribution system. If the CRBUD chooses to not obtain 4-log virus treatment certification then it must conduct source water monitoring at its raw water wells in the event of a positive coliform sample in their distribution system in accordance with the Total Coliform Rule (TCR).

The GWR provides 2-log virus treatment credit for filtration and 2-log virus treatment for disinfection based on the product of chlorine concentration (C) and contact time (T). The calculated CT for a facility is compared to tables of required CT provided by the USEPA to assess the feasibility of the log virus treatment.

To assess the efficacy of GWR 4-log virus treatment options using breakpoint chlorination through the WTP, breakpoint chlorination bench-scale testing was performed as described in the next subsection.

8.5.10.4 Florida Bird Rule

It is noted that the Florida Department of Environmental Protection (FDEP) “Bird Rule” – which requires that 4-log virus treatment be provided between the point where water is last exposed to the open atmosphere and before the first customer – is not currently being enforced by FDEP. Hence, assessing the feasibility for compliance with the “Bird Rule” was not included in this report.

8.5.10.5 GWR Compliance if Ammonia is in the Raw Water

Background ammonia is often present in ground water in Florida. The FDEP and USEPA have ruled if background ammonia is present in the raw water, or if ammonia is added before chlorine addition, the federal CT tables cannot be used for assessing chloramine disinfection credit. The FDEP and USEPA have ruled that the background ammonia can be removed via breakpoint chlorination (i.e., the addition of sufficient chlorine to oxidize inorganic ammonia in the raw water) and then the federal CT tables can be used. Alternatively, a “challenge study” can be performed, per USEPA guidelines, which demonstrates chloramine virus inactivation when the chloramine is formed in the presence of raw water ammonia.

To assess the efficacy of GWR 4-log virus treatment options using breakpoint chlorination through the WTP, breakpoint chlorination bench-scale testing was performed as described in the next subsection.

8.5.10.6 Bench-Scale Breakpoint Chlorination Results

Through bench-scale testing it was determined that there is ammonia in the CRBUD's raw water. Consequently, a breakpoint chlorination curve was developed for the CRBUD's raw water to assess the chlorine dosage needed to remove background ammonia in the raw water and achieve free chlorine within the WTP.

It is noted that the USEPA approved Hach DPD method was used for free chlorine determinations. The manual for this method states that in the presence of ammonia, nitrogen, and chloramines, the test will give a false free chlorine residual. Hence, free chlorine concentration values measured prior to the breakpoint should be considered false and should not be used to draw conclusions.

Figure 8-14 illustrates the breakpoint chlorination curve for the CRBUD's raw water for the configuration of water supply wells being operated on January 31, 2012. As shown, monochloramine, free ammonia, total chlorine and free chlorine tests were conducted for each of the chlorine doses tested. The free chlorine residual results are considered false in the chlorine dosage range of 0 to about 6.8 mg/L and should be disregarded. Raw water ammonia was present and was determined to be 0.72 mg/L. As chlorine was added, total chlorine and monochloramine increased while free ammonia was reduced (it was combining with the chlorine). Monochloramine reached a peak at chlorine dosage of 4 mg/L and then started to drop off as it was converted to dichloramine and trichloramine. The total chlorine curve indicates that breakpoint occurred at a chlorine dosage of approximately 7 mg/L.

Chlorine added after the breakpoint will theoretically form only free chlorine. Based on the slope of the free chlorine curve after the breakpoint, formation of nitrogenous disinfection by-products (N-DBPs) such as nitrosamines may be occurring. Nitrosamines are not currently regulated. The USEPA is expected to make a preliminary decision relative to regulating the nitrosamines group of disinfection by-products in late 2012 (per a report from the AWWA Government Affairs Office). Consequently, additional future testing is recommended to develop an understanding of the occurrence and formation potential of N-DBPs that may be forming during a breakpoint chlorination strategy.

Based upon an extrapolation of the free chlorine curve after the breakpoint, it is estimated that approximately 16 mg/L of chlorine would need to be added to achieve about 4 mg/L of free chlorine (which would be converted to chloramine prior to entering the distribution system). Full-scale testing of adding this dosage of chlorine is recommended to assess the impact on taste, odor and the formation of DBPs.

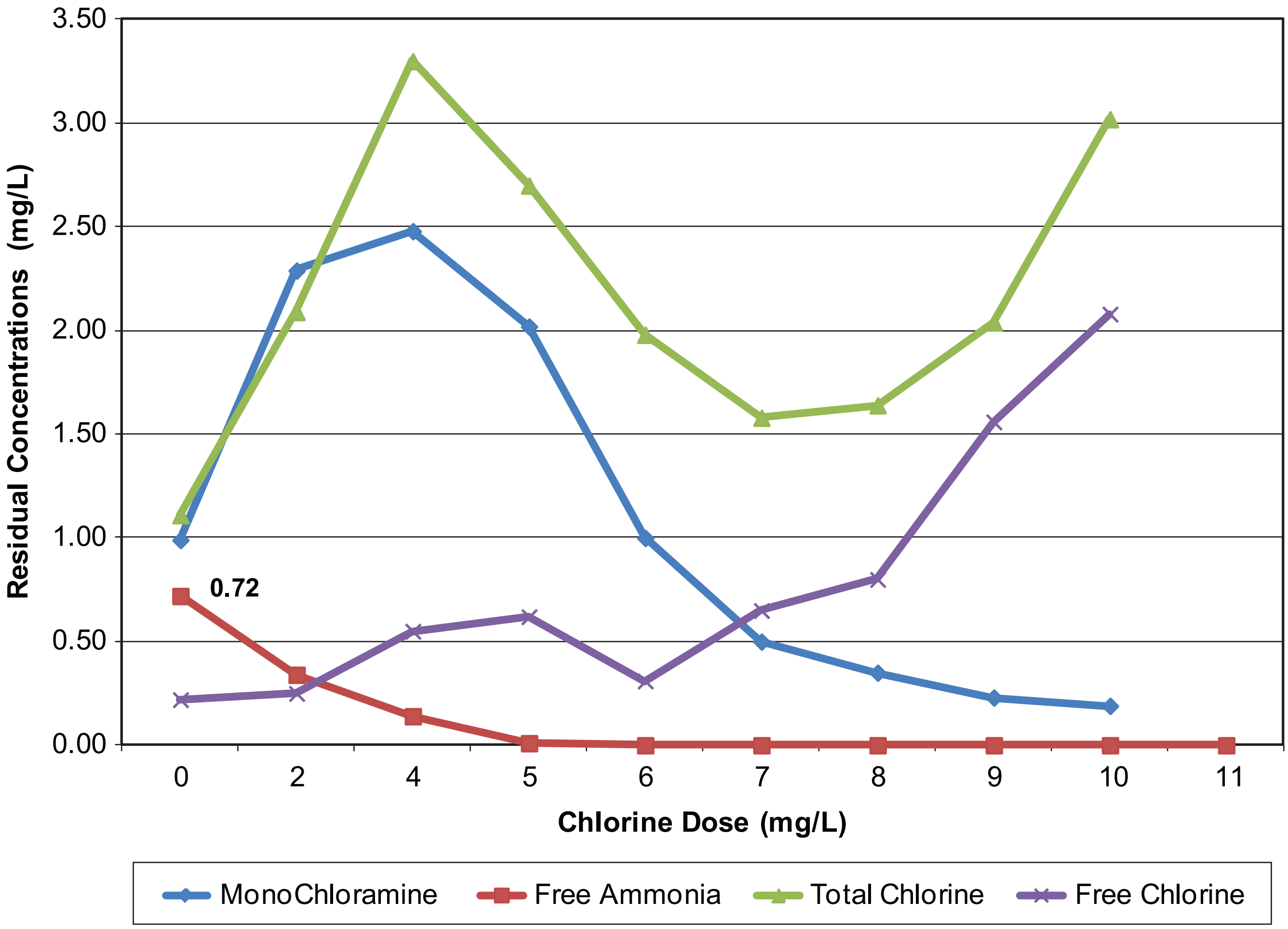


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Figure 8-14
Raw Water Breakpoint Chlorination

8.5.10.7 Evaluation of 4-Log Virus Treatment Options

The CRBUD retained Barnes, Ferland and Associates, Inc. (BFA) to assess the feasibility of four-log virus treatment. BFA prepared a technical memorandum titled "*Water Treatment Plant Four-Log Virus Treatment Evaluation*" dated November 8, 2011. This memorandum assumed that 2-log virus treatment would be granted by FDEP for the filters (a reasonable assumption) and also evaluated two options for obtaining 2-log virus treatment via disinfection. Option 1 was chloramine disinfection within the WTP and chloramine residual in the water distribution system. Option 2 was free chlorination within certain segments of the WTP with later conversion to chloramine disinfection prior to the water entering the distribution system. The following summarizes our assessment of the findings contained in the BFA memorandum.

The BFA memorandum concluded that obtaining 2-log virus treatment via chloramine disinfection (i.e., Option 1) was not feasible given the WTP's current infrastructure. The BFA memorandum speculated that it may be feasible to obtain 2-log virus treatment through chloramine disinfection via the addition of major capital improvements including construction of a two million gallon ground storage tank to increase contact time, modification of the plant piping so that all water from the filters flows to the Blue Heron Boulevard ground storage tank and then to the high service pump station and associated control and instrumentation improvements. A construction cost estimate for these improvements was not included in the BFA memorandum. It is roughly estimated these capital improvements would cost on the order of $5 million (assuming $2.50/gal for the tank plus sitework, piping, controls, electrical and engineering services along with contingency). H&S agrees with BFA's analysis and conclusions that 2-log virus treatment via chloramine disinfection is not feasible given the WTP's current infrastructure without extensive capital improvements. Further analysis of the feasibility of obtaining 2-log virus treatment via chloramine disinfection is not recommended.

The BFA memorandum concluded that obtaining 2-log virus treatment via free chlorination within certain segments of the WTP with later conversion to chloramine disinfection prior to the water entering the water distribution system (i.e., Option 2) may be feasible given the WTP's current infrastructure.

The project team reviewed a series of options relative to obtaining 2-log virus treatment via free chlorination. **Table 8.11** presents our opinion of the feasibility of the free chlorination strategies.

Table 8.11
Free Chlorination Strategy Feasibility Assessment

Option No.	Description	Feasible?	Comment
1	Free chlorine in all clearwells and Blue Heron Blvd tank	No	Would result in high DBPs
2	Free chlorine in clearwells and remove Blue Heron Blvd tank from service	No	Not operationally feasible
3	Form chloramine after south filter bank clearwell	No	Results in mixing of free chlorine and chloramine in clearwells likely resulting in odor
4	Free chlorine in clearwells, add ammonia at high service pump and transfer pump discharges	No	Results in mixing of free chlorine and chloramine in clearwells likely resulting in odor
5	Free chlorine in clearwells, chloramine in Blue Heron Blvd tank, breakpoint after Blue Heron Blvd tank	No	At low flow (5 mgd) the free chlorine contact time is 146 minutes; likely results in high DBPs
6	Form chloramine after filter clearwells (i.e., free chlorine in filter clearwells and chloramine in high service pump station clearwell)	No	At low flow (5 mgd) the free chlorine contact time is 130 minutes; likely results in high DBPs
7	Form free chlorine in north filter bank clearwell only (plus add baffle curtains in north filter bank clearwell to raise baffle factor to 0.7)	Possibly	At low flow (5 mgd) the free chlorine contact time is 71 minutes; further study of DBP formation potential of this option may be warranted

The above opinions were provided to CRBUD staff in a presentation format on September 19, 2012. **Table 8.12** presents a comparison of the cost of the existing chlorination strategy versus the estimated cost for implementation of Option 7; the cost includes capital cost along with operation and maintenance (O&M) cost on a 20-year present worth basis.

Table 8.12
Chlorination Strategy Cost Comparison

Parameter	Existing Chlorination Strategy	Option 7 Chlorination Strategy
Capital Cost	$0	$500,000
Renewal and Replacement Cost	$0	$300,000
Engineering Study	$0	$300,000
O&M 20-year Present Worth	$2,400,000	$3,400,000
Total (20-year Present Worth)	$2,400,000	$4,500,000

As indicated in **Table 8.12**, the cost difference between the two strategies (on a 20-year present worth basis) is estimated at $2.1 million. It is noted that continuing with the existing chlorination strategy would not achieve 4-log virus treatment certification. As such, continuing with the existing chlorination strategy would include additional costs for testing for fecal indicator organisms at the wells in the event of a total coliform positive in the distribution system per the TCR. Any assessment of the costs associated with conducting fecal indicator testing of the water supply would be highly speculative based upon assumptions of the likelihood and frequency of total coliform positives under the TCR. Assessing costs for testing for fecal indicator organisms at the wells in the event of a total coliform positive is beyond the scope of this Master Plan.

It is emphasized that the CRBUD's decision whether or not to invest in obtaining 4-log virus treatment certification under the GWR is likely not strictly a cost based decision. Certain non-cost policy factors – such as community expectations – should be considered by the CRBUD staff.

8.5.10.8 Conclusions and Recommendations

The BFA memorandum titled "*Water Treatment Plant Four-Log Virus Treatment Evaluation*" dated November 8, 2011 evaluated using chloramine disinfection and free chlorination disinfection for obtaining 2-log virus treatment via disinfection. Chloramine disinfection is not readily feasible due to extensive and costly capital improvements. For this Master Plan, the project team evaluated seven options relative to free chlorination strategies within certain segments of the WTP with later conversion to chloramine disinfection prior to the water entering the water distribution system. Six of the seven free chlorination strategies were determined to not be feasible; one of the seven options might be feasible. The potentially feasible chlorination strategy (i.e., Option 7) requires breakpoint chlorination through the WTP. It is recommended that full-scale testing of the Option 7 chlorination strategy be performed to assess DBP formation (including N-DBPs), taste and odor formation potential, and the practicality of implementing this strategy given the WTP structural configuration.

The CRBUD staff needs to make a policy decision whether or not $2.1 million over 20-years is worth the nonmonetary benefits of 2-log virus treatment. The CRBUD should consider non-cost factors – such as community expectations – when deciding whether or not to invest in obtaining 4-log virus treatment certification.

Given that obtaining GWR 4-log virus treatment certification is optional and the extensive improvement needs related to ensuring the reliability of the existing infrastructure, it is recommended that moving forward with the capital improvements and studies related to GWR 4-log virus treatment be assigned a low implementation priority.

For the purpose of this Master Plan, it is recommended that a budget of $300,000 be established for an engineering study to assess the efficacy of GWR 4-log virus treatment. The study should include full-scale testing of the Option 7 chlorination strategy, assessment of DBP formation, taste and odor potential under full-scale conditions, and the practicality of implementing this strategy given the WTP structural configuration. The findings of the study should be documented in a report. The report should include an assessment of the capital improvements that would be needed to achieve 4-log virus treatment.

8.5.11 Alternative Disinfectant Testing

8.5.11.1 Introduction

The WTP currently adds chlorine and ammonia to maintain a chloramine disinfectant residual in the distribution system. Chlorine is supplied via chlorine gas. Chlorine gas is currently supplied in 2,000 pound cylinders and is stored in an open area under the existing north chemical building.

Chlorine gas is an inhalation hazard and is subject to regulation by the USEPA under the Clean Air Act and the Occupational Safety and Health Administration. In the event of an uncontrolled chlorine leak, the gas could potentially represent a serious health risk to neighboring residents in the immediate area near the plant site. As an alternative source of chlorine, liquid sodium hypochlorite (a.k.a., bleach) is easily contained and does not represent a health risk to neighboring residents. It is also not subject to regulation under the Clean Air Act. Consequently, the CRBUD has determined that it wants to eliminate the use of chlorine gas and switch to liquid sodium hypochlorite (NaOCl) that is either generated on-site at 0.8 percent concentration or supplied in bulk at a 12 percent concentration.

Bench-scale testing was conducted to determine if water quality is negatively affected by changing from chlorine gas to sodium hypochlorite. For this testing on-site generated 0.8 percent sodium hypochlorite and 12 percent bulk sodium hypochlorite were obtained from a local utility in Palm Beach County. The following subsections present the findings of the alternative disinfectant bench-scale testing.

8.5.11.2 Testing of Key Water Quality Parameters

The key constituents of concern in switching from chlorine gas to sodium hypochlorite are sodium, chloride, perchlorate, bromate and chlorate. Softened water from the full scale plant was obtained from the south softener, filtered and then dosed with 6.8 mg/L of chlorine from the different disinfectants (thus matching the current full-scale plant chlorine dosage) to determine the levels of these constituents. Raw water and finished water from the plant were also collected and analyzed for comparison. The data are presented in **Table 8.13**.

Table 8.13
Finished Water Quality after Disinfection Utilizing Three Types of Disinfectant

Parameter	Raw Water	Full Scale Finished Water with Gas Chlorine	0.8% On-site Generated Sodium Hypochlorite	12% Commercially Available Sodium Hypochlorite
Sodium (mg/L)	21	19	30	24
Chloride (mg/L)	31	39	56	44
Perchlorate (mg/L)	Not Detected	Not Detected	Not Detected	Not Detected
Bromate (mg/L)	Not Detected	Not Detected	Not Detected	Not Detected
Chlorate (mg/L)	Not Detected	Not Detected	Not Detected	Not Detected

The following briefly describes the findings relative to these constituents:

Sodium: high levels of salt intake may be associated with hypertension in some individuals. Sodium levels in drinking water are normally 50 mg/L or less. Most people take in about 5,000 mg of sodium daily. The recommended amount of salt for people with high blood pressure is about 1,500 milligrams a day. High levels of sodium in drinking water are not considered harmful by the USEPA. Given the above data, the sodium concentration increase resulting from switching to sodium hypochlorite will likely not contribute to adverse health effects.

Chloride: high levels of chloride in drinking water may result in a salty taste to the water. A chloride concentration up to 250 mg/L is considered acceptable per the USEPA. Chloride levels in drinking water given the above data will likely not result in noticeable change to the taste of the water.

Perchlorate, Bromate and Chlorate: Bromate is a common contaminate in sodium hypochlorite. Bromate is linked to the purity of the salt such that higher concentrations of bromide in the salt results in higher bromate concentration in the sodium hypochlorite. Bromate is currently regulated by the USEPA with a maximum contaminant level (MCL) of 10 micrograms per liter (µg/L). Perchlorate and chlorate are decomposition products of sodium hypochlorite. Perchlorate is a regulated drinking water contaminant in California, with a MCL of 6 µg/L. Perchlorate is not regulated by the USEPA. Chlorate is also not regulated by the USEPA; however, chlorate is included on the USEPA's Third Contaminant Candidate List and is being considered by the USEPA for regulation. Based on the bench-scale testing it appears that perchlorate, bromate and chlorate were all not detected in water dosed with 6.8 mg/L of chlorine when utilizing sodium hypochlorite.

8.5.11.3 Simulated Distribution System Disinfection Byproduct Testing

The purpose of this testing was to simulate the impact on DBPs produced in the distribution system resulting from the change in disinfectant (i.e., switching from chlorine gas to 0.8 percent on-site generated sodium hypochlorite or 12 percent bulk sodium hypochlorite). This testing also assessed the impact on DBPs of changing from a chloramine residual in the distribution system to a free chlorine residual in the distribution system. The water age in the distribution system was simulated by aging the samples for two days and five days.

Finished water samples at the high service pump station were collected to assess the DBP in the simulated distribution system under the CRBUD's current disinfectant strategy (i.e., 6.8 mg/L of chlorine gas to form a chloramine residual). The results from this analysis should be considered a benchmark for comparison with the results from the testing of sodium hypochlorite disinfectants. Testing of water from the full scale plant under a free chlorine strategy was not feasible due to the background raw water ammonia.

Samples for demonstrating the effects on distribution system DBPs when disinfecting with the 0.8 percent on-site generated sodium hypochlorite and 12 percent bulk sodium hypochlorite were collected at the effluent of the south softener. The CRBUD staff had temporarily turned off the chlorine and ammonia injection upstream of the south softener prior to sample collection. The samples were filtered, pH was adjusted to 9, and chlorine from the locally generated 0.8 percent on-site generated sodium hypochlorite, and from the 12 percent bulk sodium hypochlorite were added respectively; the dosage was 6.8 mg/L to match the current WTP disinfection dosage. The samples were split so that the results from both free chlorine and chloramine strategies could be determined.

All samples were done in duplicate so that half of the samples could be held for two days and the other half of the samples held for five days to bracket the estimated water age in the distribution system. Samples for the chloramine disinfection strategy had approximately five minutes of free chlorine contact time before ammonia addition to form chloramines.

Samples were also collected to determine total organic carbon (TOC) levels in the raw water and in the effluent from the south softener. Raw water TOC was 6.2 mg/L and filtered south softener effluent was 6.4 mg/L. These TOC results are statistically identical and show that the current treatment does not provide any TOC removal at the bench-scale level.

Trihalomethanes (THMs) are formed as a byproduct predominantly when chlorine or sodium hypochlorite is used to disinfect water for drinking. THMs result from the reaction of chlorine and/or bromine with organic matter present in the water being treated. Some people who drink water containing concentrations of THMs greater than 80 µg/L over many years could experience liver, kidney, or central nervous system problems and increased risk of cancer.

All of the samples were tested for the four main constituents of trihalomethane, as follows: chloroform, bromoform, dichlorobromomethane, and chlorodibromomethane. When the concentrations of these constituents are summed together it is known as THM4. The MCL for THM4 is 80 µg/L on an annual average basis.

Haloacetic acids (HAAs) are a common DBP of drinking water disinfection when using chlorine and sodium hypochlorite. Exposure to such DBPs in drinking water has been associated with negative health impacts. The following HAAs were measured: monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and bromochloroacetic acid, together known as HAA5. The MCL for HAA5 is 60 µg/L on an annual average basis. The results from the DBPs testing are presented in **Table 8.14**.

Table 8.14
Simulated Distribution System Disinfection Byproducts Testing Results

Chlorine Source	Distribution System Disinfection Strategy	Sample Holding Time	THM4 (µg/L) Sample	THM4 (µg/L) MCL	HAA5 (µg/L) Sample	HAA5 (µg/L) MCL
WTP Finished Water (Chlorine Gas)	Chloramines	2 Day	27	80	37	60
WTP Finished Water (Chlorine Gas)	Chloramines	5 Day	29	80	43	60
0.8% Sodium Hypochlorite	Free Chlorine	2 Day	234	80	74	60
0.8% Sodium Hypochlorite	Free Chlorine	5 Day	311	80	84	60
0.8% Sodium Hypochlorite	Chloramines	2 Day	52	80	40	60
0.8% Sodium Hypochlorite	Chloramines	5 Day	52	80	46	60
12% Sodium Hypochlorite	Free Chlorine	2 Day	192	80	76	60
12% Sodium Hypochlorite	Free Chlorine	5 Day	102	80	90	60
12% Sodium Hypochlorite	Chloramines	2 Day	45	80	37	60
12% Sodium Hypochlorite	Chloramines	5 Day	44	80	41	60

Based upon the above data, free chlorine residual in the distribution system will likely result in THMs and HAAs in excess of their maximum allowable concentration set by the USEPA. Hence, free chlorination of the distribution system is not feasible. All of the chloramine residual disinfection strategies tested resulted in THMs and HAAs lower than their maximum allowable concentration set by the USEPA. However, this result should be confirmed via full-scale testing of the breakpoint chlorination within the WTP. The bench-scale data indicated that the sodium hypochlorite strategies produce about the same level of DBPs within the simulated distribution system. Consequently, both types of sodium hypochlorite (i.e., 0.8 percent versus 12 percent) tested are likely acceptable from a DBP perspective.

It is speculated that if the CRBUD implements the ferric chloride storage and feed system recommended in Subsection 8.5.8 above, it would help reduce the softener effluent TOC and turbidity which would likely reduce the resultant DBPs.

The above described testing was based upon a chlorine dosage of 6.8 mg/L. After completion of the bench-scale testing, analysis of the monthly operating reports indicated that the chlorine dosage averaged about 11 mg/L based on the weight of chlorine consumed over from the beginning of 2008 through the end of 2011. This difference may result in slightly different analytical data than presented above. However, the conclusions would remain the same.

8.5.12 Lime Feed Improvement Needs

Lime within the storage silos often "bridges" (a.k.a., clumping) causing lime flow from the hopper into the slaker to stop. This is a common difficulty faced by many utilities. Quick lime is hygroscopic (i.e., it readily takes up and retains atmospheric moisture). Given the high humidity of South Florida, eliminating bridging in a lime storage and feed system is likely impossible.

This problem is exacerbated by the lime slurry feed system which does not allow for automatic control due to the current trough type feed system. Lime is currently fed from the slakers directly to the softeners via open channel troughs. By its nature, this type of lime feed system cannot accurately control the feed rate of lime to the softeners. The inability to control the lime feed to the softeners results in poor treatment performance.

The inability to control the lime feed rate to the softeners via the open channel troughs should be resolved by the addition of a lime slurry holding tank and pumping system with VFDs. A similar system has been implemented at the Miami-Dade Preston WTP and successfully operated for the past 12 years.

The recommended lime slurry storage and feed system would provide a "buffer" in the system which would give the CRBUD additional time to recognize and react to correct a lime hopper bridging problem. Providing additional operator reaction time to correct lime feed bridging issues would reduce the impact on finished water quality due to bridging within a lime hopper. Additionally, providing a pumped lime slurry system would significantly enhance the controllability of the treatment process resulting in improved performance.

It is recommended that this proposed lime slurry system be implemented at the same time as the lime slaker replacement and the improvements to the solids handling system.

Based on rough preliminary sizing calculations, it is recommended that the lime slurry system be composed of two 10,000 gallon vertical stainless steel slurry holding tanks equipped with mixers along with two 1,200 gallon stainless steel slurry dilution tanks. The mixers will keep the slurry in suspension. Three (two duty plus one standby) transfer pumps are recommended to pump the slurry from the dilution tanks to the holding tanks. Four (three duty plus one standby) feed pumps are recommended to pump the slurry from the holding tanks to the injection points at the softeners.

Based upon the bench-scale testing results described above, full-scale testing of ferric chloride was recommended. Interference in the softening process due to pH changes from mixing ferric chloride and lime in close proximity is a possibility. Consequently, it is recommended that the lime slurry design provide flexibility in the lime feed points. Lime is currently added at the reaction zone of the treatment units; these lime feed points should be retained. The addition of new lime feed points upstream of the treatment units is recommended to assess how variation in the lime feed location affects the results of full-scale ferric chloride testing.

Modification of the lime hoppers to incorporate "bridge" breaking technology is also recommended. The modifications may include air hammers (such as the ThumperTM Timed Impactor as manufactured by Martin Engineering Company) and/or bin activators (as manufactured by Metalfab, Inc.).

8.5.13 Water Quality Improvement Needs

The bench-scale testing findings previously summarized identified a series of improvement opportunities to enhance finished water quality. This subsection identifies a series of projects to implement those improvements. **Table 8.15** lists the recommended water quality improvement projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

Table 8.15
Water Quality Improvement Projects
Water Treatment Plant

Project No.	Project Name	Project Description
WTPWQ001	Ferric Chloride and Sodium Hypochlorite Full-Scale Testing	Conduct full-scale testing of ferric chloride to confirm the results of the bench-scale testing. Conduct full-scale testing of sodium hypochlorite to assess impact of changing disinfectant on water quality.
WTPWQ002	Ferric Chloride Storage and Feed System	Based on the results of the full-scale testing of ferric chloride, prepare contract documents for the construction of a ferric chloride storage and feed system.
WTPWQ003	Automatically Track Filter Run Hours	Modify the plant control system to automatically track the filter run hours.
WTPWQ004	Create Filter Media Evaluation Program Document	The filter media condition should be evaluated annually in accordance with the AWWA document titled "*Filter Evaluation Procedures for Granular Media"*. The results should be documented in a report.

Table 8.15 (continued)
Water Quality Improvement Projects
Water Treatment Plant

Project No.	Project Name	Project Description
WTPWQ005	Filters 1-8 Media and Underdrain Replacement	Replace the filter media for Filters 1 through 8. Based on the age of the underdrains they should be replaced at the same time.
WTPWQ006	Calcium Sequesterant Storage and Feed System	Design and construct a calcium sequesterant storage and feed system (in parallel with the replacement of the media in filters 1-8) to control media degradation.
WTPWQ007	Filters 1-8 Surface Wash System	Replace the air scour system with a surface wash system for filters 1-8. This project should proceed in parallel with the project to replace the media for filters 1-8.
WTPWQ008	Lime Slurry System	Design and construct a lime slurry storage and pumping system to improve the controllability of the lime feed to the treatment process. This project should proceed in parallel with the replacement of the lime slakers (described in Subsection 8.7).

8.6 Regulatory Driven Improvement Needs

8.6.1 Introduction

A key element of a Master Plan is identification of capital improvement needs that are required for compliance with existing regulations along with potential capital improvement needs for compliance with anticipated regulations. This subsection includes recommendations for capital improvement projects for the CRBUD's WTP to maintain compliance with existing and anticipated future regulations.

This subsection is based, in-part, upon the findings of the report titled "*Water System Regulatory Review Report"* (dated August 30, 2011, issued by C Solutions), along with a synthesis of data collected during development of the Master Plan. The "*Water System Regulatory Review Report*" provided a detailed evaluation of the CRBUD's water treatment plant and water distribution system's compliance with current regulations along with an assessment of compliance requirements for anticipated future regulations.

Key findings of the "*Water System Regulatory Review Report"* are summarized in the following subsection. Later subsections of this report provide recommended capital improvements.

8.6.2 Existing Regulations

8.6.2.1 Compliance with Existing Drinking Water Regulations

The "*Water System Regulatory Review Report*" indicated that the CRBUD is in compliance with all existing drinking water regulations with the exception of reported low total chlorine residual in its distribution system as described in Section 9 (titled "Water Distribution System") of this report.

8.6.2.2 Ground Water Rule

As indicated in Subsection 8.5 the WTP is not currently certified for 4-log virus treatment under the GWR. The District has expressed a desire to obtain 4-log virus treatment certification, if feasible given budget limitations. See Subsection 8.5.10.7 above for an evaluation of feasibility. See Subsection 8.5.10.8 for recommendations.

8.6.3 Anticipated Future Regulations

8.6.3.1 Disinfection By-Products

The CRBUD is planning to change from elemental chlorine gas to sodium hypochlorite for disinfection. Sodium hypochlorite solution strength degrades over time, resulting in the formation of oxygen, chlorite, chlorate and perchlorate. Additionally, bromate may be present based on the type of salt used in the manufacture of the hypochlorite. Bromate and chlorite are currently regulated; chlorate and perchlorate are currently unregulated.

Chlorate is included on the third contaminant candidate list (CCL3) and has been shortlisted by USEPA as one of the five possible contaminants for which a regulatory determination may be made (expected by late 2013). A notice published by the USEPA on August 19, 2009 indicated a potential for a national perchlorate regulation at levels as low as 1 µg/L to 6 µg/L.

Accordingly, the proposed sodium hypochlorite facility must be designed to minimize chlorate and perchlorate formation.

The AWWA reported that the USEPA is expected to make a preliminary decision whether to regulate the nitrosamines group of nitrogenous disinfection by-products by late 2012. It is estimated that if the USEPA moves forward with rule making, a proposed rule might be issued in 2016 followed by a comment period and promulgation of a final rule. The CRBUD should monitor the status of this rule making.

8.6.3.2 Chemical Facility Anti-Terrorism Standards (CFATS)

The U.S. Department of Homeland Security's Chemical Facility Anti-Terrorism Standards (CFATS) imposes federal security regulations for high-risk chemical facilities. Facilities that are regulated under CFATS are required to prepare Security Vulnerability Assessments, which identify facility security vulnerabilities, and to develop and implement Site Security Plans.

Water treatment plants are currently exempt from the CFATS regulations; however, there have been a number of attempts by the United States Congress to eliminate the exemption. Water utilities and industry organizations, such as the AWWA have, to date, successfully argued that water utilities have done such work already under the Bioterrorism Act of 2002 and believe that local water utilities are best suited to decide what type of chemicals they should use to disinfect drinking water.

There have also been legislative attempts – such as the proposed Drinking Water System Security Act of 2009 – to require that water utilities stop using chlorine gas and instead use an "inherently safer technology" (IST), such as bleach (delivered by truck) or on-site generated bleach (utilizing energy intensive new equipment). This proposed legislation has not yet gained sufficient support to pass.

The above described legislative attempts to eliminate chlorine gas may eventually be successful. The CRBUD, under direction of the District's Board, has made the policy decision to eliminate the use of chlorine gas and switch to sodium hypochlorite disinfectant.

8.6.3.3 Florida Version of the Ground Water Rule

FDEP Drinking Water Supervisor for West Palm Beach reports that the FDEP is targeting issuing a Florida version of the GWR under 62-550, FAC. The project team attended a meeting with FDEP on the GWR on July 25, 2012. The FDEP staff stated that the date the rule will be promulgated is unknown.

8.6.3.4 Implications of Changing Disinfectant

The CRBUD Board has made the policy decision to eliminate the use of chlorine gas and switch to sodium hypochlorite disinfectant. The CRBUD has developed a report – titled "*Chlorine System Replacement Preliminary Design Report*" – that contains certain technical information such as concept layouts and facility sizing requirements for a sodium hypochlorite facility. The CRBUD intends to use this information as the basis for a detailed design of a new sodium hypochlorite facility.

The CRBUD has established a $3.8 million budget for the design, permitting, construction, engineering services during construction and contingency for the sodium hypochlorite facility described in the "*Chlorine System Replacement Preliminary Design Report"*. This budget cost is reasonable for master planning.

Sodium hypochlorite solution strength degrades over time resulting in the formation of oxygen, chlorate and perchlorate. Light, heat, organic matter, and certain heavy metals (such as copper, nickel, and cobalt) accelerate the rate of decomposition of sodium hypochlorite. As noted, previously, switching from chlorine gas to sodium hypochlorite could pose future concerns relative to chlorate and perchlorate, which are not currently regulated, depending upon the outcome of ongoing regulatory action.

Certainty regarding the possible MCLs for these currently unregulated constituents is not possible at this time. However, certain management practices for the storage of sodium hypochlorite reduce degradation and resultant chlorite, chlorate and perchlorate formation. These practices include: dilution upon delivery, control the pH (11 to 13) of the stored sodium hypochlorite (even after dilution), reduce storage time, and minimize storage temperature. Additionally, routine maintenance of the sodium hypochlorite facility should include annual emptying and flushing of the storage tanks and piping to reduce accumulation of sediment that may increase the sodium hypochlorite degradation rate. The conceptual design for the sodium hypochlorite facility prepared for this *Master Plan* and presented in the report titled "*Chlorine System Replacement Preliminary Design Report"* incorporates features to facilitate these management practices. In addition, the CRBUD should monitor the status of the regulatory initiatives relative to chlorate and perchlorate.

It is unpublished FDEP policy that sodium hypochlorite with a trade concentration of 12.5 to 17 percent, stored at a temperature of 85 degree Fahrenheit or less, may be stored for up to 14 days. Additionally, sodium hypochlorite with a trade concentration of 6.25 to 8.5 percent, stored at a temperature of 85 degree Fahrenheit or less, may be stored for up to 60 days. The conceptual design for the sodium hypochlorite facility presented in the report titled "*Chlorine System Replacement Preliminary Design Report"* will meet these FDEP regulatory policies with proper management practices.

8.6.4 Recommended Regulatory Driven Improvements

Table 8.16 aggregates the regulatory driven type improvement recommendations presented above into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

Table 8.16
Regulatory Driven Improvement Projects
Water Treatment Plant

Project No.	Project Name	Project Description
WTPREG001	Ground Water Rule 4-log Virus Treatment Certification Study	Conduct full-scale testing of the disinfection strategy for GWR virus treatment.
WTPREG002	Capital Improvements for 4-log Virus Treatment	Design and construction of the capital improvements identified during the study prepared under Project No. WTPREG001.

8.7 Renewal and Replacement Improvement Needs

All assets in the CRBUD's water and wastewater infrastructure have a limited lifespan. At the end of an asset's lifespan, the asset (e.g., pump, pipe, filter, etc.) may fail resulting in loss of service. Depending on the failure mode and level of redundancy, the consequence of failure can range from a minor inconvenience to major environmental harm and could potentially be harmful to CRBUD staff. Consequently, a key focus of this Master Plan was documenting the condition of existing infrastructure, assessment of the remaining useful life of major assets and recommending renewal and replacement (R&R) of major assets that are at or near the end of their useful life to ensure the continued reliability of the CRBUD's existing water and wastewater infrastructure over the next 20 years.

The project team conducted field investigations of the condition of major WTP assets along with the Blue Heron Boulevard water tank in January and February 2012. This subsection of the Master Plan presents the recommendations based upon the findings of the investigation. The findings of the investigation for the WTP are included in **Appendix A**. It is noted that the water storage and repump stations (Avenue C, Avenue U and North Singer Island) are addressed in Section 9 (titled "Water Distribution System") of this report.

The WTP asset condition investigation was limited to visual observation of the facilities and interviews with plant operations and maintenance staff regarding the performance, reliability, age, and condition of the existing equipment and structures. Additionally, Florida Power and Light was consulted to obtain input on the condition of the plant primary power supply cables.

The key water treatment and water storage assets that were evaluated include the following:

- Flow Meters

- Packed Tower Scrubbers
- Raw Water Transfer Pumps and Clearwell
- Raw Water Influent Flow Basins
- Alum Chemical Feed System
- Polymer Chemical Feed System
- Lime Chemical Feed System
- Chemical Disinfection System (Ammonia and Chlorine)
- Softeners
- Solids Handling Facilities
- Filtration System
- High Service Pumps
- Transfer Pumps
- Blue Heron Boulevard Finished Water Storage
- Emergency Power
- Air Compressors
- Motor Control Centers (MCCs)
- Programmable Logic Controllers (PLCs)
- Main Control Room
- Yard Piping
- Florida Power and Light Power Supply

Table 8.17 aggregates the R&R type improvement recommendations, based upon the findings of the investigation for the WTP, into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are included in **Appendix A**.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

Table 8.17
Renewal and Replacement Projects
Water Treatment Plant

Project No.	Project Name	Project Description
WTPRR001	Air Stripper Media Replacement	Replace scrubber media, spray header, and blowers. Select a proper cleaning chemical to resolve media fouling. Add chlorine injection point at scrubber inlets.
WTPRR002	Raw Water Transfer Pump Replacement	Replace all of the raw water transfer pumps (pumps 1A, 2A, 3A, 1B, 2B, and 3B) and associated piping, valves, variable frequency drives, motor control centers, disconnects, etc.
WTPRR003	Lime Softener Rehabilitation	Replace the rotor impeller drive and the walkways for all softeners. Replace local control panel for all softeners. Replace the 4-inch flushing ring valves on all softeners with new valves and electric actuators. Replace the sludge blowdown valves for all softeners with 4-inch plug valves and electric actuators (typical of four valves per softener for a total of 16 valves). Replace the existing controls for the sludge valves and "mudjet" flushing valves with a PLC based control panel.
WTPRR004	Replacement of Lime Slakers	Replace all four existing lime slakers with new slaker. Replace all existing controls. Replace all silo dust collectors. Replace lime silo level indicators.
WTPRR005	Replacement of Lime Silos	Replace all four lime silos with new lime silos.
WTPRR006	Aqueous Ammonia System	Replace the existing anhydrous ammonia system with a 19% aqueous ammonia system. This project should be constructed in the same timeframe as the chlorine system replacement project.
WTPRR007	Water Treatment Plant Disinfection	Replace the existing chlorine gas system with a sodium hypochlorite system.

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Table 8.17 (Continued)
Renewal and Replacement Projects
Water Treatment Plant

Project No.	Project Name	Project Description
WTPRR008	WTP Flow Meter Replacements and Additions	• Replace all existing raw water, influent basin, and save all basin return water flow meters with magnetic flow meters; • Replace existing finished water flow meter with a new magnetic flow meter; • New magnetic flow meter at the save all basin return water main entering the south influent basin; and • New magnetic flow meter at the 24-inch raw water main entering the north treatment unit. This project should be constructed in the same timeframe as the chlorine system replacement project to ensure that there are accurate flow meters for automation of the chemical feed systems.
WTPRR009	Filter Crack Repair	Perform detailed evaluation of the exterior walls of the filters to determine appropriate procedure to seal cracks. Following the evaluation, re-coat exterior with appropriate coating system. Implementation of crack repair should be coordinated to coincide with filter media replacement.
WTPRR010	Filter 1-8 HMI and Blower Replacement	Replace Human Machine Interface graphic displays and blowers for Filters 1-8.
WTPRR011	Filter 9-16 Media and Underdrain Replacement	Replace the filter media for Filters 9-16 within the next ten years. The underdrains were installed in 2009; they should be considered for replacement in roughly the next 20 years.
WTPRR012	Backwash System Valve and Control Replacement	Replace the backwash system valves and controls, including the following: • 12" Backwash rate of flow control valve; • Actuator for the backwash rate of flow control valve; • 12" venturi meter that measures the backwash rate; and • Associated electrical and control conduit, wire and local displays.
WTPRR013	Filter 1-8 Valve and Actuator Replacement	Replace all valves, valve actuators, flow meters and filter instrumentation (level and turbidity) for Filters 1 through 8.

**Table 8.17 (Continued)
Renewal and Replacement Projects
Water Treatment Plant**

Project No.	Project No.	Project No.
WTPRR014	Filter 9-16 Valve and Actuator Replacement	Replace all valves, valve actuators, flow meters and filter instrumentation (level and turbidity) for Filters 9 through 16.
WTPRR015	Finished Water Transfer Pump Replacement	Replace the finished water transfer pumps (Pumps 1 and 2) and associated piping and valves.
WTPRR016	High Service Pump Replacement	Replace the high service pumps (Pumps 1 through 7) and associated piping, valves, variable frequency drives, motor control centers, and the monorail crane.
WTPRR017	Blue Heron Boulevard Tank Replacement	Replace the storage tank, tank fill valve and actuator, clearwell return valve and actuator, electrical and control conduit and wires associated with the tank instruments and the valve actuators.
WTPRR018	WTP Field Instrument Replacement	Replace field instruments as they become obsolete or inoperative.
WTPRR019	Primary Logic Controller (PLC) Replacement	Replace the WTP PLCs: • Main Control Room PLC • Filter 1-8 PLC • Filter 9-19 PLC • Main MCC Room PLC • South Chemical Building PLC • North Chemical Building PLC • Scrubber System PLC
WTPRR020	WTP Electrical Single Line Diagram	Prepare a single line diagram of the plant electrical system. Include an electrical site plan (or multiple plans) that illustrate the location of the major electrical equipment.
WTPRR021	Electrical Equipment Replacement	Replace the critical plant electrical equipment: • Main power switchgear 1 and 2 • Main power automatic transfer switches 1 through 4 • Breaker No. 3
WTPRR022	Emergency Generator and Fuel System Replacement	Replace the 250 kW emergency diesel engine generator for the scrubber system, the 1,000 kW emergency diesel engine generator for the WTP and the underground fuel tank system.

Table 8.17 (Continued)
Renewal and Replacement Projects
Water Treatment Plant

Project No.	Project No.	Project No.
WTPRR023	Plant Power System Analysis	Perform a plant power system analysis including: • Load evaluation; • Circuit breaker coordination study to evaluate the operational reliability of the WTP; and • Arc flash study to update safety conditions for maintenance operations.
WTPR024	North Filter Building Door and Window Replacement	The existing doors and windows do not appear to have Florida Product Approvals for resistance to wind induced loads during storm events. Replace the doors and windows of the North Filter Building to provide hurricane-rated components with Florida Product Approvals.

8.8 WTP Facility Improvements

WTP facility improvements are projects identified by the CRBUD staff to improve and enhance utility operations. **Table 8.18** presents the WTP facility improvement projects and assigns project numbers to each for tracking purposes.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

Table 8.18
WTP Facility Improvements

Project No.	Project Name	Project Description
WTPFI001	Field Operations Building	Design and construct a new field operations building in the Master Plan. The building would be 1-story, 5,000 square foot pre-cast concrete tilt up construction type building. A crane within the building is not included.
WTPFI002	Fluoride System	Design and construct a fluoridation system at the WTP.

8.9 Opinion of Probable Project Costs

The opinions of probable cost for all of the above projects are presented in Section 12 (titled “Opinion of Probable Project Costs”) of this report.

Section 9.0
Water Distribution System

9.1 Introduction

This section of the Master Plan summarizes the following:

- Findings of the water distribution system hydraulic modeling;
- Recommended water distribution system capacity and water quality improvement projects based on the water distribution system model findings;
- Recommended regulatory driven water distribution system improvement projects; and
- Recommended water distribution system renewal and replacement (R&R) improvement projects.

9.2 Baseline Model Development

9.2.1 Introduction

This subsection summarizes the software and the piping network that were used to create the water distribution system hydraulic model. Additionally, this subsection presents the results of the model verification task. Verification is the process of measuring how close the model predictions are to the observed pressure conditions during a specific operating period. Model results are presented in Subsection 9.5.

9.2.2 Modeling Software

The water distribution system hydraulic model was developed using WaterCAD Version V8i software by Bentley Systems, Incorporated.

9.2.3 Model Network Development

The model of the existing water distribution system was based on the existing piping imported from geographic information system (GIS) shape files provided by the CRBUD in early 2012. The water distribution system hydraulic model included piping two-inches in diameter and larger throughout the CRBUD service area.

Figure 9-1 illustrates the piping network developed for the water distribution system hydraulic model.

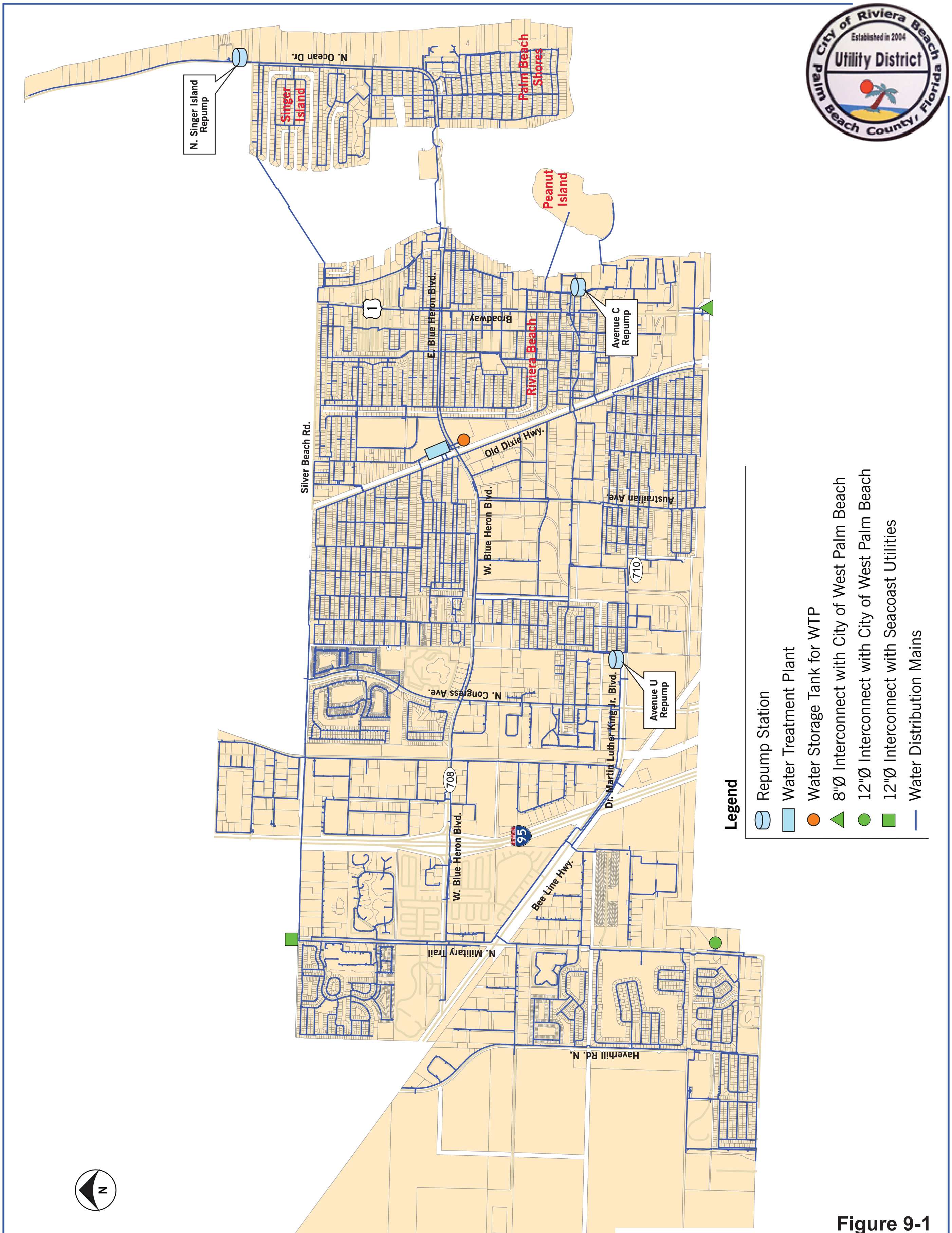

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Figure 9-1
Existing Water Distribution System

9.2.4 Extended Period Simulation (EPS)

The two basic types of water distribution system hydraulic models are:

- Steady-State Simulation
- Extended Period Simulation (EPS)

Steady-state simulation computes the state of the system (i.e., flows, pressures, pump operating status, tank water levels) assuming that neither the demands nor the system state change with time. Steady-state simulation is a snap shot of system performance at a particular time.

EPS determines the dynamic behavior of the system, computing the state of the system as water demand, pump operating status, tank water level, pressure, etc. vary over time. EPS allows the model to evaluate tanks filling and draining, regulating valves opening and closing status, along with pressures and flow rates changing throughout the system in response to varying demand conditions and automatic control strategies.

The CRBUD's water distribution system hydraulic was modeled utilizing the EPS technique to assess system performance over the course of a 24 hour period. Steady-state simulations were utilized to assess available fire flow with the model's fire flow "engine".

9.2.5 Demand Variation

EPS modeling simulates demand variation throughout the day by input of a demand pattern (or multiple patterns) into the model. The demand patterns utilized in the model are presented in Section 5 (titled "Water Demand Forecast") of this report.

9.3 Model Verification

9.3.1 Introduction

The water distribution system hydraulic model was designed to predict the system's present and future operational parameters under specific demand scenarios. The key parameters are pressure and flow. Verification of the accuracy of the model at a defined instant in time is required to gain confidence in using the model to make long term predictions.

Verification was accomplished using pressure records obtained from field operations and comparing them to model predictions. Additionally, flow records from the high service pump station and repump stations were collected from the CRBUD Data Flow System (DFS) for the purpose of model verification. For the purpose of this study, verification included reasonable minor adjustments to model factors in order to improve the predictive capability of the model.

The accuracy of the model was measured by how close the model predictions were to the actual observed and measured system conditions. For the purpose of this study, model verification was considered achieved when a reasonable margin of error (defined as an average of ten percent difference in field observed maximum pressure versus model predicted maximum pressure) was obtained.

The following subsections summarize the field data collected and the findings of the model verification process.

9.3.2 Data Collection

The project team installed eight digital pressure recorders on fire hydrants throughout the service area. Sixteen locations were monitored in two groups of eight. The first group was monitored from April 4, 2012 through April 16, 2012. The second group was monitored from April 18, 2012 through May 1, 2012. The CRBUD also monitors pressure at 17 permanent pressure monitoring stations located throughout the service area. The data from these pressure monitoring stations is recorded at the water treatment plant (WTP) in the DFS telemetry system. Pressure data from the DFS was also collected during the time frame of April 4, 2012 through May 1, 2012.

Figure 9-2 illustrates the locations where temporary pressure recorders were installed as well as the locations of the CRBUD's 17 existing permanent water distribution system pressure monitoring stations. **Table 9.1** provides a summary of the locations that pressure recorders were installed.

Figure 9-2
Water System Pressure Recorder Installation Location

Table 9.1
Temporary Pressure Recorder Installation Locations

Temporary Pressure Recorder Location (Fire Hydrant No. from GIS)	Approximate Recorder Installation Address	Recording Timeframe		Comments
		4/4 to 4/16	4/18 to 5/1	
1-0093	3045 Casa Rio Ct	X		
2-0100	Silver Beach Rd and Congress Ave	X		
3-0074	NW Corner of Ocean Ave and Inlet Way	X		
3-0105	100 Lake Shore Dr	X		
4-0028	Military Trail and Canterbury Dr S	X		
6-0090	337 E Blue Heron Blvd	X		
6-0157	Port of Palm Beach	X		
4-0099	Dyer Blvd & Military Trail	X		Recorder Failed
1-0068	7398 N Haverhill Rd		X	
3-0167	933 Silver Beach Rd		X	
3-0022	1061 Coral Way		X	
3-0074	NW Corner of Ocean Ave and Inlet Way		X	
3-0054	SE Corner of Ocean & Cabana Rd		X	
4-0067	5483 45th St		X	
6-0025	864 W. 1st. St		X	
1-049	3648 Consumer St		X	

9.3.3 Model Verification Results

The water distribution system hydraulic model performance was verified by comparing the maximum pressures predicted by the model versus the maximum pressures that were field measured in the water distribution system for a particular 24-hour period. April 13, 2012 was the day selected as the basis for model verification. For this Master Plan, the water distribution system hydraulic model was considered verified when the average of the differences observed between the maximum field-measured pressure and the maximum pressure predicted by the model were less than ten percent. **Table 9.2** summarizes the model verification results.

Table 9.2
Water Model Verification Results for April 13, 2012

Model Node	Maximum Model Pressure (psi)	Maximum Field Pressure (psi)	Difference (psi)	% Difference
NSI Repump	68.20	67.00	1.20	1.79%
Ave C Repump	69.50	67.00	2.50	3.74%
Ave U Repump	66.60	62.00	4.60	7.42%
6-0090	70.40	69.99	0.41	0.59%
4-0028	65.30	66.13	-0.83	1.25%
3-0105	70.20	69.84	0.36	0.51%
2-0100	68.40	69.55	-1.15	1.65%
1-0093	66.30	67.25	-0.95	1.42%
LS47	66.60	65.93	0.67	1.01%
LS23	69.80	70.85	-1.05	1.48%
LS40	66.50	66.50	0.00	0.00%
LS39	67.10	64.00	3.10	4.85%
LS37	66.90	68.62	-1.71	2.50%
LS31	67.20	64.13	3.07	4.78%
LS22	67.10	68.67	-1.57	2.28%
LS20	68.50	70.67	-2.17	3.06%
LS19	67.40	68.20	-0.80	1.17%
LS18	67.90	69.30	-1.40	2.02%
LS16	66.90	69.57	-2.66	3.83%
LS12	68.40	69.57	-1.16	1.67%
WTP	75.29	63.61	11.67	18.35%
			Average	**3.1%**

NSI: North Singer Island
WTP: `Water Treatment Plant

Based upon the above data, the average of the differences between the maximum field-measured pressures and the model output was 3.1 percent.

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9.3.4 Conclusions

For the April 13, 2012 data set, the average difference between the maximum field measured pressures and the model predictions was less than ten percent. Consequently, the water distribution system hydraulic model was considered acceptable for master planning.

9.4 Performance Criteria

9.4.1 Introduction

The criteria used to assess the adequacy of the CRBUD's water distribution system relative to pressure, water age and fire flow are described in the following paragraphs. Assessment of the adequacy of the Port of Palm Beach's water distribution system was not included in this Master Plan.

9.4.2 Pressure Assessment Criteria

The water distribution system hydraulic model was employed to identify capital improvement projects and additional investigations that may be necessary to maintain adequate water supply and pressure for consumption during normal operations for five-year planning increments from 2015 through 2030 during peak hour demand with no fire flow. The model was also used to assess pressure in the water distribution system during abnormal events such as a fire. The pressure criteria used to assess the adequacy of the water distribution system (relative to pressure) during normal operations and abnormal conditions are summarized in **Table 9.3**.

Table 9.3
Pressure Assessment Criteria

Conditions	Pressure	Assessment
Normal Operations (i.e., peak hour with no fire)	Less than or equal to 35 psi	Not Acceptable
Normal Operations (i.e., peak hour with no fire)	Greater than 35 psi	Acceptable
Abnormal (e.g., fire)	Less than or equal to 25 psi	Not Acceptable
Abnormal (e.g., fire)	Greater than 25 psi	Acceptable

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The above criteria during normal operations are based upon Article 8.2.1 of the "*Recommend Standards for Waterworks*" 2012 edition which states, "The normal working pressure in the distribution system should be approximately 60 to 80 psi and not less than 35 psi.

Article 8.21 of the "*Recommend Standards for Waterworks*" recommends that a water distribution system maintain a minimum pressure of 20 psi during "…all conditions of flow…". The project team selected 25 psi as the minimum during fire flow conditions for conservatism.

If the model demonstrated that the existing piping network couldn't meet the minimum pressures described above then a capital project was identified that would facilitate meeting the minimum pressure requirements.

It is noted that the CRBUD generally maintains an average pressure of 65 psi at the discharge of the high service pumping station and historically the pressure varies by about plus or minus eight percent over a typical day.

9.4.3 Water Age Assessment Criteria

In general, water with higher water age tends to have a lower quality. The age at which water quality changes from acceptable to not acceptable is governed by numerous factors and is site specific. The project team used the criteria in **Table 9.4** to judge the acceptability of water quality based on water age.

Table 9.4
Water Age Assessment Criteria

Water Age	Assessment
up to 72 hours	Acceptable
greater than 72 hours up to 96 hours	Marginal
greater than 96 hours	Not Acceptable

If the model demonstrated that the existing piping network produced a water age greater than 96 hours then a capital project was identified that would facilitate reducing water age.

9.4.4 Fire Flow Assessment Criteria

9.4.4.1 Introduction

A water distribution system must be adequate to meet customer potable water demands and simultaneously meet fire flow demands. The Insurance Services Office (ISO) establishes standards for required water flow for fire suppression purposes from fire hydrants. ISO is a private corporation that evaluates the public fire defenses of municipalities. The ISO periodically conducts fire flow tests and, based on the results, assigns an insurance classification to the City of Riviera Beach.

Fire flow demands depend upon many factors, including building use, type of construction, building height, floor area, and distance to nearby buildings. For example, fire flow requirements in residential structures no higher than two stories may range between 500 and 1,500 gpm depending upon building spacing from adjacent structures, whereas certain high risk areas may require up to 12,000 gpm. Based upon the ISO document titled "*Guide for Determination of Needed Fire Flow*".

The fire flows required are determined based on building size, type of construction, occupancy factors, exposure of a building to a fire and spacing between buildings. Typically, the minimum needed fire flow based on the ISO standard is 500 gpm while 12,000 gpm is the maximum requirement. Based upon a report obtained from one other South Florida municipality with similar land use, **Table 9.5** includes the needed fire flow for typical land uses similar to the development in the CRBUD service area.

Table 9.5
Needed Fire Flow Categorized by Land Use

Land Use	Density	Needed Fire Flow Rate (gpm)
Low Density Residential	up to 5 units/acre	500 to 1,250
Medium Density Residential	10 to 16 units/acre	1,500 to 2,500
High Density Residential	25 to 50 units/acre	3,500 to 4,500
Office Park		3,500 to 4,500
Commercial and Shopping Centers		3,500 to 6,250
Industrial		4,500 to 6,250

The adequacy of the water distribution system under fire flow demand conditions was approached as a two-step process. The next two subsections describe these steps.

9.4.4.2 Available Fire Flow

The first step was to assess the overall performance of the system under steady state conditions to deliver water for purposes of fire fighting at specified minimum pressure conditions at each pipe junction. For this Master Plan, the minimum pressure at the pipe junction used to assess the available fire flow was 25 psi. The model's fire flow "engine" was used to determine the available fire flow that can be supplied to each pipe junction. The fire flow engine is a steady state analysis and assumed that all of the high service pumps and storage tanks within the system are operational and available. The available fire flow was determined under year 2030 maximum day demand conditions to provide a general indication of the adequacy of the system.

The criteria used to assess the adequacy of the water distribution system relative to available fire flow are summarized in **Table 9.6**.

Table 9.6
Available Fire Flow Assessment Criteria

Available Fire Flow	Assessment
Less than or equal to 1,000 gpm	Not Acceptable
Greater than 1,000 gpm	Acceptable

The available fire flow analysis was employed to screen areas of the water distribution system for further assessment. Once screened, specific fire demands at specific locations were simulated utilizing the EPS modeling toolset as described in the next subsection.

9.4.4.3 Fires at Specific Locations

The second step was to evaluate the performance of the water distribution system during a series of fire flow demands (i.e., flow rate and duration) at specific locations. The following criteria were used to select the fire simulation locations:

- Areas located in the extremities of the service area;
- Locations with a large concentration of population;
- Potential areas with a high cost of losses (high risk areas) in the event of a fire; and
- Areas identified using the model's fire flow "engine" as having low – in the range of 1,000 gpm to 1,500 gpm – available fire flow.

The EPS model was employed to predict overall system response during each fire scenario. The fire scenarios were timed such that each occurred over a four hour duration during hours of typical (approximately average hour) water demand during planning year 2030 maximum day conditions. This approach is conservative, due to the low probability of a fire occurring during the peak hour of the maximum day.

The CRBUD staff selected six locations to represent key areas of the CRBUD's water distribution system as indicated in **Table 9.7**.

Table 9.7
Fire Scenarios

Location	Fire Flow Rate[1]	Duration[2]
Corniche Condos (Singer Island)	3,500 gpm	4 hours
VA Medical Center	3,500 gpm	4 hours
Port of West Palm Beach	5,000 gpm	4 hours
Britannia Business Center	3,500 gpm	4 hours
UPS Warehouse	5,000 gpm	4 hours
Caribbean Village Condo (Gramercy Park)	2,000 gpm	4 hours

Note 1: *Needed fire flow rates were calculated based upon ISO document titled "Guide for Determination of Needed Fire Flow".*

Note 2: *Article 3.3.20 of the National Fire Protection Association standard 1141 titled "Fire Protection Infrastructure for Land Development in Suburban and Rural Areas", requires that a municipal water system be designed for the minimum fire duration of two hours. Four hours was selected for the fire duration for conservatism.*

It is noted that the above assumed fire flow durations were conservatively selected for water distribution system piping capacity evaluation purposes.

If the model demonstrated that the existing piping network could not supply the minimum pressure of 25 psi (as indicated in **Table 9.3** for abnormal conditions) during the above described fire flow then a capital project was identified that would facilitate meeting the minimum pressure requirements.

9.5 Distribution System Capacity and Water Quality Improvement Needs

9.5.1 Introduction

This subsection summarizes the results and describes the improvement needs indentified utilizing the water distribution system hydraulic model. The recommended improvements were categorized as capacity or water quality improvements. Certain improvements may fall into both categories.

9.5.2 Evaluation of Existing Infrastructure

The EPS model was run under maximum day conditions for years 2012, 2015, 2020, 2025 and 2030. The model results indicate that the existing infrastructure has adequate capacity to meet the peak hour demand through the year 2030 during normal operations and with no fire flow requirements.

9.5.3 Tank Filling and Storage Capacity

The CRBUD has four finished water storage tanks. The capacity of each tank is one million gallons (MG); for a total of four MG of storage. Additionally, the WTP clearwells below the filters and the high service pump station contain between 0.2 to 0.4 MG in working volume of storage, depending on operational water depth. **Table 9.8** summarizes the finished water storage volume currently available.

Table 9.8
Available Finished Water Storage Volume

Location	Volume (MG)
WTP Clearwells	0.4
Blue Heron Boulevard Tank	1.0
North Singer Island (NSI) Tank	1.0
Avenue C Tank	1.0
Avenue U Tank	1.0
Total	**4.4**

As indicated in the table above, a total of about 4.4 MG of finished water storage is currently available.

Florida Administrative Code (FAC) 62-555.320(19) requires a minimum storage volume of 25 percent of maximum day use plus an amount of the design fire-flow volume with all tanks in service. For the purpose of this Master Plan, design fire flow volume was calculated for a design fire flow rate of 5,000 gpm and a design fire flow duration of two hours. This assumed fire flow duration is less than the duration assumed for master planning of the piping (in Subsection 9.4.4.3). The design fire flow duration of two hours complies with Article 3.3.20 of the National Fire Protection Association standard 1141 titled "*Fire Protection Infrastructure for Land Development in Suburban and Rural Areas*". Hence, it is appropriate for master planning needed water storage volume. The regulatory minimum storage volumes are summarized in **Table 9.9** for year 2012, 2015, 2020, 2025 and 2030.

Table 9.9
Regulatory Minimum
Water Storage Volume

Year	Volume (MG)
2012	2.8
2015	2.9
2020	3.0
2025	3.2
2030	3.4

Based upon the above analysis, the CRBUD has sufficient existing storage to meet the requirements of FAC 62-555.320(19) through the year 2030. Thus, no increase in water storage is needed through the year 2030 based solely on the regulatory requirements.

The project team also reviewed the City of Riviera Beach's comprehensive plan; Policy 1.5.4 from the comprehensive plan is as follows:

> *Policy 1.5.4: Potable Water: The City's water system shall provide 177 gallons per person per day (average) with a storage capacity of 4,300,000 gallons at sufficient water pressure to meet fire flow demands as determined by the Fire Chief.*

The quantity of storage in the CRBUD's existing infrastructure meets the storage capacity requirement of the City of Riviera Beach's comprehensive plan Policy 1.5.4.

It is noted that the geographic diversification of the water storage tank sites aids in overall system reliability during a severe storm event such as a thunderstorm or tornado. Consequently, it is less likely that a single storm event would damage all storage tanks in a geographically diverse set of tanks relative to a system in which storage was consolidated at one location.

Water storage tanks should be designed and operated to facilitate turnover of water in the finished water storage to minimize stagnation and/or stored water age. Poor water circulation and long detention times can lead to loss of disinfectant residual, microbial growth (i.e., nitrification), formation of disinfectant byproducts, taste and odor problems, and other water quality problems.

Historical tank water level data from the DFS (for Avenue C, Avenue U and NSI) from April 1, 2012 through May 1, 2012 indicated that the CRBUD operated the repump stations infrequently, and for durations that did not provide adequate turnover. The AWWA document titled "*Guidance Manual for Maintaining Distribution System Water Quality*" recommends a 2.5-day turnover rate, which is equal to a 40 percent turnover per day. The CRBUD's current operating practice does not achieve this recommended turnover rate. Ensuring that about 50 percent of the tank contents are pumped out each day is recommended to minimize water age and reduce the potential for nitrification.

9.5.4 Assessment of Repump Station Failures

The EPS water distribution system hydraulic model was utilized with each repump station removed from service, one at a time, to assess the impact of a repump station failure on the ability of the existing infrastructure to still meet the maximum day demand in the current year through year 2030. The model indicated that the capacity of the existing infrastructure was adequate to supply the maximum day demand from the current year through the year 2030. Thus, no capacity based improvements are recommended for the repump stations.

9.5.5 Available Fire Flow

The model's steady-state fire flow "engine" was used to determine the available fire flow that can be supplied to each pipe junction under year 2030 maximum day demand conditions while maintaining a minimum pressure of 25 psi. The water distribution system model results indicate the following:

- Available fire flow was a minimum in the Gramercy Park area (southwest corner of the service area) – ranging from about 1,000 to 1,500 gpm – and progressively increased to about 3,500 gpm at the WTP;
- Available fire flow was a minimum where the water piping dead-ends at the finger isles on the western side of Singer Island between Morse Boulevard and Pine Point Road – ranging from about 1,000 to 1,500 gpm – and progressively increased to about 3,500 gpm at the WTP; and
- Available fire flow was a minimum in the he commerce district bound by I-95 on the west, the C-17 canal on the east, Silver Beach Road on the south and Consumer Street on the north – ranging from about 1,000 to 1,500 gpm – and progressively increased to about 3,500 gpm at the WTP.
- The commerce district bound by I-95 on the west, the C-17 canal on the east, Silver Beach Road on the south and Consumer Street on the north
- The available fire flow was higher than the minimum acceptable presented in **Table 9.6**.

9.5.6 Specific Location Large Fires

The EPS model was utilized to predict overall system response during the fire events at specific locations (see Subsection 9.4.3.2) during year 2030 maximum day conditions. The model results indicate that infrastructure improvements are needed. The following summarize the recommended improvements relative to fires scenarios at the noted specific locations:

- North Singer Island Large Water Main: Construct about 5,800 feet of new 12-inch diameter pipe via open-cut construction starting at the NSI Repump Station and terminating at the northern end of Singer Island. Interconnect proposed pipe with the existing piping at strategic locations.
- Port of Palm Beach Water Main: Construct about 4,000 feet of new 12-inch diameter pipe via open-cut construction from the existing interconnect with the City of West

Palm Beach, north along Federal Highway (or adjacent to Federal Highway at an appropriate location) to East 11th Street. Continue the new pipe east on East 11th Street to interconnect with the existing water piping.

- Blue Heron Boulevard Water Main Extension: Construct about 1,600 feet of new 12-inch diameter pipe via open-cut construction to parallel the existing 12-inch water main running east to west along W. Blue Heron Boulevard between the Veterans Hospital and Military Trail. A temporary construction easement is likely needed. It may be feasible to obtain this easement at the vacant property at parcel number 56424225410000020.

- Water Main Extension between Prospect Avenue and Investment Lane: Construct about 3,000 feet of new 10-inch diameter pipe via open-cut construction (parallel with I-95) to interconnect the existing 10-inch diameter water main that runs east to west along Prospect Avenue and the existing 8-inch diameter water main at the intersection of Investment Lane and I-95. This route requires one aerial crossing of the canal (canal name and owner unknown). Also interconnect the new 10-inch diameter pipe with the existing dead-end 8-inch diameter water main running east to west along Fiscal Court. The new pipeline would require permanent easements at the following parcels: 56434230240000010, 56434219100000091 and 56434219100000100.

- Silver Beach Road Water Main Connection on West Side of C-17 Canal: Construct about 300 feet of new 12-inch diameter pipe via open-cut construction to interconnect the existing 16-inch diameter water main running east to west along Silver Beach Road with the existing 10-inch diameter water main running north to south along western edge of the C-17 canal. The new pipeline may require permanent easements at the following parcels: 00434219000001050 and 00434230000001040.

- Silver Beach Road Water Main Connection on East Side of C-17 Canal: Construct about 300 feet of new 10-inch diameter pipe via open-cut construction to interconnect the existing 16-inch diameter water main running east to west along Silver Beach Road with the existing 8-inch diameter water main running east to west along Sagewood Court. The new pipeline will require permanent easements at the following parcel numbers: 56434230290020000 and 56434230290011800.

- Gramercy Park Water Main Improvements: Construct about 7,500 feet of new 12-inch diameter pipe via open-cut construction starting at an interconnection with the existing 10-inch diameter water main located at the intersection of Military Trail and Canterbury Drive South and then going south along Military Trail to 45th Street and continuing west along 45th Street to Haverhill Road North and continuing north along Haverhill Road North to approximately the intersection of Haverhill Road North and the canal located south of Canterbury Drive South. At the intersection of Haverhill Road North and the canal (located south of Canterbury Drive South) interconnect the proposed pipe with the existing 16-inch diameter water main and the existing 12-inch diameter water main. Additionally, interconnect the proposed water main with the existing 8-inch water main near the Bobcat of Palm Beach property, the existing 10-inch water main near the intersection of Haverhill Road North and Pat Place, and the 10-inch water main near the intersection of Haverhill Road North and Caribbean Boulevard. The new pipeline will likely require a permanent easement at parcel number 4424302000001070.

- Emergency Response Plan to Open Interconnects: The water distribution system hydraulic model results indicate that opening up the interconnect with the City of Seacoast Utilities would likely be beneficial if there is a large fire at in the northwest quadrant of the service area. The water distribution system hydraulic model results also indicate that opening up the interconnect with the City of West Palm Beach would likely be beneficial if there is a large fire at the Port of Palm Beach. It is recommended that an emergency response plan be written that describes the actions the CRBUD staff would take to open these interconnects during large scale fires.

9.5.7 Water Age

The EPS model was utilized to predict water age when the existing infrastructure is operating under year 2012 annual average day demand conditions. The model results indicate that water age was 96 hours or more in the following areas:

- Southwest quadrant of the service area (generally the area south of the Bee Line Highway);
- The Port of Palm Beach area; and
- The commerce district bound by 1-95 on the west, the C-17 canal on the east, Silver Beach Road on the south and Consumer Street on the north.

The model results also indicate that the five existing automatic flushing devices (see Section 3, titled “Summary of Existing Facilities”, for additional information on the location and operating parameters of the flushing devices) appeared to provide minimal reduction in water age.

The following summarize recommended improvements to reduce water age:

- Port of Palm Beach Water Main: Same project as described in Subsection 9.5.6.

- <u>Avenue P Water Main</u>: Construct about 2,500 feet of new 8-inch diameter pipe via horizontal directional drilling (HDD) construction (to get under the Avenue S Rail spur) to complete the loop starting at the dead-end located on Sam Cooper Way (at the south end of the Rinker site) continuing east and connecting to the existing dead end pipe located on Avenue P. Easements would likely be required at parcels: 56434232430020000 and 56434232290000060.

- <u>Florida Power and Light Water Main Extension</u>: Construct about 800 feet of 8-inch diameter pipe via open-cut construction to complete loop. An easements would likely be required at parcel 56424236080010000.

- <u>Military Trail to FPL Water Main Extension</u>: Construct about 1,500 feet of new 10-inch diameter pipe via open-cut construction to interconnect the existing 10-inch pipe running north to south along Military trail with the existing 8-inch diameter pipe located on the southwest corner of the Florida Power and Light property (parcel # 56424236190010000). The proposed pipe route would likely include two canal crossings. The new pipeline would likely require easements at the following parcels: 56424236000005010, 56424236000005060, 56424236240000010, and 56424236190010000.

- <u>Port W Blvd Pipeline Extension</u>: Construct about 400 feet of new 10-inch diameter pipe via open-cut construction to interconnect the existing 10-inch pipe running north to south along Military trail with the existing 6-inch diameter pipe running east-west along Port W Blvd. Additionally, parallel the 500 foot segment of existing 8-inch pipe that runs north to south along Military trail near Port W Blvd with 600 of new 10-inch pipe (open-cut construction) and interconnect with the existing 10-inch on Military Trail at the north and south ends of the existing 8-inch diameter segment.

- <u>Water Main Extension between White Drive and 42nd Terrace North</u>: Construct about 1,400 feet of new 8-inch diameter pipe via open-cut construction to interconnect the existing dead end 8-inch diameter pipes between White Drive and 42nd Terrace North. The new pipeline would likely require easements at the following parcels: 56424236020030012 and 56424236320000000.

- <u>Water Main Extension between 49th Terrace North and Barbour Road</u>: Construct about 1,800 feet of new 8-inch diameter pipe via open-cut construction to interconnect the existing dead end 8-inch diameter pipes between 49th Terrace North to Barbour Road. The new pipeline would likely require permanent easements at the following parcels: 56424225000007120, 56424225000007230, 56424225000007060, 56424225000007200, and 56424225390020020.

- <u>Military Trail Water Main Improvements</u>: Construct about 200 feet of new 8-inch diameter pipe via open-cut construction to interconnect the existing dead-end 8-inch diameter water main on the west side of Military Trail that terminates near Dolphin Tire and the existing 12-inch diameter water main on the east side of Military Trail. A temporary construction easement is likely needed. It may be feasible to obtain this easement at the vacant property at parcel number 56424225410000050.

- Leo Lane Water Main Extension: 800 feet of new 8-inch diameter pipe via open-cut construction to interconnect the existing dead-end 8-inch diameter water main running east to west along Leo Lane (terminating on the west side of I-95) and the existing 16-inch diameter water main running east to west along the canal. It is assumed that the existing 16-inch diameter water main is on the south side of the canal. The new pipeline would require a permanent easement at parcel number 56424225000001270.

- Water Main Extension between Prospect Avenue Investment Lane: Same project as described in Subsection 9.5.6.

- Silver Beach Road Water Main Connection on West Side of C-17 Canal: Same project as described in Subsection 9.5.6.

- Silver Beach Road Water Main Connection on East Side of C-17 Canal: Same project as described in Subsection 9.5.6.

9.5.8 Failure of Intracoastal Waterway Crossings

There are two existing subaqueous water mains that cross the Intracoastal Waterway to Singer Island. The northern most existing Intracoastal Waterway crossing is a 14-inch diameter water main; this pipe was constructed in the 1950s. The existing 14-inch pipe crosses at about Silver Beach Road (on the mainland side) and Pine Point Road (on the Singer Island side). The second existing Intracoastal Waterway crossing is a 16-inch diameter water main; this pipe was also constructed in the 1950s. The existing 16-inch pipe crosses the Intracoastal Waterway at Blue Heron Boulevard.

The EPS model was used to assess the failure of either of the Intracoastal Waterway crossings under year 2012 and year 2030 maximum day demand conditions. The model results indicate that if the existing 14-inch diameter Intracoastal Waterway crossing fails then the existing 16-inch crossing can supply water to Singer Island and meet the minimum 35 psi pressure criterion under both year 2012 and year 2030 maximum day demand conditions. If the existing 16-inch diameter Intracoastal Waterway crossing fails then the existing 14-inch crossing cannot maintain the pressure on Singer Island above 35 psi under both year 2012 and year 2030 maximum day demand conditions.

The following improvement is recommended to reduce the risk associated with a failure of the existing 16-inch diameter water main Intracoastal Waterway Crossings:

- 16-inch Intracoastal Waterway Crossing Water Main: Construct about 4,000 feet of new 16-inch diameter pipe via HDD plus 1,500 feet of new 16-inch diameter pipe via open cut. The new pipe should parallel the existing 16-inch diameter pipe. Valves should be added to remove the existing 16-inch pipe from service while the new pipe is in service. After the new pipe is in service the old pipe should be removed from service (to ensure that water quality is not affected by an increase in water age) but remain serviceable as a redundant backup water main. This project should be implemented as soon as possible due to the age of the existing 16-inch diameter pipe.

The following improvement is recommended to reduce the risk associated with a failure of either of the Intracoastal Waterway water main crossings:

- Intracoastal Waterway Crossing Failure Emergency Response Plan: Prepare a written emergency response plan that identifies the actions the CRBUD would take in the event of a failure of either of the existing (or proposed) water main Intracoastal Waterway crossings. Failures could potentially be caused by age of the pipe, accidental impact, or accident during the construction of the proposed water main Intracoastal Waterway crossing. The emergency response plan should be prepared by a consultant with expertise in writing emergency response plans that addresses marine pipeline failures. The emergency response plan should include the following:
  - Failure Modes: An analysis of potential failure modes along with the description of how each particular failure would be repaired;
  - Contingency Materials: Identify contingency materials for procurement or which may already be in inventory (such as repair couplings);
  - Contingency Resources: Identify contingency resources such as diesel generators, lights, barricades, contract with divers, etc.;
  - Public Notification: This subsection of the plan would describe a program for disseminating information to the local news media. This subsection would identify personnel to participate in a Crises Communication Team, provide pre-prepared news releases and policies relative to public communications.
  - Agency Notification: This subsection of the plan would provide procedures for notifying the United State Environmental Protection Agency, Florida Department of Environmental Protection, and other agencies of an occurrence that requires regulator notification.
  - Emergency Flow Control Plan: This subsection of the plan would describe methods for minimization of water demand in the CRBUD service area –

especially Singer Island – resulting in reduced flow through the remaining existing Intracoastal Waterway crossing(s).

- Emergency Repair Plan: This subsection of the plan would describe the materials, methods and actions to be taken to repair a leaking or failed pipe.
- Response Administration: This subsection of the plan would identify the management team responsible for administering and managing the implementation of the emergency response plan.
- Preparedness Training: This subsection of the plan would describe training for personnel involved in plan management, oversight and response.
- Emergency Monitoring: This subsection of the plan would describe sampling, analysis, and reporting procedures that would be performed in the event of a pipe failure.

9.5.9 Failure of C-17 Canal Crossings

The existing water distribution system crosses the C-17 canal at three locations. The locations of the crossings are as follows:

- 16-inch ductile iron pipe subaqueous crossing of C-17 canal at Silver Beach Road;
- 12-inch ductile iron pipe subaqueous crossing of C-17 canal at Blue Heron Boulevard; and
- 14-inch ductile iron pipe aerial crossing of C-17 canal at Dr. Martin Luther King Boulevard.

The EPS model was utilized to assess the impact of failure of these critical canal crossings under year 2012 and 2030 maximum day demand conditions. The model results indicate that no infrastructure improvements are needed. However, failure of the 16-inch ductile iron pipe subaqueous crossing of the C-17 canal at Silver Beach Road causes the pressure in the southwest quadrant of the CRBUD service area to drop to less than 35 psi. The model results indicate that this low pressure could be resolved by stopping tank filling and stopping the operation of the automated flushing devices until repairs are made.

9.5.10 High Service Pumping Capacity

As indicated in Section 3 (titled "Summary of Existing Facilities"), the WTP has seven high service pumps with a capacity of 25,000 gpm with all pumps in service. The firm pumping capacity with the single largest pump out of service is 21,000 gpm. The firm pumping capacity is equivalent to 30 mgd. The AADF water demand is 8.7 mgd in the year 2030. As described in Section 5 (titled "Water Demand Forecast") of this report, the peak hour is 1.7 time the AADF. Thus, the peak hour water demand would amount to about 15 mgd. Hence, it is concluded that firm high service pumping capacity exceeds the forecasted future need.

As a cost saving measure, the CRBUD may want to consider reducing high service pumping capacity when replacing the high service pumps (from a renewal and replacement standpoint).

9.5.11 Assessment of a New Repump Station in Gramercy Park

The EPS model was used to assess the need and the impact of a new one MG ground storage tank and repump station in the southwest part of the distribution system. Based on discussion the CRBUD staff, the proposed tank and pump station matched the existing tank and pumps at Avenue U repump. The location of the proposed facility was at the old "System 2" site located west of Haverhill Road and north of Caribbean Boulevard (Parcel No. 00424302010120020).

From a pressure perspective, the model results indicate that the repump station is not needed. From a fire flow perspective, the proposed repump station provides negligible benefit. From a water quality perspective, the water age would increase in the Gramercy Park area, likely resulting in reduced water quality. A new water storage tank and repump station in the Gramercy Park area is not recommended.

9.5.12 Recommended Capacity and Water Quality Improvements

The capacity and water quality improvement needs – identified utilizing the water distribution system hydraulic model – are described in the subsections above. **Table 9.10** aggregates the improvement recommendations presented above into projects and assigns project numbers to each for tracking purposes. The table also categorizes the projects as either capacity or water quality related. Certain projects fall into both categories.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

Figure 9-3 illustrates the location of the improvements listed in **Table 9.10**.

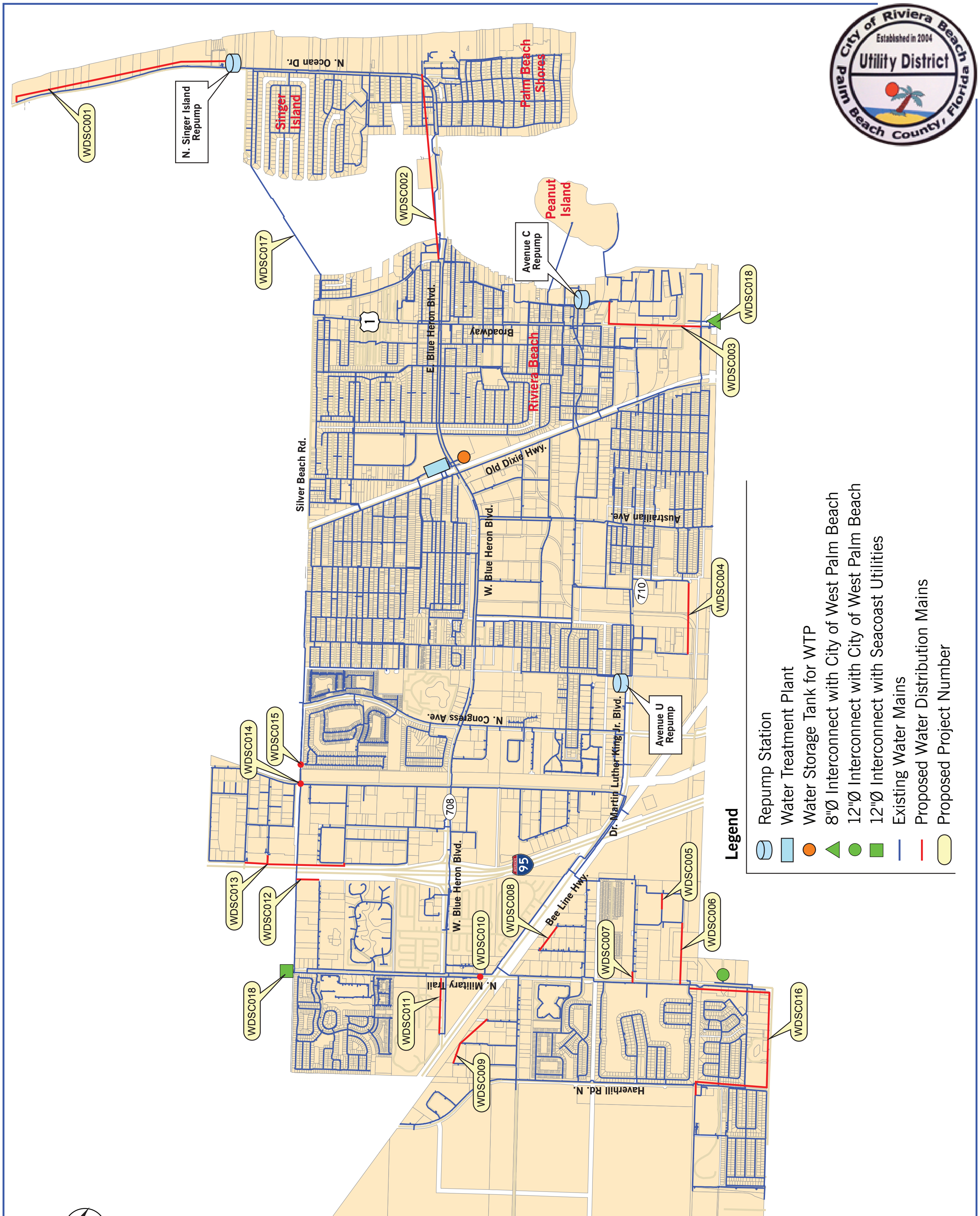

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Figure 9-3
Water Distribution System
Recommended Capacity and Water Quality Improvements

HAZEN AND SAWYER
Environmental Engineers & Scientists

Table 9.10
Capacity and Water Quality Improvement Projects
Water Distribution System

Project No.	Project Name	Category: Capacity	Category: Quality	Project Description
WDSC001	North Singer Island Large Water Main	X		Design and construct about 5,800 feet of new 12-inch diameter pipe via open-cut construction
WDSC002	16-inch Intracoastal Waterway Crossing Water Main	X		Design and construct about 4,000 feet of new 16-inch diameter pipe via HDD plus about 1,500 feet of new 16-inch diameter pipe via open-cut construction
WDSC003	Port of Palm Beach Water Main	X	X	Design and construct about 4,000 feet of new 12-inch diameter pipe via open-cut construction
WDSC004	Avenue P Water Main		X	Design and construct about 2,500 feet of new 8-inch diameter pipe via HDD construction
WDSC005	Florida Power and Light Water Main Extension		X	Design and construct about 800 feet of 8-inch diameter pipe via open-cut construction
WDSC006	Military Trail to FPL Water Main Extension		X	Design and construct about 1,500 feet of new 10-inch diameter pipe via open-cut construction
WDSC007	Port W Blvd Pipeline Extension		X	Design and construct about 400 feet of new 10-inch diameter pipe via open-cut construction
WDSC008	Water Main Extension between White Drive and 42nd Terrace North		X	Design and construct about 1,400 feet of new 8-inch diameter pipe via open-cut construction
WDSC009	Water Main Extension between 49th Terrace North and Barbour Road		X	Design and construct about 1,800 feet of new 8-inch diameter pipe via open-cut construction
WDSC010	Military Trail Water Main Improvements		X	Design and construct about 200 feet of new 8-inch diameter pipe via open-cut construction
WDSC011	Blue Heron Boulevard Water Main Extension	X		Design and construct about 1,600 feet of new 12-inch diameter pipe via open-cut construction
WDSC012	Leo Lane Water Main Extension		X	Design and construct about 800 feet of new 8-inch diameter pipe via open-cut construction
WDSC013	Water Main Extension between Prospect Avenue Investment Lane	X	X	Design and construct about 3,000 feet of new 10-inch diameter pipe via open-cut construction
WDSC014	Silver Beach Road Water Main Connection on West Side of C-17 Canal	X	X	Design and construct about 300 feet of new 12-inch diameter pipe via open-cut construction

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Table 9.10 (Continued)
Capacity and Water Quality Improvement Projects
Water Distribution System

Project No.	Project Name	Category		Project Description
		Capacity	Capacity	
WDSC015	Silver Beach Road Water Main Connection on East Side of C-17 Canal	X	X	Design and construct about 300 feet of new 10-inch diameter pipe via open-cut construction
WDSC016	Gramercy Park Water Main Improvements	X		Design and construct about 7,500 feet of new 12-inch diameter pipe via open-cut construction
WDSC017	Intracoastal Waterway Crossing Failure Emergency Response Plan	X	X	Retain a consultant to write an emergency response plan that addresses what the CRBUD would do if either of water mains crossing the Intracoastal Waterway fails
WDSC018	Emergency Response Plan to Open Interconnects	X		Retain a consultant to write an emergency response plan that addresses what the actions the CRBUD staff will take to open the interconnects with other utilities during a large scale fire

9.5.13 Routing Studies

The routes for the above described pipeline projects are preliminary and based on limited conceptual level planning. For each of the pipeline projects described above (where length and/or complexity dictate), a detailed routing study is recommended. Each routing study should include the following:

1. Identification of alternative routes (based upon discussion with CRBUD staff);
2. Recommended pipeline design criteria relative to material, wall thickness, joints, valves, etc.;
3. Determination of existing utilities along routes;
4. Recommended methods of pipeline installation within right of ways and easements;
5. Identification of canal and/or railroad crossings;
6. If a proposed route includes HDD or jack and bore then assess the following:
    a. Feasibility of HDD or jacking routes and depths based on discussion with contractors;
    b. Identification of temporary easement needs for HDD or jacking equipment; and

c. Feasibility of HDD or jacking relative to impact on existing underground utilities.

7. Determination of temporary and permanent easements needed each route;

8. An assessment of the likelihood of obtaining the identified easements (based upon CRBUD discussion with property owners);

9. Description of permitting requirements;

10. Development of conceptual drawings that identify the location of known contamination sites along each pipe route; and

11. Budgetary construction costs of alternative routes.

The routing study should be prepared in advance of beginning a detailed design and should be documented in a report.

9.6 Improvements Currently Underway

There are currently no major ongoing water distribution system improvements in design or construction.

9.7 Regulatory Driven Improvement Needs

9.7.1 Introduction

A key element of a Master Plan is identification of capital improvement needs that are required for compliance with existing regulations along with potential capital improvement needs for compliance with anticipated regulations. This subsection includes recommendations for capital improvement projects for the CRBUD's distribution system to maintain compliance with existing and anticipated future regulations.

This subsection is based, in-part, upon the findings of the report titled "*Water System Regulatory Review Report"* (dated August 30, 2011, issued by C Solutions), along with a synthesis of data collected during development of the Master Plan. The "*Water System Regulatory Review Report*" provided a detailed evaluation of the CRBUD's water distribution system's compliance with current regulations along with an assessment of compliance requirements for anticipated future regulations.

Key findings of the "*Water System Regulatory Review Report"* are summarized in the following subsection. Later subsections of this report provide recommended capital improvements

9.7.2 Existing Regulations

9.7.2.1 Compliance with Existing Regulations

The "*Water System Regulatory Review Report*" indicates that the CRBUD is in compliance with all existing drinking water regulations with the exception of reported low total chlorine residual in its distribution system as described in the following subsection.

9.7.2.2 Consent Order for Low Chlorine Residual in Gramercy Park

The CRBUD uses chloramine for disinfection of the water distribution system. Historical total chlorine residual data (from 2006 to 2010) measured at 40 locations throughout the service area indicated that the required minimum total chlorine residual (i.e., 0.6 mg/L) is maintained throughout the system. However, sampling conducted by the Palm Beach County Health Department (PBCHD) in the summer of 2010 found low total chlorine residual (less than 0.6 mg/L) in the Gramercy Park region of the service area. Gramercy Park is located at the southwest perimeter of the CRBUD service area. Follow-up sampling by the PBCHD indicated continued low total chlorine residuals at the Gramercy Park area. Chlorine residual testing at the WTP indicates total chlorine residual at the entry point to the distribution system in the 3.1 to 3.9 mg/L range. These data indicate that there is a chlorine demand within the distribution system, possibly caused by nitrification.

CRBUD received a consent order from the PBCHD in a letter dated December 23, 2010 for a failure to maintain a minimum combined chlorine residual of 0.6 mg/L throughout the drinking water distribution system per Rule 62-555.350(6) of the FAC.

Under this consent order the CRBUD is required to prepare and submit the results of the following:

1. A semi-annual chlorine burn in the system
2. A hydraulic study of the system
3. Surveillance monitoring to include weekly total coliform samples in the troubled areas
4. Additional flushing within the system in troubled areas

The CRBUD has been working to resolve low chlorine residual issues and currently performs three hours of nightly flushing at three fire hydrants within Gramercy Park and has increased superchlorination (i.e., switching to free chlorine while flushing hydrants over a two week period) of the distribution system from one to two times per year.

9.7.2.3 Water Quality Measurements

Water quality data (including pH, conductivity, nitrite, nitrate, total chlorine, free chlorine, total ammonia, temperature and heterotrophic plate count) were collected daily from May 7, 2012 through May 10, 2012, plus May 15, 2012 and May 16, 2012 at the repumping stations and the WTP. At the repump stations the sample was taken from the tank; the high service pump discharge was sampled at the WTP. **Table 9.11** presents the free and total chlorine residual data collected.

Table 9.11
Free and Total Chlorine Residuals

Location	Free Chlorine Residual / Total Chlorine Residual (mg/L)					
	5/7/2012	5/8/2012	5/9/2012	5/10/2012	5/15/2012	5/16/2012
WTP	2.6 / 3.3	2.5 / 3.3	1.7 / 3.4	2.4 / 3.1	3.2 / 3.9	2.8 / 3.2
Ave C Repump	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2
Ave U Repump	0.3 / 0.5	0.2 / 0.4	0.5 / 1.1	0.3 / 0.6	0.3 / 0.6	0.3 / 0.5
NSI Repump	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2	< 0.2 / < 0.2

The above data are indicative of poor water quality in the repump station water storage tanks. Florida Department of Environmental Protection (FDEP) rule 62-555.350(6) of the FAC requires a minimum combined chlorine residual (i.e., total minus free) of 0.6 mg/L throughout the drinking water distribution system (for systems disinfecting via chloramination). The total chlorine residual at Avenue C Repump and NSI Repump water tanks was less than 0.2 at each measurement; these data would likely be considered violations of Rule 62-555.350(6) by FDEP.

When the CRBUD detects future low chlorine residual in its water tanks it is recommended that the CRBUD do the following:

- Remove the tank and repump station from service;
- Drain the tank to disposal;
- Chlorinate the tank per AWWA C652 titled "Standard for Disinfection of Water-Storage Facilities";
- Drain the highly chlorinated water to disposal;
- Fill the tank with potable water;
- Perform bacteriological clearance testing as required by the local health department; and
- If the bacteriological clearance testing is acceptable, return the tank to service.

To attempt to resolve the issues associated with the low total chlorine residual, the following improvements are recommended:

- Unidirectional flushing;
- Adding secondary disinfection at the Avenue U repump;
- Repump station operating strategy changes (to improve tank turnover);
- Implement a water quality testing program; and
- Automated water quality monitoring.

These improvements are described in the following subsections.

9.7.2.4 Unidirectional Flushing

The CRBUD uses chloramine for disinfection of the water distribution system. Chloramine disinfection is typical for South Florida utilities; it minimizes the formation of disinfection by-products that result when using a free chlorine disinfection strategy.

Total chlorine residual of 1.0 mg/L or less likely indicates a problem in the water distribution system. A number of factors can contribute to a total chlorine residual of 1.0 mg/L or less in the water distribution system, as follows:

- Improper operation of the disinfection system at the WTP such that at certain times the WTP conveys chloraminated water into the distribution system and at other times conveys free chlorinate water into the distribution system (resulting in mixing of chlorinated and chloraminated water in the distribution system);
- High water age;
- Sediments and debris in the water distribution system piping;
- Biological slime and microbial growth in the water distribution system piping;

Low total chlorine residual (less than 1.0 mg/L), in systems utilizing chloramine disinfection, leads to the availability of free ammonia, and can result in nitrification. Nitrification is the biological oxidation of ammonia in the presence of oxygen to nitrite and then nitrate (in a two-step process involving two different bacteria). The oxidation of ammonia to nitrite is done by the genus Nitrosomonas and other bacteria. The second step (oxidation of nitrite to nitrate) is done mainly by the genus Nitrobacter. The nitrifying bacteria are autotrophic, using carbon dioxide as their carbon source, resulting in lower alkalinity and pH.

The levels of total chlorine detected in Gramercy Park suggest that nitrification may be occurring in the CRBUD's distribution system, which would tend to lower the total chlorine residual. Additionally, based on experience with other utilities, it is speculated that sediment and biological slime may have accumulated in the CRBUD's water distribution system (which would tend to lower the total chlorine residual).

If the above speculation is correct, an aggressive program of distribution system flushing coincident with superchlorination could reduce the occurrence of nitrification. During superchlorination the CRBUD switches disinfection from chloramine to free chlorine. The free chlorine enhances removal of biological growth within the system. The CRBUD currently implements superchlorination and flushing over a two week period, twice per year. The flushing is a "general flushing" accomplished by progressively opening fire hydrants, starting near the WTP and then moving outward in the distribution system. It is noted that a well performed "general flushing" of the system can be effective, but typically requires approximately 60 percent more turnover of water, resulting in higher water usage and operational cost (relative to unidirectional flushing which is described below).

Unidirectional flushing (UDF) involves opening and closing valves within the pipe network to enhance flushing velocities by isolating certain segments of the pipe network. A successful UDF requires detailed planning to define the order in which pipes are to be flushed, hydrants opened, and isolation valves opened and closed.

It is recommended that the CRBUD implement a UDF program twice per year concurrent with superchlorination. The UDF would likely be effective in flushing sediments and biological slime that may be within the CRBUD's water mains, thus improving water quality and helping maintain chlorine residuals.

Development and execution of a UDF plan requires a detailed understanding of the pipe network, operational status of in-line valves, and the ability to isolate sections of the system. The development of the UDF planning document requires use of an EPS type hydraulic model of the water distribution system as a prerequisite. The UDF planning document defines the steps to follow to perform a complete unidirectional flushing of the potable water distribution system. If desired, CRBUD can retain the UDF plan developer to provide field crews to perform the first field execution of the UDF program at an additional cost.

9.7.2.5 Secondary Disinfection System at Avenue U Booster Pump Station

Based on the findings of the "*Water System Regulatory Review Report*", CRBUD has failed to maintain a minimum combined chlorine residual of 0.6 mg/L (per Rule 62-555.350(6), FAC) in the southwestern portion of its water distribution system. This region of the service area is known as Gramercy Park.

The CRBUD performed an evaluation of the existing secondary disinfection systems along with a desktop study of the secondary disinfection approaches in order to recommend capital improvements likely to achieve higher total combined chlorine residual in the distribution system. The findings of this study are summarized in a report titled "*Secondary Disinfection System Evaluation"*, dated July 30, 2011 prepared by C Solutions. This report recommended that a new gaseous chlorination system with controls be installed at the Avenue U Repump Station (westernmost existing repump station). These improvements would add chlorine to combine the free ammonia to increase disinfectant residual (chloramine) and remove free ammonia (which likely acts as a catalyst for nitrification and subsequent rapid reduction of the distribution system disinfectant residual).

The recommended secondary disinfection system is described in detail in the "*Secondary Disinfection System Preliminary Design Report"*, dated May 10, 2012 prepared by C Solutions. For convenience, the improvements recommended in that report are summarized in the following paragraph.

Chlorine solution would be fed to one of two chemical injection points. Each injection point would consist of the chemical injection point (chlorine solution), an ammonia sample point (sample water feed to the ammonia analyzer), and a flow meter with a transmitter (sends flow signal to PLC located in repump station building). Injection Point No. 1 would be the primary chemical injection point and would be located on the 12-inch fill line prior to the ground storage tank. Injection Point No. 2 would be used as the secondary chemical injection point and would be located on the 12-inch repump station pump discharge. The existing venturi meter located on the repump station discharge water main would be utilized to provide a flow signal to the PLC for utilization of Injection Point No. 2.

The secondary disinfection system at the Avenue U Repump station would provide the following new equipment:

- Gas chlorinator and eductor
- Two chlorine injectors
- Two automatic switchover vacuum regulators (500 ppd)
- Dual chlorine cylinder scales with digital indication
- Chlorine gas detector
- Booster water pump
- Residual free ammonia analyzer (indoor mounting)

- Flow meter with transmitter (magnetic flow meter)
- Primary Logic Controller (PLC)
- Emergency eyewash and shower
- Emergency self contained breathing apparatus

The CRBUD is planning on replacing chlorine gas at the WTP with sodium hypochlorite. Therefore, it is recommended that the CRBUD consider adjusting the above described plan and use a sodium hypochlorite type of system in lieu of chlorine gas at the repump station. A variety of sodium hypochlorite technologies are available in sizes suitable for a water repumping station.

9.7.2.6 Repump Station Operating Strategy Changes

Based upon discussions with operations staff relative to the operating strategy for the repump stations, the repump stations are operated in a manner that provides little turnover of the water in the ground storage tanks, resulting in high water age. High water age contributes to the occurrence of nitrification and resultant degradation of chloramine residual.

It is recommended that the CRBUD retain a control system integrator to modify the operating strategy at the repump stations to automate tank filling and pumping to ensure that half of the tank contents are pumped out each day. This may not be feasible at Avenue C Repump – while also filling the tank to full capacity – due to the size of the tank and the capacity of the pumps. Consequently, it is recommended that the CRBUD consider “short filling” the Avenue C tank (e.g., only fill it to 50 percent of capacity) to facilitate adequate turnover.

Assessing the cost for implementation of repumping station operating strategy changes to reduce water age requires a more detailed study than that typical of a master planning effort. The scope of work for this Master Plan did not include the level of study needed to accurately assess the cost of implementing the recommended improvement. For the purpose of this Master Plan, a “placeholder” budget estimate will be assessed in Section 12 (titled “Opinion of Probable Project Costs”) of this report. The value presented in Section 12 should be considered a place holder and should be refined by the CRBUD based upon obtaining a quote from a control system integrator.

9.7.2.7 Water Quality Testing Program

It is recommended that the CRBUD collect samples from the Avenue C, Avenue U, NSI, and Blue Heron Boulevard water tanks along with the WTP high service pump station discharge and analyze the following parameters:

- pH
- Conductivity
- Nitrite (As N)
- Nitrate (As N)
- Total Chlorine
- Free Chlorine
- Monochloramine
- Free Ammonia (As N)
- Total Ammonia (As N)
- Water Temperature
- Heterotrophic plate count use R2A agar

It is recommended that these data be collected once per day for seven days, every six months.

9.7.2.8 Automated Water Quality Monitoring

Given the occurrence of low total chlorine residual in the CRBUD's water distribution system, installation of automated water quality monitoring panels at strategic locations within the distribution system is recommended. Implementation of this recommendation is likely warranted even if implementation of other recommended improvements resolves the low total chlorine residual issue in Gramercy Park. The parameters recommended for inclusion in an automated water quality monitoring panel are as follows:

- Water temperature
- Turbidity
- Total chlorine residual
- Monochloramine
- Free ammonia
- Total ammonia
- Conductivity
- pH
- Pressure

It is recommended that the water quality panels be equipped with communication equipment to transmit telemetry to the WTP. The WTP control system historian would have to be modified to log the data and provide historical trending graphs. Modification of the WTP control system to produce hard copies of automated weekly and monthly reports is recommended.

Installation of the water quality panels would require access to a water line for sampling, a drain for disposal of sample water, electrical power, and access to an appropriate means of communicating telemetry back to the WTP. Additionally, installation of the panel within a secure building owned by the CRBUD is preferable. However, installation of the panel outdoors is generally feasible. The system should be designed to cause an alarm to be activated at the WTP if the total chlorine residual drops below 1.5 mg/L.

The recommended locations for installation of the panels are as follows:

- Avenue C Repump (sample the pump station discharge)
- Avenue U Repump (sample the pump station discharge)
- NSI Repump (sample the pump station discharge)
- CRBUD Lift Station 19 (sample location to be determined during detailed design)
- CRBUD Lift Station 37 (sample the 8-inch diameter pipe along Caribbean Blvd.)
- CRBUD Lift Station 39 (sample location to be determined during detailed design)

The above recommended locations are preliminary and should be refined during detailed design to suit actual field conditions.

9.7.3 Anticipated Future Regulations

The CRBUD needs to prepare and submit a Stage 2 DBP Compliance Monitoring Plan prior to October 1, 2013. It is recommended that the CRBUD task one of its general engineering consultants to develop the Stage 2 DBP Compliance Monitoring Plan. It is recommended that the CRBUD set a budget of $20,000 (includes a 30 percent contingency) for creating this planning document.

The Water Research Foundation is currently implementing Project No. 4427; the objective of which is to develop a guidance manual and Web-based decision support tool to help small drinking water utilities achieve compliance with Stage 2 Disinfectant/Disinfection By-Product Rule. The CRBUD is a participant in this Water Research Foundation project. It is anticipated that the guidance manual and Web-based decision support tool will available in late 2012 or early 2013.

9.7.4 Recommended Regulatory Driven Improvements

Table 9.12 aggregates the regulatory driven type improvement recommendations presented above into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled “Project Implementation Plan”) of this Master Plan.

Table 9.12
Regulatory Driven Improvement Projects
Water Distribution System

Project No.	Project Name	Project Description
WDSREG001	Unidirectional Flushing (UDF) Plan	The levels of total chlorine detected in Gramercy Park suggest that nitrification may be occurring in the CRBUD's distribution system. Conducting UDF concurrent with superchlorination is a potential solution. Retain a consultant to develop a UDF Plan.
WDSREG002	UDF Field Assistance	Proper implementation of UDF requires specialized knowledge. Retaining a field crew from the UDF consultant to assist with the execution of the UDF is recommended.
WDSREG003	Secondary Disinfection System at Avenue U Booster Pump Station	Implement the secondary disinfection system at Avenue U Repump Station as described in detail in the "Secondary Disinfection System Preliminary Design Report".
WDSREG004	Repump Station Operating Strategy Changes	Retain a control system integrator to automate the operation of tank filling and pumping to ensure that 50 percent of the tank contents are pumped each day to minimize water age and reduce the likelihood of nitrification and resultant water quality reduction.
WDSREG005	Water Quality Testing Program	Collect water quality data once per day for seven days from the Avenue C, Avenue U, NSI, and Blue Heron Boulevard water tanks along with the high service pump station discharge. Collect data every six months. The data are needed to establish the occurrence of nitrification.
WDSREG006	Automated Water Quality Monitoring	Install automated water quality monitoring panels at six strategic locations in the distribution system to measure pH, conductivity, total chlorine residual (and other parameters) to infer when nitrification is occurring. Monitor and record the data at the WTP.
WDSREG007	Stage 2 DBP Compliance Monitoring Plan	Retain one of the CRBUD's general engineering consultants to develop the Stage 2 DBP Compliance Monitoring Plan.

9.8 Renewal and Replacement Improvement Needs

9.8.1 Introduction

All assets in the CRBUD's water and wastewater infrastructure have a limited lifespan. At the end of an asset's lifespan, the asset (e.g., pump, pipe, water tank, etc.) may fail resulting in loss of service. Depending on the failure mode and level of redundancy, the consequence of failure can range from a minor inconvenience to major disruption of customer service. Consequently, a key focus of this Master Plan was documenting the condition of existing infrastructure, assessment of the remaining useful life of major assets and recommending renewal and replacement (R&R) of major assets that are at or near the end of their useful life to ensure the continued reliability of the CRBUD's existing water and wastewater infrastructure over the next 20 years.

This subsection focuses on the R&R needs for the water distribution system. The two main components of the water distribution system are the repump stations and water distribution system piping and accessories such as valves, hydrants, customer meters, etc. The following subsections present the methodology used to plan for R&R needs along with a brief description of the recommended improvements.

9.8.2 Water Distribution System Piping Replacement

9.8.2.1 Introduction

In 2007, the USEPA published the "*Drinking Water Infrastructure Needs Survey and Assessment*" ("*Assessment*"). The purpose of the "*Assessment"* was to document the 20-year (2007 to 2027) capital investment needs of the public water systems in the United States. The "*Assessment"* estimated that $335 billion (in January 2007 dollars) would be needed nationally over the next 20 years for R&R of existing water infrastructure (including supply, treatment, distribution, and storage). About $201 billion (in January 2007 dollars) was estimated to be needed for R&R of water distribution infrastructure.

The magnitude of the above described estimate for water distribution system piping R&R reflects that much of the water piping in the United States is approaching the end of its useful life. If water piping is allowed to age to the point of failure, the result can be contamination of drinking water, loss of service, high costs both to replace the pipes (on an emergency basis which is more costly than on a planned basis), unforeseen costs resulting from property damage due to pipe failure, and potential loss of life in certain catastrophic failure modes. Hence, the CRBUD has decided that planning for water distribution system piping R&R needs is a critical element of this Master Plan.

The age and condition of buried piping are key attributes to assessing water distribution system piping R&R needs. Assessment of the condition of buried piping can be challenging and expensive. The CRBUD decided, for this Master Plan, that buried piping condition would not be physically evaluated. It was decided that a limited desktop assessment of the underground water distribution piping would be performed to determine the existing piping age and material based upon available records. Section 3 (titled "Summary of Existing Facilities") of this report summarizes the findings of existing pipe age and material assessment.

The following subsections present the recommended water distribution system R&R improvement needs.

9.8.2.2 Expected Useful Life of Water Piping

The expected useful life of water piping depends on numerous factors. These factors include material, fabrication, installation methods, operating conditions, corrosion, coatings, traffic loading, etc. A detailed analysis of these factors relative to the CRBUD's water piping was not feasible as part of this Master Plan. Rather, it was decided that the Master Plan would assess the expected useful life of piping based on a review of industry literature. **Table 9.13** summarizes the findings of a review of industry literature on the average useful life of piping by material.

Table 9.13
Expected Average Useful Life of Water Piping

Material (fabrication time frame)	Useful Life (years)	Source
Cast iron (late 1800s to about 1920)	120	AWWA, 2001. "Dawn of the Replacement Era".
Cast iron (1920s to 1950)	100	AWWA, 2001. "Dawn of the Replacement Era".
Cast iron & ductile iron (1950s to current)	75	AWWA, 2001. "Dawn of the Replacement Era".
Cement asbestos (1950s to current)	70	"Asbestos-Cement Pipe: A Special Report". Retrieved September 19, 2012 from http://www.chrysotile.com.
Galvanized Steel (1900s to current)	70	AWWA, 2012. "Buried No Longer: Confronting America's Water Infrastructure Challenge".
Polyvinyl Chloride (PVC) (1900s to current)	55	AWWA, 2012. "Buried No Longer: Confronting America's Water Infrastructure Challenge".
High Density Polyethylene (HDPE) (1955 to current)	100	Plastics Pipe Institute, 2010. "Oxidation and Polyethylene Piping Systems: A Closer Look".

9.8.2.3 Piping Replacement Recommendations

Using the average useful life estimates presented above and counting the years since the original installations provides an indication of the remaining useful life of the existing water distribution piping. For this Master Plan, it was assumed that all metal and cement asbestos piping in the CRBUD water distribution system that was installed in 1960 or earlier would reach the end of its useful life over the next 20 years and would need to be replaced. It was also assumed that all PVC pipe installed in 1970 or earlier would need to be replaced over the next 20 years.

It is recommended that the CRBUD plan for a pipeline replacement program to replace piping that is approaching the end of its useful life. The following presents a brief summary of the recommended pipeline replacement program scope.

- Asbestos Cement Pipe Replacement: Over the 20 year planning period, replace asbestos cement pipe installed in 1960 and earlier. It is recommended that the existing asbestos cement pipe that has reached the end of its useful life be replaced. For the purpose of estimating cost, ductile iron pipe with a cement mortar lining is assumed for the replacement piping. Based upon the available data, the estimated quantity of asbestos cement piping to replace – broken down by diameter – is as follows:
    - About 72,000 feet of 4-inch diameter piping
    - About 132,000 feet of 6-inch diameter piping
    - About 18,000 feet of 8-inch diameter piping
    - About 25,000 feet of 10-inch diameter piping
    - About 7,000 feet of 12-inch diameter piping
    - About 8,000 feet of 14-inch diameter piping
    - About 2,500 feet of 16-inch diameter piping
- Cast and Ductile Iron Pipe Replacement: Over the 20 year planning period, replace cast iron and ductile iron pipe installed in 1960 and earlier. It is recommended that the existing cast and ductile iron pipe that has reached the end of its useful life be replaced. For the purpose of estimating cost, ductile iron pipe with a cement mortar lining is assumed for the replacement piping. Based upon the available data, the estimated quantity of cast and ductile iron piping to replace – broken down by diameter – is as follows:
    - About 4,500 feet of 4-inch diameter piping
    - About 8,600 feet of 6-inch diameter piping
    - About 5,100 feet of 8-inch diameter piping
    - About 9,100 feet of 10-inch diameter piping
    - About 9,600 feet of 12-inch diameter piping
    - About 600 feet of 14-inch diameter piping
    - About 1,000 feet of 20-inch diameter piping
- Galvanized Steel Pipe Replacement: Over the 20 year planning period, replace galvanized steel pipe installed in 1960 and earlier. It is recommended that the existing galvanized steel pipe that has reached the end of its useful life be replaced. For the purpose of estimating cost, ductile iron pipe with a cement mortar lining is

assumed for the replacement piping. Based upon the available data, the estimated quantity of cast and ductile iron piping to replace – broken down by diameter – is as follows:

- About 10,800 feet of 4-inch diameter piping
- About 540 feet of 6-inch diameter piping

- PVC Pipe Replacement: Over the 20 year planning period, replace the PVC pipe installed in 1970 and earlier. It is recommended that the existing PVC pipe that has reached the end of its useful life be replaced. For the purpose of estimating cost, ductile iron pipe with a cement mortar lining is assumed for the replacement piping. Based upon the available data, the estimated quantity of PVC piping to replace – broken down by diameter – is as follows:

  - About 600 feet of 4-inch diameter piping
  - About 8,800 feet of 6-inch diameter piping
  - About 2,400 feet of 8-inch diameter piping
  - About 1,300 feet of 10-inch diameter piping
  - About 2,600 feet of 12-inch diameter piping

- 14-inch Intracoastal Waterway Crossing Pipeline Replacement: The existing 14-inch Intracoastal Waterway crossing pipe is at the end of its useful life. Replacement of the existing pipe via HDD is likely feasible. The feasibility of this option should be assessed further with qualified contractors. The basis for the opinion of probable project cost was assumed as construction of about 4,000 feet of new 14-inch diameter pipe via HDD plus 500 feet of new 20-inch diameter pipe via open cut. The feasibility of the replacement of the existing pipe via pipe burst cannot be determined at the Master Plan level of planning. Additionally, the feasibility of rehabilitation of the existing piping via lining cannot be determined at the Master Plan level of planning. It is recommended that the CRBUD consider conducting a study to assess the feasibility of available replacement and rehabilitation options; the study would likely indentify construction cost saving opportunities.

- Miscellaneous Pipe Replacement: To account for uncertainties and unplanned emergency repair needs, it is recommended that the CRBUD include a Miscellaneous Pipe Replacement line item in its R&R funding to repair failed pipes. It is assumed that the total quantity of pipe that would be replaced over the 20 year planning period is as follows:

  - About 25,000 feet of 6-inch diameter piping

- About 25,000 feet of 8-inch diameter piping
- About 25,000 feet of 10-inch diameter piping
- About 25,000 feet of 12-inch diameter piping

9.8.3 Backflow Preventer Replacement

Backflow preventers (which are also called cross-connection control assemblies) are required to prevent contamination from entering the water distribution system. Typically, backflow preventers are owned by the property owner that water is being supplied to. Based upon the CRBUD's GIS system, the CRBUD owns the backflow preventers listed in **Table 9.14**.

Table 9.14
Existing CRBUD Owned Backflow Preventers

Diameter (inches)	Type	Quantity
4	Reduced Pressure Zone	44
6	Reduced Pressure Zone	28
8	Reduced Pressure Zone	14
10	Reduced Pressure Zone	10

It is recommended that the CRBUD plan for replacing all of the CRBUD owned backflow preventers over the next 20 years. The opinion of probable cost for the overall backflow preventer replacement program will assume that the CRBUD staff will perform the planning, design, permitting, material procurement and installation of the replacement backflow preventers.

9.8.4 Fire Hydrant Replacement

Based upon the document titled "*Taking Stock of Your Water System, A Simple Asset Inventory for Very Small Drinking Water Systems"* published by the USEPA in 2004, the estimated average useful life of a fire hydrant is 40 years. For this Master Plan it is assumed that all fire hydrants installed in 1989 and earlier need to be inspected and either rehabilitated or replaced over the next 20 years.

Based on the known age distribution the existing fire hydrants presented in Section 3 (titled "Summary of Existing Facilities), there are 586 fire hydrants that were installed in 1989 or earlier. The fire hydrant installation date data in Section 3 also indicates that the date of installation of 337 fire hydrants is unknown. Based on the geographic location of the hydrants with unknown installation dates, it is speculated that they were installation in 1989 or earlier. Consequently, there are 923 fire hydrants that would likely be at the end of their useful life and would need to be replaced over the next 20 years.

It is recommended that the CRBUD inspect all fire hydrants in its system over a one year period. Water distribution system service providers, such as Wachs Water Services and Mueller Services Company could be retained for the inspections and can likely inspect 100 hydrants per month. Based upon the inspection findings, a program for repair and replacement over the next 20 years is recommended. For master planning purposes, replacement of 923 fire hydrants over the next 20 years is assumed.

9.8.5 Annual Large Water Meter Replacement

As indicated in Section 3 (titled "Summary of Existing Facilities") of this report, the CRBUD have determined that all existing large commercial water meters (4-inches and larger) need to be replaced with Automatic Meter Reading (AMR) type meters. There are no data available to the project team to determine the number and location of the large commercial water meters 4-inches and larger.

Based upon discussion with the CRBUD staff, an annual budget of $50,000 per year was established to implement a large water meter replacement program. The $50,000 budget should be considered a placeholder number. The CRBUD should refine this budget when information on the number, location, and age of water meters becomes available.

9.8.6 Automatic Flushing Device Replacement

The CRBUD currently has five automatic flushing devices in the distribution system. They were installed in 2010. The estimated average useful life of this type of equipment is 10 years. It is recommended that the CRBUD plan for replacement of the automatic flushing devices when they reach the end of their useful life.

9.8.7 Water Pressure Monitoring Station Replacement

As indicated in Section 3 (titled "Summary of Existing Facilities") of this report, the CRBUD currently has 17 water distribution system pressure monitoring stations. Each station is composed of the following:

- Pressure transmitter;
- Remote telemetry unit (and associated enclosure);
- Radio;
- Antenna; and
- Conduit and wire.

Based on experience, the average useful life of the above equipment is 15 years. Hence, it is recommended that the CRBUD plan for replacing all of its water distribution system pressure monitoring stations within the next 20 years.

9.8.8 Repump Station Rehabilitation

The project team conducted field investigation of the condition of major above ground distribution system assets at the Avenue C, Avenue U and NSI repump stations in late February 2012. The findings of the investigation for the repump stations are included in **Appendix B**. This subsection presents the recommendations based upon the findings of the investigation.

The repump stations asset condition investigation was limited to visual observation of the facilities and interviews with operations and maintenance staff regarding the performance, reliability, age, and condition of the existing equipment and structures. The key assets that were evaluated include the following:

- Tanks
- Pumps and Motors
- Aboveground Piping and Valves
- Hydropneumatic Tanks
- Flow Meters
- Chlorine System
- Air Compressors
- Fencing / Gates
- Doors, Windows, and Louvers
- Paint
- Main Power Breakers
- Emergency Power
- Automatic Transfer Switches
- Motor Control Centers (MCCs)
- Variable Frequency Drives (VFDs)
- Solid State Soft Starters
- Panelboards
- Lighting
- Field Instrumentation
- Control Panels
- Programmable Logic Controllers (PLCs)

Based upon the findings of the site investigation, it is recommended that the CRBUD plan on rehabilitation of the Avenue C and Avenue U repump stations within the next five years. It is also recommended that CRBUD plan on rehabilitation of the NSI repump station in about the year 2030. The following provides a brief summary of the proposed scope of rehabilitation. Refer to **Appendix B** for more detailed descriptions of rehabilitation needs.

- Avenue C Repump Station Rehabilitation: Within the next five years, rehabilitate the Avenue C repump station; a brief summary of the proposed rehabilitation scope follows:
  - Replace pumps, motors, valves, piping, controls, and electrical.
  - Site rehabilitation (such as repair fencing, painting, mill and resurface pavement, etc.).
  - Architectural rehabilitation (such as door, window and louver replacement).
- Avenue U Repump Station Rehabilitation: Within the next five years, rehabilitate the Avenue U repump station; a brief summary of the proposed rehabilitation scope follows:
  - Replace pumps, motors, valves, piping, controls, and electrical.
  - Site rehabilitation (such as repair fencing, painting, mill and resurface pavement, etc.).
  - Architectural rehabilitation (such as door, window and louver replacement).
- NSI Repump Station Rehabilitation: Plan for rehabilitating the NSI repump station by the year 2030. A brief summary of the proposed rehabilitation scope follows:
  - Replace pumps, motors, valves, piping, controls, and electrical.
  - Site rehabilitation (such as repair fencing, painting, mill and resurface pavement, etc.).
  - Architectural rehabilitation (such as door, window and louver replacement

9.8.9 Recommended Renewal and Replacement Improvements

Table 9.15 aggregates the R&R type improvement recommendations described above into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above for projects related to the replacement of piping, backflow preventers, fire hydrants, water meters, flushing devices, and pressure monitoring stations. **Appendix B** contains more detailed descriptions for the repump station replacement projects.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled “Project Implementation Plan”) of this Master Plan.

Table 9.15
Renewal and Replacement Projects
Water Distribution System

Project No.	Project Name	Project Description
WDSRR001	Asbestos Cement Pipe Replacement	Design and construct replacing asbestos cement pipe installed in 1960 and earlier.
WDSRR002	Cast and Ductile Iron Pipe Replacement	Design and construct replacing cast iron and ductile iron pipe installed in 1960 and earlier.
WDSRR003	Galvanized Steel Pipe Replacement	Design and construct replacing galvanized steel pipe installed in 1960 and earlier.
WDSRR004	PVC Pipe Replacement	Design and construct replacing the PVC pipe installed in 1970 and earlier.
WDSRR005	14-inch Intracoastal Waterway Crossing Pipeline Replacement	Design and construct about 4,000 feet of new 14-inch diameter pipe via HDD plus about 500 feet of new 20-inch diameter pipe via open-cut construction.
WDSRR006	Miscellaneous Pipe Replacement	This line item is a “placeholder” to establish a budget to account for uncertainties and unplanned emergency repair needs.
WDSRR007	Backflow Preventer Replacement	Replace CRBUD owned backflow preventers that are at the end of their useful life.
WDSRR008	Fire Hydrant Replacement	Replace 550 fire hydrants over the next 20 years.

Table 9.15 (continued)
Renewal and Replacement Projects
Water Distribution System

Project No.	Project Name	Project Description
WDSRR009	Annual Large Water Meter Replacement	Replace all existing large commercial water meters (4-inches and larger) with automatic meter reading type meters.
WDSRR010	Automatic Flushing Device Replacement	Replace automatic flushing devices that are at the end of their useful life.
WDSRR011	Water Pressure Monitoring Station Replacement	Replace the existing water pressure monitoring stations that are at the end of their useful life.
WDSRR012	Avenue C Repump Station Rehabilitation	Design and construct rehabilitation of the Avenue C repump station.
WDSRR013	Avenue U Repump Station Rehabilitation	Design and construct rehabilitation of the Avenue U repump station.
WDSRR014	NSI Repump Station Rehabilitation	Design and construct rehabilitation of the NSI repump station.
WDSRR015	MLK Road Construction (Phase C - Australian to Old Dixie)	CRBUD determined the scope and cost of this project in its Capital Improvement Plan approved in 2012. CRBUD opinion of probable cost for this project is $2,200,000.
WDSRR016	Silver Beach Road Improvements	CRBUD determined the scope and cost of this project in its Capital Improvement Plan approved in 2012. CRBUD opinion of probable cost for this project is $240,000.
WDSRR017	Utility Infrastructure in NSA	CRBUD determined the scope and cost of this project in its Capital Improvement Plan approved in 2012. CRBUD opinion of probable cost for this project is $500,000.
WDSRR018	West 13th Infrastructure	CRBUD determined the scope and cost of this project in its Capital Improvement Plan approved in 2012. CRBUD opinion of probable cost for this project is $350,000.

9.9 Opinion of Probable Project Costs

The opinions of probable cost for all of the above projects are presented in Section 12 (titled “Opinion of Probable Project Costs”) of this report.

Section 10.0
Wastewater System

10.1 Introduction

This section of the Master Plan summarizes the following:

- Findings of the wastewater transmission system hydraulic modeling;
- Recommended wastewater transmission system capacity improvement projects based on the model findings;
- Recommended regulatory driven wastewater system improvement projects; and
- Recommended wastewater system renewal and replacement (R&R) improvement projects.

10.2 Baseline Model Development

10.2.1 Introduction

This subsection of the Master Plan summarizes the software and the piping network that was used to create the wastewater transmission system model. Additionally, this subsection presents the results of the model verification task. Verification is the process of measuring how close the model predictions are to the observed pressure conditions during a specific operating period. Model results are presented in Subsection 10.5 below.

10.2.2 Modeling Software

The wastewater transmission system model was developed using the WaterCAD Version V8i software by Bentley Systems, Incorporated.

10.2.3 Model Network Development

The model of the existing wastewater transmission system was based on the existing lift station piping network imported from geographic information system (GIS) shape files provided by the CRBUD in early 2012. The model includes the CRBUD owned lift stations that are interconnected into the force main system. The CRBUD owned lift stations that discharge to the gravity collection system (i.e., CRBUD lift stations that do not directly interconnect with the force main system) were not included in the model. Rather, the flows from these lift stations that discharge to gravity systems were routed downstream to the nearest CRBUD lift stations that interconnect with the force main system.

Private lift stations were also not included in the wastewater transmission system hydraulic model. The estimated flows from the private lift stations that discharge into the CRBUD owned force main system were added at appropriate force main system model junction nodes. Thus, the impact of private lift stations on CRBUD lift stations that are interconnected via force main could be assessed. The privately owned lift stations that discharge to the gravity collection system (i.e., private lift stations that do not directly interconnect with the force main system) were not included in the model. Rather, the flows from these private lift stations that discharge to gravity systems were routed downstream to the nearest CRBUD lift stations that interconnect with the force main system.

Lift station attributes, such as wet well dimensions, pump on-off levels, pump make and model, impeller size, pump curve, etc. were based upon various sources of information. The sources of information included: data sheets provided by the CRBUD, review of available record drawings, and field data collected by the CRBUD staff.

Section 3 (titled "Summary of Existing Facilities") of this report provides a brief summary of the wastewater gravity collection and force main piping along with a description of the CRBUD owned lift stations and private lift stations.

Figure 10-1 illustrates the existing wastewater collection and transmission system piping which was used as the basis for developing the wastewater transmission system hydraulic model.

10.2.4 Extended Period Simulation (EPS)

The two basic types of hydraulic models are:

- Steady-State Simulation
- Extended Period Simulation (EPS)

Steady-state simulation computes the state of the system (i.e., flows, pressures, lift station operating status, wet well sewage levels) assuming that neither the wastewater generation rate nor the system state change with time. Steady-state simulation is a snap shot of system performance at a particular time.

EPS determines the dynamic behavior of the system, computing the state of the system as wastewater generation rate, lift station operating status, wet well level, force main pressure, etc. vary over time. EPS allows the model to evaluate wet well level, daily pump run time, along with force main pressures and flow rates throughout the system.

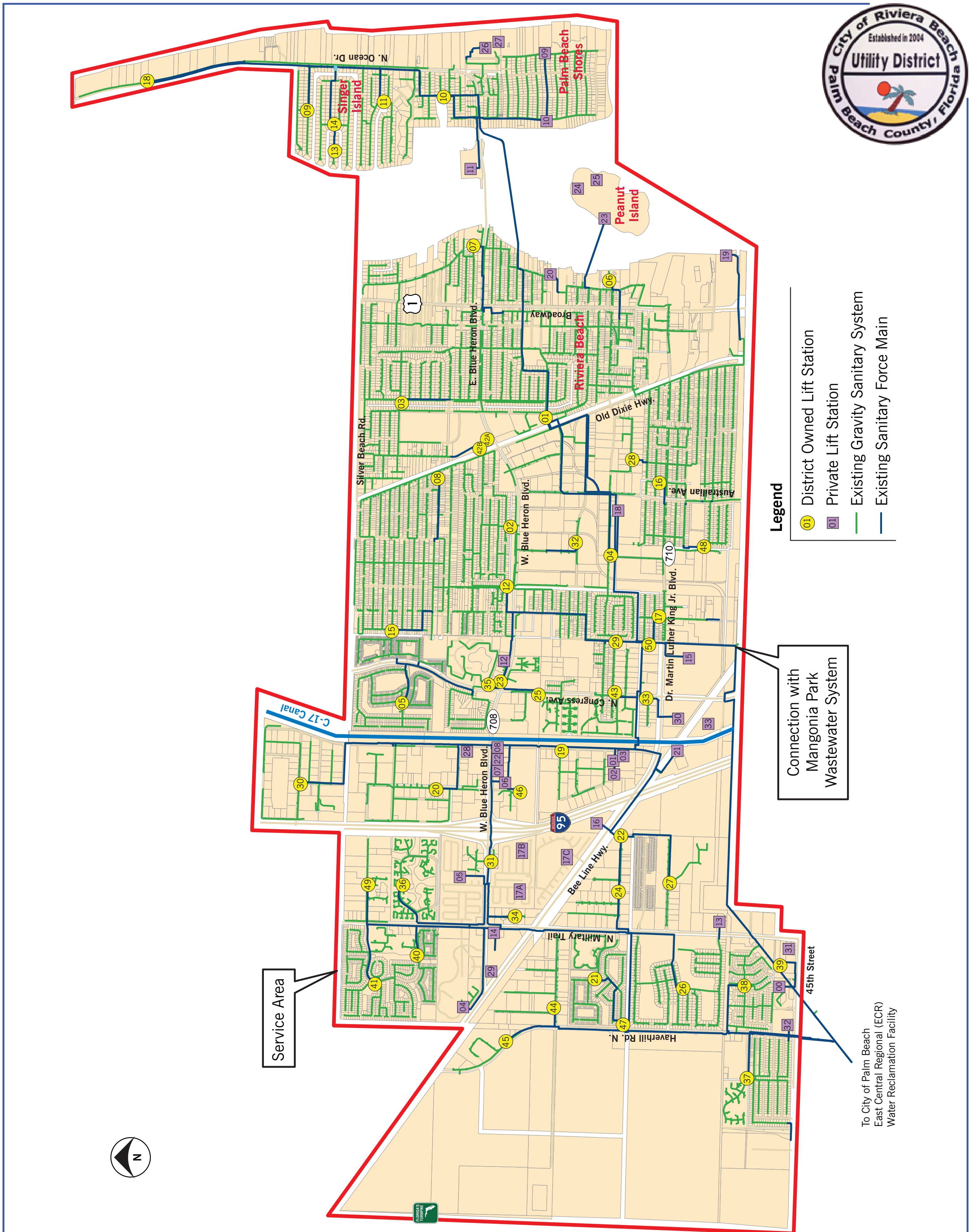

Figure 10-1
Existing Wastewater Collection and Transmission System

The CRBUD's wastewater transmission system was modeled utilizing the EPS technique.

10.2.5 Demand Variation

EPS modeling simulates wastewater flow variation throughout the day by input of a flow pattern into the model. The wastewater flow pattern utilized in the wastewater model is presented in Section 6 (titled "Wastewater Flow Forecast") of this report.

10.3 Model Verification

10.3.1 Introduction

The wastewater transmission system hydraulic model was designed to predict the system's present and future operational parameters under specific demand scenarios. The key parameters are pressure and flow. Verification of the accuracy of the model at a defined instant in time is required to gain confidence in using the model to make long term predictions.

Verification was accomplished using pressure records obtained from field operations and comparing them to model predictions. Additionally, all wastewater from the CRBUD that enters the ECRWRF is recorded via a flow meter. Data from this flow meter were collected and utilized for model verification. For the purpose of this study, verification included reasonable minor adjustments to model factors in order to improve the predictive capability of the model.

To assess the accuracy of the model, the average of the peak field measured conditions (over a selected 24-hour period) were compared to the peak pressures in the model predictions (over the same timeframe). For the purpose of this study, model verification was considered achieved when an overall average of ten percent difference was achieved for a selected 24-hour period. This goal was achieved as presented in Subsection 10.3.3.

The following subsections summarize the field data collected and the findings of the model verification process.

10.3.2 Field Data Collection

The project team installed digital pressure recorders on the discharge side of the pumps at certain CRBUD owned lift stations that were believed (based upon the GIS system) to interconnect with the existing transmission force main network. Fourteen locations were monitored in two groups of seven. The first group was monitored from May 16, 2012 through May 30, 2012. The second group was monitored from June 2, 2012 through June 19, 2012.

Figure 10-2 illustrates the locations where temporary pressure recorders were installed. **Table 10.1** provides a summary of the locations that pressure recorders were installed.

Table 10.1
Temporary Pressure Recorder Installation Locations

Temporary Pressure Recording Location	Lift Station Where Recorder Was Installed	Approximate Recorder Installation Address	Recording Timeframe		Comment
			5/16 to 5/30	6/2 to 6/19	
1-1	LS-10	2801 Park Avenue	X		
1-2	LS-1A	2051 Avenue "H" West	X		
1-3	LS-4	1270 Avenue "P"	X		
1-4	LS-50	900 Avenue "U"	X		
1-5	LS-22	3895 West Road Drive	X		
1-6	LS-30	3800 Investment Lane	X		Note 1
1-7	LS-47	4700 Haverhill Road	X		
2-1	LS-9	1134 Gulfstream Way		X	Note 1
2-2	LS-23	1950 Blue Heron Blvd		X	
2-3	LS-5	Thousand Oak States		X	Note 1
2-4	LS-46	700 Central Industrial Dr. S		X	
2-5	LS-34	7148 Military Trail & Derons Road		X	
2-6	LS-38	5900 Bimini Cir. East		X	
2-7	LS-41	7050 Woodbine Trail		X	

Note 1: *Based on the field pressure recording data collected, these lift station discharge to downstream gravity collection basins. Hence, these data could not be used for verification of the transmission system hydraulic model.*

Table 10.1 indicates that lift stations 5, 9, and 30 were originally believed to discharge to the force main network but the field pressure data indicate that these lift stations discharge to downstream gravity collection basins. This interpretation of the pressure recording data was confirmed with the CRBUD staff. The wastewater transmission piping in the model was adjusted accordingly.

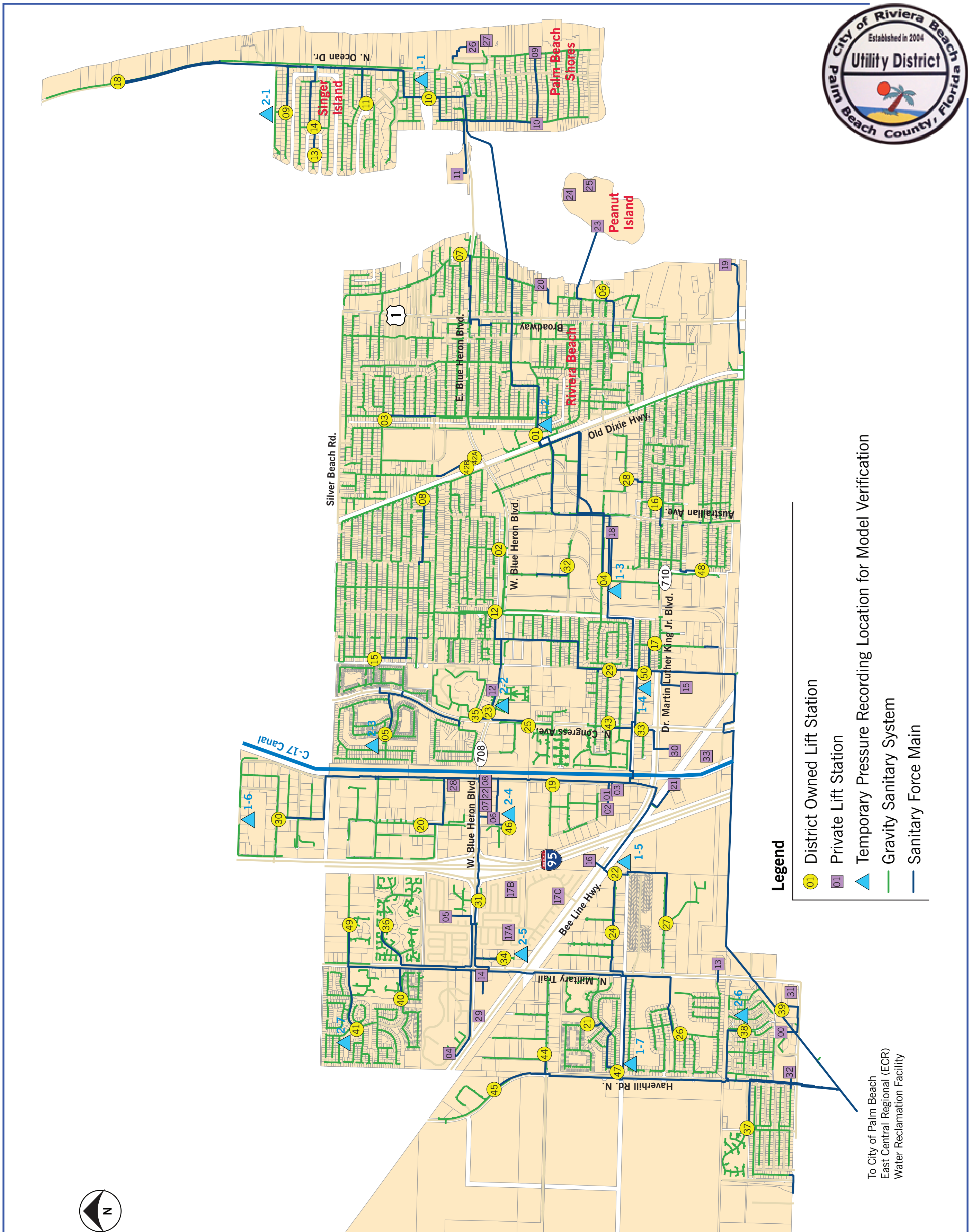

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Figure 10-2
Wastewater System Pressure Recorder Installation Location

10.3.3 Model Verification Results

The wastewater transmission system model performance was verified by comparing the model output versus the field measured pressures in the transmission system for a particular 24-hour period. May 24, 2012 was the day selected as the basis for model verification for the first group of field data. June 12, 2012 was the day selected as the basis for model verification for the second group of field data. Since the data collected for lift stations 5, 9, and 30 indicate that the lift stations discharge to downstream gravity collection basins; these data could not be used for verification of the wastewater transmission system model.

Figures 10-3 and **10-4** graphically illustrate the pressure recording data for May 24, 2012, superimposed on the pressure predicted by the model for lift stations 10 and 47, respectively. These graphs illustrate that the model predictions have similar patterns to the actual field recorded pressure data. These figures are provided as examples. Similar data are imbedded within the model for the other locations used for verification.

Table 10.2 summarizes the model verification results.

Table 10.2
Wastewater Model Verification Results

Model Node	Recording Date		Average of the Peaks over the 24-Hour Period			
	5/24/12	6/12/12	Model Pressure (psi)	Field Pressure (psi)	Difference (psi)	% Difference
LS-1	X		32.9	31.5	1.40	4.4%
LS-4	X		20.0	22.5	-2.50	11.1%
LS-10	X		16.9	17.5	-0.60	3.4%
LS-22	X		18.8	16.3	2.50	15.3%
LS-23		X	17.5	15.0	2.50	16.7%
LS-34		X	10.0	16.3	-6.30	38.7%
LS-38		X	15.6	17.5	-1.90	10.9%
LS-41		X	26.3	25.0	1.30	5.2%
LS-46		X	25.0	20.5	4.50	22.0%
LS-47	X		14.5	13.1	1.40	10.7%
LS-50	X		18.0	21.0	-3.00	14.3%
Average for May 24, 2012 Data						**10%**
Average for June 12, 2012 Data						**19%**
Overall Average						**14%**

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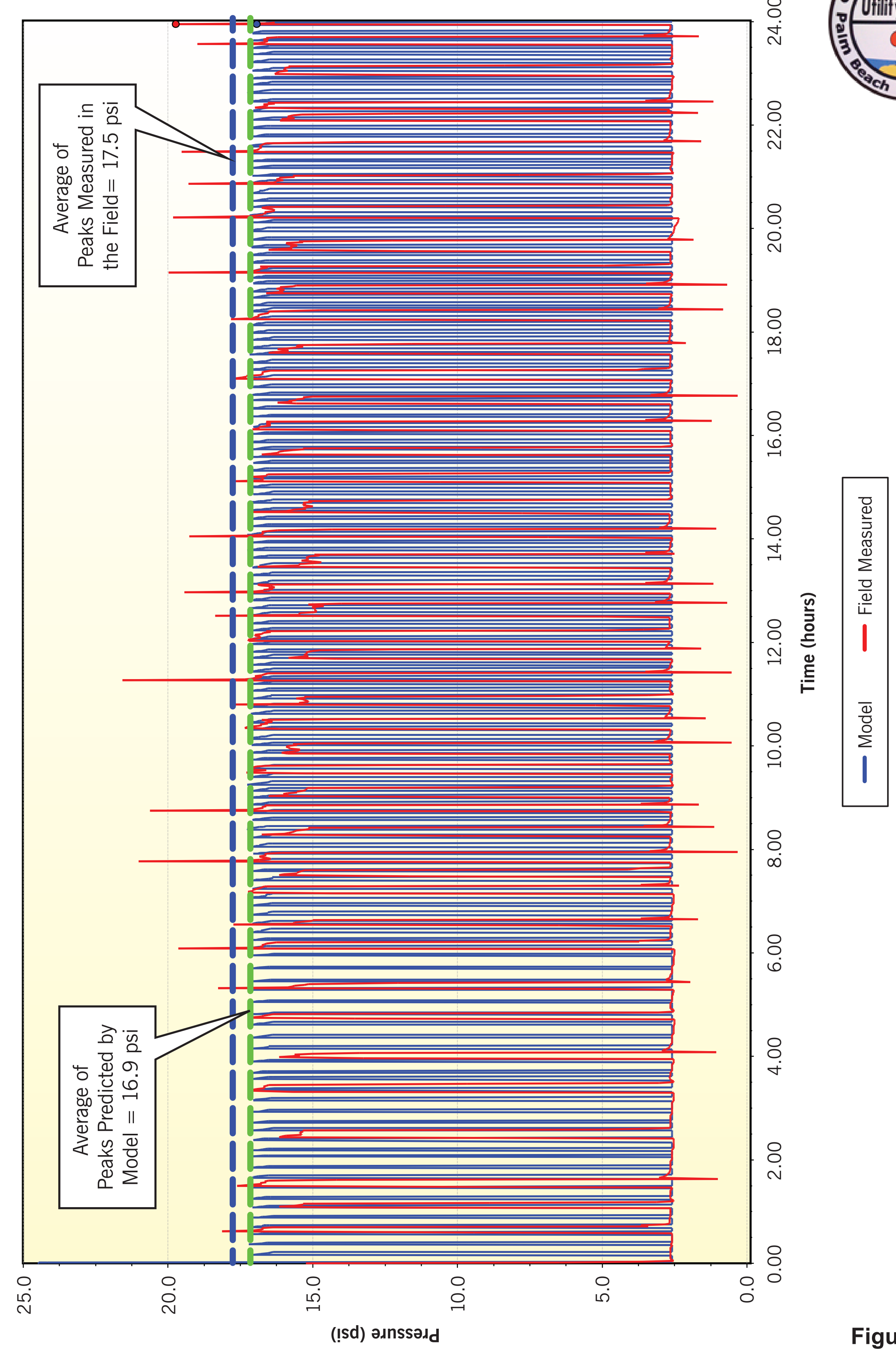

Figure 10-3
Model Verification Results - Lift Station 10

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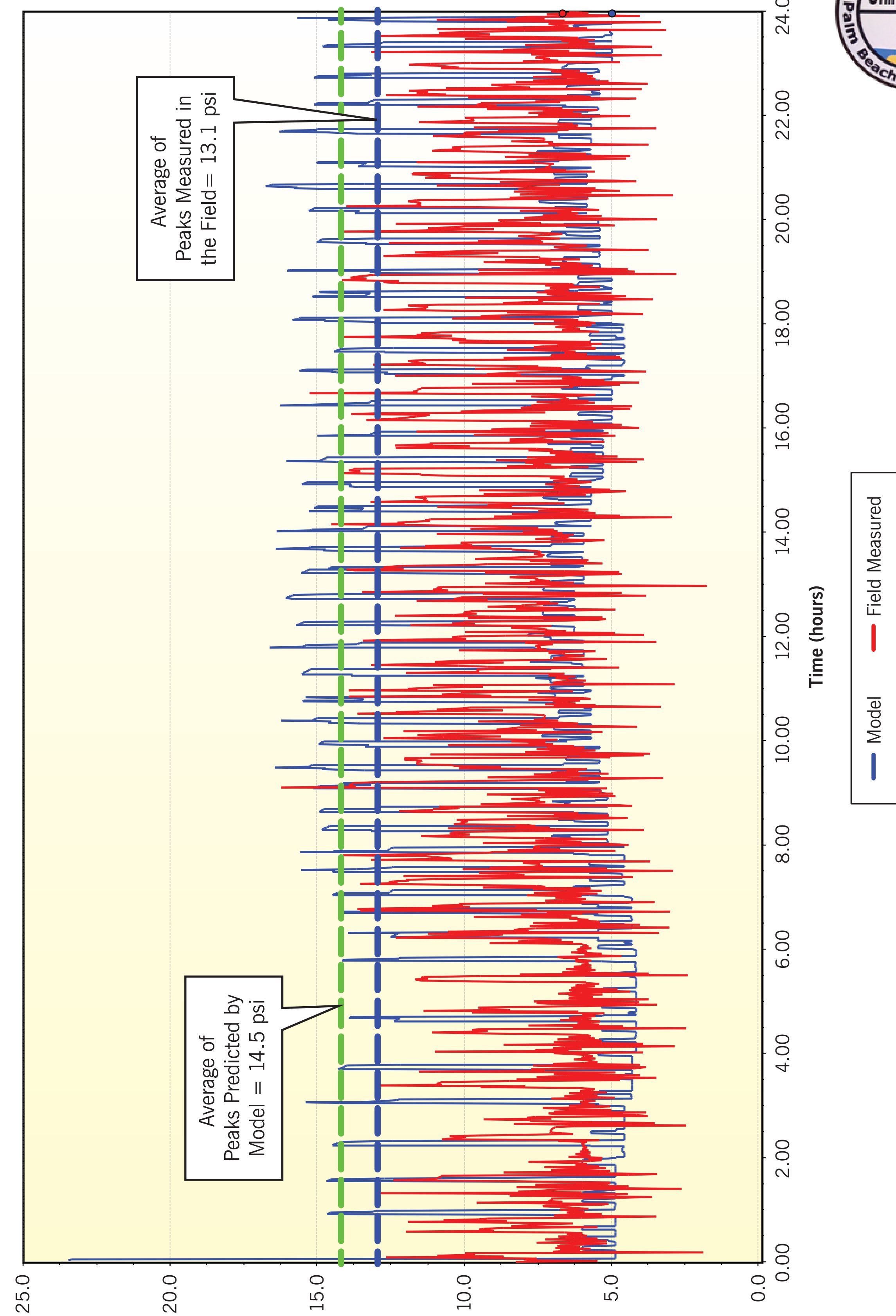

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Figure 10-4
Model Verification Results - Lift Station 47

10.3.4 Conclusions

Based upon **Table 10.2**, the average of the differences between the field measured pressures and the model output was 10 percent for the May 24, 2012 data, 19 percent for the June 12, 2012 data, and the overall average was 14 percent. The wastewater transmission system hydraulic model was considered acceptable for master planning transmission system improvement needs over the next 20 years.

10.4 Performance Criteria

10.4.1 Introduction

The criteria used to assess the adequacy of the CRBUD's wastewater transmission system relative to lift station run time, force main flow velocity, and headloss are described in the following paragraphs.

10.4.2 Pump Run Time Assessment Criteria

Pump run time is the hours per day per duty pump that operate in a lift station (assuming one pump is out of service). For example, given a triplex station with the first duty pump running 12 hours per day and the second duty pump running 2 hours per day, the run time would be 7 hours per day per duty pump. The run time analysis is based upon annual average day wastewater flow conditions. The criteria in **Table 10.3** were used to assess the capacity of the pumps in each lift station relative to run time.

Table 10.3
Duty Pump Run Time Assessment Criteria

Type	Run Time per Duty Pump	Assessment
Duplex (1 duty + 1 backup)	10 hours per day or less	Acceptable
Duplex (1 duty + 1 backup)	Greater than 10 hours per day	Not Acceptable
Triplex (2 duty + 1 backup)	10 hours per day or less	Acceptable
Triplex (2 duty + 1 backup)	Greater than 10 hours per day	Not Acceptable

If the model predicted that run time for a lift station would be greater than 10 hours per day per duty pump then a capital project to upgrade the size of the pumps was identified to bring lift station run time into the acceptable range.

10.4.3 Force Main Flow Velocity Assessment Criteria

The velocity of wastewater flowing through a force main is a key factor in assessing force main capacity. The diameter of the force main should be sized such that the velocity during pumping will be neither too low (less than two feet per second) such that deposits build-up (potentially clogging the pipeline) nor too high (greater than eight feet per second) resulting in excessive energy consumption. The force main is considered the piping outside of the lift station; piping internal to the lift station is not considered force main. **Table 10.4** presents the criteria utilized to assess the capacity of force mains relative to flow velocity.

Table 10.4
Force Main Flow Velocity Assessment Criteria

Flow Velocity (fps)	Assessment
less than 2	Not Acceptable
2 to 8	Acceptable
greater than 8	Not Acceptable

If the model indicated that the flow velocity in the existing force main piping was not acceptable then a capital project to upgrade the size of the force main was identified to bring velocity into the acceptable range.

10.4.4 Wet Well Surcharge Assessment Criteria

Surcharge means to overload the sewer system; the wastewater flow is greater than the system is capable of conveying per unit of time. The result of a surcharge is the water level in the wet well rises. If sewage rises above the top of the wet well slab, it will overflow (potentially causing a health hazard). **Table 10.5** presents the criteria used to assess the capacity of the system relative to wet well surcharge.

Table 10.5
Wet Well Surcharge Assessment Criteria

Sewage Level in Wet Well	Assessment
above the lead pump on setpoint + 1.00	Not Acceptable
below the lead pump on setpoint + 1.00	Acceptable

If the model predicted that the sewage level in the wet well would be above the lead pump on setpoint level plus one foot, then a capital project was identified to reduce the likelihood of surcharging the system.

10.5 Model Results and Capacity Improvement Needs

10.5.1 Introduction

This subsection summarizes the modeling results and describes the capacity type improvement needs indentified utilizing the wastewater transmission system hydraulic model.

10.5.2 Evaluation of Existing Infrastructure

The EPS model under maximum day conditions was run for 2012, 2015, 2020, 2025 and 2030. **Table 10.6** summarizes the model results for existing force mains that exhibited capacity issues under maximum day flow conditions.

Table 10.6
Force Mains with Inadequate Capacity

Description	Approx. Length (ft)	Existing Diameter (in)	Flow Velocity (fps)				
			2012	2015	2020	2025	2030
Strozier Street Force Main: The existing wastewater force main along Strozier Street from W 12th Street (near lift station 29) to the canal between W 11th Street and W 10th Street (nearby lift station 50).	800	12	10	10	10	10	10
C-17 Canal Crossing Force Main: The existing force main interconnecting lift station 47 and Lift Station 50 starting on the west side of the C-17 canal is 16-inch diameter whereupon it changes to 8-inch diameter just west of the canal, crosses the canal and continues west to Congress Avenue at which point it changes to 16-inch diameter again.	2,000	8	11	11	11	11	11
Lift Station 4 Force Main: The existing lift station 4 force main is composed of approximately 300 feet of 6-inch and 8-inch diameter force main that interconnects with an existing 18-inch diameter transmission pipe that runs east to west along the canal south of West 13th Street.	300	6 & 8	9	9	9	9	9

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Based upon the above table, the model indicated that three force mains in the existing wastewater transmission system exhibited flow velocity greater than eight feet per second.

Table 10.7 summarizes the model results for lift stations that exhibited capacity issues relative to run time and surcharging of the wet well.

Table 10.7
Lift Stations with Inadequate Capacity Based on Model Output

Lift Station	Wet Well					Run Time (Hrs/day per Duty Pump)					Comments
	2012	2015	2020	2025	2030	2012	2015	2020	2025	2030	
LS-1A	S	S	S	S	S	10	10	11	11	12	
LS-4	S	S	S	S	S	14	15	16	17	22	
LS-10	S	S	S	S	S	13	14	15	15	15	
LS-12	okay	okay	okay	okay	okay	9	10	10	11	12	Note 1
LS-23	okay	okay	okay	okay	okay	9	10	10	11	12	Note 1
LS-49	okay	okay	okay	okay	okay	4	5	6	9	11	Note 2
LS-50	S	S	S	S	S	15	16	17	17	20	Note 3

Legend: *S: wet well surcharges*

Note 1: *Pump runtime is okay for 2012.*

Note 2: *Pump runtime is okay with the exception of 2030.*

Note 3: *Lift station 50 has four pumps with two pumps out of service. Hence, this lift station was considered having one duty pump and one backup pump for the purpose of calculating the duty pump run time.*

The project team attempted to compare the model output run times for the lift stations listed in **Table 10.7** with historical run times from the Data Flow System (DFS). Based upon the data obtained from the DFS, a comparison with the model output was not feasible. It is recommended that the CRBUD maintain a historical log of lift station pump run time based upon monthly field inspection of the pump run-hour meters at each lift station.

Based upon the above findings, recommended improvements were identified as follows:

- Strozier Street Force Main Upgrade: Remove approximately 800 feet of existing 12-inch diameter wastewater force main along Strozier Street from W 12th Street (near lift station 29) to the canal between W 11th Street and W 10th Street (nearby lift station 50) and replace with a new 16-inch force main via open-cut construction.

- C-17 Canal Crossing Wastewater Force Main Upgrade: The existing force main interconnecting lift station 47 and lift station 50 starting on the west side of the C-17 canal is 16-inch diameter and it changes to 8-inch diameter just west of the canal, crosses the canal and continues west to Congress Avenue at which point it changes to 16-inch diameter again. Remove the existing 8-inch diameter force main from the west side of the C-17 canal to just east of Congress Avenue and replace it with a 16-inch diameter force main. An aerial crossing of the C17 canal will be required. It is roughly estimated to require 2,000 feet of 16-inch diameter force main via open-cut construction.

- Lift Station 4 Force Main Replacement: The existing lift station 4 force main is composed of approximately 300 feet of 6-inch and 8-inch diameter force main that interconnects with an existing 18-inch diameter transmission pipe that runs east to west along the canal south of West 13th Street. Remove the existing 6-inch and 8-inch diameter force main and replace it with a new 10-inch force main via open-cut construction. It is recommended that this force main upgrade be constructed at the same time as the pump upgrade for this lift station. For the purpose of this Master Plan it is assumed that the cost for the force main replacement would be included with the lift station 4 upgrade.

- Lift Station 4 Pump Upgrade: Based upon field observations, lift station 4 appears to be in generally good condition. However, the pumps appear to be undersized for current conditions. It is recommended that the existing pumps be removed and replaced with higher capacity pumps. A preliminary pump selection such as Flygt model NP3153.181 with a design capacity of 600 gpm at 80 feet total dynamic head is recommended. This preliminary pump selection should be refined during detailed design based upon field measurements of inflow rate and pressure recording of the discharge force main. It is recommended that this pump upgrade be constructed at the same time as the force main upgrade for this lift station.

- Lift Station 10 Replacement / Rehabilitation: Based upon field observations, certain components of lift station 10 appear to be at the end of their useful life. Hence, rehabilitation or replacement of this lift station is recommended. The rehabilitation or replacement of this lift station is described in a later subsection on renewal and replacement.

- Lift Station 50 Replacement / Rehabilitation: Based upon field observations, certain components of lift station 50 appear to be at the end of their useful life. Hence, rehabilitation or replacement of this lift station is recommended. The rehabilitation or replacement of this lift station is described in a later subsection on renewal and replacement.

- Lift Stations 1A, 12, 23, and 49 Pump Upgrade: The pumps for lift stations 1A, 12, 23, and 49 appear adequately sized for current conditions but may be somewhat undersized for future conditions. Near-term upgrades of the pumping capacities at these lift station are likely not required. It is recommended that the CRBUD monitor the pump run time at these lift stations going forward and plan for an upgrade of the pumps as part of a renewal and replacement project over the long term.

10.5.3 Lift Station 47 Overflow

Lift station 47 has two submersible pumps (one duty and one backup) and serves as the master lift station for the area west of the C-17 canal. The CRBUD staff indicated at the initiation of this Master Plan that lift station 47 has overflowed in the past. Furthermore, the CRBUD staff indicated that if the pumps at lift station 47 are shut off, the lift station would overflow in about four hours.

Consequently, the wastewater transmission system model was utilized to assess the capacity of lift station 47. The model results indicate that lift station 47 would have a duty pump run time of about eight hours during the year 2030 maximum day flow and that the wet well would not overflow. Hence, the model predicts that the capacity of lift station 47 is adequate.

The field pressure recording data collected for model verification appear to indicate that model predictions closely match field conditions at lift station 47. Consequently, it is speculated that the cause of the historical overflows may be related to a mechanical, electrical or control issue that cannot be assessed utilizing a wastewater transmission system hydraulic model.

To resolve this issue, additional study is warranted. The following project is recommended for inclusion with R&R projects (described in Subsection 10.8):

Lift Station 47 Rehabilitation: Collect additional data on lift station 47 to assess the reason for historical overflows. Data collection should include wet well inflow – if feasible – along with discharge force main pressure recording to refine the wastewater transmission system hydraulic model performance assessment. The evaluation should include detailed interviews with CRBUD maintenance staff. The evaluation should offer an opinion on the cause of historical overflows and offer recommendations relative to mitigating the likelihood of future overflows. Based on the results of the evaluation phase, prepare contract documents for the rehabilitation of this lift station. The rehabilitation should also include replacing the existing emergency generator at lift station 47 with a new diesel engine generator designed to handle to total rated capacity of the station (as described in Subsection 10.7.2.3).

10.5.4 Proposed Lift Station 10 Replacement / Rehabilitation

Based upon field observations, certain components of lift station 10 appear to be at the end of their useful life. Hence, rehabilitation or replacement of this lift station is recommended. The replacement / rehabilitation of this lift station is described in a later subsection on renewal and replacement. This subsection presents results from the the wastewater transmission system hydraulic model to assess the size of pumps for the replacement / rehabilitated station.

The CRBUD retained Barnes, Ferland and Associates, Inc. (BFA) to prepare a report titled "*Wastewater Lift Station No. 10 Preliminary Design Report".* The report was issued in April 2011. This report recommended replacing the existing lift station with a new lift station at generally the same location as the existing station. It also recommended that the proposed lift station include two constant speed submersible pumps (one duty and one backup) and that the pumps be designed for 1,400 gpm at 46 feet total dynamic head (TDH) and a pump curve similar to a Flygt Model NP3171.181.

The wastewater transmission system hydraulic model was utilized to assess the above preliminary pump selection. The flow forecast for the lift station 10 basin prepared for this master plan is conservative relative to the forecast prepared by BFA. Using the flow forecast from this master plan may oversize the replacement pumps for lift station 10; which is acceptable for master planning purposes. It is recommended that the one of the first actions during the detailed design of lift station 10 replacement / rehabilitation should be to install pressure and flow recorders at the station to obtain site specific data for the purpose of validating the required capacity of lift station.

10.5.5 Proposed Lift Station 50 Replacement / Rehabilitation

Based upon field observations, certain components of lift station 50 appear to be at the end of their useful life. Hence, rehabilitation or replacement of this lift station is recommended. The replacement of this lift station is described in a later subsection on renewal and replacement. This subsection presents results from utilizing the wastewater transmission system hydraulic model to assess the size of pumps for the replacement station.

The CRBUD retained BFA to prepare a report titled "*Wastewater Lift Station No. 50 Preliminary Design Report".* The report was issued in April 2011. This report recommended replacing the existing lift station with a new lift station at generally the same location as the existing station. It also recommended that the proposed lift station include four variable speed submersible pumps (three duty and one backup) and that the pumps be designed for 3,000 gpm at 67 feet TDH and a pump curve similar to a Flygt Model NP3301.180.

The wastewater transmission system hydraulic model was utilized to assess the above preliminary pump selection. Based on the wastewater transmission system hydraulic model, the pumps recommended by BFA would result in the duty pumps operating about 10 hours per day under current conditions and about 12 hours per day under year 2030 conditions. The year 2030 run time exceeds the recommended criteria of no more than 10 hours per day per duty pump. Hence, it is concluded that the preliminary pump selection in the BFA report titled "*Wastewater Lift Station No. 50 Preliminary Design Report"* should be reassessed.

The wastewater transmission system hydraulic model was utilized to make a preliminary assessment of pump sizing for the proposed replacement of lift station 50. The recommended pump sizing and certain other key criteria are summarized in **Table 10.8**.

Table 10.8
Recommended Design Criteria – Lift Station 50

Parameter	Value
No. of Pumps	4 (3 duty + 1 backup)
Type	submersible
Design Point	3,700 gpm at 85 ft TDH
Speed Control	variable frequency drive

It is noted that pump capacity in **Table 10.8** matches the capacity of the existing pumps. It is recommended that the one of the first actions during the detailed design of lift station 50 replacement / rehabilitation should be to install pressure and flow recorders at the station to obtain site specific data for the purpose of validating the required capacity of lift station.

The BFA report recommended that this lift station be designed as a repump station with a wet well. It is recommended that during detailed design that an in-line booster pump station configuration be considered in lieu of repumping. An in-line booster pump station would eliminate the need for the wet well and likely reduce odor.

10.5.6 Gravity Collection System

The CRBUD elected to not include an assessment of the capacity of the gravity collection system under the scope of work for this Master Plan. Consequently, this

Master Plan does not include an evaluation of the capacity of the gravity collection system.

10.5.7 Summary of Recommended Capacity Improvements

The wastewater transmission system capacity improvement needs, identified utilizing the hydraulic model, are described in the subsections above. **Table 10.9** aggregates the improvement recommendations presented above into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled "Project Implementation Plan") of this Master Plan.

Table 10.9
Capacity Improvement Projects
Wastewater Transmission System

Project No.	Project Name	Project Description
WWCAP001	Strozier Street Force Main Upgrade	Design and construct about 800 feet of new 16-inch diameter force main via open-cut construction.
WWCAP002	C-17 Canal Crossing Wastewater Force Main Upgrade	Design and construct about 2,000 feet of new 16-inch diameter force main via open-cut construction.

10.6 Improvements Currently Underway

The major wastewater improvement projects currently underway are presented in this subsection.

The CRBUD staff informed the project team that lift station 6 (near marina) is old and will be replaced with a new lift station designated lift station 6A at a new location. Old lift station 6 is a can type station and will be abandoned in place. The new lift station 6A will be a submersible type lift station. The CRBUD staff anticipates lift station 6A will be online in late 2012 / early 2013. Additionally, in October 2012 the CRBUD received proposals from engineering consultants to design the replacement (or rehabilitation if deemed appropriate) of lift stations 10 and 50.

There are no other major wastewater infrastructure improvement projects currently underway.

10.7 Regulatory Driven Improvement Needs

10.7.1 Introduction

A key element of a Master Plan is identification of capital improvement needs that are required for compliance with existing regulations along with potential capital improvement needs for compliance with anticipated regulations. This subsection provides recommendations for capital improvement projects for the CRBUD's wastewater transmission system to maintain compliance with existing and anticipated future regulations.

10.7.2 Existing Regulations

10.7.2.1 Compliance with Existing Regulations

The CRBUD contributes wastewater to the ECRWRF. Currently, the ECRWRF is in compliance with existing wastewater treatment regulations. Known proposed regulatory changes relative to treatment are unlikely to impact capital or operational cost at ECRWRF. Consequently, it is believed that existing and proposed wastewater treatment regulations will not impact the CRBUD.

The key current regulations applicable to the CRBUD's wastewater infrastructure are:

- National Pretreatment Program; and
- Chapter 62-604, FAC, titled "Collection Systems and Transmission Facilities"

The CRBUD's compliance status relative to these existing regulations, along with recommended capital improvements is presented below.

The ECRWRF has recently completed developing planning level documents to upgrade the ECRWRF biosolids treatment system. For the purpose of this Master Plan, the ECRWRF biosolids upgrade is considered a regulatory driven improvement need for the CRBUD. The CRBUD will be responsible for certain funding relative to the planned ECRWRF biosolids capital improvements. The ECRWRF Biosolids Upgrades are summarized in a subsection below.

10.7.2.2 National Pretreatment Program

The objectives of the National Pretreatment Program (Volume 40 Code of Federal Regulation (CFR) Part 403) are to:

- Prevent the introduction of pollutants into a wastewater treatment plant that will cause interference with its operation;
- Prevent the introduction of pollutants into a wastewater treatment plant that will pass through the treatment plant, inadequately treated, into waters of the State;
- Provide protection for both public health and welfare and municipal workers; and
- Promote beneficial reuse and recycling of domestic wastewater and residuals from the treatment plant.

The CRBUD accomplishes these objectives through implementation of an industrial pretreatment program (IPP). CRBUD's IPP is contained in the City of Riviera Beach Code of Ordnances Chapter 20, Article VII, titled "*Industrial Wastewater Pretreatment*" (sections 20-289 through 20-450). Based upon a "Pretreatment Agreement" dated November 7, 2001, the City of West Palm Beach administers the CRBUD's IPP.

All sewer system users that discharge industrial wastewater (i.e., any material resulting from manufacturing, industrial, commercial processes, and natural resource development) are required to obtain an industrial wastewater discharge permit. The permit requires certain pretreatment standards be met in accordance with FAC rule 62-625.410 titled "*Pretreatment Requirements for Existing and New Sources of Pollution*" and the City of Riviera Beach Code of Ordnances Chapter 20, Article VII, titled "Industrial Wastewater Pretreatment".

The CRBUD reports that historically, the annual fee for each industrial wastewater discharge permittee in the CRBUD service area has been relatively low. The CRBUD also reports that it has been notified by the City of West Palm Beach that the cost for each permittee will increase in the near future. This cost increase will be addressed in Section 14 (titled "Financial Considerations") of this Master Plan.

10.7.2.3 Emergency Power

Chapter 62-604, FAC, requires that all collection/transmission systems shall be operated and maintained so as to provide uninterrupted service and that emergency pumping shall be provided for all pump stations as follows:

- Lift stations that receive flow from one or more pump stations through a force main or lift stations discharging through pipes 12 inches or larger shall provide for uninterrupted pumping capabilities, including an in-place emergency generator.
- For lift stations not addressed in item 1 above, emergency pumping capability may be accomplished by connection of the station to at least two independent utility substations, by providing a connection for portable or in-place engine-driven generating equipment, or by providing portable pumping equipment.

- Such emergency standby systems shall have sufficient capacity to start up and maintain the total rated running capacity of the station.

Based upon field investigation of the existing lift stations, the following improvements were identified relative to emergency power:

- Lift Station 10 Emergency Power Improvements: Lift station 10 is required to have an in-place emergency generator since it discharges into a force main that is 12-inches or larger. The existing lift station 10 does not have an emergency power generator as required by 62-604.400(2)(a), FAC. Lift station 10 is currently planned for replacement / rehabilitation as described in the BFA report titled "*Wastewater Lift Station No. 10 Preliminary Design Report"*, dated April 2011. Consequently, this compliance issue will be resolved once lift station 10 is replaced / rehabilitated. For master planning purposes, these improvements are incorporated into the lift station rehabilitation improvements described in the R&R projects (described in Subsection 10.8).

- Lift Station 47 Emergency Power Improvements: The existing lift station 47 has an existing 250 kilowatt emergency power generator. CRBUD staff reported that the existing emergency power generator is capable of providing power for one of the three pumps located at the lift station. The lift station is required to be equipped with an emergency power generator capable of maintaining the total rated running capacity of the station per 62-604.400(2)(a)3, FAC. Consequently, the capacity of the existing emergency power generator is not sufficient. It is recommended that the existing emergency generator at lift station 47 be replaced with a diesel engine generator designed to handle to total rated capacity of the station. For master planning purposes, it is roughly estimated that a 400 kilowatt generator is appropriate to power the rated capacity of the station. The sizing of this generator is preliminary and should be refined during detailed design. It was assumed that a generator of this capacity can fit within the constraints of the existing lift station generator room. This assumption must be checked during detailed design. It is roughly estimated that the existing 1,000 gallon underground diesel fuel tank would be capable of providing 40 hours of fuel storage for the new generator. It was assumed that the existing diesel fuel tank would be retained and used with the new generator. For master planning purposes, these improvements are incorporated into the lift station rehabilitation improvements described in the R&R projects (described in Subsection 10.8).

10.7.2.4 Protection from Lightning and Power Surges

62-604.400(2)(b), FAC, requires that lift stations be protected from lightning and transient voltage surges. As a minimum, stations shall be equipped with lightning arrestors, surge capacitors or other similar protection devices, and phase protection.

During the week of May 7, 2012, heavy thunderstorms were experienced within the City of Riviera Beach causing the reported failure of lift stations 24, 26, 27, 28, and 46 resulting from either power surges or power phase discrepancies. The CRBUD have taken corrective action to return these lift stations to service.

CRBUD staff reported that the following lift stations do not have full lightning, surge, or phase protection as required by 62-604.400(2)(b), FAC:

- LS 2
- LS 18
- LS 20
- LS 25
- LS 27

Based upon the above findings, it is recommended that lightning and surge protection systems be designed and constructed for Lift Station 2, 18, 20, 25, and 27 to comply with 62-604.400(2)(b), FAC. For master planning purposes, these improvements are incorporated into the lift station rehabilitation improvements described in the R&R projects (described in Subsection 10.8).

10.7.2.5 Operation and Maintenance Manual

Although some manufacturer provided operations and maintenance manuals exist for particular lift stations, an operations and maintenance manual as required by 62-604.500(4), FAC, was not present at the CRBUD. This rule applies to both new and existing wastewater collection / transmission facilities. It is recommended that CRBUD retain a qualified professional to prepare a system-wide operation and maintenance manual per the requirements of 62-604.500(4), FAC.

10.7.2.6 ECRWRF Biosolids Upgrades

The ECRWRF currently treats biosolids via partial stabilization at the treatment plant via aerobic digestion, dewatering, and then further stabilizes the biosolids at an off-site regional composting facility under a service contract with the Solid Waste Authority of Palm Beach County (SWAPBC). The existing composting facility service contract with the SWAPBC expires on September 30, 2014. As a result, the ECRWRF biosolids will need to be handled in a different manner. For the purpose of this Master Plan, the ECRWRF biosolids upgrade is considered a regulatory driven improvement need for the CRBUD. The CRBUD will be responsible for certain funding relative to the planned ECRWRF biosolids capital improvement.

The ECRWRF has recently completed a study titled "*Engineering Report for Biosolids Treatment and Management*" (hereinafter "*Biosolids Report*"), prepared by Hazen and Sawyer, P.C. and issued final in May 2012. The *Biosolids Report* recommended the ECRWRF improvements listed below to sustain long term biosolids disposal at a 70 million gallon per day facility rating.

- Conversion of existing sludge decant tanks to aerated sludge storage tanks;
- Rehabilitation and upgrades to the gravity belt thickening facility;
- A new anaerobic digestion facility consisting of six digesters;
- A new centrifuge dewatering facility;
- A new thermal sludge drying facility;
- A new septage/fat, oil and grease (SFOG) receiving/transfer facility;
- Solids processing odor control system; and
- Related upgrades to electrical and SCADA systems.

The cost associated with the construction of the above that the CRBUD is responsible for in accordance with its large user agreement has been included in Section 14 (titled "Financial Considerations") of this Master Plan.

10.7.3 Anticipated Future Regulations

The project team assessed emerging trends in local, state, and federal wastewater regulations to identify potential future compliance issues. The focus of the assessment was relative to owning and operating a wastewater collection and transmission system. Based upon the review, wastewater collection and transmission system capital improvements are not expected to be necessary for compliance with anticipated future regulations.

10.7.4 Recommended Regulatory Driven Improvement

Several regulatory driven improvements were identified above. All but two were included with R&R projects (described in Subsection 10.8). The two regulatory driven improvement projects that are not included with the R&R projects are aggregated in **Table 10.10**. This table assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

Table 10.10
Regulatory Driven Improvement Projects
Wastewater Transmission System

Project No.	Project Name	Project Description
WWREG001	Wastewater System Operation and Maintenance Manual	Retain a qualified professional to prepare a system-wide operation and maintenance manual per the requirements of 62-604.500(4), FAC.
WWREG002	ECRWRF Biosolids Upgrades	ECRWRF improvements to sustain long term biosolids disposal at a 70 million gallon per day facility rating.

10.8 Renewal and Replacement Improvement Needs

10.8.1 Introduction

All assets in the CRBUD's water and wastewater infrastructure have a limited lifespan. At the end of an asset's lifespan, the asset (e.g., pump, pipe, water tank, etc.) may fail resulting in loss of service. Depending on the failure mode and level of redundancy, the consequence of failure can range from a minor inconvenience to major disruption of customer service. Consequently, a key focus of this Master Plan was documenting the condition of existing infrastructure, assessment of the remaining useful life of major assets and recommending R&R of major assets that are at or near the end of their useful life to ensure the continued reliability of the CRBUD's existing water and wastewater infrastructure over the next 20 years.

This subsection focuses on the R&R needs for the CRBUD's wastewater infrastructure. The wastewater infrastructure serving the CRBUD's customers include the following:

- Wastewater Collection System
- Wastewater Lift Stations
- Wastewater Transmission System Piping

The following subsections present the methodology used to identify R&R needs along with a brief description of the recommended improvements.

10.8.2 Wastewater Collection System Piping Replacement

10.8.2.1 Introduction

In 2008, the USEPA published the "*Clean Watersheds Needs Survey*" (hereinafter, *CWNS*). The *CWNS* is a comprehensive assessment of the capital needs (over a 20 year planning horizon) to meet the water quality goals set in the Clean Water Act. The *CWNS* estimated that $42 billion (in January 2008 dollars) would be needed nationally over the next 20 years for R&R of existing wastewater collection and transmission system infrastructure.

The magnitude of the above described estimate for wastewater collection system infrastructure R&R reflects that much of the infrastructure in the United States is approaching the end of its useful life. If wastewater collection and transmission system infrastructure is allowed to age to the point of failure, the result can be contamination of surface water (and possibly drinking water), loss of sewer service, high costs both to replace the pipes (on an emergency basis which is more costly than on a planned basis), and unforeseen costs resulting from property damage due to pipe failure.

The CRBUD decided that assessment of wastewater gravity collection system R&R needs would not be included in this Master Plan. However, for completeness, this subsection of the report includes a brief review of certain R&R needs related to the wastewater gravity collection system.

10.8.2.2 Sanitary Sewer Evaluation Survey

Wastewater production is affected by the portion of potable water usage that enters the system from sanitary fixtures including toilets, sinks, bathtubs, showers and lavatories. Most gravity sewer systems also include some amount of undesirable water entering the system via inflow and infiltration (I-I). I-I are terms used to describe the ways that groundwater and stormwater enter the sanitary sewer system.

Inflow results from improper connections, such as a roof drain from a residential home. Infiltration is caused by groundwater entering the sanitary sewer systems through cracks and/or leaks in the gravity collection system piping and/or manholes. The quantity of infiltration is affected by rainfall, groundwater elevation, and tidal elevation.

I-I reduces the available capacity of sanitary sewer systems and increases the operation and maintenance cost of the downstream lift stations. Additionally, I-I increases the cost associated with treatment.

The CRBUD has not quantified the amount of I-I entering its wastewater gravity collection system. The CRBUD decided that the scope of work for this Master Plan would not include quantification of the flow contributed to the sewer system from I-I.

The CRBUD requested that this Master Plan establish a “placeholder” cost (for budgeting purposes) to conduct an I-I study and a sewer system evaluation survey (SSES) in targeted areas of the wastewater collection system. Hence, it is recommended that the CRBUD conduct an I-I study and SSES in a phased approach as outlined below.

- Phase 1 – I-I Study: The I-I study would include analysis of dry and wet weather flows both for the system-level and for individual pump station collection areas (basins). System-level analysis would estimate the approximate proportions of infiltration, inflow, and wastewater. Basin-level analysis would prioritize individual pump station collection areas by I-I severity. A report documenting the findings of Phase 1 would be produced that prioritizes basins by I-I severity so that follow-up inspections (conducted in Phase 2) could focus on those areas where the greatest I-I reduction potential likely exists. The recommendations of the Phase 1 report would be implemented in Phase 2.

- Phase 2 – SSES: The SSES would be a detailed investigation to develop a gravity sewer rehabilitation plan. The investigation would be designed to permit the identification of specific system defects. The investigation would likely include activities such as night flow isolation, closed-circuit television inspection of sewer mains and laterals, manhole inspection, and smoke testing to identify sources of inflow. A report documenting the findings of Phase 2 would be produced that prioritizes recommended rehabilitation work based on cost-effectiveness and other factors (such as structural condition, public nuisance, health hazards, system hydraulics, and operation and maintenance demand). The findings of the Phase 2 report would be implemented during Phase 3.

- Phase 3 – Implementation of the Rehabilitation Plan: The Phase 2 report would serve as the basis for the planning and implementation of Phase 3. Phase 3 typically includes procurement and oversight of specialty sewer contractors to perform repair of gravity sewers, laterals, and manholes. Repairs would include traditional excavated repairs as well as “trenchless” repairs such as lining and chemical grouting where warranted. Phase 3 may also include post-rehabilitation flow monitoring to document the flow reductions achieved.

This Master Plan provides an opinion of probable project cost to implement Phase 1 and Phase 2 (for I-I study and SSES) in Section 12 (titled “Opinion of Probable Project Costs”). Determination of a cost for Phase 3 is not feasible at this time.

10.8.2.3 Vitrified Clay Pipe Lining

Roughly 165 miles out of a total of 169 miles of the gravity sewers in the CRBUD’s service area is vitrified clay pipe. Prior to the 1970s the joints of clay pipe were generally of the bell-and-spigot type, with the sealing material being cement mortar. In the early 1970s factory-applied compression joints and couplings that generally eliminate leaking joints and the potential for I-I became standard.

Hence, it can be concluded that vitrified clay piping installed in the CRBUD gravity sewer collection system prior to 1970 likely has the older style joints. It is speculated that leaking joints at clay pipe may be an issue of concern relative to I-I. Additionally, tree-root invasion, at the joints of the old-style (prior to 1970) clay pipe, has historically been a problem where mature trees exist in other communities.

Given the above speculation, it is recommended that the CRBUD establish a “placeholder” project for lining existing vitrified clay pipe. For the purpose of this Master Plan, the CRBUD decided to assume 200,000 feet of 8-inch diameter pipe lining via cured-in-place methods over the 20-year planning period.

10.8.2.4 Gravity Sewer Pipe Replacement

The USEPA’s document titled “*Clean Water and Drinking Water Infrastructure Gap Analysis Report*” (USEPA document number 816-R-02-020), issued in September 2002 indicated that the average expected useful life of gravity sewer piping was 80 to 100 years. This value was deemed acceptable for master planning. For this Master Plan, it was assumed that gravity sewer piping installed in 1950 or earlier would reach the end of its useful life over the next 20 years and would need to be replaced (unless it were lined as described above).

The CRBUD’s records indicated that gravity sewer system piping was installed after 1950. Hence, it could be concluded that R&R of gravity sewer system piping will not be needed over the 20 year planning horizon of this Master Plan. However, to account for uncertainties and unplanned emergency repair needs, the CRBUD decided to include a Gravity Sewer Pipe Replacement line item in its R&R planning. The planning for this item was based on replacement of gravity sewer piping over the next 20 years as follows:

- About 15,000 feet of 6-inch diameter gravity sewer piping
- About 15,000 feet of 8-inch diameter gravity sewer piping

10.8.3 Wastewater Lift Stations

10.8.3.1 Introduction

In mid February 2012, the project team conducted field investigations of the condition of major accessible features of the wastewater lift stations. The wastewater lift stations asset condition investigation was limited to visual observation of the facilities and interviews with operations and maintenance staff regarding the performance, reliability, age, and condition of the existing equipment and structures. The key assets that were evaluated included the following:

Mechanical

- Pumps
- Aboveground Piping and Valves
- Odor Control (if present)

Structural

- Concrete (wet well, valve vault, pump building or enclosure)
- Metal Hatches
- Doors, Windows, and Louvers
- Coatings

Electrical

- Main Power Breakers
- Emergency Power (if present)
- Automatic Transfer Switches (if present)
- Motor Control Centers (MCCs)
- Variable Frequency Drives (if present)
- Solid State Soft Starters (if present)
- Panelboards
- Field Instrumentation
- Local Control Panels
- Programmable Logic Controllers (if present)
- Remote telemetry (radio and antenna)

The findings of the investigation are summarized in **Appendix C**. This subsection presents recommended improvements based upon the findings of the investigation.

10.8.3.2 Expected Useful Life of Lift Stations

A useful indicator for master planning purposes is an assessment of the remaining useful life of an asset. To assess the remaining useful life, the year the asset was placed into service (or last rehabilitated) and the expected average useful life need to be known (or estimated). The year that each lift station was installed or last rehabilitated was determined through a review of available record drawings and discussion with

CRBUD staff. The expected average useful life of a lift station was based upon a literature search.

The USEPA's document titled "*Clean Water and Drinking Water Infrastructure Gap Analysis Report*" (USEPA document number 816-R-02-020), issued in September 2002 indicated that the expected average useful life of a wastewater lift station was 15 years for the mechanical and electrical equipment and 50 years for the concrete structures. For this Master Plan, a composite expected average useful life of 30 years was used to assess the overall timeframe when major R&R of lift stations would be needed over the 20-year planning time frame.

10.8.3.3 Recommendations

Table 10.11 summarizes the recommended lift station improvements. The table includes a column labeled "replace lift station". "Replace lift station" means to abandon the exiting lift station and construct a new lift station either nearby the existing lift station or at a new location. The table also includes a column labeled "rehabilitate lift station". For the purpose of this Master Plan, "rehabilitate lift station" is assumed to include the following:

- Replace pumps, motors, and electrical panels;
- Replace local control panels, field instruments, radio, antenna, antenna mast;
- Replace valve vaults with new precast concrete vault, hatch, piping, and valves;
- Replace piping within the wet well;
- Replace piping between wet well and the valve vault;
- Replace fencing around the station; and
- Clean, repair, and coat interior surface of existing wet well.

The table also includes a series of sub-columns labeled "Immediate", "5 years", "10 years", "15 years", and "20 years". If the "Immediate" sub-column is checked (with an "X") it means that the improvement is recommended for implementation as soon as possible. If the "5 years" sub-column is checked (with an "X") it means that the improvement is recommended for implementation within the next 5 years. The other sub-columns similarly indicate the time frame that the improvement is recommended for implementation. Additionally, the table includes a column labeled "odor". If the odor column is checked (with an "X") it means conducting an odor study is recommended. The odor study should assess the need to add an odor control system and recommend an odor control system technology for implementation.

Table 10.11
Recommended Lift Station Improvements

Lift Sta. No.	Replace Lift Station					Rehabilitate Lift Station					Odor	Comments
	Immediate	5 years	10 years	15 years	20 years	Immediate	5 years	10 years	15 years	20 years		
1A										X	X	
2							X					
3									X			
4A									X			
5									X			
6												Lift Station 6 is currently being replaced
7									X			
8									X			
9								X				
10						X						
11			X									Convert can station to submersible
12										X	X	Replace discharge check valves and isolation valves as soon as possible
13			X									Convert can station to submersible
14			X									Convert can station to submersible
15									X			
16			X									Convert can station to submersible
17	X											
18							X					
19	X											Convert can station to submersible
20							X					
21							X					
22									X			
23									X			
24								X				
25						X						
26	X											
27							X					

Table 10.11 (continued)
Recommended Lift Station Improvements

Lift Sta. No.	Replace Lift Station					Rehabilitate Lift Station					Odor	Comments
	Immediate	5 years	10 years	15 years	20 years	Immediate	5 years	10 years	15 years	20 years		
28							X					
29								X				
30							X					
31							X					
32							X					
33								X				
34							X					
35							X					
36							X					
37							X					
38								X				
39								X				
40							X					
41							X					
42A								X				
42B								X				
43								X				
44									X			
45									X			
46									X			
47						X						Perform study as soon as possible to assess operational issues with pumps, historical overflows and configuration of the existing wet well
48										X		
49										X		
50	X											

The timeframes presented in the above table are idealized without regard the budget limitation. The above table is presented to assist the CRBUD staff to prioritize lift station rehabilitation projects given limited budgets. The actual time frames that lift station rehabilitations would be implemented will be based upon funding availability and may not coincide with the above table.

10.8.4 Wastewater Transmission System Piping Replacement

10.8.4.1 Introduction

The age and condition of buried piping are key attributes to assessing wastewater transmission system piping R&R needs. Assessment of the condition of buried piping is challenging and expensive. The CRBUD decided, for this Master Plan, that buried piping condition would not be physically evaluated. It was decided that a limited desktop assessment of the underground wastewater transmission system piping would be performed to estimate the existing piping age and material based upon available records. Section 3 (titled "Summary of Existing Facilities") of this report summarizes the findings of existing pipe age and material assessment.

The following subsections present the recommended wastewater transmission system R&R improvement needs.

10.8.4.2 Force Main Pipe Replacement

The USEPA's document titled "Clean Water and Drinking Water Infrastructure Gap Analysis Report" (USEPA document number 816-R-02-020), issued in September 2002 indicated that the average expected useful life of wastewater force main was 25 years. This value is overly conservative. A more optimistic expected average useful life of force main is estimated to be about 75 years (based upon the expected average useful life of water piping presented in Subsection 9.8.2.2). For this Master Plan, it was assumed that force main piping in the CRBUD wastewater transmission system that was installed in 1960 or earlier would reach the end of its useful life over the next 20 years and would need to be replaced.

It is recommended that the CRBUD plan for replacing wastewater transmission system force main with a diameter of 10-inches and less that was installed in 1960 and earlier. The estimated quantity of force main to be replaced over the next 20 years – broken down by diameter – is as follows:

- About 5,100 feet of 4-inch diameter piping
- About 1,600 feet of 6-inch diameter piping
- About 1,300 feet of 8-inch diameter piping
- About 3,000 feet of 10-inch diameter piping

10.8.4.3 Parallel Intracoastal Force Main

The existing force main piping system has one 16-inch diameter force main that crosses the Intracoastal Waterway and conveys all of the wastewater collected on Singer Island at lift station 10 to the mainland lift station 1A. The CRBUD staff report that this pipe was constructed in the 1950's era. A failure of this pipeline, due to age or other factors, would result in loss of service and potentially short-term environmental damage.

It is recommended that a new 16-inch diameter force main – approximately parallel to the existing force main – be designed and constructed. Assumptions on the likely project scope are briefly outlined below.

- About 5,500 feet of 16-inch diameter directional drill high density polyethylene (HDPE) pipe from East 20th Street (on-shore side) to Cascade Lane (Singer Island side);
- About 6,300 feet of 16-inch diameter open cut ductile iron pipe to connect the HDPE to the lift stations 1A and 10;
- About 6,300 feet of topographic survey;
- Based on the preliminary pipe route it is estimated that temporary easements may be needed at the vacant lots located at the following parcel numbers to provide staging area for the drilling equipment and pipe: 56434228110070050, 56434228110070040, 56434228110070020, and 56434228110070010;
- Benthic survey of Intracoastal crossing location; and
- Geotechnical study and report as needed by the permitting agencies and for design purposes.

The above assumptions were used to establish the basis for preparing an opinion of probable project cost.

10.8.4.4 Routing Study for 16-inch Force Main Intracoastal Crossing

The subsection above recommended design and construction of a new 16-inch force main crossing the Intracoastal waterway. It was assumed that the proposed force main would approximately parallel the existing 16-inch Intracoastal crossing.

Assessing the feasibility of the above described pipe route is beyond scope of work for this Master Plan. Hence, preparing a routing study should be completed in advance of initiating design of the proposed Intracoastal crossing. An outline of the likely scope of work for the recommended routing study is presented below.

- Identification of alternative routes (based upon discussion with CRBUD staff);

- Recommended pipeline design criteria relative to material, wall thickness, joints, valves, etc.;
- Determination of existing utilities along routes;
- Recommended methods of pipeline installation within right of ways;
- Feasibility of HDD based on discussion with contractors;
- Identification of temporary easement needs for HDD equipment;
- Feasibility of HDD relative to impact on existing underground utilities.
- Determination of temporary and permanent easements needed for each route;
- An assessment of the likelihood of obtaining the identified easements (based upon CRBUD discussion with property owners);
- Description of permitting requirements;
- Development of conceptual drawings that identify the location of known contamination sites along each pipe route; and
- Budgetary construction costs of alternative routes.

The routing study should be prepared in advance of beginning a detailed design and should be documented in a report.

10.8.4.5 Rehabilitate Existing 16-Inch Force Main Crossing the Intracoastal

Due to the absence of record drawings of the existing force main, the feasibility of the rehabilitation of the existing pipe via trenchless methods cannot be determined at the Master Plan level of planning. Once the existing force main is removed from service, it is recommended that the CRBUD consider conducting a feasibility study to assess the efficacy of rehabilitating the existing force main. For the purpose of this Master Plan, it is recommended that "placeholder" projects be included for: 1) conducting the feasibility study, and 2) design and construction of the rehabilitation of the existing force main.

10.8.4.6 On-Call Underground Contractor

To account for uncertainties and unplanned emergency repair needs for wastewater system piping, the CRBUD decided to include an "On-Call Underground Contractor" line item in its R&R planning. The CRBUD proposed an annual $100,000 budget for this item.

10.8.4.7 Aerial Pipe Crossing Rehabilitation

The CRBUD retained BFA to evaluate the condition and recommend improvements for aerial pipe crossings for raw water transmission, water transmission, and wastewater transmission piping owned by the CRBUD. The findings of the study are documented in a technical memorandum titled "*Aerial Pipe Crossing Evaluation and Assessment*" issued in October 2011. This report recommended rehabilitation of 22 existing aerial pipe crossings. Per the CRBUD's request, the recommended rehabilitation was consolidated into two proposed projects, as follows:

- Rehabilitation of the 30-inch Force Main Crossing of the M-Canal: Design and perform rehabilitation of the 30-inch force main aerial crossing of the M-Canal. The CRBUD decided to identify this as a separate project in this Master Plan since the CRBUD determined that implementation of this project is high priority given that the M-Canal is interconnected with the primary drinking water supply for the City of West Palm Beach.

- Rehabilitation of Aerial Pipeline Crossings: Design and perform rehabilitation of the 21 aerial piping crossings described in the BFA titled "*Aerial Pipe Crossing Evaluation and Assessment*" (not including the 30-inch force main crossing of the M-Canal, which would be rehabilitated under a separate project).

10.8.5 Recommended Renewal and Replacement Improvements

Table 10.12 aggregates the R&R type improvement recommendations described above into projects and assigns project numbers to each for tracking purposes. The project descriptions in this table are abridged. More detailed project descriptions are provided in the subsections above.

The order of the following list of recommendations is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 14 (titled "Project Implementation Plan") of this Master Plan.

Table 10.12
Renewal and Replacement Projects
Wastewater System

Project No.	Project Name	Project Description
WWRR001	Inflow and Infiltration Study and Sewer System Evaluation Survey	Prepare an inflow and infiltration study along with a sewer system evaluation survey to identify and prioritize gravity sewer piping for rehabilitation to limit inflow and infiltration.
WWRR002	Clay Pipe Lining	This is a “placeholder” project for lining existing vitrified clay pipe. Lining of 200,000 feet of 8-inch diameter pipe is assumed.
WWRR003	Gravity Sewer Pipe Replacement	This line item is a “placeholder” to establish a budget to account for uncertainties and unplanned emergency repair needs.
WWRR004	Lift Station 10 Replacement	Replace the existing lift station 10.
WWRR005	Lift Station 50 Replacement	Replace the existing lift station 50.
WWRR006	Replace Lift Stations 11, 13, 14, and 16	Replace the existing can type lift stations (11, 13, 14, and 16) with a submersible type stations.
WWRR007	Lift Station Rehabilitation – Phase 1	Rehabilitate up to 15 lift stations over the period 2013 to 2017.
WWRR008	Lift Station Rehabilitation – Phase 2	Rehabilitate up to 10 lift stations over the period 2018 to 2022.
WWRR009	Lift Station Rehabilitation – Phase 3	Rehabilitate up to 10 lift stations over the period 2023 to 2027.
WWRR010	Lift Station Rehabilitation – Phase 4	Rehabilitate up to 5 lift stations over the period 2028 to 2032.
WWRR011	Odor Study	Conduct odor study at lift stations 1A and 12.
WWRR012	Lift Station 47 Rehabilitation	Perform study as soon as possible to assess operational issues with lift station 47 pumps, historical overflows, and configuration of the existing wet well. Includes rehabilitation of lift station along with installation of a new 400 kilowatt generator to replace the existing generator.
WWRR013	Force Main Pipe Replacement	Design and construct replacement of wastewater transmission system force main that was installed in 1960 and earlier.
WWRR014	Parallel Intracoastal Force Main	Design and construct a new 16-inch diameter force main – approximately parallel to the existing force main – to cross the Intracoastal Waterway.

Table 10.12 (continued)
Renewal and Replacement Projects
Wastewater System

Project No.	Project Name	Project Description
WWRR015	Routing Study for 16-inch Force Main Intracoastal Crossing	Prepare a routing study in advance of initiating design of the proposed 16-inch force main Intracoastal crossing.
WWRR016	Rehabilitate Existing 16-Inch Force Main Crossing the Intracoastal	Conduct a feasibility study to assess the efficacy of rehabilitating the existing 16-inch force main crossing the Intracoastal. Design and construction rehabilitation of the existing 16-inch force main crossing the Intracoastal.
WWRR017	On-Call Underground Contractor	Retain the services of an underground contractor to perform “on-call” service.
WWRR018	Rehabilitation of the 30-inch Force Main Crossing of the M-Canal	Design and perform rehabilitation of the 30-inch force main aerial crossing of the M-Canal.
WWRR019	Rehabilitation of Aerial Pipeline Crossings	Design and perform rehabilitation of the aerial piping crossings described in the BFA titled “*Aerial Pipe Crossing Evaluation and Assessment*” (not including the 30-inch force main crossing of the M-Canal).
WWRR020	Replacement of Lift Station Pumps	CRBUD staff identified an annual $100,000 budget for replacement of the lift station pumps.

10.9 Opinion of Probable Project Costs

The opinions of probable cost for all of the above projects are presented in Section 12 (titled “Opinion of Probable Project Costs”) of this report.

Section 11.0
Site Security

11.1 Introduction

The project team conducted site visits at the water treatment plant and the potable water storage facilities to assess existing security provisions and evaluate the possible implementation of additional security provisions that may be warranted. The team reviewed a variety of security issues and recommended a series of security improvements. Due to the confidential nature of evaluation findings and recommendations, they are not summarized herein. The findings of the security assessment and associated recommendations are described in a separate site security report that is available from the City of Riviera Beach Utility District's (CRBUD's) Executive Director.

11.2 Opinion of Probable Project Costs

The opinions of probable cost for the security projects that were identified are presented in Section 12 (titled "Opinion of Probable Project Costs") of this report.

Section 12.0
Opinion of Probable Project Costs

12.1 Introduction

This section of the master plan provides opinions of probable project cost for the recommended water and wastewater projects identified in earlier sections of the report.

The tables presented in this section include the following columns: 1) project number, 2) project name, 3) improvement type, and 4) cost. The project number is a unique identification code to facilitate project tracking. The project name is a short descriptive title related to the project scope. Detailed descriptions of the project scopes are presented in prior sections of this report.

The improvement type column is indicative of what drives the need for the project, as described in the following:

1. Regulatory: Regulatory driven projects are improvements that are considered necessary for compliance with current regulations and possible future regulations. The CRBUD has an ongoing issue with maintaining chlorine residual in the Gramercy Park area of its water distribution system. Regulatory driven projects related to the water distribution system are recommended to aid the CRBUD achieve regulatory compliance relative to distribution system chlorine residual.

2. Capacity: Capacity driven projects are improvements that increase the capacity of the water distribution and wastewater pumping and transmission systems to meet the needs of current customers as well meeting the needs for forecasted population growth. Based on the CRBUD's Water Use Permitting efforts prior to the initiation of this master plan, the CRBUD determined that capacity improvements to the water supply and water treatment facilities were not needed. Consequently, capacity assessments of the CRBUD's water supply and water treatment facilities are not included in this master plan.

3. Renewal and Replacement: The CRBUD's water and wastewater infrastructure is relatively old and certain elements have reached the end of their useful life. R&R projects are intended to either rehabilitate (i.e., renew) or replace infrastructure that is at the end of its useful life and maintain the reliability of the existing infrastructure at current capacity.

4. Water Quality: Projects categorized as “water quality” are intended to enhance water treatment plant operational effectiveness resulting in improved drinking water quality.

5. Water System Security: Projects identified as security related are intended to improve the security of the water treatment plant and repump stations.

6. Facility Improvement: Facility improvement projects were projects identified by the CRBUD staff to enhance operational effectiveness. Additionally, the CRBUD identified adding fluoridation at the water treatment plant as a facility improvement type project.

The order that the projects are presented in this section is neither an indication of the sequence that the projects should be implemented nor a ranking of their priority. The projects are prioritized in Section 13 (titled “Project Implementation Plan”) of this Master Plan.

12.2 Opinion of Probable Project Costs

The opinion of probable costs presented herein has been prepared based upon master plan level information. Because of the level of scope development at this stage the opinion is an “Order Of Magnitude” estimate as defined by the Association for the Advancement of Cost Engineering International (AACE). The expected range of accuracy for this type of opinion is +100 percent to -50 percent. These opinions of probable cost have been prepared for guidance in project evaluation and implementation from the information available at this stage of the estimate. The final costs of the projects will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions. As a result, the final project costs will vary from the opinions presented herein.

The cost opinions are “project costs” and are inclusive of: construction costs; contractor overhead and profit; estimated allowance for permit application fees; 20 percent estimated allowance for engineering services during the design, permitting, construction and startup of the project; along with a 30 percent contingency. The costs are based upon year 2012 dollars and do not include escalation for inflation.

12.3 Water Supply Projects

The opinion of probable costs for water supply related projects are presented in **Table 12.1**.

Table 12.1
Opinion of Probable Project Costs
Water Supply

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WELLREG001	Proposed Wells A and B	Regulatory	$2,200,000
WELLREG002	Proposed Salt Water Monitor Well	Regulatory	$30,000
WELLREG003	GWR Sanitary Survey Improvements	Regulatory	$350,000
WELLRR001	Annual Specific Capacity Testing	R&R	$1,800,000
WELLRR002	Well Pump Replacement	R&R	$4,000,000
WELLRR003	Rehabilitation of Raw Water Wells	R&R	$2,000,000
WELLRR004	Convert Production Well to Monitor Well	R&R	$34,000
WELLRR005	Drill and Equip New Replacement Wells – Phase 1	R&R	$2,900,000
WELLRR006	Drill and Equip New Replacement Wells – Phase 2	R&R	$2,900,000
WELLRR007	Raw Water Asbestos Cement Piping Replacement	R&R	$2,180,000
Total - Water Supply			**$18,394,000**

12.4 Water Treatment Projects

The opinion of probable costs for water treatment related projects are presented in **Table 12.2**.

Table 12.2
Opinion of Probable Project Costs
Water Treatment

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WTPWQ001	Ferric Chloride and Sodium Hypochlorite Full-Scale Testing	Water Quality	$490,000
WTPWQ002	Ferric Chloride Storage and Feed System	Water Quality	$950,000
WTPWQ003	Automatically Track Filter Run Hours	Water Quality	$60,000
WTPWQ004	Create Filter Media Evaluation Program Document	Water Quality	$30,000
WTPWQ005	Filters 1-8 Media and Underdrain Replacement	Water Quality	$2,400,000
WTPWQ006	Calcium Sequesterant Storage and Feed System	Water Quality	$150,000
WTPWQ007	Filters 1-8 Surface Wash System	Water Quality	$450,000
WTPWQ008	Lime Slurry System	Water Quality	$2,200,000
WTPREG001	Ground Water Rule 4-log Virus Treatment Certification Study	Regulatory	$280,000
WTPREG002	Capital Improvements for 4-log Virus Treatment	Regulatory	$650,000
WTPRR001	Air Stripper Media Replacement	R&R	$600,000
WTPRR002	Raw Water Transfer Pump Replacement	R&R	$1,090,000
WTPRR003	Rehabilitation of Lime Softening Units	R&R	$1,100,000
WTPRR004	Replacement of Lime Slakers	R&R	$2,000,000

Table 12.2 (Continued)
Opinion of Probable Project Costs
Water Treatment

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WTPRR005	Replacement of Lime Silos	R&R	$2,100,000
WTPRR006	Aqueous Ammonia System	R&R	$470,000
WTPRR007	Water Treatment Plant Disinfection	R&R	$3,800,000
WTPRR008	WTP Flow Meter Replacements and Additions	R&R	$650,000
WTPRR009	Filter Crack Repair	R&R	$400,000
WTPRR010	Filter 1-8 HMI and Blower Replacement	R&R	$250,000
WTPRR011	Filter 9-16 Media and Underdrain Replacement	R&R	$1,990,000
WTPRR012	Backwash System Valve and Control Replacement	R&R	$100,000
WTPRR013	Filter 1-8 Valve and Actuator Replacement	R&R	$1,020,000
WTPRR014	Filter 9-16 Valve and Actuator Replacement	R&R	$1,180,000
WTPRR015	Finished Water Transfer Pump Replacement	R&R	$250,000
WTPRR016	High Service Pump Replacement	R&R	$1,880,000
WTPRR017	Blue Heron Boulevard Tank Replacement	R&R	$2,000,000
WTPRR018	WTP Field Instrument Replacement	R&R	$400,000
WTPRR019	Primary Logic Controller (PLC) Replacement	R&R	$740,000
WTPRR020	WTP Electrical Single Line Diagram	R&R	$40,000

Table 12.2 (Continued)
Opinion of Probable Project Costs
Water Treatment

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WTPRR021	Electrical Equipment Replacement	R&R	$180,000
WTPRR022	Emergency Generator and Fuel System Replacement	R&R	$630,000
WTPRR023	Plant Power System Analysis	R&R	$180,000
WTPRR024	North Filter Building Door and Window Replacement	R&R	$200,000
WTPFI001	Field Operations Building	Facility Improvement	$1,100,000
WTPFI002	Fluoride System	Facility Improvement	$400,000
Total - Water Treatment			**$32,410,000**

12.5 Water Distribution System Projects

The opinion of probable costs for water distribution system related projects are presented in **Table 12.3**.

Table 12.3
Opinion of Probable Project Costs
Water Distribution

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WDSC001	North Singer Island Large Water Main	Capacity	$1,300,000
WDSC002	16-inch Intracoastal Crossing Water Main	Capacity	$3,080,000
WDSC003	Port of Palm Beach Water Main	Capacity	$590,000
WDSC004	Avenue P Water Main	Capacity	$1,000,000

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Table 12.3 (Continued)
Opinion of Probable Project Costs
Water Distribution

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WDSC005	Florida Power and Light Water Main Extension	Capacity	$200,000
WDSC006	Military Trail to FPL Water Main Extension	Capacity	$480,000
WDSC007	Port W Blvd Pipeline Extension	Capacity	$290,000
WDSC008	Water Main Extension between White Drive and 42nd Terrace North	Capacity	$320,000
WDSC009	Water Main Extension between 49th Terrace North and Barbour Road	Capacity	$440,000
WDSC010	Military Trail Water Main Improvements	Capacity	$80,000
WDSC011	Blue Heron Boulevard Water Main Extension	Capacity	$390,000
WDSC012	Leo Lane Water Main Extension	Capacity	$200,000
WDSC013	Water Main Extension between Prospect Avenue Investment Lane	Capacity	$710,000
WDSC014	Silver Beach Road Water Main Connection on West Side of C-17 Canal	Capacity	$170,000
WDSC015	Silver Beach Road Water Main Connection on East Side of C-17 Canal	Capacity	$140,000
WDSC016	Gramercy Park Water Main Improvements	Capacity	$1,680,000
WDSC017	Intracoastal Crossing Failure Emergency Response Plan	Capacity	$40,000
WDSC018	Emergency Response Plan to Open Interconnects	Capacity	$30,000
WDSREG001	Unidirectional Flushing (UDF) Plan	Regulatory	$65,000

Table 12.3 (Continued)
Opinion of Probable Project Costs
Water Distribution

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WDSREG002	UDF Field Assistance	Regulatory	$1,100,000
WDSREG003	Secondary Disinfection System at Avenue U Booster Pump Station	Regulatory	$150,000
WDSREG004	Repump Station Operating Strategy Changes	Regulatory	$50,000
WDSREG005	Water Quality Testing Program	Regulatory	$200,000
WDSREG006	Automated Water Quality Monitoring	Regulatory	$480,000
WDSREG007	Stage 2 DBP Compliance Monitoring Plan	Regulatory	$20,000
WDSRR001	Asbestos Cement Pipe Replacement	R&R	$44,100,000
WDSRR002	Cast and Ductile Iron Pipe Replacement	R&R	$7,400,000
WDSRR003	Galvanized Steel Pipe Replacement	R&R	$1,650,000
WDSRR004	PVC Pipe Replacement	R&R	$2,790,000
WDSRR005	14-inch Intracoastal Crossing Pipeline Replacement	R&R	$3,410,000
WDSRR006	Miscellaneous Pipe Replacement	R&R	$19,200,000
WDSRR007	CRBUD Owned Backflow Preventer Replacement	R&R	$1,100,000
WDSRR008	Fire Hydrant Replacement	R&R	$3,180,000
WDSRR009	Annual Large Water Meter Replacement	R&R	$1,050,000

Table 12.3 (Continued)
Opinion of Probable Project Costs
Water Distribution

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WDSRR010	Automatic Flushing Device Replacement	R&R	$80,000
WDSRR011	Water Pressure Monitoring Station Replacement	R&R	$450,000
WDSRR012	Avenue C Repump Station Rehabilitation	R&R	$2,000,000
WDSRR013	Avenue U Repump Station Rehabilitation	R&R	$2,000,000
WDSRR014	NSI Repump Station Rehabilitation	R&R	$2,000,000
WDSRR015	MLK Road Construction (Phase C - Australian to Old Dixie)	R&R	$2,200,000
WDSRR016	Silver Beach Road Improvements	R&R	$240,000
WDSRR017	Utility Infrastructure in NSA	R&R	$500,000
WDSRR018	West 13th Infrastructure	R&R	$350,000
Total - Water Distribution			**$106,905,000**

12.6 Water System Security Projects

The opinion of probable costs for water system security related projects are presented in **Table 12.4**.

Table 12.4
Opinion of Probable Project Costs
Water System Security

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
SCRTY001	Water Treatment Plant	Water System Security	$900,000
SCRTY002	Repump Station No. 1 – Avenue “U”	Water System Security	$20,000
SCRTY003	Repump Station No. 2 – Avenue “C”	Water System Security	$15,000
SCRTY004	Repump Station No. 3 – North Singer Island	Water System Security	$15,000
SCRTY005	SCADA System	Water System Security	$60,000
Total - Water System Security			**$1,010,000**

12.7 Wastewater Collection System Projects

The opinion of probable costs for wastewater collection system related projects are presented in **Table 12.5**.

Table 12.5
Opinion of Probable Project Costs
Wastewater Collection

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WWRR001	Inflow and Infiltration Study and Sewer System Evaluation Survey	R&R	$491,000
WWRR002	Clay Pipe Lining	R&R	$17,000,000
WWRR003	Gravity Sewer Pipe Replacement	R&R	$4,800,000
Total - Wastewater Collection			**$22,291,000**

12.8 Wastewater Lift Station Projects

The opinion of probable costs for wastewater lift station related projects are presented in **Table 12.6**.

Table 12.6
Opinion of Probable Project Costs
Wastewater Lift Stations

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WWRR004	Lift Station 10 Replacement	R&R	$1,100,000
WWRR005	Lift Station 50 Replacement	R&R	$2,500,000
WWRR006	Replace Lift Stations 11, 13, 14, and 16	R&R	$820,000
WWRR007	Lift Station Rehabilitation – Phase 1	R&R	$4,410,000
WWRR008	Lift Station Rehabilitation – Phase 2	R&R	$2,940,000
WWRR009	Lift Station Rehabilitation – Phase 3	R&R	$2,940,000
WWRR010	Lift Station Rehabilitation – Phase 4	R&R	$1,470,000
WWRR011	Odor Study	R&R	$50,000
WWRR012	Lift Station 47 Rehabilitation	R&R	$2,200,000
WWRR020	Replacement of Lift Station Pumps	R&R	$1,050,000
WWREG001	Wastewater System Operation and Maintenance Manual	Regulatory	$50,000
WWREG002	ECR Biosolids Upgrade	Regulatory	Note 1
Total - Wastewater Lift Stations			**$19,530,000**

Note 1: *A capital cost for the ECR Biosolids Upgrade project is not included in this table. Rather, a cost for this project is included in the financial model (described in Section 14 titled "Financial Considerations") as a debt service.*

12.9 Wastewater Force Main Projects

The opinion of probable costs for wastewater force main related projects are presented in **Table 12.7**.

Table 12.7
Opinion of Probable Project Costs
Wastewater Force Mains

Project No.	Project Name	Improvement Type	Project Cost (Year 2012 $)
WWRR013	Force Main Pipe Replacement	R&R	$1,960,000
WWRR014	Parallel Intracoastal Force Main	R&R	$6,900,000
WWRR015	Routing Study for 16-inch Force Main Intracoastal Crossing	R&R	$100,000
WWRR016	Rehabilitate Existing 16-Inch Force Main Crossing the Intracoastal	R&R	$1,840,000
WWRR017	On-Call Underground Contractor	R&R	$2,000,000
WWRR018	Rehabilitation of the 30-inch Force Main Crossing of the M-Canal	R&R	$80,000
WWRR019	Rehabilitation of Aerial Pipeline Crossings	R&R	$170,000
WWCAP001	Strozier Street Force Main Upgrade	Capacity	$200,000
WWCAP002	C-17 Canal Crossing Wastewater Force Main Upgrade	Capacity	$600,000
Total - Wastewater Force Mains			**$13,850,000**

12.10 Summary of Project Costs by Category and Improvement Type

Table 12.8 presents an overall summary of the projects costs based on infrastructure category and improvement type.

Table 12.8
Opinion of Probable Projects Costs
Summarized by Category and Improvement Type

Category – Improvement Type (Note 1)	Project Cost (Year 2012 $)
Water Supply – Regulatory	$2,580,000
Water Supply – R&R	$15,814,000
Water Treatment Plant – Water Quality	$6,730,000
Water Treatment Plant – Regulatory	$930,000
Water Treatment Plant – R&R	$23,250,000
Water Treatment Plant – Facility Improvement	$1,500,000
Water Distribution System – Capacity	$11,140,000
Water Distribution System – Regulatory	$2,065,000
Water Distribution System – R&R	$93,700,000
Water System Security	$1,010,000
Wastewater – Regulatory	$50,000
Wastewater – R&R	$54,821,000
Wastewater – Capacity	$800,000
Total	**$214,390,000**

Note 1: *A capital cost for the ECR Biosolids Upgrade project is not included in this table. Rather, a cost for this project is included in the financial model (described in Section 14 titled "Financial Considerations") as a debt service.*

12.11 Summaries of Project Costs

Table 12.9 summarizes the water projects costs broken down by infrastructure area.

Table 12.9
Summary of Water Project Costs

Infrastructure Area	Project Cost (Year 2012 $)
Water Supply	$18,394,000
Water Treatment	$32,410,000
Water Distribution	$106,905,000
Water System Security	$1,010,000
Total - Water	**$158,719,000**

Table 12.10 summarizes the wastewater projects costs broken down by infrastructure area.

Table 12.10
Summary of Wastewater Project Costs (Note 1)

Infrastructure Area	Project Cost (Year 2012 $)
Wastewater Collection	$22,291,000
Wastewater Lift Stations	$19,530,000
Wastewater Force Mains	$13,850,000
Total - Wastewater	**$55,671,000**

Note 1: *A capital cost for the ECR Biosolids Upgrade project is not included in this table. Rather, a cost for this project is included in the financial model (described in Section 14 titled "Financial Considerations") as a debt service.*

Table 12.11 aggregates the water and wastewater costs and summarizes the costs broken down by improvement type.

Table 12.11
Summary of Costs by Improvement Type

Improvement Type	Project Cost (Year 2012 $)
Regulatory	$5,625,000
Renewal and Replacement	$187,585,000
Water Quality	$6,730,000
Facilities	$1,500,000
Capacity	$11,940,000
Water System Security	$1,010,000
Total	**$214,390,000**

Table 12.12 aggregates the water and wastewater projects costs to provide an overall cost summary.

Table 12.12
Overall Cost Summary

Infrastructure	Project Cost (Year 2012 $)
Water	$158,719,000
Wastewater	$55,671,000
Total	**$214,390,000**

Section 13.0
Project Implementation Plan

13.1 Introduction

Prior sections of this Master Plan included a series of recommended improvements to the City of Riviera Beach Utility District (CRBUD) water and wastewater infrastructure; the improvements were also aggregated into projects and assigned project numbers for the purpose of tracking implementation. This section of the Master Plan presents the methodology used to prioritize the projects. Two prioritization methodologies were utilized, as follows:

- Prioritization Methodology 1: Projects related to renewal and replacement (R&R) of existing infrastructure were prioritized using methodology 1, which factored in the condition, estimated remaining useful life, and the consequence of failure to assess the risk of failure of the existing infrastructure.

- Prioritization Methodology 2: Projects not related to R&R of existing infrastructure were prioritized using methodology 2, which assessed the consequences of not implementing the project relative to certain qualitative (criticality) parameters.

Certain improvement projects recommended in the prior sections of this report are not related to R&R of existing infrastructure. For example, Section 9 (titled "Water Distribution System") recommended adding automated water quality monitoring panels to certain locations in the water distribution system due to the ongoing challenge of low total chlorine residual in the Gramercy Park area. Assessing condition and remaining useful life is not meaningful relative to this type of project (since these projects are not related to existing infrastructure). Hence, projects that are not related to the R&R of existing infrastructure were prioritized using Methodology 2, which factored in the criticality of the recommended improvements.

This section also categorizes the prioritized projects into one of the following implementation timeframes: 1) urgent, 2) high, 3) medium, 4) low, and 5) programmatic. Additionally, project implementation cost schedules through the year 2032 are presented herein.

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13.2 Prioritization Methodology 1

13.2.1 Introduction

Prioritization methodology 1 was applied to projects related to R&R of existing infrastructure and was used to assess the risk of failure. Risk of failure was calculated as the product of the likelihood of failure and the consequence of failure as indicated in the following equation:

Risk of Failure = Likelihood of Failure X Consequence of Failure

Risk of failure is conceptually illustrated in **Figure 13.1**. Existing infrastructure with a high likelihood of failure and a high consequence of failure has a resultant high risk. Higher risk equates to higher prioritization for implementation. Once the risk of failure has been estimated, the projects can be ranked in order of priority and an implementation plan can be developed. The following two subsections present the methodology utilized to assess the likelihood of failure and the consequence of failure. A later subsection assesses risk and prioritizes and ranks the projects.

13.2.2 Likelihood of Failure

The likelihood of failure is based on an existing asset's physical condition and remaining useful life. For this Master Plan, physical condition was assessed for the existing water treatment plant, water repump stations, and the wastewater lift stations. The condition scores were based on **Table 13.1**, and the condition assessments are presented in the Appendices.

Table 13.1
Condition Score

Condition Description	Condition Score
Very good	1
Good	2
Fair	3
Poor	4
Very poor	5

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The CRBUD decided that assessing the physical condition for the existing raw water wellfield, water distribution system, wastewater collection system, and wastewater transmission system would not be included in this Master Plan. Consequently, the CRBUD staff, utilizing their expertise in the condition of these types of assets, assisted the project team in ranking the projects relative to each other.

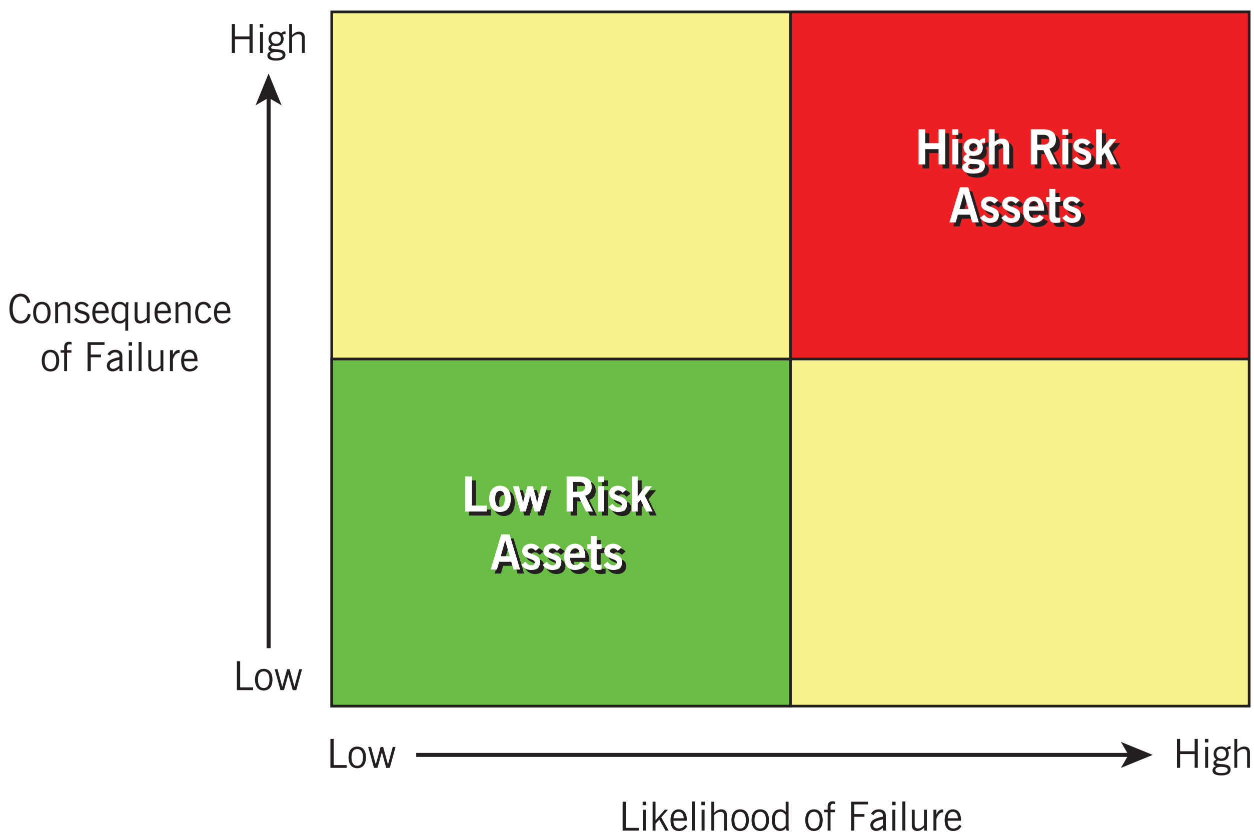

Figure 13-1
Risk of Failure

The estimated remaining useful life (in years) of an asset was based upon the age of the asset and an estimate of the expected average useful life. The age of the existing asset was based upon available records and input from the CRBUD staff. The expected average useful life of an asset was based upon an industry literature search and input from the CRBUD staff. The remaining useful life, in years, was converted to a numerical score in accordance with **Table 13.2**.

Table 13.2
Remaining Useful Life Score

Remaining Useful Life (years)	Remaining Useful Life Score
Greater than 15	1
5 to 15	3
Less than 5	5

The condition score and the useful life score were added together to determine the likelihood of failure score.

13.2.3 Consequence of Failure

When assets fail the consequences depend on the failure mode and level of redundancy. Consequences of failure can range from a minor inconvenience to major disruption of customer service, environmental damage and possibly result in danger to public health. The consequence of failure is assessed based upon a measure of the asset's criticality (e.g., a single asset of a type is more critical than an asset with redundancy). For this Master Plan, the consequence of failure was assessed based upon the following criticality parameters:

- Public Health and Safety
- Regulatory Compliance
- Ability to Return an Asset to Service
- Effect on Customers and Service

Each criticality parameter was weighted with an importance factor as indicated in **Table 13.3**.

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Table 13.3
Criticality Parameter Weighting

Criticality Parameter	Importance Factor
Public Health and Safety	35%
Regulatory Compliance	25%
Ability to Return Asset to Service	10%
Effect on Customers and Service	30%
Total	**100%**

Each criticality parameter was then assigned a score from 1 to 10 to describe the impact of failure on that parameter as negligible to severe, respectively. Descriptions of scores 1, 4, 7, and 10 relative to each criticality parameter are summarized below.

1. Public Health and Safety

   1 – Negligible (No adverse health effects or injuries)

   4 – Low (No lost time injuries or medical attention required)

   7 – Moderate (Medical attention required, lost time, or injuries)

   10 – Severe (Widespread outbreak of illness or loss of life)

2. Regulatory Compliance

   1 – Negligible (100 percent compliance with permits)

   4 – Low (Permit violations but no enforcement)

   7 – Moderate (Permit violations with minor enforcement action)

   10 – Severe (Enforcement with large fines, extensive environmental impact)

3. Ability to Return Asset to Service

   1 – Negligible (Redundant asset or service restored in less than 4 hrs)

   4 – Low (Service restored within 4 to 24 hrs)

   7 – Moderate (Service restored within 24 to 48 hrs)

   10 – Severe (Service not restored within 48 hrs)

4. Effect on Customers and Service

   1 – Negligible (No impact to customers, no taste and odor complaints, no service disruption)

   4 – Low (Infrequent taste and odor complaints, minor service disruption)

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7 – Moderate (Occasional taste and odor complaints, short term service disruption)

10 – Severe (Widespread taste and odor complaints, long term or widespread service disruption)

It is noted that the “taste and odor complaints” indicated in the “Effect on Customers and Service” criticality parameter applies to drinking water infrastructure only.

Relative to the “Effect on Customers and Service” criticality parameter, “minor service disruption” are disruptions in service for up to 8 hours; examples include the following:

- sanitary sewer lateral backup/clog;
- wastewater force main removed from service for planned repair;
- wastewater lift station removed from service for planned repair;
- customer water meter temporarily removed from service for planned repair;
- minor failure of a water distribution pipe that can be repaired within 8 hours by CRBUD staff;
- water repump station temporarily removed from service for planned repair; and
- temporary shutdown of the WTP for minor planned (or unplanned) repairs to a component such that water from storage is required to maintain service for up to 8 hours.

Relative to the “Effect on Customers and Service” criticality parameter, “short term service disruption” are disruptions in service from 8 to 24 hours; examples include the following:

- sanitary sewer lateral backup/clog;
- wastewater force main removed from service for planned repair or minor force main failure (such as a joint separation) that can be repaired within 24 hours;
- wastewater lift station removed from service for planned repair or minor failure (such as an electrical component) that can be repaired within 24 hours;
- minor failure of a water distribution pipe that can be repaired within 8 to 24 hours by CRBUD staff;
- minor failure of a water distribution pipe (or WTP) that results in a “boil water” order from the health department;

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- water repump station temporarily removed from service for planned repair or minor component failure (such as an electrical component) that can be repaired within 24 hours; and
- temporary shutdown of the WTP for minor planned (or unplanned) repairs to a component such that water from storage is required to maintain service for 8 to 24 hours.

Relative to the “Effect on Customers and Service” criticality parameter, “long term or widespread service disruption” are disruptions in service lasting longer than 24 hours; examples include the following:

- wastewater force main break that requires extensive contractor assistance to repair (such as a failure of the force main crossing the Intracoastal Waterway);
- wastewater lift station failure that requires by-pass pumping of the lift station for a period longer than 24 hours (such as an extended power disruption);
- water distribution pipe break that requires extensive contractor assistance to repair (such as a failure of a water main crossing the Intracoastal Waterway);
- water repump station failure that requires extensive contractor assistance to repair (such as a failure of long lead time electrical component); and
- partial or full shutdown of a major component at the WTP that impacts either quantity that can be produced (such a treatment unit failure) or quality of the finished water (such as the disinfection system) for period longer than 24 hours.

For each recommended project, a score of 1 to 10 was assigned for each criticality parameter, multiplied by importance factors and then the products were totaled. The total value represents the consequence of failure.

13.2.4 Prioritization and Ranking

The risk of failure value was calculated for all R&R type projects. The risk value represents the priority of the project relative to other projects scored using the same methodology. The risk of failure value was used to initially rank the projects from highest to lowest priority.

In certain cases, the CRBUD staff decided to rank projects higher than determined via the above described scoring methodology to account for qualitative issues associated with a particular project.

There is no direct comparison between the scores using prioritization methodologies 1 and 2. The ranks of the projects using the two methodologies were compared with each other and then ranked relative to each other, based on input from the CRBUD staff, to determine an overall ranking for each project.

13.3 Prioritization Methodology 2

13.3.1 Introduction

Prioritization methodology 2 was applied to projects that are not related to R&R of existing infrastructure. Projects that are not related to R&R of existing infrastructure include: new infrastructure recommended to achieve regulatory compliance, water quality related improvements (such as looping of water distribution piping and testing of water treatment plant process improvements), and capacity driven improvement projects.

Prioritization methodology 2 was used to assess the criticality of the recommended improvements based on a set of weighted factors as described in the next subsection.

13.3.2 Criticality Analysis

Assessing a project on criticality parameters provides a method for comparison of the project with other projects on a non-cost basis. For this Master Plan, a total of four criticality parameters were selected for assessing each project not related to R&R of existing infrastructure as follows:

- Public Health and Safety
- Regulatory Compliance
- Ability to Return an Asset to Service
- Effect on Customers and Service

Each criticality parameter was weighted with an importance factor as indicated in **Table 13.4**.

Table 13.4
Criticality Parameter Weighting

Criticality Parameter	Importance Factor
Public Health and Safety	35%
Regulatory Compliance	25%
Ability to Return Asset to Service	10%
Effect on Customers and Service	30%
Total	**100%**

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Each criticality parameter was then assigned a score from 1 to 10 to qualitatively describe the impact if the project were not implemented. Descriptions of scores 1, 4, 7, and 10 relative to each criticality parameter are summarized below.

1. Public Health and Safety

   1 – Negligible (No adverse health effects or injuries)

   4 – Low (No lost time injuries or medical attention required)

   7 – Moderate (Medical attention required, lost time, or injuries)

   10 – Severe (Widespread outbreak of illness or loss of life)

2. Regulatory Compliance

   1 – Negligible (100 percent compliance with permits)

   4 – Low (Permit violations but no enforcement)

   7 – Moderate (Permit violations with minor enforcement action)

   10 – Severe (Enforcement with large fines, extensive environmental impact)

3. Ability to Return Asset to Service

   1 – Negligible (Redundant asset or service restored in less than 4 hrs)

   4 – Low (Service restored within 4 to 24 hrs)

   7 – Moderate (Service restored within 24 to 48 hrs)

   10 – Severe (Service not restored within 48 hrs)

4. Effect on Customers and Service

   1 – Negligible (No impact to customers, no taste and odor complaints, no service disruption)

   4 – Low (Infrequent taste and odor complaints, minor service disruption)

   7 – Moderate (Occasional taste and odor complaints, short term service disruption)

   10 – Severe (Widespread taste and odor complaints, long term or widespread service disruption)

It is noted that the “taste and odor complaints” indicated in the “Effect on Customers and Service” criticality parameter applies to drinking water infrastructure only.

Relative to the "Effect on Customers and Service" criticality parameter, examples of "minor service disruption"; "short term service disruption"; and "long term or widespread service disruption" are presented in subsection 13.2.3.

13.3.3 Prioritization and Ranking

For each recommended project, a score of 1 to 10 was assigned for each criticality parameter, multiplied by importance factors and then the products were totaled. The value represents the criticality of the project relative to other projects scored using the same methodology. The criticality value was used to initially rank the projects from highest to lowest priority.

In certain cases, the CRBUD staff decided to rank projects higher than determined via the above described scoring methodology to account for qualitative issues associated with a particular project.

There is no direct comparison between the scores using prioritization methodologies 1 and 2. The ranks of the projects using the two methodologies were compared with each other and then ranked relative to each other, based on input from the CRBUD staff, to determine an overall ranking for each project.

13.4 Project Implementation Timeframes

The ranked projects were grouped into implementation timeframes as indicated in **Table 13.5**. The ranking, grouping and implementation timeframes presented below are not intended to take into account the feasibility to fund the projects. Rather, the ranking, grouping and implementation timeframes are presented as an idealized goal based upon the project team's judgment of infrastructure needs. Given limitations on available funding, the CRBUD should use the rankings presented in subsection 13.5 as a basis for making investment decisions.

Table 13.5
Implementation Timeframes

Group	Description	Implementation Timeframe Fiscal Year
1	Urgent Priority: High likelihood of asset failure with severe consequences if asset fails for R&R type project (or severe consequences for non-implementation of non-R&R projects).	2013 to 2015
2	High Priority: Medium to high likelihood of asset failure with medium to high consequences if asset fails for R&R type project (or medium to high consequences for non-implementation of non-R&R projects).	2016 to 2020
3	Medium Priority: Low to medium likelihood asset failure with low to medium severity of consequences if asset fails for R&R type projects (or low to medium consequences for non-implementation of non-R&R projects).	2021 to 2025
4	Low Priority: Low likelihood of asset failure and low consequences if asset fails for R&R type project (or low consequences for non-implementation of non-R&R projects).	2026 and beyond
P	Programmatic: Certain types of projects lend themselves to implementation on an annual (or otherwise recurring) basis, such as annual fire hydrant replacement. These types of projects were categorized as programmatic.	Annually

Actual timeframes for implementation of projects depends upon budget limitations, which are described in subsection 13.6.

13.5 Project Ranking

A meeting was conducted with CRBUD staff on October 4, 2012. During this meeting the scoring method was reviewed, the scoring ranges and weighting factors were agreed upon, and project rankings and implementation timeframes were adjusted based upon CRBUD input. The project team met again on October 24, 2012 to review the project rankings and obtain certain data relative to preparing a financial model to assess the feasibility of funding the capital improvement program. The project rankings were finalized at the October 24, 2012.

Table 13.6 presents the water projects ranking and grouping results.

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Table 13.6
Water Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
1	WTPRR007	Water Treatment Plant Disinfection	**$3,800,000**	1
2	WTPRR006	Aqueous Ammonia System	**$470,000**	1
3	WTPRR008	WTP Flow Meter Replacements and Additions	**$650,000**	1
4	WDSC002	16-inch Intracoastal Crossing Water Main	**$3,080,000**	1
5	WTPRR004 & WTPWQ008	Replacement of Lime Slakers and New Lime Slurry System	**$4,200,000**	1
6	WTPRR001	Air Stripper Media Replacement	**$600,000**	1
7	WTPWQ007	Filters 1-8 Surface Wash System	**$450,000**	1
8	WTPWQ006	Calcium Sequesterant Storage and Feed System	**$150,000**	1
9	WTPWQ005	Filters 1-8 Media and Underdrain Replacement	**$2,400,000**	1
10	WDSREG003	Secondary Disinfection System at Avenue U Booster Pump Station	**$150,000**	1
11	WTPWQ004	Create Filter Media Evaluation Program Document	**$30,000**	1
12	WDSC017	Intracoastal Crossing Failure Emergency Response Plan	**$40,000**	1
13	WDSC018	Emergency Response Plan to Open Interconnects	**$30,000**	1

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Table 13.6 (continued)
Water Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
14	WDSREG001	Unidirectional Flushing (UDF) Plan	**$65,000**	1
15	WDSREG002	UDF Field Assistance	**$1,100,000**	1
16	WDSREG007	Stage 2 DBP Compliance Monitoring Plan	**$20,000**	1
17	WDSREG006	Automated Water Quality Monitoring	**$480,000**	1
18	WDSREG005	Water Quality Testing Program	**$200,000**	P, 1 (Note 1)
19	WELLREG002	Proposed Salt Water Monitor Well (required by SFWMD)	**$30,000**	1
20	WTPWQ001	Ferric Chloride and Sodium Hypochlorite Full-Scale Testing	**$490,000**	1
21	WTPWQ002	Ferric Chloride Storage and Feed System	**$950,000**	1
22	WDSREG004	Repump Station Operating Strategy Changes	**$50,000**	1
23	SCRTY001	New WTP Perimeter Wall	**$900,000**	1
24	SCRTY002	Site Security - Avenue U Repump	**$20,000**	1
25	SCRTY003	Site Security - Avenue C Repump	**$15,000**	1
26	SCRTY004	Site Security - NSI Repump	**$15,000**	1
27	SCRTY005	Site Security - SCADA System	**$60,000**	1
28	WTPRR009	Filter Crack Repair	**$400,000**	1
29	WDSRR015	MLK Road Construction (Phase C - Australian to Old Dixie)	**$2,200,000**	1
30	WDSRR016	Silver Beach Road Improvements	**$240,000**	1
31	WDSRR017	Utility Infrastructure in NSA	**$500,000**	1

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Table 13.6 (continued)
Water Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
32	WDSRR018	West 13th Infrastructure	**$350,000**	1
33	WELLREG001	New Raw Water Wells A and B	**$2,200,000**	2
34	WTPRR003	Rehabilitation of Lime Softening Units	**$1,100,000**	2
35	WTPRR018	WTP Field Instrument Replacement	**$400,000**	2
36	WTPRR019	Primary Logic Controller (PLC) Re-placement	**$740,000**	2
37	WTPRR022	Emergency Generator and Fuel System Replacement	**$630,000**	2
38	WTPRR024	North Filter Building Door and Window Replacement	**$200,000**	2
39	WTPFI001	New Utility Field Operations Building	**$1,100,000**	2
40	WTPRR020	WTP Electrical Single Line Diagram	**$40,000**	2
41	WDSC004	Avenue P Water Main	**$1,000,000**	2
42	WDSC005	Florida Power and Light Water Main Extension	**$200,000**	2
43	WDSC006	Military Trail to FPL Water Main Extension	**$480,000**	2
44	WDSC007	Port W Blvd Pipeline Extension	**$290,000**	2
45	WDSC008	Water Main Extension between White Drive and 42nd Terrace North	**$320,000**	2
46	WDSC009	Water Main Extension between 49th Terrace North and Barbour Road	**$440,000**	2
47	WDSC010	Military Trail Water Main Improvements	**$80,000**	2
48	WDSC011	Blue Heron Boulevard Water Main Extension	**$390,000**	2
49	WDSC012	Leo Lane Water Main Extension	**$200,000**	2

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Table 13.6 (continued)
Water Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
50	WDSC013	Water Main Extension between Prospect Avenue Investment Lane	**$710,000**	2
51	WDSC014	Silver Beach Road Water Main Connection on West Side of C-17 Canal	**$170,000**	2
52	WDSC015	Silver Beach Road Water Main Connection on East Side of C-17 Canal	**$140,000**	2
53	WDSC016	Gramercy Park Water Main Improvements	**$1,680,000**	2
54	WDSRR005	14-inch Intracoastal Crossing Pipeline Replacement	**$3,410,000**	2
55	WTPRR011	Filter 9-16 Media and Underdrain Replacement	**$1,990,000**	3
56	WTPRR013	Filter 1-8 Valve and Actuator Replace-ment	**$1,020,000**	3
57	WTPRR014	Filter 9-16 Valve and Actuator Replacement	**$1,180,000**	3
58	WTPRR012	Backwash System Valve and Control Replacement	**$100,000**	3
59	WTPWQ003	Automatically Track Filter Run Hours	**$60,000**	3
60	WELLRR005	Drill and Equip New Replacement Wells – Phase 1	**$2,900,000**	3
61	WELLRR004	Convert Production Well to Monitor Well	**$34,000**	3
62	WDSRR011	Water Pressure Monitoring Station Replacement	**$450,000**	3
63	WDSRR012	Avenue C Repump Station Rehabilitation	**$2,000,000**	3
64	WDSRR013	Avenue U Repump Station Rehabilitation	**$2,000,000**	3
65	WDSC001	North Singer Island Large Water Main	**$1,300,000**	4
66	WTPRR015	Finished Water Transfer Pump Replacement	**$250,000**	4
67	WTPRR002	Raw Water Transfer Pump Replacement	**$1,090,000**	4

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Table 13.6 (continued)
Water Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
68	WTPRR016	High Service Pump Replacement	**$1,880,000**	4
69	WTPRR005	Replacement of Lime Silos	**$2,100,000**	4
70	WTPRR010	Filter 1-8 HMI and Blower Replacement	**$250,000**	4
71	WTPRR021	Electrical Equipment Replacement	**$180,000**	4
72	WDSC003	Port of Palm Beach Water Main	**$590,000**	4
73	WELLRR006	Drill and Equip New Replacement Wells – Phase 2	**$2,900,000**	4
74	WDSRR014	NSI Repump Station Rehabilitation	**$2,000,000**	4
75	WTPRR023	Plant Power System Analysis	**$180,000**	4
76	WTPRR017	Blue Heron Boulevard Tank Replacement	**$2,000,000**	4
77	WTPREG001	Ground Water Rule 4-log Virus Treatment Certification Study	**$280,000**	4
78	WTPREG002	Capital Improvements for 4-log Virus Treatment	**$650,000**	4
79	WTPFI002	Fluoride System	**$400,000**	P
80	WELLREG003	GWR Sanitary Survey Improvements (every 3 years)	**$350,000**	P
81	WELLRR001	Annual Specific Capacity Testing	**$1,800,000**	P
82	WELLRR002	Well Pump Replacement	**$4,000,000**	P
83	WELLRR003	Rehabilitation of Raw Water Wells	**$2,000,000**	P
84	WELLRR007	Raw Water Asbestos Cement Piping Replacement	**$2,180,000**	P
85	WDSRR001	Asbestos Cement Pipe Replacement	**$44,100,000**	P

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Table 13.6 (continued)
Water Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
86	WDSRR002	Cast and Ductile Iron Pipe Replacement	**$7,400,000**	P
87	WDSRR003	Galvanized Steel Pipe Replacement	**$1,650,000**	P
88	WDSRR004	PVC Pipe Replacement	**$2,790,000**	P
89	WDSRR006	Miscellaneous Pipe Replacement	**$19,200,000**	P
90	WDSRR007	CRBUD Owned Backflow Preventer Replacement	**$1,100,000**	P
91	WDSRR008	Fire Hydrant Replacement	**$3,180,000**	P
92	WDSRR009	Replacement of Large Water Meters	**$1,050,000**	P
93	WDSRR010	Automatic Flushing Device Replacement	**$80,000**	P
Total			**$158,719,000**	

Notes:

1: The "Water Quality Testing Program" is a programmatic type project that the CRBUD staff elected to rank with Group 1 to emphasize the importance of the programmatic need.

P: Projects denoted as group “P” are programmatic, which lend themselves to implementation on a recurring periodic basis over the life of the capital improvement program.

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Table 13.7 presents the wastewater projects ranking and grouping results.

Table 13.7
Wastewater Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
1	WWRR014 & WWRR015	Parallel Intracoastal Force Main (16-inch FM routing study, design & construction)	**$7,000,000**	1
2	WWRR017	On-Call Underground Contractor	**$2,000,000**	P, 1 (Note 1)
3	WWRR005	Lift Station 50 Replacement	**$2,500,000**	1
4	WWRR004	Lift Station 10 Replacement	**$1,100,000**	1
5	WWRR018	Aerial Crossing Rehabilitation (30-inch Force Main Crossing of the M-Canal)	**$80,000**	1
6	WWRR019	Aerial Crossing Rehabilitation (other crossings)	**$170,000**	1
7	WWRR012	Lift Station 47 Rehabilitation	**$2,200,000**	1
8	WWRR006	Replace Lift Stations 11, 13, 14, and 16	**$820,000**	2
9	WWRR007	Lift Station Rehabilitation – Phase 1	**$4,410,000**	2
10	WWRR008	Lift Station Rehabilitation – Phase 2	**$2,940,000**	2
11	WWRR009	Lift Station Rehabilitation – Phase 3	**$2,940,000**	3
12	WWREG001	Wastewater System Operation and Maintenance Manual	**$50,000**	4
13	WWRR010	Lift Station Rehabilitation – Phase 4	**$1,470,000**	4
14	WWRR016	Rehabilitate Existing 16-Inch Force Main Crossing the Intracoastal	**$1,840,000**	4
15	WWRR001	Inflow and Infiltration Study and Sewer System Evaluation Survey	**$491,000**	4

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Table 13.7 (continued)
Wastewater Projects Ranking and Grouping

Rank	Project No.	Project Name	Project Cost (Year 2012 $)	Group
16	WWRR011	Odor Study	**$50,000**	4
17	WWCAP001	Strozier Street Force Main Upgrade	**$200,000**	4
18	WWCAP002	C-17 Canal Crossing Wastewater Force Main Upgrade	**$600,000**	4
19	WWRR020	Replacement of Lift Station Pumps	**$1,050,000**	P
20	WWRR013	Force Main Pipe Replacement	**$1,960,000**	P
21	WWRR002	Clay Pipe Lining	**$17,000,000**	P
22	WWRR003	Gravity Sewer Pipe Replacement	**$4,800,000**	P
Total			**$55,671,000**	

Notes:

1: The "On-Call Underground Contractor" is a programmatic type project that the CRBUD staff elected to rank with Group 1 to emphasize the importance of the programmatic need.

P: Projects denoted as group "P" are programmatic, which lend themselves to implementation on a recurring periodic basis over the life of the capital improvement program.

As indicated in subsection 13.4, the ranking, grouping and implementation timeframes presented above are idealized and do not account for funding limitations. Actual timeframes for implementation of projects depends upon budget limitations described in the next subsection.

13.6 Budget Limitations

Table 13.8 presents a summary of the expenditure timeframe based upon the rankings and "idealized" implementation timeframes presented above. The "idealized" implementation timeframes do not consider the feasibility of project funding.

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Table 13.8
Capital Improvement Program Expenditure Summary
Based on Idealized Implementation Timeframes

Category	FY 2013 to 2015	FY 2016 to 2020	FY 2021 to 2025	FY 2026 and beyond	Total
Water	$23,765,000	$26,110,000	$34,409,000	$74,435,000	$158,719,000
Wastewater	$ 8,241,000	$20,744,000	$10,866,000	$15,820,000	$ 55,671,000
Total	**$32,006,000**	**$46,854,000**	**$45,275,000**	**$90,255,000**	**$214,390,000**

Legend: *FY: Fiscal Year.*

Section 14 (titled "Financial Consideration") reflects the assessment of the financial condition of the CRBUD to determine the feasibility of funding the projects recommended in this Master Plan. Based upon financial modeling, it was determined that the above expenditure timeframes would require significant near term rate increases, above those already planned by the CRBUD prior to initiating this report.

The CRBUD staff decided that for the first 11 years (i.e., fiscal years 2013 to 2023) of the capital improvement program, expenditures would need to be limited to urgent and high priority capital improvements, based upon the assumptions listed below, to maintain rate increases at an acceptable level:

- Group 1 and the vast majority of Group 2 (i.e., urgent and high priority ranking) projects would be included in the capital improvement program and the costs would be spread out from fiscal year 2013 to 2023;
- Group 3 and 4 projects (and approximately $2.35M of Group 2 projects) would not be included in the first 11 years of the capital improvement program and would be implemented sometime after fiscal year 2023; and
- Programmatic type wastewater projects would be funded at approximately 36 percent of the estimated need for the first 11 years with the balance of the improvement needs being delayed until after fiscal year 2023.
- Programmatic type water projects would be funded at approximately 25 percent of the estimated need for the first 11 years with the balance of the improvement needs being delayed until after fiscal year 2023.

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13.7 Capital Improvement Program Expenditure Schedule

Based on financial considerations and the assumptions above, a plausible expenditure schedule for the capital improvement program is presented in **Table 13.9**.

Table 13.9
Capital Improvement Program Expenditure Schedule

Category	**FY 2013 to 2017**	**FY 2018 to 2023**	**FY 2024 and Beyond**	**Total**
Water	$30,185,000	$35,525,000	$ 96,009,000	$158,719,000
Wastewater	$16,270,000	$12,948,000	$ 26,453,000	$ 55,671,000
Total	**$46,455,000**	**$45,473,000**	**$122,462,000**	**$214,390,000**

Legend: *FY: Fiscal Year.*

Note: *Costs are in 2012 dollars.*

The financial feasibility of the capital improvement schedule presented in **Table 13.9** is assessed in Section 14 (titled "Financial Consideration") of this report.

It is recommended that the CRBUD update this Master Plan on a five year cycle and reassess the ranking of the projects, financial forecast and associated capital improvement program expenditure schedule.

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Section 14.0
Financial Considerations

14.1 Introduction

As presented in the previous sections of the City of Riviera Beach Utility District's (CRBUD's) Water and Wastewater Master Plan ("Master Plan"), a significant amount of capital improvements have been recommended for the Water and Wastewater System ("System"). The primary purpose of the master planning process was to: 1) identify the total estimated short- and long-term capital needs of the System and the general timing of such needs; and 2) ensure, for the wastewater system, that it adequately funds the capital needs and capital cost recovery practices consistent with the financial requirements for the East Central Regional Water Reclamation Facility ("ECRWRF") of which the CRBUD is a participant. The ECRWRF is governed by a Board (the "ECR Board") whose members are comprised of the partnered entities which include the City of West Palm Beach, the City of Lake Worth, the City of Riviera Beach, the Town of Palm Beach, and Palm Beach County. The mission of the ECR Board is to operate and maintain the wastewater treatment and disposal facility in a cost-effective, reliable, and safe manner which meets all Federal, State and local permits and regulations.

Based on the identified capital needs of the CRBUD, the associated operational expenditure requirements that are anticipated to result, in part, from the implementation of these capital requirements, and to provide additional information as part of the master planning process, a capital funding plan has been prepared for consideration by the CRBUD. The primary purpose of the capital funding plan is to: 1) assist in the prioritization and timing of the identified capital needs based on certain assumptions regarding funds availability; and 2) identify the potential financial impacts and rate adjustments which may be necessary for the implementation of the capital improvement program. With respect to the capital funding plan, an eleven-year forecast period representing the current budget year 2013 and the ten Fiscal Year period 2014-2023 (collectively, the "Forecast Period") was recognized for purposes of financial trending and overall strategic planning.

14.2 Methodology

In the development of the financial analysis for the evaluation of the capital funding plan and in the determination of potential increases in water (including irrigation) and wastewater rates for service, a generally accepted approach to the development of the available funds for future capital needs and the overall funding requirements from rates (referred to as the "Revenue Requirements") was recognized. This method, which is

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commonly used by public utilities that have issued utility bonds in support of the funding of capital improvements, included the following general approach:

1. An evaluation of the utility area service requirements for the individual water and wastewater systems was performed. This included a review of recent historical customers served and corresponding usage requirements such that: 1) a representative forecast of CRBUD System needs on a "By Utility – By Customer Class" basis from a financial standpoint could be prepared; and 2) a projection of rate revenues consistent with the service area needs could be developed.

2. A projection of the Net Revenue Requirements from rates, which equates to the expenditure requirements funded from monthly user charges, was developed. A summary of the derivation of the Net Revenue Requirements is summarized below:

   + Cost of Operation and Maintenance
   + Debt Service Payments (Senior and Subordinate)
   + Transfers and Administration Payments
   + Capital Project Financing (Pay-As-You-Go and Additional Bonds)
   + Working Capital Reserves / Financial Compliance
   − Other Operating Revenue
   − Interest Income
   − Any Other Sources of Income (e.g., Grants or Contributions)
   = Net Revenue Requirements (Expenditures Funded from Rates)

3. Included as a component of Net Revenue Requirements was the capital funding plan (of the capital improvements) as previously discussed in this Report. The funding of the capital improvements recognized the following parameters: 1) the use of any available operating reserves as a first priority; 2) the recognition of an increasing pay-as-you-go program (funded by deposits to a Renewal and Replacement Fund from rates); and 3) the use of long-term debt financing to fund projects that are unable to be funded by available cash.

4. A component of the financial evaluation included the review of the cash balances of the various funds and accounts that are or should be maintained by the City on behalf of the CRBUD. The objective of this evaluation was to identify funds available for future capital expenditures and to project minimum fund balances to maintain adequate working capital balances.

5. Maintain compliance with the rate covenant requirements outlined in Bond Resolution 01-04 (the "Bond Resolution") which authorized the issuance of the

Water and Sewer Revenue Bonds, Series 2004 (the "Series 2004 Bonds") and which will be relied upon for the issuance of any additional parity bonds, and any other subordinate loan documents.

6. Determine the necessary annual rate adjustments that would be considered as sustainable and which will be required to fund the Net Revenue Requirements, the assumed capital plan based on the availability of funds produced by such rates, and to meet the overall financial needs of the CRBUD with a target to: 1)limit any additional increases during the Forecast Period, where practical, to inflationary-related levels while ii) maintaining minimum working capital reserves to mitigate any near-term financial risks due to unplanned or extraordinary events that may occur.

The remainder of this section provides a discussion of the financial forecast, including the estimate of the customers served by the CRBUD, the projection of the Gross Revenues and corresponding Net Revenue Requirements of the CRBUD, a discussion of the CRBUD revenues, and a presentation of our observations and conclusions relative to the financial analysis.

14.3 Customer Statistics

14.3.1 General

As mentioned above a major component in the determination of the sufficiency of the rates to meet the CRBUD's capital plan is the projection of water and wastewater demand and customers served. The customer statistics that represent the determinants for developing future sales revenues consist of two main components: 1) the number of individual meters in active service (customers); and 2) their respective demand (metered or billed use) for water and wastewater service. Collectively, these components drive the forecast of sales revenues and certain other miscellaneous revenues. It should be noted that the customer and demand forecast recognized for the financial forecast is generally different than the forecast prepared for developing the capital planning needs as previously identified in the Report. The financial forecast does not rely on linear population projections used for long-term planning purposes but relies on the actual customers being served, trends in monthly usage or billed sales, and the overall revenues being received from rates. Generally the customer and sales forecast is lower in the near term than a capital planning forecast. This section provides for the principal assumptions and determinations made in the forecast of projected customer statistics.

14.3.2 Water System

In order to evaluate trends in Water System customer growth and sales (monthly use per customer), an evaluation of the three years ended September 30, 2012 (the "Historical

Period") statistics was evaluated. A review of the recent trends in change in customers served and the corresponding sales growth indicated that the Water System has experienced marginal decreases in customers and sales as a result of a continued negative economic conditions, which has been further compromised in terms of water sales due to water use restrictions that were implemented by the City pursuant to Ordinance No. 3085 Sec. 20-124. Regarding the effects of water restrictions, our experience has indicated that once customers become acclimated to new usage patterns, for example using less water due to mandated watering restrictions, the usage patterns rarely return to those levels in effect prior to the water use restrictions.

As previously mentioned, the continued sluggish economy is considered to be directly affecting customer growth and water sales. The marginal trends are due to a depressed housing market, which has affected water use by active customers, water use associated with new construction / re-development (which effects annual water use), as well as the potential water use by seasonal customers that annually return to the CRBUD and the length of time that the seasonal customers may stay. Additionally, the City of Riviera Beach, which in the past used large amounts of water to irrigate City property, is considered one of the larger users of the CRBUD's Water System. The City, based on recommendations of the CRBUD staff, have installed raw water wells throughout the CRBUD in continuing efforts to reduce the amount of "finished" water that has been used to irrigate City property. All of these issues have had a direct effect on utility sales and revenues.

The historical customer statistics were based on the "Period Billing Reports" provided by CRBUD staff for the Historical Period and are summarized in **Table 14.1**.

Table 14.1
Historical Water System Customer and Sales Statistics by Class

Description	Fiscal Year Ended September 30, 2010	2011	2012
Residential – Single Family:			
Average Annual Accounts	11,493	11,563	11,489
Annual Consumption (Kgal)	763,376	762,617	715,786
Average Monthly Use per Account	5,535	5,496	5,192
Residential – Multi Family			
Average Annual Accounts	620	622	624
Annual Consumption (Kgal)	490,622	497,234	488,019
Average Monthly Use per Account	65,926	66,609	65,156
Commercial			
Average Annual Accounts	1,198	1,180	1,187
Annual Consumption (Kgal)	484,164	459,332	450,203
Average Monthly Use per Account	33,674	32,439	31,598
Hotel / Motel			
Average Annual Accounts	30	25	26
Annual Consumption (Kgal)	70,836	70,703	64,683
Average Monthly Use per Account	198,978	235,677	207,317
Total Water System			
Average Annual Accounts	13,341	13,391	13,326
Annual Consumption (Kgal)	1,808,998	1,789,886	1,718,691
Average Monthly Use per Account	11,299	11,139	10,748

Note: *Amounts shown based on information as provided by the CRBUD from its utility billing reports for each respective year shown.*

As can be seen above for the most recently completed Fiscal Year (2012), the CRBUD provided service to approximately 13,326 average annual retail water accounts, which represents a decrease in customers served of approximately 0.48% when compared to Fiscal Year 2011 results. The 3-year average annual growth rate for the Water System during the Historical Period was a negative growth rate of approximately (0.06%). Additionally as can be seen above, the average use per account for all customers served has declined by approximately (4.3)% since Fiscal Year 2010. Based on these recent historical trends, discussions with CRBUD staff, and assumptions made by PRMG, projections of water customer account and corresponding sales statistics for the Fiscal Years 2013 through 2023 (the "Forecast Period") were developed. This forecast served as the basis for the development of the projected revenues from current and approved rates for the Forecast Period. This Water System customer and sales forecast is shown on **Table 14.2** below.

Table 14.2
Projected Water System Customer and Sales Statistics by Class

Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Projected Fiscal Year Ending September 30,										
Residential – Single Family:											
Average Annual Accounts	11,489	11,519	11,549	11,579	11,609	11,639	11,669	11,699	11,729	11,759	11,789
Annual Consumption (Kgal)	689,325	691,125	692,925	694,725	696,525	698,325	700,125	701,925	703,725	705,525	707,325
Average Monthly Use per Account	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Residential – Multi Family											
Average Annual Accounts	624	624	624	624	624	624	624	624	624	624	624
Annual Consumption (Kgal)	486,850	486,850	486,850	486,850	486,850	486,850	486,850	486,850	486,850	486,850	486,850
Average Monthly Use per Account	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
Commercial											
Average Annual Accounts	1,187	1,191	1,195	1,199	1,203	1,207	1,211	1,215	1,219	1,223	1,227
Annual Consumption (Kgal)	453,799	455,328	456,856	458,385	459,914	461,443	462,972	464,500	466,029	467,558	469,087
Average Monthly Use per Account	24,500	24,500	24,500	24,500	24,500	24,500	24,500	24,500	24,500	24,500	24,500
Hotel/Motel											
Average Annual Accounts	26	26	26	26	26	26	26	26	26	26	26
Annual Consumption (Kgal)	49,608	49,608	49,608	49,608	49,608	49,608	49,608	49,608	49,608	49,608	49,608
Average Monthly Use per Account	159,000	159,000	159,000	159,000	159,000	159,000	159,000	159,000	159,000	159,000	159,000
Total Water System											
Average Annual Accounts	13,326	13,360	13,394	13,428	13,462	13,496	13,530	13,564	13,598	13,632	13,666
Annual Consumption (Kgal)	1,679,582	1,682,911	1,686,239	1,689,568	1,692,897	1,696,226	1,699,555	1,702,883	1,706,212	1,709,541	1,712,870
Average Monthly Use per Account	10,503	10,497	10,491	10,485	10,479	10,473	10,468	10,462	10,456	10,450	10,445

As can be seen on **Table 14.2**, the forecast in the Water System customers assumes an average annual compound growth rate approximating 0.25% per year (essentially no real change in customers served) with the growth being considered to be primarily residential in nature (assumed limited commercial growth). The customer growth rate for the Forecast Period was based on an assumed increase in accounts averaging 30 new accounts per year for the single family residential class and an assumed four new accounts per year for the commercial customer class. The average water sales per account were assumed to continue at the reduced levels, which correspond more closely to the actual Fiscal Year 2012 levels. Specifically and based on discussions with CRBUD staff, the average use per water customer over the Forecast Period was assumed to decrease slightly in Fiscal Year 2013 and was subsequently held constant thereafter which was considered as a reasonable approach for the development of the Forecast Period water sales.

14.3.3 Wastewater System

The Wastewater System has experienced similar declines in both the customer base and billed wastewater (sales) levels when compared to the Water System. In Fiscal Year 2012 the CRBUD served approximately 13,274 wastewater accounts (99.6% of the total water accounts, exclusive of separately metered use, served in Fiscal Year 2012). The historical wastewater customer accounts and billed flow (sales) statistics as reported by the CRBUD for the Historical Period is summarized in **Table 14.3**.

Table 14.3
Historical Wastewater System Customer and Billed Flow Statistics by Class

Description	Fiscal Year Ended September 30, 2010	2011	2012
Residential – Single Family:			
Average Annual Accounts	11,497	11,566	11,492
Annual Billed Flow (Kgal)	763,376	762,614	716,293
Average Monthly Use per Account	5,533	5,495	5,194
Residential – Multi Family			
Average Annual Accounts	620	622	623
Annual Billed Flow (Kgal)	486,773	493,807	483,155
Average Monthly Use per Account	65,409	66,150	64,653
Commercial			
Average Annual Accounts	1,143	1,127	1,134
Annual Billed Flow (Kgal)	376,937	355,402	373,889
Average Monthly Use per Account	27,488	26,289	27,482
Hotel/Motel			
Average Annual Accounts	29	24	25
Annual Billed Flow (Kgal)	70,142	70,703	64,683
Average Monthly Use per Account	205,094	245,497	217,057
Total Wastewater System			
Average Annual Accounts	13,289	13,339	13,274
Annual Billed Flow (Kgal)	1,697,228	1,682,526	1,638,020
Average Monthly Use per Account	10,643	10,512	10,284

As can be seen above, the Wastewater System provided service to an estimated 13,274 average annual retail wastewater customers during the most recently completed Fiscal Year (2012). The CRBUD's System generally provides both potable water and wastewater service to its customers; approximately 99% of the water customers also receive wastewater service. As stated in Subsection 14.3.2, the Wastewater System customers served and billed wastewater flow has also declined over the Historical Period as a result of the watering restrictions and the continued negative outlook in the economy. It should be noted that the billed wastewater flow is based on metered water use (serves as a proxy for sewer requirements which is typical in the industry) and, therefore, the market and conservation effects on water use may affect billed wastewater flow. Based on recent historical trends, discussions with CRBUD staff, and the previous assumptions recognized for the Water System, the following projections shown in **Table 14.4** for Wastewater System customer accounts and billed flow (sales) was assumed for the Forecast Period which served as the basis for the for the development of the projected revenues from current and approved rates.

Table 14.4
Projected Wastewater System Customer and Billed Flow Statistics by Class

Description	Projected Fiscal Year Ending September 30,										
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential – Single Family:											
Average Annual Accts.	11,492	11,522	11,552	11,582	11,612	11,642	11,672	11,702	11,732	11,762	11,792
Annual Billed Flow (Kgal)	606,795	608,379	609,963	611,547	613,131	614,715	616,299	617,883	619,467	621,051	622,635
Avg. Monthly Use per Acct.	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400
Residential – Multi Family											
Average Annual Accts.	623	623	623	623	623	623	623	623	623	623	623
Annual Billed Flow (Kgal)	478,272	478,272	478,272	478,272	478,272	478,272	478,272	478,272	478,272	478,272	478,272
Avg. Monthly Use per Acct.	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000	64,000
Commercial											
Average Annual Accts.	1,134	1,138	1,142	1,146	1,150	1,154	1,158	1,162	1,166	1,170	1,174
Annual Billed Flow (Kgal)	357,131	358,391	359,651	360,911	362,171	363,431	364,691	365,951	367,211	368,471	369,731
Avg. Monthly Use per Acct.	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
Hotel/Motel											
Average Annual Accts.	25	25	25	25	25	25	25	25	25	25	25
Annual Billed Flow (Kgal)	65,560	65,560	65,560	65,560	65,560	65,560	65,560	65,560	65,560	65,560	65,560
Avg. Monthly Use per Acct.	220,000	220,000	220,000	220,000	220,000	220,000	220,000	220,000	220,000	220,000	220,000
Total Sewer System											
Average Annual Accts.	13,274	13,308	13,342	13,376	13,410	13,444	13,478	13,512	13,546	13,580	13,614
Annual Billed Flow (Kgal)	1,507,758	1,510,602	1,513,446	1,516,290	1,519,134	1,521,978	1,524,822	1,527,666	1,530,510	1,533,354	1,536,198
Avg. Monthly Use per Acct.	9,466	9,459	9,453	9,447	9,441	9,434	9,428	9,422	9,416	9,410	9,404

As can be seen in **Table 14.4**, the projection of accounts was based on similar assumptions used in the projection of water customer accounts. The average annual compound growth rate for the Wastewater System accounts for the Forecast Period was assumed to approximate 0.2% per year. For the Forecast Period and recognizing that wastewater use is based on metered water use, an increase in the billed flow was assumed based on the projected customer growth assumptions and recognition of historical trends in the average billed flow per account trends. Based on discussions with CRBUD staff, the average billed wastewater flow per customer over the Forecast Period was assumed to decrease slightly in Fiscal Year 2013 and was subsequently held constant thereafter which was considered as a reasonable approach for the development of the Forecast Period wastewater sales.

14.3.4 Irrigation System

The CRBUD's Irrigation System (potable water used for water-only irrigation service) has experienced a marginal decline in account growth during the Historical Period. During Fiscal Year 2012, the CRBUD served approximately 399 accounts which represented a slight increased (0.6%) above the reported customer level for Fiscal Year 2011. Additionally, irrigation water use increased by 12.5% between Fiscal Year 2011 and Fiscal Year 2012, and increased on a compound annual average basis from Fiscal Year 2010 to Fiscal Year 2012 by approximately 4.5%. The historical irrigation water customer account and billed flow (sales) statistics as reported by the CRBUD for the Historical Period is summarized in **Table 14.5**.

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Table 14.5
Historical Irrigation System Customer and Sales Statistics by Class

Description	Fiscal Year Ended September 30,		
	2010	2011	2012
Residential – Single Family:			
Average Annual Accounts	3	5	4
Annual Consumption (Kgal)	236	488	91
Average Monthly Use per Account	6,378	8,561	1,978
Residential – Multi Family:			
Average Annual Accounts	386	379	378
Annual Consumption (Kgal)	275,291	268,322	300,324
Average Monthly Use per Account	59,394	59,076	66,282
Commercial			
Average Annual Accounts	13	14	18
Annual Consumption (Kgal)	11,516	10,140	13,333
Average Monthly Use per Account	72,428	62,209	62,304
Total Irrigation System			
Average Annual Accounts	403	397	399
Annual Consumption (Kgal)	287,043	278,950	313,748
Average Monthly Use per Account	59,417	58,578	65,487

The projection of Irrigation System customers and sales was based on a similar approach as previously discussed for the Water and Wastewater Systems, which resulted in only a marginal change in the Irrigation System customer base and sales. Based on the above recent historical trends, discussions with CRBUD staff, and the previous assumptions recognized for the Water and Wastewater Systems, the following projections shown in **Table 14.6** for Irrigation System customer accounts and consumption (sales) was assumed for the Forecast Period which served as the basis for the for the development of the projected revenues from current and approved rates.

Table 14.6
Projected Irrigation System Customer and Sales Statistics by Class

Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Projected Fiscal Year Ending September 30,										
Residential – Single Family:											
Average Annual Accounts	4	5	6	7	8	9	10	11	12	13	14
Annual Consumption (Kgal)	90	113	137	160	183	207	230	254	277	300	324
Average Monthly Use per Account	1,950	1,950	1,950	1,950	1,950	1,950	1,950	1,950	1,950	1,950	1,950
Residential – Multi Family:											
Average Annual Accounts	378	379	380	381	382	383	384	385	386	387	388
Annual Consumption (Kgal)	294,515	295,295	296,075	296,855	297,635	298,415	299,195	299,975	300,755	301,535	302,315
Average Monthly Use per Account	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000
Commercial											
Average Annual Accounts	18	18	18	18	18	18	18	18	18	18	18
Annual Consumption (Kgal)	12,038	12,038	12,038	12,038	12,038	12,038	12,038	12,038	12,038	12,038	12,038
Average Monthly Use per Account	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Total Irrigation System											
Average Annual Accounts	399	401	403	405	407	409	411	413	415	417	419
Annual Consumption (Kgal)	306,643	307,446	308,250	309,053	309,856	310,660	311,463	312,267	313,070	313,873	314,677
Average Monthly Use per Account	64,004	63,852	63,701	63,552	63,404	63,258	63,113	62,970	62,828	62,687	62,548

As can be seen above, the projection of accounts was based on recent historical trend and discussions with CRBUD staff. The projected annual compound rate of growth assumed for the Forecast Period for the Irrigation System accounts approximated 0.5% per year. Based on discussions with CRBUD staff, the average billed Irrigation System billed sales per customer during the Forecast Period was assumed to decrease slightly in Fiscal Year 2013 and was subsequently held constant thereafter which was considered as a reasonable approach for the development of the Forecast Period irrigation water sales.

14.4 Capital Project Affordability Analysis

A significant component associated with the determination of the expenditure level or amount of capital improvements to be constructed or implemented during the Forecast Period rests with: 1) the availability of funds (net revenues) derived from rates after the payment of all current expenditures; and 2) the unencumbered balance of capital-related funds available for future capital funding. With respect to the available net revenues, the capital funding analysis can be further subdivided to recognize: 1) a pay-as-you-go ("paygo") approach (limit the capital expenditures to only those funds that are received by the CRBUD); 2) the leveraging of the net revenues through the issuance of debt; or 3) a combination of the two capital funding methods. Capital funding using the paygo method is the least costly since funds are spent only as received; however, the timing of the receipt of the funds in the future may not match the immediate need for capital thus putting the utility at risk. The leveraging of the net revenues provides the most available funds up front, but may place a financial strain (reduced flexibility) on the utility since the repayment of debt is a fixed cost pledged for repayment from rates, which carries an interest component and certain financial compliance terms as delineated in the Bond Resolution that authorized the issuance of the outstanding bonds for the System (the "Bond Resolution"). Because of the need for immediate capital to fund "priority" projects coupled with the general constraint to limit future rate adjustments and maintain financial flexibility, a combination of the two approaches was considered.

In order to evaluate the amount of capital expenditures, the following methodology was recognized:

1. Section 13 (titled “Project Implementation Plan”) of this report ranked projects in groups, as follows: 1) Group 1 – Urgent; 2) Group 2 – High; 3) Group 3 – Medium; 4) Group 4 – Low and 5) Programmatic. The purpose of the grouping was to indicate the project team’s opinion relative to the priority that projects should be implemented based on a variety of factors. **The CRBUD should fund all Group 1 projects, the majority of Group 2 projects, and initiate funding of Programmatic improvements.** Any available funds should begin to fund programmed improvements (ongoing renewals, replacements and upgrades due to the assets beginning to reach the end of their useful life and

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the cost to replace is less than the ongoing cost to maintain). Listed below are descriptions for each project priority group:

a. **Priority Group 1** - Urgent Priority projects– High likelihood of asset failure with severe consequences if asset fails for R&R type project (or severe consequences for non-implementation of non-R&R projects).

b. **Priority Group 2** – High Priority – Medium to high likelihood of asset failure with medium to high consequences if asset fails for R&R type project (or medium to high consequences for non-implementation of non-R&R projects).

c. **Priority Group 3** - Medium Priority – Low to medium likelihood asset failure with low to medium severity of consequences if asset fails for R&R type projects (or low to medium consequences for non-implementation of non-R&R projects).

d. **Priority Group 4 -** Low Priority – Low likelihood of asset failure and low consequences if asset fails for R&R type project (or low consequences for non-implementation of non-R&R projects).

e. **Priority Group P –** Programmatic – Certain types of projects lend themselves to implementation on an annual (or otherwise recurring) basis, such as annual fire hydrant replacement. These types of projects were categorized as programmatic.

f. **Priority Group P, 1** – Urgent Priority and Programmatic type projects

g. **Capital Outlay (CO)** - Budgetary or departmental capital

2. Utilize unencumbered available cash reserves (e.g., would not include funds necessary to maintain working capital / financial reserves) as a first priority of funding.

3. Annually fund from rates a minimum deposit to the Renewal and Replacement Fund (the "R&R Fund"), which is considered as a required deposit and which is equal to 5.0% of the gross revenues of the preceding year as defined in the Bond Resolution, which would be allocable to capital funding on a paygo basis.

4. To the extent practical and recognizing compliance with financial policies, prudent liquidity planning, and the rate covenants and other components of the Bond Resolution, leverage any remaining net revenues through the issuance of additional bonds in order to fund priority identified capital projects.

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The identified capital needs, if funding were not an issue, is summarized in **Table 14.7** for the Forecast Period. The capital needs also include budgetary or departmental capital considered recurring that is part of the annual operating budget and includes expenditures for vehicles and equipment (these expenditures are not a part of the capital needs identified in the master plan which focused on System needs). The capital needs identified in the Master Plan also include minor capital such as the replacement of meters, hydrants, and minor pumps. For the purposes of the financial evaluation and recognizing that the capital needs are expressed in current dollars, the capital needs were escalated by 3% per year to account for inflation which is consistent with the average annual change in the construction cost index as published in the Engineering News Record for the last twenty years.

Table 14.7 presents the capital plan by priority group and **Table 14.8** presents the escalated capital plan initially considered for the financial evaluation.

Table 14.7
Capital Improvement Plan by Priority Group – Current Year Dollars (Not Escalated)

	Projected Fiscal Year Ending September 30,										
Description	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Priority Group											
1	$10,090,000	$10,501,000	$6,894,000	$1,810,000	$7,270,000	$220,000	$0	$0	$200,000	$0	$0
2	0	300,000	1,300,000	5,742,000	2,622,000	6,625,000	3,175,000	3,150,000	588,000	588,000	0
3	0	0	0	0	0	0	0	0	2,793,000	2,733,000	2,522,000
4	0	245,500	245,500	0	0	0	0	0	0	0	0
P	300,000	250,000	1,560,000	1,560,000	1,610,000	1,560,000	5,435,000	5,525,000	5,435,000	5,435,000	5,485,000
P, 1	100,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000
CO	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558
Total CIP	**$11,425,558**	**$12,342,058**	**$11,045,058**	**$10,157,558**	**$12,547,558**	**$9,450,558**	**$9,655,558**	**$9,720,558**	**$10,061,558**	**$9,801,558**	**$9,052,558**

[1] Adjustment to recognize the then estimated future cost of the capital expenditures which are anticipated to be funded from Utility System revenues in the year of expenditure; the three percent (3%) factor approximates the average annual change in the construction cost index as published by the *Engineering News Record* for the past twenty (20) years.

Table 14.8
Capital Improvement Plan by Priority Group – Future Year Dollars (Escalated at 3% beginning in Fiscal Year 2015) [1]

	Projected Fiscal Year Ending September 30,										
Description	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Priority Group											
1	$10,090,000	$10,501,000	$7,100,820	$1,920,410	$7,946,110	$247,720	$0	$0	$246,000	$0	$0
2	0	300,000	1,339,000	6,092,262	2,865,846	7,459,750	3,679,825	3,761,100	723,240	744,996	0
3	0	0	0	0	0	0	0	0	3,435,390	3,462,711	3,291,210
4	0	245,500	252,865	0	0	0	0	0	0	0	0
P	300,000	250,000	1,606,800	1,655,160	1,759,730	1,756,560	6,299,165	6,596,850	6,685,050	6,886,145	7,157,925
P, 1	100,000	110,000	113,300	116,710	120,230	123,860	127,490	131,340	135,300	139,370	143,550
CO	935,558	935,558	963,625	992,627	1,022,565	1,053,438	1,084,312	1,117,056	1,150,736	1,185,352	1,220,903
Total CIP	**$11,425,558**	**$12,342,058**	**$11,376,410**	**$10,777,169**	**$13,714,481**	**$10,641,328**	**$11,190,792**	**$11,606,346**	**$12,375,716**	**$12,418,574**	**$11,813,588**

[1] Adjustment to recognize the then estimated future cost of the capital expenditures which are anticipated to be funded from Utility System revenues in the year of expenditure; the three percent (3%) factor approximates the average annual change in the construction cost index as published by the *Engineering News Record* for the past twenty (20) years.

In the development of the capital affordability analysis, the CRBUD requested that four capital scenarios be considered with the focus being to determine the availability of funds to meet the capital needs of the System. Specifically, the CRBUD requested the following scenarios in order to assess the magnitude of the capital plan and how much capital funding the CRBUD could reasonably afford without placing a large burden on the customers, as follows:

1. **Scenario 1** – Considered as the status quo scenario, includes the maintenance of the approved rates through Fiscal Year 2019 and funds capital on a pay-as-you-go basis based on the amount of funds produced by the approved rates. Continue the implementation of similar rate adjustments beyond Fiscal Year 2019 and continue to provide for the capital funding needs on a pay-as-you-go basis predicated on funds availability during the remainder of the forecast period as shown on **Table 14.8**.

   The CRBUD's current and approved rates and the continued 2020 rates are considered as being very competitive in the region but need to be increased to meet the long-term capital needs from the basis of sustainability. Accordingly, this scenario was not considered as being a viable option since it would not provide sufficient funds to finance the annual revenue requirements and the necessary capital needs of the CRBUD System through Fiscal Year 2019 of the Forecast Period. The required rate increase needed to fund the capital needs on a pay-as-you-go basis beginning in 2020 (after the implementation of the approved rates) would be significant and was considered as not being a palatable adjustment to present to the City.

2. **Scenario 2 –** Reflects the status quo rate scenario mentioned above (Scenario 1) adjusted for the imposition of additional wastewater rate adjustments to account for the potential increase in ECRWRF costs associated with the planned upgrade in wastewater treatment facilities and the change in bio-solids disposal which was not known at the time of the CRBUD rate study prepared in Fiscal Year 2008. This scenario resulted in increased funds available for capital expenditures when compared to Scenario 1.

   It is recommended that the CRBUD adjust the wastewater rates to recover the increased ECRWRF treatment costs that will be passed on to the CRBUD by the ECR Board. Based on estimates regarding the cost of construction and increased operating expenses associated with the ECRWRF project, it was estimated that the approved wastewater rates would need to be further adjusted by 13%, at the beginning of Fiscal Year 2014 and an additional 8% at the beginning of Fiscal Year 2015 to recover such increased costs. However, even with the additional adjustments to recover the anticipated increased ECRWRF wastewater treatment costs, this option was not considered as being

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viable since such rates would not produce sufficient funds to finance the necessary capital project costs as identified on **Table 14.8**. Although the financial presentation under this scenario is improved as a direct result of the recognition of the increased revenue associated with the imposition of additional wastewater rate adjustments, additional rate increases are identified as being needed to fund the capital needs on a pay-as-you-go basis which is still considered as being material.

3. **Scenario 3 –** Recognizes a levelized rate implementation approach to fund the capital plan shown on **Table 14.8** after the recognition of the additional revenues associated with the implementation of the approved rates (Scenario 1) and the additional wastewater system rate adjustments associated with the pass-through of the ECRWRF increased costs (Scenario 2).

   This scenario would provide for the availability of funds to finance the capital program on a pay-as-you-go basis which is considered needed to promote the long-term sustainability of the CRBUD System. However, significant additional rate increases would be required at the beginning of the Forecast Period averaging approximately 15% annually for the next four years which was considered as being material and most likely as not being implementable.

4. **Scenario 4 –** Reflects a phased approach to the capital funding and rate adjustment plan as documented in the prior scenarios and is considered as a compromise for the prioritization of the capital projects in the Report. This scenario recognizes a reduction in the amount of capital projects being funded during the Forecast Period when compared to the other scenarios and to develop a plan that meets the short-term capital needs of the City yet attempts to limit the imposition of increased rates (which would result if the full capital plan was funded). For this scenario, the capital projects to be funded from operations included: i) all of the Group 1 projects; ii) the majority of Group 2 projects iii) and no Group 3 and Group 4 projects (deferred to future periods in this scenario due to the lack of availability of funds); and iv) initiate funding of Programmatic improvements. **Table 14.9** shown below presents the capital plan by priority group for this scenario only and the following **Table 14.10** subsequently presents the inflation-escalated capital plan considered for this scenario. When compared to the other scenarios, the capital plan represented in this scenario resulted in a reduction of over $15 million in capital funding needs. This scenario recognizes the implementation of the approved rates (Scenario 1): i) the additional wastewater rate adjustments associated with the pass-through of the ECRWRF increased costs in Fiscal Years 2014 and 2015 as discussed in (Scenario 2): ii) additional annual rate adjustments of 2% for Fiscal Year 2014 and 3.0% per year from Fiscal Year 2016 through 2019 for water and irrigation and 4% per year from Fiscal Year 2016 through 2019 for

sewer (above the approved increases for all utilities) iii) and 4.5% per year from fiscal year 2020 through 2023 after the end of the approved rate-phasing period (assumes a price index for inflation of 1.0% - 2.0% plus an additional 2.5% to initiate the phase-in of the capital funding plan).

Scenario 4 was considered as the most viable option to present in the Report since it 1) produces the lowest (responsible) rate option over the Forecast Period; 2) allows for the funding of all Group 1 projects (which the project team identified as the highest implementation priority) and the majority of the Group 2 projects; 3) begins the initiation of the annual funding for ongoing projects annually from operations which is prudent from a service sustainability standpoint; and 4) provides the ability to leverage CRBUD System revenues in the future (i.e., issuance of additional bonds) to fund the projects at the lowest initial cost to the customer. In order to review the customer impacts of this scenario, reference is made **Table 14.27** located in Subsection 14.7-Customer Impact Analysis which presents the change in the monthly bill as well as the "dollar per day" impact to a typical residential customer. A typical customer is a single family residence with a ¾” meter with an average monthly usage at 6,000 gallons per month.

The remainder of the discussion of the financial forecast presented in this section focuses only on the Scenario 4 analysis.

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Table 14.9
Adjusted Capital Improvement Plan by Priority Group for Scenario 4 Analysis – Not Escalated

	Projected Fiscal Year Ending September 30,										
Description	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Priority Group											
1	$10,090,000	$9,221,000	$8,174,000	$1,810,000	$7,270,000	$220,000	$0	$0	$200,000	$0	$0
2	0	300,000	1,200,000	4,270,000	300,000	6,487,000	4,267,000	2,562,000	882,000	882,000	588,000
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
P	300,000	225,000	335,000	1,685,000	735,000	1,535,000	5,410,000	5,500,000	5,410,000	5,410,000	5,460,000
P, 1	100,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000
CO	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558	935,558
Total CIP	**$11,425,558**	**$10,791,558**	**$10,754,558**	**$8,810,558**	**$9,350,558**	**$9,287,558**	**$10,722,558**	**$9,107,558**	**$7,537,558**	**$7,337,558**	**$7,093,558**

Table 14.10
Adjusted Capital Improvement Plan by Priority Group for Scenario 4 Analysis
Future Year Dollars (Escalated at 3% beginning in Fiscal Year 2015) [1]

	Projected Fiscal Year Ending September 30,										
Description	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Priority Group											
1	$10,090,000	$9,221,000	$8,419,220	$1,920,410	$7,946,110	$247,720	$0	$0	$246,000	$0	$0
2	0	300,000	1,236,000	4,530,470	327,900	7,304,362	4,945,453	3,059,028	1,084,860	1,117,494	767,340
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
P	300,000	225,000	345,050	1,787,785	803,355	1,728,410	6,270,190	6,567,000	6,654,300	6,854,470	7,125,300
P, 1	100,000	110,000	113,300	116,710	120,230	123,860	127,490	131,340	135,300	139,370	143,550
CO	935,558	935,558	963,625	992,627	1,022,565	1,053,438	1,084,312	1,117,056	1,150,736	1,185,352	1,220,903
Total CIP	**$11,425,558**	**$10,791,558**	**$11,077,195**	**$9,348,002**	**$10,220,160**	**$10,457,790**	**$12,427,445**	**$10,874,424**	**$9,271,196**	**$9,296,686**	**$9,257,093**

[1] Adjustment to recognize the then estimated future cost of the capital expenditures which are anticipated to be funded from Utility System revenues in the year of expenditure; the three percent (3%) factor approximates the average annual change in the construction cost index as published by the *Engineering News Record* for the past twenty (20) years.

14.5 Financial Forecast

For the purpose of this Financial Forecast and as previously mentioned, a projected eleven-year study period has been utilized for the determination of the sufficiency of the water and wastewater rates to meet the projected CRBUD System Revenue Requirements and be sufficient to provide funds for financing the capital improvement program as shown in **Table 14.10**. The objective of using this Forecast Period is to determine the potential rate levels or adjustments that will ensure continuing an adequate service to meet future period requirements. It was determined that the revenue requirements for this analysis would be predicated on the projected utility costs for the eleven fiscal year period ending September 30, 2023 (the "Forecast Period"). This forecast of utility operations was prepared in order to provide a general surety to the CRBUD that the utility rates would be adequate in the future to meet all of the estimated System expenditure needs, satisfy any bond/loan rate covenant requirements associated with any outstanding bonds or loans during the Forecast Period and to fully fund the capital improvement program as previously presented.

The classification of Revenue Requirements can be organized into five main categories: 1) operation and maintenance expenses (adjusted to exclude depreciation and amortization expenses); 2) annual principal and interest payments on existing and future debt / loans / notes; 3) funding of the capital improvement program; 4) transfers to other departments / cost centers of the CRBUD; and 5) deposits to working capital reserves and other funds to maintain or meet management objectives / policies regarding financial position. The sum of these payments represent the gross revenue requirements of the System which are to be recovered from the available financial resources of the System, including rate revenues, available cash reserves, and/or proceeds from debt issuance.

The development of the estimated revenue requirements for the CRBUD's System required several assumptions and considerations and the preparation of certain analyses relative to utility operations. The following is a discussion of the principal considerations and assumptions relied upon in the development of the capital finance plan prepared for the Forecast Period.

14.5.1 Projected Sales Revenues

The gross revenues of the CRBUD System consist of two main categories: 1) Sales Revenues derived from the application of monthly user charges; and 2) Other Operating Revenues, including interest income. The projection of sales revenue was based on the projected customer statistics as previously discussed and the existing and approved water, wastewater, and irrigation rates for monthly service. The CRBUD has approved a series of rate adjustments through the Fiscal Year 2019 which were developed pursuant to a rate study prepared during the Fiscal Year 2008 (the "Approved Rates"). The

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Approved Rates expressed on a percentage change basis are summarized in **Table 14.11**.

Table 14.11
Approved Rates – Percentage Increase

Approved Rate Increases (Avg.)	Projected Fiscal Year Ending September 30, [1]										
	2013 [2]	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Water Increases	2.00%	2.04%	2.00%	2.04%	2.00%	2.03%	1.99%	0.00%	0.00%	0.00%	0.00%
Wastewater Increases	5.38%	4.14%	1.99%	5.15%	2.07%	3.63%	3.60%	0.00%	0.00%	0.00%	0.00%
Irrigation Increases	2.00%	2.04%	2.00%	2.04%	2.00%	2.03%	1.99%	0.00%	0.00%	0.00%	0.00%

[1] Based on rates as approved by the CRBUD; Approved Rates only through Fiscal Year 2019.

[2] Fiscal Year 2013 Approved Rates currently in effect for the CRBUD.

Table 14.12 presents the projected Water System rate revenue for the Forecast Period based on the Approved Rates shown in **Table 14.11**. The projected compound growth rate in water sales revenues for the Forecast Period, based on the customer account and sales forecast as previously discussed and the application of the Approved Rates, resulted in an average annual increase of approximately 1.41% per year.

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Table 14.12
Projected Water System Rate Revenues from Approved Rates

Description	Projected Fiscal Year Ending September 30,										
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential – Single Family:											
Base Revenue	$1,753,643	$1,794,161	$1,834,865	$1,877,147	$1,919,623	$1,963,690	$2,007,959	$2,013,121	$2,018,283	$2,023,446	$2,028,608
Use Revenue	2,123,121	2,170,133	2,217,360	2,271,751	2,326,394	2,381,288	2,436,435	2,442,699	2,448,963	2,455,227	2,461,491
Total Revenue	3,876,764	3,964,293	4,052,225	4,148,898	4,246,016	4,344,978	4,444,394	4,455,820	4,467,246	4,478,673	4,490,099
Residential – Multi Family											
Base Revenue	$95,273	$97,221	$99,168	$101,190	$103,213	$105,310	$107,407	$107,407	$107,407	$107,407	$107,407
Use Revenue	2,896,758	2,955,180	3,013,602	3,076,892	3,140,183	3,203,473	3,266,764	3,266,764	3,266,764	3,266,764	3,266,764
Total Revenue	2,992,031	3,052,400	3,112,770	3,178,082	3,243,395	3,308,783	3,374,171	3,374,171	3,374,171	3,374,171	3,374,171
Commercial											
Base Revenue	$235,605	$241,231	$246,889	$252,767	$258,678	$264,812	$270,980	$271,875	$272,770	$273,665	$274,559
Use Revenue	2,654,724	2,718,308	2,782,253	2,846,571	2,911,256	2,980,922	3,050,985	3,061,055	3,071,131	3,081,207	3,091,283
Total Revenue	2,890,329	2,959,539	3,029,142	3,099,338	3,169,934	3,245,733	3,321,966	3,332,930	3,343,901	3,354,872	3,365,843
Hotel/Motel											
Base Revenue	$3,969	$4,050	$4,131	$4,215	$4,299	$4,387	$4,474	$4,474	$4,474	$4,474	$4,474
Use Revenue	301,121	307,074	313,026	319,476	325,925	332,374	338,823	338,823	338,823	338,823	338,823
Total Revenue	305,089	311,123	317,157	323,691	330,224	336,760	343,297	343,297	343,297	343,297	343,297
Total Water System											
Base Revenue	$2,088,490	$2,136,662	$2,185,053	$2,235,319	$2,285,813	$2,338,198	$2,390,820	$2,396,877	$2,402,934	$2,408,992	$2,415,049
Use Revenue	7,975,723	8,150,694	8,326,241	8,514,689	8,703,756	8,898,057	9,093,007	9,109,340	9,125,680	9,142,020	9,158,360
Total Revenue	**$10,064,213**	**$10,287,355**	**$10,511,294**	**$10,750,008**	**$10,989,569**	**$11,236,255**	**$11,483,826**	**$11,506,217**	**$11,528,615**	**$11,551,012**	**$11,573,409**

The projected Wastewater System rate revenue for the Forecast Period based on the Approved Rates as presented on **Table 14.11** is shown on **Table 14.13** below. The projected compound growth rate in wastewater sales revenues for the Forecast Period, based on the customer account and sales forecast as previously discussed and the application of the Approved Rates, resulted in an average annual increase of approximately 2.25% per year.

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Table 14.13
Projected Wastewater System Rate Revenues from Approved Rates

Description	Projected Fiscal Year Ending September 30,										
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential – Single Family:											
Base Revenue	$1,133,603	$1,183,574	$1,210,222	$1,275,909	$1,305,690	$1,356,564	$1,409,084	$1,412,705	$1,416,327	$1,419,948	$1,423,570
Use Revenue	1,116,503	1,168,088	1,195,527	1,259,787	1,287,575	1,340,079	1,392,836	1,396,416	1,399,995	1,403,575	1,407,155
Total Revenue	2,250,106	2,351,661	2,405,750	2,535,696	2,593,265	2,696,643	2,801,919	2,809,121	2,816,322	2,823,524	2,830,725
Residential – Multi Family											
Base Revenue	$61,428	$63,969	$65,239	$68,602	$70,022	$72,563	$75,178	$75,178	$75,178	$75,178	$75,178
Use Revenue	1,898,740	1,975,263	2,013,525	2,118,745	2,161,789	2,238,313	2,319,619	2,319,619	2,319,619	2,319,619	2,319,619
Total Revenue	1,960,168	2,039,232	2,078,764	2,187,347	2,231,811	2,310,876	2,394,798	2,394,798	2,394,798	2,394,798	2,394,798
Commercial											
Base Revenue	$139,792	$146,087	$149,512	$157,770	$161,598	$168,044	$174,705	$175,308	$175,912	$176,516	$177,119
Use Revenue	1,417,810	1,480,155	1,514,131	1,598,836	1,637,013	1,700,857	1,768,751	1,774,862	1,780,973	1,787,084	1,793,195
Total Revenue	1,557,602	1,626,242	1,663,643	1,756,606	1,798,611	1,868,901	1,943,456	1,950,171	1,956,885	1,963,600	1,970,315
Hotel/Motel											
Base Revenue	$2,449	$2,551	$2,601	$2,735	$2,792	$2,893	$2,997	$2,997	$2,997	$2,997	$2,997
Use Revenue	187,502	195,369	199,302	209,792	214,381	222,248	230,116	230,116	230,116	230,116	230,116
Total Revenue	189,951	197,919	201,904	212,527	217,173	225,142	233,113	233,113	233,113	233,113	233,113
Total Sewer System											
Base Revenue	$1,337,272	$1,396,181	$1,427,575	$1,505,017	$1,540,102	$1,600,064	$1,661,964	$1,666,190	$1,670,415	$1,674,640	$1,678,865
Use Revenue	4,620,554	4,818,875	4,922,486	5,187,160	5,300,759	5,501,497	5,711,322	5,721,013	5,730,704	5,740,394	5,750,085
Total Revenue	**$5,957,827**	**$6,215,055**	**$6,350,061**	**$6,692,176**	**$6,840,861**	**$7,101,561**	**$7,373,286**	**$7,387,202**	**$7,401,118**	**$7,415,034**	**$7,428,950**

Table 14.14 presents the projected irrigation system rate revenue (considered as a component of the Water System for overall financial planning purposes but shown separately since the rates for service are different) for the Forecast Period based on the Approved Rates as presented in **Table 14.11**. The projected compound growth rate in irrigation sales revenues for the Forecast Period, based on the customer account and sales forecast as previously discussed and the application of the Approved Rates, resulted in an average annual increase of approximately 1.47% per year.

14.5.2 Projected Other Operating Revenues

With respect to the determination of the available funds to finance the capital needs of the CRBUD, the projection of other operating revenues are applied to gross revenue requirements in order to determine the net revenue requirements which must be funded from monthly user rates. Based on recent reported historical results and discussions with CRBUD staff, the projection of other operating revenues, exclusive of interest income, assumed for the Forecast Period is shown on **Table 14.15**.

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Table 14.14
Projected Irrigation System Rate Revenues from Approved Rates

Description	Projected Fiscal Year Ending September 30,										
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential – Single Family:											
Base Revenue	$585	$752	$926	$1,107	$1,295	$1,490	$1,692	$1,864	$2,036	$2,208	$2,380
Use Revenue	119.7	153.68	190.43	227.2	265.35	306.36	347.3	383.54	418.27	453	489.24
Total Revenue	704.31	906	1,117	1,334	1,560	1,796	2,039	2,247	2,454	2,661	2,869
Irrigation											
Base Revenue	$72,043	$73,710	$75,385	$77,125	$78,873	$80,687	$82,509	$82,724	$82,939	$83,154	$83,369
Use Revenue	1,584,491	1,621,170	1,658,020	1,695,042	1,732,236	1,772,585	1,813,122	1,817,849	1,822,575	1,827,302	1,832,029
Total Revenue	1,656,534	1,694,880	1,733,405	1,772,167	1,811,109	1,853,272	1,895,631	1,900,573	1,905,514	1,910,456	1,915,398
Commercial											
Base Revenue	$4,507	$4,598	$4,689	$4,786	$4,882	$4,981	$5,080	$5,080	$5,080	$5,080	$5,080
Use Revenue	78,006	79,571	81,136	82,821	84,507	86,192	87,877	87,877	87,877	87,877	87,877
Total Revenue	82,514	84,170	85,825	87,607	89,389	91,173	92,957	92,957	92,957	92,957	92,957
Total Irrigation System											
Base Revenue	$77,135	$79,061	$81,001	$83,018	$85,050	$87,158	$89,280	$89,667	$90,055	$90,442	$90,829
Use Revenue	1,662,617	1,700,894	1,739,347	1,778,091	1,817,008	1,859,084	1,901,346	1,906,109	1,910,871	1,915,633	1,920,396
Total Revenue	**$1,739,752**	**$1,779,955**	**$1,820,347**	**$1,861,109**	**$1,902,058**	**$1,946,241**	**$1,990,627**	**$1,995,777**	**$2,000,926**	**$2,006,074**	**$2,011,225**

Table 14.15
Summary of Projected Other Operating Revenue (exclusive of Interest Income)

	Projected Fiscal Year Ending September 30,										
Description	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Water Meter Connect Fee	$10,000	$10,206	$10,436	$10,692	$10,965	$11,245	$11,531	$11,826	$12,127	$12,437	$12,754
Hydrant Rental/Fire Line Fees	125,000	127,250	129,795	132,650	135,701	138,823	142,016	145,282	148,623	152,042	155,539
Sewer Connections Fee	200	204	209	214	219	225	231	237	243	249	255
Penalty & Interest on A/R	100,000	102,055	104,356	106,917	109,646	112,445	115,315	118,257	121,273	124,366	127,536
Miscellaneous Revenues	50,000	50,900	51,918	53,060	54,281	55,529	56,806	58,113	59,449	60,817	62,215
Total Revenue	**$285,200**	**$290,615**	**$296,713**	**$303,533**	**$310,812**	**$318,266**	**$325,899**	**$333,714**	**$341,716**	**$349,909**	**$358,299**

Although not recognized in the above summary of other operating revenues, Impact Fees derived from new customer growth can play an important role in the determination of the Net Revenue Requirements and the availability of funds for capital improvements. Particularly for utilities which are approaching build-out, as is the case within the CRBUD, Impact Fees are often used to pay annual debt service payments on outstanding bonds issued for the purpose of expansion to the existing CRBUD System (when there is no longer any anticipated expansion related capital needs of the CRBUD System). Impact Fee revenues are projected to generate approximately $2 million in revenues over the Forecast Period which were based on the existing fees currently in effect and the assumed growth in new water and wastewater customers. Impact fees can only be used to pay for expansion-related capital expenditures or to pay expansion-related debt service payments. Due to the uncertainty with respect to the timing and ultimate receipt of the Impact Fees and recognizing the low growth projections and uncertain economy, the financial forecast does not recognize the use of the impact fee revenues to fund the CRBUD System expenditures (assumed to accrue during the Forecast Period for a future use).

14.5.3 Projection of Utility District Operating Expenses

The basis for the development of the projected operating expenses for the CRBUD's water, wastewater, and irrigation systems was predicated on the Fiscal Year 2013 budget. The Fiscal Year 2013 operating expenses projections and the underlying assumptions therein as incorporated by the CRBUD were considered reasonable and reflect anticipated operations for the purpose of the analysis. Such amounts were escalated for the Forecast Period based on a variety of escalation parameters.

For the Fiscal Year 2013, the budgeted expenses identified as the General Fund Transfer-Administrative Fee is approximately $2.9 million which approximates 22.4% of the total Fiscal Year 2013 budgeted Operation and Maintenance (O&M). It is our understanding that the transfer is recognized by the City as a reimbursement of operating expenses associated with providing customer billing and accounting services as well as other expenses that are accounted for in the General Fund which benefit the Utility System; examples of such costs would include but not be limited to City management, finance and accounting, human resources, and purchasing. Based on discussions with City staff, of the total $2.9 million budgeted for the General Fund Transfer-Administrative Fee, approximately $715,943 is for the Payment-In-Lieu-of-Taxes (PILOT) transfer. The PILOT has remained constant for several years; in Fiscal Year 2013 the PILOT is approximately 5.48% of total O&M expenditures. Our experience has indicated that the average administrative fee transfer generally ranges from 6% to 12% of the operating expenses but can be significantly higher if the customer accounting, utility billing and customer service functions are included as a component of the transfer as is the case of the City. Recognizing i) that the Administrative Fee and the PILOT represent a significant operating expense to the Utility System; ii) the level of

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transfer currently recognized in the Fiscal Year 2013 Budget which was continued for the Forecast Period; and iii) the level of capital needs identified for the Utility System which includes a significant portion of such needs being deferred to future periods (essentially unfunded), it may be beneficial to reevaluate the current General Fund transfer amount be conducted to support the transfer amount but also to educate the utility staff on the component costs that form the basis for the transfer.

A summary developed for the projection of operating expenses is presented in **Table 14.16**.

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Table 14.16
Summary of Projected Operating Expenses

Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
		Projected Fiscal Year Ending September 30,									
Operating Expenses											
Summary											
Personnel (Salary & Benefits)	$4,825,374	$4,976,940	$5,133,394	$5,294,899	$5,461,623	$5,633,744	$5,811,441	$5,994,904	$6,184,327	$6,379,911	$6,581,865
Electricity	715,000	743,600	773,344	804,278	836,449	869,907	904,703	940,891	978,527	1,017,668	1,058,375
Chemicals	491,500	501,318	512,333	524,613	537,709	551,131	564,885	578,980	593,425	608,228	623,398
Insurance	278,583	280,277	281,981	283,696	285,421	287,157	288,903	290,659	292,427	294,205	295,994
Other Operating Variable	890,420	913,696	938,640	965,477	993,651	1,022,837	1,052,942	1,080,255	1,108,565	1,137,915	1,168,346
Maintenance and Repairs	464,500	481,915	499,992	518,755	538,233	558,451	579,438	601,225	623,841	647,319	671,691
Contingency	622,022	674,414	717,459	742,393	755,418	776,840	798,877	821,456	841,886	865,894	890,680
Professional Services	2,275,012	2,315,965	2,362,288	2,414,261	2,469,792	2,526,601	2,584,716	2,644,168	2,704,988	2,767,207	2,830,857
Payment to ECR Board	1,784,106	2,545,742	3,103,803	3,282,111	3,208,243	3,291,869	3,377,106	3,465,935	3,500,380	3,594,608	3,692,214
PILOT	715,943	728,830	743,407	759,762	777,236	795,112	813,400	832,108	851,247	870,825	890,854
Total Operating Expenses	**$13,062,460**	**$14,162,699**	**$15,066,640**	**$15,590,243**	**$15,863,776**	**$16,313,648**	**$16,776,412**	**$17,250,583**	**$17,679,613**	**$18,183,780**	**$18,704,275**

The total CRBUD System operating expenses, excluding the annual ECRWRF operating expenses, are projected to increase at an average annual compound growth rate of approximately 2.90% per year. The following assumptions were made related to the escalation of these expenses and are as follows:

1. Personnel expenses were escalated by a composite of 5.0% factor annually, reflecting adjustments to salary for inflation and longevity, as well as adjustments to benefits such as insurance and retirement.

2. Electrical expenses were escalated over the Forecast Period at 4.0% per year based on: 1) recent reported cost increases and the continued application of inflation on the cost of electrical expense based on the ten-year average of Bureau of Labor Statistics - US City Average – Electricity index; and 2) an allowance for system growth.

3. Insurance expenses associated with liability and property insurance was escalated at 5.0% per year based on discussions related to recent trends in such costs experienced by the CRBUD and other southeast urban communities.

4. Other operating supplies and chemicals were escalated based on the on the growth in water and wastewater flows where applicable plus an inflationary factor for a recognized average annual rate of approximately 2.0%.

5. Maintenance and repairs were escalated at a rate of 4.0% based on observed industry averages recognizing inflation for materials and supplies.

6. Professional services were escalated at a rate of 3.0% recognizing a general inflationary indexing with consideration being given that such cost are primarily labor-related.

7. Gas and oil expenses were escalated at a rate of 7.0% annually based on recent historical trends based on the ten-year average of Bureau of Labor Statistics - US City Average – Fuel & Oil index.

8. A contingency allowance of 5.0% of the projected operating expenses was recognized in each fiscal year of the Forecast Period. The allowance has been included in order to recognize unknown or unplanned expenditures that may occur during such Forecast Period and to recognize potential changes in revenues, which may occur due to weather, conservation, and/or other factors.

14.5.4 Projection of Existing and Anticipated Debt Service

A major revenue requirement for the CRBUD is the payment of debt service on borrowed funds to finance capital improvements for the CRBUD System. As of October 1, 2013 the CRBUD had approximately $27,402,499 in outstanding bonds and loans as summarized in **Table 14.17**.

Table 14.17
Outstanding Bonds and Loans

Item	Amount Outstanding as of October 1, 2013
Water and Sewer Revenue Bonds Series 2004	$27,110,000
Assumed Water and Sewer Obligations to Consolidated Utility	292,499
Total Outstanding Bonds and Loans	$27,402,499

The debt service requirements included in this subsection for the Outstanding Bonds and Loans are based on the actual debt service payment schedules for each issue and are presented on a "gross" basis (i.e., not net of interest earnings on any debt service related funds or accounts). Furthermore, the payment of the annual debt service requirement on the Outstanding Bonds and Loans are payable solely from the Net Revenues (rates and other income) of the CRBUD System and are not secured by the full faith and credit of the CRBUD (no CRBUD General Fund revenues are pledged for payment). **Table 14.18** presents a schedule of the CRBUD's existing annual debt service.

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Table 14.18
Summary of Annual Debt Service Payments – Outstanding Bonds and Loans

Fiscal Year Ending	Series 2004 Bonds			Obligations to Consolidated Utility			Total Outstanding Debt Service		
September 30,	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
2013	$710,000	$1,266,894	$1,976,894	$27,857	$2,229	$30,086	$737,857	$1,269,123	$2,006,980
2014	735,000	1,239,800	1,974,800	27,857	2,229	30,086	762,857	1,242,029	2,004,886
2015	760,000	1,211,769	1,971,769	27,857	2,229	30,086	787,857	1,213,998	2,001,855
2016	795,000	1,183,109	1,978,109	27,857	2,229	30,086	822,857	1,185,338	2,008,195
2017	820,000	1,153,325	1,973,325	27,857	2,229	30,086	847,857	1,155,554	2,003,411
2018	850,000	1,120,950	1,970,950	27,857	2,229	30,086	877,857	1,123,179	2,001,036
2019	885,000	1,086,250	1,971,250	27,857	2,229	30,086	912,857	1,088,479	2,001,336
2020	920,000	1,050,150	1,970,150	27,857	2,229	30,086	947,857	1,052,379	2,000,236
2021	955,000	1,007,875	1,962,875	27,857	2,229	30,086	982,857	1,010,104	1,992,961
2022	1,005,000	958,875	1,963,875	27,857	2,229	30,086	1,032,857	961,104	1,993,961
2023	1,055,000	907,375	1,962,375	13,929	1,115	15,043	1,068,929	908,490	1,977,418
2024	1,105,000	853,375	1,958,375	0	0	0	1,105,000	853,375	1,958,375
2025	1,160,000	796,750	1,956,750	0	0	0	1,160,000	796,750	1,956,750
2026	1,220,000	737,250	1,957,250	0	0	0	1,220,000	737,250	1,957,250
2027	1,280,000	674,750	1,954,750	0	0	0	1,280,000	674,750	1,954,750
2028	1,345,000	609,125	1,954,125	0	0	0	1,345,000	609,125	1,954,125
2029	1,415,000	540,125	1,955,125	0	0	0	1,415,000	540,125	1,955,125
2030	1,485,000	467,625	1,952,625	0	0	0	1,485,000	467,625	1,952,625
2031	1,560,000	391,500	1,951,500	0	0	0	1,560,000	391,500	1,951,500
2032	1,635,000	311,625	1,946,625	0	0	0	1,635,000	311,625	1,946,625
2033	1,715,000	227,875	1,942,875	0	0	0	1,715,000	227,875	1,942,875
2034	1,805,000	139,875	1,944,875	0	0	0	1,805,000	139,875	1,944,875
2035	1,895,000	47,375	1,942,375	0	0	0	1,895,000	47,375	1,942,375
Total	**$27,110,000**	**$17,983,622**	**$45,093,622**	**$292,499**	**$23,405**	**$315,903**	**$27,402,499**	**$18,007,026**	**$45,409,525**

As can be seen above the remaining total debt service on outstanding bonds and notes as of October 1, 2013 is $45.4 million.

In order to provide funding for the immediate capital improvement expenditure requirements yet allow for the phase in of rates at sustainable levels, it is assumed that the CRBUD would issue additional utility revenue bonds payable from the gross revenues of the CRBUD ("Additional Bonds"). Specifically, the capital funding plan recognizes the issuance of the following Additional Bonds as listed in **Table 14.19**.

Table 14.19
Future Additional Bonds

Item	Estimated Principal Amount
Utility System Revenue Bonds, Series 2013 (the "Series 2013 Bonds")	$28,195,000
Utility System Revenue Bonds, Series 2017 (the "Series 2017 Bonds")	$22,830,000
Utility System Revenue Bonds, Series 2021 (the "Series 2021 Bonds")	$12,375,000

The principal assumptions associated with the issuance of the Series 2013 Bonds are as follows:

1. A deposit to the Construction Fund from the proceeds of the Series 2013, 2017, and 2021 Bonds are estimated to be approximately $24,016,950, $20,164,615, and $10,956,700 respectively.

2. In addition to the cost of issuance the Additional Bonds, the funding of a debt service reserve account in the amount of $1,824,765, $1,702,948, and $899,030 for Series 2013, 2017, and 2021, respectively. The debt service reserve is equal to the annual debt service payment on the Additional Bonds.

3. The annual average rate of interest assumed for the bonds at 4.50% Series 2013 and 6.00% for Series 2017 and Series 2021.

4. The issuance of the bonds will be on or about October 1st in each the respective Series year.

5. A thirty-year repayment term with the first two years of the repayment term representing interest-only payments (to level in the approved rates to allow for increased net revenue margins) with level debt service payments thereafter.

Table 14.20, 14.21, and 14.22 provides the projected annual debt service payments during the Forecast Period.

Table 14.20

Projected Series 2013 Bonds Annual Debt Service Repayment Schedule (Fiscal Year Accrual)

Fiscal Year	Start Balance	Principal	Interest	Capital Interest	Payment Made	End Balance
2013	$28,195,000	$0	$1,268,775	$1,268,775	$0	$28,195,000
2014	28,195,000	0	1,268,775	0	1,268,775	28,195,000
2015	28,195,000	0	1,268,775	0	1,268,775	28,195,000
2016	28,195,000	555,990	1,268,775	0	1,824,765	27,639,010
2017	27,639,010	581,010	1,243,755	0	1,824,765	27,058,000
2018	27,058,000	607,155	1,217,610	0	1,824,765	26,450,845
2019	26,450,845	634,477	1,190,288	0	1,824,765	25,816,368
2020	25,816,368	663,029	1,161,737	0	1,824,765	25,153,339
2021	25,153,339	692,865	1,131,900	0	1,824,765	24,460,474
2022	24,460,474	724,044	1,100,721	0	1,824,765	23,736,430
2023	23,736,430	756,626	1,068,139	0	1,824,765	22,979,804
2024	22,979,804	790,674	1,034,091	0	1,824,765	22,189,130
2025	22,189,130	826,254	998,511	0	1,824,765	21,362,876
2026	21,362,876	863,436	961,329	0	1,824,765	20,499,440
2027	20,499,440	902,290	922,475	0	1,824,765	19,597,150
2028	19,597,150	942,893	881,872	0	1,824,765	18,654,256
2029	18,654,256	985,324	839,442	0	1,824,765	17,668,932
2030	17,668,932	1,029,663	795,102	0	1,824,765	16,639,269
2031	16,639,269	1,075,998	748,767	0	1,824,765	15,563,271
2032	15,563,271	1,124,418	700,347	0	1,824,765	14,438,853
2033	14,438,853	1,175,017	649,748	0	1,824,765	13,263,836
2034	13,263,836	1,227,893	596,873	0	1,824,765	12,035,943
2035	12,035,943	1,283,148	541,617	0	1,824,765	10,752,796
2036	10,752,796	1,340,889	483,876	0	1,824,765	9,411,906
2037	9,411,906	1,401,229	423,536	0	1,824,765	8,010,677
2038	8,010,677	1,464,285	360,480	0	1,824,765	6,546,392
2039	6,546,392	1,530,178	294,588	0	1,824,765	5,016,215
2040	5,016,215	1,599,036	225,730	0	1,824,765	3,417,179
2041	3,417,179	1,670,992	153,773	0	1,824,765	1,746,187
2042	1,746,187	1,746,187	78,578	0	1,824,765	0
2043	0	0	0	0	0	0
Total		**$28,195,000**	**$24,879,986**	**$1,268,775**	**$51,806,211**	

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Table 14.21
Projected Series 2017 Bonds Annual Debt Service Repayment Schedule (Fiscal Year Accrual)

Fiscal Year	Start Balance	Principal	Interest	Capital Interest	Payment Made	End Balance
2017	$22,830,000	$0	$1,369,800	$0	$1,369,800	$22,830,000
2018	22,830,000	0	1,369,800	0	1,369,800	22,830,000
2019	22,830,000	333,148	1,369,800	0	1,702,948	22,496,852
2020	22,496,852	353,137	1,349,811	0	1,702,948	22,143,715
2021	22,143,715	374,325	1,328,623	0	1,702,948	21,769,390
2022	21,769,390	396,785	1,306,163	0	1,702,948	21,372,606
2023	21,372,606	420,592	1,282,356	0	1,702,948	20,952,014
2024	20,952,014	445,827	1,257,121	0	1,702,948	20,506,187
2025	20,506,187	472,577	1,230,371	0	1,702,948	20,033,610
2026	20,033,610	500,931	1,202,017	0	1,702,948	19,532,679
2027	19,532,679	530,987	1,171,961	0	1,702,948	19,001,692
2028	19,001,692	562,846	1,140,101	0	1,702,948	18,438,845
2029	18,438,845	596,617	1,106,331	0	1,702,948	17,842,228
2030	17,842,228	632,414	1,070,534	0	1,702,948	17,209,814
2031	17,209,814	670,359	1,032,589	0	1,702,948	16,539,455
2032	16,539,455	710,581	992,367	0	1,702,948	15,828,874
2033	15,828,874	753,216	949,732	0	1,702,948	15,075,658
2034	15,075,658	798,408	904,539	0	1,702,948	14,277,250
2035	14,277,250	846,313	856,635	0	1,702,948	13,430,937
2036	13,430,937	897,092	805,856	0	1,702,948	12,533,845
2037	12,533,845	950,917	752,031	0	1,702,948	11,582,928
2038	11,582,928	1,007,972	694,976	0	1,702,948	10,574,956
2039	10,574,956	1,068,451	634,497	0	1,702,948	9,506,505
2040	9,506,505	1,132,558	570,390	0	1,702,948	8,373,947
2041	8,373,947	1,200,511	502,437	0	1,702,948	7,173,436
2042	7,173,436	1,272,542	430,406	0	1,702,948	5,900,895
2043	5,900,895	1,348,894	354,054	0	1,702,948	4,552,000
2044	4,552,000	1,429,828	273,120	0	1,702,948	3,122,172
2045	3,122,172	1,515,618	187,330	0	1,702,948	1,606,555
2046	1,606,555	1,606,555	96,393	0	1,702,948	0
2047	0	0	0	0	0	0
Total		**$22,830,000**	**$27,592,143**	**$0**	**$50,422,143**	

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Table 14.22
Projected Series 2021 Bonds Annual Debt Service Repayment Schedule (Fiscal Year Accrual)

Fiscal Year	Start Balance	Principal	Interest	Capital Interest	Payment Made	End Balance
2021	$12,375,000	$156,530	$742,500	$0	$899,030	$12,218,470
2022	12,218,470	165,922	733,108	0	899,030	12,052,548
2023	12,052,548	175,877	723,153	0	899,030	11,876,670
2024	11,876,670	186,430	712,600	0	899,030	11,690,240
2025	11,690,240	197,616	701,414	0	899,030	11,492,624
2026	11,492,624	209,473	689,557	0	899,030	11,283,151
2027	11,283,151	222,041	676,989	0	899,030	11,061,110
2028	11,061,110	235,364	663,667	0	899,030	10,825,747
2029	10,825,747	249,485	649,545	0	899,030	10,576,261
2030	10,576,261	264,455	634,576	0	899,030	10,311,806
2031	10,311,806	280,322	618,708	0	899,030	10,031,485
2032	10,031,485	297,141	601,889	0	899,030	9,734,343
2033	9,734,343	314,970	584,061	0	899,030	9,419,374
2034	9,419,374	333,868	565,162	0	899,030	9,085,506
2035	9,085,506	353,900	545,130	0	899,030	8,731,606
2036	8,731,606	375,134	523,896	0	899,030	8,356,472
2037	8,356,472	397,642	501,388	0	899,030	7,958,830
2038	7,958,830	421,500	477,530	0	899,030	7,537,330
2039	7,537,330	446,791	452,240	0	899,030	7,090,539
2040	7,090,539	473,598	425,432	0	899,030	6,616,941
2041	6,616,941	502,014	397,016	0	899,030	6,114,927
2042	6,114,927	532,135	366,896	0	899,030	5,582,793
2043	5,582,793	564,063	334,968	0	899,030	5,018,730
2044	5,018,730	597,906	301,124	0	899,030	4,420,823
2045	4,420,823	633,781	265,249	0	899,030	3,787,043
2046	3,787,043	671,808	227,223	0	899,030	3,115,235
2047	3,115,235	712,116	186,914	0	899,030	2,403,119
2048	2,403,119	754,843	144,187	0	899,030	1,648,276
2049	1,648,276	800,134	98,897	0	899,030	848,142
2050	848,142	848,142	50,889	0	899,030	0
2051	0	0	0	0	0	0
Total		**$12,375,000**	**$14,595,908**	**$0**	**$26,970,908**	

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14.5.5 Summary of Capital Improvement Program (CIP) Funding Analysis

The initial (total) CIP based on the facilities analysis was reduced as a result of the CIP Affordability Analysis. Specifically, based on discussions with the CRBUD staff and in order to produce a sustainable rate adjustment plan, the initial CIP was re-prioritized in order to maintain a reasonable level of affordability in regards to funding necessary capital improvements. A summary of forecasted CIP projects and the corresponding funding sources assumed for the Forecast Period is presented in **Table 14.23**.

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Table 14.23
Summary of Forecasted Capital Improvement Program

	Projected Fiscal Year Ending September 30,											
Description	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Total**
Capital Projects:												
Water System	$6,240,000	$7,731,000	$9,984,820	$4,859,380	$2,120,420	$6,919,270	$8,785,220	$7,122,210	$5,405,850	$5,315,065	$5,539,725	$70,022,960
Wastewater System	4,250,000	2,125,000	128,750	3,495,995	7,077,175	2,485,082	2,557,913	2,635,158	2,714,610	2,796,269	2,496,465	32,762,417
Budgeted Departmental Capital	935,558	935,558	963,625	992,627	1,022,565	1,053,438	1,084,312	1,117,056	1,150,736	1,185,352	1,220,903	11,661,730
Total Capital Funding Needs	**$11,425,558**	**$10,791,558**	**$11,077,195**	**$9,348,002**	**$10,220,160**	**$10,457,790**	**$12,427,445**	**$10,874,424**	**$9,271,196**	**$9,296,686**	**$9,257,093**	**$114,447,107**
Funding Sources:												
]Rate Revenues	$0	$185,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$185,000
Operating Reserves [1]	0	0	0	0	0	0	0	0	0	0	0	0
Impact Fees	0	0	0	0	0	0	0	0	0	0	0	0
Renewal and Replacement Fund	1,975,558	2,135,558	3,548,925	1,841,427	1,361,395	1,402,498	5,830,417	6,054,246	3,137,186	2,978,157	3,067,478	33,332,845
Capital Improvement Fund	4,850,000	1,055,000	1,076,350	1,957,545	934,515	2,744,062	2,673,813	2,814,258	2,837,610	2,922,969	1,924,875	25,790,997
Series 2013 Bonds (Additional)	4,600,000	7,416,000	6,451,920	5,549,030	0	0	0	0	0	0	0	24,016,950
Series 2017 Bonds (Additional)	0	0	0	0	7,924,250	6311230	3923215	2005920	0	0	0	20,164,615
Series 2021 Bonds (Additional)	0	0	0	0	0	0	0	0	3296400	3395560	4264740	10,956,700
Total	**$11,425,558**	**$10,791,558**	**$11,077,195**	**$9,348,002**	**$10,220,160**	**$10,457,790**	**$12,427,445**	**$10,874,424**	**$9,271,196**	**$9,296,686**	**$9,257,093**	**$114,447,107**

[1] It is noted that during the Forecast Period, certain transfers from operating reserves to the Renewal and Replacement Fund and the Capital Improvement Fund were recognized.

As can be seen in table 14.23 above it is anticipated that the capital expenditure needs of the CRBUD are estimated to be approximately $114.4 million over the Forecast Period. The R&R Fund will fund approximately of CIP funding, approximately $33.3 million or 29.0%, is planned to be financed from deposits made annually from rates (operations) to the Renewal and Replacement Fund (Fund 412 – the "R&R Fund"). Unencumbered funds currently on deposit in the Capital Improvement Fund (Fund 413 – the "CIP Fund") will provide approximately $25.8 million in financing of the identified capital projects. Additionally, $55.1 million or approximately 48% of the CIP program is anticipated to be funded from the assumed issuance of the Series 2013, 2017, and 2021 Bonds.

The rate competitiveness of a utility is directly affected by the capital needs of a utility. The greater the immediate funding requirements for capital needs of a utility, generally the greater the impact is on the need for additional rate relief, which may result in rates becoming less competitive due to such capital funding needs. The key is to balance the paygo capital funding with the leveraging of revenues through the issuance of bonds such that a utility can have flexibility in future financial strategies and to minimize rate shock that can occur when large capital programs are in need of implementation and funding.

14.5.6 Projected Transfers

Another component in the determination of the projection of gross revenue requirements of the CRBUD is the projection of required and recommended transfers to the R&R Fund. The minimum provisions for the transfer to such fund is delineated in the Bond Resolution which provides that the CRBUD shall transfer monies to the R&R Fund annually in an amount equal to the Renewal and Replacement Fund Requirement or the amount necessary to have on deposit a balance equal to such requirement. The Bond Resolution defines the Renewal and Replacement Fund Requirement as the amount equal to five percent (5%) of the Gross Revenues for the preceding Fiscal Year or such other amount as may be designated by certificate of the Consultant from time to time which was considered as being a minimum funding level for capital planning purposes.

In order to meet the capital needs of the CRBUD, provide for the increased equity funding from rates consistent with the nature of the identified capital improvements, and maintain the overall financial creditworthiness of the CRBUD, we have recognized an annual deposit to the R&R Fund in excess of the minimum requirement reflected in the Bond Resolution. A summary of the projected transfers to the R&R Fund assumed for the Forecast Period is summarized below in **Table 14.24**.

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Table 14.24
Annual Renewal and Replacement Fund Deposit Funded from Operations

Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Recommended Minimum Deposits [1]:											
Prior Years Gross Revenues	$18,228,965	$17,861,738	$19,386,605	$20,690,781	$22,128,835	$23,358,154	$24,808,917	$26,349,297	$27,500,991	$28,750,103	$30,057,843
Percent of Prior Year Gross Revenue	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Minimum R&R Fund Transfer	911,448	893,087	969,330	1,034,539	1,106,442	1,167,908	1,240,446	1,317,465	1,375,050	1,437,505	1,502,892
Additional Deposits:											
Additional Percent	0.00%	0.50%	5.00%	5.00%	5.00%	5.00%	5.00%	6.00%	6.50%	7.00%	7.00%
Recommended Additional Deposit	0	89,309	969,330	1,034,539	1,106,442	1,167,908	1,204,446	1,580,958	1,787,564	2,012,507	2,104,049
Recognized Deposit	**$911,448**	**$982,396**	**$1,938,661**	**$2,069,078**	**$2,212,883**	**$2,335,815**	**$2,480,892**	**$2,898,423**	**$3,162,614**	**$3,450,012**	**$3,606,941**

[1] Based on provisions of the Bond Resolution which authorized the issuance of the Series 2004 Bonds (senior lien).

In addition to the R&R Fund, the Bond Resolution requires the funding of a debt service Reserve Fund to provide a surety to the Bond Holders regarding the payment of the annual debt service. The required balance to be maintained is delineated in the Bond Resolution and is defined as the Debt Service Reserve Requirement. Such requirement is considered by the CRBUD to be fully funded and there are no projected withdrawals from such fund during the Forecast Period that would subsequently necessitate a deposit from Net Revenues; therefore no deposits to the Reserve Fund have been assumed during the Forecast Period.

14.6 Revenue Sufficiency

14.6.1 General

The sufficiency of a utility's existing rates are determined through the: 1) ability of the utility's cash flow derived from the revenues of the CRBUD to meet Net Revenue Requirements; and 2) the ability of the Gross Revenues to meet the funding requirements and rate covenants as defined in the various resolutions and agreements which authorized the issuance of the Outstanding Bonds and Loans (also referred to as the "debt coverage" requirement). The following provides for a discussion and identification of the revenue sufficiency based on the cash and debt coverage needs of the CRBUD.

14.6.2 Net Revenue Requirements

The Net Revenue Requirements of the Utility were based on data provided by the CRBUD and our assumptions as discussed earlier. The projected net revenue requirements along with revenue surplus or deficiencies based on the assumptions previously discussed and the maintenance of the current rates for service are listed in **Table 14.25**.

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Table 14.25
Projected Water and Wastewater System Net Revenue Requirements

Description	Projected Fiscal Year Ending September 30,										
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Operating Expenses:	$13,062,460	$14,162,699	$15,066,640	$15,590,243	$15,863,776	$16,313,648	$16,776,412	$17,250,583	$17,679,613	$18,183,780	$18,704,275
Other Revenue Requirements:											
Existing Debt Service	$2,018,667	$2,016,105	$2,022,605	$2,018,786	$2,018,036	$2,019,036	$2,018,636	$2,016,836	$2,019,086	$2,018,836	$1,986,000
Proposed Debt Service	0	1,268,775	1,268,775	1,824,765	3,194,565	3,194,565	3,527,713	3,527,714	4,426,743	4,426,743	4,426,743
Capital Funded from Rates	0	185,000	0	0	0	0	0	0	0	0	0
Transfer to R&R Fund – Minimum Requirement	911,448	893,087	969,330	1,034,539	1,106,442	1,167,908	1,240,446	1,317,465	1,375,050	1,437,505	1,502,892
Transfer to R&R Fund – Additional	0	89,309	969,330	1,034,539	1,106,442	1,167,908	1,240,446	1,580,958	1,787,564	2,012,507	2,104,049
Transfer to Cap Improvement Fund	0	0	0	0	750000	1250000	1500000	1500000	2000000	2000000	2000000
Transfers From Operating Reserves	0	0	0	0	0	0	0	0	0	0	0
Transfer to Debt Service Reserve Requirement	0	0	0	0	0	0	0	0	0	0	0
General Fund Transfer	0	0	0	0	0	0	0	0	0	0	0
Gross Revenue Requirements	$15,992,575	$18,614,975	$20,296,681	$21,502,872	$24,039,260	$25,113,065	$26,303,652	$27,193,555	$29,288,056	$30,079,371	$30,723,959
Less Income and Funds from Other Sources:											
Other Revenues	$272,345	$275,634	$279,879	$284,108	$287,450	$291,258	$295,561	$299,819	$303,517	$307,046	$312,058
Interest Income	27,176	38,401	47,369	55,775	69,833	84,368	86,712	79,194	78,148	85,296	96,024
Impact Fees Used to Pay Debt Service	0	0	0	0	0	0	0	0	0	0	0
Net Revenue Requirements	$15,693,054	$18,300,940	$19,969,434	$21,162,989	$23,681,977	$24,737,439	$25,921,379	$26,814,541	$28,906,391	$29,687,029	$30,315,877
Revenue From Existing Water, Wastewater and Irrigation Rates	$17,575,562	$18,092,098	$18,487,386	$19,104,833	$19,529,873	$20,077,049	$20,636,327	$20,677,526	$20,718,731	$20,759,936	$20,801,142
Revenue Surplus/(Deficiency) Under Existing Rates:											
Amount	$1,882,507	($208,842)	($1,482,047)	($2,058,156)	($4,152,104)	($4,660,390)	($5,285,053)	($6,137,015)	($8,187,660)	($8,927,093)	($9,514,735)
Percent of Rate Revenue	0.00%	-2.05%	-14.24%	-19.34%	-38.16%	-41.89%	-46.47%	-53.86%	-71.72%	-78.04%	-83.01%

Based on the assumptions relative to the projection of the financial needs of the CRBUD and in order to promote the financial creditworthiness of the CRBUD, the following rate adjustments were recognized. The rate adjustments include: 1) the continuation of the phase-in of the approved rates through the Fiscal Year 2019; 2) the pass-through of the estimated increase in the cost of operations and capital improvements for the ECRWRF in Fiscal Years 2014 and 2015; and 3) additional levelized rate adjustments subsequent to the approved rate phase-in program. **Table 14.26** summarizes the proposed rate adjustments reflected in the financial and capital expenditure funding forecast:

Table 14.26
Summary of Approved and Assumed Additional Rate Adjustments During Forecast Period (Percentage Increase)

Forecast Period Year	Water	Wastewater	Irrigation
2014	4.08%	17.68%	4.08%
2015	5.06%	10.15%	5.06%
2016	5.10%	9.36%	5.10%
2017	5.06%	6.15%	5.06%
2018	5.09%	7.78%	5.09%
2019]	5.05%	7.74%	5.05%
2020	4.50%	4.50%	4.50%
2021	4.50%	4.50%	4.50%
2022	4.50%	4.50%	4.50%
2023	4.50%	4.50%	4.50%

[1] Amounts shown reflect Approved Rate adjustments as approved by the CRBUD which will be implemented on October 1st of each respective Fiscal Year.

[2] In order to calculate the actual realized rate increase that a customer will see on their new bill you must calculate the total rate increase the following way; for example FY 2013 has an approved rate index of 4.14% and a proposed rate increase of 13%. In order to calculate what the total rate increase would be for FY 2013 you would do the following; 1.0414 * 1.13 = 1.176782 which would equal the 17.68% rate increase as presented on Table 1-9.

[3] Amounts shown reflect proposed or additional rate adjustments (the "Additional Rates") above the Approved Rates phasing plan as identified in this financial analysis which are considered as being required to meet the projected Revenue Requirements and capital funding needs of the System.

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Based on the recognition of the Approved and Additional Rates, the ability to fund the Revenue Requirements and maintain the overall creditworthiness of the System is shown below in **Table 14.27**.

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Table 14.27
Recommended Water and Wastewater System Rate Adjustments

Description	Projected Fiscal Year Ending September 30, 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Net Revenue Requirements	$15,693,054	$18,300,940	$19,969,434	$21,162,989	$23,681,977	$24,737,439	$25,921,379	$26,814,541	$28,906,391	$29,687,029	$30,315,877
RATE RECOMMENDATIONS:											
Approved Increase Water	2.00%	2.04%	2.00%	2.04%	2.00%	2.03%	1.99%	0.00%	0.00%	0.00%	0.00%
Approved Increase Wastewater	5.38%	4.14%	1.99%	5.15%	2.07%	3.63%	3.60%	0.00%	0.00%	0.00%	0.00%
Approved Increase Irrigation	2.00%	2.04%	2.00%	2.04%	2.00%	2.03%	1.99%	0.00%	0.00%	0.00%	0.00%
Months Rate Increase in Effect	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Revenue From Existing Water, Wastewater and Irrigation Rates:	$17,575,562	$18,092,098	$18,487,386	$19,104,833	$19,529,873	$20,077,049	$20,636,327	$20,677,526	$20,718,731	$20,759,936	$20,801,142
Revenue Surplus/(Deficiency) Under Existing Rates:											
Amount	$1,882,507	($208,842)	($1,482,047)	($2,058,156)	($4,152,104)	($4,660,390)	($5,285,053)	($6,137,015)	($8,187,660)	($8,927,093)	($9,514,735)
Percent of Rate Revenue	0.00%	-2.05%	-14.24%	-19.34%	-38.16%	-41.89%	-46.47%	-53.86%	-71.72%	-78.04%	-83.01%
RATE RECOMMENDATIONS:											
Projected Increase Water	0.00%	2.00%	3.00%	3.00%	3.00%	3.00%	3.00%	4.50%	4.50%	4.50%	4.50%
Projected Increase Wastewater	0.00%	13.00%	8.00%	4.00%	4.00%	4.00%	4.00%	4.50%	4.50%	4.50%	4.50%
Projected Increase Irrigation	0.00%	2.00%	3.00%	3.00%	3.00%	3.00%	3.00%	4.50%	4.50%	4.50%	4.50%
Months Rate Increase in Effect	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Revenue From Water, Wastewater, and Irrigation Rates:											
Current Year Rate Adjustment	0	1,001,936	835,786	613,397	627,042	645,272	663,955	891,718	893,495	895,272	897,049
Prior Year Cumulative Rate Adjustment	0	0	1,068,254	2,103,036	2,883,665	3,759,142	4,711,825	5,584,419	6,779,483	8,032,632	9,346,588
Adjusted Water, Wastewater, and Irrigation Revenue	$17,575,562	$19,094,033	$20,391,427	$21,821,266	$23,040,580	$24,481,462	$26,012,107	$27,153,664	$28,391,710	$29,687,840	$31,044,779
Revenue Surplus / (Deficiency) Under Proposed Rate Adjustments	$1,882,507	$793,094	$421,993	$658,277	($641,397)	($255,977)	$90,728	$339,122	($514,681)	$811	$728,903
As A Percent of Existing Revenue	0.00%	0.00%	0.00%	0.00%	-2.78%	-1.05%	0.00%	0.00%	-1.81%	0.00%	0.00%

As a result of the implementation of the identified rate adjustments, based upon the assumptions discussed earlier within this section, it is anticipated that the CRBUD will meet projected Revenue Requirements of the CRBUD's Water and Wastewater System. As mentioned above, additional rate adjustments are recommended in order to meet the Revenue Requirements and promote the sustainability of the System. Specifically, for Fiscal Years 2014 and 2015, respective additional rate adjustments of 13.0% and 8.0% above the Approved Rates for such years are recommended in order to recover (pass-through) the increased ECRWRF operating and capital costs that were not anticipated or known during the preparation of the rate evaluation that supported the Approved Rate phasing program. Additionally Fiscal Year 2014 and 2015 will have a 2.0% and 3.0% rate increase, respectively, for water and irrigation. After Fiscal Year 2015, it was assumed that an index allowance (at 1.0% - 2.0% per year) coupled with an additional 2.0% adjustment (total of 3.0% for water and irrigation and 4.0% for sewer annually) for Fiscal Years 2015 - 2019 (the last year of the Approved Rate phasing program). After the Fiscal Year 2019, the financial plan assumes the implementation of an index allowance (at 2.0% per year) coupled with an additional 2.5% adjustment (total of 4.5% annually) in order to: 1) maintain utility margins and cash reserves (liquidity); 2) provide for the ability to issue additional bonds at a favorable credit rating (reduces financing costs); 3) provide for increased capital funding (deposits to the R&R Fund) over time which recognizes that the level of capital expenditures will increase in amount over time; and 4) minimize the overall rate impacts on the customers, thus providing for an affordable plan. The risk to this financial plan is that the need for additional capital expenditures, which were deferred to future periods as discussed earlier, may be required earlier than anticipated which will put financial pressure on the need for additional rate increases. The CRBUD will need to monitor this closely and continuously update the financial plan to the extent the Revenue Requirements increase due to the additional capital improvement financing or due to other significant changes in the System (e.g., continued reduced water sales, increased costs from the ECRWRF above projections, higher inflation or borrowing costs which will affect expenditures, etc.).

14.6.3 Financial Position and Performance Measures

Included as part of the development of the Financial Forecast and the review of the overall sufficiency of System revenues, is an evaluation of CRBUD's financial position. This evaluation includes the development of ratios and the review of financial performance indicators to present "where the CRBUD may be financially" during the Forecast Period based on the assumptions documented in this Report. In the development of the Net Revenue Requirements to be funded from rates, consideration as to the financial performance was recognized. The primary purpose of this additional analysis was to develop a financial plan to maintain a strong credit rating, especially when one recognizes the current financial constraints being placed upon the CRBUD (e.g., low growth and development, need to meet increased expenditures due to

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ECRWRF capital program, need for significant capital reinvestment due to asset age and condition [remaining service live], etc.).

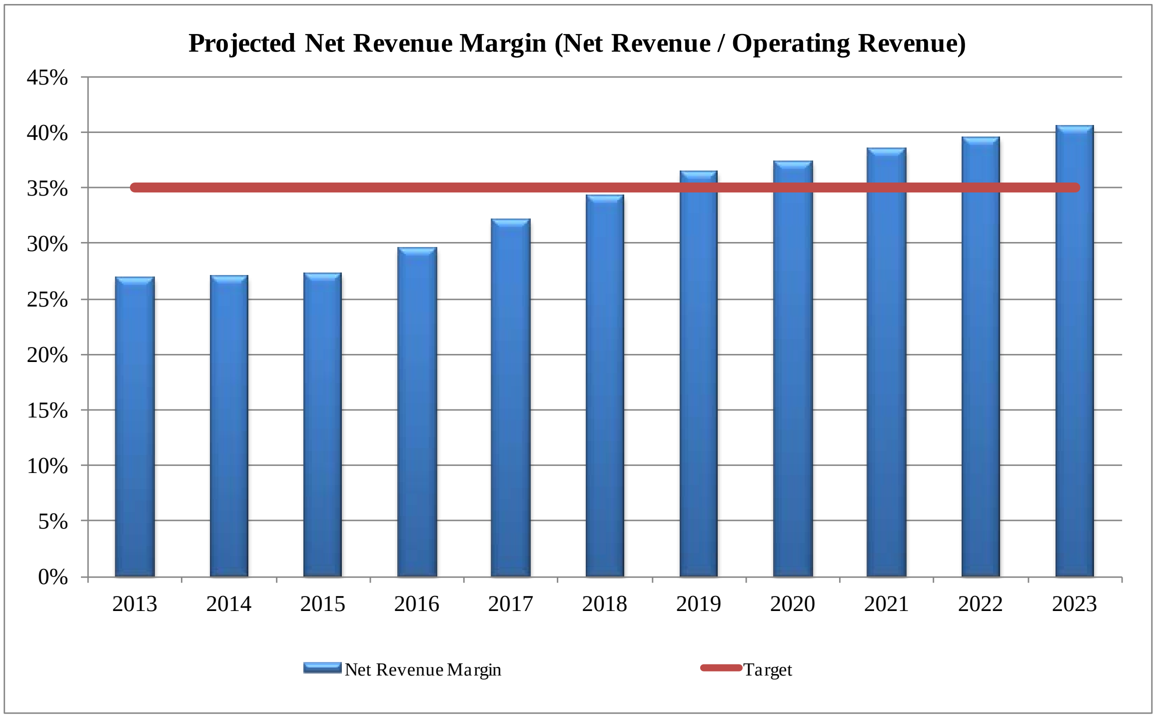
The analysis includes a series of charts and figures prepared to provide the CRBUD with a visual representation of the financial and statistical trends in the selected financial ratios or benchmarks anticipated for the System over the Forecast Period. The following is a brief description of financial ratios and financial results evaluated for the CRBUD's consideration.

14.6.4 Net Revenue Ratio

The Net Revenue Ratio is a measure of a utility system's ability to meet its operating expenses and indicates the net contribution margin estimated to be earned by the CRBUD. The contribution margin represents the amount of Net Revenues from CRBUD operations that are available to meet the CRBUD's other expenditure requirements after the payment of the operating expenses (e.g., available to pay debt service, deposits to a R&R Fund, etc.). Since impact fees are restricted as to use for new customers (expansion-related expenditures) and are a one-time revenue (not recurring like sales of service revenue), such revenues have not been included or recognized in the evaluation of the Net Revenue Margin. A relatively low Net Revenue Ratio (for example, 25 percent) indicates that a large portion of operating revenue is used to pay operating expenses. A high Net Revenue Ratio (for example, 45 percent) indicates a significant portion of operating revenues is available for CRBUD expenditures other than the payment of operating expenses (could link to a high debt burden). As can be seen below on **Figure 14-1** and assuming the implementation of the recommended rate adjustments, the Net Revenue Ratio is projected to be below the projected target which is based on the medians used by the rating agencies in the evaluation of utility credits. It should be noted that the cost of debt service for the ECRWRF is considered as an operating expense of the CRBUD and the increased costs associated with the capital improvements are affecting the ratio. However, recognizing the Additional Rates, the ratio is projected to marginally increase during the Forecast Period which is considered a favorable trend. This increase in the Net Revenue Ratio is recommended and should be continued after the Forecast Period. This indicates that the CRBUD's contribution margins are anticipated to increase over time which is consistent with the need to fund increased debt service payments to finance the capital program as well as the establishment of a dedicated deposit for ongoing (existing customer) pay-as-you-go capital financing.

The CRBUD should aim to achieve a Net Revenue Margin at a minimum of 35% to promote the CRBUD’s financial creditworthiness; which ratio also approximates Moody's Investors Services, Inc. median for municipal water and wastewater utilities. As can be seen on **Figure 14-1**, it is projected the CRBUD will be below this target ratio for the majority of the Forecast Period and will need to continue to monitor this trend and the overall contribution to capital reinvestment from System Operations.

Figure 14-1
Projected Net Revenue Margin (Net Revenue / Operating Revenue)

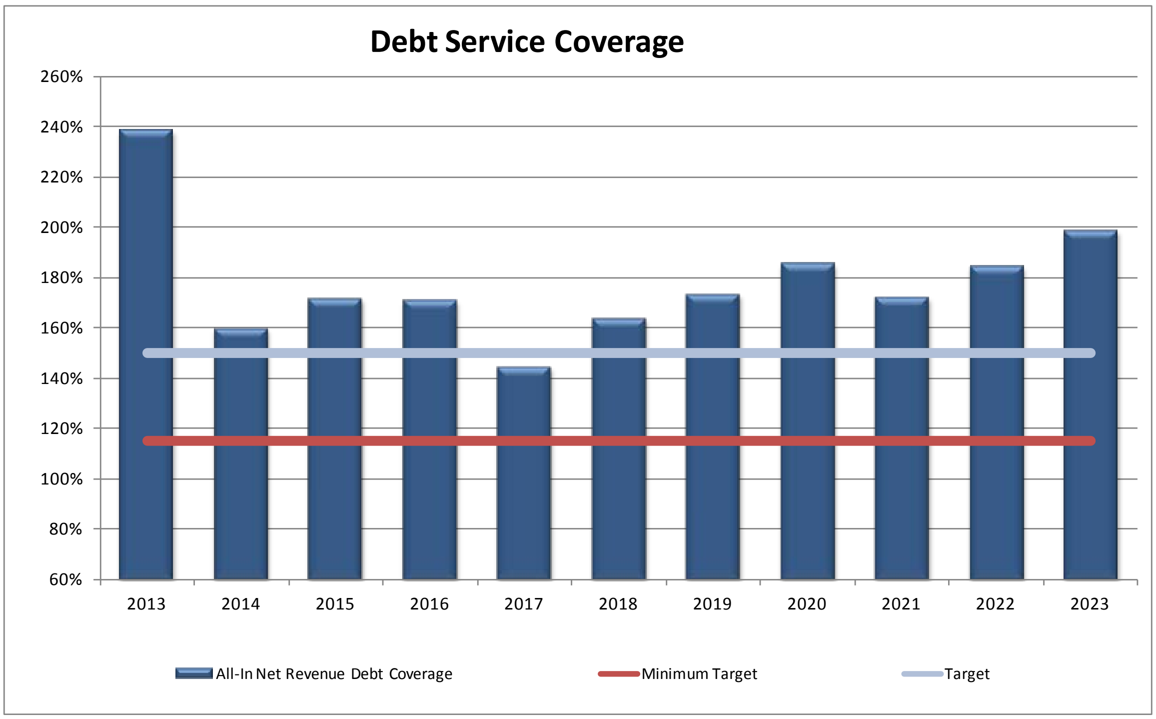


14.6.5 Debt Service Coverage Ratio

An important component in the development of the revenue sufficiency and rate analysis is the determination of whether the rate covenants as outlined in the Bond Resolution authorizing the issuance of the CRBUD's Outstanding and Additional Parity Bonds will be met. Generally, these covenants are in the form of certain debt service coverage ratios, which are applicable to the level of rates both currently and projected to be in place. The CRBUD's Bond Resolution contains a rate covenant (reference article 4.8 of the Bond Resolution) which provides that the CRBUD will at all times fix, charge and collect reasonable rates and charges so that the Net Revenues shall be adequate to pay at least one hundred fifteen percent (115%) of the Annual Debt service Requirement of the Bonds and that such Net Revenues shall be sufficient to make all of the payments required by the terms of the Bond Resolution. This ratio reflects the ability of the Net Revenues of the System to fund the Annual Debt Service Requirement. The rating agencies rely on this ratio in the review of utility credits since it links to the total ability to pay debt from ongoing revenues of the utility over the life of the repayment term of such debt and presents the overall leveraging capability of such utility.

A projection of the debt service coverage recognizing the identified rate adjustments is listed in **Table 14.24** and the issuance of the Additional Bonds as shown on **Table 14.19** is summarized in **Figure 14-2**. **Figure 14-2** indicates that the debt service coverage is projected to be favorable and is greater than the recommended minimum target of 1.50 which is representative of a good investment grade rating. One reason for the favorable trend in the coverage ratio is the increase in the funding of the R&R Fund which is being used to finance pay-as-you-go capital; such additional deposits may be available in the long-term to provide funds for the issuance of additional bonds above what is assumed for the financial forecast.

Figure 14-2
Projected Annual All-In Debt Service Coverage



The result of the implementation of the identified rate adjustments by the CRBUD is anticipated to:

1. Fully fund the forecasted Net Revenue Requirements of the CRBUD as previously identified;

2. Meet the minimum debt service coverage requirement (the rate covenant as defined in the Bond Resolution) for the Series 2004 Bonds and Additional Bonds;

3. Meet the additional bonds test as identified in the Bond Resolution required for the issuance of the Additional Bonds which requires a minimum calculated coverage ratio of 1.15 determined on an historical basis; and

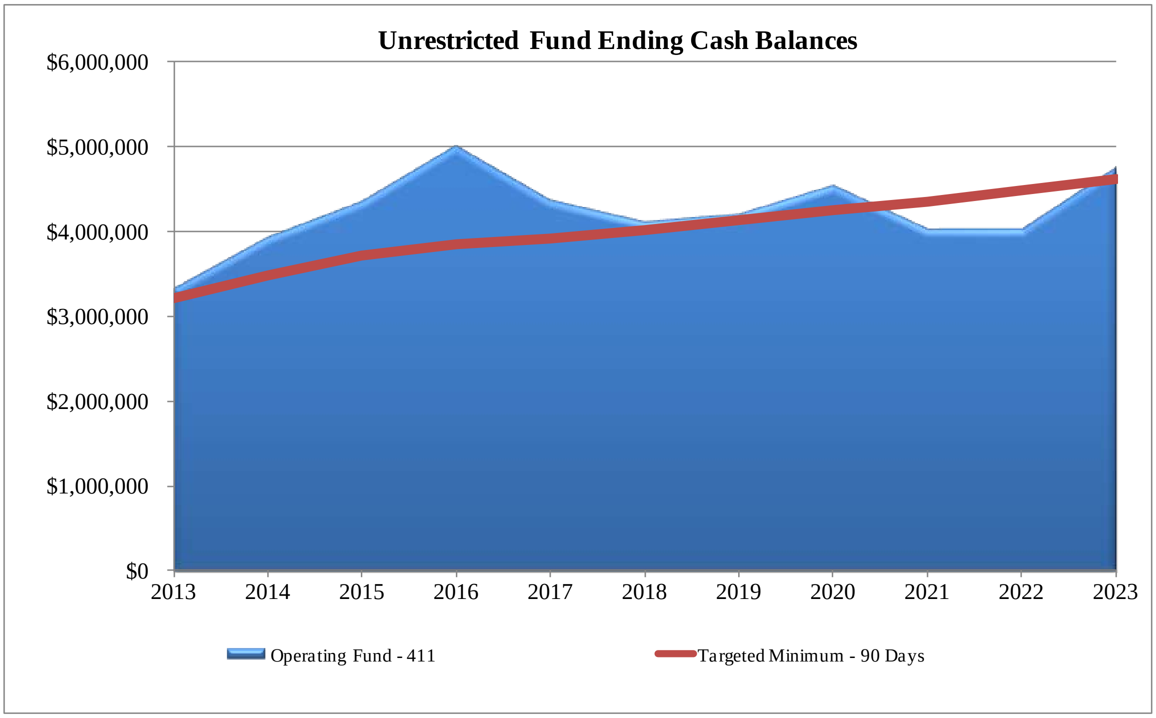
4. Provide for the required minimum working capital needs of the CRBUD as discussed below.

14.6.6 Available Operating Reserves (Working Capital) – Liquidity

Another important component of the evaluation of the CRBUD's operations is the resulting ending cash balance or cash position of the utility. The estimated ending cash balance for all of the CRBUD's funds is shown in **Table 14.28**. The estimated ending cash balances for the Operating Fund (Fund 411), which is considered as unrestricted cash, is graphically shown in **Figure 14-3** for the Forecast Period. This fund represents the operating reserves of the Utility that can be used for any purpose, including capital. In the development of the cash balances, such amounts do not include: 1) debt service sinking fund or reserve funds established as part of the issuance or repayment of bonds; 2) funds on deposit in the Construction Fund which is funded by bond proceeds; both of which are restricted to a particular purpose in accordance with the issuance of bonds; and 3) any funds established for future capital expenditures. Although many utilities consider the funds established for future capital expenditures as unrestricted operating reserves, they have not been included in this analysis due to the material amount of future capital expenditures that are required for the System.

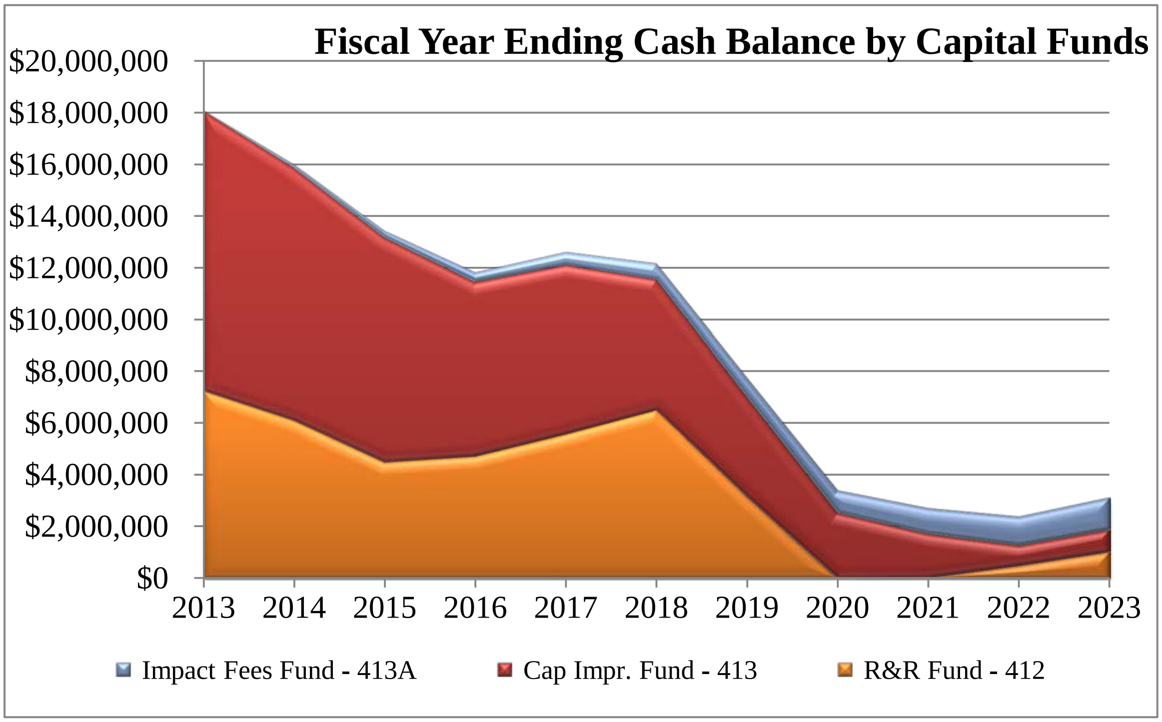
Figure 14-3 indicates that the ending cash balance for Fund 411 is projected to decline to the use of funds to meet the capital needs of the Utility System yet is projected to stabilize at the suggested minimum target level of ninety (90) days of operating expenses (averaging approximately $3.2 million to $4.6 million during the Forecast Period. In the early portion of the Forecast Period, monies on deposit in the fund are being used to fund the capital improvement program in order to minimize the Additional Recommended Rates in addition to the Approved Rates phasing program (net revenue availability). In Fiscal Years 2021 and 2022, the ending cash balance for Fund 411 drop just below the 90 target; however by the 90 O&M target reserve is achieved in FY 2023. The reduction in fund availability is a risk of the CRBUD that will need to be closely monitored since it reflects a reduction in operating flexibility and the ability to fund unanticipated expenditures or changes in Net Revenues.

Figure 14-3
Unrestricted Cash Ending Fund Balances



In addition to the operating reserves, a summary of the capital-related funds was also evaluated. The capital funds include balances in the: 1) the R&R Fund; 2) impact fee funds; 3) capital improvement fund (funded from the proceeds of the Series 2004 Bonds); and 4) Construction Fund funded from the proceeds of the Series 2013 Bonds. **Figure 14-4** illustrates the fiscal year ending cash balance by fund. **Figure 14-4** indicates that the CRBUD must rely on all of the available capital-related funds to meet the capital expenditure requirements as discussed earlier in this section. Since there are limited funds for future capital, outside the annual pay-as-you-go funding (i.e., deposits to the R&R Fund), the need for operating reserves is even more enhanced and rates may need to be increased at a greater amount than presented if conditions warrant. This is an issue that must be closely monitored by the CRBUD as the available cash reserves are utilized for capital needs.

Figure 14-4
Fiscal Year Ending Cash Balance by Fund



A summary of the ending cash balances for all of the funds or cash requirements are summarized on **Table 14.28.**

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Table 14.28
Projected Water, Wastewater, and Irrigation System Ending Cash Balances

	Projected Fiscal Year Ending September 30,										
Description	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Operating Fund – 411	$3,327,650	$3,935,744	$4,357,737	$5,016,014	$4,374,617	$4,118,641	$4,209,368	$4,548,490	$4,033,809	$4,034,620	$4,763,522
Customer Dep. Fund – 411A	$1,878,749	$1,878,749	$1,878,749	$1,878,749	$1,878,749	$1,878,749	$1,878,749	$1,878,749	$1,878,749	$1,878,749	$1,878,749
R&R Fund – 412	$7,265,222	$6,112,060	$4,501,796	$4,729,447	$5,580,935	$6,514,252	$3,164,727	$8,904	$34,332	$506,187	$1,045,650
Cap Impr. Fund – 413	$10,799,636	$9,744,636	$8,668,286	$6,710,741	$6,526,226	$5,032,164	$3,858,351	$2,544,093	$1,706,483	$783,514	$858,639
Impact Fees Fund – 413A	$0	$120,038	$240,347	$361,046	$482,258	$604,104	$726,709	$850,197	$974,696	$1,100,335	$1,227,246
Debt Proceeds Fund – 413B	$19,416,950	$12,000,950	$5,549,030	$0	$12,240,365	$5,929,135	$2,005,920	$0	$7,660,300	$4,264,740	$0
DSR Fund – 414	$1,824,765	$1,824,765	$1,824,765	$1,824,765	$3,527,713	$3,527,713	$3,527,713	$3,527,713	$4,426,743	$4,426,743	$4,426,743
Sinking Fund - 414A	$1,299,146	$1,310,365	$1,331,115	$1,897,696	$2,609,731	$2,640,803	$3,004,912	$3,045,783	$3,625,200	$3,681,590	$3,723,343
Total Projected End of Year Balances	**$45,812,119**	**$36,927,308**	**$28,351,826**	**$22,418,459**	**$37,220,595**	**$30,245,562**	**$22,376,450**	**$16,403,930**	**$24,340,313**	**$20,676,479**	**$17,923,893**

14.7 Customer Impact Analysis

14.7.1 Customer Impact

In order to provide additional information to the CRBUD regarding the proposed rates, an analysis to illustrate the impact for the standard 5/8" x 3/4" meter customer was prepared. This meter size was selected since it represents the meter used to serve approximately 86% of all accounts, assuming that all residential single family customers use a 5/8" x 3/4" meter. The effect of the proposed rate adjustments for Fiscal Year 2014, recognizing the average monthly use per account for the individually metered Residential Class of approximately 6,000 gallons is shown in **Table 14.29**:

Table 14.29
Monthly Bill Increase
Single Family Residential Customer Using 6,000 Gallons of Service [1] [2]

Item	Water	Sewer	Total
FY 2013 Existing Rates	$28.44	$19.26	$47.70
FY 2014 Adopted Rate Increase	2.04%	4.14%	
Adjusted Bill	$29.02	$20.06	$49.08
Increase in Monthly Bill	$0.58	$0.80	$1.38
Dollar per Day	$0.02	$0.03	$0.05
FY 2014 Recommended Rate Increase	2.00%	13.00%	
Adjusted Bill	$29.60	$22.66	$52.27
Increase in Monthly Bill	$1.16	$3.40	$4.57
Dollar per Day	$0.04	$0.11	$0.15
FY 2015 Adopted Rate Increase	2.00%	1.99%	
Adjusted Bill	$30.19	$23.12	$53.31
Increase in Monthly Bill	$0.59	$0.45	$1.04
Dollar per Day	$0.02	$0.02	$0.03
FY 2015 Recommended Rate Increase	3.00%	8.00%	
Adjusted Bill	$31.10	$24.97	$56.06
Increase in Monthly Bill	$0.91	$1.85	$2.76
Dollar per Day	$0.03	$0.06	$0.09
FY 2016 Adopted Rate Increase	2.04%	5.15%	
Adjusted Bill	$31.73	$26.25	$57.98
Increase in Monthly Bill	$0.63	$1.29	$1.92
Dollar per Day	$0.02	$0.04	$0.06
FY 2016 Recommended Rate Increase	3.00%	4.00%	
Adjusted Bill	$32.68	$27.30	$59.99
Increase in Monthly Bill	$0.95	$1.05	$2.00
Dollar per Day	$0.03	$0.04	$0.07

Table 14.29
Monthly Bill Increase
Single Family Residential Customer Using 6,000 Gallons of Service [1] [2]

Item	Water	Sewer	Total
FY 2017 Adopted Rate Increase	2.00%	2.07%	
Adjusted Bill	$33.34	$27.87	$61.20
Increase in Monthly Bill	$0.65	$0.57	$1.22
Dollar per Day	$0.02	$0.02	$0.04
FY 2017 Recommended Rate Increase	3.00%	4.00%	
Adjusted Bill	$34.34	$28.98	$63.32
Increase in Monthly Bill	$1.00	$1.11	$2.11
Dollar per Day	$0.03	$0.04	$0.07
FY 2018 Adopted Rate Increase	2.03%	3.63%	
Adjusted Bill	$35.04	$30.03	$65.07
Increase in Monthly Bill	$0.70	$1.05	$1.75
Dollar per Day	$0.02	$0.04	$0.06
FY 2018 Recommended Rate Increase	3.00%	4.00%	
Adjusted Bill	$36.09	$31.23	$67.32
Increase in Monthly Bill	$1.05	$1.20	$2.25
Dollar per Day	$0.04	$0.04	$0.08
FY 2019 Adopted Rate Increase	1.99%	3.60%	
Adjusted Bill	$36.80	$32.36	$69.16
Increase in Monthly Bill	$0.72	$1.12	$1.84
Dollar per Day	$0.02	$0.04	$0.06
FY 2019 Recommended Rate Increase	3.00%	4.00%	
Adjusted Bill	$37.91	$33.65	$71.56
Increase in Monthly Bill	$1.10	$1.29	$2.40
Dollar per Day	$0.04	$0.04	$0.08
FY 2020 Adopted Rate Increase	0.00%	0.00%	
Adjusted Bill	$37.91	$33.65	$71.56
Increase in Monthly Bill	$0.00	$0.00	$0.00
Dollar per Day	$0.00	$0.00	$0.00
FY 2020 Recommended Rate Increase	4.50%	4.50%	
Adjusted Bill	$39.61	$35.17	$74.78
Increase in Monthly Bill	$1.71	$1.51	$3.22
Dollar per Day	$0.06	$0.05	$0.11

Note:

[1] Based on identified rate adjustment as applied on a uniform basis.

[2] Dollar per Day calculation is based on 30 days/month

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14.7.2 Rate Comparison – Monthly User Fees

In order to provide the CRBUD with additional information with respect to the proposed rates, this report provided bill comparisons based on the CRBUD's existing and proposed water and wastewater rates with those currently being charged by other neighboring communities. The bills for the neighboring Florida utilities were calculated based on rates in effect as of the billing month of October 2012 (beginning of the current Fiscal Year). The monthly bills for the various Florida utilities used for the comparison are exclusive of local taxes. The average residential customer for the CRBUD uses approximately 6,000 gallons of monthly water and wastewater service (if combined services are provided). A comparison of water and wastewater rates at this consumption level between the CRBUD and the utilities surveyed is provided in **Table 14.30**.

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Table 14.30
Monthly Water and Wastewater Rate Comparison (6,000 Gallons)[1]

Item	Water	Sewer	Total
City of Riviera Beach Utility District (CRBUD):			
CRUBD – Existing	**$28.44**	**$19.26**	**$47.70**
CRUBD – Proposed 2014 [2]	**29.60**	**22.66**	**52.27**
Other Southeast Florida Utilities:			
City of Boca Raton	$17.27	$16.15	$33.42
Broward County	26.32	38.02	64.34
City of Boynton Beach	20.36	28.87	49.23
City of Cooper City	28.84	41.63	70.47
City of Coral Springs	24.00	36.01	60.01
City of Dania Beach	41.54	66.28	107.82
City of Delray Beach	19.47	38.39	57.86
City of Fort Lauderdale	22.29	37.71	60.00
City of Hollywood	29.02	42.94	71.96
Town of Jupiter	25.12	20.61	45.73
City of Lake Worth [3]	38.88	41.33	80.21
Town of Lantana	27.46	39.74	67.20
Martin County	28.22	40.62	68.84
Palm Beach County [3]	22.11	27.61	49.72
City of West Palm Beach [3]	39.34	31.65	70.99
Seacoast Utility Authority	23.40	29.87	53.27
City of Tamarac	23.43	42.91	66.34
Village of Tequesta	27.29	20.61	47.90
Village of Wellington	29.69	28.03	57.72
Other Southeast Florida Utilities' Average	**$27.06**	**$35.21**	**$62.26**
ECR Partner's Average	**$33.44**	**$33.53**	**$66.97**

[1] Amounts shown assumed service through a 5/8" x 3/4" meter; other Florida utilities represent utilities located in the southeast portion of the state in general proximity to the Utility District.

[2] Represents Fiscal Year 2014 proposed 13% sewer only rate increase due to unanticipated ECR O&M costs, plus the approved rate increases of 2.04% for water and irrigation and 4.14% for sewer.

[3] Represents the Utility District's ECR partners

As can been seen above the comparison provides the average bill for all neighboring utilities surveyed as well as an average of all the ECR partners surveyed. Under the existing and proposed rates, the CRBUD is much lower than those utilities survey and there appears to be a need to increase rates when compared to the industry. This is especially evident for the wastewater system, including for those entities that are served by the ECRWRF (average wastewater bill of $33.53 per month) when compared to the CRBUD (average wastewater bill of $22.66 per month, even with the additional 13.0% increase above the Approved Rates). Recognizing the capital needs of the System, the trend in cash balances, and the uncertainty in the market, the CRBUD should consider increasing the Approved Rates to meet the ongoing needs of the Utility over the long-run.

Appendix A

Water Treatment Plant Site Investigation

This document summarizes the site investigation findings for the existing infrastructure at the Riviera Beach Utility District Water Treatment Plant (WTP) from a site visit made on 2/07/2012. The investigation was limited to visual observation of the facilities and interviews with plant operations and maintenance staff regarding the performance, reliability and condition of the existing equipment. This document provides discussion and recommendations for the following water treatment facility components:

- Flow Meters
- Packed Tower Scrubbers
- Raw Water Transfer Pumps and Clearwell
- Raw Water Influent Flow Basins
- Alum Chemical Feed System
- Polymer Chemical Feed System
- Lime Chemical Feed System
- Chemical Disinfection System (Ammonia and Chlorine)
- Softeners
- Solids Handling Facilities
- Filtration System
- High Service Pumps
- Blue Heron Boulevard Finished Water Storage Tank
- Emergency Power
- Air Compressors
- Yard Piping
- Motor Control Centers (MCCs) and
- PLCs
- Main Control Room
- Florida Power and Light Primary Power

Expected asset life was based upon a variety of industry literature and engineering judgment. Table 1 presents the asset life assumptions used to assess remaining useful life.

Table 1
Expected Equipment Life

Item	Useful Life (Yrs.)
Blower	15
Chemical Storage and Feed	10
Compressor	20
Engine	30
Emergency Generator	20
Pump & Motor (greater than 5 hp)	20
Pump & Motor, small (< 5 hp)	10

Table 1
Expected Equipment Life

Item	Useful Life (Yrs.)
Air Strippers	50
Air Strippers Packing Material	5
Concrete Structures	30
Deep Injection Well	50
Fuel Storage	15
Electrical Systems	20
Instrumentation	10
Hardware (Control)	5
Software (Control)	1
HVAC Systems	15
Piping, Valves and Accessories (> 8")	30
Variable Frequency Drive	10
Painting	7
Roofing Materials (shingles, tile, membrane)	20
Well Pump & Motor	10
Well Replacement	30
Well Redevelopment	10
Sluice Gates	30
Filter Media	10
Filter Under drain	20
Hydrotreator Rake and Drive Unit	15
Mixer	20
Monitor Well Sampling	5
Lime Storage System	10
Lime Slakers	10
Vacuum Priming System	20
Electrical Transformers	10

1. Flow Meters

This section of the appendix covers the flow meters located within the WTP, including the main raw water influent flow meter located on the 24-inch influent main to the packed tower scrubbers, influent flow meters for water into the South Chemical Building and North Chemical Building's Raw Water Influent Basins, magnetic flow meter measuring flow into Softener No. 1, and the WTP finished water effluent flow meter located on the discharge of the high service pump station. The influent flow meters and magnetic flow meter into Softener No. 1 are intended to provide flow control signals for pacing lime, aluminum sulfate (Alum), polymer, ammonia, and chlorine. Flow meters associated with filter operation are covered in Section 11 and 15 of this appendix.

Each Raw Water Influent Basin has two influent lines: one from the raw water transfer pumps at the Packed Tower Scrubber Complex clearwell (raw water influent main) and the other returning water from the "Save All Basins" that receive the softeners' lime sludge blowdown water and filter backwash (return water main). The South Raw Water Influent Basin has a 24-inch venturi flow meter with transmitter (Rosemount 1151 smart flow transmitter) on the raw water influent main (Picture A.1-1) but no flow meter on the return water main. An additional 20-inch magnetic flow meter (Picture A.5-1) is located on the influent flow line from the South Raw Water Influent Basin to Softener No. 1 to determine the flow to Softener No. 1 or 2 from the South Raw Water Influent Basin. The North Raw Water Influent Basin has a 30-inch venturi flow meter with transmitter (Rosemount 1151 smart flow transmitter) on the raw water influent main and a 10-inch ventrui flow meter with transmitter on the return water main (Picture A.1-2).

The current raw water influent flow meters (two in total), return water flow meter, and the finished water effluent flow meter were installed in 1995. The magnetic flow meter on the influent main to Softener No. 1 was installed in 2009.

1.1 Observed Conditions

Mechanical: Gaseous ammonia is injected just prior to the venturi flow meter on the South raw water influent main and can cause of severe scaling within the meter. The proximity of the ammonia injection point immediately following the venturi flow meter on the north raw water influent main might also cause scaling in the meter.

Instrumentation: The main raw water influent flow meter and the WTP finished water effluent flow meter were the only two flow meters mentioned above observed to be operational and in good working condition. The differential pressure transmitter was replaced on the venturi effluent flow meter in 2010 to provide higher reading range and solve flow measurement issues. It was reported by Staff that none of the three venturi flow meters installed on either the south or north raw water influent or return water mains, nor the magnetic flow meter on the influent line to Softener No. 1 were returning accurate flow measurements. The flow transmitter for the South Raw Water Influent Basin has significant deficiencies and is in poor condition; a calibration sticker was present from CC Controls with a date of 9/22/11. The magnetic flow meter on the influent line to Softener No. 1 is relatively new and could be suffering from scaling of the flow element. The City should locate and safely store as-built information and calibration sheets for each flow meter so that appropriate periodic calibrations can be performed.

Electrical: All electrical equipment appears to be in functional condition.

1.2 Recommended Improvements

Mechanical: The ammonia injection point should be relocated based upon the chlorination strategy that is implemented. Injection of gaseous ammonia into hard water is not recommended due to its scaling potential. It is likely that any cleaning and/or calibration of the flow meters will be ineffective if scaling issues are not rectified.

Table 2 lists the existing WTP flow meters and their status.

Table 2
Description and Status of Existing WTP Flow Meters

Description Existing Flow Meter	Status
24-inch raw water influent flow meter (magnetic flow meter)	End of its useful life
30-inch raw water flow meter into north influent basin (venturi)	End of its useful life
10-inch save all basin return water main entering the north influent basin	End of its useful life
24-inch raw water flow meter into south influent basin (venturi)	End of its useful life
20-inch raw water flow meter into south treatment unit (magnetic flow meter)	Installed in 2009 and reportedly not accurate
30-inch finished water flow meter on discharge of high service pump station manifold (venturi)	End of its useful life

Accurate flow metering is required to facilitate automatic operation of the proposed sodium hypochlorite facility (described in a separate report). Consequently, all existing flow meters (shown in Table 2 above) are recommended for replacement with new magnetic flow meters; flow signals should be tied into the control system. Furthermore, new flow meters should be added (and flow signals tied into the control system) at the 10-inch save all basin return water main entering the south influent basin and 24-inch raw water main entering the north treatment unit so that the flow through each unit process can be fully accounted.

2. Packed Tower Scrubbers

This section covers the packed tower scrubbers located at the head of the WTP. The packed tower scrubbers were constructed in 1988 as part of a remediation project to clean volatile organic chemicals (VOCs) discovered in the wellfield.

2.1 Observed Conditions

Mechanical: The ability to control the flow rate into individual scrubbers using flow control valves is no longer available. The current local motorized valve actuators either fully open or close the valve (normally valve 100% open) and the originally installed flow meters (for control of the flow control valves) were removed in 1995. Blower No. 3 has a failed gasket. Variable speed (via VFDs) for the blowers is only active for Blowers 1,2, and 4; the VFD for Blower No. 3 has been removed. Staff reported that the injection ports for packed tower scrubber media cleaning are clogged. Additionally, the backwash cleaning pump has been out of service for over three years. A black-red slime buildup in the packing media was reported by Staff, likely indicating iron fouling.

Instrumentation: The pressure transmitter located upstream of the influent motor operated valve (MOV) has defects requiring significant maintenance. The variable frequency drives (VFDs) for the blowers are controlled manually. Staff indicated that they would like the ability to monitor pH, H_2S and pressure of the scrubber air.

Electrical: The disconnects for Blower No. 1 and 2 are not accessible. MOV power conduits are broken at slab. The light fixture located above the stairs to the packed tower scrubber deck was observed to be broken.

Structural: The walls of the Packed Tower Scrubber Complex were in good condition.

2.2 Recommended Improvements

Mechanical: The cleaning system and all components need to be replaced and proper media cleaning restarted. It is critical that the type of fouling (sulfide or iron) be evaluated to define proper chemical for cleaning; hydrochloric acid (HCl) is recommended for iron fouling and caustic or brine solution for sulfide fouling. From present reports iron fouling seems likely and HCl is recommended as the cleaning chemical. A chlorine injection point should also be added to the packed tower influent line to provide for shock chlorination for cleaning of the packed media. The packing media should be replaced immediately. Random packing has been shown not to work well for the scrubbing of raw water and structured packing would be preferred; however, retrofitting structured packing media into the current towers could require some major modifications and needs to be evaluated to determine its feasibility. The shroud connections from the blower to the stripping tower as well as the blower bases are rusted out. The gasket in Blower No. 3 needs to be replaced. The bases and shroud connections to the stripping towers need to be replaced for all blowers. The air-to-water ratio for the packed tower scrubber should be re-evaluated to define whether airflow (supplied by blowers) and the water loading rate are operating within desired limits. Typically if the towers and inlet pipes are at the same elevation, flow control with flow control valves is not required. The blowers are at the end of their estimated useful life and should be replaced with the sizes determined from the design re-evaluation of the packed tower scrubbers. Typically properly sized blowers will not require VFDs.

Instrumentation: The pressure transmitter upstream of the influent MOV requires replacement. It is recommended to add a pH monitor in the packed tower sump to help control cleaning chemical dosing. Alternatively, pH monitors can be supplied with the cleaning solution chemical dosing pump (package system) to control cleaning chemical dosing.

Electrical: The disconnects for Blower 1 and 2 need to be relocated to meet code requirements and provide maintenance accessibility. Power conduit for Blower No. 1 needs to be replaced. The MOV power conduits, broken at slab, need to be replaced. The light fixture located above the stairs to the packed tower scrubber deck should be replaced; it is recommended that LED type light fixtures be considered as replacement for energy conservation.

3. Raw Water Transfer Pumps and Clearwell

This section covers the raw water transfer pumps and clearwell located at the Packed Tower Scrubber Complex at the head of the WTP. Six (6) vertical turbine raw water transfer pumps are mounted on top of the clearwell and transfer raw water to either the South or North Raw Water Influent Basins located on the third floor of the respective chemical buildings. Raw Water Transfer Pumps 1A, 2A, and 3A transfer water to the South Raw Water Influent Basin while Raw Water Transfer Pumps 1B, 2B, and 3B transfer water to the North Raw Water Influent Basin. No cross-connection exists to allow pumping to an alternate raw water influent basin. Raw Water Transfer Pumps 1B and 2A have VFDs.

The raw water clearwell, raw water transfer pumps, associated piping and vales were constructed with the packed tower scrubbers in 1988. VFDs for Raw Water Transfer Pumps 1B and 2A were added in 1995.

3.1 Observed Conditions

Mechanical: It was reported by staff that all six center-post guided (silent) pump discharge check valves (Picture A.3-1) tend to freeze open. Silent check valves installed in the vertical down position may have the tendency to have the disc, which is heavy, "fall off" the seat and not create a tight seal. All raw water transfer pumps are old and at the end of their estimated useful life. A chlorine injection point also exist on the discharge piping of Raw Water Transfer Pumps 1B, 2B, and 3B, but is not in use.

Instrumentation: A bubbler is used for level indication in the clearwell and is functional. Staff has indicated that they would prefer the use of an ultrasonic level indicator instead of the existing bubbler. Currently the raw water transfer pumps are manually controlled, including VFD speed settings, based on the level in the clearwell. The pressure gauges located on the raw water transfer pump discharge all appear to have discolored lenses. A pressure gauge is missing on Raw Water Transfer Pump 2A.

Electrical: Motors on Raw Water Transfer Pumps 1B and 2A (utilizing VFDs) are not inverter duty rated. All motors are old and at the end of their design lives.

Structural: The walls of the Packed Tower Scrubber Complex were in good condition. One crack was observed on the west side of the top slab of the clearwell.

3.2 Recommended Improvements

Mechanical: Replace all six check valves; it is recommended that the silent check valves be re-installed on the horizontal discharge pipe instead of in the vertical down position as they are currently installed. Considering the varying pump sizes and operation of the WTP at significantly lower flows than originally designed, it is recommended that the pump selection be re-evaluated. All pumps, valves, and appurtenances should be replaced within the next 5 years.

Instrumentation: Replace the existing pressure gauges located on the pump discharge lines and install a discharge pressure gauge for Raw Water Transfer Pump 2A. Replace the bubbler with a ultrasonic level transmitter and wire the signal to the same input as the existing bubbler level signal.

Electrical: The motors on Raw Water Transfer Pumps 1B and 2A are being used with VFDs for better process control. These motors do not have the recommended insulation to withstand the voltages generated from VFDs. This issue will shorten the motor life. Inverter (VFD) duty rated motors should be used with VFDs. This higher rated insulation can also be applied to most motors when they are rewound by authorized motor repair shops. All motors should be replaced within the next 5 years.

Structural: Perform an inspection of the interior of the clearwell to properly asses condition of the structure.

4. Raw Water Influent Basins

This section covers the Raw Water Influent Basins. Each raw water influent basin has two influent lines: one from the raw water transfer pumps at the Packed Tower Scrubber Complex clearwell (raw water influent main) and the other returning water from the "Save All Basins" that receive flow from the softeners' lime sludge blowdown and filter backwash (return water main).

The South Raw Water Influent Basin was constructed in 1964 with the South Chemical Building while the North Raw Water Influent Basin was constructed in 1979 with the North Chemical Building.

4.1 Observed Conditions

Mechanical: The original raw water influent basins contained tray aerators that were removed following the construction of the Packed Tower Scrubber Complex. The North Raw Water Influent Basin was out of service during the site visit. Algae buildup on both the South and North Raw Water Influent Basins were evident. A chlorine injection point for algae control was observed at both basins, but is currently not utilized.

Structural: The basins are in good condition.

4.2 Recommended Improvements

Mechanical: The ammonia injection point should be relocated based upon the selected chlorination strategy. Injection of gaseous ammonia prior to the open influent basins provides additional nutrients for algae growth. Additionally the evaluation of maintaining a chlorine injection point prior to the raw water influent basins for algae control should be evaluated; preferably on the discharge of the raw water transfer pumps in order to provide proper mixing.

Structural: When basins are out of service inspect to see condition of waterproofing.

5. Alum Chemical Feed System

This section covers the Alum metering pumps located on the first floor of the South Chemical Building and the 10,000 gallon Alum storage tank located directly outside on the south side of the South Chemical Building. here are four Alum metering pumps (one dedicated to each softener with a fourth for standby). These skid mounted pumps were installed in 2009. The Alum storage tank is a glass lined steel tank that was installed in the 1979 and has since been patched three times (Picture A.5-1). Another glass lined steel storage tank sits directly south of the alum storage tank and is out of service. It was originally used to store activated silica.

5.1 Observed Conditions

Mechanical: The skid mounted alum metering pumps, valves, and appurtenances are in new condition. Three metering pumps exist to pump to each softener with three injection points: two injection points in the South Raw Water Influent Basin and one injection point into the North Raw Water Influent Basin. A fourth metering pump exist as a backup. The Alum storage tank has clearly been patched but appears to be in functional condition.

Instrumentation: Monitoring and control of alum metering pumps is available locally or in the control room. The pumps serving the two injection points in the South Raw Water Influent Basin are designed to be flow paced using signals from the raw water influent flow venturi meter and the magnetic flow meter located on the fill line to Softener No. 1 that are currently not functional (see Section 1 of this appendix). The pump serving the injection point in the North Raw Water Influent Basin is designed to be flow paced using signals from the raw water influent and return water return venturi flow meters that are currently not functional (see Section 1 of this appendix). Thus, feed rate is manually controlled by the operators.

Electrical: All electrical equipment appears new and in good condition.

Structural: The room is in good condition.

5.2 Recommended Improvements

Mechanical: The injection of a coagulant, such as aluminum sulfate (Alum), into the Raw Water Influent Basins ahead of the softeners is acceptable for proper operation; however, the results from bench scale testing revealed that ferric chloride would likely be a more efficient coagulant than Alum. It is thus recommended that the Alum be replaced with ferric chloride and the Alum Storage Tanks be demolished and replaced. Replacement of the Alum chemical feed system and transition to a ferric chloride chemical feed system are described in the Master Plan Section 8.

Instrumentation: It is recommended that the influent metering for flow into both the South and North Raw Water Influent Basins be modified as recommended in Section 1 of this appendix in order to provide proper control for the chemical metering pumps.

6. Polymer Chemical Feed System

This section covers the polymer feed system located on the first floor of the North Chemical Building. The polymer system consist of five US Filter Polyblend M Series polymer feed system (Model M240), and two polymer drum scales with digital indicators. Polymer is injected above the deck of the softeners into the secondary mixing zone of each softener (Picture A.9-3).

The polymer feed system was recently replaced with the Polyblend M Series polymer feed system and moved to the North Chemical Building in 2010. The two polymer drum weight scales were installed in the early 2000s and reused.

6.1 Observed Conditions

<u>Mechanical:</u> It was observed that the polymer feed system is relatively new and in good working condition.

<u>Instrumentation:</u> Monitoring and control of the polymer feed system is available locally or in the control room; control is currently maintained from the control room. The metering pumps are designed to be flow paced using signals from the raw water influent flow venturi meters located on the fill lines to the South and North Raw Water Influent Basins and the magnetic flow meter on the influent line to Softener No.1. All of these flow meters are currently not functional (see Section 1 of this appendix); thus, feed rate is manually controlled by the operators. The polymer drum scales appear corroded and have significant deficiencies with near-term failure possible.

<u>Electrical:</u> All electrical equipment appears to be in functional condition.

<u>Structural:</u> The room is in good condition with the exception of the coating on the floors which has failed.

6.2 Recommended Improvements

<u>Mechanical:</u> Based on the results from bench scale testing it is recommended that Alum be replaced with ferric chloride (as the coagulant). The floc formed with Alum is light and fragile and tends to require the addition of flocculation aids to help form a floc that is more efficiently removed through settling and filtration. The switch to ferric chloride would likely lower or eliminate the need for polymer. Recommendations for the use of polymer are presented with the findings of the bench scale testing in Section 8 of the Master Plan.

<u>Instrumentation:</u> If polymer addition is still required, the polymer drum scales should be replaced to match the number of injection points required.

<u>Structural:</u> Clean and re-coat floors with chemical resistant and skid resistant coating.

7. Lime Chemical Feed System

This section covers the lime feed system located on the third floor and roof of the South and North Chemical Buildings. The lime feed system consist of lime silo fill lines, lime silos, storage hopers, dust collectors, and lime slakers. Each chemical building has two feed lines, two dust collectors, bifurcated lime storage area (two lime silos), two hopers, and two lime slakers. The numbering of this equipment is 1 - 4 with number 1 being the southernmost unit; therefore, Lime Slakers No. 1 and 2 are located in the South Chemical Building and Lime Slakers No. 3 and 4 are located in the North Chemical Building.

The lime chemical feed system (Lime Slakers No. 1 and 2) in the South Chemical Building was constructed in 1964 as part of the construction of the South Chemical Building. The lime chemical feed system (Lime Slakers No. 3 and 4) in the North Chemical Building was constructed in 1979 as part of the construction of the North Chemical Building. The lime fill lines were most recently replaced with the installation of four dust collectors in 2007. Lime Slakers No. 1, 2 and 3 were most recently replaced in 2002,, and Lime Slaker No. 4 in 2004. Four non-contact radar level indicators (Siemens LR260) for both the South and North Chemical Buildings were installed in 2010.

7.1 Observed Conditions

<u>Mechanical:</u> Staff reported that the fittings for the lime silo fill lines are replaced every three years due to wear; however, the installed fittings are not "wear back type" fittings. All four dust collectors are in good condition and properly functioning. Staff reported that the lime slakers are currently the biggest maintenance issue in the water treatment plant. Additionally, staff reported major difficulties with the lime feed stopping in the hoper due to "bridging". No temperature gauges were present on any of the slaker tanks, and lime slurry in the slaker weir box was cold to the touch. The condition of the slaker equipment is generally poor: all four dry feeders have significant deficiencies with near-term failure possible and all four dissolver tanks, although in better condition, require significant maintenance to repair minor defects and deficiencies. The lime slurry from Lime Slakers No. 1 and 2, located in the South Chemical Building, flows into a common slaker weir box with fixed weir openings that proportion flow of lime slurry to Softeners No. 1 and 2 (Picture A.7-1). For all three softeners, lime slurry flows from the weir box to the softeners via open channel troughs fabricated from PVC pipe. This configuration cannot accurately control the feed rate of lime to the softeners. The inability to control the lime feed to the softeners results in poor treatment performance. The lime injection points are into the secondary mixing zone of the softeners.

<u>Instrumentation:</u> The non-contact radars for lime silo pebble lime level indication in both the south and north lime silos are providing inaccurate measurements; a review of historical data trends shows that the readings are erratic. All four control panels appear to require significant maintenance and some of the indicators do not appear to be fully functional.

<u>Electrical:</u> 208 Volt 3 phase power feed is provided for the for the lime slaker equipment motors in the South Chemical Building. A transformer on the first floor of the South Chemical Building (Picture A.7-2) is used to convert power from the 480V 3 phase supply to 120/208V 3phase. 480V 3phase power is provided for the lime slaker equipment motors in the North Chemical Building. Limited access was provided for the disconnect switches for Lime Slakers No. 1 and 2 (Picture A.7-3) and Lime Slakers No. 3 and 4 (Picture A.7-4). National Electrical Code (NEC) requires 42 inches of clearance perpendicular to equipment with working voltages of 480V.

Structural: The room and roof are in good condition on both the North and South Chemical Buildings. Corrosion is evident on the stairs and handrails in both the South and North Chemical Buildings (for all floors).

7.2 Recommended Improvements

Mechanical: For the next required replacement of the lime fill line fittings, install "wear back" type fittings specified for this service. The lime slakers appear to be in poor condition and should be replaced within the next 5 years. The inability to control the lime feed rate to the softeners should be resolved by the addition of a lime slurry holding tank and pumping system with VFDs. It is recommended that this proposed lime slurry holding tank and feed pump system be implemented at the same time as the lime slaker replacement. Improved coagulation could be achieved if lime was injected into the primary mixing zone of the softeners; this could be achieved by tapping into the deck plate and placing the lime injection drop pipe through the deck plate into the primary mixing zone.

Instrumentation: A guided wave radar level transmitter for level indication should be installed for each lime storage area (total of 4 instruments for the North and South Chemical Building). All control panels and VFDs control for the lime feeder should be replaced within the next 5 years as part of the replacement of the lime slakers.

Electrical: With the replacement of the lime slakers provide motors that run on 480V 3phase power in the South Chemical Building and remove transformer on first floor. The NEC should be consulted for the placement of the new disconnect switches.

Structural: Clean and re-coat the stairs and handrails in both the South and North Chemical Buildings (for all floors).

8. Chemical Disinfection System (Ammonia and Chlorine)

This section covers the chemical disinfection system that consist of both chlorine and ammonia feed systems. The ammoniators are located on the second floor of the South Chemical Building and the 1,000 gallon liquefied Anhydrous Ammonia Storage Tank is located directly south of Softener No. 1 (Picture A.8-1). Ammonia is currently transferred in a gaseous state (pressurized) to one of two the injection points located in the raw water influent mains to the South and North Raw Water Influent Basins. The gas chlorinators are located on the second floor of the North Chemical Building and the chlorine cylinders are located on the non-enclosed first floor (eastern side) of the North Chemical Building. Chlorine is transferred under vacuum from the chlorine cylinders to the chlorinators and transferred to the various injection points as a chlorine solution. Currently, five primary chlorine injection points are utilized: one in each of the three softeners (as represented in Picture A.9-3) and one in each of the raw water influent mains into both the North and South Raw Water Influent Basins (Picture A.1-1 and Picture A.1-2). Additionally, a secondary chlorine injection point is utilized in the finished water clearwell.

The ammoniators were originally constructed in 1983 and replaced in 1995. The Anhydrous Ammonia Storage Tank was constructed in 1983 and is at the end of its estimated useful life. The chlorination system was constructed in 1979 and the chlorine scales installed in 1994.

8.1 Observed Conditions

Mechanical: It was observed that the disinfection system (both chlorine and ammonia feed systems) are in need of replacement. The chlorination system currently does not comply with existing codes and regulations and is discussed in detail in the report titled *Water* Treatment *Plant Disinfection Alternatives Evaluation* (dated September 6, 2010). The ammoniators are in extremely poor condition and have significant deficiencies. Additionally, multiple safety concerns exist in the ammoniator room including: lack of “no smoking” signage, lack of gas leak detection and alarms, and a tripping hazard on the stair landing to the ammonia room. The ammonia storage tank is old and shows corrosion on the tank and tank base supports (Picture A.8-1).

Instrumentation: Instrumentation for the chlorination and ammoniation system is old and requires complete replacement as indicated above.

Electrical: Electrical power feeders and panels for the chlorination and ammoniation system are at the end of their estimated useful lives and should be relocated during replacement.

Structural: The ammoniator and chlorinator rooms are in good condition. The mechanics room located in the South Chemical Building next to the ammoniator room is in good condition but staff reports water intrusion through windows during rain events.

8.2 Recommended Improvements

Ammonia: It is recommended that the anhydrous ammonia storage and feed system be replaced in its entirety with a 19 percent aqueous ammonia storage and feed system. The replacement should also include replacing the ammonia injection points to injection into the finished water discharge line following the high service pumps to facilitate compliance with the Ground Water Rule. The timeframe for the replacement of the ammonia system should parallel the replacement of the chlorination system.

It is roughly estimated that about 1,500 gallons of 19 percent aqueous ammonia would be needed to maintain a 30 day supply at average flow and dosage (estimated at 1 mg/L). Normal chemical delivery trucks in the range of 4,000 to 5,000 gallon capacity. The minimum recommended storage tank capacity is 7,000 gallons to facilitate delivery of a complete load of chemical to obtain the best available price per gallon. The 7,000 gallon storage tank would be in a concrete secondary containment area. It is assumed that aqueous ammonia would be injected at high service pump discharge. Two metering pumps with local panels are proposed (1 duty plus 1 standby).

Chlorine System: A separate report prepared under this Master Plan describes the proposed chlorine replacement.

9. Softeners

This section covers the three solids contact clarifiers (softeners): 3.5mgd Softener No. 1 (southernmost softener), 6.5mgd Softener No. 2 (center softener), 7.5mgd Softener No. 3 (northernmost softener). Softener No. 1 was constructed in 1957, Softener No. 2 in 1964, and Softener No. 3 in 1979. All three softeners were sandblasted and repainted in 2009. Softener No. 3 was down for service when the site visit was made.

Associated instrumentation for the softeners include: a local control panel located on top of each softener for operation of the rotor impeller drive; "mudjet" control panel located on the first floor of the South Chemical Building (Picture A.9-1) for operation of flushing ring valves in all softeners, and softener blowdown control panel located on the first floor of the South Chemical Building (Picture A.9-2) for operation of sludge blowdown valves on all softeners.

9.1 Observed Conditions

Mechanical: The rotor impeller drives for Softeners No. 2 and 3 shows signs of corrosion and are at the end of their estimated useful lives. It was observed that the sludge blanket in Softener No. 2 (with Softener No. 3 out of service for cleaning of lime sludge buildup) was too high, indicating insufficient blowdown, hardening of sludge in the sludge concentrators, and/or clogging of the flushing water valves. High turbidity could also be observed washing into the radial outflow launders of Softener No. 2 indicating high sludge blanket or insufficient settling (Picture A.9-3). All mechanical equipment seems to be in functional condition; however, significant lime sludge caking and scaling were evident and have likely clogged and/or damaged the sludge blowdown valves, sludge blowdown piping, and flushing ring valves. The sludge blowdown valves for all softeners are at the end of their estimated useful life. Staff reports that the 10-inch drain valves for Softeners No. 2 and 3 need to be replaced.

Instrumentation: The pH probe (Rosemount model 23555-00) on Softener No. 1 was installed in 2007 and is in functional condition. The local control panel on Softener No. 1 for the rotor impeller drive is faded and unreadable and appears to require significant maintenance. No instrumentation was observed on Softener No. 2 or Softener No. 3 with run status indicated in the control room. The "mudjet" (flushing valves) and softener blowdown control panels for all three softeners are located on the first floor (west side) of the South Chemical Building and appear to be in functional condition.

Electrical: The motor starters and VFDs for Softeners No. 1 and 2 are located on the first floor (east side) of the South Chemical Building and are all in like new condition. The motor starters and VFD for Softener No. 3 is located in the MCC Room of the North Chemical Building (second floor) and is in like new condition. The liquid-tight flexible conduit on the rotor impeller drive for Softener No. 1 has started to deteriorate (Picture A.9-4). The motor for the rotor impeller drive on Softener No. 2 shows signs of corrosion (Picture A.9-5). Based on staff reports, lighting should be improved on the elevated walkways and no light poles where observed on Softeners No. 2 and 3.

Structural: Superficial corrosion was observed at several locations on all softeners (shown in Picture A.9-6 for Softener No. 1). Deeper corrosion was observed at base of tank for Softener

No. 3 (Pictures A.9-7 and A.9-8). Minor corrosion was observed on the walkways and handrails for all softeners.

9.2 Recommended Improvements

Mechanical: The rotor impeller drives for Softeners No. 2 and 3 require replacement or rehabilitation within the next 5 years. The 4-inch flushing ring valves should be immediately replaced on all three softeners with hydraulically operated actuators. The sludge blowdown valves for all softeners should be replaced with new 4-inch plug valves and electrical actuators (typical of four valves per softener for a total of 16 valves) within the next five years. The sludge blowdown valves on Softeners No. 2 and 3 likely require immediate replacement. A quick opening actuator should be utilized and typically is either hydraulic or pneumatic (or electrical). Operational improvements should be made to maintain the sludge blanket to an appropriate operational elevation as recommended by manufacturer. It is recommended that the softeners be operated in a base-loaded mode that maintains the sludge blanket at a constant level; generally achieved by providing a constant inflow. Softener No. 2 requires shutdown and removal of caked lime sludge within the softener.

Instrumentation: The local control panel for the rotor impeller drive should be replaced on Softener No. 1 to provide clear indication of operation. Local control panels should be installed for Softener Nos. 2 and 3 to provide for local operation and indication of the rotor impeller drive. With the replacement of the sludge blowdown valves on all softeners, the softener and "mudjet" control panel should be replaced with a PLC for valve control (See Section 16 of this appendix). New pH probes should be installed for Softener Nos. 2 and 3.

Electrical: The liquid-tight flexible conduit on the rotor impeller drive for Softener No. 1 should be replaced during the next motor service. The motor for the rotor impeller drive on Softener No. 2 should be replaced with the rotor impeller drive as recommended above. Add a lighting pole with LED type fixtures on Softener Nos. 2 and 3.

Structural: For correction of superficial corrosion observed at several locations on softeners re-coat tank with appropriate coating system. Perform inspections of the tank interiors of Softeners No. 1 and 3 to determine extent of corrosion at base and potential repairs necessary. An inspection of the tank interior of Softener No. 2 is also recommended for completeness. For the minor corrosion observed on the walkways and handrails of softeners, re-coat bridge steel members.

10. Solids Handling Facilities

This section covers the gravity thickener, vacuum filters (located on the second floor east side of the North Chemical Buidling), and the return water pumps in the "Save All Basins". The gravity thickener and vacuum filter were constructed in 1979. Both facilities have been reported to be off-line for approximately 15 years. The return water pumps and associated equipment were last replaced in 1994. Sludge blowdown is fed via gravity to the "Save All Basins" where lime sludge is dug out and stock-piled in the northwest portion of the WTP site.

10.1 Observed Conditions

Mechanical: All vacuum filter equipment is inoperable. The gravity thickener mechanical equipment is inoperable. The return water pumps in the "Save All Basins" and associated equipment are in functional condition.

Instrumentation: All gravity thickener and vacuum filter instrumentation is inoperable.

Electrical: The MCCs for the gravity thickener and vacuum filters, located on the second floor of the North Chemical Building, have failed and require replacement. The MCCs for the return water pumps are in functional condition, but are poorly located.

Structural: The vacuum filter room is located on the second floor (east side) of the North Chemical Building and is overall in good condition. Cracks were observed on the east wall with evidence of water intrusion and corrosion of wall reinforcement. The gravity thickener basin is in good condition. Minor corrosion is evident on the metal walkway and handrails and some of the handrail post are loose. The weirs are either missing or in disrepair.

10.2 Recommended Improvements

Based upon discussion with the CRBUD Director, the staff are satisfied with the operation of the existing system (i.e., creating piles of sludge at the north end of the facility). Hence, the now improvements to the sludge handling system are proposed. It is recommended that the gravity thickener and the vacuum filter be demolished and removed from the site.

11. Filtration System

This section covers the granular media filters and associated equipment. The WTP has 16 rapid-rate granular media filters separated into two banks: the South Filter Bank (Filters No. 1 - 8) and the North Filter Bank (Filters No. 9-16). All are dual-media filters as manufactured by Leopold, but have different washing methods: the North Filter Bank utilizes upflow water wash with surface wash; the South Filter Bank utilizes upflow water wash with air scour. Filters No. 1-4 were constructed in 1957. Filters No. 4-8 were constructed in 1964. Filters 1 - 8 were restored in 1996 including: the installation of new media, new Leopold underdrains, and the replacement of surface wash with air scour (blower installed). Filters No. 9-16 were constructed in 1979 and refurbished with new valves and valve actuators 2009 (Picture A.11-1). This refurbishment also included the cleaning of the filter media. New local computer screen control panels were added for all filters in 2010. Injection grouting, patching of the filter box exterior walls with stucco, and painting for all filters was performed in 2010

11.1 Observed Conditions

Mechanical: Evaluation of the filter media in the South Filter Bank (Filters 4 and 8) revealed that the sand and anthracite coal were not stratified and were mixed together. Similar evaluations of filter media in the North Filter Bank (Filter 15) revealed well stratified media that was in good condition. All of the filter equipment, piping, valves, and flow meters appear to be in functioning condition. The drain to the "Save All Basins" was removed for Filters No. 1 - 16 and the filters can currently only be drained to the clearwell. The blower for the air-scour wash for Filters 1 - 8 is in good condition but has worn door gaskets.

Instrumentation: The majority of instrumentation appeared to be in functional condition. About half of the turbidimeters from Filters 1-8 were misreading. Plant staff indicated they needed to be cleaned fairly often. Only two turbidity meters (with AIT) are installed for the Filters No. 9-16; a composite turbidity sample is taken for Filters No. 9, 11, 13, and 15 and likewise for Filters No. 10, 12, 14, and 16. Both turbidity meters (manufactured by HF Scientific) have significant deficiencies and currently are not used. The backwash and effluent flow meter and rate of flow control valve are in functional condition. The filters are controlled by an Allen Bradley ControlLogix PLC and touchscreen HMI stations mounted to control consoles located in front of each filter. The PLC and consoles are about 2 years old and in good working condition, aside from one damaged touchscreen computer. Plant staff indicated that the filters can be automatically backwashed, but typically perform backwash manually from the filter control consoles on the touchscreen HMI.

Electrical: All electrical equipment appears to be in good and functioning condition. The Electrical panel on the lower exterior north wall of Filter No. 7 (Picture A.11-2) was observed to have water in it.

Structural: Minor corrosion was observed on the walkways and handrails for all filters (Picture A.11-3). The wash troughs for all filters were in good structural condition. The interior surface of the filter walls for Filters No. 1-8 were in good structural condition. Minor cracks with leakage were observed on the exterior surface of the filter walls for Filters No. 1, 3, 5, and 7 (Picture A.11-4 and Picture A.11-5). Cracks with leakage were observed on the exterior surface of the filter walls for Filters No. 2, 4, 6, and 8. For Filters No. 9-16 many cracks were observed on the interior surface of the filter walls and occur at longitudinal and transversal walls. Several cracks were observed at approximately equal spacing and at wall intersections (Picture A.11-6). Cracks on walls supporting wash troughs extend from the corners of wash trough opening to top of wall (Picture A.11-7). Interior surfaces of walls are not coated. Multiple cracks with leakage, concentrated on the lower portion of the west walls of Filters No. 9, 11, 12, 13, and 15 (Picture A.11-8) and the south wall of Filter No. 9 (Picture A.11-9), were observed. Attempts to seal cracks on the walls of Filters No. 9-16 have had little success. Stucco applied to the exterior walls has several hollow areas and is detaching from wall. The North filter building (9-16) doors and windows do not have Florida Product Approvals for resistance to wind induced loads during storm events.

11.2 Recommended Improvements

Mechanical: The filter media in Filters No. 1 - 8 should be replaced within the next 5 years. The three door gaskets on the blower for the air-scour wash for Filters 1 - 8 should be replaced.

Instrumentation: Alternative turbidimeters should be reviewed and pilot tested to determine which turbidimeters require the least amount of maintenance. Replace all turbidimeters with the recommended model based on pilot test results.

Electrical: Drill holes in the bottom of the Electrical panel on the lower exterior north wall of Filter No. 7 (Picture A.11-2) to drain water or find source of water and eliminate it. Exterior electrical panels should be NEMA 4X 316 stainless steel for outside use.

Structural: Re-coat the steel members for the minor corrosion on the walkways and handrails for all filters. Re-coat exterior of filters with appropriate coating system to cover the minor cracks observed on the exterior surface of the filter walls for Filters No. 1, 3, 5, and 7. Inject cracks with appropriate grout system to seal cracks and re-coat exterior with appropriate coating system on the exterior surface of the filter walls for Filters No. 2, 4, 6, and 8. Seal cracks with appropriate grout system to prevent possible long term corrosion of reinforcing steel for the interior surface of the filter walls of Filters No. 9-16. Inject cracks with appropriate grout system to seal cracks and re-coat exterior with appropriate coating system on the exterior walls of Filters No. 9, 11, 13, and 15. Perform detailed evaluation of the exterior walls of Filters No. 10, 12, 14, and 16 to determine appropriate procedure to seal cracks, since past attempts to seal cracks have failed and walls present extensive cracking. The evaluation should include a review of the structural design and quality of concrete utilized for construction. Following the evaluation, re-coat exterior with appropriate coating system. Replace the doors and windows of the North Filter Building to provide hurricane-rated components with Florida Product Approvals.

12. High Service Pumps and Finished Water Storage

This section covers the high service pumps (HSPs), finished water transfer / backwash pumps (finished water transfer pumps), on-site ground storage tank (GST), and finished water clearwell.

The high service pump building was originally constructed in 1979 and HSPs No. 1 -5 and Finished Water Transfer Pumps No. 1 and 2 originally installed in the same year. HSPs No. 6 and 7 (with VSDs) were originally installed in 1990 and HSP No. 1 replaced in the same year. VFD control was added to HSP No. 1, 6, and 7 in 2002. Finished Water Transfer Pumps No. 1 and 2 were last replaced in 1996. The south finished water clearwell was constructed in 1954 and expanded in 1964 with the addition of Filters No. 5-8. The north finished water clearwell was constructed with Filters No. 9-16 in 1979. The GST was last rehabilitated in 1995. The high service and finished water transfer pumps and motors are reported to be original and have not been replaced since construction.

460 Volt 3 phase power is provided to all of the high service and finished water transfer pumps. HSP No. 1, 6, and 7 are controlled by VFDs while the MCCs for HSP No. 2, 3, 4, and 5 located in the Main MCC Room (see Section 16 of this appendix).

12.1 Observed Conditions

Mechanical: It was observed that either HSP No. 4 or 5 (constant speed) are always on with one or more of the VFD controlled high service pumps (No. 1, 6, or 7). HSPs No. 2 or 3 are rarely operated. Staff explained that either HSP No. 4 or 5 is always on because they have the best startup time if power is temporarily lost (switch to generator), preventing any low pressure situations in the distribution system during emergencies.

Instrumentation: Constant speed pumps are remotely controlled and manually started or stopped. HSPs No. 1, 6, 7 are automatically started and stopped based on set rotation (Lead, Lag No. 1, Lag No. 2) selected by operators and controlled based on a setpoint pressure indicated from the finished water discharge pressure indicating transmitter. The existing chlorine residual analyzer (Hach Model CL17) is nearing the end of its of its estimated useful life and is not installed with the manufacturer's recommended sample conditioning accessories such as a filter and bubble trap.

Electrical: The High Service Pump (HSP) and finished water transfer pump motors are in functional condition. Motors on HSPs No. 1, 6, and 7 (utilizing VFDs) are not inverter duty rated. All motors are at the end of their estimated useful lives.

Structural: The High Service Pump Building is in good condition.

12.2 Recommended Improvements

Mechanical: Considering the varying HSP sizes and the WTP operating at significantly lower flows than originally designed, it is recommended that the pump selection and operation be re-evaluated and an automated operation strategy be developed that more evenly distributes the run time on pumps. All pumps, valves, and appurtenances should be replaced within the next 5 years.

Instrumentation: The chlorine residual analyzer should be replaced within the next 5 years.

Electrical: The motors on HSPs No. 1, 6, and 7 do not have the recommended insulation to withstand the voltages generated from VFDs. This issue can shorten the motor life. It is recommended that the motors for HSPs No. 1, 6, and 7 be replaced with inverter (VFD) duty rated motors. This higher rated insulation can also be applied to most motors when they are rewound by authorized motor repair shops. All motors should be replaced at the time of accompanying pump replacement within the next 5 years.

13. Emergency Power

This section covers the emergency power provisions at the WTP. Emergency power is provided by two generators: 1000kW Main Generator located on the first floor (west side) of the South Chemical Building and the 250kW Packed Tower Scrubber Complex Generator located on the south west corner of the Packed Tower Scrubber Complex. The 1000kW Main Generator was originally installed in 1979 and was replaced in 1992. The Main Generator provides backup power for all WTP processes apart from the packed tower scrubbers and raw water transfer pumps. The 250kW Packed Tower Scrubber Complex Generator was installed in 1988 with the construction of the Packed Tower Scrubber Complex and provides emergency power for the packed tower scrubbers and raw water transfer pumps. A 12,000 gallon underground diesel fuel storage tank, located south of Softener No. 1, supplies fuel to both generators.

13.1 Observed Conditions

Mechanical: The fuel supply appears to be in functional condition.

Instrumentation: Only local control and monitoring exist. Staff would like to have more detailed monitoring of the generator status.

Electrical: The 1000kW Main Generator is near the end of its estimated useful life but is in functional condition and currently under a maintenance contract. The exhaust piping (Picture A.13-1) has significant deficiencies and is leaking. Staff reported that the generator exhaust shroud requires significant maintenance and has failing components. The 1600A main breaker (Picture A.13-2) located in the southeast corner of the room has limited accessibility, is susceptible to water damage if the hurricane shutters are removed, and has an open bottom which makes it susceptible to possible rodent damage and failure. Hurricane shutters have been installed over the air intake louvers to prevent rain damage to electrical equipment (especially the 1600A main breaker) and is likely causing severe airflow restrictions for proper cooling air for the generator (Picture A.13-2).

The 250kW Packed Tower Scrubber Complex Generator is in good condition and currently under a maintenance contract. The exhaust appears to be too close to the roof and may be causing roof damage.

Structural: The packed tower generator room and main generator room (first floor of South Chemical Building) are in overall good condition. The east wall of the first floor of the South Chemical Building (main generator room), however, has interior and exterior cracks with evidence of water intrusion.

13.2 Recommended Improvements

Instrumentation: Remote monitoring should be provided for both generators. A fuel storage leak detection system with indication should be provided.

Electrical: The leaking exhaust piping for the Main Generator should be replaced or re-wrapped to eliminate leaks. Staff reports that the exhaust shroud and radiator is currently scheduled to be replaced by the City's generator maintenance service provider, Power Pro-tech. The main breaker and signal converter should be relocated to provide for better accessibility and protection from rain if air intake louvers are utilized. The main breaker panel bottom should be covered to prevent possible damage from rodents. Methods to provide for proper airflow and the removal of the hurricane shutters from the air intake louvers should be evaluated. Consideration for the addition of an internal wall to separate the Main Generator from the rest of the room should be evaluated to help reduce noise concerns for operators that require access to other process equipment while the generator is operational. The location of the roof exhaust for the 250kW Packed Tower Scrubber Complex Generator should be evaluated to ensure that it is not lending to roof deterioration.

Structural: Repair/replace exterior stucco of east wall of main generator room to seal cracks and minimize re-appearance of cracks. Re-coat interior and exterior of wall with appropriate coating system; the exterior coating should bridge small cracks and provide protection for water intrusion.

14. Air Compressors

This section covers all air compressors in the WTP. Two air compressors (5hp Aero Vac Model SSAPOL5-80T) exist on the first floor of the South Chemical Building (west side - Alum room) and have 29,000 and 18,300 hours of operation respectively (Picture A.9-2). Both of these air compressors were installed in the early 1980's. One additional air compressor, manufactured by Powerex, is located on the first floor (west side - polymer room) of the North Chemical Building and was installed in 2005.

14.1 Observed Conditions

Mechanical: All air compressors were in functional condition. However, the two air compressors in the South Chemical Building have reached the end of their estimated useful life (although the staff has reported reliable operation from these air compressors).

Instrumentation: The compressor in the North Chemical Building has a local control panel and is automatically controlled by a pressure switch on the receiver tank. The instrumentation is in functional condition. The two compressors in the South Chemical Building have a similar instrumentation. The instrumentation is in functional condition.

Electrical: All electrical equipment appears to be in functional condition.

14.2 Recommended Improvements

Mechanical: The two air compressors in the South Chemical Building will require replacement in the next 5 years.

Instrumentation: The instrumentation should be replaced with the replacement of the mechanical equipment.

15. Yard Piping

This section covers the yard piping and other miscellaneous motor operated valves and appurtenances not covered as part of other process equipment. A visual inspection of the underground yard piping was not conducted as part of the condition assessment. There are three main motor operated valves in the yard piping:

- Clearwell Fill Valve which controls the flow of water from the Blue Heron GST back to the clearwell
- Storage Tank Fill Valve which controls the filling of the Blue Heron GST from the transfer pumps

- Backwash Rate of Flow Control Valve which controls the filter backwash flow rate (Section 11 of this appendix)

15.1 Observed Conditions

Mechanical: The sludge-blowdown gravity main is likely clogged and not providing sufficient capacity to effectively transfer lime sludge to the "Save All Basins". The Clearwell Fill Valve, Storage Tank Fill Valve, and Backwash Rate of Flow Control Valve are all reported to be in good condition.

Instrumentation: Instrumentation (MOV and clearwell level indicator) is provided for the 16-inch Clearwell Fill Valve on the return finished water main from the Blue Heron GST to the clearwell. The existing valve is controlled by fully opening or fully closing the valves. Staff indicated that they would like the ability to throttle the valve. Instrumentation (flow meter and MOV) is also provided for the 12-inch backwash rate of flow controller and is reported to be in functional condition.

Electrical: Electrical supplies to all motor operated valves (MOVs) are reported to be in functional condition.

15.2 Recommended Improvements

Mechanical: The gravity main transferring sludge blowdown to the "Save All Basins" should be replaced as part of the installation of the new solids handling facilities.

Instrumentation: Replace the 16-inch butterfly Clearwell Fill Valve with a flow control valve and a motorized actuator for modulating service. Wire the actuator to the nearest PLC and program to facilitate remote manual control of valve position from the control room HMI, and automatic control to prevent excessively high or low clearwell levels.

16. Motor Control Centers (MCCs) and PLCs

This section covers the motor control centers (MCCs) and programmable logic controllers (PLCs). Three MCC Rooms exist on the WTP site: the Main MCC Room, located between the South and North Filter Banks; the Packed Tower MCC Room, located on the southeast corner of the Packed Tower Scrubber Complex; and the North Chemical Building MCC Room, located on the second floor (north-west side) of the North Chemical Building. Seven PLCs are installed in various locations within the WTP: Main MCC Room, Packed Tower MCC Room, South Chemical Building (first floor east side), North Chemical Building MCC Room, South Filter Bank (No. 1-8) Control Room, North Filter Bank (No. 9-16) Control Room, and the Main Control Room. The Main MCC Room, Packed Tower MCC Room, Main Control Room, and North and South Filter Bank Control Rooms are climate controlled.

The Main MCC Room was constructed in 1979 with Automatic Transfer Switch (ATS) No. 1,2, and 3; MCCs for HSPs No. 1-5 and Transfer Pumps No. 1 and 2; and uninterruptable power supply (UPS). VFDs for No. 1, 6, and 7 where installed in 2002; the RTU was installed in 1989 and the radios replaced five years ago; the PLC was installed in 1999. The packed tower MCC Room was constructed in 1988 with MCCs for the raw water transfer pumps, ATS No. 4, and the bubbler control panel. VFDs for raw water pumps 1B and 2A were added in 1995 and the PLC in 1999. PLCs were installed in the North and South Chemical Building in 1999. The PLC in the South Filter Bank Control Room was installed in 1996 and the PLC in the North Filter Bank in 2010. All PLCs are Allen Bradley SLC 5/04 except for those installed in the filter control rooms which are Control Logix.

16.1 Observed Conditions

Instrumentation: The instrumentation in the Main MCC Room (PLCs and RTU) is in functional condition. The fiber optic cables in the PLC panel are loose and should be terminated on fiber optic patch panels. The instrumentation in the Packed Tower MCC Room (PLCs and bubbler control panel) is functional. The instrumentation in the North Chemical Building MCC Room (PLCs and RTU) is functional.

Electrical: The electrical equipment in the Main MCC Room and Packed Tower MCC Room is functional. The MCCs in North Chemical Building MCC are in poor condition with some not functional.

Structural: The packed tower MCC room is in good condition as well as the MCC room located on the second floor of the North Chemical Building. The walls of the Main MCC Room are in good condition. Roof leaks are evident in the ceiling and roof of the Main MCC Room (Picture A.16-1) and the underside of the roof deck shows corrosion which may have been caused by the roof leak. Staff has reported the active leak under the roof mounted AC unit.

16.2 Recommended Improvements

Instrumentation: All PLCs with the exception of the PLC in the North Filter Bank Control Room are nearing the end of their useful life and should be replaced in the next 5 years.

Electrical: The MCCs in the North Chemical Building should be replaced and relocated to provide a better operational environment. Replacement of the MCCs should correspond to the replacement of the related process equipment (i.e. solids handling process equipment).

Structural: Perform an inspection of the roofing system of the Main MCC Room to verify integrity of system, determine if there are additional leaks, and determine whether the roofing system requires repairs or replacement.

17. Main Control Room

This section covers the Main Control Room at the WTP. The Main Control Room houses the Main Control Panel, control console, and the Data Flow System (DFS) Hyper Server Unit. The front of the Main Control Panel is equipped with indicator lights, switches, digital displays, and an alarm annunciator. The panel provides remote monitoring and control of various plant processes. The manufacturer and model of the PLC and remote I/O inside the Main Control

Panel are Allen Bradley PLC 5. The PLC and remote I/O rack were installed in the Main Control Panel in 1999. The control room console includes four HMI workstation computers that were installed in 2007. The HMI software is GE iFix version 4.0 and currently uses 1505 active tags. The console also contains one computer dedicated for offsite monitoring and control using the DFS telemetry system, one computer for the WTP gate access control, one computer for security camera monitoring, one computer for weather monitoring, and one computer for access to the Utility District's billing system. The computer systems are connected to servers in the Administration Building for data backup.

17.1 Observed Conditions

Instrumentation: Plant staff report that the Main Control Panel, PLC, DFS Hyper Server, and computer systems are fully functional. Though the PLC is an older model, it is still available today should spare parts be required for repairs. Plant staff indicated they would like to add data to the computerized historical recording system but found the system to be incapable or too complex. The control room is situated on the first floor of the control building adjacent to the top slab of the finished water clearwell and is prone to flooding. The layout of the control room console is not ideal due to the presence of building columns in the console work area, and the need to walk around the console to reach the Main Control Panel.

17.2 Recommended Improvements

Instrumentation: The Main Control Panel PLC is near the end of its estimated useful life and should be replaced within the next 5 years. The project should address options for possible relocation of the control room and improving the layout of the control room such as eliminating the Main Control Panel and using the SCADA computers instead. The control console is designed for older CRT based computer computers with a deep monitor cabinet. A smaller desk type console could be used with flat panel computer monitors. A wall mounted large screen display should also be considered for displaying critical operations data and alarms or security images. The computers are nearing the end of their estimated useful life and should be replaced within the next 2 years. The plant control software should be upgraded to the latest version of GE iFix. A detailed review of the historical and backup systems used at the plant is recommended. Historical data management software such as GE iHistorian should be considered to improve usability of the system by plant staff. Software training for key plant staff is also recommended. A more detailed evaluation to define the scope of the project is recommended.

Electrical: Electrical improvements required for the update of the instrumentation of the control room should be performed in coordination with the instrumentation recommendations defined above. High efficiency fluorescent lighting should be considered when replacing defective existing fixtures.

18. Florida Power and Light Primary Power

The project team contacted the Florida Power and Light (FPL) manager of the CRBUD's WTP account. The account manager is Kyle Martin (phone number 561-640-2209). Based upon discussion with Mr. Martin, in 2011 FPL upgraded the hardwire power feed to the WTP and City Hall to "…hurricane standards". Mr. Martin indicated that the FPL owned transformers are "older" but in good condition and if there is a problem FPL will replace immediately at their cost. Mr. Martin also indicated that the WTP has plenty of capacity; currently the WTP has 1500KVA of transformation and in the last couple of years (2010 to 2011) had a max usage (load) of approximately 800KW (essentially using half the capacity). Hence, unless the CRBUD wanted to move the FPL vault to a new location, no additional renewal and replacement expenditures are envisioned for the CRBUD WTP relative to the FPL side of the primary power supply in the next 25 years.

19. Miscellaneous Recommendations

This section provides for general recommendations not identified in the sections above. It is recommended that the following engineering activities and evaluations be performed:

- Develop a current single line power diagram of the WTP.
- Perform a plant power system analysis including:
  - A Plant load analysis evaluation.
  - A circuit breaker coordination study to evaluate the operational reliability of the WTP.
  - An arc flash study to update safety conditions for maintenance operations.
- Any electrical equipment scheduled for replacement or major repairs partially due to location in environmentally adverse atmospheres should be considered a candidate for installation in a climate controlled (air conditioned) atmosphere.

20. Renewal and Replacement Schedule

Based upon the condition assessment, age of the equipment, expected useful life and discussion with the CRBUD operations and maintenance staff a renewal and replacement schedule was developed. The renewal and replacement schedule identifies the major equipment items at the WTP along with age and remaining useful life. Given that a significant number of similar items (e.g., slakers 1 through 4) are at the end of their useful life at the same time, similar items have been grouped together in logical replacement projects in which all similar items would be replaced concurrently (e.g., "Replacement of Slakers" Project No. WTPRR004). This approach is common industry practice. Additionally, each project has been assigned a project number to facilitate tracking the status of projects from concept through construction.

Table 3
Water Treatment Plant R&R Schedule

Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
Scrubber System Spray Headers (1-4)	1988	15	24	0	4	WTPRR001	Scrubber System Rehabilitation
Scrubber Packing Material (1-4)	2004	5	8	0	4		
Scrubber Blowers	1988	10	24	0	4		
Scrubber Power Feeders (disconnects, breakers, etc)	1988	30	24	6	4		
Transfer Pump No. 1A (Pump & Motor) - 75hp	1988	20	24	0	1	WTPRR002	Raw Water Transfer Pump Replacement
Transfer Pump No. 1A Valves (20" Silent CV and BFV)	1988	30	24	6	1		
Transfer Pump No. 2A (Pump & Motor) - 60hp	1988	20	24	0	1		
Transfer Pump No. 2A Valves (16" Silent CV and BFV)	1988	30	24	6	1		
Transfer Pump No. 3A (Pump & Motor) - 30hp	1988	20	24	0	1		
Transfer Pump No. 3A Valves (12" Silent CV and BFV)	1988	30	24	6	1		
Transfer Pump No. 1B (Pump & Motor) - 60hp	1988	20	24	0	1		
Transfer Pump No. 1B Valves (16" Silent CV and BFV)	1988	30	24	6	1		
Transfer Pump No. 2B (Pump & Motor) - 50hp	1988	20	24	0	1		
Transfer Pump No. 2B Valves (14" Silent CV and BFV)	1988	30	24	6	1		
Transfer Pump No. 3B (Pump & Motor)	1988	20	24	0	1		
Transfer Pump No. 3B Valves (12" Silent CV and BFV)	1988	30	24	6	1		
VFDs (Pump No. 1B and 2A)	1995	10	17	0	2		
Transfer Pump MCCs	1988	20	24	0	4		
Power Feeders (disconnects, breakers, etc)	1988	30	24	6	1		

Table 3
Water Treatment Plant R&R Schedule

Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
Softener 1 Rotor Impeller Drive	1957	**15**	55	0	1	WTPRR003	Lime Softener Rehabilitation
Softener 1 Sludge Blowoff Valves and Actuators	1957	**10**	55	0	3		
Softener 1 Flushing Water Valves and Actuators	1957	**10**	55	0	1		
Softener 1 Access Walkways / Rails	1957	**40**	55	0	1		
Softener 1 Local Control Panel	1957	**15**	55	0	1		
Softener 1 Power Feeders	1957	**30**	55	0	1		
Softener 2 Rotor Impeller Drive	1964	**15**	48	0	1		
Softener 2 Sludge Blowoff Valves and Actuators	1964	**10**	48	0	4		
Softener 2 Flushing Water Valves and Actuators	1964	**10**	48	0	1		
Softener 2 Access Walkways / Rails	1964	**40**	48	0	1		
Softener 2 Local Control Panel	1964	**15**	48	0	1		
Softener 2 Power Feeders	1964	**30**	48	0	1		
Softener 3 Rotor Impeller Drive	1979	**15**	33	0	1		
Softener 3 Sludge Blowoff Valves and Actuators	1979	**10**	33	0	4		
Softener 3 Flushing Water Valves and Actuators	1979	**10**	33	0	1		
Softener 3 Access Walkways / Rails	1979	**40**	33	7	1		
Softener 3 Local Control Panel	1979	**15**	33	0	1		
Softener 3 Power Feeders	1979	**30**	33	0	1		

Table 3
Water Treatment Plant R&R Schedule

Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
Dust Collectors No. 1	2007	10	5	5	1	WTPRR004	Replacement of Lime Slakers
Lime Slaker No. 1	2002	10	10	0	1		
Lime Silo Radar No. 1	2007	10	5	5	1		
Slaker No. 1 Elec. & Control Panel	2002	15	10	5	1		
Dust Collectors No. 2	2007	10	5	5	1		
Lime Slaker No. 2	2002	10	10	0	1		
Lime Silo Radar No. 2	2007	10	5	5	1		
Slaker No. 2 Elec. & Control Panel	2002	15	10	5	1		
Dust Collectors No. 3	2007	10	5	5	1		
Lime Slaker No. 3	2002	10	10	0	1		
Lime Silo Radar No. 3	2007	10	5	5	1		
Slaker No. 3 Elec. & Control Panel	2002	15	10	5	1		
Dust Collectors No. 4	2007	10	5	5	1		
Lime Slaker No. 4	2004	10	8	2	1		
Lime Silo Radar No. 4	2007	10	5	5	1		
Slaker No. 4 Elec. & Control Panel	2004	15	8	7	1		
Lime Silo No. 1	1979	50	33	17	1	WTPRR005	Replacement of Lime Silos
Lime Silo No. 1 Power Feeders	2002	30	10	20	1		
Lime Silo No. 2	1979	50	33	17	1		
Lime Silo No. 2 Power Feeders	2002	30	10	20	1		
Lime Silo No. 3	1979	50	33	17	1		
Lime Silo No. 3 Power Feeders	2002	30	10	20	1		
Lime Silo No. 4	1979	50	33	17	1		
Lime Silo No. 4 Power Feeders	2004	30	8	22	1		

Table 3
Water Treatment Plant R&R Schedule

Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
19% Aqueous Ammonia Storage and Feed System	1981	30	31	0	1	WTPRR006	Aqueous Ammonia System
Core sodium hypochlorite facility	1981	30	31	0	1	WTPRR007	Chlorine System Replacement
Replace 24" Main Raw Water Influent Flow Meter	1995	30	17	13	1	WTPRR008	WTP Flow Meter Replacements and Additions
Replace 24" Raw Water Influent Flow Meter (south)	1995	30	17	13	1		
Replace 30" Raw Water Influent Flow Meter (north)	1995	30	17	13	1		
Replace 10" Return Water Influent Flow Meter (north)	1995	30	17	13	1		
New 10" Return Water Influent Flow Meter (south)							
Replace 24" South Softener Influent Flow Meter	2009	30	3	27	1		
New 24" North Softener Influent Flow Meter							
Replace 30" flow meter on discharge of HSPS	1988	30	24	6	1		
Miscellaneous Mechanical	1988	30	24	6	1		
Electrical and Controls	1988	30	24	6	1		
Filter 1-4 Crack and Leak Repair	1954	50	58	0	1	WTPRR009	Filter Crack Repair
Filter 5-8 Crack and Leak Repair	1964	50	48	2	1		
Filter 9-16 Crack and Leak Repair	1979	50	33	17	1		

Table 3
Water Treatment Plant R&R Schedule

Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
Filter 1-8 75hp Air Scour Blower	1996	15	16	0	1	WTPRR010	Filter 1-8 HMI and Blower Replacement
Filter 1-8 HMI Control Panel	2010	5	2	3	8		
Filter 9-16 Filter Media / Gravel	2009	10	3	7	8	WTPRR011	Filter 9-16 Media and Underdrain Replacement
Filter 9-16 Underdrain Blocks	2009	20	3	17	8		
Filter 9-16 HMI Control Panel	2010	5	2	3	8		
Backwash System 12" Backwash Rate Control Valve	2009	30	3	27	1	WTPRR012	Backwash System Valve and Control Replacements
Backwash System 12" Flow Control Valve Actuator	2009	15	3	12	1		
Backwash System 12" Backwash Flow Meter	2009	30	3	27	1		
Backwash System 12" Flow Meter FIT	2009	10	3	7	1		
Backwash System Electrical and Controls	2009	20	3	17	1		
Filter 1-8 12" Backwash Isolation BFV	1996	30	16	14	8	WTPRR013	Filter 1-8 Valve and Actuator Replacement
Filter 1-8 12" Backwash Isolation BFV Actuator	1996	15	16	0	8		
Filter 1-8 12" Influent BFV	1996	30	16	14	8		
Filter 1-8 12" Influent BFV Actuator	1996	15	16	0	8		
Filter 1-8 6" Air Valve	1996	30	16	14	8		
Filter 1-8 6" Air Valve Actuator	1996	15	16	0	8		
Filter 1-8 6" Air double door blower check valve	1996	30	16	14	8		
Filter 1-8 8" Rate of Flow Control Valve	1996	30	16	14	8		
Filter 1-8 8" Rate of Flow Control Valve Actuator	1996	15	16	0	8		
Filter 1-8 8" Rate of Flow Control Venturi Flow Meter	1996	30	16	14	8		
Filter 1-8 8" Venturi Flow Meter FIT	1996	10	16	0	8		
Filter 1-8 Valve Replacement Electrical & Controls	1996	30	16	14	1		

Table 3
Water Treatment Plant R&R Schedule

Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
Filter 9-16 12" Rate of Flow Control Valve	2009	30	3	27	8	WTPRR014	Filter 9-16 Valve and Actuator Replacement
Filter 9-16 12" Rate of Flow Control Valve Actuator	2009	15	3	12	8		
Filter 9-16 12" Rate of Flow Control Venturi Flow Meter	2009	30	3	27	8		
Filter 9-16 12" Venturi Flow Meter FIT	2009	10	3	7	8		
Filter 9-16 3" Surface Wash BFV	2009	30	3	27	8		
Filter 9-16 3" Surface Wash BFV Actuator	2009	15	3	12	8		
Filter 9-16 16" Influent BFV	2009	30	3	27	8		
Filter 9-16 16" Influent BFV Actuator	2009	15	3	12	8		
Filter 9-16 16" Backwash Isolation BFV	2009	30	3	27	8		
Filter 9-16 16" Backwash Isolation BFV Actuator	2009	15	3	12	8		
Filter 9-16 20" Backwash Drain BFV	2009	30	3	27	8		
Filter 9-16 20" Backwash Drain BFV Actuator	2009	15	3	12	8		
Filter 9-16 Valve Replacement Electrical & Controls	2009	20	3	17	1		
Transfer Pump No. 1 (Pump & Motor) - 100hp	1979	20	33	0	1	WTPRR015	Finished Water Transfer Pump Replacement
Transfer Pump No. 1 Valves (12" Silent CV and BFV)	1979	30	33	0	1		
Transfer Pump No. 1 (Pump & Motor) - 40hp	1979	20	33	0	1		
Transfer Pump No. 1 Valves (12" Silent CV and BFV)	1979	30	33	0	1		

Table 3
Water Treatment Plant R&R Schedule

Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
High Service Pump 1 and Motor - 250hp	1990	20	22	0	1	WTPRR016	High Service Pump Replacement
High Service Pump 1 Valves (12" CV and BFV)	1979	30	33	0	1		
High Service Pump 2 and Motor - 150hp	1979	20	33	0	1		
High Service Pump 2 Valves (12"CV and BFV)	1979	30	33	0	1		
High Service Pump 3 and Motor - 150hp	1979	20	33	0	1		
High Service Pump 3 Valves (12" CV and BFV)	1979	30	33	0	1		
High Service Pump 4 and Motor - 200hp	1979	20	33	0	1		
High Service Pump 4 Valves (12" CV and BFV)	1979	30	33	0	1		
High Service Pump 5 and Motor - 200hp	1979	20	33	0	1		
High Service Pump 5 Valves (12" CV and BFV)	1979	30	33	0	1		
High Service Pump 6 and Motor - 250hp	1990	20	22	0	1		
High Service Pump 6 Valves (12" CV and BFV)	1990	30	22	8	1		
High Service Pump 7 and Motor - 250hp	1990	20	22	0	1		
High Service Pump 7 Valves (12" CV and BFV)	1990	30	22	8	1		
VFDs (HSP Pump No. 1, 6, and 7)	2002	10	10	0	3		
High Service Pump MCCs	2002	15	10	5	4		
High Service Pump Incoming Power Feeders	2002	30	10	20	1		
3 ton Monorail Overhead Crane (no frame)	1979	15	33	0	1		
Finished Water Above Ground Storage Tank (1MG)	1995	50	17	33	1	WTPRR017	Blue Heron Blvd Tank Replacement
Finished Water 16" Storage Tank Fill Valve (BFV)	1995	30	17	13	1		
Finished Water 16" Storage Tank Fill Valve Actuator	1995	15	17	0	1		
Finished Water 16" Clearwell Fill Valve (BFV)	1995	30	17	13	1		
Finished Water 16" Clearwell Fill Valve Actuator	1995	30	17	13	2		
Electrical and Controls for control valves	1995	20	17	3	1		

Table 3
Water Treatment Plant R&R Schedule

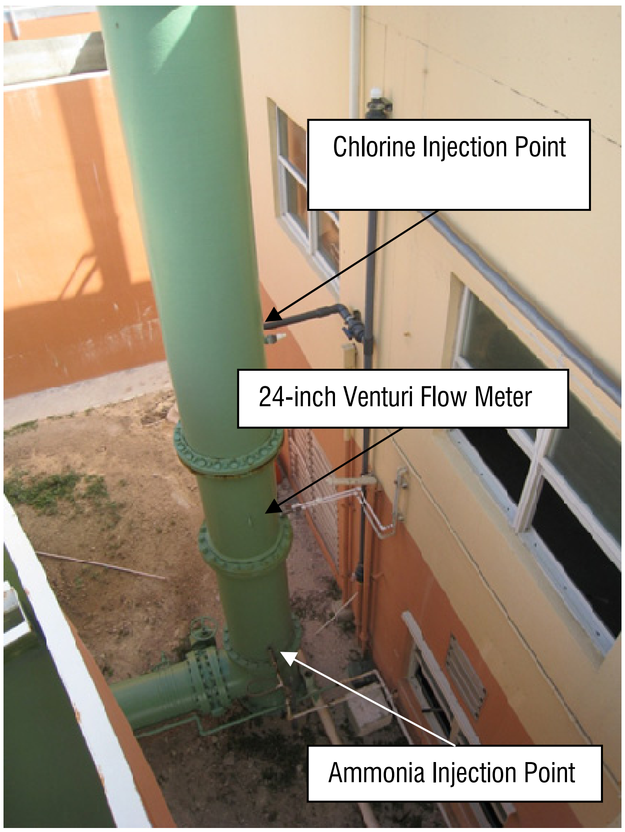
Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
Field Instrumentation	1995	10	17	0	1	WTPRR018	WTP Field Instrumentation Replacement
PLC Main Control Room	1999	10	13	0	1	WTPRR019	Primary Logic Controller (PLC) Replacement
PLC Filters No. 1-8	1996	10	16	0	1		
PLC Filters No. 9-16	2010	10	2	8	1		
PLC Main MCC Room	1999	10	13	0	1		
PLC South Chemical Building	1999	10	13	0	1		
PLC North Chemical Building	1999	10	13	0	1		
PLC Packed Tower Scrubber Complex	1999	10	13	0	1		
Develop Electrical Single Line Diagram for WTP						WTPRR020	WTP Electrical Single Line Diagram
Main Florida Power & Light Power Transformers	2009	30	3	27	1	WTPRR021	Electrical Equipment Replacement
Main Power Switchgear No. 1 and 2	1979	20	33	0	1		
Main Power ATS (No. 1-3)	1979	20	33	0	3		
Main Power ATS No. 4	1988	20	24	0	1		
Breaker No. 3	1988	20	24	0	1		
250kW Emergency Generator - Scrubbers	1988	25	24	1	1	WTPRR022	Emergency Generator and Fuel System Replacement
1000kW Main Emergency Generator	1992	25	20	5	1		
Emergency Generator Fuel Storage Tank	1979	25	33	0	1		

Table 3
Water Treatment Plant R&R Schedule

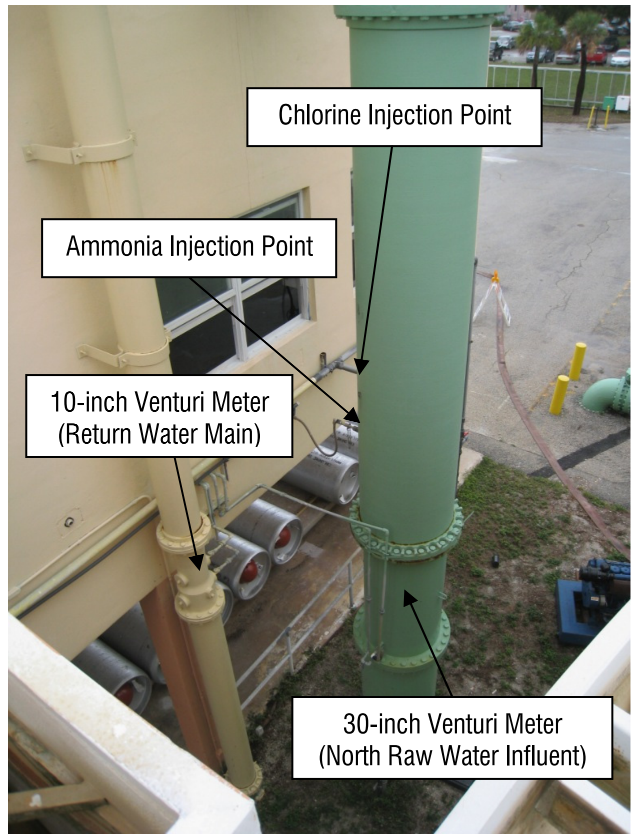
Equipment	Install Date	Useful Life (years)	Equipment Age	Remaining Useful Life	Quantity	Project No.	Project Name
Perform a plant power system analysis						WTPRR023	Plant Power System Analysis
North Filter Building Door and Window Replacement	1979	30	33	0	1	WTPRR024	North Filter Building Door and Window Replacement

Appendix A - Pictures

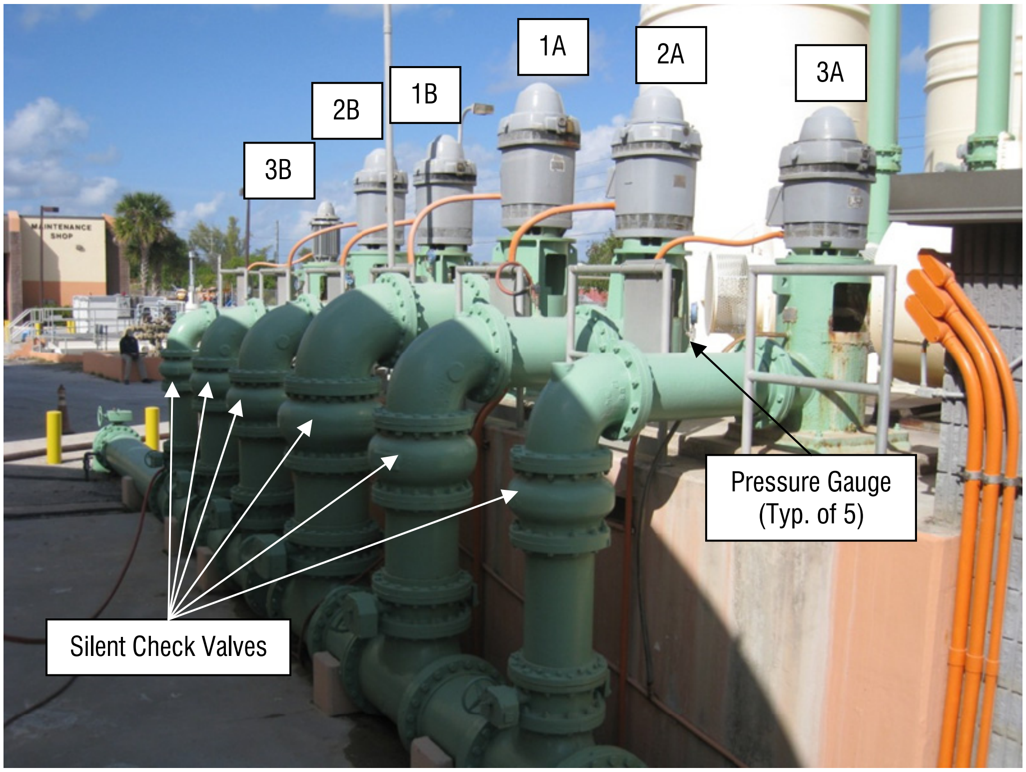
This Appendix contains all pictures referenced in the Water Treatment Plant Condition Assessment Memorandum. Pictures are named as follows: Picture [Appendix Reference].[Section Reference] - [Picture Number in Section].



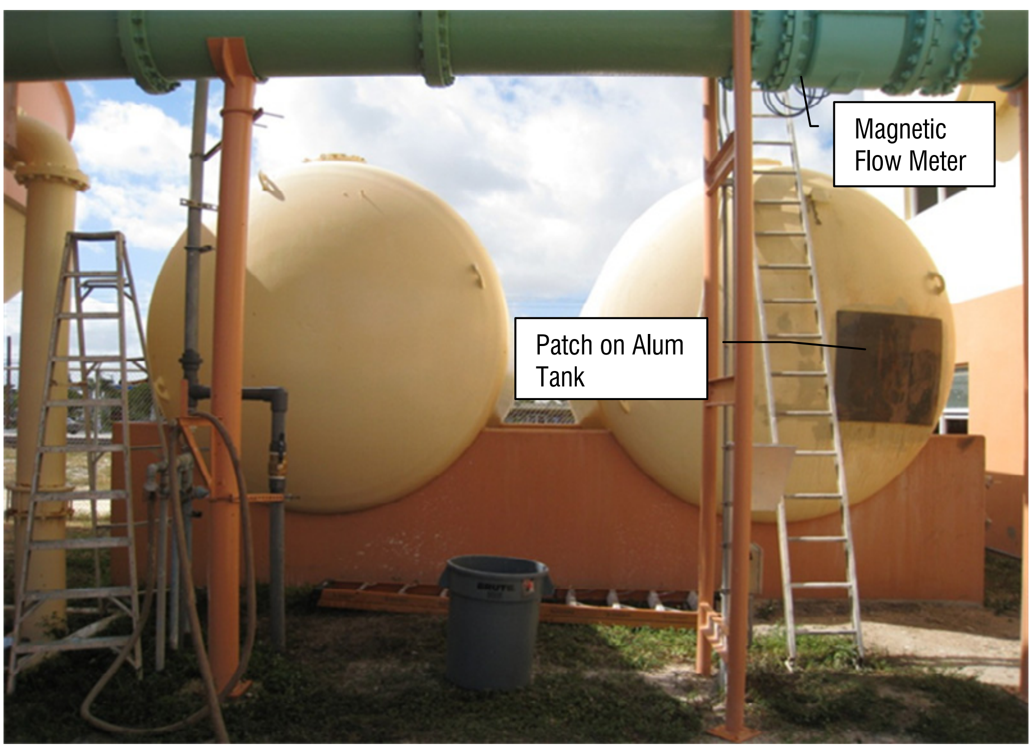
Picture A.1-1 South Raw Water Influent Main



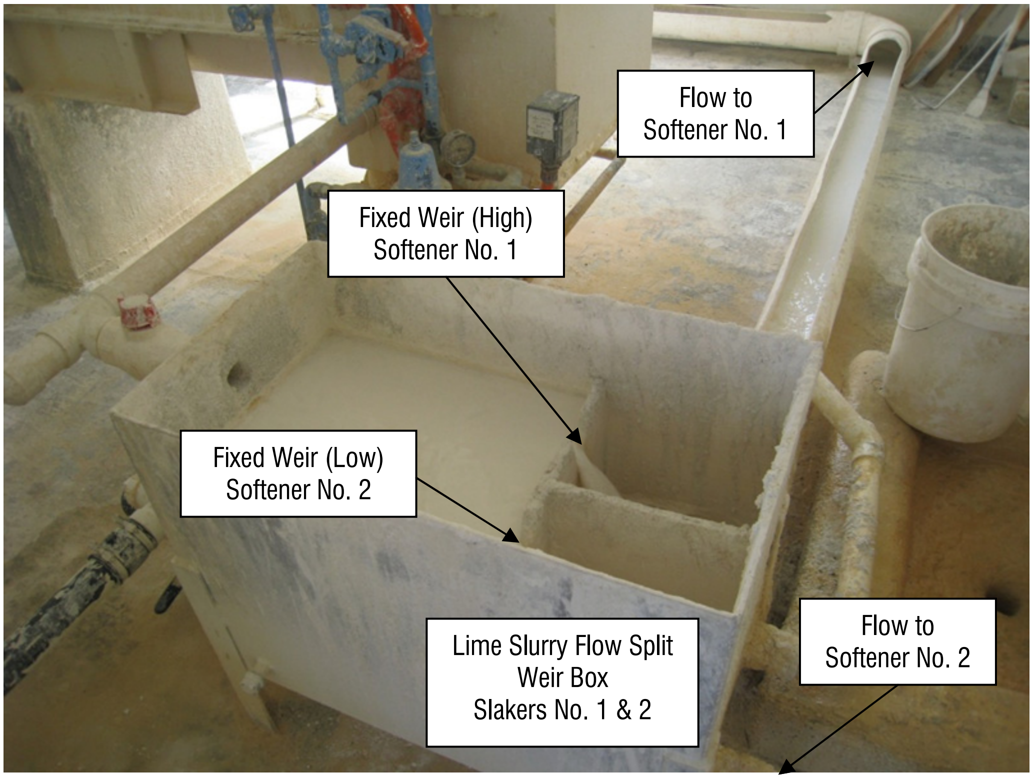
Picture A.1-2 North Raw Water Influent and Return Water



Picture A.3-1 Raw Water Transfer Pumps

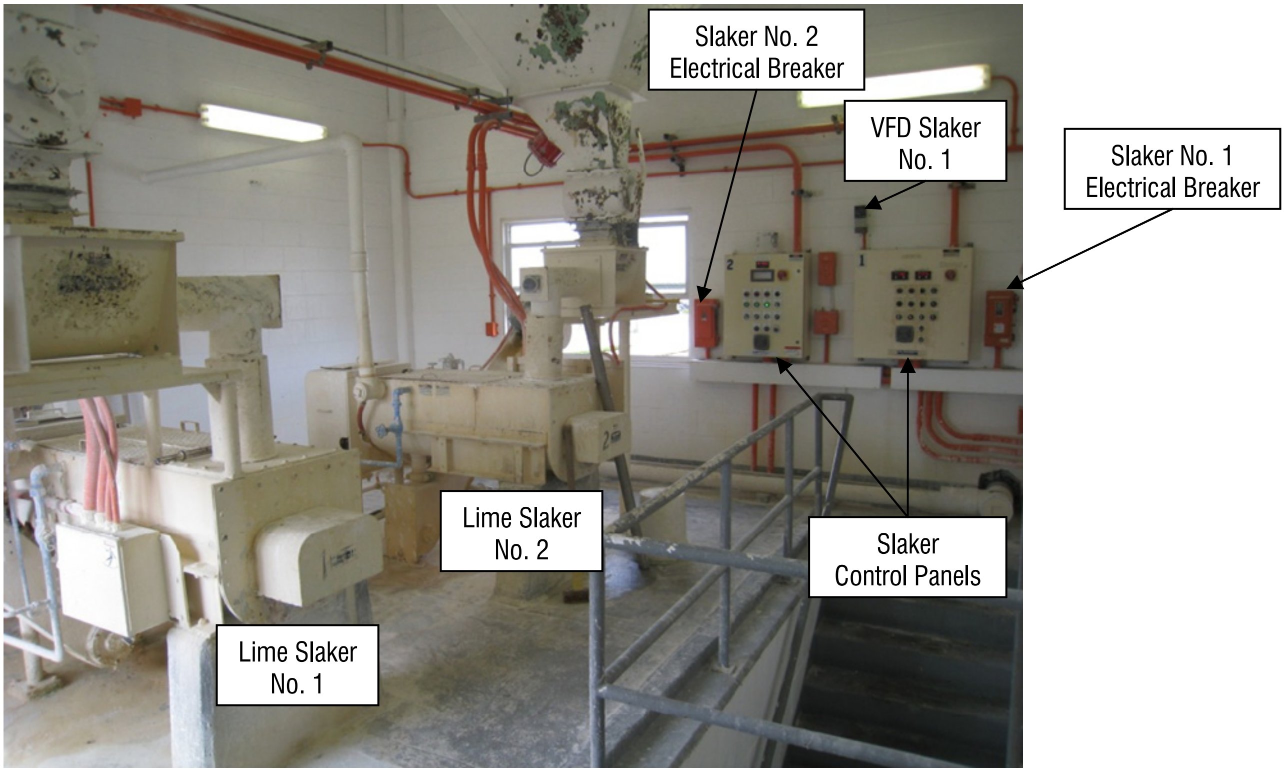


Picture A.5-1 Alum Storage Tanks and Magnetic Flow Meter (Softener No. 1)

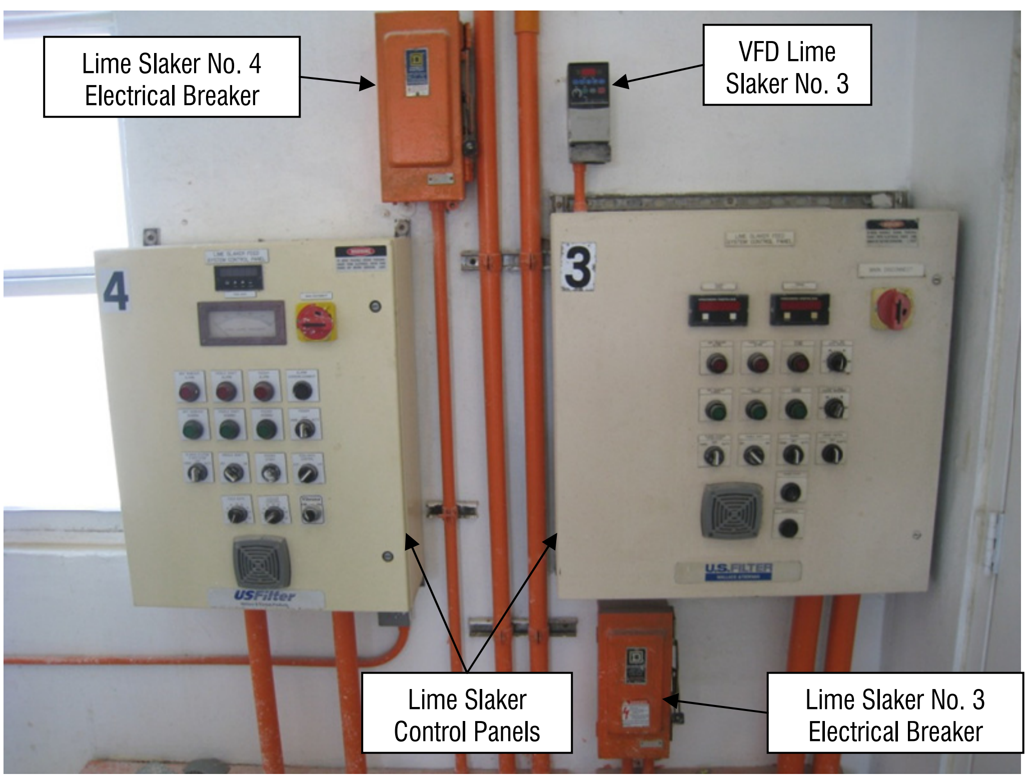


Picture A.7-1 Lime Slurry Weir Box - 3rd Floor South Chemical Building (Lime Slaker Room)

Picture A.7-2 Transformer - 1st Floor South Chemical Building (Alum Pump Room)

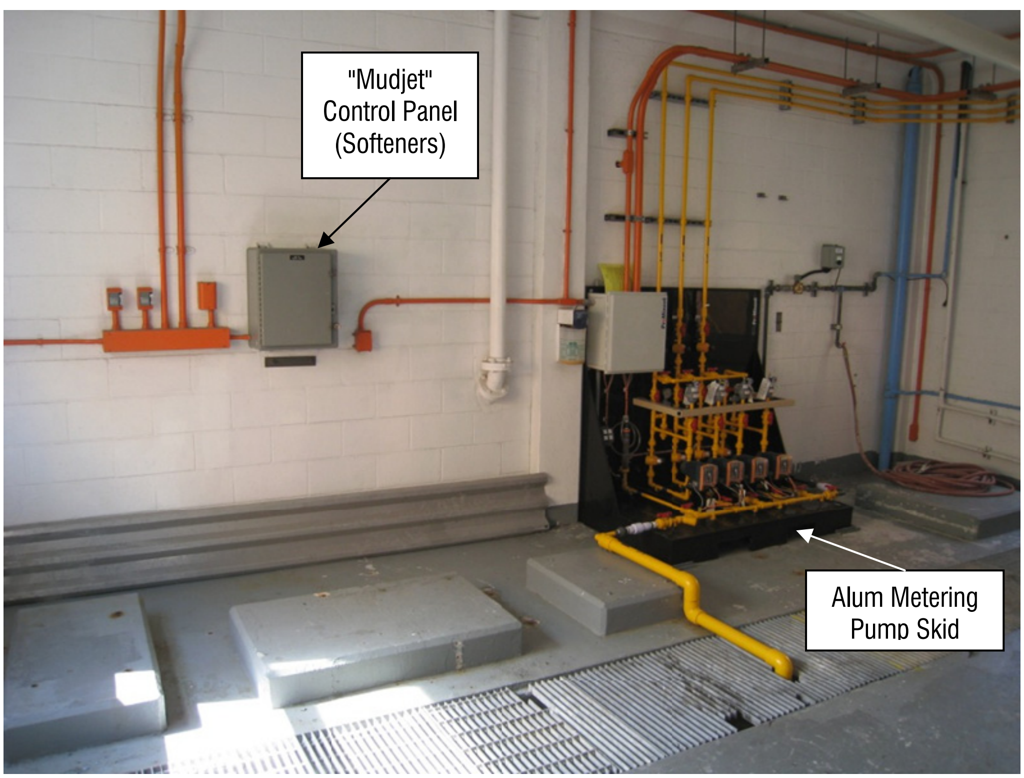


Picture A.7-3 Lime Slaker Room - 3rd Floor South Chemical Building (Northwest view)

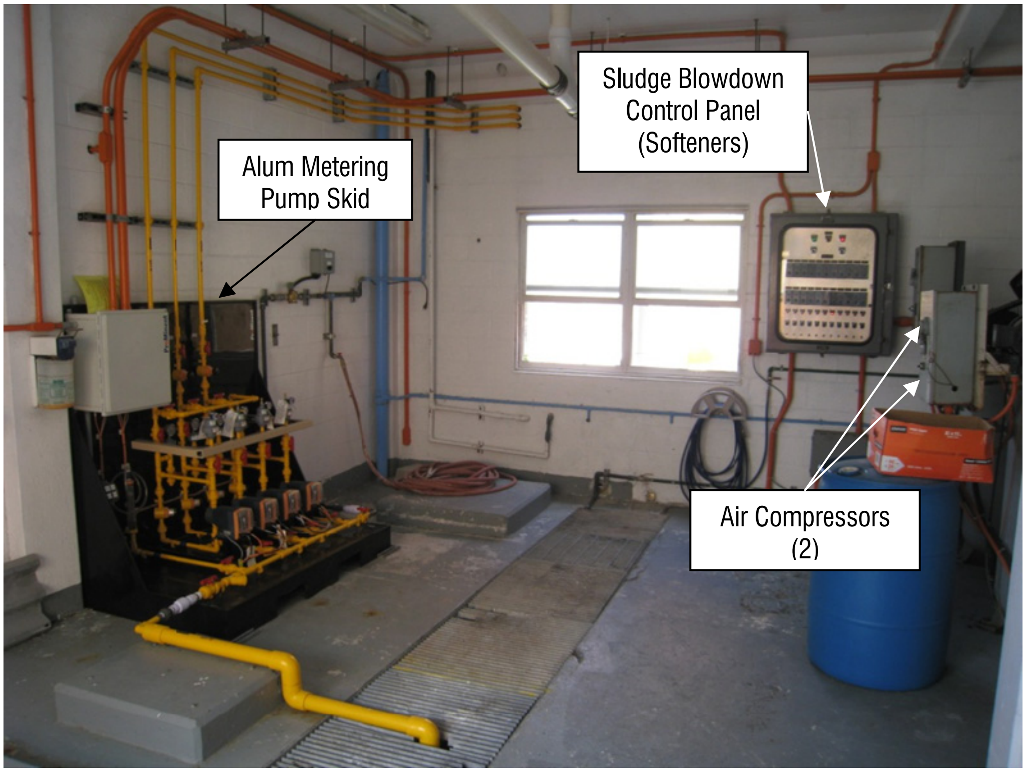


Picture A.7-4 Lime Slaker No.3 and 4 Control Panels - 3rd Floor North Chemical Building

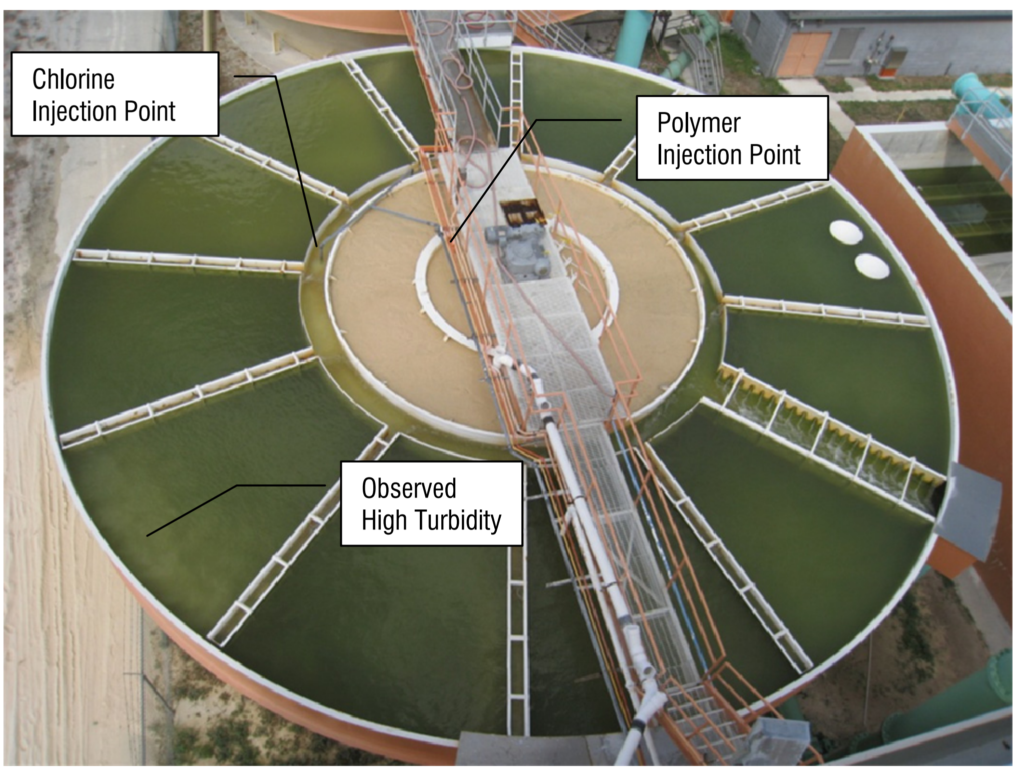
Picture A.8-1 1000 gallon Liquefied Anhydrous Ammonia Storage Tank



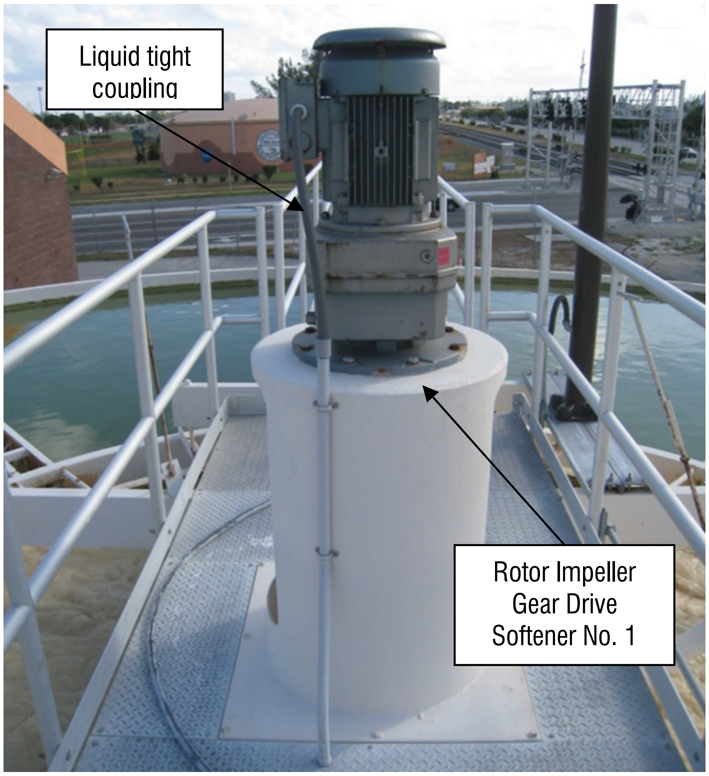
Picture A.9-1 South Chemical Building 1st Floor (West Wall) - Alum Room



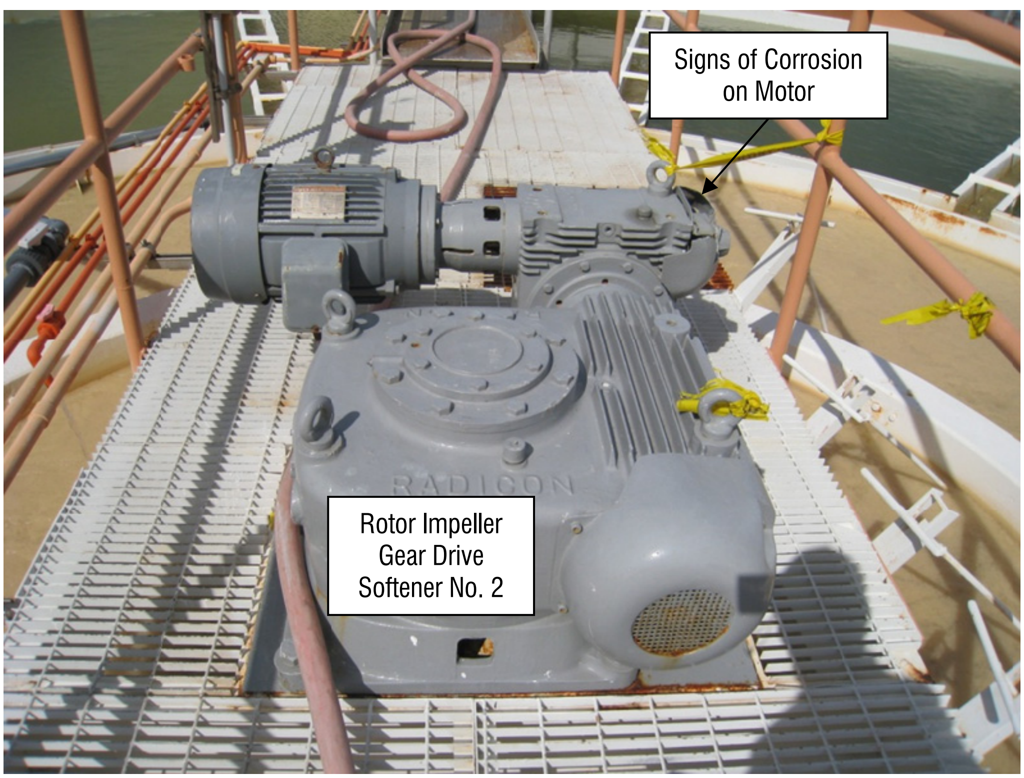
Picture A.9-2 South Chemical Building 1st Floor (Northwest view)



Picture A.9-3 Softener No. 2



Picture A.9-4 Softener No. 1 Rotor Impeller Gear Drive

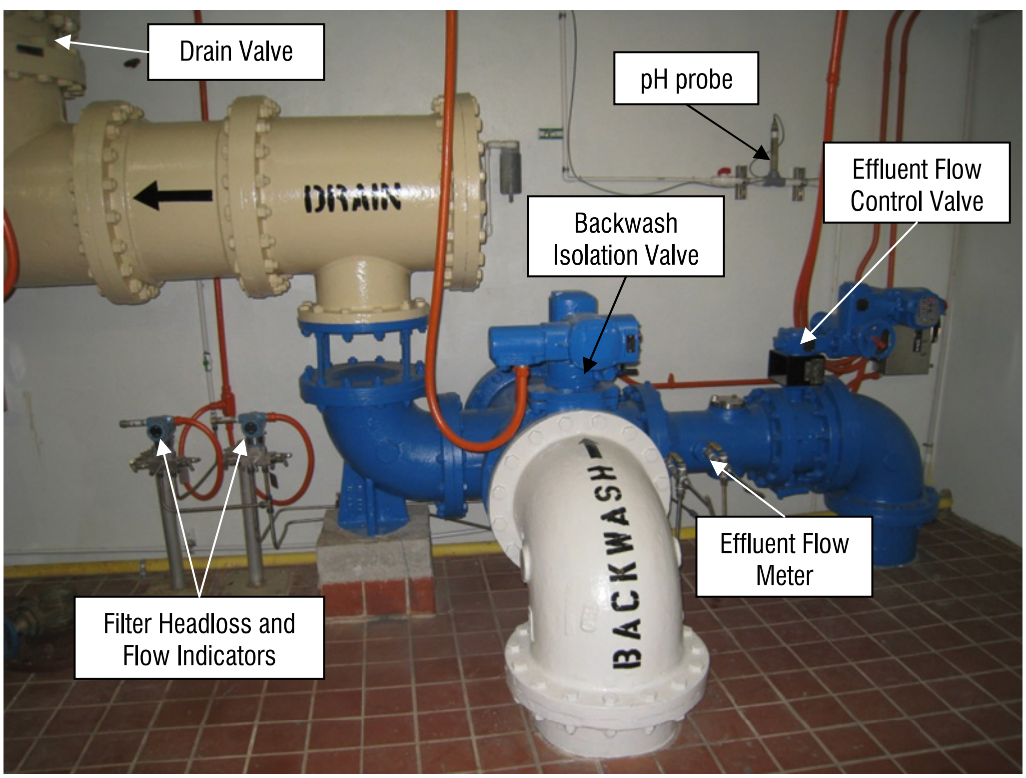


Picture A.9-5 Softener No. 2 Rotor Impeller Gear Drive

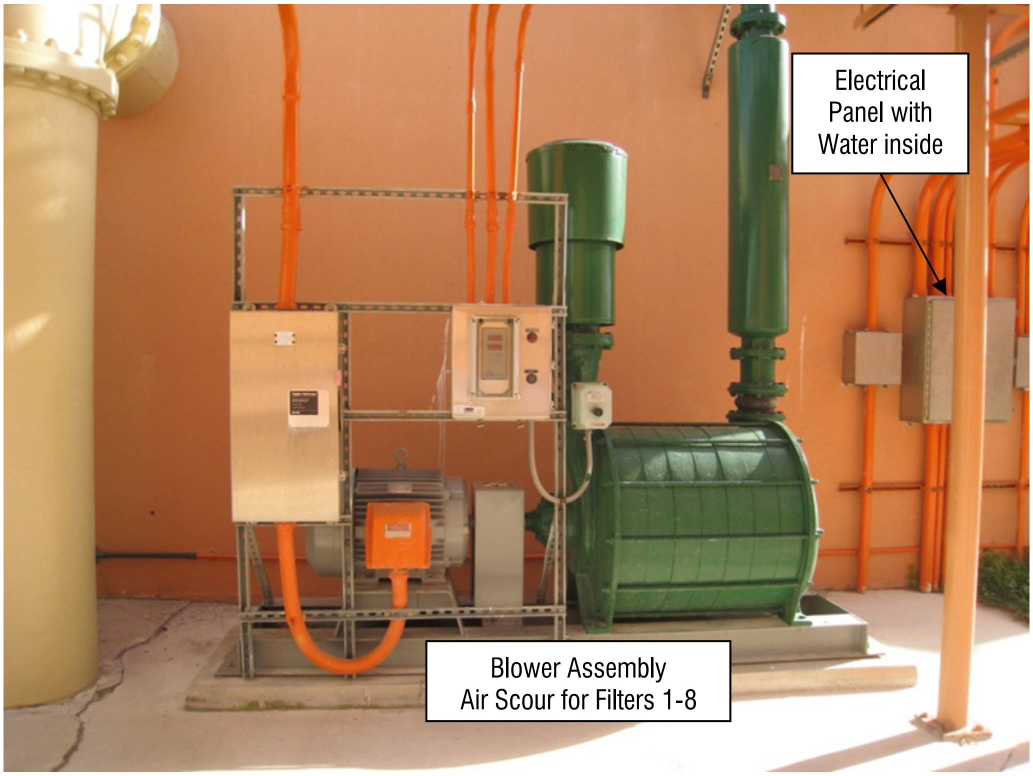
Picture A.9-6 Softener No. 1 Base of Tank

Picture A.9.7 Softener No. 3 Base of Tank

Picture A.9.8 Softener No. 3 Base of Tank



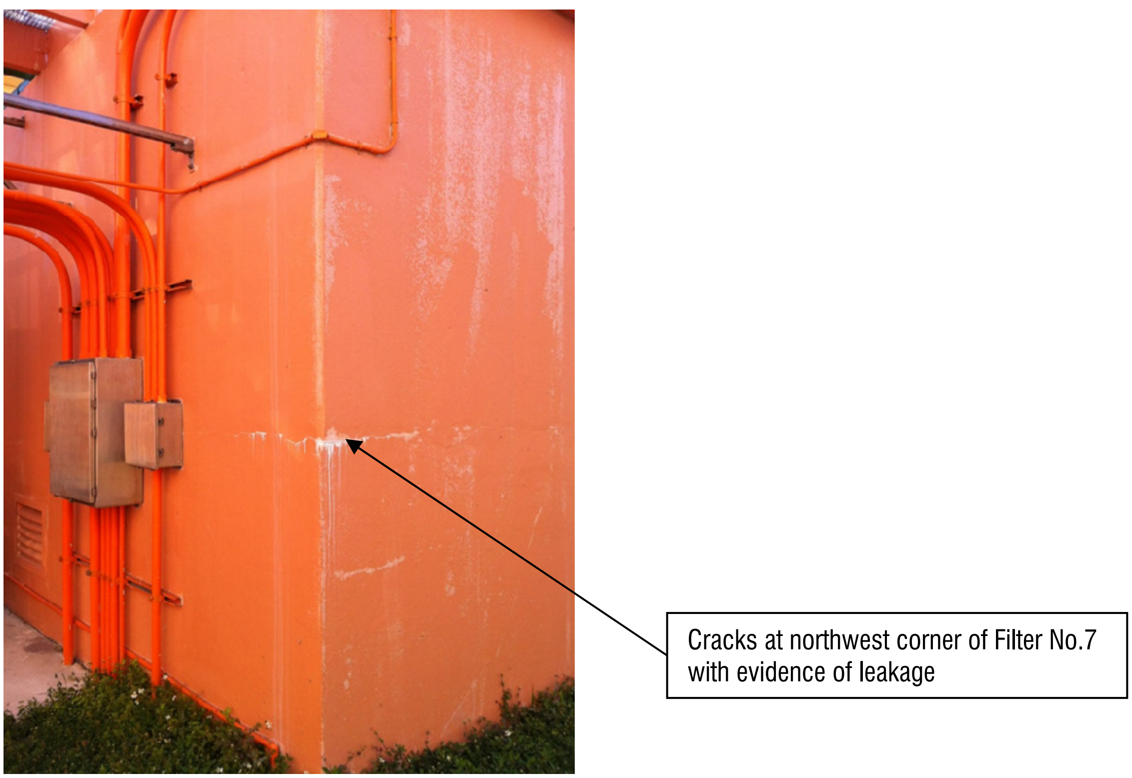
Picture A.11.1 Filter Piping Gallery (Filter No. 15)



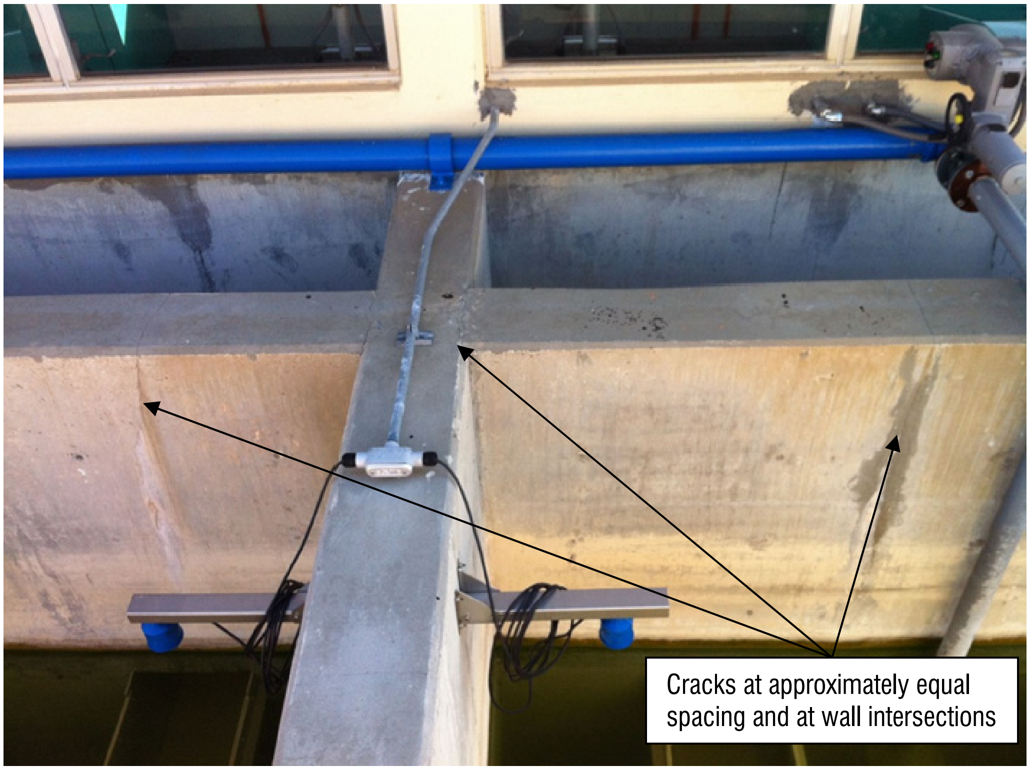
Picture A.11.2 Filter Air Scour Blower (Filters 1-8)

Picture A.11.3 Bridge Corrosion on South Filter Bank

Picture A.11.4 Exterior West wall of Filters No. 1,3,5, and 7



Picture A.11.5 Exterior Northwest wall of Filter No. 7

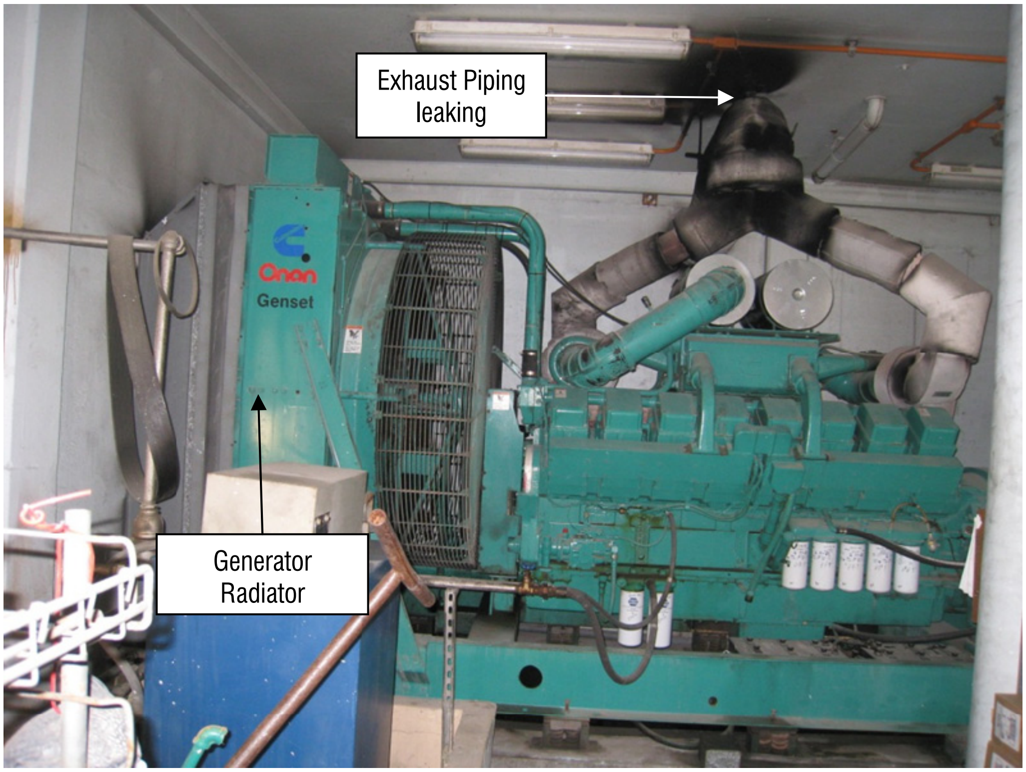


Picture A.11.6 Interior Filter Wash Trough Walls (typical of Filters 9-16)

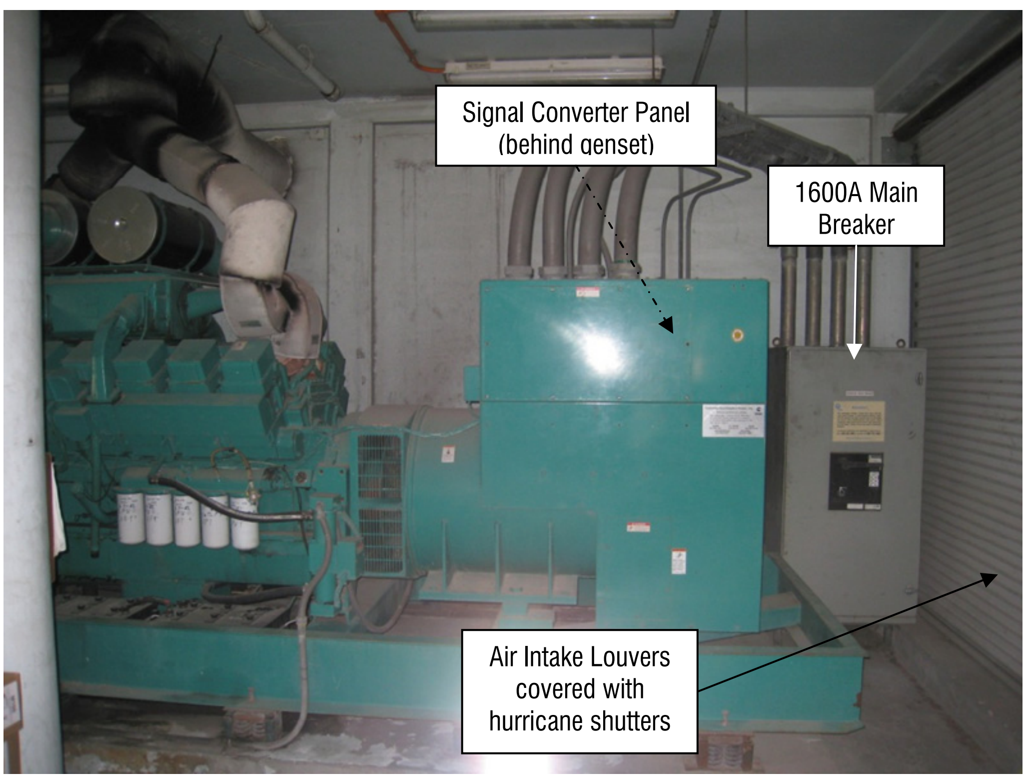
Picture A.11.7 Interior Filter Wash Trough (typical of Filters 9-16)

Picture A.11.8 Exterior West wall of Filters No. 9, 11, 13, and 15

Picture A.11.9 Exterior South wall of Filter No. 9



Picture A.13.1 Main Generator - 1st Floor South Chemical Building (East Room)



Picture A.13.2 Main Generator Main Breaker and Air Louvers

Picture A.16.1 Roof Leak above Main MCC Room

Appendix B

Repump Station Site Investigations

Avenue C Repump Station

Date of Site Visit: February 29, 2012

Mechanical Observations (prepared by Jorge Atoche):

- **Site:** The site has a decorative fence in the front and chain link fence around the back. A double door decorative access gate is located in the front. The condition of the entire fence and gate appear to be good, but requires repair in some locations. The existing access driveway paved area is in fair condition. The space available around the property is limited.

- **Yard Piping:** The above ground yard piping connecting the storage tank with the pump station is ductile iron and appears to be in fair condition. The control valve on the vault is made of stainless steel and the isolation valves are made of cast iron. The piping and valves on the outside valve vault and the ladder and cage for the water storage tank and associated hatches also appear to be in good condition. The storage tank vent screening is damaged.

- **Pump Station:** The current pumps were installed in 1997. The station is fully operational and has two equal size horizontal split case pumps (Fairbanks Morse), one duty and one standby. Each pump has a capacity of 900 GPM @ 150 ft (3550 rpm) with 60 hp motors (230V, 3 phase, 60 Hz). The pumps are constant speed. The pumps are 4"x 6" (discharge/ suction). Piping and fittings inside the pump station are ductile iron. The isolation valves and the check valves are made of cast iron. A noticeable degree of corrosion is apparent on the outside of the pumps, piping, fittings and valves. In particular a higher degree of corrosion is noted at the pump bearing in each side of the casing. Drain piping from the pumps is made of PVC and appears to be in fair condition. The overall condition of the painting of the pumps, pipe, fittings and valves is poor.

- **Chlorine Gas System:** The current chlorine gas system is not operational. The system utilizes 50 lb cylinders to supply a feed system with and injector and carrier water booster. Piping for the chlorine solution is PVC and tubing is used to transport the gas prior to mixing with water. The chlorine room has a dedicated air extraction fan. The room has a noticeable degree of corrosion. The booster pump also has visible corrosion on the outside.

- **Hydro-Pneumatic Tank:** The hydro-pneumatic tank was fabricated by Buffalo Tank in 1981. The tank is rated for a working pressure of 100 psi @ 350 ºF. The tank is mounted on concrete supports. The tank hatches, valves, fittings and the exterior painting appear to be in fair condition. Compressed air is added to the tank to maintain the proper air/water ratio within the tank.

- **Air Compressor:** The air compressor and air receiver tank package (5 hp unit, Powerex) appears to be in fair condition, but shows some signs of corrosion. There is not desiccant dryer and filter downstream of the air receiver unit.

Avenue C Repump Station

- **Gas Backup Pump Drive:** One of the pumps is equipped with a propane gas engine to operate when electric utility power is not available. The engine silencer is located outside the pump station building. The gas engine and silencer show noticeable signs of corrosion and wear. The existing propane tank is located below ground on the backyard.

Architectural / Structural Observations (prepared by J.P. Silva):

- **Site:** Front gate painting is deteriorated. Barbed wire above the chain link fence is also damaged.

- **Pump Station Exterior:** Overall condition of exterior is good. There are some cracks around windows, and a crack between the building and the exterior wall fence. Doors, windows, and louvers do not have signs indicating wind rating.

- **Pump Station Interior:** Tiled floor, trench grating, doors, and windows are in good condition. Interior painting is peeling in several locations. Stains on ceiling and walls may indicate possible roof leaks.

- **Pump Station Roofing:** Riviera Beach Utilities staff indicated that roofing has not been replaced in the past 10 years. Ceiling and wall stains are evidence of a leak but Riviera Beach Utilities staff are not aware if repairs have been made or if it still leaks.

- **Chlorine Room:** Chlorine room at time of inspection was locked so observation was through window. Chlorine environment has caused corrosion of steel elements in the room, as well as corrosion of door hardware. Floor tiles are worn.

- **Outside Valve Vault:** Overall good condition. There is corrosion on ladder rungs embedded in the concrete walls.

- **Water Storage Tank:** Overall good condition. Minor cracks on decorative elements.

- **Hydropneumatic Tank:** Overall good condition. Minor corrosion around hatch.

Electrical Observations (prepared by J. Broad):

- **Motor Control Center (MCC):** The main MCC is a GE Series 8000 which is in rough condition. There is much internal corrosion of components in the motor starters. Recommend a new MCC in the next 5 years.

- **Backup Power:** There is no generator at this station. The only backup is a dual powered pump which can be operated automatically on electric power and control. Emergency backup operation is by gasoline engine and requires hands on local control. The CRBUD would prefer to have a generator so that power to the SCADA and pump controller is available for station operation during power outages. There is sufficient area outside the station to install a standalone combination generator with a base fuel storage tank much like the installation at the North Singer Island pump station.

- **Lighting:** Lighting is incandescent and adequate.

- **Solid State Soft Starters:** The two high service pumps are started with solid state soft starters by WEG. There is considerable corrosion on the components in these enclosures. The corroded equipment should either be replaced or complete new motor control center should be provided.

- **Ventilation Fan:** Ventilation fans severely corroded and should be replaced with chemical and moisture resistant units.

- **Air Compressor:** The air compressor appears to be in fair condition.

- **Valve Vault:** The valve vault wiring condition is as expected and does not require change at this time.

- **Water Tank Conduit and Wiring:** The existing conduit and wiring for the tank is at the end of its useful life. New conduits and wiring are recommended for the water storage tank.

- **Surge Protection:** The existing lightning protection and incoming power surge protection system are inadequate.

Instrumentation and Control Observations (prepared by E. Curtis):

- **Main Control Panel:** Installed in 1998 by CC Controls. Utility staff indicated that the panel is fully functional. The pumps are typically started and stopped manually at the water treatment plant via the Data Flow System (DFS) radio telemetry system. The pump control panel will automatically start and stop the pumps if the water distribution system pressure falls below a setpoint as measured by pressure switches located in the Pressure Control Panel.

- **Pressure Control Panel:** Installed in 1998 by CC Controls. The panel houses the water distribution pressure transmitter, 2 pressure switches (for automatic pump control during periods of low pressure), one flow indicator transmitters, and a pressure gauge. The pressure gauge appears functional, though obscured by its own isolation valve handle. The pressure transmitter and flow meter instruments appear to be functional.

Avenue C Repump Station

- **Venturi Meter:** A flanged Venturi meter is installed in the pump station within the pipe trench. The flow tube is noted as “existing” on the 1998 as-built drawings. If it was part of the pump station original installation, it may be nearing the end of its useful life. The impulse piping is connected to one flow transmitter. Utility staff indicated that the flow meter system is fully functional.

- **Hydro-pneumatic Tank:** The hydro-pneumatic tank is equipped with conductance level switches to measure the water level within the tank. Compressed air is added to the tank to maintain the proper air/water ratio within the tank. The Main Control Panel controls the addition of compressed air by opening the “Add Air Valve” when the water level rises to the high level switch and closes when the water level falls to the low level switch. The air compressor is controlled by an air pressure switch and a local control panel at the air compressor to maintain air pressure within the compressed air receiver tank.

- **Water Storage Tank:** The water storage tank level is monitored by a hydrostatic level transmitter and pressure gauge near the DFS telemetry panels. In addition, 5 float switches are provided for alarms. A high level switch is used to close the Fill Valve. Two low level float switches prevent the pumps from running until the tank has sufficient water. The tank Fill Valve is a hydraulically actuated control valve that controls the filling of the water storage tank. The Fill Valve is equipped with a solenoid valve to facilitate remote control from the Main Control Panel. The operator may manually open or close the Fill Valve from the Main Control Panel or from the water treatment plant via the DFS radio telemetry system. The Fill Valve is equipped with a limit switch to indicate opened and closed status. When controlled remotely, the Fill Valve will close when either pump is running.

- **Backup Pump Drive:** One of the pumps is equipped with a gasoline engine to operate when electric utility power is not available. Local manual controls are provided to operate this pump. Utility staff would like a backup power generator so that the pump station controls can be powered and remotely monitored during utility power outages.

Avenue C Repump Station Recommendations:

1. Assess condition of existing decorative fence and make repairs as needed. Repair screening on storage tank vents.

2. Monitor the condition of the pumps and motors, and plan for future replacement within 5 to 10 years. Replace the piping and valves when the pumps are replaced.

3. Consider VFDs for pumps.

Avenue C Repump Station

4. Prepare for replacement of entire chlorine gas supply and monitoring system in the next 5 years. Replace the chlorine analyzer.

5. Assess internal condition of the hydro-pneumatic tank and plan for replacement in 5 years.

6. Monitor closely the condition of the air compressor and gas engine and plan for replacement within 5 years. Provide a desiccant and filter for the air compressor system.

7. Consider replacement of gas engine with a diesel generator.

8. In general, most of the mechanical equipment is more than half way or close to the end of their expected useful lives and should be monitored closely for potential replacement.

9. Replace barbed wire on fence and repaint front gate.

10. Caulk joint between exterior fence wall and pump station building, and repaint exterior of pump station with painting system capable of bridging minor cracks.

11. Repaint interior of pump station and chlorine room.

12. Have the roofing inspected for leaks by a roofing contract; repair as required.

13. Replace door hardware in chlorine room.

14. Remove rungs in valve vault and replace with aluminum ladder attached to concrete wall.

15. If the CRBUD desires to harden building for hurricanes, replace doors and louvers with components having Florida Product Approvals.

16. The North Singer Island pump station has an extensive lightning protection system consisting of both lightning rods on the pump station and storage tank; main power surge protection is also provided. This concept should be implemented at repump stations "C".

17. A new MCC in the next 5 years is recommended.

18. New conduits and wiring are recommended for the water storage tank.

19. Solid state soft starters should be replaced within the next 5 years.

20. All instrumentation and control panels are approaching their expected useful life. By about 2013, replace all instrumentation and control panels. Replace the Main Control Panel with a Programmable Logic Controller (PLC) based control panel, and replace the DFS remote telemetry unit (RTU) Panel with a unit capable of connecting to the PLC via Ethernet, similar to the North Singer Island Repump Station RTU.

Avenue U Repump Station

Date of Site Visit: February 29, 2012

Mechanical Observations (prepared by Jorge Atoche):

- **Site:** The chain link fence around the site and the double door access gate appear to be in fair condition. The existing access driveway paved areas are limited. There are not delimited parking spots. There is limited exterior lighting. It appears there is not a dedicated stormwater system on the site. Most of the property size is vacant. There is a fuel storage tank for vehicle supply located next to the pump station building.

- **Yard Piping:** The above ground yard piping connecting the storage tank with the pump station is ductile iron and appears to be in fair condition. The piping and valves on the outside valve vault and the ladder and cage for the water storage tank and associated hatches also appear to be in good condition. The control valve on the vault is made of stainless steel and the isolation valves are made of cast iron.

- **Pump Station:** The current pumps were installed in 1997. The station is fully operational and has two equal size horizontal split case pumps (Crane Pumps), one duty and one standby. Each pump has a capacity of 2000 GPM @ 120 ft (1750 rpm) with 100 hp motors (230V, 3 phase, 60 Hz). The pumps are constant speed. The pumps are 6"x 8" (discharge/ suction). Piping and fittings inside the pump station are ductile iron. The isolation valves and the check valves are made of cast iron. Some degree of corrosion is noted on the outside of the pumps, piping, fittings and valves. This may be related to a chlorine leak experienced recently at the pump station. In particular a higher degree of corrosion is noted at the pump bearing in each side of the casing. Drain piping from the pumps is made of PVC and appears to be in fair condition. The overall condition of the painting of the pumps, pipe, fittings and valves is fair.

- **Chlorine Gas System:** The current chlorine gas system is operational. The system utilizes 50 lb cylinders to supply a feed system with and injector and carrier water booster. Some of the cylinders are not secured to the wall or floor. Piping for the chlorine solution is PVC and tubing is used to transport the gas prior to mixing with water. The chlorine room has a dedicated air extraction fan, but currently uses a portable fan for air extraction. The room has a noticeable degree of corrosion. The booster pump also has visible corrosion on the outside. The chlorine analyzer (Hach CL17) at the pump station is not functional.

- **Hydro-Pneumatic Tank:** The hydro-pneumatic tank was fabricated by Buffalo Tank in 1981. The tank is rated for a working pressure of 100 psi @ 350 ºF. The tank is mounted on concrete supports. The tank hatches, valves, fittings and the exterior painting appear to be in fair condition. Compressed air is added to the tank to maintain the proper air/water ratio within the tank.

- **Air Compressor:** The air compressor and air receiver tank package (5 hp unit, Ingersoll Rand T30 model) appears to be in fair condition. The desiccant dryer and filter downstream also appear to be in fair condition

- **Backup Generator:** The pump station has a 250kW diesel generator (Cummins/Onan) supplied in 1997. A concrete double wall 2,000 gallon diesel bulk storage tank by ConVault is located outside adjacent to the pump station. A 25 gallon Simplx day tank is located inside the pump station next to the generator. Fuel piping appears to be welded black steel. The generator and associated bulk storage and day tank appear to be in fair condition and are maintained by an outside maintenance company. The generator silencer is located outside and also appears to be in fair condition.

Architectural / Structural Observations (prepared by J.P. Silva):

- **Site:** The chain link fence around the site is damaged on the west and north sides of the site. Barbed wire above the chain link fence is also damaged. Entrance gate is in fair condition with some corrosion.

- **Pump Station Exterior:** Overall condition of exterior is good. There is some corrosion on the louvered door and the window protection on the west side of the building. Doors, windows, and louvers do not have signs indicating wind rating.

- **Pump Station Interior:** Overall condition of interior is good. Tiled floor, trench grating, doors, and windows are in good condition. The station had a chlorine solution line break which may have caused some of the interior painting to peel. Peeling of the paint may also be caused by water intrusion through the wall. All interior louver screens are damaged.

- **Pump Station Roofing:** Riviera Beach Utilities staff indicated that roofing has not been replaced except for shingles on the east side. No evidence of leaks were observed and Riviera Beach Utilities staff were not aware of any past leaks. Fascia on the east side of the building is damaged and there is vegetation under the roof flashing.

- **Chlorine Room:** Chlorine environment has caused corrosion of steel elements and louvers in the room.

- **Above Ground Diesel Fuel Storage Tank:** Appears to be in good condition.

- **Outside Valve Vault:** Overall good condition. There is corrosion on ladder rungs embedded in the concrete walls.

- **Water Storage Tank:** Overall good condition. Two cracks with leakage evidence were observed on the southeast.

- **Hydropneumatic Tank:** Overall good condition. Minor corrosion around hatch.

Avenue U Repump Station

Electrical Observations (prepared by J. Broad):

- **General:** The station's last major update was in 1997. At that time a generator was added and motor controls updated to soft starters.

- **Chlorine Lines:** The station has had a previous chlorine solution line break which contaminated some of the electrical controls and equipment causing corrosion in the equipment and on the exterior of the equipment enclosures. The enclosures exterior could be cleaned up but the interior components life has been shortened and should be replaced to prevent current and future intermittent problems. It would be great if the chlorine solution lines could be better located or isolated from the electronic and electrical controls.

- **Generator:** The station has a 250kW diesel generator inside the station circa 1997. A concrete double wall 2,000 gallon diesel bulk storage tank by ConVault is located outside adjacent to the pump station. The generator and associated day tank appear to be in good condition and are maintained by an outside maintenance company. The only comment from the owner was that the generator did not have a block heater installed. This could be installed if desired, however, discussion with Onan confirming necessity should be done first.

- **Automatic Transfer Switch:** The station Lake Shore automatic transfer switch has some components with considerable corrosion possibly due to the chlorine issue. The enclosure is a Nema 1 without any gaskets or seals on the door. If replaced, recommend a minimum of Nema 12 with oil and chemical resistant gaskets for the doors or isolate the chemicals from the electrical equipment.

- **Solid State Soft Starters:** The two high service pumps are started with solid state soft starters by Saftronics. There is some corrosion on the components in these enclosures which should either be replaced or an entirely new motor starter should be provided.

- **Panelboard A:** Electrical panel board "A" was added in 1997 and appears good condition from outside, however, internal observation was not determined but should be inspected by electrician due to chlorine leak. Panel board "A" is likely at the end of its useful life

- **Panelboard B:** Electrical panel board "B" was original equipment. Panel board "B" is at the end of its useful life.

- **Lighting:** The internal lighting is incandescent and is adequate.

- **Air Compressor:** The air compressor appears to be in fair condition. No electrical recommendations for this.

Avenue U Repump Station

- **Valve Vault:** The valve vault wiring condition is as expected and does not require change at this time.

- **Conduit:** New conduits and wiring are recommended for the water storage tank.

- **Surge Protection:** The existing lightning protection and incoming power surge protection system are inadequate.

Instrumentation and Control Observations (prepared by E. Curtis):

- **Main Control Panel:** Installed in 1997 by CC Controls. The exterior of the stainless steel enclosure was damaged from a chlorine leak that occurred in mid 2011. Utility staff indicated that the pump controls are fully functional. The pumps are typically started and stopped manually at the water treatment plant via the DFS radio telemetry system. The pump control panel will automatically start and stop the pumps if the water distribution system pressure falls below a setpoint as measured by pressure switches located in the Pressure Control Panel. The panel may also start the pumps automatically if a hardwired signal (fire alarm) from a nearby business is energized. A pilot light labeled "SYSCO Firewater Request" indicates the status of this signal. The water pressure indicator on the control panel was reading 5.63 psi while the pressure transmitter in the Pressure Control Panel indicated about 57 psi.

- **Pressure Control Panel:** Installed in 1997 by CC Controls. The panel houses the water distribution pressure transmitter, 2 pressure switches (for automatic pump control during periods of low pressure), two flow indicator transmitters (dual range measurement of flow rate), and a pressure gauge. The exterior of the stainless steel enclosure was damaged from a chlorine leak that occurred in mid 2011. The pressure gauge is not working and its fill fluid leaked inside the panel. The pressure transmitter and flow meter instruments appear to be functional. Utility staff indicated that the instruments have not been recalibrated since their original installation in 1997.

- **Venturi Meter:** A flanged BIF Venturi meter is installed in the pump station within the pipe trench. The nameplate indicates a size of 12x7 inches. The flow tube appears to have a date engraved on the flow tube of "4-14-81". If this is the installed date for the Venturi, it may be nearing the end of its useful life. The impulse piping is connected to two flow transmitters (one low range and one high range). Utility staff indicated that the flow meter system is fully functional.

- **Chlorine Residual Analyzer:** The Hach CL17 chlorine residual analyzer in the pump room was last calibrated on 7/13/11 but was damaged shortly after the chlorine leak. The instrument is currently non-functional and needs to be replaced.

<u>Avenue U Repump Station</u>

- **Hydro-pneumatic Tank:** The hydro-pneumatic tank is equipped with conductance level switches to measure the water level within the tank. Compressed air is added to the tank to maintain the proper air/water ratio within the tank. The Main Control Panel controls the addition of compressed air by opening the "Add Air Valve" when the water level rises to the high level switch and closes when the water level falls to the low level switch. The air compressor is controlled by an air pressure switch and a local control panel at the air compressor to maintain air pressure within the compressed air receiver tank.

- **Water Storage Tank:** The water storage tank level is monitored by a hydrostatic level transmitter and pressure gauge near the DFS telemetry panels. In addition, high and low level float switches are provided for alarms. Two low level float switches prevent the pumps from running until the tank has sufficient water. The tank Fill Valve is a hydraulically actuated control valve that controls the filling of the water storage tank. The Fill Valve is equipped with a solenoid valve to facilitate remote control from the Main Control Panel. The operator may manually open or close the Fill Valve from the Main Control Panel or from the water treatment plant via the DFS radio telemetry system. The Fill Valve is equipped with a limit switch to indicate opened and closed status. When controlled remotely, the Fill Valve will close when either pump is running.

- **Backup Power Generator:** The generator, fuel system, and automatic transfer switch are automatically controlled by local control panels. Generator system alarms are transmitted to the DFS telemetry panel for remote monitoring

Avenue U Repump Station Recommendations:

1. Repair/add pavement areas as needed.

2. Monitor closely the condition of the pumps and motors; plan for replacement within the next 5 to 10 years. Replace piping and valves when the pumps are replaced.

3. Consider VFDs for pumps.

4. Prepare for replacement of entire chlorine gas supply and monitoring system in the next 5 years.

5. Assess internal condition of the hydro-pneumatic tank and plan for replacement in 5 years.

6. Monitor closely the condition of the air compressor and generator and plan for replacement within 5 to 10 years.

7. In general, most of the mechanical equipment is more than half way or close to the end of their expected service life and should be monitored closely for potential replacement.

Avenue U Repump Station

8. Replace chain link fence on west and north sides.

9. Replace louver on west side door.

10. Replace all louver screens.

11. Determine if moisture is penetrating pump station building on east side and repair if necessary.

12. Repaint interior of pump station and chlorine room.

13. Replace louver in chlorine room.

14. Repair fascia and flashing in pump station building after vegetation is removed.

15. Assess leakage of water storage tank and repair as necessary.

16. Remove rungs in valve vault and replace with aluminum ladder attached to concrete wall.

17. If CRBUD desires to harden building for hurricanes, replace doors and louvers with components having Florida Product Approvals.

18. The North Singer Island pump station has an extensive lightning protection system consisting of both lightning rods on the pump station and storage tank but also main power surge protection. This concept should be implemented at repump station “U”.

19. Solid state soft starters should be replaced within the next 5 years.

20. Panel board “A” is likely at the end of its useful life and should be replaced within the next 5 years.

21. Panel board “B” is at the end of its useful life and should be replaced within the next 5 years.

22. Immediately replace the non-functional chlorine residual analyzer.

23. The useful life of all electronic equipment in the pump room was reduced due to chlorine exposure. However, instruments outside the pump room are approaching their expected useful life as well. To avoid disruption of operations, replace all instrumentation and control panels immediately. Replace the Main Control Panel with a PLC based control panel, and replace the DFS RTU Panel with a unit capable of connecting to the PLC via Ethernet, similar to the North Singer Island Repump Station RTU.

NSI Repump Station

Date of Site Visit: February 29, 2012

Mechanical Observations (prepared by Jorge Atoche):

- All the mechanical equipment was recently replaced (2010), including the pumps, piping, valves, fittings, gen-set, fuel storage, hydro-pneumatic tank, air compressor and other pump station components.

Architectural / Structural Observations (prepared by J.P. Silva):

- **Site:** Pump Station was recently renovated and exterior fencing is in good condition.
- **Pump Station Exterior:** Pump station was recently renovated and is in good condition.
- **Pump Station Interior:** Pump station was recently renovated and is in good condition.
- **Pump Station Roofing:** Pump station was recently renovated and roofing was replaced. No evidence of leaks were observed.
- **Chlorine Room:** Chlorine room is no longer used for chlorine storage or dosage and instead is used to house electrical equipment and has been provided with air conditioning. Room is in good condition.
- **Outside Valve Vault:** Overall good condition. There is corrosion on ladder rungs embedded in the concrete walls.
- **Water Storage Tank:** Overall good condition. Tank was recently coated. Corrosion was observed on roof vent. Ladder does not have safety cage.
- **Hydropneumatic Tank:** Tank was recently replaced and is in good condition.

Electrical Observations (prepared by J. Broad):

- **General Observation:** This station has been recently (2010) upgraded. The station electrical equipment looks new and is in good condition.
- **Main Breaker:** There is a 800A main breaker installed on the exterior of the station west wall. Incoming power surge protection is also provided and installed adjacent to the main breaker.
- **Generator:** The new separate generator with sound attenuated enclosure and base diesel fuel tank is located on the east side of the storage tank. Condition is like new.

NSI Repump Station

- **Automatic Transfer Switch:** The automatic transfer switch is located inside the station adjacent to the power panelboard. Condition is like new.

- **Panelboard:** Since there is not any equipment that require motor starters, there is no motor control center (MCC) in this station, instead a 480V panelboard is used to power the equipment. Panelboard is like new.

- **Variable Frequency Drive:** The high service pumps are VFD controlled with VFDs installed in a separate air-conditioned room.

Instrumentation and Control Observations (prepared by E. Curtis):

- **PLC Control Panel:** Installed in 2010 by CC Controls. The panel contains an Allen Bradley ControlLogix PLC, touchscreen operator interface terminal, and Hydraulic Pressure Control Valve indicator lights and control switch. The PLC is programmed to control the pump VFDs, the hydraulic pressure control valve, the hydro-pneumatic tank "Add Air Valve" solenoid valve, and other functions. The PLC is connected to the DFS telemetry panel via Ethernet communications cable to facilitate remote monitoring and control of the pumps from the water treatment plant. The PLC Control Panel receives most of the pump station instrumentation signals, with the exception of some power and generator status signals, which are wired directly to the DFS RTU panel.

- **Auxiliary Control Panel:** Installed in 2010 by CC Controls. The panel provides lights and switches for control of the water storage tank Fill Valve, the Chlorine Booster Pump, and provides the low level pump shutdown, similar to Avenue U and Avenue C Repump Stations. It is not clear why these functions were not included in the PLC Control Panel, which has ample space.

- **Magnetic Flow Meter:** A flanged magnetic flow meter is installed in the pump station within the pipe trench. Excessive sensor cable is currently coiled up on top of the flow tube, which could cause malfunction. Utility staff indicated that they have not observed problems with the flow meter.

- **Hydro-pneumatic Tank:** The hydro-pneumatic tank is equipped with conductance level switches to measure the water level within the tank. Compressed air is added to the tank to maintain the proper air/water ratio within the tank. The conductance level switches are wired to the air compressor control panel, which is wired to the PLC Control Panel. The PLC Control Panel controls the addition of compressed air by opening the "Add Air Valve" when the water level rises to the high level switch and closes when the water level falls to the low level switch. The air compressor is controlled by an air pressure switch and a local control panel at the air compressor to maintain air pressure within the compressed air receiver tank.

NSI Repump Station

- **Water Storage Tank:** The water storage tank level is monitored by a hydrostatic level transmitter and tank mounted sight gauge. In addition, 6 float switches are provided for alarms. A high level switch is used to close the Fill Valve. Two low level float switches prevent the pumps from running until the tank has sufficient water. The tank Fill Valve is a hydraulically actuated control valve that controls the filling of the water storage tank. The Fill Valve is equipped with a solenoid valve to facilitate remote control from the Main Control Panel. The operator may manually open or close the Fill Valve from the Auxiliary Control Panel or from the water treatment plant via the DFS radio telemetry system and PLC Control Panel. The Fill Valve is equipped with a limit switch to indicate opened and closed status. When controlled remotely, the Fill Valve will close when either pump is running.

- **Backup Power Generator:** The generator, fuel system, and automatic transfer switch are automatically controlled by local control panels. Generator system alarms are transmitted to the DFS telemetry panel for remote monitoring at the water.

NSI Repump Station Recommendations:

1. There is no need for any short term (i.e., over the next 5 years) replacement of mechanical equipment. Continue monitoring the pump station components and provide maintenance as needed.

2. There is no need for any short term structural / architectural repairs or replacement.

3. Determine if ladder on storage tank requires safety cage by OSHA standards and provide if necessary.

4. The instrumentation and control panels are in new condition. Their expected service life is 15 years. As such, plan to replace the instrumentation and control panels in 2025.

Appendix C

Lift Station Condition Evaluation

1. Condition Evaluation Findings

This Appendix documents the findings of the wastewater lift station condition evaluation.

The project team conducted site visits of the fifty-one (51) lift stations owned and operated by City of Riviera Beach Utility District (CRBUD). The site visits were made on 2/10/2012, 2/11/2012, and 2/13/2012. The purpose of the site visits was to assess the condition of the equipment and structures. The investigation was limited to visual observation of the facilities and interviews with wastewater operations and maintenance staff regarding the performance, reliability and condition of the existing equipment.

The team scored the condition of the following major elements:

- Mechanical (pumps, valves, piping, and odor control);
- Structural (wet well, valve vault, pump station enclosure/building); and
- Electrical (motors, power feed, controls, and backup power generator).

The condition scoring system utilized for each of the major elements is presented in **Table 1**.

Table 1
Condition Scoring

Score	Description
1	Very good
2	Good
3	Fair
4	Poor
5	Very poor

Table 2 summarizes the condition score of each lift station. This table also indicates the expected average remaining useful life of the lift stations. The category column is an indication of the capacity of the lift station, as follows:

- Small lift stations have motors with a capacity of less than 15 horsepower;
- Medium lift stations have motors with a capacity of 15 horsepower or more but are not considered master or sub-master stations; and
- Master lift stations are stations that pump directly to the ECRWRF under normal operating conditions. The CRBUD staff has also identified "sub-master" lift stations that serve as critical repumping stations for substantial portions of the service area.

Table 2
Lift Station Condition Evaluation Findings

Lift Sta. No.	Construction or Rehab Date	Type	Category	Condition Score				Remaining Useful Life
				Mechanical	Structural	Electrical	Average	
1A	2004	DPS	sub-master	0.5	0.5	1	0.7	22
2	1996	S	medium	1	1	1	1.0	14
3	1960	S	medium	0.5	0	0.3	0.3	0
4A	2009	S	medium	0	0	0.3	0.1	27
5	2003	S	medium	1	1	1	1.0	21
6	1960	CAN	small	3	1.5	1	1.8	0
7	2004	S	medium	1	0	1	0.7	22
8	1996	S	small	1	1	1	1.0	14
9	1961	S	small	2	2	1.7	1.9	0
10	1993	S	sub-master	2	1.5	1	1.5	11
11	1996	CAN	small	2	1	1	1.3	14
12	1993	S	sub-master	2	1	1	1.3	11
13	1965	CAN	small	1	1	1.4	1.1	0
14	1965	CAN	small	1	1.5	1.4	1.3	0
15	2005	S	medium	0.5	1	1	0.8	23
16	1965	CAN	small	3	1.5	1.4	2.0	0
17	1965	S	medium	4	1	1.3	2.1	0
18	1985	S	medium	1	1	1	1.0	3
19	1970	CAN	medium	1.5	1.5	1.4	1.5	0
20	1970	S	medium	1.5	1	1	1.2	0
21	2001	S	medium	1	1	1	1.0	19
22	2008	S	sub-master	1	1	1	1.0	26
23	2008	S	medium	1	1	0.3	0.8	26
24	1980	S	small	2	1	1	1.3	0
25	1986	S	medium	3	1	1	1.7	4
26	1977	S	medium	3	1	1	1.7	0
27	1981	S	small	4	1	1.3	2.1	0
28	1979	S	small	3	2	1	2.0	0
29	1979	S	small	2	1	1.3	1.4	0
30	1985	S	small	2.5	1.5	1	1.7	3
31	1984	S	small	2.5	2	1.3	1.9	2
32	1970	S	small	3	2	1.4	2.1	0
33	1983	S	small	2	1	1	1.3	1
34	1983	S	small	3	1	1	1.7	1
35	1987	S	small	3	1	1	1.7	5

Table 2
Lift Station Condition Evaluation Findings

Lift Sta. No.	Construction or Rehab Date	Type	Category	Condition Score				Remaining Useful Life
				Mechanical	Structural	Electrical	Average	
36	1983	S	medium	1.5	1	1	1.2	1
37	1984	S	medium	2	1	1	1.3	2
38	1996	S	small	2	1	1	1.3	14
39	1980	S	small	3	1.5	1	1.8	0
40	2010	S	medium	1.5	1	1	1.2	28
41	1993	S	medium	1.5	1	1	1.2	11
42A	1960	S	small	1	1	1	1.0	0
42B	1960	S	small	1.5	1	1	1.2	0
43	1987	S	small	2	1	1	1.3	5
44	1991	S	small	1	1	1	1.0	9
45	1991	S	small	1	1	1	1.0	9
46	1982	S	small	1	2	1	1.3	0
47	1992	S	master	2	1.4	1.3	1.6	10
48	1995	S	small	1	1	1	1.0	13
49	1995	S	small	1	1	1	1.0	13
50	1966	DPS	master	4	1.5	1.3	2.3	0

Legend:

CAN: "Can" type lift station

DPS: Dry-pit submersible type lift station

S: Submersible pump in wet well type lift station

2. Master and Sub-Master Lift Stations

RBUD considers the following five lift stations (LS) as master or sub-master lift stations:

- LS 50 - Master
- LS 47 - Master
- LS 1A - Sub-master
- LS 10 - Sub-master
- LS 12 - Sub-master

LS 50 and 47 are the primary master lift stations and all flow in the CRBUD service area is designed to be repumped by one of these stations. LS 10 repumps all flow from Singer Island to LS 1A where it is repumped with other flows from the eastern part of the CRBUD service area to LS50. LS 12 is considered a sub-master lift station and repumps flows within its service area to LS 50.

A summary of the observed conditions and recommended improvements for each master lift station is discussed below.

2.1 Lift Station 50

Lift Station 50 is the primary eastern master lift station and all equipment with the exception of a new discharge magnetic flow meter has passed the end of its estimated useful life. LS 50 essentially is designed to repump all flow east of the C17 canal, although some flows east of the C17 canal can be redirected to LS 47. This lift station is one of only two stations in the system whose condition was judged to be failing (score=1) as evidenced by recent bypass pumping of the wet well. Currently, CRBUD is redirecting all the flow possible to LS 47 and having LS 1A pump directly to the ECRWRF instead of into LS 50. This is the most critical repair and replacement (R&R) need in RBUD's wastewater service area. CRBUD is aware of this criticality and has recently completed a preliminary design report, titled *Wastewater Lift Station No. 50 Improvements Project* dated April 2011, for the replacement of LS 50 with a large submersible lift station.

2.1.1 Observed Conditions

Mechanical: The mechanical inspection revealed only two of the four pumps are still present in the station, and the remaining two pumps (Pumps No. 3 and 4) appeared in extremely poor condition. Pump No. 4 was running during the inspection and was observed to be leaking wastewater from the volute. Additionally, the discharge check valve also appeared to be leaking. Extreme corrosion was observed on the pumps and corrosion was evident on the valves, piping, and walkways. The three 30-inch influent pipes and valves connecting the original wet well to the current wet well appeared functional with the gate valves showing some corrosion. The discharge piping and valve assembly are in varying condition with severe corrosion evident on the piping in Bypass Valve Vault while piping is in good condition in the Magnetic Flow Meter Vault. It appears that the original venturi flow meter was removed to allow for the connection of a bypass tee in the Bypass Valve Vault with a new valve vault and magnetic flow meter installed for the monitoring of flow in the Magnetic Flow Meter Vault. The lift station also has odor issues with a non-functional odor control system. The connection of the washdown area drains directly to the original wet well and is reported to generate odor issues. The station appears to have originally had a biological odor control system that has been replaced with non-impregnated carbon media that was disconnected at time of site visit. Severe odor was noticeable in the odor control area and it is likely that the carbon media is exhausted and the current odor control system (Heyward Model HI750) has failed.

Structural: The structural inspection found the Bypass and Magnetic Flow Meter Vaults to be in fair condition. The ground floor of the pump building was observed to be in fair condition with some corrosion noted on the roof flashing (although the roof was not inspected) and paint peeling on portions of the walls and on some doors. Some windows were damaged and covered with plywood while some of the louvers on doors were corroded. In the dry pit corrosion was evident on the walls, floor, stairs, handrails, and walkways. Roof hatches were only observed to have minor corrosion. Internal damage of the floor coatings and general wall paint was also noted in the dry pit with potential water damage on ceiling sited as possibly being an issue.

Electrical / Instrumentation: The electrical inspection found that the local control panels require significant maintenance. Variable frequency drives (VFD) enclosures were gutted and are now being used for two soft starters. The pump controller was also gutted with the Panel board, transfer switch, and MCC found to be in fair condition. Both the bubbler (wet well level indication) and the SCADA system (TAC II DFS) were found to be in functional condition. The existing transformers also appear to be in poor condition.

2.1.2 Recommendations

It is recommended that this lift station be replaced as soon as possible. Due to the criticality of LS 50 it also recommended that CRBUD make provisions for interim pumping at the existing station should the remaining pumps fail before the construction of the replacement lift station is complete.

2.2 Lift Station 47

Lift Station 47 is the primary western master lift station and is designed to repump all flow west of the C17 canal, although some flows west of the C17 canal can be redirected to LS 50. This lift station's condition was judged to be require significant maintenance (score=3) and was observed to have design deficiencies as described below.

2.2.1 Observed Conditions

Mechanical: The mechanical inspection found that the submersible pumps appear to be in functional condition but that one pump is smaller than the other two, counter to the original design documents, and that none of the three submersible pump motors are submerged likely causing issues for the cooling of the motors. The pump station has a severe grease issue with a thick floatable grease blanket evident throughout. The wet well has a large surface area while being very shallow which provides for dead zones that promote the accumulation of solids and grease leading to odor issues. Additionally, the design of the wet well appears to be the reason for the lack of submergence of the submersible pump motors. If the water level is raised to submerge the motors the water level is close to the top of the wet well and also is at the level of the discharge pipe which, apparently not being installed as a sealed wall pipe, reportedly leaks wastewater into the discharge valve vaults. All discharge check and isolation valves are extremely corroded and Check Valve No. 2 has failed and is leaking. Staff reports that spare parts can no longer be found for this check valve and thus they are unable to repair it. The discharge valve vaults are too small and do not provide sufficient access for the maintenance of the valves. Additionally, none of the discharge valves have valve supports nor were any dismantling couplings provided; coupled with the size of the valve vault this provides for a safety hazard for the maintenance crew and is likely an impediment to the proper maintenance of the discharge valves. The Magnetic Flow Meter Vault hatch does not provide sufficient clearance for removal of the flow meter and the discharge magnetic flow meter flange is installed too closed to wall. Dismantling will be an issue, especially without the presence of a dismantling coupling. The station appears to have originally had a biological odor control system and has been replaced with non-impregnated carbon media. Severe odor was noticeable in the odor control area and it is likely that the carbon media is exhausted and the current odor control system (Heyward Model HI750) has failed.

Structural: The structural inspection found the control building exterior with the windows, doors, and louvers to be in fair condition. The fence enclosing the site was also found to be in fair condition along with the building roof (although not inspected in detail). The chemical room has signs of corrosion and paint peeling. The valve vault was dirty but the coating appeared to be intact.

Electrical / Instrumentation: The electrical/instrumentation inspection found that the local control panels had minor defects and deficiencies requiring significant maintenance. Instrumentation including the bubbler, ultrasonic flow meter, and SCADA system were all found to be in functional condition.

Design issues appear to exist with the control and backup power capability of the station. Staff reported that Pumps No. 1 and 2 are controlled by the water level in the wet well as measured by the bubbler and Pump No. 3 is controlled by the water level in the wet well as measured by floats with the signal hardwired to the local control panel of Pump No. 3. Pump No. 3 is provided as the sole backup pump (although smaller than the first two pumps) and when energized at a high-high water level is reported to switch the lead pump off; thus if the two larger pumps (Pump No. 1 and 2) are running and the water level in the wet well continues to rise, the smaller pump (Pump No. 3) turns off a larger pump when energized and the water level will continue to rise at a slightly faster rate. This control methodology may be flawed. Also it is reported by staff that the emergency generator can only provide backup power for a single pump. The original design shows a triplex station (two design pumps with a third pump as backup). The generator should be able to provide power for at least the two largest pumps running.

2.2.2 Recommendations

It is recommended that this lift station have a detailed design evaluation performed to ascertain alternatives to provide for better operation using the existing station's configuration. This evaluation should also include alternatives for the redesign of the lift station to eliminate the limitations imposed by the existing wet well configuration. The odor control system should also be evaluated to select a suitable odor control system. The discharge check valves and isolation valves should be immediately replaced and the valve vaults enlarged to accommodate proper maintenance of the valves.

2.3 Lift Station 1A

Lift Station 1A is the newest master lift station in CRBUD's service area (constructed in 2004) and overall is in good condition. LS 1A is designed to repump all flow on Singer Island from LS 10 and flows from the surrounding eastern portion of the service area to LS 50.

2.3.1 Observed Conditions

Mechanical: The mechanical inspection found that the dry-pit submersible pumps were in like-new condition.

The station has two carbon media odor control systems (Heyward Model HI750), one for each wet well. The second odor control system is reported to be located in the wet well room of the pump building but could not be inspected due to hazardous space entry concerns. However, severe corrosion was noted at the entrance to the wet well room as an apparent result of wastewater gases from the wet well that do not appear to be treated by the odor control system.

Structural: The structural inspection found the discharge valve vault and the dry-pit room to be in good condition while the wet well was not inspected. The fence surrounding the station was in good condition.

Electrical / Instrumentation: The electrical/instrumentation inspection found all the equipment to be in functional condition.

2.3.2 Recommendations

It is recommended that the odor control system for this lift station be evaluated to select a suitable odor control system.

2.4 Lift Station 10

Lift Station 10 is the primary master lift station for Singer Island and is designed to repump all flow on Singer Island to LS 1A through a 16 inch force main that crosses the intracoastal waterway. This is the oldest master lift station in CRBUD's service area and is at the end of its useful life.

2.4.1 Observed Conditions

Mechanical: The mechanical inspection found that the station was in aged condition. The submersible pumps were not visible but reportedly are in functional condition and require above average maintenance. All discharge check and isolation valves are corroded. The discharge valve vaults have no dismantling couplings but provide sufficient access for the maintenance of the valves. Additionally, none of the discharge valves have valve supports. The station has carbon media odor control system (Heyward Model HI750) and at the time of inspection odor was not noticeable and the system appeared functional.

Structural: The structural inspection found the discharge valve vault to be in functional condition while minor deficiencies were noted with the wet well. The wet well is located adjacent to a seawall and differential settlement was evident on the west side. Cracks were apparent in the top slab of the wet well as well as the interior wall that may allow for infiltration of the groundwater. The interior coating of the wet well is damaged and some erosion was apparent. Staff reported infiltration of ground water into the wet well near the wall penetration of the 16-inch force-main on the east wall of the wet well and below the operating water level in the wet well on the west wall (reported when they pump the water level down). The fence surrounding the station was in good condition.

Electrical / Instrumentation: The electrical/instrumentation inspection found all the equipment to be in functional condition.

2.4.2 Recommendations

A preliminary design report titled *Wastewater Lift Station No. 10 Improvements Project*, dated April 2011 was prepared for the lift station and recommended the complete replacement of the station with a new duplex submersible pump station with a new biological odor control system and generator.

2.5 Lift Station 12

Lift Station 12 is considered to be a sub-master lift station. The lift station receives gravity flows from the surrounding area and serves to repump flows to LS50.

2.5.1 Observed Conditions

Mechanical: The mechanical inspection found that the station was in aged condition. The submersible pumps were not visible but reportedly are in functional condition. Discharge Check Valve No. 1 has failed and is currently being bypassed while Check Valve No. 2 appears in poor condition (Picture A.1.1-21). The isolation valves appear to be in functional condition. The discharge valve vaults have no dismantling couplings but provide sufficient access for the maintenance of the valves. Additionally, none of the discharge valves have valve supports. Piping and valves for bypass pumping were present and appeared to be in functional condition. Odor was noticeable at the site and no odor control is present; however, Staff reported odor complaints are not received concerning LS 12. The station has a large wet well that likely contributes to the noticeable odor at the station.

Structural: The structural inspection found the wet well to have some minor damage to the coating but was in fair condition as was the discharge valve vault. The fence surrounding the station was in fair condition.

Electrical / Instrumentation: The electrical/instrumentation inspection found all the equipment to be aged but in functional condition with the exception of the level probes which had failed due to rodents. At the time of inspection the station was controlled from floats while the probes are repaired.

2.5.2 Recommendations

It is recommended that the discharge valves be replaced immediately and the addition of an odor control system be evaluated (i.e. non-impregnated carbon media).

2.6 Master Lift Station Recommendation Summary

This section summarizes the above recommendations as follows:

- Lift Station 1A
  - Conduct an odor study
  - Rehabilitate the lift station in the next 20 years
- Lift Station 10
  - Replace lift station and wet well as soon as possible
- Lift Station 12
  - Conduct an odor study
  - Replace discharge check valves and isolation valves as soon as possible
  - Rehabilitate the lift station in the next 20 years
- Lift Station 47
  - Rehabilitate the lift station in the next 15 years
  - Perform study to assess operational issues with pumps, historical overflows and configuration of the existing wet well
- Lift Station 50
  - Replace lift station and wet well as soon as possible

3. Medium Lift Stations

CRBUD has 18 lift stations that are neither master nor sub-master stations but have a motor horsepower greater than or equal to 15hp; these lift stations are categorized as "medium" lift stations.

All medium lift stations are wet well submersible duplex stations with the exception of LS 19 which is a Smith & Loveless dry can station. Pump manufacturers include Flygt, Homa, Davis EMU, Ebara, Fairbanks Morse, and Smith and Loveless in order of numerical precedence. CRBUD has expressed a desire to standardize on wet well submersible lift stations with Flygt pumps. CRBUD staff indicated that its experience with Flygt pumps is that the pumps are easy to work on and parts have been readily available.

Of the 18 medium stations four (LS 3, 4,5, 7 and 23) have been rehabilitated or replaced within the last 10 years per CRBUD's desired standard. The remaining medium lift stations are not standardized and the equipment is nearing or has past the end of its estimated useful life.

Three medium lift stations (LS 17, LS 25, and LS 26) were observed to have failed or have significant deficiencies. These lift station are discussed below.

3.1 Lift Station 17

LS 17 is a non standard duplex submersible pump station that requires immediate replacement and redesign. Staff has reported this station to be the number one priority for replacement outside LS 50 and LS10. The station's pumps appear to not meet the operational hydraulic conditions. Additionally, CRBUD staff reported that an "electrical issue" that can disable pumping at LS 50. The CRBUD reported multiple failures of equipment.

3.1.1 Observed Conditions

Mechanical: A hole has been drilled into the discharge pipe to induce headloss and keep the pumps from "running off the curve" and cavitating. Additionally no pump rails exist for extraction of the pumps and the staff must enter through a very small manway and lift the pumps out of the wet well for maintenance. It appears that the station might have originally been a dry can station with the submersible pumps now placed directly in the wet well, piping brought above ground, and no signs of a dry-pit can visible. Multiple repair clamps were observed on the discharge pipe within the wet well and above ground. Additionally, PVC pipe has been utilized above ground where it is more prone to failure with exposure to the sun. Severe corrosion was observed on the discharge isolation and check valves.

Structural: The structural inspection found the wet well to have some minor damage to the coating but was in functional condition. Corrosion was also evident on the access ladder in the wet well. The fence surrounding the station was in fair condition.

Electrical / Instrumentation: The electrical/instrumentation inspection found all the equipment to be aged but in functional condition.

3.1.2 Recommendations

It is recommended that this lift station and wet well be replaced as soon as possible.

3.2 Lift Station 26

LS 26 is a duplex submersible pump station. The station has accessibility issues being located in an easement between a golf course and single family homes with maintenance access possible only by traversing private property. The CRBUD reported multiple failures of equipment.

3.2.1 Observed Conditions

Mechanical: The discharge pipe is severely corroded with multiple repair clamps observed on the discharge pipe within the wet well. The discharge piping and valves have been heavily painted with signs of corrosion evident through the bubbling of paint. Piping is above ground but no pipe or valve supports were provided with bricks being used as makeshift supports.

Structural: Corrosion was apparent on the wet well walls and access hatches but deemed functional. Cracks were visible on the wet well top slab. Corrosion was evident on the fence surrounding the station.

Electrical / Instrumentation: The electrical/instrumentation inspection found all the equipment to be aged but in functional condition.

3.2.2 Recommendations

This lift station and wet well are recommended for replacement as soon as possible. Prepare a study to assess the feasibility of relocating the lift station.

3.3 Lift Station 25

LS 25 is a duplex submersible lift station with a design flow of 1000 gpm.

3.3.1 Observed Conditions

Mechanical: One pump has failed and the other is reported by CRBUD staff to be in poor condition. The discharge pipe is heavily painted with signs of corrosion showing through peeling paint. Corrosion was observed on the discharge isolation and check valves. One check has failed with the bottom almost completely rusted through.

Structural: The structural components appear to be in functional condition with some signs of corrosion present on the wet well walls and access hatches. Some corrosion was also evident on the fence surrounding the station.

Electrical / Instrumentation: The electrical/instrumentation inspection found all the equipment to be aged but in functional condition.

3.3.2 Recommendations

It is recommended that this lift station be rehabilitated as soon as possible.

3.4 Medium Lift Station Recommendation Summary

It is recommended that the lift station and wet well be replaced as soon as possible at the following locations:

- Lift station 17
- Lift station 19 (additionally convert can station to submersible station)

- Lift station 26

It is recommended that the following lift station be rehabilitated as soon as possible:

- Lift station 25

It is recommended that the following lift stations be rehabilitated within the next 5 to 10 years:

- Lift station 2
- Lift station 18
- Lift station 20
- Lift station 21
- Lift station 36
- Lift station 37
- Lift station 40
- Lift station 41

It is recommended that the following lift stations be rehabilitated within the next 15 years:

- Lift station 3
- Lift station 4
- Lift station 5
- Lift station 7
- Lift station 15
- Lift station 23

For the purpose of this Master Plan, lift station rehabilitation is assumed to include the following:

- Replace pumps, motors, and electrical panels;
- Replace local control panels, field instruments, radio, antenna, antenna mast;
- Replace valve vaults with new precast concrete vault, hatch, piping, and valves;
- Replace piping within the wet well;
- Replace piping between wet well and the valve vault;
- Replace fencing around the station; and
- Clean, repair, and coat interior surface of existing wet well.

In advance of initiating a detailed design of the above recommended improvements, a preliminary design report is recommended to refine the rehabilitation scope along with evaluating and selecting pumps that are suitable for the hydraulic design conditions for a particular station.

4. Small Lift Stations

CRBUD has 28 lift stations with motors less than 15 horsepower; these lift stations are categorized as “small” lift stations.

Small pump stations include wet well submersible duplex stations, dry can stations, and two small onsite submersible pump stations at the water treatment plant. Pump manufacturers include Flygt, Smith and Loveless, KSB, Homa, Reliance, Scan, Fairbanks Morse, Gorman Rupp, and Enpo Cornell in order of numerical precedence. CRBUD has expressed a desire to standardize on Flygt as pump manufacturer due to its quality and number of existing pumps in the service area.

LS6, LS11, LS13, LS14 and LS16 are existing small dry can type stations. The CRBUD staff indicated a preference to replace the existing dry can stations with submersible stations.

The small submersible and dry can lift stations share similar issues and are discussed as groups below. LS33 is discussed in a separate section below due to a reported capacity issue.

4.1 Small Submersible Lift Stations

The variability of submersible lift station configurations makes maintenance difficult and combined with the age contributes to the issues noted in site investigations. Issues include safety concerns, design issues, and severe corrosion. These issues are represented with a couple of examples from particular small submersible lift stations below.
LS9 is clearly aged and in poor condition and serves as an example of excessive hatch weight and possible rodent infestation. LS9 has a solid iron wet well hatch cover that is heavy and is a concern for the injury of staff. The current condition of LS9 likely leads to an environment more suitable to nuisance inhabitation; rodent infestation was evident and control wires are reportedly in need of replacement every two months.

LS28 is also in poor condition and represents a common design issue of undersized discharge valve vaults. The valve vault wall has been chipped away to allow room for the manifold of the discharge pipes, even with valves that are attached flange to flange without any disconnection couplings (another common issue for lift stations of all sizes). This provides for extremely difficult maintenance of valves and is likely a deterrent to proper maintenance.

LS39 serves as an example of severe corrosion of the discharge piping and valves that likely has rendered the valves inoperable and provides a deterrent to maintenance. Additionally, severe corrosion is evident on the discharge pipes and represent piping integrity concerns. Sever corrosion was also observed at the valve vault hatches at LS31. LS31 also exemplifies the corrosion of existing electrical panels to the point where electrical elements are no longer properly protected and prone to failure.

4.2 Small Dry Can Lift Stations

LS6, LS11, LS13, LS14 and LS16 are existing small dry can type stations and are standardized Smith & Loveless lift stations. LS6 is currently being replaced by LS6A at a new location. LS6A will be a submersible type station. The CRBUD anticipate LS6A going into service in late 2012 / early 2013.

Three out of the five small dry can stations were found to be in less than functional condition (score of < 4) and none were found to have been rehabilitated or constructed within the last 15 years. The standardization of the dry can lift stations seems to have benefitted maintenance, with the stations well maintained considering their age (the majority constructed in the 1960s).

The integrity of the dry pit can has failed at LS6 and LS16; the stations were inaccessible due to water in the dry pit. It was unclear whether the water was due to rainwater intrusion from hatch, leakage from wet well into drywell, or a combination of both.

All of the existing small dry can type stations had non-functional fans. Corrosion was evident in the dry-pit cans but in general the lift stations seemed in reasonable condition.

4.3 Lift Station 33

The CRBUD staff noted that LS33 has excessive pump run times. It is noted that the wastewater transmission system hydraulic model indicates that LS33 runs for about 4 hours per day under current conditions. Pump on/off status data for LS33 was obtained from the CRBUD's Data Flow System. The data indicated that the average run time for LS33 was about 3.6 hours per day during April 2012. These data appear to correlate with the output of the model relative to run time. Hence, the CRBUD staff's opinion that the run time for LS 33 is excessive should be investigated further. The CRBUD staff also reported pump starts greater than 200 per day. The CRBUD's Data Flow System indicated that there was an average of about 90 starts per day during April 2012. The high starts per day may be caused by improper setting of the pump start and stop set points.

This station was scheduled for relocation and replacement in 2010 with a new station; that project was canceled by the CRBUD. Due to the age and condition of this lift station, it is recommended that LS33 replaced within the next 5 years.

4.4 Small Lift Station Recommendation Summary

It is recommended that the following can type lift stations and wet wells be replaced with submersible type lift stations within the next 10 years:

- Lift station 6
- Lift station 11
- Lift station 13
- Lift station 14
- Lift station 16

It is recommended that the following lift stations be rehabilitated within the next 5 years:

- Lift station 27
- Lift station 28
- Lift station 30
- Lift station 31
- Lift station 32

- Lift station 34
- Lift station 35

It is recommended that the following lift stations be rehabilitated within the next 10 years:

- Lift station 9
- Lift station 24
- Lift station 29
- Lift station 33
- Lift station 38
- Lift station 39
- Lift station 42A
- Lift station 42B
- Lift station 43

It is recommended that the following lift stations be rehabilitated within the next 15 to 20 years:

- Lift station 8
- Lift station 22
- Lift station 44
- Lift station 45
- Lift station 46
- Lift station 48
- Lift station 49

For the purpose of this Master Plan, lift station rehabilitation is assumed to include the following:

- Replace pumps, motors, and electrical panels;
- Replace local control panels, field instruments, radio, antenna, antenna mast;
- Replace valve vaults with new precast concrete vault, hatch, piping, and valves;
- Replace piping within the wet well;
- Replace piping between wet well and the valve vault;
- Replace fencing around the station; and
- Clean, repair, and coat interior surface of existing wet well.

In advance of initiating a detailed design of the above recommended improvements, a preliminary design report is recommended to refine the rehabilitation scope along with evaluating and selecting pumps that are suitable for the hydraulic design conditions for a particular station.