Brown AND Caldwell

Albuquerque Bernalillo County
Water Utility Authority

Southside Water Reclamation Plant Rehabilitation and Asset Management Plan

May 2010

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

30DMA	30-day moving average
AACE	Association for the Advancement of Cost Engineering International
AAF	annual average flow
AM	asset management
ASPS	Activated Sluge Pump Station
BC	Brown and Caldwell
BCE	business case evaluation
DAF	Dissolved Air Flotation
E&IC	electrical, instrumentation and control
EPA	Environmental Protection Agency
EWW	existing washwater system
FIS	feeder isolation switch
fps	feet per second
gpd	gallons per day
gpm	gallons per minute
GSS	Generator Switching Station
HDPE	high-density polyethylene
HEX	heat exchange
Hp	horsepower
HRT	hydraulic retention time
IMLR	internal mixed liquor recyce
I/O	input/output
kcf	kilo cubic feet
kW	kilowatt
LSG	low pressure sludge gas
MCRT	mean cell residence time
MG	million gallons
mgd	million gallons per day
MLE	Modified Ludzack-Ettinger
MMF	maximum month flow
MTBF	mean time between failures
NFPA	National Fire Protection Association
NG	natural gas
NMED	New Mexico Environment Department
NRF	Nitrogen Removal Facilitites
OF	overflow
O&M	operation and maintenance
PCU	power control unit
PDF	peak day flow
PHF	peak hourly flow
PIF	peak instantaneous flow
PPE	personal protective equipment
PVRV	pressure vacuum relief valve
RAS	return activated sludge
RRAMP	Reclamation Rehabilitation and Asset Management Plan
RUL	remaining useful life
SLR	solids loading rate
SOR	surface oveflow rate
SST	stainless steel
SWRP	Southside Water Reclamation Plant
TIN	total inorganic nitrogen
TPAD	temperature-phase anaerobic digestion
TWAS	thickened waste activated sludge
UV	ultraviolet
UWAS	unthickened waste activated sludge
VFD	variable frequency drive
VS	volatile solids
VSS	volatile suspended solids
WAS	waste activated sludge
WUA	Water Utility Authority

EXECUTIVE SUMMARY

This executive summary provides an overview of the Southside Water Reclamation Plant's (SWRP) Reclamation Rehabilitation and Asset Management Plan (RRAMP). Many of the SWRP's assets have reached or are near the end of their useful life. Facilities and equipment are in poor condition and have reached their capacity limits, and in parts of the plant the safety of the staff is of concern due to these conditions. Some of the facilities are so deteriorated and failed that they are negatively affecting the plant's performance and damaging downstream systems. Project improvements to address these issues have been developed based on asset management techniques and with input from the Albuquerque Bernalillo County Water Utility Authority (WUA). The overall goal of this RRAMP is to provide a path forward for the rehabilitation of the SWRP such that it performs reliably and safely over the next 20 years.

The SWRP is the largest wastewater plant in New Mexico and it currently serves over five hundred thousand people in the Albuquerque and Bernalillo County area. The SWRP was built in the 1960s with numerous facility upgrades throughout the years. The plant is rated for a maximum monthly flow (MMF) of 76 million gallons per day (mgd) and currently treats approximately 58 mgd on a MMF basis. The SWRP employs the following treatment processes:

- Preliminary Treatment – Screening, grit removal, and grit dewatering,
- Primary Clarification – Also used for primary sludge thickening in past,
- Activated Sludge – Modified Ludzack-Ettinger (MLE) activated sludge basins,
- Final Clarification,
- Disinfection – Gaseous chlorine (to be replaced with UV in 2010),
- Reuse – Pressure filtration,
- Dissolved Air Flotation (DAF) Thickening – WAS only thickening,
- Anaerobic Digestion – Primary and Secondary Digesters,
- Sludge Dewatering – Centrifuges,
- Cogeneration.

Due to the corrosive nature of wastewater and the surrounding atmosphere, wastewater plant structures and especially the mechanical and electrical equipment at these plants have a typical life-span of 30 years at best. The last major upgrade at the SWRP was the Nitrogen Removal Facilities (NRF) project in 1998 with additional upgrades at the grit removal and sludge dewatering facilities in 1997. Since these improvements, the SWRP has repaired and replaced equipment as needed to prolong the life of the existing facilities. Despite this effort, some systems like the vortex grit removal system in the Preliminary Treatment Facility have failed and need to be replaced or redesigned to be reliable and perform as intended. While some of the plant's equipment is newer than 30 years as a result of maintenance and replacement activities, the vast majority of the plant's structures, mechanical equipment and electrical gear is 30 years of age and has reached the end of its useful life. While the SWRP maintenance staff has done a commendable job at this facility, the demands of increasingly failing equipment due to their age and condition are simply overwhelming what the staff and their limited budget can do.

ES.1 Project Background

The WUA is fully aware of the need to immediately begin implementing a plan to rehabilitate the SWRP. The purpose of the RRAMP is to develop a plan that will map out the necessary steps to achieve this rehabilitation. The objective for this rehabilitation plan or vision is to provide a facility that will:

- Meet permit requirements and conditions stipulated by the regulatory agencies
- Ensure a safe working environment for the SWRP staff
- Create positive public perception by being a good neighbor (minimizes odors, noise and is aesthetically pleasing)
- Function properly and efficiently in which the WUA can take pride in operating and maintaining.

The RRAMP began with the Brown and Caldwell (BC) staff meeting the SWRP's management, maintenance, and operations staff during three informal meetings from May to September of 2009. In Workshop 1, BC staff obtained historical and conditional information on the plant processes and assets during process area meetings with the WUA staff and toured the SWRP facilities. With the data and information collected from Workshop 1, BC began the capacity evaluation and asset management tasks. In an interim workshop with the WUA staff in Denver, the BC team presented the results from the BioWin™ modeling, hydraulic review and digester evaluation, and began the process of developing improvement projects. During Workshop 2, BC and WUA staff prioritized the recommended projects. The WUA's perspective, feedback, and guidance in these meeting helped to chart the course for the recommended projects described in this RRAMP. All the SWRP process facilities with exception to disinfection were evaluated as part of this RRAMP.

ES.2 Capacity Evaluation Results

A capacity evaluation was performed on each process area to determine if the existing facility can treat to the SWRP rated capacity of 76 million gallons per day. The capacity of the SWRP's process systems were evaluated with BioWin™ modeling or using conventional methods. Each process area chapter within this RRAMP includes details and assumptions that provided the basis for the capacity evaluation. An equivalent influent maximum month flow was calculated for the liquid and solids stream processes. The capacity results for both the liquid and solids streams are provided in Figures ES-1 and ES-2 respectively.

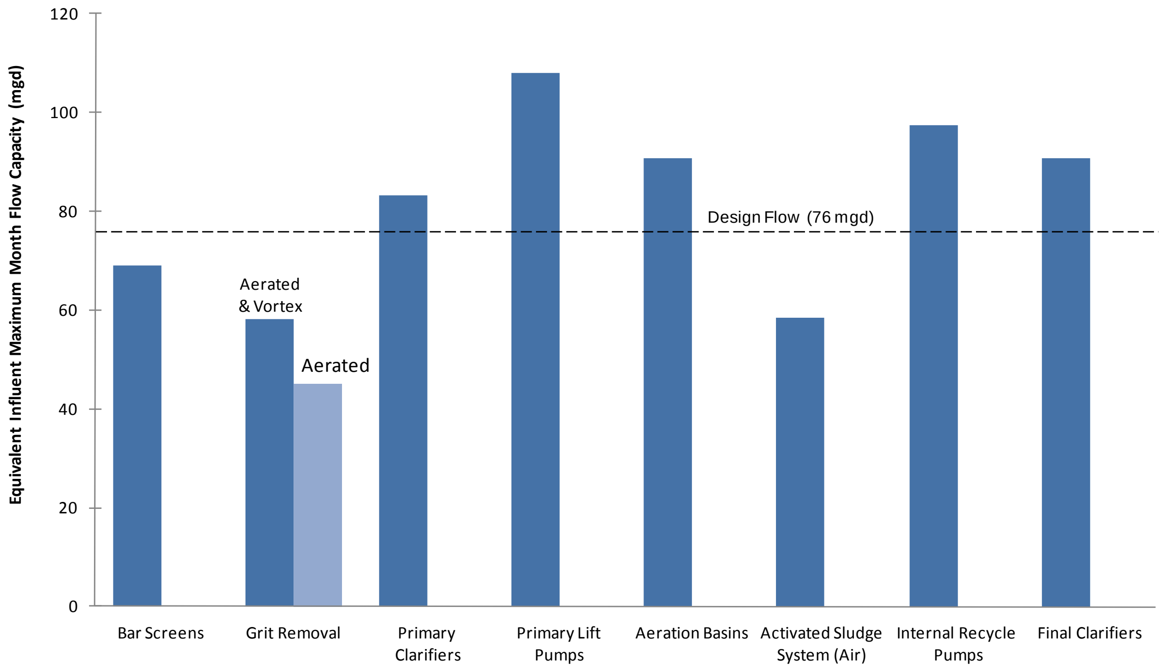

Figure ES-1. Liquid Stream Capacity Results

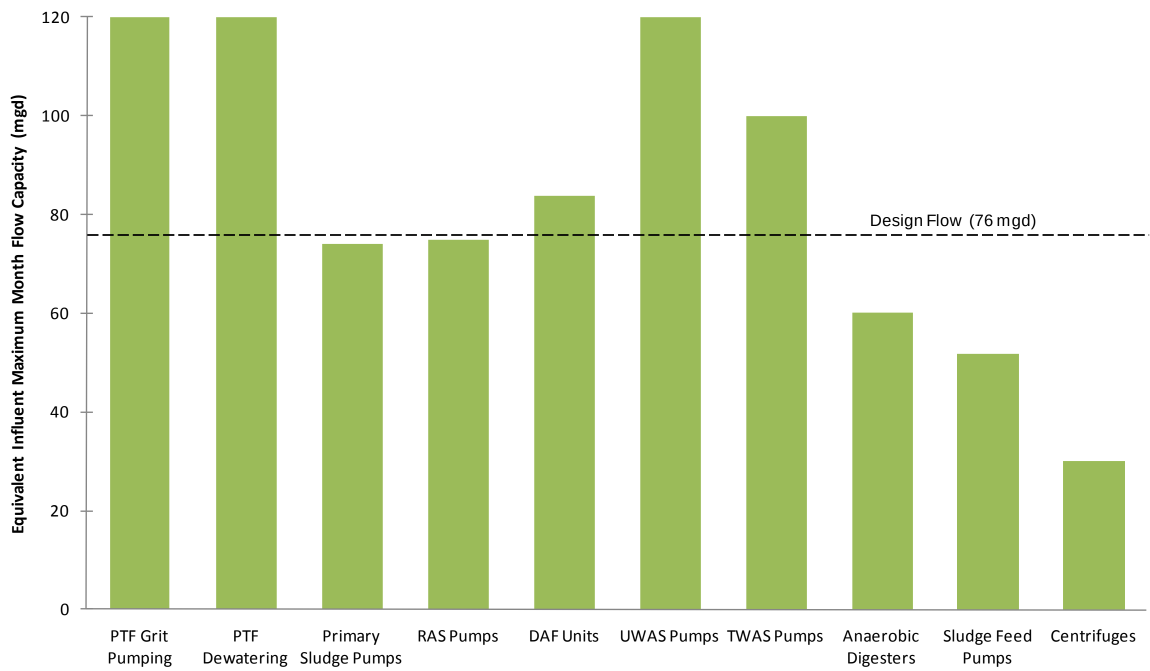

Figure ES-2. Solids Stream Capacity Results

The activated sludge system capacity, shown on Figure ES-1, is limited because there is a lack of adequate blower capacity to meet the most stringent total inorganic requirements at design flow conditions. However, the aeration basins do have adequate capacity despite the blower deficiency. The grit removal systems include both the aerated and vortex equipment and would appear to have adequate capacity; however, only the aerated system is currently functional and it cannot meet the peak flow capacity as shown in Figure ES-1. As presented in Figures ES-1 and ES-2 the following major process systems have capacity deficiencies:

- Bar Screens,
- Grit Removal System,
- Primary Sludge Pumps,
- Aeration Blowers,
- Anaerobic Digester Systems, and
- Sludge Dewatering Systems.

In addition to the above noted systems, the RAS pumps are just under capacity and an additional pump is recommended to provide the recommended level of redundancy for the system.

ES.3 Asset Assessment

The first step in developing a list of recommended projects was to conduct an assessment of the plant's assets and to evaluate those results in terms of overall risk. The BC/WUA team used a modified Water Environment Research Foundation (WERF) Sustainable Infrastructure Management Program Learning Environment (SIMPLE) approach to asset management based on "triple bottom line" criteria for municipal services as applied to the SWRP. SIMPLE is web-based knowledge management tool built around an extensive collection of asset management best practices and tools and was developed by WERF. It provides users an in-depth understanding of asset management for wastewater facilities and is especially useful for facilities interested in starting an asset management program of their own.

Each asset was evaluated in terms of probability of failure, consequence of failure, and redundancy. Using this information, a total risk score was then calculated for each asset. The risk score was used to determine the asset's priority for replacement with a high risk score indicating that the asset is a high priority or critical for replacement. The highest priority assets are shown below in Table ES-1.

Table ES-1. High Priority Assets

Risk Score	Process Area	Asset Classification	Asset
18.2	Anaerobic Digesters	AD 1-8 Digester System & AD Sludge Blending	Primary Digester Covers/Gas/OF systems
18.2	Anaerobic Digesters	AD 9-14 Structures	Primary Digester Covers/Gas/OF systems
18.2	Preliminary Treatment	Vortex Grit System - Pista Grit	Vortex Grit Chamber
17.9	Preliminary Treatment	Screening	Barscreens
17.7	Electrical Distribution System	Critical Power Systems	Critical Power Systems
17.6	Final Clarifiers	Other Assets	Algae Removal
17.5	Preliminary Treatment	EI&C	Power
17.5	Aeration Basins/ Blower Bldgs/Lift Pumps/Activated Pump Station	South Aeration System	Blowers
17.2	Preliminary Treatment	Vortex Grit System - Pista Grit	Pumps
16.3	Anaerobic Digesters	AD 1-8 Digester System & AD Sludge Blending	Primary Digesters

ES.4 Project Summaries

Upon completing the asset inventory and risk score and in conjunction with the WUA, projects were then developed based on these critical assets and engineering logic. A complete list of the recommended projects is provided in Chapter 13. This table is organized by process area beginning with the Preliminary Treatment Facility. Miscellaneous plant projects are presented at the end of the table. Included in this table is a brief description of each of the recommended projects.

ES.5 Project Prioritization

Projects were initially developed based on individual asset risk scores, engineering logic, and collaboration with the WUA. During Workshop 2, BC and WUA staff discussed the initial project list and reprioritized the projects. The project descriptions were finalized during these discussions and conceptual construction cost estimates were then generated by BC. An average project risk score was calculated for each project based on the assets related to the project description. The prioritized list was again reorganized based on the review of the cost estimates and WUA's cash flow schedule and prioritizing input from the WUA. The final prioritized list of projects with average project risk scores and costs is presented in Table ES-2.

A project risk scoring system was developed and details are explained in the RRAMP. Projects were prioritized in three categories: a score greater than 12 is considered a high priority, a score between 8 and 12 is considered moderate priority, and a score less than 8 is considered a low priority and miscellaneous projects were not scored and given the lowest priority. Some low or moderate projects for the anaerobic digesters and primary clarifiers were incorporated with higher priority projects since they will be included during the overall process area projects. The total project cost includes design, construction management, and construction costs.

Table ES-2. Prioritized List of Recommended Projects				
Priority	Project Number	Project Name	Risk Score	Total Project Cost
High	1.2	New PTF	17	$ 23,050,000
High	21	Final Clarifier Algae Removal System Improvements	18	$ 2,460,000
High	6.2	New SDB	12	$ 12,660,000
High	17	Aeration Basin Foam Removal System Improvements	14	$ 890,000
High	2A	Aeration Blower Improvements Phase 1- North Blower and HVAC Improvements	12	$ 5,220,000
High	3.2	Digester Capacity Improvements	16	$ 26,800,000
High	3.3	Primary Digester Mixing Improvements	16	$ 5,650,000
High	3.4	Primary Digester Covers and Rehabilitation	17	$ 14,680,000
Moderate	3.5	Secondary Digester Covers and Rehabilitation	11	$ 5,150,000
Moderate	3.6	Sludge Withdrawal Pump Improvements	11	$ 360,000
High	3.7	Digester Low Pressure Gas System Improvements	16	$ 1,200,000
High	3.8	Digester EI&C Improvements	15	$ 6,270,000
High	5.1	Plant Wide Power System Study and Upgrades	12	$ 2,880,000
High	5.2	Critical Power System Alternatives	18	$ 2,590,000
High	4.1	Digester Building Hot Water Loop Improvements	16	$ 400,000
High	4.4	Digester Piping and Valving Improvements (moved up in priority w/rehab)	10	$ 180,000
High	4.5	Digester HVAC Improvements	16	$ 1,180,000
High	4.6	Digester Feed Improvements	9	$ 330,000
High	2B	Aeration Blower Improvements Phase 2 - South Blowers and Building	15	$ 10,080,000
High	31	Lightning Protection System Upgrade	12	$ 200,000
High	7	Plant-Wide Non Potable Water System Improvements - all process areas	8	$ 1,580,000
Low	12.1	Primary Clarifier Capacity Improvements – New Clarifiers and Gravity Thickeners	7	$ 18,460,000
Moderate	12.2	Primary Clarifier Tank and Mechanism Improvements	8	$ 2,040,000
Low	12.3	Primary Clarifier Spray Water and Wash Water Improvements	6	$ 190,000
Moderate	12.4	Primary Clarifier EI&C Improvements	10	$ 4,410,000
Low	19.1	Primary Clarifier Draining Improvements	7	$ 180,000
Low	19.2	Primary Clarifier Sludge Pumping, Process Piping, and Valving Improvements	7	$ 890,000
Low	19.3	Pump House #1, #2 & #3 Improvements	3	$ 280,000

Table ES-2. Prioritized List of Recommended Projects				
Priority	Project Number	Project Name	Risk Score	Total Project Cost
Low	19.4	Primary Clarifier Odor Control Rehabilitation	7	$ 3,160,000
Low	19.5	Primary Clarifier Pump House #1, #2, #3 EI&C Improvements	7	$ 3,390,000
Low	9	Final Clarifier Improvements	6	$ 9,210,000
Low	26	DAF Tank and Mechanism Rehabilitation	3	$ 1,050,000
Low	16	DAF Comprehensive Valve/Piping Improvements	7	$ 900,000
Low	15	DAF HVAC and Foul Air Improvements	6	$ 470,000
Low	25	DAF Saturation System Improvements	6	$ 240,000
Low	24B	DAF TWAS, UWAS and Scum Pumping Improvements	3	$ 970,000
Low	13	DAF EI&C Improvements	7	$ 4,730,000
Low	28.1	Gas Sphere Improvements	6	$ 360,000
Low	28.2	South Cogen Power Improvements	5	$ 130,000
Low	28.3	North Cogen Power Improvements	4	$ 130,000
Low	28.4	Gas Holder Improvements	4	$ 870,000
Low	28.5	Digester Gas Quality Improvements	1	$ 11,190,000
Low	28.6	Fuel Gas Metering	2	$ 100,000
Low	28.7	N & S Cogen Sound Attenuation Improvements	2	$ 170,000
Low	28.8	Remove and Replace South Cogen Generators	3	$ 1,330,000
Low	29.1	Aeration Basin Miscellaneous Improvements	6	$ 570,000
Low	29.2	Spray and Wash Water System Improvements	7	$ 460,000
Low	29.3	Aeration Basin and ASPS EI&C Improvements	3	$ 830,000
Low	29.4	Diffuser Improvements	5	$ 2,420,000
Low	29.5	RAS Pump Improvements	2	$ 2,110,000
Low	27	DAF Polymer Batch and Feed System Improvements	3	$ 1,430,000
Lowest	32	Cogen Heat Recovery Utilization Improvements	-	$ 360,000
Lowest	33	Site Security	-	$ 610,000
Lowest	34	Stormwater	-	$ 260,000
Lowest	35.1	NF -1 Modify Abandoned PTF to be Warehouse Facility	-	$ 940,000
Lowest	35.2	NF -2 Modify Abandoned SDB to be Maintenance Facility	-	$ 1,250,000
Lowest	35.3	NF -3 Demo Old O&M Office Bldg and Provide New O&M Office Bldg.	-	$ 11,970,000
Lowest	36	Landscaping	-	$ 2,000,000

Table ES-2. Prioritized List of Recommended Projects				
Priority	Project Number	Project Name	Risk Score	Total Project Cost
Lowest	37	Drying Bed Demolition and Rehabilitation	-	$ 1,240,000
			Total	$ 215,110,000

ES.6 Business Case Evaluations

The objective of the business case evaluation is to provide documentation and justification of proposed capital projects, primarily for decision makers who may not know or understand the technical requirements of the facility. The basic business case process includes identification of the need or 'drivers' for the project, the problem statement, the evaluation of alternatives, and description of the recommended project. A business case evaluation (BCE) template was developed in conjunction with WUA to set a standard procedure by which the WUA will evaluate and justify the SWRP's capital improvements projects.

BCEs were completed on the first two highest priority projects that will begin immediately from the RRAMP. They are the Preliminary Treatment Facility and Sludge Dewatering Building projects. The BCEs detail the justification for the major expenditures of the WUA's first three years of budget. The WUA will continue the development of the BCE process for future capital improvement projects at the SWRP and other WUA facilities. The Preliminary Treatment Facility and Sludge Dewatering Building BCEs are provided in Chapter 15. The recommendations from these evaluations are to construct new facilities for the preliminary treatment and sludge dewatering/solids handling processes.

ES.7 Conclusions

The long term rehabilitation plan has been established from the prioritized list of projects (Table ES-2) and within the WUA's priorities and budget. This rehabilitation plan (RRAMP) summarizes the projects necessary to be completed to achieve the WUA's vision for the SWRP. This vision or objective will upgrade the facility so that it will meet permit requirements and conditions stipulated by the regulatory agencies, ensure a safe working environment for the SWRP staff, create positive public perception, function properly and efficiently, and ultimately become a facility that the staff takes great pride in.

A cash flow schedule was developed to meet the WUA's budget of approximately $42M through FY 2012 and about $15M per fiscal year The RRAMP prioritized the projects to accommodate the allotted budget. Figure ES-3 shows the fiscal year (July through June) cash flow for the recommended projects over the next eighteen years.

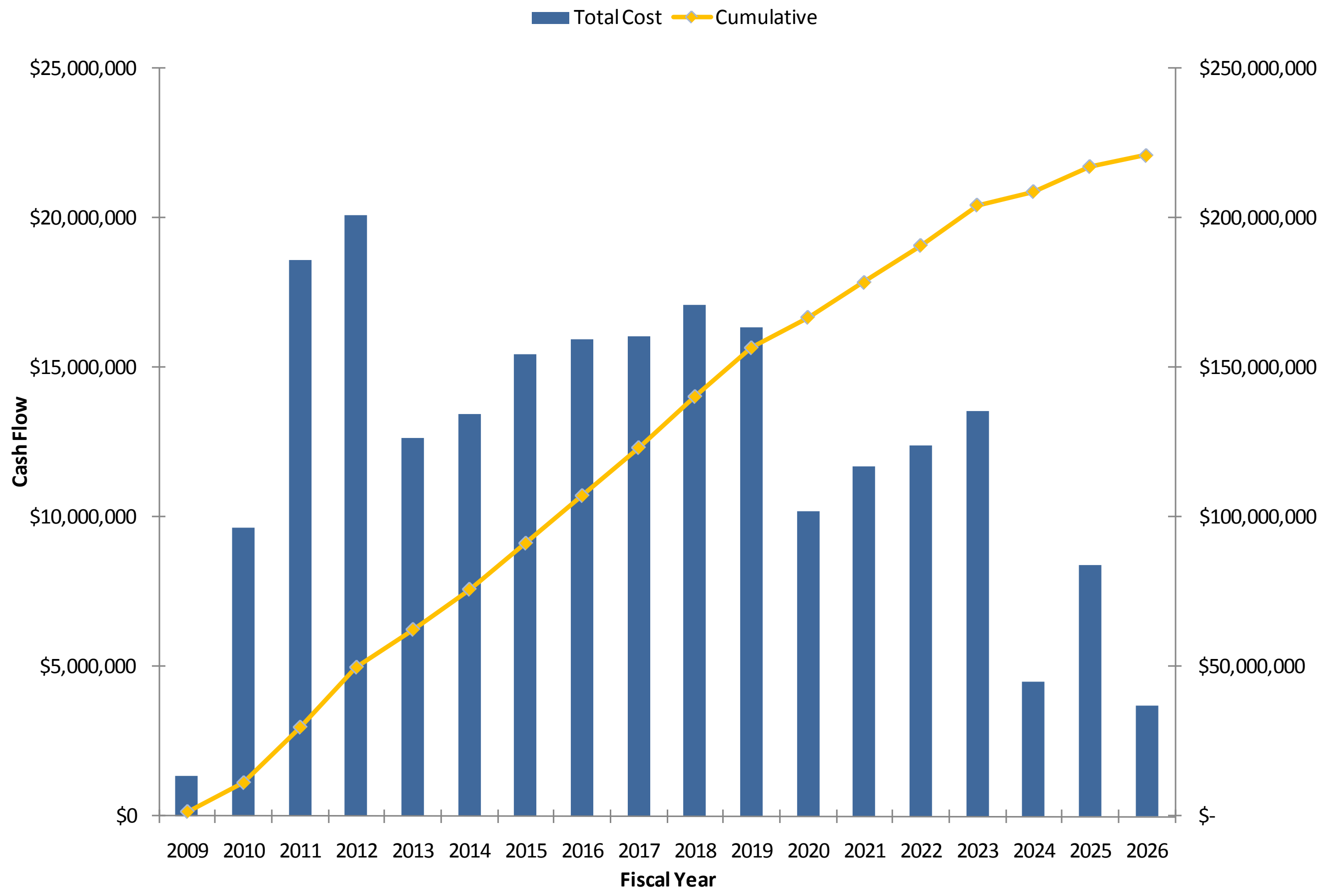

Figure ES-3. Fiscal Year and Cumulative Cash Flow

The following table details the projects for the 2010 to 2027 timeline for the RRAMP and their associated costs. The schedule also details the design, bid and construction durations for these projects. This rehabilitation plan (RRAMP) has set the direction for planning the capital improvement projects needed to ensure the WUA's vision for the SWRP can be achieved.

Table ES-3. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1.2	New PTF	$23,050,000	7/1/2010	5/1/2011	7/1/2011	9/1/2013	$1,020,000	$4,680,000	$9,600,000	$7,200,000														
21	Final Clarifier Algae Removal System Improvements	$ 2,460,000	1/1/2010	5/1/2010	7/1/2010	3/1/2011	$1,500,000	$780,000																
6.2	New SDB	$12,660,000	1/1/2010	11/1/2010	1/1/2011	3/1/2013	$900,000	$4,840,000	$5,280,000	$1,320,000														
17	Aeration Basin Foam Removal System Improvements	$ 890,000	1/1/2010	8/1/2010	10/1/2010	3/1/2012	$170,000	$600,000	$150,000															
2A	Aeration Blower Improvements Phase 1- North Blower/HVAC Improvements	$ 5,220,000	1/1/2011	8/1/2011	10/1/2011	3/1/2013		$960,000	$3,240,000	$810,000														
3.2	Digester Capacity Improvements	$26,800,000	7/1/2013	8/1/2014	10/1/2014	9/1/2017				$900,000	$2,450,000	$8,400,000	$8,400,000	$6,300,000										
3.3	Primary Digester Mixing Improvements	$ 5,650,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$154,167	$30,833		$540,000	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000	$180,000							
3.4	Primary Digester Covers and Rehabilitation	$14,680,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$400,000	$80,000		$1,440,000	$1,920,000	$1,920,000	$1,920,000	$1,920,000	$1,920,000	$1,920,000	$480,000							
3.5	Secondary Digester Covers and Rehabilitation	$ 5,150,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$141,667	$28,333		$540,000	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000	$180,000							
3.6	Sludge Withdrawal Pump Improvements	$ 360,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$8,333	$1,667		$36,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$12,000							
3.7	Digester Low Pressure Gas System Improvements	$ 1,200,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$33,333	$6,667		$90,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$30,000							
3.8	Digester EI&C Improvements	$ 6,270,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$170,833	$34,167		$630,000	$840,000	$840,000	$840,000	$840,000	$840,000	$840,000	$210,000							

Table ES-3. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
4.1	Digester Building Hot Water Loop Improvements	$ 400,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$25,000	$5,000		$180,000	$180,000													
4.4	Digester Piping and Valving Improvements	$ 180,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$8,333	$1,667		$90,000	$90,000													
4.5	Digester HVAC Improvements	$ 1,180,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$66,667	$13,333		$540,000	$540,000													
4.6	Digester Feed Improvements	$ 330,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$16,667	$3,333		$180,000	$180,000													
5.1	Plant Wide Power System Study and Upgrades	$ 2,880,000	1/1/2011	2/1/2012	4/1/2012	3/1/2016		$240,000	$500,000	$720,000	$720,000	$720,000	$180,000											
5.2	Critical Power System Alternatives	$ 2,590,000	1/1/2011	2/1/2012	4/1/2012	3/1/2016		$120,000	$410,000	$600,000	$600,000	$600,000	$150,000											
2B	Aeration Blower Improvements Phase 2 - South Blowers and Building	$10,080,000	1/1/2020	11/1/2020	1/1/2021	3/1/2023											$700,000	$3,850,000	$4,200,000	$1,050,000				
31	Lightning Protection System Upgrade	$ 200,000	1/1/2010	8/1/2010	10/1/2010	3/1/2012	$20,000	$120,000	$30,000															
7	Plant-Wide Non Potable Water System Improvements - all process areas	$ 1,580,000	7/1/2011	8/1/2012	10/1/2012	9/1/2021		$60,000	$90,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$90,000						
12.1	Primary Clarifier Capacity Improvements (New PCs)	$18,460,000	9/1/2016	10/1/2017	12/1/2017	11/1/2020							$400,000	$900,000	$5,760,000	$5,760,000	$5,280,000							

Table ES-3. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
12.2	Primary Clarifier Tank and Mechanism Improvements	$ 2,040,000	9/1/2016	4/1/2017	6/1/2017	11/1/2018							$80,000	$720,000	$1,210,000									
12.3	Primary Clarifier Spray Water and Wash Water Improvements	$ 190,000	9/1/2016	4/1/2017	6/1/2017	11/1/2018								$60,000	$110,000									
12.4	Primary Clarifier EI&C Improvements	$ 4,410,000	9/1/2016	4/1/2017	6/1/2017	11/1/2018							$200,000	$1,530,000	$2,530,000									
19.1	Primary Clarifier Draining Improvements	$ 180,000	1/1/2018	11/1/2018	1/1/2019	3/1/2021										$110,000	$120,000	$30,000						
19.2	Primary Clarifier Sludge Pumping, Process Piping, and Valving Improvements	$ 890,000	1/1/2018	8/1/2018	10/1/2018	3/1/2020									$170,000	$600,000	$150,000							
19.3	Pump House #1, #2 & #3 Improvements	$ 280,000	1/1/2018	11/1/2018	1/1/2019	3/1/2021										$110,000	$120,000	$30,000						
19.4	Primary Clarifier Odor Control Rehabilitation	$ 3,160,000	1/1/2018	8/1/2018	10/1/2018	3/1/2020									$600,000	$1,920,000	$480,000							
19.5	Primary Clarifier Pump House #1, #2, #3 EI&C Improvements	$ 3,390,000	1/1/2018	8/1/2018	10/1/2018	3/1/2020									$640,000	$2,160,000	$540,000							
9	Final Clarifier Improvements	$ 9,210,000	10/1/2019	11/1/2020	1/1/2021	12/1/2023										$150,000	$500,000	$2,640,000	$2,880,000	$2,880,000				
26	DAF Tank and Mechanism Rehabilitation	$ 1,050,000	1/1/2020	8/1/2020	10/1/2020	3/1/2022											$170,000	$600,000	$150,000					

Table ES-3. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
16	DAF Comprehensive Valve/Piping Improvements	$ 900,000	1/1/2019	2/1/2020	4/1/2020	3/1/2023										$120,000	$170,000	$240,000	$240,000	$60,000				
15	DAF HVAC and Foul Air Improvements	$ 470,000	10/1/2020	11/1/2021	1/1/2022	12/1/2024													$110,000	$120,000	$120,000			
25	DAF Saturation System Improvements	$ 240,000	10/1/2020	11/1/2021	1/1/2022	12/1/2024													$110,000	$120,000	$120,000			
24B	DAF TWAS, UWAS and Scum Pumping Improvements	$ 970,000	10/1/2020	8/1/2021	10/1/2021	12/1/2023											$30,000	$130,000	$360,000	$360,000				
13	DAF EI&C Improvements	$ 4,730,000	1/1/2019	11/1/2019	1/1/2020	3/1/2022										$300,000	$1,760,000	$1,920,000	$480,000					
28.1	Gas Sphere Improvements	$ 360,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024														$100,000	$240,000			
28.2	South Cogen Power Improvements	$ 130,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024														$50,000	$120,000			
28.3	North Cogen Power Improvements	$ 130,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024														$50,000	$120,000			
28.4	Gas Holder Improvements	$ 870,000	10/1/2021	8/1/2022	10/1/2022	12/1/2024												$30,000	$130,000	$360,000	$360,000			
28.5	Digester Gas Quality Improvements	$11,190,000	4/1/2022	11/1/2022	1/1/2023	6/1/2024													$840,000	$6,380,000	$3,480,000			
28.6	Fuel Gas Metering	$ 100,000	10/1/2022	2/1/2023	4/1/2023	12/1/2023														$80,000				
28.7	N & S Cogen Sound Attenuation Improvements	$ 170,000	10/1/2022	2/1/2023	4/1/2023	12/1/2023														$160,000				
28.8	Remove and Replace South Cogen Generators	$ 1,330,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024													$60,000	$430,000	$840,000			

Table ES-3. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
29.1	Aeration Basin Miscellaneous Improvements	$ 570,000	10/1/2023	2/1/2024	4/1/2024	12/1/2024														$30,000	$490,000			
29.2	Spray and Wash Water System Improvements	$ 460,000	10/1/2023	2/1/2024	4/1/2024	12/1/2024														$30,000	$410,000			
29.3	Aeration Basin and ASPS EI&C Improvements	$ 830,000	10/1/2023	2/1/2024	4/1/2024	12/1/2024														$60,000	$740,000			
29.4	Diffuser Improvements	$ 2,420,000	1/1/2013	2/1/2014	4/1/2014	3/1/2020				$120,000	$250,000	$360,000	$360,000	$360,000	$360,000	$360,000	$90,000							
29.5.1	Remove and Replace Existing RAS Pump	$ 750,000	10/1/2021	2/1/2022	4/1/2022	12/1/2022												$60,000	$660,000					
29.5.2	Expand RAS Pump Station	$ 1,360,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024													$60,000	$430,000	$840,000			
27	DAF Polymer Batch and Feed System Improvements	$ 1,430,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024													$60,000	$430,000	$840,000			
32	Cogen Heat Recovery Utilization Improvements	$ 360,000	10/1/2021	5/1/2022	7/1/2022	12/1/2023													$100,000	$240,000				
33	Site Security	$ 610,000	10/1/2020	2/1/2021	4/1/2021	12/1/2021											$30,000	$490,000						
34	Stormwater	$ 260,000	10/1/2020	2/1/2021	4/1/2021	12/1/2021											$30,000	$250,000						
35.1	NF -1 Modify Abandoned PTF to be Warehouse Facility	$ 940,000	1/1/2024	5/1/2024	7/1/2024	3/1/2025															$580,000	$300,000		
35.2	NF -2 Modify Abandoned SDB to be Maintenance Facility	$ 1,250,000	1/1/2024	5/1/2024	7/1/2024	3/1/2025															$770,000	$390,000		

Table ES-3. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
35.3	NF -3 Demo Old O&M Office Bldg and Provide New O&M Office Bldg.	$11,970,000	1/1/2024	11/1/2024	1/1/2025	3/1/2027															$900,000	$4,510,000	$4,920,000	$1,230,000
36	Landscaping	$ 2,000,000	1/1/2010	2/1/2011	4/1/2011	3/1/2021	$120,000	$170,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$60,000						
37	Drying Bed Demolition and Rehabilitation	$ 1,240,000	10/1/2021	2/1/2022	4/1/2022	12/1/2022												$90,000	$1,070,000					
	General Miscellaneous Tasks	$12,000,000	1/1/2010			12/1/2021	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000						
Total Cost							$5,715,000	$13,735,000	$20,500,000	$17,256,000	$10,698,000	$15,768,000	$15,458,000	$15,558,000	$17,068,000	$17,278,000	$12,582,000	$11,470,000	$11,510,000	$13,420,000	$10,970,000	$5,200,000	$4,920,000	$1,230,000

1. INTRODUCTION

1.1 Purpose

The Southside Water Reclamation Plant (SWRP) is facing many challenges due to failing infrastructure and equipment, capacity bottlenecks, process upsets, and limited operations support. To address these challenges, the WUA and Brown and Caldwell developed a Reclamation Rehabilitation and Asset Management Plan (RRAMP) to determine the most critical areas for improvements and develop a plan for replacement over the next ten to twelve year timeframe.

The RRAMP was developed from a capacity evaluation and asset assessment of the SWRP's process areas. The capacity evaluation included BioWin™ process modeling and a hydraulic and process capacity review of each process area, except the disinfection area which is currently in upgrade pre-design. The results from this evaluation determined process and equipment capacity constraints and these results were considered as part of the asset assessment. The asset assessment was based on specific groups of assets within each process area as identified with the WUA. The asset assessment considered a number of parameters to determine which asset groups were critical for rehabilitation. The asset assessment results were then evaluated and grouped to develop projects for the SWRP's 10-year plan.

1.2 Capacity Evaluation

One component of developing the RRAMP was to evaluate the current capacity of the treatment processes and equipment. These results were then evaluated with the asset risk assessment to develop a prioritized list of projects for the SWRP. In this evaluation, the existing treatment processes and equipment were evaluated based on a combination of Brown and Caldwell standard design criteria, industry standards, and the *State of New Mexico Recommended Standards for Wastewater Facilities*, 2003 which was prepared by the New Mexico Environment Department (NMED). The current conditions and basic design data for the treatment processes and equipment were provided by WUA staff and further evaluated during Brown and Caldwell's site visit in May 2009 for Workshop 1. The most recent capacity analysis memorandum, *Wastewater Master Plan 2000-2025, Project Task Memorandum No.16, Southside Water Reclamation Plant Capacity Analysis* dated 1999 (referred to as the CDM Memo throughout this RRAMP), was also reviewed and provided additional information for the major assets at the facility. Process areas reviewed in this evaluation include Preliminary Treatment, Primary Clarifiers, Aeration Basins, Final Clarifiers, DAFs, Digesters, Sludge Dewatering, and Cogeneration.

1.2.1 Background

The SWRP is the largest wastewater treatment facility in New Mexico and serves over five hundred thousand people. A capacity analysis of the SWRP was conducted in 1999 by CDM. The conclusions of the report found that most of the liquid and solids treatment processes have adequate capacity for 76 mgd with firm capacity or one unit out of service. The activated sludge system was capacity limited at the assumed ultimate influent strength scenario and a supplemental carbon source would be needed to meet the 76 mgd. The anaerobic digesters were also found to be lacking in capacity with two units assumed offline for firm capacity. Expansion of the anaerobic digesters was identified to provide the full rated capacity of 76 mgd. To alleviate this, it was recommended that an additional sludge blending tank be added to improve the sludge consistency to the centrifuges but this was not installed. The aeration basins and the DAFs also fell short of the 76 mgd design capacity under the high-concentration influent scenario.

1.2.2 Flows and Loads

The SWRP has a maximum month flow (MMF) design capacity of 76 mgd which is the design rating of the nitrogen removal facilities that were constructed in 1998. This flow has been determined to be the future or "build-out" flow condition of the SWRP. Once the SWRP reaches this capacity, it is anticipated that new satellite facilities will be built to treat excess flows. Therefore, the ultimate capacity of the existing SWRP process facilities will be compared against this design flow of 76 mgd.

1.2.3 Peaking Factors

The annual average flow (AAF) was calculated based on the MMF of 76 mgd. To determine this, a 30-day moving average (30DMA) of the influent flow data was calculated for the years 2000 to 2008. The maximum 30DMA flow for each year appeared to occur in the months of August or September and was assumed to be equivalent to MMF. A peaking factor related to annual average flow was calculated for each year and an average of these values was determined. The average peaking factor of MMF to AAF was 1.06. This is the same value as used in the CDM Memo. This same calculation was performed for the maximum daily flow values and the average peak day to annual average peaking factor value for 2000 to 2008 was determined to be 1.18.

Peak hourly flow (PHF) is typically used to evaluate the maximum design surface overflow rates for clarifiers and is integral to assessing certain equipment capacities. Since no hourly flow data were available for 2000 to 2008 and the MMF to AAF peaking factor (calculated above) matched well with the previous capacity analysis value, it was decided that the PHF to AAF peaking factor of 1.5 stated in the CDM Memo would be used for this capacity evaluation update.

Process systems and equipment that are designed to handle peak hydraulic conditions were evaluated in terms of a peak flow. This peak flow condition is based on the maximum 15-minute interval flow experienced at the plant which in this report will be referred to as the peak instantaneous flow (PIF). These data were provided by the SWRP for the years 2000 to 2008. The average of these annual values was 112 mgd. The peaking factor of 2.11 was calculated as the average of the maximum 15-minute flow divided by the annual average flow. By applying this peaking factor to the annual average of 72 mgd, the PIF for this evaluation was 151 mgd. These data are provided in Appendix A.

Table 1-1 shows the peaking factors and flows used in the liquid stream process capacity evaluation.

Table 1-1. Liquid Stream Peaking Factors and Future Flows

Flow Term	Peaking Factor Ratio to AAF	Future Flow (mgd)
Annual Average Flow (AAF)		72
Maximum Monthly Flow (MMF)	1.06	76
Peak Day Flow (PDF)	1.18	85
Peak Hourly Flow (PHF)	1.50	107
Peak Instantaneous Flow (PIF)	2.11	151

A similar method was used to determine the solids stream peaking factors. Since plant data from 2008 were used to calibrate and determine the capacity of the plant processes, this same data set was used to determine the solids stream peaking factors. Plant data, where available, were used to determine historical peaking factors for sludge flow. These data are provided in Appendix A. If sludge flow data was not available, as was the case for TWAS flow, the flow was back calculated from the solids loading. As discussed in the BioWin™ Technical Memo (Appendix B), the sludge yields based on the plant data were unrealistically high and our analysis suggests that it is the WAS plant data that is over predicted. Therefore, it was determined that the BioWin™ capacity results be used to calculate the future maximum month solids flow values (based on the influent MMF of 76 mgd) for all solids streams except the primary sludge and dewatered sludge. The future flow of the primary sludge and dewatered sludge were calculated as a ratio of the 2008 influent MMF and future influent MMF. The solid stream peaking factors, flows, and nominal unit loadings are presented in Table 1-2.

Table 1-2. Solids Stream Peaking Factors and Future Flows

Solid Stream	Future AAF (mgd)	Peaking Factor PDF to AAF	Future PDF (mgd)	Peaking Factor MMF to AAF	Future MMF (mgd)
Primary Sludge	0.25	2.61	0.66	1.59	0.40
WAS	0.98	1.78	1.73	1.35	1.32
TWAS	0.18	1.86	0.34	1.10	0.20
Blended Sludge	0.39	2.18	0.85	1.31	0.51
Digested Sludge	0.39	2.18	0.85	1.31	0.51
Dewatered Sludge	0.66	1.71	1.12	1.17	0.77

1.2.4 General Capacity Approach

The process area capacities were determined using standard calculations and BioWin™ modeling. The BioWin™ model was used primarily to determine the overall treatment capacity of the SWRP. Preliminary treatment systems and pumps are just some examples of facilities and equipment for which the BioWin™ model does not directly determine capacities and in these cases, standard methods were used. The BioWin™ model simulation results are discussed within each appropriate process area chapter with additional details provided in Appendix B.

A hydraulic review was performed on critical process elements at the SWRP. These results are detailed within the appropriate process area chapters and details can be found in Appendix C.

1.3 Asset Risk Assessment

The goal of this asset risk assessment is to evaluate and prioritize plant needs based on risk. The first step in the asset assessment was to develop a list of each asset or asset class for each process area of the SWRP. This list was developed in the process meeting discussions with SWRP staff during Workshop 1.

The next step was to assess each asset class or major asset and estimate the risk of failure, and the impact of that failure. Asset failure can be caused by multiple factors including mortality, inadequate capacity, limited performance, and efficiency of extraordinary costs. Assets or asset classes that have a high likelihood of failure and have a significant impact if they fail should have higher priority in the development of the capital improvement program for the SWRP.

The WUA is utilizing the WERF SIMPLE approach to asset management that includes the definition of business risk. Business risk exposure and the consequences of asset failure are ideally presented in actual dollar costs. However, the scope of the risk assessment for the SWRP RRAMP project is limited to rating assets on relative consequence of failure based on 'triple bottom line' criteria for municipal services as applied to the SWRP. The business risk assessment for this phase of the RRAMP is based on relative weighted risk scores for assets or asset groups that are a product of the probability of failure score and the consequence of failure score. The risk of asset failure is further modified or reduced if there is no reliable means of redundancy for the asset.

Risk Score = Consequence of Failure x Probability of Failure x Redundancy Factor

The weighted risk scores are used to identify and prioritize asset risk and to develop potential capital improvement projects based on most critical assets and asset groups as shown in Figure 1-1. For example, those assets with a business risk score higher than 12 would be the highest priority for replacement or other action. Those with moderate priority would receive a risk score of 8 to 12. The highest priority assets were then be grouped into the potential capital projects. The following chapters provide the asset risk score spreadsheets for each process area.

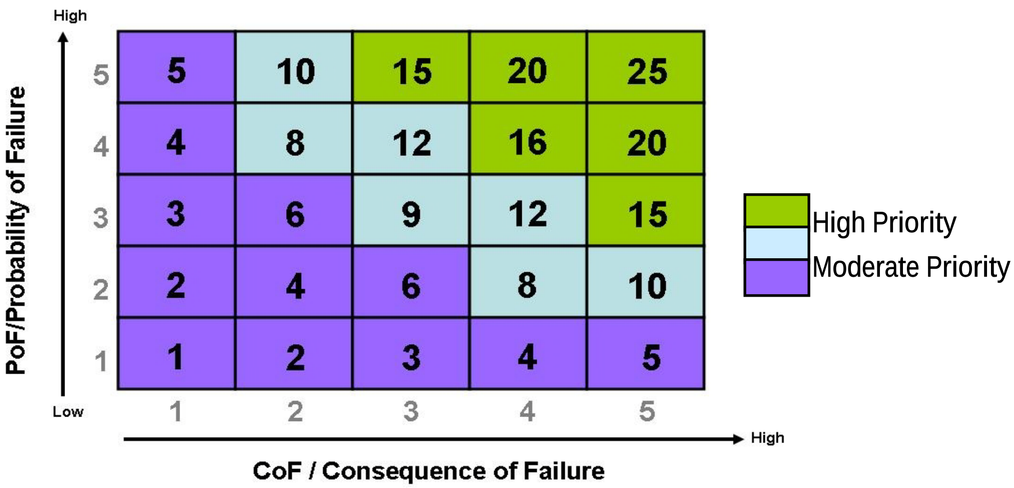

Figure 1-1. Asset Risk Score Priorities

The following subsections describe the components factored in the probability of failure, consequence of failure, and redundancy factor. Each component subsection has a description of how they are measured and weighted.

1.3.1 Probability of Failure

For the SWRP RRAMP the likelihood of failure is estimated for major asset classes based on the following factors. Each of these factors is weighted, as indicated, based on estimated importance in affecting the probability of failure. Each factor impacting the probability of failure is rated for each asset class on a relative scale from 1 to 5 as discussed in the following sections.

Table 1-3. Probability of Failure	
Probability of Failure Factor	Weighted Importance
Age	30%
Condition	50%
History	20%

1.3.1.1 Age

As an asset approaches its expected useful life, the probability of failure generally increases due to wear or fatigue. Age may contribute to obsolescence if parts cannot be obtained or the equipment is not compatible with current technology. Remaining Useful Life (RUL) is the difference between the expected life and the age of an asset.

Table 1-4. Asset Age Ratings	
Rating	Current Age
1	Less than 20% of expected useful life
2	20% to 40% of expected useful life
3	40% to 60% of expected useful life
4	60% to 80% of expected useful life
5	> 80% of expected useful life

1.3.1.2 Condition

The condition of the asset is typically the most significant cause of asset failure. Deterioration - excessive wear and lack of maintenance may cause assets to fail prematurely and unexpectedly. Without a detailed physical assessment such as teardown and inspection, a relative evaluation can be made based on appearance, noise, vibration, performance, etc.

Table 1-5. Asset Condition Ratings	
Rating	Condition Ranking
1	Like new
2	Some visible wear and corrosion
3	Noticeable degradation of condition or performance
4	Significant and measurable deterioration, requires extraordinary maintenance
5	Has failed or imminent failure expected

1.3.1.3 History

If the asset has a history of failure, it is a strong indication that the probability of a future failure is high. The significance of the number of failures, meaning that the component or system does not perform the intended function, will vary with the type of asset and the cost to repair or maintain. In more sophisticated analyses, this is addressed in a computation of the mean time between failures (MTBF). For this analysis, the following general guidelines are used for typical mechanical and electrical equipment in a wastewater plant.

Table 1-6. Asset Frequency of Failure Ratings	
Rating	Frequency of Failure
1	Never failed
2	Fails > every 5 years
3	Fails 1 to 5 years
4	Fails < 1 year
5	Fails < 1 month

1.3.2 Consequence of Failure

The consequence of asset failure for the SWRP is measured in terms of the 'triple bottom line' of municipal services to reflect the role of the SWRP in the community, and to provide a balanced approach to the risk assessment. The consequence of failure of assets is improved or offset by redundancy within asset groups and is discussed later in this section.

Multiple factors are used within each of the triple bottom line categories and each service level: social, environmental, and economic is considered equal for this evaluation. The factors and their weighted importance within each of the three service categories are listed in the following table.

Table 1-7. Consequence of Failure	
Consequence of Failure Factor	Weighted Importance (%)
Social	38.6
Disruption of Service	10.5
Health and Safety	13.2
Public Image	4.4
Board Policy	10.5
Environmental	32.5
Permit Compliance	16.3
Ecosystem	8.0
Aesthetics	8.2
Economic	28.9
Level of Service	17.0
Damage	6.8
High O&M Costs	5.1

Each factor is rated on a relative scale. More sophisticated methods are available to measure and weigh the consequences of failure including comparable costs, but these methods are outside the scope of this project. A reasonableness approach using best judgment and experience in wastewater treatment facilities is used to provide a rating for each asset or asset group. The general rating scale for the impacts of asset failures is listed in the following table.

Table 1-8. Consequence of Failure Ratings

Consequence of Failure Factor Rating	Potential Impact
0	No impact
1	Low or insignificant impact
3	Moderate, some measurable impact, disruption, or cost
5	High, substantial, dramatic, or multiple impacts

The following sections provide brief explanations of the consequence of failure factors and how they are applied to the rating.

1.3.2.1 Disruption of Service

Wastewater plant assets do not typically have a direct impact on customers or citizens, but there are conditions of failure than can impact customers. These may include, for example, influent pump failure that could cause a sewer line backup into residences or businesses, or loss of plant power that would prevent operation of some or all processes. Effluent reuse pump failure could impact reclaimed water customers, and digester failure may impact businesses or users relying on biosolids quality.

1.3.2.2 Health and Safety

Health and safety can be the most important factor to be included in the community or customer service category that considers plant staff are part of the community. Safety can apply to buildings and electrical equipment, as well as rotating equipment. For example, a building with inadequate lighting or railings would be judged to have failed since it does not meet its intended or required purpose in a safe manner. Dangerous conditions that currently exist without a specific failure incident should also be considered as an asset failure and may have a high impact.

1.3.2.3 Public Image

Public image within a wastewater plant is typically related to ongoing problems or failures or extended duration of other failure consequences. Ongoing odor issues may exist without asset failure if there are not adequate odor control facilities. Permit violations or ongoing safety problems can be publicized and may be caused by multiple or combinations of failures, and should be characterized as having public image impacts.

1.3.2.4 Board Policy

Board policy reflects community or social needs and expectations and is an important criteria is measuring the impact on the community. There are typically multiple policies that the plant needs to meet. Examples includes providing adequate treatment plant capacity, meeting all regulatory requirements, controlling costs, and minimizing treatment plant impacts such as odors and traffic on plant neighbors.

Inadequate capacity or capacity restrictions are considered a community impact if they restrict the capability of the community to achieve development or growth goals or otherwise limit service to the community. This can also be an impact without a specific failure incident. The asset failure is ongoing if the process or equipment does not have capacity to meet the desired needs of the community.

1.3.2.5 Permit Compliance

Failure of the asset or asset class would result in violation of the permits or other regulatory performance requirements associated with the SWRP. Typically this would include effluent or biosolids limits, but could include electrical code, OSHA, or similar requirements. Failure of some assets, such as disinfection or aeration, would directly affect permit violation and have a high impact, while others may have lesser or indirect impacts such as primary clarifier collector mechanism failure.

1.3.2.6 Ecosystem (Overflows and Spills)

While overflows and spills could be considered part of permit compliance, they represent a substantial impact on the environment that should be considered as a separate impact or factor. This may include chemical spills as well as wastewater spills and overflows.

1.3.2.7 Aesthetics (Odor, Noise)

Odor is an environmental nuisance but may become serious enough to be an environmental hazard. Failure of some systems can cause or exacerbate odors. Failure of an odor control system can be a high impact, but failure of influent screening equipment can be a moderate odor impact due to screenings build-up. Other aesthetic issues could be impacts from noise or visual appearance of the reclamation plant. Excessively loud or high frequency noise, or noise at night, may impact surrounding neighbors. Aesthetic issues have consequences that are typically identified by citizen complaints or through community involvement in design review or project approval.

1.3.2.8 Level of Service

Failure or loss of performance of a major asset or asset group can impact the performance of the treatment plant and may affect the performance or costs of other processes. This is a measure of the impact of failure of an asset, or the current inadequate performance of a process or asset group. For example, if the grit removal system is not performing adequately, it will affect the downstream performance and costs related to accelerated equipment wear and manual removal.

1.3.2.9 High O&M Costs

Asset failures, whether a specific incident, or ongoing extraordinary maintenance or attention, may require plant staff to continuously respond to maintain service levels and plant performance. Assets that are not performing as intended may also require extraordinary operator attention to prevent process or other related plant failure. This extraordinary effort diverts plant staff from other regular and necessary duties and tends to create other and ongoing failures. Energy inefficiency is also a measure of high O&M costs.

1.3.2.10 Damage

Damage is the direct cost of an asset failure. It may be measured in costs of emergency response, repair, clean-up, damage to other facilities such as flooding, temporary equipment, fines, claims, and other related costs. For example, failure of power supply equipment such as breakers can have multiple costs impacts including expensive repairs, permit violation fines, injury to workers, and temporary emergency power.

1.3.3 Redundancy

Backup equipment reduces the probability of failure of a group of equipment or asset class. For example, multiple influent pumps or aeration blowers with one or more standby units reduces the likelihood that the entire asset group or class will fail and impact the wastewater plant performance. However, if the standby equipment is cannibalized or otherwise not operable, it does not provide redundancy.

The Redundancy Factor is a relative weighting of the reduction of the consequence of failure of assets within an asset group where redundancy is present. The consequence of failure score is reduced by the percentage shown in the following table to provide a new consequence score that considers the level of redundancy. If there is no reliable redundancy, the consequence of failure rating is not reduced.

Table 1-9. Asset Redundancy Ratings

Redundancy Factor	Reduction of Consequence (%)	Level of Redundancy
1	80	Full redundancy at peak conditions, redundant equipment in good condition
2	50	Full redundancy at average conditions
3	25	Partial redundancy at peak conditions
4	10	Partial redundancy at average conditions
5	0	No reliable redundancy

2. PRELIMINARY TREATMENT

2.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the Preliminary Treatment Facility (PTF). In terms of risk, the preliminary treatment process ranks highest among the SWRP facilities because it is lacks adequate capacity to handle peak flows and the equipment is poor condition. Inadequate grit removal is a significant issue at this facility as ongoing inadequate grit removal has had serious negative impacts on the downstream processes. The electrical systems are generally unreliable, in poor condition, and a safety concern. Electrical failures have resulted in a bypass of the preliminary and primary treatment areas which is detrimental to the performance of the downstream systems and causes premature wear of the downstream assets.

Rehabilitation of this process area is a crucial first step in the rehabilitation of the SWRP facilities and improving overall plant performance.

The majority of the Preliminary Treatment Facility assets were ranked as high (Risk Score greater than 12) or moderate (Risk Score between 8 and 12) priorities for replacement. A summary table of the critical issues is presented in Table 2-1 with justification for these rankings being described in the following sections.

Alternatives were evaluated to address the critical issues at the Preliminary Treatment Facility. Due to the high risk of many of these assets and lack of space for new assets in the existing building, the chosen alternative was to construct a new Preliminary Treatment Facility. In the interim, until the new facility is online, the existing grit system must be rehabilitated to provide an interim level of service which is needed by the SWRP.

Table 2-1. Preliminary Treatment Facility Process Area Summary

Asset Classification	Total Risk	Assessment Implications
Vortex Grit Chambers	18.2	Critical for capacity of facility and integrity of downstream systems
Bar Screens	17.9	Critical for capacity and reducing system bypasses
Power	17.5	Critical for staff safety, reducing system bypasses/overflows, and process stability/function
Vortex Grit Pumps	17.2	Critical for capacity of facility and integrity of downstream systems
Screenings Dewatering	15.4	Critical for performance and integrity of downstream systems
Grit Classifiers	14.6	Critical for performance and integrity of downstream systems
Truck Loading	14.1	Critical for staff safety and performance
Conveyors	9.5	Essential for staff safety and code compliance
I&C	9.4	Essential for O&M staff safety and operation flexibility
Gates	8.8	Essential for O&M staff safety and operation flexibility

2.2 Introduction

The preliminary treatment system consists of mechanical bar screens and grit removal systems that include an aerated grit removal process operated in parallel with a vortex grit removal process. Grit removed from the influent flow stream is further processed for organics separation and dewatering. There is no process for dewatering the screenings. Both screenings and grit are conveyed to the truck bay for disposal. The preliminary treatment facility also includes a lift station which pumps flow from the lower bar screens to the influent channel of the grit systems. Both the preliminary treatment building and lift station have HVAC and odor control systems. Also, there are three electrical systems that are associated with this facility. A hydraulics review of this facility was limited to the upper bar screens as this was identified as the major concern by the SWRP staff. A summary of this hydraulics review is provided in Section 2.3.1.3.

2.3 Capacity Evaluation Results

The preliminary treatment design criteria are based on the peak instantaneous flow (PIF) conditions of 151 mgd and the rated capacities of the major preliminary treatment assets were evaluated against this treatment flow rate but the results are presented in terms of an equivalent maximum monthly flow (MMF). The equivalent MMF was determined by taking the firm equipment rated capacities and applying the appropriate peaking factors (presented in Table 1-1) to calculate the MMF. Individual assets have slightly different assumptions for this capacity evaluation; therefore, specific assumptions are listed for each major asset described. The preliminary treatment facility capacity evaluation includes the following systems:

- Bar Screens
- Grit Removal Systems
- Lift Pumps
- Grit Dewatering Equipment

2.3.1 Bar Screens

There are four (4) upper mechanically cleaned (climber-type) bar screens that receive flow from Lift Station No. 20 and the Tijeras Interceptor and two (2) lower screens that receive flow from Interceptor 142A. Based on the 1999 CDM Capacity Analysis Memo (CDM Memo) and confirmed by the SWRP, the flow splits between the upper and lower bar screens are 80 percent and 20 percent, respectively. The flow from the upper screens moves by gravity to the grit removal process influent channel where it combines with the flow from the lower screens after this lower flow is pumped to this channel via Lift Station No. 11.

2.3.1.1 Assumptions

The firm capacity of the bar screens is based on the assumption that one lower and one upper screen are out of service. The New Mexico Environment Department (NMED) redundancy guidelines recommend that the mechanical bar screen design should include one additional when there are two or more duty screens in a preliminary treatment system. This is to allow for one unit to be taken out of service for cleaning or repair while the remaining mechanical bar screens are in use. The design capacity of the bar screens is based on information provided by SWRP staff in the 2009 Basic Design Data which states 25.0 mgd/unit for the lower bar screens and 37.5 mgd/unit for the upper bar screens. The next section compares design capacity to current operating condition capacity.

At design average flow conditions, the NMED wastewater facility design guidelines recommend approach channel velocities to be no less than 1.25 feet per second (fps) to prevent settling and no greater than 3.0 fps to prevent forcing material through openings. This velocity is measured in the approach channel and is not the velocity of the flow through the bar screens. Results from the CDM Memo indicated that the velocities upstream of the screens were below the design requirements in 1999 but the bar spacing of the bar screens were 3/4-inch which is larger than the 3/8-in spacing that the upper bar screens have. The lower bar screens will also be changed to 3/8-in spacing as part of an upcoming plant improvements project. These results are supported by the hydraulics review conducted for this evaluation. A summary of the upper bar screen approach velocities for a range of plant flows is presented in Table 2-2. Only the low flow condition will not meet these guidelines, but low flow is the worst case scenario and is expected to occur for a short period of the day. At the PIF condition, the velocity will not exceed the design recommendation of 3.0 fps with one bar screen offline.

Table 2-2. Upper Bar Screen Approach Velocity

Flow Conditions	Upper Bar Screens Flow (mgd) [1]	Flow Per Bar Screen (mgd) [2]	Channel Width (ft)	Channel Depth (ft)[3]	Velocity (fps)	NMED Design Guidelines [4]
Low Flow [5]	25 (20)	5	5.5	3	0.5	1.25 to 3.0
Average Annual	72 (58)	19	5.5	3.3	1.6	
Maximum Month	76 (61)	20	5.5	3.3	1.7	
Peak Day	85 (68)	23	5.5	3.4	1.9	
Peak Hour	107(86)	29	5.5	3.5	2.3	
Peak Instantaneous	151(121)	40	5.5	3.9	2.9	

1 – Total plant flow with upper bar screen flow shown in parenthesis. Based on 80/20 flow split between upper and lower bar screens

2 – Flow per unit is based on one unit of out service except for the low flow condition.

3 – Channel depth was based on 1999 Hydraulic Profile.

4 – NMED Design Guidelines are specific for average flow conditions and presented for comparison purposes only.

5 – Based on assumption that low flow was 33% of annual average, 80/20 split between upper and lower bar screens and all bar screens online.

2.3.1.2 Capacity

The design capacity of the bar screens is presented in Table 2-3. The deficiency is based on the difference between the firm capacity as provided by SWRP staff and the evaluation criteria of 76 mgd. The results indicate that additional bar screens are required to meet the plant capacity when one unit is out of service in the upper and lower channel under the assumption that the flow splits between the two channels at a ratio of 80/20.

Table 2-3. Bar Screen Design Data

Bar Screens Location	Total Number	Clear Opening Space Between Bars (in)	Unit Capacity (mgd)	Firm PIF Capacity (mgd) [1]	Firm MMF Capacity (mgd)	Design MMF (mgd) [2]	Capacity Deficiency (mgd) [3]	Additional Units Required [3]
Upper	4	3/8	37.5	112.5	56.5	60.8	4.3	1
Lower	2	3/4	25.0	25.0	12.6	15.1	2.5	1

Notes: 1 – Firm capacity assumes 1 unit out of service on both the upper and lower bar screens.

2 – Flow splits between the upper and lower bar screens are based on the CDM Memo and 80% to 20% of the flow.

3 – A bypass exists from the upper to lower bar screen influent channel which could transfer the 15.5 mgd deficiency from the upper to lower bar screens and therefore avoid the need for an additional upper bar screen. With both 25 mgd bar screens operating in *the lower there is 18 mgd of additional capacity. However, this bypass channel was viewed as an emergency bypass and is not regarded as a means of accounting for deficient capacity.*

The results as presented in Table 2-3, assume that the bar screens are working as intended and all design conditions are met. However, as discussed with the SWRP staff, this is currently not the case. At higher flows, all four upper bar screens are used to treat the incoming flow stream and often, the flow from the upper bar screens is bypassed to the lower screens because the four upper screens cannot handle all the flow.

A hydraulic evaluation of the bar screens under design and current operating conditions was performed to determine the impact of the bar screen spacing and provide recommendations for operation. The results of this evaluation are provided in the following sections.

2.3.1.3 Hydraulic Evaluation of Bar Screens

The hydraulic review of the preliminary treatment facilities was limited to the upper bar screens as this was the primary area of concern identified by the SWRP staff. The facility has experienced a lack of freeboard upstream of the upper bar screens during high flow events. Freeboard is defined as the distance from top of the wall of the upstream channel down to the water surface elevation. This level of analysis was intended to determine the capacity of the upper bar screens under design and current conditions, and provide the SWRP with recommendations for operations and potential future changes. However, if changes are to be made to the bar screens or other PTF equipment, and work proceeds to preliminary and final design, a detailed hydraulic profile and hydraulic evaluations of the entire preliminary treatment facilities will be required including upstream facilities, the main preliminary treatment facility liquid stream, the grit removal process, Lift Station 11, and downstream facilities.

Headloss through the bar screen is based on several factors including downstream water surface, flow passing the bar screen, the physical characteristics of the bar screen such as width and bar spacing, and the level of blinding in the screen or how dirty the screen is. All these factors should be included in the selection of a bar screen. For evaluation of both design and current operating conditions, a simple bar screen headloss equation (see Eq. 2-1) was used and compared with manufacturer's data.

$$Headloss_{barscreen} = \frac{V_b^{\ 2} - V_u^{\ 2}}{2gC} \qquad \text{(Eq. 2-1)}$$

In the equation V_b= velocity through the screens, V_u=upstream velocity, g =gravity constant, C=screen loss coefficient (set at 0.7). The velocity through the screen is a function of the flow, bar spacing and geometry, and the percent blinding.

2.3.1.3.1 Design Conditions

Brown and Caldwell evaluated the bar screen capacity under design conditions for the upper bar screens and presented below in Table 2-3 is a summary of the hydraulics review. The evaluation was performed at four different downstream water levels and four different percent blindings. Downstream water surface elevations ranged from 2.5 to 4 feet and the percent blinding range from 20 to 50 percent. Based on the most current (1999) hydraulic profile, the downstream water surface is approximately 3.3 feet under average rates and 3.9 feet under PIF rates. Typical percent design blinding operations for a bar screen are 20 to 30 percent. Generally, the standard minimum upstream freeboard for a bar screen is 18-inches and this was assumed for the design condition evaluation. The bar screen capacity (mgd) was determined for different combinations of downstream water surfaces and percent blindings to produce a minimum upstream freeboard of 18-inches. Additional detail of the analysis can be found in the Appendix C of this report.

Table 2-4. Upper Bar Screen Hydraulic Review - Maximum Allowable Flow (MGD) Per Screen Under Design Conditions. [1]

		Percent Blinding of the Bar Screen [2]			
		20 %	30 %	40 %	50 %
Downstream Water Surface Elevation (feet) [3] /Depth (feet)	4,930.0/ 4.0	33	29	25	20
	4,929.5 / 3.5	38	33	28	23
	4,929.0 / 3.0	42	37	32	26
	4,928.5 / 2.5	46	40	35	28

Notes: 1 – A freeboard limit of 18-inches below the top of wall was used as the evaluation criteria when determining the maximum allowable flow per screen.

2 – Brown and Caldwell recommends assuming between a 20% and 30 % blinding at the screens for design. The manufacturer of the bar screen recommends a typical operation of 30-40%, but acknowledged that many owners will operate the bar screens with blinding closer to 40-50%.

3 – The CDM Memo showed the downstream water surface at 4929.08 ft for average flows and 4929.64 ft for peak flows.

2.3.1.3.2 Current Operating Conditions

Current operation of the PTF results in a significantly higher downstream water surface at the upper bar screen than expected from the design conditions. Due to mechanical and capacity limitations and changes in operation in the grit removal process, the downstream water surface is approximately 4931.2 (5.2 feet) or 2 feet higher than the design condition. This difference in downstream water surface has a large impact on the amount of flow that can be passed through the bar screens without adversely impact the upstream freeboard and causing an overflow. Currently, the bar screens operation is dependent on the differential head across the bar screen and that value is currently set at 12-inches. Therefore, the minimum upstream freeboard is approximately 9-inches before bar screens are cleaned which is significantly less than the design freeboard assumption of 18-inches.

Brown and Caldwell evaluated the bar screen capacity under current operating conditions for the upper bar screens and presented below in Table 2-4 is a summary of the hydraulics review. Similar to the design conditions evaluation presented in Table 2-4, for each combination of the downstream water surface elevations and percent blinding, the bar screen capacity (mgd) is reported that produced a minimum upstream freeboard of 9-inches.

Table 2-5. Upper Bar Screen Hydraulic Review – Maximum Allowable Flow (MGD) Per Screen Under Current Conditions. 3					
		Percent Blinding of the Bar Screen 2			
		20 %	30 %	40 %	50 %
Downstream Water Surface Elevation (feet) 1 /Depth (feet)	4,931.2/ 5.2	31	28	23	18

Notes: *1 – Plant Staff confirm that downstream water surface at 4931.2 ft for average flows.*

2 – Brown and Caldwell recommends between a 20% and 30% blinding at the screens

3 – A freeboard limit of 9-inches below the top of wall was used as the evaluation criteria when determining the maximum allowable flow per screen.

2.3.1.3.3 Conclusion

The bar screen hydraulic evaluation at design conditions (for downstream water surface and typical percent blinding) was consistent with the manufacturer's rating of 37.5 mgd/screen. The hydraulic capacity of the bar screens at different downstream depths and different percent blindings were calculated and are presented above.

Under the current operating conditions (downstream water surface raised approximately 2 feet than the design condition) the capacity of the bar screens needs to be de-rated from 37 to 28 mgd or close to 25 percent. In addition, communication with plant staff has indicated that the capacity of the bar screens appears to be even less, which would indicate that the percent blinding may be higher than the BC recommended value of 30 percent.

2.3.1.3.4 Recommendations

The downstream water surface elevation is most directly a function of the weir elevations at the aerated grit and vortex basins (listed as 4,928.0 feet in the CDM Memo's supporting spreadsheet), the amount of the flow passing over the weir, and how the grit removal equipment is presently being operated. Plant staff have also indicated that the pumped flow from the lower bar screens also causes water to back-up downstream of the upper bar screens. It is not clear at this level of review if the SWRP has the ability to lower the downstream water level. However, a lower water surface downstream would help increase the amount of flow that could be passed through the screen without impacting the amount of upstream freeboard. A more detailed review of the entire preliminary treatment and primary clarifiers would be required to adequately determine the extent to which this level could be lowered.

Actual design or historical operations data for the downstream and upstream water surfaces and typical percent blinding for peak flows were not available. A more detailed evaluation of the bar screens will require a review of past and present operations (both downstream water surface elevations and percent blinding). In addition, it is recommended that the operation and performance of the bar screens be reviewed with the manufacturers to confirm the validity of the current performance.

The 9-inch freeboard upstream of the upper bar screens is lower than recommended for new facilities however, the current operating practice which has a high downstream water surface elevation (even during average conditions), combined with bar screen headlosses, does not allow the freeboard to be increased much. If the downstream water surface increases above the current average depth of 5.2 feet, then the allowable 12-inch differential across the bar screen should be reduced. It is recommended that the allowable differential across the bar screen be adjusted according to the downstream water surface elevation. During peak flow events, the allowable differential may need to be reduced. These changes would need to be analyzed further for hydraulic impacts and should be confirmed with the bar screen manufacturers for performance impacts.

2.3.2 Grit Removal Systems

The SWRP has two grit removal systems that are designed to run in parallel: vortex process and aerated grit process. There are two aerated grit chambers and three vortex grit systems. At the time of this study, the vortex grit systems were not in use due to constant plugging. In addition, plant staff reported that grit was accumulating in the aerated grit chambers up to depths of 3 to 4 feet and needed to be manually removed.

2.3.2.1 Assumptions

The aerated basins and the vortex basins were evaluated with slightly different set of assumptions. The firm capacity of the aerated grit systems is based primarily on the assumption that the vortex basins are completely off-line. When the vortex basins were evaluated, it was assumed that one of the vortex basins was offline and the aerated grit basins was fully online and operating at its full capacity. Since the current operation of the grit removal has changed from design (i.e. with the vortex basins being taken offline) it was necessary to review the capacity of the aerated grit chambers under both design and current operating conditions. The vortex basins were then compared to design values.

2.3.2.2 Design Capacity

The design capacity of the grit systems was evaluated versus the 151 mgd PIF and the results are presented in terms of a maximum monthly flow. The results of this evaluation are presented in Table 2-5 below. The evaluation of both grit removal basins shows that the units lack capacity and improvements are needed to meet peak demands.

The rated design capacity of the aerated grit basins is listed as 45 mgd in the summary data provided by the SWRP staff. This flow rate results in a detention time in the aerated grit chamber of 3.76 min which is above the recommended minimum as provided by the NMED. Since details on the higher detention time were not available, a range of firm capacities was initially reviewed for this evaluation. The NMED recommendation for minimum detention time is 3 minutes for grit removal, and therefore it is possible that a higher rated capacity of 61 mgd could be used for the aerated grit chambers. For the purpose of this evaluation the original design capacity of 45 mgd was used in Table 2-6. To confirm a higher rated capacity for the grit removal, additional hydraulic and performance review is required, along with additional communication with the equipment manufacturer. In this evaluation, the aerated grit basins were evaluated separately from the vortex system since the vortex system has been abandoned by the SWRP staff. This firm capacity therefore results in a deficiency and two additional aerated units are required. The capacity deficiency is the difference between the design MMF and calculated equivalent firm capacity. If a deficiency is found, an additional number of units (with similar unit capacities) were estimated. In the case of the vortex system, it was assumed that both aerated grit systems were online and could handle 45.2 mgd of the peak flow. This would result in 30.8 mgd that vortex system would need to process. Assuming two of three of the vortex units were online, there was also a capacity deficiency and two additional vortex systems would be needed.

Table 2-6. Grit System Design Data

Grit System	Number	Unit Capacity (mgd) 1	Firm PIF Capacity (mgd) 2	Firm MMF Capacity (mgd)	Design MMF (mgd) 3	Capacity Deficiency (mgd)	Additional Units Required4
Aerated	2	45	90	45.2	76	30.8	1
Vortex	3	13	26	13.1	30.8	17.7	2

Notes: *1 – The unit capacity for the aeration basins was provided in the 2009 Basic Design Data and equates to a detention time of 3.76 minutes based on an aerated basin total volume of 235,000 gallons. The unit capacity of vortex basins was provided in the CDM Memo and assumes a derating of 50% from the manufacturer's data. This is 50% derated value is consistent with Brown and Caldwell's design of vortex grit systems.*

2 – Firm capacity of the aerated basins assumed the vortex basins were completely off-line and a detention time of 3.76 minutes. Both units were assumed to be on-line. Firm capacity of the vortex basins assumes both aerated basins are online as well as two of three vortex systems.

3 – The design MMF for the aerated basins was calculated assuming the vortex units were completely taken off-line and the entire flow passed through the aerated basins. The flow for the vortex basins assume the aerated basins are taking flow at their capacity (45.2 mgd) and the vortex basins would make up the deficiency of 30.8 mgd.

4 – If capacity deficiency is evaluated based on PIF, a total of two aerated grit basins and three vortex grit systems would be required.

2.3.2.3 Current Operating Conditions Capacity

The vortex basins are currently offline and therefore no additional review was performed for current operating conditions. Based on communication with plant staff these units need to be replaced for mechanical reasons.

Review of the current operating conditions in the aerated grit basins is difficult without an extensive long term study. For the purpose of this evaluation, review was based on plant staff observations. With the vortex basins offline, the aerated grit chambers are currently overloaded and not able to keep up with peak loading rates which are as high as 112 mgd. Therefore under these higher flow rates (which are typically associated with high grit loads) grit accumulates in the chambers. Once grit begins to accumulate in the chambers, the working volume and therefore detention of the grit chambers is reduced and the performance of the aerated grit chambers is hindered. Additional review of the grit removal equipment and operating practice is needed to determine why grit is accumulating in the grit chamber at the current rate. Plant staff has reported that grit begins to accumulate at flows of 65 mgd. Since this observed capacity is significantly lower than the rated capacity, further review specifically of the grit pumps is recommended.

2.3.3 Lift Pumps

There are three (3) pumps located in Lift Station 11 that lift the waste stream from the lower screens effluent channel to the grit removal process influent channel where it combines with the flow that passes through the upper bar screens.

2.3.3.1 Assumptions

The evaluation of the lift pumps was based on the assumptions that one of the three pumps was out of service for repairs. Peaks flows for the lift station assumed that 20 percent of the total plant peak flow enters Lift Station 11.

2.3.3.2 Capacity

The capacity evaluation for the lift pumps shows that with one pump out of service, the firm capacity of the lift pumps is equal to the peak flows. These results are presented in Table 2-6. Similar to the bar screens, the lift pump rated capacity does not match what the SWRP staff has experienced in the field. The SWRP staff has typically had to use all three pumps to lift the flow from the lower bar screens. There is a concern that the pumps are experiencing impeller wear issues which may be hindering the capacity of the pumps. The wet well design should also be reviewed versus current Hydraulic Institute design. Brown and Caldwell has evaluated other pump stations where improper intake conditions, such as vortexing, grit accumulation, or floor velocities have reduced the rated capacity of the pump by up to 20 percent. It is recommended that the pumps be further investigated if this issue continues.

Table 2-7. Lift Pump Design Data

Lift Pumps	Number	Unit Capacity (mgd) [1]	Firm PIF Capacity (mgd) [2]	Firm MMF Capacity (mgd)	Design MMF (mgd) [3]	Capacity Deficiency (mgd)	Additional Units Required
At LS 11	3	15.8	31.6	15.9	7.6	0	0

Notes: 1 – The capacity of each lift pump was based on data in the 2009 Basic Design Data

2 – Firm capacity assumes that one of the pumps is out of service

3 – Flows for the lift pumps are based on 20% of the plant's influent design flow of 76 mgd.

2.3.4 Grit Dewatering Equipment

Grit removed by the vortex or aerated grit basins is pumped in a slurry form to one of three dewatering systems. There are eight (8) grit pumps for the aerated basins and three (3) for the Pista grit basins. Each dewatering system consists of a grit classifier /selector tank positioned over a grit clarifier. The classifier/selector separates the grit from the organic matter, and then the grit is settled in the clarifier and falls on the grit escalator for continued dewatering.

2.3.4.1 Assumptions

The evaluation of the grit removal equipment assumed that one entire train (grit classifier, clarifier, and escalator) would be out of service for repair and that the remaining two units have adequate flexibility designed into their piping that they could serve either grit removal basin or a portion of both.

2.3.4.2 Capacity

The results of the capacity evaluation are presented below in Table 2-7. The grit pump capacities are listed in the table; however, the firm capacity was not evaluated as they are programmed to run in a sequential operating so that the loading to the dewatering units is constant at 250 gpm. The requirement for an additional unit is better performed by reviewing the accumulation of grit in the basins rather than a comparison of pumping capacities. The SWRP staff noted to Brown and Caldwell that the sequential operation of grit pumping may be one of the primary contributors to grit plugging in both the aerated grit systems and the vortex grit systems. The capacity of the dewatering systems (classifiers), when evaluated versus the current flow and loading of 250 gpm from the grit pumps, shows that adequate dewatering capacity is available, however, this capacity should also be compared to actual operation and staff experience. The accumulation of the grit in the basins indicated that either the grit pumping rate of 250 gpm is not sufficient or the operation of the pumps is not effectively removing sufficient grit. If further analysis of the grit removal rate shows that flow and corresponding loading rates need to be increased from the 250 gpm rate, then the capacity of the dewatering equipment may be insufficient.

Table 2-8. Grit Dewatering Equipment Design Data

Dewatering Component	Number	Unit Capacity (gpm or CY /hr) [1]	Firm Capacity (mgd) [2]	Peak Grit Loading (cf / hr) [3]	Capacity Deficiency (mgd)	Additional Units Required
Vortex Basin Grit Pumps	3	250	Firm capacity not defined, capacity review should be based on historical loadings and observations.			
Aerated Basin Grit Pumps	8	250				
Grit Classifier / Selector Grit Clarifier Grit Escalator	3 3 3	2 CY /hr	4CY /hr	0.6 cf/hr/mgd or 3.55 CY /hr	*See Note 4	

Notes: 1 – The capacity of the dewatering equipment (classifier /selection, clarifier, and escalator) is based on data provided in the CDM Memo and is based primarily on the capacity of the escalator.

2 – The grit pumps operate in sequence to maintain a constant 250 gpm feed to the dewatering equipment.

3- The peak grit loading is based on data provided in the CDM Memo.

4- Capacity is dependent on the variability of the grit loading.

2.3.5 Summary

All major components of the preliminary treatment liquid stream were evaluated with comparison to the design MMF of 76 mgd. The grit dewatering system was evaluated against an assumed amount of grit that would accompany this flow. The firm capacity of each area was calculated based on the existing equipment and their design capacity. If a capacity deficiency was found, that value was listed along with the additional number of units required to address the deficiency. The evaluation provided the following results:

- The following capacity assumptions assume that the water surface can be lowered after the bar screens:
  - One additional upper bar screen is required based on the assumptions that one of the units is out of service and 80 percent of the peak flow enters the upper bar screen channel.
  - One additional lower bar screen is required based on the assumptions that one of the units is out of service and 20 percent of the peak flow enters the upper bar screen channel.
- If the water surface cannot be lowered after the bar screen, it's estimated that at least two upper and two lower bar screens will be required but further investigation of the hydraulic conditions is needed.
- At least one additional aerated grit basins are required (two are needed if calculated based on PIF) based on the assumption that entire vortex process system could be out of service.
- At least two additional vortex basins are required (three are needed if calculated based on PIF) based on the assumption that both aerated basins are on-line but one of the vortex units is out of service.
- The vortex grit system is considered a failed system so additional grit removal capacity is a critical need.
- The lift pumps at Lift Station 11 theoretically have sufficient capacity to meet peak flow requirements based on the assumption that one unit is out of service and 20 percent of the peak plant flow enters the lower bar screens. However, operator experience indicates that the capacity is less than design and the additional capacity is likely needed. Further inspection and evaluation of these pumps is recommended.
- At least one additional grit classifier is recommended to address peak flow conditions.

2.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The preliminary treatment facility assets were evaluated based on a number of factors to determine overall risk which was based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the preliminary treatment facility asset risk assessment are presented in Table 2-8.

Table 2-9. Preliminary Treatment Facility Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	0.3	0.5	0.2	1	0.105	0.132	0.044	0.105	0.386	0.163	0.08	0.082	0.325	0.17	0.068	0.051	0.289	1				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
Structure	Building	50	22	3	4	3	3.5	1	3	1	3	0.86	1	1	1	0.325	3	1	3	0.731	1.916	4	6.0	15	
EI&C	Power	20	22	5	4	4	4.3	3	3	3	3	1.158	5	5	3	1.461	5	5	5	1.445	4.064	5	17.5	3	
	Instrumentation & Controls	15	22	5	4	3	4.1	3	3	1	1	0.86	3	3	1	0.811	3	3	3	0.867	2.538	4	9.4	9	
Screening	Bar Screens	25	20	5	4	4	4.3	3	3	3	5	1.368	5	5	3	1.461	5	5	3	1.343	4.172	5	17.9	2	Ranking does not consider lower Bar screens FY 03 replacement.
Vortex Grit System - Pista Grit	Pumps	25	12	3	5	5	4.4	1	5	1	5	1.334	5	3	1	1.137	5	5	5	1.445	3.916	5	17.2	4	Ranking considers impacts to downstream process.
	Vortex Grit Chamber	25	12	3	5	5	4.4	3	5	1	5	1.544	5	3	1	1.137	5	5	5	1.445	4.126	5	18.2	1	Rankings consider impacts to downstream process.
Aerated Grit Systems	Pumps	25	11	3	4	4	3.7	1	3	1	5	1.07	3	1	1	0.651	5	3	3	1.207	2.928	3	8.1	11	Rankings consider impacts to downstream process.
	Grit Chambers	75	11	1	2	1	1.5	1	3	1	5	1.07	3	1	1	0.651	3	3	3	0.867	2.588	2	1.9	21	Rankings consider impacts to downstream process.
	Blowers	20	11	3	3	3	3	1	1	1	1	0.386	1	1	1	0.325	3	1	3	0.731	1.442	2	2.2	20	Rankings consider impacts to downstream process.
Grit Classifiers	Grit Classifiers	30	11	3	5	5	4.4	3	3	1	3	1.07	3	3	1	0.811	5	5	5	1.445	3.326	5	14.6	6	Rankings consider impacts to downstream process.
Misc Mechanical	Odor Control	15	6	3	4	4	3.7	3	3	3	0	0.843	3	0	5	0.899	1	3	5	0.629	2.371	4	7.9	12	
	HVAC	20	2	1	4	4	3.1	1	3	1	0	0.545	3	0	3	0.735	3	3	5	0.969	2.249	4	6.3	14	
	Ferrous Chloride	10	20	5	3	4	3.8	1	1	1	0	0.281	1	1	1	0.325	1	1	3	0.391	0.997	3	2.8	18	
	Gates	30	11	2	4	4	3.4	1	3	1	0	0.545	3	3	1	0.811	5	3	3	1.207	2.563	5	8.7	10	
Materials Handling	Monorails	20	2	1	3	1	2	1	3	0	1	0.606	0	0	1	0.082	1	1	3	0.391	1.079	2	1.1	22	
	Truck Loading	20	20	5	4	5	4.5	3	5	1	1	1.124	3	3	5	1.139	3	3	3	0.867	3.13	5	14.1	7	
	Screenings Dewatering	20	20	5	5	5	5	3	3	5	3	1.246	3	3	3	0.975	3	3	3	0.867	3.088	5	15.4	5	
	Conveyors	20	3	1	4	4	3.1	3	5	3	1	1.212	1	3	3	0.649	5	3	3	1.207	3.068	5	9.5	8	
Other	Upstream Grit System	40	4	1	1	1	1	3	1	1	0	0.491	3	3	1	0.811	5	1	1	0.969	2.271	5	2.3	19	
Lift Station 11	Building	50	9	1	4	2	2.7	1	1	0	1	0.342	1	1	1	0.325	3	1	3	0.731	1.398	4	3.4	17	
	Lift Pumps	25	9	2	2	2	2	1	3	1	0	0.545	3	3	1	0.811	3	3	3	0.867	2.223	4	4.0	16	
	HVAC / Odor Control	15	5	2	5	5	4.1	3	1	3	0	0.579	1	1	5	0.653	3	3	3	0.867	2.099	4	7.7	13	

2.4.1 General Equipment

As discussed in the previous sections, the preliminary treatment facility assets lack the capacity to meet future demands and mechanical integrity to ensure process stability. The most crucial issues were identified as the following:

2.4.1.1 Bar Screens

The bar screens lacks adequate capacity and redundancy to treat influent flows. BC did not visually assess the bar screens but based on the Facility Condition Assessment Report from 2008 by Black & Veatch, the bar screens were found to be in good condition. There is no means to dewater the screenings and presently the SWRP dry the grit outside on beds. This drying method has the potential to cause odors and encourage complaints from neighbors.

2.4.1.2 Grit Removal Systems

The grit removal systems are imperative for the performance and integrity of downstream systems and equipment. SWRP staff has noted grit buildup in the primary clarifiers and aeration basins.

- **Vortex Grit System –** This system has been abandoned due to equipment failure and unreliable operation. The grit tanks are consistently plugged and require a great deal of maintenance. Maintenance of this system poses serious safety concerns to the SWRP staff as there is inadequate access to the mechanical components.
- **Aerated Grit System –** This system is currently overworked since the vortex grit system is out of commission and it must handle all influent flows. Although the condition of the system is considered generally good, the capacity of this system is not adequate for future needs. The aerated grit pumps require a high amount of maintenance.
- **Grit Classifiers –** The grit classifiers are not performing as intended. Little grit is removed and it appears that the grit maybe recycled back through the system and not adequately collected.

2.4.1.3 HVAC/Odor

The Preliminary Treatment Facility HVAC system is currently inoperable meaning that there are insufficient air exchanges in these buildings. This is a serious health and safety issue for SWRP staff who work in these areas. Without proper air ventilation, the odor control system cannot operate properly thus, the air within the building becomes concentrated with hydrogen sulfide gas (H_2S), causing corrosion of the equipment located in these areas. When the HVAC system was operating, the staff measured air flows as great as 18 air exchanges per hour but it seems that system draws H_2S into occupied areas. This lack of proper HVAC and odor control has made this facility a hazardous environment for personnel and a corrosive environment for equipment.

2.4.1.4 Gates

Many of the gates are not completely functional, are leaking and not seating properly. This poses a hazard for maintenance staff requiring access the gate channels and limits operation flexibility. It is difficult for the maintenance staff to access the gate mechanisms and make proper repairs.

2.4.2 Electrical Equipment

2.4.2.1 General

There are three electrical systems associated with the primary treatment facility, each fed from the medium-voltage system. Padmount switches feed dedicated transformers for each system. Medium-voltage power has proven unreliable, mostly due to the complexities of the cogeneration system (See Chapter 11 for more detail on these issues). While the padmount switches and transformers appear to be in good condition, we were unable to remove them from service to inspect the interior working parts and terminations. One of the switches has failed in the past, causing injury to the electrician operating the equipment.

2.4.2.2 East Electrical System (Bar Screens)

The equipment in the room is in poor condition due to age and H_2S corrosion. Lack of proper ventilation has caused operators to prop electrical room doors open, allowing corrosive gasses to enter the electrical rooms. Failure of air-handling equipment has contributed significantly to the H_2S corrosion. The equipment is near the end of its useful life and should be replaced.

The emergency portable generator has failed and been removed. When power fails, staff focuses on getting the cogeneration facility or utility power restored.

Power failures in this area have caused significant disruption to the lower bar screen area, resulting in the need to bypass the facility at times.

2.4.2.3 West Electrical System (Grit)

The equipment in this room is in fair condition, but is being effected by H_2S corrosion. The equipment has significant remaining useful life, but will deteriorate quickly if the H_2S issues are not addressed.

The emergency portable generator has failed and been removed. When power fails, staff focuses on getting the cogeneration facility or utility power restored. Raw sewage overflows result within a few minutes of power failure.

Equipment access and egress from the room are very tight and in some cases they do not meet code requirements.

2.4.2.4 Lift Station 11 Electrical System

The electrical feed appears to be routed through an old switchboard to get to the new electrical building. Otherwise, the equipment is in good condition.

There are provisions for connection of a portable generator, but staff indicates that this has never been used during a power failure. Instead, power failures result in complete bypass of the primary treatment process to the Activated Sludge Pump Station.

2.4.3 Instrumentation and Controls

Influent flow measurement needs to be improved to provide accurate information on influent flows and flow split. Other instrumentation improvements are needed to minimize trip hazards and improve performance.

Plant staff prefers a central location within the building from which to perform operations, but controls are spread throughout the building on local control panels for each equipment item.

Screening equipment is typically run in hand to prevent overflows from clogging.

2.5 Recommendations/Conceptual Workplan

Alternatives were further developed to address the preliminary treatment facility's high risk assets. Since all the major components of this facility were considered high risk, the only viable alternatives were:

1. Completely rehabilitate the existing facility
2. Construct a new preliminary treatment facility

Alternative 2 was selected primarily because rehabilitation of the existing facility would not accommodate the additional capacity requirements that were determined from this evaluation. It is critical that a preliminary treatment system be capable of processing peak influent flows without having to bypass untreated flow to the downstream systems. The best way this can be accomplished at the SWRP is with a new, properly designed preliminary treatment system that achieves these goals. In the interim, the existing preliminary treatment facility will require interim rehabilitation measures to continue service.

Further details on the project, project justification, and cost estimates are provided in Chapter 13.

Table 2-10. Preliminary Treatment Facility Alternatives

Alternative 1	Pros	Cons
Improve Existing Preliminary Treatment Facility	Utilize existing facilities that have no issues	Not possible geographically to extend or build onto existing facility
	Time to complete improvements can be less than new facility	None or limited space for addition of new bar screens, new electrical equipment, new grit removal equipment, new grit classifiers.
	Less cost than new facility	Construction sequence would be extremely intrusive to operations & plant capacity
	Infrastructure components can be re-utilized	Existing facility will need to be thoroughly evaluated to assure Alternative 1 is possible.
		Re-route of existing interceptors and force mains will be required
		HVAC and odor control systems need serious rehabilitation
Alternative 2	**Pros**	**Cons**
Provide New Preliminary Treatment Facility	Layout facility to best suit operations and maintenance	More costly than improving existing
	Construction sequence issues will be less intrusive to operations and plant capacity	Reroute of existing interceptors and force mains will be required
	Could relocate reliable existing equipment to new facility	Time to complete improvements will be more than improving existing
		New infrastructure improvements will be required

3. PRIMARY CLARIFIERS AND PUMP HOUSES

3.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the primary clarifiers and pump houses. In terms of risk, this process area ranks moderately among the SWRP facilities because capacity is adequate but systems are older. Although the effluent launders on the primary clarifiers have been covered and odor control systems provided, there appears to be a buildup of H_2S gas that is deteriorating the concrete in these covered areas. Primary Clarifiers 1-4 are the oldest of the eight clarifiers and are in need of replacement. None of the primary clarifier structures or the mechanisms have cathodic protection. Also, due to the thick consistency of the primary sludge, the primary sludge pumps are having difficulty pumping the sludge and as a result, become plugged and the pump stators burn out frequently. The electrical components are showing signs of deterioration and a lack of proper HVAC has caused corrosion in the pump houses.

A few assets ranked as moderate priority for replacement (Risk Score between 8 and 12) but most were ranked as low priority (Risk Score less than 8). A summary table of the top risk score assets is presented in Table 3-1 and justification for these rankings is described in the following sections.

Brown and Caldwell and the WUA agree that due to the age and condition of Primary Clarifiers 1-4, construction of new primary clarifiers and pump houses appears to be a better approach than rehabilitating this older, smaller group of primary clarifiers. This approach would also allow for a new process of incorporating separate primary sludge thickening in new gravity thickeners. Additional rehabilitation and improvements are anticipated for the remaining primary clarifiers and pump house.

Table 3-1. Primary Clarifiers and Pump Houses Process Area Summary

Asset Classification	Total Risk	Assessment Implications
PC 1-4 – Mechanisms	10.8	Essential for capacity and reducing system bypasses
PC 1-4, PH 1&2 – Power	10.2	Essential for plant processes
PC 1-4, PH 1&2 – I&C	8.5	Essential for system integrity
PC 1-4 – Tanks	7.7	Necessary for performance and integrity of downstream systems
PC 5-8, PH 3 – Sludge Pumps/Pipes/Valves	7.3	Necessary for maintenance, performance, and capacity
PC 5-8 – Mechanisms	7.1	Necessary for performance and integrity of downstream systems
PC 1-8 – Tank Draining	6.9	Necessary for safety, capacity, and maintenance
PC 1-4, PH 1&2 – Sludge Pumps/Pipes/Valves	6.8	Necessary for maintenance, performance, and capacity
PC 1-8 – Odor Control	6.7	Necessary for maintaining positive public image

3.2 Introduction

Screened and degritted wastewater flows from the preliminary treatment facility to eight primary clarifiers. The primary influent flows through a control gate structure which splits the flow between Primary Clarifiers 1-4 and Primary Clarifiers 5-8. Seven primary clarifiers are typically online with one large clarifier normally kept off-line in case of emergency. The primary effluent is pumped to the aeration basins via lift pumps located at Pump Houses (PH) #1 and #2 and the Activated Sludge Pump Station (ASPS). The primary solids are pumped via the sludge pumps located in Pump Houses #1, #2, and #3 and transferred to a sludge blending tank.

3.3 Capacity Evaluation Results

The primary clarifier and pump house capacity evaluation criteria are based on the peak hourly flow (PHF) condition of 107 mgd and the rated capacities of the major preliminary treatment assets were evaluated against this level of total treatment flow rate but the results are presented in terms of an equivalent maximum monthly flow (MMF). The equivalent MMF was determined by taking the firm equipment rated capacities and applying the appropriate peaking factors (presented in Table 1-1 and Table 1-2) to calculate the MMF. The primary sludge pump capacity is based on 2008 plant data with assumptions noted below. Individual assets have slightly different assumptions for this capacity evaluation; therefore, specific assumptions are listed for each major asset described. The primary clarifier capacity evaluation includes the following systems:

- Primary Clarifiers
- Primary Effluent Pumps
- Primary Sludge Pumps

3.3.1 Primary Clarifiers

3.3.1.1 Assumptions

At design average flow conditions, the NMED wastewater facility design guidelines recommend no more than 700 gpd/ft^2. The peak hourly flow recommendation is no more than 1,200 gpd/ft^2. The 2009 Basic Design Data (provided by the SWRP) states an average hydraulic loading rate of 1,000 gpd/ft and a peak hydraulic loading of 2,000 gpd/ft^2. Firm capacity is based on one of Primary Clarifiers 5-8 being out of service since these are the largest clarifiers and operations typically keeps one of these offline for emergencies.

3.3.1.2 BioWin™ Results

The BioWin™ model calibration found that the annual average surface overflow rate (SOR) was around 550 gpd/ft^2 in 2008 assuming one of the larger clarifiers was offline. At the maximum month design flow of 76 mgd, the primary SOR (still assuming one of the larger clarifiers is offline) was 770 gpd/ft^2.

3.3.1.3 Capacity

The capacity of the primary clarifiers was also evaluated based on the NMED peak hourly design SOR of 1,200 gpd/ft^2. These results are presented in Table 3-2.

Table 3-2. Primary Clarifiers Design Data								
Primary Clarifiers	Number	Diameter (ft)	Design Flow [1] (mgd)	Firm PHF Capacity (mgd) [2]	Firm MMF Capacity (mgd)	Design MMF Flow (mgd)	Capacity Deficiency (mgd)	Additional Units Required
1-4	4	120	13.6	54.4	38.4	76	0	0
5-8	4	150	21.2	63.6	44.9			
			Total	118	83.3			

Notes: 1 – Design flow based on the NMED peak hourly design flow SOR of 1,200 gpd/ft².

2 – Firm capacity assumes one of Primary Clarifiers 5-8 is offline

3.3.2 Primary Effluent Pump Stations

There are three (3) separate pump stations that pump primary effluent to the aeration basins. Pump Houses #1 and #2 pump flow from Primary Clarifiers 1 through 4. The ASPS pumps primary effluent from Primary Clarifiers 5 through 8. All three pump stations pump the primary effluent into one common header that feeds into the aeration basins. Flow from Primary Clarifiers 5 through 8 can be diverted to Pump House #1 via a bypass line. The pumps in PH#1 and #2 are all variable speed. Three pumps in the ASPS are variable speed and two pumps are constant speed.

3.3.2.1 Assumptions

The primary effluent pump capacity evaluation considered all three pump stations online. Firm capacity was based on one of the larger pumps offline in each pump station.

3.3.2.2 Capacity

The capacity evaluation for the sludge pumps relied on the design information provided in the 2009 Basic Design Criteria provided by the SWRP. The results of the primary effluent pump capacity evaluation are provided in Table 3-3.

Table 3-3. Primary Effluent Pump Design Data							
Primary Effluent Pumps	Number	Unit Capacity (mgd) [1]	Firm PHF Capacity (mgd) [2]	Firm MMF Capacity (mgd)	Design MMF (mgd)	Capacity Deficiency (mgd)	Additional Units Required
PH #1	2	10.7	10.7	7.6	76	0	0
	2	9	18	12.7			
PH #2	2	10.7	10.7	7.6			
	2	9	18	12.7			
ASPS	5	23.8	95.2	67.3			
Total			152.6	107.9			

Notes: 1 – Design capacity stated in the 2009 Basic Design Data

2 – Firm capacity assumes one large pump is offline in each pump station.

3.3.3 Primary Sludge Pumps

There are a total of eleven (11) primary sludge pumps: three (3) sludge pumps in both Pump Houses #1 and #2 and five (5) sludge pumps in Pump House #3.

3.3.3.1 Assumptions

The capacity evaluation for the sludge pumps is based on 2008 plant data used to determine the primary sludge flows. These data were also used to determine the primary sludge peaking factors for peak day and maximum month conditions. These peaking factors were applied to the future flows based on historical data and the future flow was based on a ratio of influent flows (See Chapter 1.3). The primary sludge plant data were highly variable and the peak day solids percentage in 2008 was 11.3 while the average solids percentage was 5.0 (these values omit outlying data points). Due to the fact that the peak day solids percentage was extremely high and with the understanding that the SWRP is planning to operate on a thin sludge pumping mode in the future, the maximum month solids percentage of 6.8 was used to determine the peak day sludge flow from the calculated peak day solids loading. Based on these assumptions, the design MMF of primary sludge flow was determined to be 0.40 mgd. These calculations are provided in Appendix A.

The CDM Memo assumed an operating time of six hours per day for the primary sludge pumps. At that rate the capacity for each of these pumps would be 0.6 mgd/day or a total of 0.66 mgd for all eleven pumps at one time. Brown and Caldwell recommends that the sludge pump capacity be evaluated based on an eight hour operating day which seems reasonable if the SWRP is operating the primary clarifiers in thin-sludge pumping mode as the sludge would need to be withdrawn more frequently. This would apply an additional peaking factor of three (24 hours/8 hour operation = 3) to the flow.

3.3.3.2 Capacity

The results of the primary sludge pump capacity evaluation are provided in Table 3-4.

Table 3-4. Primary Sludge Pump Design Data

Primary Sludge Pumps	Number	Unit Capacity (mgd) [1]	Firm PDF Capacity (mgd) [2]	Firm MMF Capacity (mgd)	Design MMF (mgd)	Capacity Deficiency (mgd)	Additional Units Required[4]
PH #1	3	0.24	0.48	0.29	0.40		
PH #2	3	0.24	0.48	0.29			
PH #3	5	0.24	0.96	0.58			
Total			1.92	1.16	1.2 [3]	0.04	0

Notes: 1 – Design capacity stated in the 2009 Basic Design Data

2 – Firm capacity assumes one pump offline in each Pump House

3 – Assumes 8-hrs operating time for the sludge pumps. To accommodate this, the flow has been increased by a factor of 3

4 – See summary below.

3.3.4 Summary

The primary clarifiers appear to have adequate capacity to meet the future peak hourly flow conditions. The primary effluent pumps also appear to have adequate capacity to meet the future design flow conditions. Based on an eight hour operating time period, the primary sludge pumps are slightly below the design flow.

Changing the speed/motors on the pump to get more flow may be a viable option, but since the firm capacity and peak flow are so close, we would not recommend another pump without further evaluation.

3.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The primary clarifier and pump houses' assets were evaluated based on a number of factors to determine overall risk which is based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the preliminary treatment facility asset risk assessment are presented in Table 3-5.

Table 3-5. Primary Clarifiers and Pump Houses Asset Risk Assessment Results																									
Classification	Asset(s)	Expected Life		Probability of Failure				Consequence of Failure														Redundancy Factor	Risk Score	Rank No.	Notes
								Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
			Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence				
PC 1-4 Structure	Tanks	75	50	4	4	4	4	1	1	1	3	0.596	3	3	1	0.811	3	1	3	0.731	2.138	4	7.7	4	
PC 1-4 Mechanical	Mechanisms	30	50	5	4	3	4.1	1	3	1	1	0.65	5	3	3	1.301	3	3	5	0.969	2.92	4	10.8	1	Ranking includes all in-tank mechanical equipment
Pump House 1 & 2 Structure	Building	50	50	5	4	3	4.1	1	3	1	0	0.545	1	0	1	0.245	1	1	3	0.391	1.181	4	4.4	18	
PC 1-4, PH 1&2 EI&C	Power	20	50	5	4	4	4.3	1	3	1	0	0.545	3	3	3	0.975	5	1	4	1.122	2.642	4	10.2	2	Includes distribution equipment for lift pumps
	Instrumentation & Controls	15	50	5	3	3	3.6	1	3	1	0	0.545	5	5	1	1.297	3	1	4	0.782	2.624	4	8.5	3	
PC 1-4, PH 1&2 Pumping System	Sludge Pumps/ Pipes/ Valves	25	10	3	4	5	3.9	1	3	1	3	0.86	1	1	3	0.489	3	3	5	0.969	2.318	3	6.8	9	Scum pumping is considered in this ranking
	Grinders	20	4	2	1	1	1.3	0	1	0	0	0.132	0	1	0	0.08	3	1	1	0.629	0.841	2	0.5	23	
	Lift Pumps		50				0					0				0						–	–	–	Ranking included with Aeration Basins section.
PC 1-4, PH 1&2 Misc. Mechanical	Odor Control	15	10	4	4	4	4	3	3	3	1	0.948	3	0	5	0.899	1	1	3	0.391	2.238	3	6.7	10	
	HVAC	20	10	3	3	4	3.2	0	3	0	0	0.396	3	0	3	0.735	1	3	3	0.527	1.658	3	4.0	19	
PC 1-4 Other	Spraywater and Washwater Systems	20	20	5	4	4	4.3	1	3	1	0	0.545	1	1	3	0.489	3	3	3	0.867	1.901	3	6.1	16	
	Tank Draining	20	50	5	3	4	3.8	1	3	1	1	0.65	3	1	3	0.815	3	3	5	0.969	2.434	3	6.9	7	Ranking considers long duration to drain tank
	Cathodic Protection	20	25	5	4	4	4.3	3	3	1	1	0.86	1	1	1	0.325	3	3	3	0.867	2.052	3	6.6	12	
PC 5 - 8 Structure	Tanks	75	20	2	4	4	3.4	1	1	1	3	0.596	3	3	1	0.811	3	1	3	0.731	2.138	4	6.5	14	

Table 3-5. Primary Clarifiers and Pump Houses Asset Risk Assessment Results

Classification	Asset(s)	Expected Life		Probability of Failure				Consequence of Failure: Social					Consequence of Failure: Environmental				Consequence of Failure: Economic					Redundancy Factor	Risk Score	Rank No.	Notes
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
			Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence				
PC 5 - 8 Mechanical	Mechanisms	30	20	4	2	3	2.8	1	3	1	1	0.65	5	3	3	1.301	3	3	3	0.867	2.818	4	7.1	6	Ranking includes all in-tank mechanical equipment. PC 5 is in poorest condition.
Pump House 3 Structure	Building	50	20	3	2	2	2.3	1	3	1	0	0.545	3	0	1	0.571	1	1	1	0.289	1.405	2	1.6	22	
PC 5 - 8, PH 3 EI&C	Power	20	20	5	3	2	3.4	1	3	1	0	0.545	2	2	3	0.732	3	1	3	0.731	2.008	4	6.1	15	Ranking considers no back up power available.
	Instrumentation & Controls	15	4	2	3	3	2.7	1	3	1	0	0.545	1	1	1	0.325	1	1	3	0.391	1.261	4	3.1	20	
PC 5 - 8, PH 3 Pumping System	Sludge Pumps/ Pipes/ Valves	25	20	4	4	5	4.2	1	3	1	3	0.86	1	1	3	0.489	3	3	5	0.969	2.318	3	7.3	5	Scum pumping is considered in this ranking
	Grinders	20	4	2	1	1	1.3	0	1	0	0	0.132	0	1	0	0.08	3	1	1	0.629	0.841	2	0.5	23	
PC 5 - 8, PH 3 Misc Mechanisms	Odor Control	15	10	4	4	4	4	3	3	3	1	0.948	3	0	5	0.899	1	1	3	0.391	2.238	3	6.7	10	
	HVAC	20	5	2	3	3	2.7	0	3	0	0	0.396	0	1	0	0.08	1	1	3	0.391	0.867	3	1.8	21	
PC 5 -8 Other	Spraywater and Washwater Systems	20	20	5	4	4	4.3	1	3	1	0	0.545	1	1	3	0.489	3	3	3	0.867	1.901	3	6.1	16	
	Tank Draining	20	20	5	3	4	3.8	1	3	1	1	0.65	3	1	3	0.815	3	3	5	0.969	2.434	3	6.9	7	Ranking considers long duration to drain tanks.
	Cathodic Protection	20	20	5	4	4	4.3	3	3	1	1	0.86	1	1	1	0.325	3	3	3	0.867	2.052	3	6.6	12	

3.4.1 General Equipment

As discussed in the previous sections, the primary clarifiers and pump houses appear to have adequate capacity to meet future demands, with the exception of sludge pumps; however, these systems lack the mechanical integrity to ensure process stability. The most crucial issues are identified in the following subsections.

3.4.1.1 Primary Clarifiers Mechanisms

There is a lack of cathodic protection for all primary clarifiers and there are structural problems with the newer Primary Clarifiers 5-8. The concrete where the effluent troughs are covered is severely corroded which is likely due to a build-up of H_2S gas.

Primary Clarifiers 1-4 are fifty years old, there is significant concrete corrosion, and most of the mechanical equipment requires replacement. Some of the scum scrappers are bent and many of the parts have to be built in-house because they are no longer available.

The primary clarifiers have been piece-meal rehabilitated and their equipment replaced on an as-failed emergency basis over the years; however, have now have reached a point where major comprehensive rehabilitation is required.

3.4.1.2 Primary Clarifiers - Draining

The SWRP staff has difficultly draining the primary clarifiers because there is no permanent means to drain them. The staff must use a portable pump that is directly connected to the drive mechanism starter box. This poses a safety hazard to the staff and takes a great deal of time to drain a single clarifier.

3.4.1.3 Sludge Pumps, Pipes, and Valves

The sludge pumps are so old that the plant staff has to manufacture in-house replacements as replacement parts are no longer available from the supplier/manufacturer.

The sludge piping lines are often clogged due to what the operators believe is the sludge piping's restrictive alignment and sizing which causes the sludge pumps to run dry. Proper run-dry prevention controls are not in place which has on occasion caused the motors to burn up. Overall, these issues require intensive maintenance and can strain the staff.

3.4.1.4 Odor Control

As mentioned previously, there appears to be a build-up of H_2S gas that is degrading the effluent launder concrete in the primary clarifiers. This area around the effluent launders is covered and the air is collected and treated by individual biofilters located at each primary clarifier. This evidence of concrete deterioration suggests that the blowers used to transport the foul air to the biofilters are not working as intended.

3.4.2 Electrical Equipment

3.4.2.1 General

There are two electrical systems associated with the primary clarifiers and pump stations, each fed from the medium-voltage system. Medium-voltage switches feed dedicated transformers for each system. Medium-voltage power has proven unreliable, mostly due to the complexities of the cogeneration system (See Section 11 for more detail on these issues). While the switches and transformers appear to be in fair condition, the switches could not be removed from service to inspect their interior condition.

3.4.2.2 Primary Clarifiers 1-4 North and South Electrical Rooms

The system is fed by one of the older switch/transformer combinations in the plant. A single transformer and outdoor switchgear feed both the North and South electrical rooms. These systems are starting to show visible signs of deterioration.

Lack of proper ventilation has caused operators to prop electrical room doors open, allowing corrosive gasses to enter the electrical rooms. The equipment in the room is in poor condition due to age and H_2S corrosion. Failure of air-handling equipment has contributed to the H_2S corrosion. The equipment is near the end of its useful life and should be replaced.

Note that the electrical distribution system for these rooms also provides power for critical north lift pumps covered under Section 4. There does not appear to be any provision for the connection of a standby generator at this facility. When power fails, staff focuses on getting the cogeneration facility or utility power restored. Power failures in this area have resulted in critical lift pump failures.

3.4.2.3 Primary Clarifiers 5-8

The system is fed by padmount switch 89-A1, which is in poor condition.

The equipment in this building is old, but in fair condition. The building is too small and lacks proper cooling. Lack of proper ventilation has caused operators to prop electrical room doors open, allowing corrosive gasses to enter the electrical rooms. H_2S corrosion and roof leakage onto electrical equipment needs to be addressed.

3.4.3 Instrumentation and Controls

The primary sludge lines at both facilities are prone to clogging. When this happens, run-dry protection instrumentation fails to detect the problem, often resulting in burned-up motors on the primary sludge pumps. Control features designed to optimize sludge density cannot be used because any thickening in the sludge causes lines to clog. Instead, pumps run continuously, resulting in excess amounts of water being pumped to the sludge blending tank when the staff has to water down the thickened sludge so it can be pumped more easily.

3.5 Recommendations/Conceptual Workplan

This section describes the general workplans and recommended improvements for the primary clarifiers and pump houses clarifiers. Details on the project, project justification, and cost estimates are provided in Chapter 13.

The conceptual workplan for the primary clarifiers and pump houses includes a number of rehabilitation projects to add additional capacity and to improve the primary clarifier structures, pump houses, and sludge pumping. The primary work effort includes four new primary clarifiers with similar capacity as Primary Clarifiers 5-8 to replace Primary Clarifiers 1-4 due their age and poor condition and the construction of new gravity thickeners to transfer the primary sludge thickening operation from the primary sludge clarifiers to dedicated thickening systems.

Because the primary clarifiers show signs of structural corrosion likely due to a build-up of H_2S gas from thickened primary sludge fermenting in the tanks, it would advantageous to rethink the operation of the primary clarifiers as thickeners. Operating the primary clarifiers in a thin-sludge pumping mode will allow the sludge to be pumped at a much lower solids concentration. This would help reduce the potential to produce H_2S gas and alleviate the stress on the sludge lines and pumps. The thin, primary sludge could then either be directed to a covered, dedicated primary clarifier to serve as a sludge thickener or a new gravity thickener.

Another benefit of having a dedicated primary sludge thickener is that the volatile fatty acids produced can be used as a carbon source in the aerations basins. This is further discussed in Chapter 4.

For the conceptual workplan, Brown and Caldwell is recommending that four new primary clarifiers and two new gravity thickeners be constructed.

Improvements at the primary clarifiers and pump house are comprised of the following phased projects:

- Primary Clarifier and Pump House Improvements – Phase 1
  - **Capacity –** Demolish the two older primary clarifiers, build four new primary clarifiers, and construct two gravity thickeners. A new pump house with three new primary sludge pumps will also be included.
  - **Clarifier Tank and Mechanism –** Primary Clarifiers 5-8 will have concrete repair and the mechanisms will be repaired or replaced. Primary Clarifiers 1-2 will have their mechanisms replaced for continued operation while the new primary clarifiers are constructed.
  - **Primary Clarifier Spray Water and Wash Water –** The spray water and wash water systems will be repaired or replaced and new hydrants will be installed for each primary clarifier.
  - **Primary Clarifier EI&C –** Repair and replace as required for project improvements
- Primary Clarifier and Pump House Improvements – Phase 2
  - **Clarifier Draining –** Piping modifications will be made to allow the clarifiers to drain. Also includes repairs and/or replacement of pumps at existing tank drain systems at Primary Clarifiers 5-8.
  - **Sludge Pumping, Piping, and Valving –** Improvements include replacement of sludge pumps and piping and valving replacement/rehabilitation.
  - **Pump Houses #1, #2, #3 –** Improvements include repair of the building structures and interior systems.
  - **Clarifier Odor Rehabilitation –** The existing primary clarifiers will be covered and the odor control system will be rehabilitated.

4. AERATION BASINS

4.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the Aeration Basins. In terms of risk, this process area ranks moderately among the SWRP facilities because most systems are in good condition; however, air capacity and treatment performance are a concern. The aeration basins provide the primary means of biological treatment of the SWRP's wastewater stream. Adequate air is needed to provide treatment and meet critical effluent permit limits. The SWRP has violated its effluent permit in the past due to blower failures. The SWRP has also experienced foaming events which have affected the secondary treatment process and caused safety concerns. Electrical and instrumentation components are also in need of repair and replacement.

The South blowers and foam control assets ranked as high priority for replacement (Risk Score greater than 12). The North blowers and building HVAC ranked as a moderate priority (Risk Score between 8 and 12) and the remaining assets were ranked as lower priorities (Risk Score less than 8). A summary of the risk scores for the principal assets in this process area is provided in Table 4-1 and justifications for these rankings are discussed in the following sections.

As part of a near term improvements project, we recommend installing new blowers to add air capacity to the aerations basins. As part of longer term improvements we recommend modifying the aeration basins to collect and transport foam and perform comprehensive repair and replacement of portions of the mechanical and electrical components of this process area. Additional replacement and repair improvements are anticipated for the mechanical and electrical components of this process area.

Table 4-1. Aeration Basins Process Area Summary

Asset Classification	Total Risk	Assessment Implications
South Aeration System -Blowers	17.5	Critical for process performance and permit compliance
South – Foam Control	13.5	Essential for process performance and staff safety
North – Foam Control	13.5	Essential for process performance and staff safety
North Aeration Blowers	11.9	Critical for process performance and permit compliance
North Blower Building HVAC	11.9	Essential for equipment performance
North – Valves and Gates	7.0	Necessary for operational flexibility
North – Spray Water and Washwater Systems	6.9	Necessary for maintenance
South – Valves and Gates	6.9	Necessary for operational flexibility
South – Spray Water and Washwater Systems	6.9	Necessary for maintenance
South Blower Building	6.9	Necessary for process performance and permit compliance

4.2 Introduction

The activated sludge system consists of fourteen (14) activated sludge basins. Each basin consists of three (3) anoxic zones, two (2) "swing zones" that can operate in anoxic or oxic mode, and four (4) oxic zones. Oxic

Zone No.4 is not aerated but serves as a DO control zone to allow a depletion of oxygen in the mixed liquor before it is recycled to Anoxic Zone No.1. Mixed liquor flows from Oxic Zone No. 3 to an effluent channel and then is distributed to the final clarifiers. There are twelve (12) blowers that supply air to the oxic zones of the aeration basins.

4.3 Capacity Evaluation Results

The capacity of the activated sludge system was evaluated with the BioWin™ model. The model was calibrated with plant data and simulations were run to evaluate treatment and capacity constraints. The activated sludge system includes the aeration basins, aeration system, and final clarifiers. Details on the BioWin™ model calibration and evaluation results are provided in Appendix B. The activated sludge system capacity evaluation includes the following systems:

- Aeration Basins
- Aeration Blowers
- Mixed Liquor Internal Recycle Pumps

The capacity of the aeration basins was based on the mixed liquor concentration and solids loading to secondary clarifiers. Based on these parameters, the aeration basins have a capacity of 90.8 mgd on a MMF basis (assuming one unit out of service). Constraints due to permit effluent limits and air requirements of the activated sludge system were modeled in BioWin™ and these results are discussed in the following sections.

4.3.1 Aeration Basins

4.3.1.1 Assumptions

The following assumptions were made as part of the BioWin™ model to determine future capacity at the MMF of 76 mgd:

- Thirteen (13) aeration basins online
- Eleven (11) final clarifiers online
- Aerated solids retention time of seven (7) days
- Strictest total inorganic nitrogen (TIN) permit limits of 6.7 mg/l on a 30-day average basis, and 10 mg/l on a maximum daily basis based on low flow in the Rio Grande

4.3.1.2 Results

From an examination of the plant data, the corresponding influent loads, and some data mining to eliminate apparent outliers, the month of March 2008 was selected to represent the design "maximum month" condition. This month was chosen because the highest solids loading rate in the secondary clarifiers occurred in March. Therefore, March 2008 was used to develop the influent itinerary for the BioWin™ simulator. Parameter concentrations used in the simulator corresponded with actual March 2008 data. Therefore, to develop the capacity evaluations, concentrations were kept the same as March 2008, but influent flows were increased until the month average of 76 mgd was met. The data used in the BioWin™ model are provided in Appendix B.

The BioWin™ model found that the existing configuration of the aeration basins would not meet the strictest TIN permit limits without a supplemental carbon source such as acetic acid at the design flow of 76 mgd.

The results also found that additional blowers would be needed to provide aeration for treatment and this is discussed in the following section.

4.3.2 Aeration Blowers

There are a total of twelve (12) aeration blowers; four (4) in the North Blower Building and eight (8) in the South Blower Building.

4.3.2.1 Assumptions

Since the North and South Blowers feed into one single header for the aeration basins, the capacity evaluation of the aeration blowers assumes that one out of the twelve blowers is offline.

4.3.2.2 Capacity

The results obtained by BioWin™ for the amount of air required to maintain required dissolved oxygen concentrations appeared to be significantly more than currently experienced in the plant. The approach used in BioWin™ was to use the default aeration parameters, but with input values of appropriate alpha values and other site specific parameters, such as temperature and atmospheric pressure.

The plant currently has twelve blowers installed. Under current operating conditions at 55 mgd, only six blowers are in operation.

A number of scenarios were run in the BioWin™ model to meet the strictest TIN effluent limits at 76 mgd. Under these assumptions, a supplemental carbon source would be required and the air requirement for this scenario is presented in the table below.

The capacity evaluation of the aeration blowers is presented in Table 4-2.

Table 4-2. Blower Design Data

Aeration Basin Blowers	Number	Unit Capacity (scfm) [1]	Firm Capacity (scfm) [2]	Maximum Air Requirement (scfm) [3]	Capacity Deficiency (scfm)	Additional Units Required
North	4	7,140	28,560	114,000	35,460	5
South	8	7,140	49,980			
		Total	78,540			

Notes: 1 – Based on CDM 2001 Report and confirmed with blower curves provided by the SWRP.

2 – Assumes only one blower is offline in the South Blower Building

3 – Based on the maximum air requirement determined from BioWin™ with acetic acid addition

The plant simulations at 76 mgd MMF design capacity and lowest TIN limits show a blower deficiency in Table 4-2. To confirm this predicted deficiency, improvements in the plant, operational monitoring is required, including process air flows to each basin and operating dissolved oxygen levels in each zone of the basins. By these means, better data of the relationship between COD and nitrogen removal, and operating DO and process air through the basins can be better calibrated with a plant simulator.

4.3.3 Mixed Liquor Internal Recycle (IR) Pumps

Each aeration basin has one internal mixed liquor recycle pump with fourteen (14) pumps in total. Each pump is located in the DO control zone of each basin and serves to recycle a portion of the mixed liquor stream to the first anoxic zone. This recycle system provides nitrates for the denitrification process in the anoxic zones.

4.3.3.1 Assumptions

Based on the pump curves, the mixed liquor IR pumps can pump up to 30 mgd. At 55% output, the pumps produce around 10.5 mgd. The operators have a fixed rate operation of 150% return which is their desired recycle rate.

4.3.3.2 Capacity

The capacity evaluation for the mixed liquor IR pumps is presented in Table 4-3.

Table 4-3. IMLR Pump Design Data

Recycle Pump	Number	Unit Capacity (mgd) [1]	Firm MMF Capacity (mgd) [2]	Design MMF (mgd) [3]	Capacity Deficiency (mgd)	Additional Units Required
IMLR	14	30	390	304	0	0

Notes: 1 – Capacity provided by in CDM Memo and confirmed by pump performance curve.

2 –Based on thirteen aeration basins and IR pumps online.

3 –Maximum month flow based on 400% recycle rate.

4.3.4 Summary

In summary, an additional carbon source will be needed to meet the most stringent permit limits and additional aeration blowers are needed to meet the future air requirements. However, the mixed liquor IR pumps have sufficient capacity for future recycle flows.

4.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The aeration basin assets were evaluated based on a number of factors to determine overall risk which was based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the aeration basin asset risk assessment are presented in Table 4-4.

Table 4-4. Aeration Basins/Blower Buildings/Lift Pumps/Activated Sludge Pump Station Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
North Structures	Aeration Basins	75	10	1	2	1	1.5	0	1	1	1	0.281	1	1	1	0.325	1	1	3	0.391	0.997	2	0.7	33	
	Foam Control	20		3	4	4	3.7	3	3	3	3	1.158	5	5	3	1.461	5	5	5	1.445	4.064	4	13.5	2	
	Blower Bldg.	50	10	2	2	1	1.8	0	1	1	3	0.491	1	1	1	0.325	1	1	3	0.391	1.207	2	1.1	31	
North EI&C	Power	20	10	3	3	3	3	1	3	1	0	0.545	5	1	1	0.977	3	3	3	0.867	2.389	4	6.5	14	North lift pumps power distribution equipment is included with Pri 1 - 4
	Instrumentation & Controls	15	10	4	4	4	4	1	1	1	0	0.281	3	1	1	0.651	3	3	3	0.867	1.799	4	6.5	13	
North Aeration System	Blowers	20	10	3	2	5	2.9	3	3	3	5	1.368	5	3	3	1.301	5	5	5	1.445	4.114	5	11.9	4	
	Diffusers	20	10	3	3	3	3	1	3	1	3	0.86	3	1	1	0.651	1	1	3	0.391	1.902	3	4.3	22	Ranking does not consider replacement scheduled in near future.
	Air Valves	20	10	3	4	5	3.9	1	1	1	3	0.596	3	1	1	0.651	3	3	5	0.969	2.216	3	6.5	12	
North Pumping System	Lift Pumps	25	16	4	1	1	1.9	1	3	1	3	0.86	3	5	1	0.971	5	3	1	1.105	2.936	2	2.8	27	Ranking does consider replacement scheduled with FY03 project.
	RAS Pumps	25	10				0					0				0				0	0	–	–	–	RAS pump ranking is included in South Pumping Systems section below.
	Recycle Pumps	20	10	3	3	3	3	1	3	1	3	0.86	3	1	1	0.651	1	1	3	0.391	1.902	4	5.1	19	
North Misc Mechanical	Mixers	20	10	3	2	1	2.1	1	1	1	3	0.596	3	1	1	0.651	3	1	1	0.629	1.876	3	3.0	23	
	Chemical Feed Systems	15	10	4	2	2	2.6	1	3	1	0	0.545	3	1	1	0.651	3	5	3	1.003	2.199	2	2.9	25	Ranking includes HCL, Soda Ash, Acetic Acid & NaOCL.
	HVAC	20	10	3	4	4	3.7	3	3	3	3	1.158	3	3	3	0.975	5	5	5	1.445	3.578	4	11.9	5	
	Valves & Gates	25	10	3	4	5	3.9	1	3	1	0	0.545	3	3	1	0.811	3	4	5	1.037	2.393	3	7.0	6	Ranking includes basin feed valves, RAS valves, RAS Bypass Gates, and drain valves.
North Other	Spray Water & Washwater Systems	20	10	3	4	5	3.9	1	3	1	0	0.545	3	3	1	0.811	3	5	3	1.003	2.359	3	6.9	7	
South Structures	Aeration Basins	75	20	2	3	2	2.5	0	5	1	1	0.809	1	1	1	0.325	1	1	3	0.391	1.525	2	1.9	29	Ranking includes RAS Channels
	Foam Control	20		3	4	4	3.7	3	3	3	3	1.158	5	5	3	1.461	5	5	5	1.445	4.064	4	13.5	2	
	Blower Building	50	50	5	4	5	4.5	0	3	1	3	0.755	3	1	1	0.651	1	3	5	0.629	2.035	3	6.9	10	
	Activated Pump Station	50	10	2	1	1	1.3	0	1	1	1	0.281	3	1	1	0.651	1	1	1	0.289	1.221	2	0.8	32	

Table 4-4. Aeration Basins/Blower Buildings/Lift Pumps/Activated Sludge Pump Station Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
South EI&C	South BB Power		50	1	1	2	1.2	1	1	1	0	0.281	3	1	1	0.651	5	1	3	1.071	2.003	3	1.8	30	
	APS Power	20	10	3	2	3	2.5	1	3	1	0	0.545	5	5	1	1.297	5	5	5	1.445	3.287	3	6.2	16	Includes critical lift pump power
	Instrumentation & Controls	15	10	4	4	3	3.8	1	1	1	0	0.281	5	1	1	0.977	3	1	3	0.731	1.989	4	6.8	11	
South Aeration System	Blowers	20	30	5	5	5	5	1	3	1	5	1.07	5	1	1	0.977	5	5	5	1.445	3.492	5	17.5	1	
South Aeration System	Diffusers	20	10	3	5	4	4.2	1	3	1	3	0.86	3	1	1	0.651	1	1	3	0.391	1.902	3	6.0	17	
	Air Valves	20	5	2	3	3	2.7	1	1	1	3	0.596	3	1	1	0.651	3	3	3	0.867	2.114	3	4.3	21	
South Pumping Systems	Lift Pumps	25	10	3	1	1	1.6	1	3	1	3	0.86	3	5	1	0.971	5	3	1	1.105	2.936	2	2.3	28	
	RAS Pumps	25	10	3	3	3	3	1	1	1	3	0.596	3	1	1	0.651	3	1	3	0.731	1.978	5	5.9	18	
	Recycle Pumps	25	10	3	3	3	3	1	3	1	3	0.86	3	1	1	0.651	1	1	3	0.391	1.902	4	5.1	19	
South Misc. Mechanical	Mixers	20	10	3	2	1	2.1	1	1	1	3	0.596	3	1	1	0.651	3	1	1	0.629	1.876	3	3.0	23	
	Chemical Feed Systems	15	10	4	2	2	2.6	1	3	1	0	0.545	3	1	1	0.651	3	5	3	1.003	2.199	2	2.9	25	Ranking includes HCL, Soda Ash, Acetic Acid & NaOCL.
	HVAC	20	15	4	4	4	4	1	3	1	0	0.545	3	1	1	0.651	3	3	3	0.867	2.063	3	6.2	15	
	Valves & Gates	25	10	3	4	5	3.9	1	3	1	0	0.545	3	3	1	0.811	3	5	3	1.003	2.359	3	6.9	7	Ranking includes Basin Feed Valves, RAS Valves, RAS Bypass Gates, and Drain Valves.
South Other	Spray Water & Washwater Systems	20	10	3	4	5	3.9	1	3	1	0	0.545	3	3	1	0.811	3	5	3	1.003	2.359	3	6.9	7	

4.4.1 General Equipment

As discussed in the previous sections, the aeration basin blowers lack the capacity to meet the design capacity under low flow conditions stated in the current effluent permit. Other mechanical components are recommended for repair to ensure process stability. The most crucial issues were identified as the following:

4.4.1.1 South Building and Blowers

The blowers in the South Blower Building and the building structure itself have exceeded their useful life. Due to structural issues with the building, the blower foundations have had to be fixed at a cost of $100,000 each. It is unknown at this time if the building can be structurally rehabilitated.

4.4.1.2 Foam Control

Nuisance foam is trapped within the aeration basins due to low hanging structures and poor hydraulics in the basins. This allows the foam to buildup in the basins which has caused the walkway on the basins to rise and poses a serious safety concern for staff that need to access those areas. In addition to these issues, foam can also upset the activated sludge process.

4.4.1.3 Valves and Gates

The air valves at the aeration basins are submerged. These valves need to be relocated such that they are out of the water and the actuators and controls should to be replaced. The tank drain valves do not function well and also should be replaced.

4.4.1.4 Spray and Washwater Systems

The existing spray and washwater systems is not functioning as required due to broken sections of pipe, leaks at pipe joints and broken or removed spray nozzles. Additionally, the system does not have freeze protection. These systems are needed for general maintenance of the aeration basins and to help spray down/move foam.

4.4.2 Electrical Equipment

4.4.2.1 General

The medium-voltage system feeds several electrical systems in four locations associated with the aeration systems. While the medium-voltage switches and transformers appear to be in fair condition, we were unable to remove them from service to inspect the interior working parts and terminations.

Medium-voltage power has proven unreliable, mostly due to the complexities of the cogeneration system (See Section 10 for more detail on these issues). While the medium voltage switches and transformers appear to be in fair condition, we were unable to remove them from service to inspect the interior working parts and terminations.

While the secondary-selective systems allow good flexibility for maintenance, they add little to the overall power reliability due to the single utility source and cogeneration complexities.

4.4.2.2 North Lift Pumps – Primary Pump Houses 1 & 2

The distribution system for these pumps is covered in Section 3. Only the lift pump drives are considered here. The drives were recently replaced and are in good condition.

4.4.2.3 North Blowers

Padmount switch 89-24 feeds dual 4160V transformers. The primary of these transformers is tied together at padmount switch 89-24, creating a single point of failure for an otherwise secondary-selective system.

Additional transformers convert the 4160V power to 480V for smaller loads. This transformer arrangement results in double-transformation for the 480V loads, increases the size of the 4160V transformers, and increases the effect of failure of the 4160V transformers.

The equipment in this building is in fair condition. Roof leakage into the MCC room needs to be addressed.

4.4.2.4 South Blowers

The Generator Switching Station (GSS) feeds dual 4160V transformers. The secondary of these transformers is tied together at padmount switch 89-7, creating a single point of failure for an otherwise secondary-selective system.

Smaller 480V loads are provided with a separate feed from GSS and an alternate feed from the South Cogeneration system.

The equipment in this building is in fair condition, including newer starters for the blowers.

4.4.2.5 AS Load Center, AS Pump Station, and South AB MCC Building (Mixing Building)

The AS Plant Load Center is a secondary-selective outdoor switchgear assembly fed from GSS and the South Cogeneration system. This switchgear powers the AS Pump Station and the South AB MCC Building. The switching arrangement allows the critical influent pumps in the AS Pump Station to be powered directly from the 480V cogeneration system. Because the switching must be performed manually, restoration of lift-pump power could be significantly delayed.

The AS Plant Load Center exterior is showing signs of deterioration, but is otherwise in fair condition.

The equipment in the AS Pump Station building is in good condition.

The equipment in the South AB MCC building is in good condition, but dried sludge on the floor raises drainage concerns.

4.4.3 Instrumentation and Controls

While control strategies appear to be appropriate for aeration control, several problems should be addressed to optimize performance.

- Aeration control valves were recently upgraded, but no longer connect properly to the control system. This has resulted in the entire aeration system being switched to manual. This affects both process performance and efficiency for the largest loads in the plant.
- Influent flow from a common header is distributed to each basin through a series of automatic control valves and flow meters. The valves and meters have been problematic.
- RAS flow from a common header is distributed to each basin through a series of automatic control valves and flow meters. The valves and meters have been problematic due to age and performance.
- Deterioration of fiberglass electrical and instrumentation boxes needs to be addressed.
- Short circuits in the controls wiring, particularly in the North Blower Building, have made it difficult for staff to keep the control system functioning properly.

4.5 Recommendations/Conceptual Workplan

This section describes the general workplans and recommended improvements for the aeration basins. Details on the project, project justification, and cost estimates are provided in Chapter 13.

4.5.1 Process Capacity and Denitrification Improvements

As determined from the BioWin™ modeling of the SWRP, the characteristics of the influent wastewater limits the capability of the existing activated sludge process to denitrify without an added carbon source. The SWRP has the facilities needed to provide acetic acid in the future, but chemical addition is expensive.

To address this challenge, the SWRP could produce its own volatile fatty acids to feed to the anoxic zone of the aeration basins. This would reduce the costs of using a chemical carbon source like acetic acid. Another option would be to reconfigure the last oxic zone to have an intermediate anoxic zone for acetic acid feed and increase the IMLR pump flow to 25 mgd per train. This would prolong the need for acetic acid addition while meeting stringent TIN effluent limits.

We recommend evaluation of both of these options when moving forward in preliminary design.

4.5.2 Blower Capacity Improvements

Additional blowers are required to meet the plant's design capacity of 76 mgd MMF. The general workplan is broken into two phases. In Phase 1 the blowers in the North Blower Building will be replaced with high efficiency blowers with more capacity and in Phase 2, the South Blower building will be abandoned, a new blower building and blowers will be constructed and installed.

4.5.3 Foam Control Improvements

Foam entrapment is a major issue in the aeration basins that should be addressed. The overall goals would be to first, move the foam and secondly, to collect and discard it. The general workplan is to modify the aeration basin channel walls to hydraulically transport the foam to the effluent channel, then to construct classifying selector stations along the effluent channel to collect and pump the foam to the DAF system for processing. We also recommend having the capabilities of using a chlorination spray water system in the event that the classifying selector system is not working as intended.

4.5.4 Other Improvements

Additional improvements for the aerations basins will include the following:

- **Spray Water and Washwater Systems –** Comprehensive removal and replacement of the existing systems with installation of new hose stations.
- **E&IC –** Improvements includes new control valves, actuators, and flow meters for RAS and primary effluent lines.
- **Diffusers –** Replace ceramic diffusers with membrane diffusers and replace aging membrane diffusers as needed.
- **RAS Pumps –** Improvements include removing and replacing problematic pump and adding one additional pump for redundancy.
- **North Blower Building HVAC –** Improvements include providing a new air conditioning unit at the MCC room with a purafil prefilter system along with adding cooling capabilities at the blower room.

- **Miscellaneous –**The air valves will be relocated and actuators will be replaced, the drain valves will be repaired and replaced, and there will be removal and selective replacement of some of the aeration basin tank drain valves.

5. FINAL CLARIFIERS

5.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the Final Clarifiers. In terms of risk, this process area ranks moderately among the SWRP facilities because most systems are in adequate condition; however, significant rehabilitation of many of the systems within the final clarification process area is recommended. The most critical issue with the final clarifiers is providing even flow and solids distribution to each of the final clarifiers. Some final clarifiers are more loaded than others and this proves to be an operations challenge for the SWRP staff. The structures and mechanisms lack cathodic protection and require rehabilitation. Algae growth in the final clarifiers is a concern and must be remediated before the new UV disinfection system comes on line next year.

The algae removal system ranks highest in terms of risk. The majority of the asset risk scores ranked as moderate priorities for replacement (Risk Score between 8 and 12). A summary table of the top risk score assets is presented in Table 5-1 and justification for these rankings is described in the following sections.

Improvement projects to address these risk assets will include modifications to the distribution boxes to provide even flow and solids distribution, covers on the effluent launders to stop algae growth in the final clarifiers, and improvements to the clarifier structures and water systems.

Table 5-1. Final Clarifiers Process Area Summary

Asset Classification	Total Risk	Assessment Implications
North and South FCs – Algae Removal	17.6	Necessary for future permit compliance with UV disinfection system
South FC 1-4 – Mechanisms	9.3	Essential for capacity of facility and integrity of downstream systems
South FC 5-8 – Weir Boxes and Gates	9.2	Essential for providing even flow and solids distribution
South FC 1-4 – Weir Boxes and Gates	8.6	Essential for providing even flow and solids distribution
North FC 1-4 – Weir Boxes and Gates	7.9	Essential for providing even flow and solids distribution
North FC 1-4 – Spray and Washwater Systems	7.7	Essential for maintenance
South FC 1-8 – Spray and Washwater Systems	7.5	Essential for maintenance

5.2 Introduction

The mixed liquor from the aeration basins flows into three (3) final clarifier splitter boxes. Each splitter box distributes flow into a set of four (4) clarifiers. There are four (4) clarifiers in the North and eight (8) clarifiers in the South for a total of twelve (12) final clarifiers. The waste activated sludge (WAS) is collected separately in hoppers and pumped to the DAF units. The unthickened WAS (UWAS) pumps are discussed in the DAFT chapter of this report. The return activated sludge (RAS) flows by gravity from the final clarifiers to the Activated Sludge Pump Station (ASPS) where it is pumped to the aeration basins. There are four (4) RAS pumps in total.

5.3 Capacity Evaluation Results

The capacity of the final clarifiers was evaluated as part of the overall process capacity of the activated sludge system and the results are presented in terms of an equivalent maximum monthly flow (MMF). The equivalent MMF was determined by taking the firm equipment rated capacities and applying the appropriate peaking factors (presented in Table 1-1) to calculate the MMF. This capacity evaluation was performed in the BioWin™ model with the results primarily discussed in the Aeration Basins Chapter (Chapter 4). The final clarifier capacity evaluation considered the following:

- Final Clarifiers
- RAS Pumps

5.3.1 Final Clarifiers

5.3.1.1 Assumptions

Based on input from SWRP staff, nine to ten clarifiers are typically on-line but the firm capacity of the clarifiers was based on eleven clarifiers on-line. The NMED guidelines state that the surface overflow rate (SOR) should not exceed 1,200 gpd/ft^2 at peak hourly flow and the peak solids loading rate (SLR) should not exceed 50 lb/d/ft^2.

5.3.1.2 BioWin™ Results

The BioWin™ model calibration determined that the maximum SLR at future design flow of 76 mgd MMF would be 26 lb/d/ft^2 (with one clarifier out of service) and the maximum SLR of 34 lb/d/ft2 was indicated at a MMF of 91 mgd (with one clarifier out of service). This is significantly less than the NMED requirement of 50 lb/d/ft^2 and suggests that there is adequate capacity available for design capacity of 76 mgd MMF.

The capacity of the final clarifiers is based on the SLR determined from the BioWin™ modeling and the results are presented in Table 5-2. These results indicated that the final clarifiers have adequate capacity for future solids loading conditions.

Table 5-2. Final Clarifier Design Data

Final Clarifiers	Number	Diameter (ft)	Maximum SLR (lb/d/ft^2)[1]	Firm MMF Capacity (mgd)	Design MMF (mgd)	Capacity Deficiency (mgd)	Additional Units Required
North	4	135	34	91	76	0	0
South	8	135					

Notes: 1 –Based on BioWin™ modeling assuming all aeration basins are online and eleven clarifiers are online.

5.3.2 RAS Pumps

There are a total of four (4) RAS pumps that serve the final clarifiers. Three RAS pumps are located in the ASPS and one RAS pump is located outside. According to the CDM Memo, the RAS pumps were designed to provide a firm capacity for pumping 100 percent of the future design flow of 76 mgd; however, the plant staff has often used all four pumps to meet their current flow demands. The capacity issue may be due to the pumping equipment, system pipes, or an incorrect wet well design and should be further evaluated. Regardless of the apparent difference between the actual delivered capacity and the theoretical capacity of the RAS pumping station, the plant staff has requested that additional redundancy be added to the system with the addition of another in-place spare pump.

5.3.2.1 Assumptions

The RAS pumps are assumed to be constantly running and capable of their rated capacity of 25 mgd each.

5.3.2.2 Capacity

The capacity evaluation for the RAS pumps is presented in Table 5-3. These results indicate that there is a slight capacity deficiency of 1 mgd at the design MMF of 76 mgd.

Table 5-3. RAS Pump Design Data

Pumps	Number	Unit Capacity (mgd) [1]	Firm MMF Capacity (mgd) [2]	Design MMF (mgd)	Capacity Deficiency (mgd)	Additional Units Required[3]
RAS	4	25	75	76	1	1

Notes: 1 – Design capacity stated in the 2009 Basic Design Data
2 – Assumes one pump is offline.
3 – See summary below.

5.3.3 Summary

The capacity evaluation for the final clarifiers indicates that there is adequate firm capacity to meet the design capacity peak flow conditions related to both SOR and SLR conditions. The capacity evaluation for the RAS pumps indicated that there is adequate firm capacity to meet the future MMF of 76 mgd. However, SWRP staff often is required to use all four pumps to meet their desired recycle rates which indicate that there is a problem with either the pumping system or wet well design. While the issue with the RAS pumps delivering less flow than their theoretical capacity should be investigated further and resolved, the plant staff has indicated that regardless of any regained capacity in the system, they would like an additional pump installed to provide additional redundancy and flexibility to the RAS system. This request is incorporated as a recommendation in this work effort.

5.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The final clarifier assets were evaluated based on a number of factors to determine overall risk which was based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy.

Results from the final clarifier asset risk assessment are presented in Table 5-4.

Table 5-4. Final Clarifiers Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	0.3	0.5	0.2	1	0.105	0.132	0.044	0.105	0.386	0.163	0.08	0.082	0.325	0.17	0.068	0.051	0.289	1				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
North FC 1-4 Structures	Tanks	75	10	2	2	2	1	0	1	0	3	0.447	1	1	1	0.325	3	1	1	0.629	1.401	3	1.9	26	
North FC 1-4 Mechanical	Mechanisms	30	10	3	3	4	5	1	1	1	1	0.386	3	1	1	0.651	5	5	5	1.445	2.482	3	7.3	12	Ranking includes all in-tank equipment.
North FC 1-4 EI&C	Power	20	10	3	3	2	1	0	3	0	0	0.396	3	1	1	0.651	3	1	1	0.629	1.676	3	2.6	23	
	Instrumentation & Controls	15	10	4	4	2	2	0	1	0	0	0.132	1	1	1	0.325	1	2	2	0.408	0.865	3	1.7	29	
North FC 1-4 Flow Splitters	Structure	75	10	2	2	3	3	0	1	0	5	0.657	3	1	1	0.651	5	1	3	1.071	2.379	4	5.8	16	Ranking considers flow splitting issues
	Weir Boxes & Gates	25	10	3	3	4	4	0	1	0	5	0.657	3	1	1	0.651	5	1	3	1.071	2.379	4	7.9	7	Ranking considers flow splitting issues
North FC 1-4 Pumping Systems	RAS Pumps	25	10									0				0				0	0	–	–	–	RAS pumping is ranked in activated pump station section.
	WAS Pumps & Scum Pumps	25	4									0				0				0	0	–	–	–	WAS and Scum pumping is ranked in DAFT section.
North FC 1-4 Misc Mechanical	Valves	40	10	2	2	1	1	0	1	0	0	0.132	3	1	1	0.651	3	1	3	0.731	1.514	2	1.0	31	
	Tank Draining	20	10	3	3	1	1	0	3	0	0	0.396	1	1	1	0.325	3	1	3	0.731	1.452	3	1.7	28	
North FC 1-4 Other	Spray Water & Washwater Systems	20	10	3	3	5	5	1	3	1	0	0.545	3	3	1	0.811	3	3	5	0.969	2.325	3	7.7	8	Scum removal considered in this ranking
	Algae Removal	20	10	3	3	5	5	3	3	5	3	1.246	5	3	3	1.301	5	5	5	1.445	3.992	5	17.6	1	Ranking considers no present system in place for algae control.
	Cathodic Protection	20	10	3	3	4	4	1	1	1	1	0.386	3	1	1	0.651	3	3	3	0.867	1.904	4	6.3	15	
South FC 1-4 Structure	Tanks	75	40	4	4	3	3	0	3	0	3	0.711	1	1	1	0.325	3	3	3	0.867	1.903	3	4.7	19	
South FC 1-4 Mechanical	Mechanisms	30	40	5	5	5	5	1	1	1	1	0.386	3	1	1	0.651	5	5	5	1.445	2.482	3	9.3	4	Ranking includes all in-tank mechanical equipment.
South FC 1-4 EI&C	Power	20	40	5	5	3	3	0	3	0	0	0.396	3	1	1	0.651	3	1	1	0.629	1.676	3	4.5	20	
	Instrumentation & Controls	15	16	5	5	3	3	0	1	0	0	0.132	1	1	1	0.325	2	2	2	0.578	1.035	3	2.8	22	
South FC 1-4 Flow Splitters	Structure	75	40	4	4	3	3	0	1	0	5	0.657	3	1	1	0.651	5	1	3	1.071	2.379	4	7.1	13	Ranking considers flow splitting issues
	Weir Boxes and Gates	25	15	4	4	4	4	0	1	0	5	0.657	3	1	1	0.651	5	1	3	1.071	2.379	4	8.6	6	Ranking considers flow splitting issues
South FC 1-4 Pumping Systems	RAS Pumps	25										0				0				0	0	–	–	–	RAS pumping is ranked in activated pump station section.

Table 5-4. Final Clarifiers Asset Risk Assessment Results																									
								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
	WAS Pumps & Scum Pumps	25										0				0				0	0	–	–	–	WAS and Scum pumping is ranked in DAFT section.
South FC 1-4 Misc. Mechanical	Valves	40	2	1	1	3	3	0	1	0	0	0.132	3	1	1	0.651	3	1	3	0.731	1.514	2	1.8	27	
	Tank Draining	20	40	5	5	2	2	0	3	0	0	0.396	1	1	1	0.325	3	1	3	0.731	1.452	1	0.8	32	Ranking considers drain system improvements with FY 01 project.
South FC 1-4 Other	Spray Water & Washwater Systems	20	22	5	5	4	5	1	3	1	0	0.545	3	3	1	0.811	3	3	3	0.867	2.223	3	7.5	9	Scum removal considered in this ranking
	Algae Removal	20	N/A	3	3	5	5	3	3	5	3	1.246	5	3	3	1.301	5	5	5	1.445	3.992	5	17.6	1	Ranking considers no present system in place for algae control.
	Cathodic Protection	20	40	5	5	4	4	1	1	1	1	0.386	3	1	1	0.651	3	3	3	0.867	1.904	4	7.4	11	
South FC 5-8 Structure	Tanks	75	27	2	2	2	2	0	3	0	2	0.606	1	1	1	0.325	3	1	1	0.629	1.56	2	1.6	30	
South FC 5-8 Mechanical	Mechanisms	30	15	3	3	3	3	1	1	1	1	0.386	3	1	1	0.651	5	5	5	1.445	2.482	3	5.6	18	Ranking includes all in-tank mechanical equipment.
South FC 5-8 EI&C	Power	20	27	5	5	2	2	0	3	0	0	0.396	3	1	1	0.651	3	1	1	0.629	1.676	3	3.6	21	
	Instrumentation & Controls	15	27	5	5	2	3	0	1	0	0	0.132	1	1	1	0.325	1	2	2	0.408	0.865	3	2.0	25	
South FC 5-8 Flow Splitters	Structure	75	27	2	2	3	3	0	1	0	5	0.657	3	1	1	0.651	5	1	3	1.071	2.379	4	5.8	16	Ranking considers flow splitting issues
	Weir Boxes and Gates	25	27	5	5	4	4	0	1	0	5	0.657	3	1	1	0.651	5	1	3	1.071	2.379	4	9.2	5	Ranking considers flow splitting issues
South FC 5-8 Pumping Systems	RAS Pumps	25										0				0				0	0	–	–	–	RAS pumping is ranked in activated pump station section.
	WAS Pumps & Scum Pumps	25										0				0				0	0	–	–	–	WAS and Scum pumping is ranked in DAFT section.
South FC 5-8 Misc Mechanical	Valves	40	2	1	1	3	3	0	3	0	0	0.396	3	1	1	0.651	3	1	3	0.731	1.778	2	2.1	24	
	Tank Draining	20	27	5	5	2	2	0	3	0	0	0.396	1	1	1	0.325	3	1	3	0.731	1.452	1	0.8	32	

Table 5-4. Final Clarifiers Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
South FC 5-8 Other	Spray Water & Washwater Systems	20	22	5	5	4	5	1	3	1	0	0.545	3	3	1	0.811	3	3	3	0.867	2.223	3	7.5	9	Scum removal considered in this ranking
	Algae Removal	20	N/A	3	3	5	5	3	3	5	3	1.246	5	3	3	1.301	5	5	5	1.445	3.992	5	17.6	1	Ranking considers no present system in place for algae control.
	Cathodic Protection	20	15	4	4	4	4	1	1	1	1	0.386	3	1	1	0.651	3	3	3	0.867	1.904	4	6.9	14	

5.4.1 General Equipment

As discussed in the previous sections, the main concern for this process area is the ability to evenly distribute flow to the final clarifiers. Other mechanical components within the final clarification process area should be repaired to ensure process stability. The most crucial issues which were identified are discussed in the following subsections.

5.4.1.1 Flow Distribution

There are three distribution boxes that feed mixed liquor to the three groups of four individual final clarifiers. Each of these boxes has weirs and gates that are used to control flow to individual clarifiers. The main issue with this operational system is that some final clarifiers are more heavily loaded than others. The plant staff has noted that the final clarifiers in the North tend to be overloaded compared to the other clarifiers. Details on this hydraulic evaluation are provided in the Hydraulic Review Memorandum in Appendix C.

5.4.1.2 Spray and Washwater Systems

There are complete system failures and evidence of water hammer issues in the lines and the systems should be replaced. Many hydrants are broken making it difficult to wash down the clarifiers, remove algae build-up, and properly perform maintenance.

5.4.1.3 Algae Removal

There is excessive buildup of algae on the final clarifiers that should be addressed before the new UV disinfection system is online. The presence of algae in the wastewater effluent stream can reduce the effectiveness of the UV light which can potentially result in a permit violation.

5.4.2 Electrical Equipment

5.4.2.1 General

5.4.2.2 North Clarifiers 1-4

Power distribution for the north final clarifiers comes from the north blower building discussed in Section 4. The electrical equipment at the clarifiers is in good condition.

5.4.2.3 South Clarifiers 1-4

Power distribution for the south final clarifiers 1-4 comes from the South AB MCC Building (Mixing Building) discussed in Section 4. Corrosion of fiberglass electrical and instrumentation boxes needs to be addressed. Some flooding of disconnect switches and junction boxes create a hazardous condition and needs to be addressed. Lack of proper lightning protection has caused equipment failures and is hazardous to personnel.

5.4.2.4 South Clarifiers 5-8

Power distribution for the south final clarifiers 1-4 comes from the South AB MCC Building (Mixing Building) discussed in Section 4. Corrosion of fiberglass electrical and instrumentation boxes needs to be addressed. Some flooding of disconnect switches and junction boxes create a hazardous condition and needs to be addressed. Lack of proper lightning protection has caused equipment failures and is hazardous to personnel.

5.4.3 Instrumentation and Controls

While control strategies appear to be appropriate for final clarifier control, several problems need to be addressed to optimize performance.

- RAS and WAS flows are controlled from each final clarifier through control valves and flow meters. The valves and meters have been problematic.
- More control signals need to be made available for the connection of analyzers needed to improve the process.

5.5 Recommendations/Conceptual Workplan

This section describes the general workplans and recommended improvements for the final clarifiers. Details on the project, project justification, and cost estimates are provided in Chapter 13.

5.5.1 Algae Removal

A number of options can be considered for algae removal including mechanical brushes or effluent launder covers. The recommended workplan is to cover the effluent launders and this is considered a critical project as the UV system is planned to be online in the spring of 2010.

5.5.2 Mixed Liquor Distribution from Aeration Basins to Final Clarifiers

The flow distribution to the individual final clarifiers should be addressed to improve the performance of this system. The recommended workplan is to modify the existing distribution boxes to improve flow and solids distribution to the final clarifiers.

5.5.3 Other Improvements

Additional improvements for the final clarifiers that will be included with the distribution improvements project will include the following:

- **Spray Water and Washwater Systems –** Improvements include complete removal and replacement of existing spray water system with new distribution pipe and spray nozzles. Two new hose stations will be added at each clarifier. Scum box automated spray systems will also be added.
- **Final Clarifier Tank and Mechanisms –** Improvements include removal and replacement of mechanisms at South Final Clarifiers #1-4 and mechanical localized rehabilitation at the balance of the final clarifiers. Also addition of cathodic protection systems and localized concrete repairs for all final clarifiers is included.
- **E&IC –** Improvements include new drive and sludge blanket instruments and replacement of all the clarifier drive disconnects with NEMA 4X devices.

6. DISSOLVED AIR FLOTATION THICKENERS

6.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the DAF Facility. In terms of risk, this process area ranks moderately among the SWRP facilities because most systems are in operating condition but rehabilitation is needed. Some equipment has reached their useful life and should be replaced while other equipment components should be upgraded to meet design capacity needs.

A few of the assets ranked as moderate priorities for replacement (Risk Score between 8 and 12) but the majority ranked as low priorities (Risk Score less than 8). A summary table of the top risk score assets is presented in Table 6-1 and justification for these rankings is described in the following sections.

Rehabilitation of the older systems and the addition of some equipment to provide capacity needs (i.e. air compressor) is recommended as improvement projects.

Table 6-1. Dissolved Air Flotation Thickeners Process Area Summary

Asset Classification	Total Risk	Assessment Implications
Non-Potable Water Systems	10.0	Essential for capacity of facility and integrity of downstream systems
Valves/Piping	9.4	Essential for performance and integrity of downstream systems
Power	9.1	Essential for capacity and reducing system bypasses
HVAC	8.9	Essential for staff safety and integrity of equipment
Instrumentation and Controls	7.7	Essential for performance and integrity of equipment
Bottom Sludge Pumps	6.1	Necessary for system performance
Saturation System	5.9	Necessary for performance of the DAF units
Polymer System Transfer Pumps/Pipe	4.8	Necessary for performance of the DAF units
Polymer System Feed Pumps/Pipe	4.8	Necessary for performance of the DAF units
UWAS and Scum Pumps	4.4	Necessary for capacity and performance

6.2 Introduction

Waste activated sludge from the final clarifiers (referred to as unthickened WAS or UWAS) is thickened in the dissolved air flotation thickeners (DAFs). The DAF system includes the UWAS pumping system, process tanks, saturation system, polymer system, thickened WAS (TWAS) pumping system, and bottom sludge pumping system.

6.3 Capacity Evaluation Results

Provided in this section are the results of the DAF capacity analysis. The DAF capacity analysis focused on the overall DAF sizing and its major pumping systems. It was beyond of the scope of this effort to analyze the capacity of the auxiliary systems which include the saturation system, polymer system, and bottom sludge pumps and as such for these individual subsystems, they were only analyzed from a rehabilitation needs perspective. The DAF facility capacity evaluation includes the following systems:

- DAF Units
- UWAS Pumps
- TWAS Pumps

6.3.1 DAF Units

DAF unit capacity can be expressed as both a hydraulic and solids loading rate; however, DAFs are generally not limited by the hydraulic loading rate (in terms of gpm/ft^2). However, this does not refer to the hydraulic capacity of the DAF units and appurtenances. Based on CDM Memo, the DAF units were expected to handle a hydraulic loading of 0.8 gpm/ft^2.

The recommended foam control improvements (Chapter 4) would increase the feed flows to the DAF units due to surface wasting of mixed liquor from the activated sludge system. This increase in flow depends on the hydraulic capacity of connecting pipe work and other hydraulic appurtenances that were not evaluated as part of the RRAMP. In terms of hydraulic loading, the DAFs are capable of handling loads much higher than the design value of 0.8 gpm/ft^2. Hydraulic loadings above 5 gpm/ft^2 are not expected to be an issue with properly designed DAF systems. Therefore, a hydraulic capacity assessment of the DAF system and associated appurtenances is required to properly evaluate the impacts of surface wasting.

Since the hydraulic loading rates would not be an issue with the DAFs, this evaluation focused on the solids loading rate aspects of the DAF system.

6.3.1.1 Assumptions

Brown and Caldwell recommends a design solids loading rate of 0.5 to 1.5 lb/ft^2/hr for thickening of biological solids. This is slightly lower than the 2 lb/ft^2/hr loading rate provided in the 2009 Basic Design Criteria (provided by the SWRP) for the DAFs (also used in the CDM Memo). For the purpose of this assessment, 2 lb/ft^2/hr will be used as the capacity limitation of the DAF process units at peak day conditions. The solids loadings to the DAF units were determined with the BioWin™ model and with historical peaking factors applied to the data.

6.3.1.2 Capacity

The capacity of the DAF units is presented in Table 6-2. These results indicate that the DAF units have adequate capacity for peak day loads.

Table 6-2. DAFT Design Data

DAFs	Number	Area (ft^2) [1]	Unit Capacity (lb/d) [2]	Firm Capacity (lb/d) [3]	Peak Day Load (lb/d) [4]	Capacity Deficiency (lb/d)	Additional Units Required
Process Units	7	322	15,456	92,736	84,435	0	0

Notes: 1 – Design capacity stated in the 2009 Basic Design Data

2 – Based on 2.0 lb/ft^2/hr peak loading limit

3 – Based on one unit offline

4 – Based on BioWin™ data at peak day and adjusted by future peak day flow

6.3.2 UWAS Pumps

There are a total of nine (9) UWAS pumps that transfer WAS from the final clarifiers to the DAF process units.

6.3.2.1 Assumptions

Similar to the other processes, for this evaluation, one UWAS pump was assumed to be offline in order to determine the system's firm capacity. It should be noted that in the CDM Memo it was assumed that two units were offline for firm capacity, however, the memo did not state why this done.

6.3.2.2 Capacity

The capacity of the UWAS pumps is presented in Table 6-3. These results indicate that there is adequate capacity for these pumps.

Table 6-3. UWAS Pump Design Data

Pumps	Number	Unit Capacity (mgd) [1]	Firm PDF Capacity (mgd) [2]	Firm MMF Capacity (mgd)	Design MMF (mgd)	Capacity Deficiency (mgd)	Additional Units Required
UWAS	9	0.43	3.43	2.60	1.32	0	0

Notes: 1 – Design capacity stated in the 2009 Basic Design Data

2 – Assumes one pump offline

6.3.3 TWAS Pumps

There are a total of four (4) TWAS pumps that pump the thickened sludge from the DAF collection troughs to the blended sludge tank.

6.3.3.1 Assumptions

The CDM Memo assumed that the TWAS pumps operate 24-hours and this is same assumption was made in this evaluation. The peak day flow predicted from BioWin™ and historical peaking factors was calculated as 0.20 mgd. It is assumed that the standby pump is primarily offline and is only used when the smaller TWAS pumps are out of service.

6.3.3.2 Capacity

The capacity of the TWAS pumps is presented below in Table 6-4. These results indicated that the TWAS pumps have adequate capacity for the peak flow. It is important to note that even with the standby pump offline, the three TWAS pumps should provide adequate capacity to meet the peak flow.

Table 6-4. TWAS Pump Design Data

Pumps	Number	Unit Capacity (mgd) [1]	Firm PDF Capacity (mgd) [2]	Firm MMF Capacity (mgd)	Design MMF (mgd) [3]	Capacity Deficiency (mgd)	Additional Units Required[4]
TWAS	3	0.18	0.36	0.21			
Standby	1	0.53	0.53	0.31	0.20	0	0
Total	4	-	0.89	0.52			

Notes: 1 – Design capacity stated in the 2009 Basic Design Data

2 – Assumes one TWAS pump is offline

6.3.4 Summary

Based on the capacity evaluation of the DAF units the existing tanks can process the projected future solids loading. Also, the UWAS and TWAS pumps are sufficient to meet future demands and no additional pumps are required based on this evaluation. There is concern that the TWAS pumps are not pumping at their rated capacity and as such, we are recommending that additional TWAS pumps be considered during the preliminary design of the rehabilitation of this process area.

6.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The DAF Facility assets were evaluated based on a number of factors to determine overall risk which was based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy.

Results from the DAF Facility asset risk assessment are presented in Table 6-5.

Table 6-5. DAF Facility Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
Structure	DAF Tanks	75	30	3	2	3	2.5	0	1	0	2	0.342	1	1	1	0.325	3	3	3	0.867	1.534	3	2.9	12	TWAS Hoppers are considered in this ranking.
	DAF Building	50	30	4	3	4	3.5	0	3	0	0	0.396	1	0	1	0.245	1	3	3	0.527	1.168	2	2.0	15	
EI&C	Power	20	30	5	4	4	4.3	0	3	0	0	0.396	3	3	3	0.975	3	3	5	0.969	2.34	4	9.1	3	
	Instrumentation & Controls	15	14	5	4	4	4.3	0	3	0	0	0.396	3	3	3	0.975	1	3	5	0.629	2	4	7.7	5	
Mechanical	Collectors	20	12	3	3	3	3	0	1	0	1	0.237	1	0	1	0.245	3	1	3	0.731	1.213	3	2.7	13	
	Saturation System	20	12	3	4	4	3.7	0	3	0	1	0.501	1	0	3	0.409	3	3	3	0.867	1.777	4	5.9	7	Recirculation Pumps and Pressure Vessels are considered in this ranking.
Pumping Systems	TWAS Pumps	25	15	4	1	3	2.3	0	1	0	1	0.237	1	0	1	0.245	1	1	1	0.289	0.771	3	1.3	17	Ranking considers pumps replaced in 2008
	Bottom Sludge Pumps	25	14	3	5	4	4.2	0	1	0	2	0.342	1	0	1	0.245	3	3	3	0.867	1.454	5	6.1	6	
Polymer System	WAS (UWAS) and Scum Pumps	25	1	1	3	4	2.6	0	1	0	2	0.342	3	1	1	0.651	3	3	3	0.867	1.86	4	4.4	10	
	Polymer Storage Tanks	15	30	5	3	3	3.6	0	1	0	0	0.132	1	3	0	0.403	1	1	1	0.289	0.824	3	2.2	14	Ranking considers improvements made in 2009
	Polymer Batch Tanks	20	30	5	2	2	2.9	0	1	0	0	0.132	1	1	0	0.243	3	1	1	0.629	1.004	2	1.5	16	
	Transfer Pumps/Pipe	15	20	5	4	4	4.3	0	1	0	0	0.132	1	1	0	0.243	3	3	3	0.867	1.242	4	4.8	8	
	Feed Pumps/Pipe	15	20	5	4	4	4.3	0	1	0	0	0.132	1	1	0	0.243	3	3	3	0.867	1.242	4	4.8	8	
Misc. Mechanical	Odor Control	15	9	4	4	4	4	1	1	1	0	0.281	1	1	3	0.489	1	3	3	0.527	1.297	3	3.9	11	
	HVAC	20	16	4	5	5	4.7	0	3	0	0	0.396	3	3	3	0.975	1	3	3	0.527	1.898	5	8.9	4	
	Valves/Piping	20	23-30	5	4	5	4.5	0	3	0	0	0.396	3	1	3	0.815	3	3	3	0.867	2.078	5	9.4	2	Ranking includes all Sludge Systems.
Other	NPW Systems	20	?	4	5	5	4.7	1	3	0	0	0.501	3	1	1	0.651	3	3	5	0.969	2.121	5	10.0	1	

6.4.1 General Equipment

As discussed in the previous sections, most of the equipment is in adequate condition, but some mechanical components should be repaired to ensure process stability. The most crucial issues which were identified are discussed in the following subsections.

6.4.1.1 Effluent Wash Water System (EWW)

The existing washwater system (EWW) is not working and lacks adequate pressure. The EWW receives its supply water from the secondary effluent non potable water distribution system.

The EWW is also used as the carrier water for the polymer system. It is likely that solids in this stream are hindering the performance of the polymer before it can reach the DAF units. The use of NPW for the polymer system should be rehabilitated with screens or other conditioning equipment or replaced with a different source water system.

6.4.1.2 Valves and Piping

All the control and mechanical valves in this facility are old and should be replaced. Additionally, some of the piping is old and in poor condition and should be rehabilitated or replaced.

6.4.1.3 HVAC and Foul Air

The existing HVAC systems (North and South areas) do not provide a sufficient number of air exchanges in the DAF Facility to properly ventilate the process areas. There is also a lack of heating in the building and inadequate cooling in the MCC rooms and compressor room. The existing odor control system is offline and plant staff reported that the system did not function as required when it was operating.

6.4.1.4 Bottom Sludge Pumps

The bottom sludge pumps have been out of commission for a few years. Bottom sludge pumps serve to remove grit from the process tanks which also helps to maintain adequate capacity for treatment.

6.4.1.5 Saturation System

Currently, there is only one air compressor that supplies the air to the saturation system. This lack of redundancy is a serious concern as compressed air is necessary for the DAF process to function. The saturation system including the air panels, receiver tank, and recirculation pumps have not been inspected or rehabilitated recently and are due for both. The saturation tanks are pressure vessels and have never been inspected or rehabilitated which is a serious safety concern. The air valves and control system for the saturation system for the air panel are unreliable..

6.4.1.6 Polymer System

The polymer storage tanks were recently upgraded to include a manway and clean out of the polymer lines, however, the polymer transfer lines reportedly freeze during colder months which in-turn comprise the delivery of polymer to the DAF system. Overall, the system is old, unreliable, and difficult to control.

6.4.1.7 TWAS, UWAS, and Scum Pumps

The TWAS pumps do not appear to be operating at their rated capacity and plant staff has indicated that they would like more capacity to handle events when the hoppers become overloaded. The valve that provides bypassing of pumps is broken and limits the flexibility of this pumping system. The UWAS and scum from the final clarifiers flow to the same line. The UWAS and scum pumps both pull from this line and pump to the DAF units. Because of the foam which is present in the scum these pumps often lose prime and shut down.

6.4.2 Electrical Equipment

6.4.2.1 General

The DAF Switchgear is a secondary-selective switchgear assembly fed from medium-voltage GSS and the 480V South Cogeneration system. This switchgear powers the all loads for the DAF and South Digesters (9-14). Because the switching must be performed manually, restoration of power could be significantly delayed.

While the secondary-selective system allows good flexibility for maintenance, it adds little to the overall power reliability due to the single utility source and cogeneration complexities.

The equipment in the south electrical room is nearing the end of its useful life. For its age, the equipment appears to be in relatively decent condition. Internal deterioration due to roof leakage is possible.

Although newer than equipment in the south electrical room, the equipment in the north electrical room is in poor condition. This is primarily due to very wet conditions in the room, roof leakage onto the electrical equipment, and lack of ventilation. Standing water in the room creates a significant hazard for personnel operating the electrical equipment. The main switchgear for the process is in this room.

Elsewhere in the building, significant corrosion of conduits has resulted in cable faults. Some conduits are routed through conduits or behind walls, where personnel suspect significant corrosion. Lack of proper ventilation has caused operators to prop electrical room doors open, allowing corrosive gasses to enter the electrical rooms.

6.4.3 Instrumentation and Controls

The instrumentation and controls for this building are antiquated and ineffective. Pressurization system controls, sludge box level controls, and WAS pump controls are all problematic and should be replaced. Wiring in the control cabinets is congested and difficult to work on, and control panels are nearing the end of their life.

6.5 Recommendations/Conceptual Workplan

The workplan for the DAF Facility includes the rehabilitation of the existing systems and replacement of the deteriorated system components Additional redundancy for air compressors and other auxiliary equipment, as identified future preliminary design efforts, should also be considered and are included as part of the workplan included here. The following are recommended improvements for the DAF Facility. Additional details regarding these projects and cost estimates are provided in Chapter 13.

- **EI&C –** Repair and replace as needed for improvements.
- **Comprehensive Valves and Piping –** Improvements include repair and replace piping, valves, and other appurtenances as needed.
- **HVAC and Foul Air –** Improvements include installing new air conditioning units to serve the MCC rooms and the compressor room and rehabilitating the existing air handling units, hot water system and duct systems for the process areas. Also the existing foul air system will be rehabilitated using new fans and new scrubbers.

- **Bottom Sludge Pumps –** The SWRP is rehabilitating these pumps in-house and these pumps will not be included as a specific project in the RRAMP.
- **UWAS, Scum, and TWAS Pumping –** Improvements include installing a new TWAS pumps for additional redundancy and capacity, and repair and replacement of the pump piping systems.
- **Saturation System –** Improvements include removal and replacement of existing compressors with two new duplex compressors and rehabilitation of the saturation system pressure vessels and air control panels.
- **DAF Tanks and Mechanisms –** Improvements include rehabilitation older DAF units (#1-3) and repair and replacement of the mechanisms for units (#4-7)
- **Polymer System –** Improvements include replacement of the existing polymer system with new dry storage, batching, and mixing system.

7. ANAEROBIC DIGESTERS AND SLUDGE BLENDING FACILITIES

7.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the Digester and Sludge Blending Facilities.

Also presented are discussions of two viable options to address the capacity shortfall: construction of additional digesters and operation as a temperature-phased anaerobic digestion process or TPAD. This section also discusses cover and mixing options and provides an assessment of the available digester gas as it is relates to the plant's existing cogeneration system.

In terms of risk, the digester process ranks highest among the SWRP facilities as it is the only solids stabilization process, has many recognized deficiencies, and lacks adequate primary digester capacity for the estimated solids generated by the 76 mgd maximum monthly flow (MMF) design condition. Additionally, our analysis of available 2008 data show that the process may not meet USEPA Part 503 requirements for Class B biosolids for the maximum two-week and maximum month loadings. There are several deficiencies, especially with respect to cover integrity and mixing which threaten process integrity in the near term.

A summary table of the principal critical issues, based upon risk score, is presented in Table 7-1. An additional item was added, the rehabilitation of deteriorated digester piping and valves, as this work would be efficiently conducted during digester renovations. Each of these assets were ranked as critical or high priority for replacement (Risk Score greater than 12). Because of similarities of the issues for both the North (Digesters 1-8) and South (Digesters 9-14), some of the issues are grouped in pairs. Justification for these rankings is described in the following sections.

Based upon our evaluation, we recommend that the digester complex undergo substantial rehabilitation in the near-term to repair deteriorated equipment and expanded to meet the plant's MMF design condition. As the system is almost at full capacity utilization (estimated at 97 percent), for the current liquid process flow, any renovations should be limited or carefully staged such that the available capacity is not significantly compromised during the rehabilitation process. We recommend that the planning for these rehabilitations and new digester capacity be started as soon as possible.

The current plant data and the BioWin™ modeling which was conducted as part of this project conflict and the additional capacity estimates presented should be considered conditional until a complete and representative data set can be obtained during preliminary design phase. On an annual average basis, the plant data show blended sludge flow as being approximately 40 percent greater than the BioWin™ data set and 30 percent greater for the solids loading. On a maximum month basis, the plant data show blended sludge flow approximately 65 percent greater than the BioWin™ data set and 55 percent greater than for the solids loading.

Table 7-1. Anaerobic Digesters and Blending Process Area Summary		
Asset Classification	Total Risk	Assessment Implications
Primary Digester Covers/Gas/OF Systems	18.2/18.2	Integrity is critical for capacity and safe containment of flammable gas and odors.
Primary Digester Structures	16.3./16.3	Insufficient capacity for 76 mgd maximum month equivalent flow.
AD 9-14 – Sludge Withdrawal Pumps	16.3	Critical for staff safety and performance. Additionally, only one line to Dewatering (single point of failure).
Primary Digester Mixing	16.2/15.8	Insufficient mixing to maintain necessary effective volume for treatment for near term needs. Current equipment difficult to maintain.
Digester Complex Power (E I &C)	16.2/14.8	Sustained lack of power will result in solids accumulation in process, shutdown of dewatering and eventually forcing the holding of solids in liquid stream facilities.
Secondary Digester Covers and Gas Systems	16.1/16.1	Integrity is critical for capacity and safe containment of flammable gas and odors.
Heat Loop – Building Hot Water System	16.0/16.0	Reliable heat is critical to maintaining anaerobic digestion process.
Low Pressure Digester Gas System	15.7/15.5	Critical for staff safety, air permit, odor control and continued reliable operation of cogeneration systems.
Digester Complex – HVAC	15.5/15.5	Loss of heat in winter can result in freezing of digester gas systems and result in uncontrolled gas release. Gas rooms should be isolated from other parts of the buildings for NFPA 820 compliance and electrical equipment ratings.
Digester Feed Improvements (Instrumentation and Controls)	15.4/12.2	Current system requires a high level of operator input and can result in unbalanced digester feeding resulting in reduced performance. Automated systems would also alleviate reliance on solids storage before and after digestion process.
Digester Piping and Valves	5,6/5,6	Existing piping and valves are old. Valves are reportedly failing and undergoing as-needed replacements. Potential for pipe deterioration and/or reduced capacity due to deposits can affect operations.

Note: 1- Where two values are shown, the first refers to Digesters 1-8 and the second to Digesters 9-14.

7.2 Introduction

7.2.1 Process Overview

Primary sludge and scum from the Pump Houses and Thickened Waste Activated Sludge (TWAS) from the DAFT are combined in the Sludge Blending Tank and pumped to the anaerobic digesters. One digester is fed at a time from the Sludge Blending Tank. The current level of treatment is intended to provide the equivalent of USEPA Part 503, Class B biosolids.

The Sludge Blending Tank has paddle mixers and odor control. The Sludge Blending Tank and associated mixing and odor control systems were rehabilitated in a FY 1999 project. At the present time, the operators report that the blending tank is too small and that the tank capacity is limiting ability to waste large volumes of secondary solids (WAS).

There are ten (10) primary digesters, with mixing and heating to maintain mesophilic temperatures, and four (4), unmixed and unheated secondary digesters. Both the primary and secondary digester covers are configured such that the extent of the liquid surface is the full area enclosed by the tank walls. The current operation is to feed the digesters one at a time, which displaces volume in the primary digesters, which then overflow to the secondary digesters. In 2008, much of the available mixing capacity was out of service and one smaller primary digester was kept out of service to provide reserve storage volume in case of a failure of the dewatering system.

While there is some additional solids reduction occurring, the secondary digesters generally serve as holding tanks prior to discharge to the dewatering system. There are two secondary digesters for each group of digesters (Digesters 1-8 and Digesters 9-14) and thickened sludge pumps associated with each pair of secondary digesters. The former gas mixing system for each secondary digester has been removed and the tanks are not mixed.

Similarly to the Sludge Blending Tank, secondary digester capacity is also viewed by the operators as limiting, as the secondary digesters are always all in service. This holding capacity is viewed as necessary, by the operators, to accommodate the frequent outages in the dewatering system.

As noted above, the desired capacity rating for the digesters and related systems is equivalent to the 76 mgd MMF. In the CDM Memo, the predicted digester capacity was 63 mgd equivalent flow.

7.2.2 Digester Tank Volumes

There are several sets of information available that describe the volume of the digesters. For our analysis, we applied the dimensions from the "Basic Design Data" (Year 2002), the "Final Design and Analysis Report - Southside Water Reclamation Plant (SWRP) Digester Rehabilitation,"CH2MHill June 2008, and design drawings, where available. The information used in our analysis is presented in Table 7-2 and Table 7-3.

Table 7-2. Primary Digester Capacity Information

	Number	Diameter (ft)	Sidewater Depth (ft)	Cone Depth (ft)	Sidewater Volume (cu ft)	Cone Volume (cu ft)	Total Unit Volume (MG)
Digesters 1,3,5,7,9	5	75	22.5	9.4	99,400	13,900	0.847 MG
Digesters 2, 8	2	75	25.5	9.4	112,700	13,900	0.947 MG
Digesters 11, 13, 14	3	85	22.5	10.6	127,700	20,100	1.106 MG
Grand Totals	10						9.45 MG

Table 7-3. Secondary Digester Capacity Information

	Number	Diameter (ft)	Sidewater Depth (ft)	Cone Depth (ft)	Sidewater Volume (cu ft)	Cone Volume (cu ft)	Total Unit Volume (MG)
Digesters 4,6	2	75	22.5	9.4	99,400	13,900	0.847 MG
Digesters 10,12	2	85	25.5	10.6	127,700	20,100	1.106 MG
Grand Totals	4						3.65 MG

The volumes presented in Table 7-2 and Table 7-3 are gross volumes (all volume between the liquid surface and the cone bottom). In 2008, all of the secondary digesters were in service and one smaller primary digester was out of service. Thus, the available gross volume of the primary digesters in 2008 was 8.60 million gallons (MG). During 2008, a substantial amount of mixing equipment was also out of service and the digesters reportedly have accumulated a significant amount of grit at the bottom and scum mats at the surface.

7.3 Capacity Evaluation Results

The following sections describe the process of evaluates and compares the plant solids data to the BioWin™ results and presents the capacity evaluation results for the anaerobic digesters

7.3.1 Solids Data Evaluation

7.3.1.1 BioWin™ Results

To assess the current digester system performance, the calibrated BioWin™ model with 2008 hourly results, was reduced to average daily data for a year. The generated results were analyzed to create a table of relationships (factors or ratios) for average, maximum and minimums for the daily results as well as running 7-, 14- and 30-day averages. To create the running averages for a year, an appropriate number of days of December data was "wrapped," or averaged with, January data to provide the appropriate number of values (7, 14, or 30) for the required averages. As an example, the 7-day averages for January 2, would include January 1 and the last five days of December.

For predictions of future requirements, digester loading and HRT relationships apparent in the 2008 modeling results are assumed to hold for the future cases.

As it was a reference provided by WUA, and believed to be accurate at the time modeling was undertaken, Brown and Caldwell used the sum of the primary digester capacities (8.663 MG) listed in the "Basic Design Data" for 2002. As described in Section 7.2.2, there are several references on the capacities and, after reconciling the various available references, we found that the volume used for modeling was only slightly (0.7 percent) more than the 2008 available gross primary digester volume (8.60 MG) and approximately 3 percent more than a true "firm capacity" of 8.34 MG with one of the larger primary digesters out of service.

The VSS loadings and HRTs for the existing digesters were examined under the current conditions (54.1 mgd plant influent flow; 58.4 maximum month plant influent flow) for the annual average, maximum day, maximum month and maximum two-week flows and loadings. The results, based on the BioWin™ modeling and presented in Table 7-4, show that the digesters are generally underloaded and are well within the criteria cited in Table 7-6 for 8.663 MG capacity.

Table 7-4. Computed Loadings and HRTs in Existing Digesters under Current Conditions

Loading Condition		Sludge Parameters		Digester Parameters[2]	
		Blended Sludge[1]	Ratio to Max Month	HRT, day	VSS Loading lb/d-ft³
Annual Average	Flow, MGD	0.237	0.915	37	0.064
	VSS Loading, lb/d	74,530	0.727		
Maximum Day	Flow, MGD	0.390	1.51	22	0.111
	VSS Loading, lb/d	128,900	1.26		
Maximum Month	Flow, MGD	0.259	1.00	33	0.088
	VSS Loading, lb/d	102,500	1.00		
Maximum Two-Weeks	Flow, MGD	0.272	1.05	32	0.091
	VSS Loading, lb/d	105,800	1.03		

[1] Blended sludge is combined Primary and TWAS

[2] For digester volume of 8.663 million gallons (MG) capacity

Volatile solids (VS) destruction efficiency from the 2008 BioWin™ data are reported in Appendix D along with computed VS destroyed and gas flow from the primary digesters, gas yield per pound of VS destroyed and total gas production.

The digester capacity of 8.663 MG, assumes that all of the available volume of the in-service digesters is performing as designed. As noted above, in 2008 there was a substantial outage of mixing equipment and the digesters reportedly accumulated grit at the bottom and scum mats at the surface. This combination of factors suggests that the available or effective volume of the digesters is currently much less than the gross volume. The reduced effective volume is evidenced by the volatile solids reduction in the primary digesters which was 46.5 percent (40-60 percent expected; M&E, 4th Ed) and the TSS reduction which was 32.5 percent (30-40 percent expected; M&E, 4th Ed), on a 14-day average basis. This suggests that the primary digesters are already stressed. The operators have also expressed concern over the digester's performance. Well operated, non-overloaded, high-rate digesters operating with effective volumes nearer their gross volumes generally provide higher VSS and TSS reduction performance. Available literature, and other information developed by Brown and Caldwell, suggests that an effective volume of 90 percent would be about the best that could be achieved with this type of digester.

Gas yield, per pound of VS destroyed, 16.1 on average, is generally within the expected range of 13-18 cubic feet per pound (M&E, 4th Ed), although a daily range from 10 to 26.5 is reported from the BioWin™ simulation.

Presuming that the digesters are stressed in the 14-day maximum condition, we have estimated that the effective volume in the on-line digesters is approximately 70 percent (8.60 x 0.7= 6.02 MG). The corresponding HRT and loading are presented in Appendix D.

7.3.1.2 Review of Available Plant Data

The available plant data were reviewed for capacity analysis. Due to wide variations in the influent and primary effluent TSS and COD data, all the 2008 plant data was "mined" to remove the values which exceeded two standard deviations of the annual average value. Data that fell within these criteria were included in data set used for the BioWin™ calibration. This data screening process removed data outliers that could potentially affect the model calibration. The BioWin™ model is based on just the plant influent data. Details on the BioWin™ model calibration and results can be found in Appendix B.

The VSS loadings and HRTs for the existing digesters were examined under the current conditions (54.1 mgd plant influent flow; 58.4 maximum month plant influent flow) for the annual average, maximum day, maximum month loadings and presented in Table 7-5. For comparison, a two-week maximum value was computed based upon the ratio to the maximum month from the BioWin™ modeling. The average blended volatile solids concentration was computed as 73.2 percent and the effective volume, based upon the discussion above, is 6.02 MG. The values presented show that the digesters are generally overloaded when compared to the criteria cited in Table 7-6 (values exceeding the criteria are underlined). Additionally, the computed 13-day HRT for the two week maximum period and the 14 day HRT for the monthly maximum indicate a potential for falling below the USEPA Part 503, minimum 15 day MCRT requirement, especially as loads increase.

Table 7-5. Plant Data Loadings and HRTs in Existing Digesters under Current Conditions

Loading Condition		Sludge Parameters		Digester Parameters[2,3]	
		Blended Sludge[1]	Ratio to Max Month	HRT, day	VSS Loading lb/d-ft[3]
Annual Average	Flow, MGD	0.33	0.877	18	0.107
	VSS Loading, lb/d	117,300	0.727		
Maximum Day	Flow, MGD	0.71	1.65	8.5	0.325
	VSS Loading, lb/d	357,800	1.77		
Maximum Month	Flow, MGD	0.43	1.00	14	0.184
	VSS Loading, lb/d	202,200	1.00		
Maximum Two-Weeks	Flow, MGD	0.45	1.05	13	0.189
	VSS Loading, lb/d	208,300	1.03		

[1] Blended sludge is combined Primary and TWAS

[2] For digester volume of 6.02 million gallons (MG) capacity

[3] For average volatile solids concentration of 73.2% in the blended sludge

7.3.1.3 Analysis

As the currently available plant data do not present a complete picture of anaerobic digester process performance, we assembled available plant information and supplemented this data set with BioWin™ modeling information. However, the available plant solids data and the 2008 BioWin™ data differ substantially. On an annual average basis, the plant data show blended sludge flow approximately 40 percent greater than the BioWin™ data set and 30 percent greater for the solids loading. On a maximum month basis, the plant data show blended sludge flow approximately 65 percent greater than the BioWin™ data set and 55 percent greater for the solids loading. Given these differences, the findings provided here should only be viewed as preliminary and additional data regarding flow, solids load and performance of the digester system should be collected and incorporated into any preliminary design or more detailed study efforts.

The two data sets (BioWin™ and plant) data support the finding that there is insufficient primary digester capacity for the future MMF design condition. Additionally, our analysis of the plant data set indicates that there is a near-term capacity shortfall that may affect compliance with Part 503, Class B biosolids requirements.

Challenges with available solids data were also encountered during a previous digester capacity analysis (CDM Memo). As the BioWin™ data set provided a reasonable correlation to the liquid stream process performance observed from the available data, the capacity analysis was performed based on the lower solids predictions from the BioWin™ modeling. However, the validity of the predictions, presented in the next section, can only be determined once additional data collection and analysis are done.

7.3.2 Capacity Evaluation

7.3.2.1 Class B Biosolids Criteria

While improving the solids stream treatment system is necessary due to aging equipment and infrastructure it is also required for continued reliability for production of Class B biosolids. Production of Class B biosolids is necessary for land application, which allows the WUA flexibility in their disposal options. As stated in the

United States Environmental Protection Agency (EPA) standards, the following criteria must be met to define biosolids as Class B, using anaerobic digestion as the stabilization process:

- Anaerobic digestion with a minimum mean cell residence time (MCRT)of 15 days
- Maintain temperature in the digesters at not less than 35 degrees C (95 degrees F)
- Minimum volatile solids reduction of 38 percent (for vector-attraction reduction)

The key parameters for anaerobic digester design are Hydraulic Retention Time (HRT; equivalent to MCRT in systems without recycle) and Volatile Suspended Solids (VSS) loading. Table 7-6 lists the critical operating conditions for the digestion system evaluation.

Table 7-6. Digester Design Criteria

Parameters	Conditions	Values
HRT	Minimum (maximum two-week loading and one largest tank out of service)	15 days
	Average (at annual average loading and all tanks in service)	20 – 22 days
VSS Loading	Average (at annual average loading and all tanks in service)	< 0.12 lb/d-ft3
	Maximum Two-Week period (one largest tank out of service)	< 0.14 lb/d-ft3
	Peak (one largest tank out of service)	< 0.18 lb/d-ft3

The predicted capacity required for the digester system is based upon values extracted from the BioWin™ model and factored based upon relationships within the BioWin™ data set. The values and factors are presented in Table 7-7. Presented in Table 7-8 are the corresponding data and relationship factors used to convert flows and loads used in the digester capacity analyses.

Table 7-7. Maximum Month Basis Data

	Max Month Influent Flow (mgd)	Influent COD Load (lb/d)	Primary Sludge Flow (mgd)	TWAS Flow (mgd)	Sludge Blending Flow (mgd)	Primary Sludge TSS load (lb/d)	Primary Sludge (%Vs)	Primary Sludge Vs (lb/d)	TWAS TSS load (lb/d)	TWAS (%Vs)	TWAS Vs (lb/d)	Sludge Blend VS Load to Prim Dig (lb/d)
Max Month Basis Data	76.0	452,000	0.310	0.200	0.510	130,000	94.0%	122,200	66,194	75.0%	49,600	171,800
Average Daily	70.3	344,500			0.465							124,900
Maximum Daily	79.5	530,500			0.767							216,100
14 day Max	77.4	468,500			0.535							177,400

Table 7-8. Flow and Load Factors Based Upon Maximum Month Data			
	Max Month Influent Flow (mgd)	Sludge Blending Flow (mgd)	Sludge Blend VS Load to Prim Dig (lb/d)
Max Month Basis Data	76.0	0.510	171,800
30-day Max	1.00	1.00	1.00
Daily Average	0.93	0.91	0.73
Daily Max	1.04	1.50	1.26
14-day Max	1.02	1.05	1.03

7.3.2.2 Process Capacity of Current Digesters

The capacity of the current digesters was estimated assuming that all of the treatment occurs in the primary digesters. An iterative calculation, employing 90 percent effective capacity, as was used in the CDM Memo, with one of the larger primary digesters out of service (firm capacity), yielded an available effective volume of 7.51 MG. This yielded results indicating that the existing digester complex has an approximate capacity of 60 mgd maximum month which is equivalent to an average daily flow of 55.5 mgd. As shown in Table 7-9, for the 60 mgd equivalent, the computed blended solids flow was 0.404 mgd and the loading was 136,100 lb VS/day. The limiting criterion was the 14-day maximum VS loading of 0.14 lbVS/d-ft^3. The corresponding 14-day maximum HRT is 18 days. This compares favorably with the 63 mgd equivalent rating presented in the CDM Memo. However, we believe 90 percent effective capacity to be close to ideal mixing conditions for these digesters, with insignificant grit and scum accumulation, and much improved from the current situation. Presuming that the effective volume could be increased to 90 percent (by cleaning digesters and repairing mixers), the 60 mgd capacity rating is less than 3 percent greater than the maximum month experienced in 2008. As such, near term improvements centering on both rehabilitation and capacity addition should be undertaken promptly.

Table 7-9. Process Capacity Loadings and HRTs in Existing Digesters					
Loading Condition		Sludge Parameters		Digester Parameters[2,3]	
		Blended Sludge[1]	Ratio to Max Month	HRT, day	VSS Loading lb/d-ft^3
Annual Average	Flow, MGD	0.367	0.915	21	0.098
	VSS Loading, lb/d	98,600	0.727		
Maximum Day	Flow, MGD	0.606	1.51	12	0.170
	VSS Loading, lb/d	171,000	1.26		
Maximum Month	Flow, MGD	0.404	1.00	19	0.136
	VSS Loading, lb/d	136,000	1.00		
Maximum Two-Weeks	Flow, MGD	0.422	1.05	13	0.140
	VSS Loading, lb/d	140,000	1.03		

[1] Blended sludge is combined Primary and TWAS

[2] For digester volume of 7.51MG capacity

7.3.2.3 Digester Volume Requirements for Future Maximum Month Condition

The plant design capacity for the maximum month condition is 76 mgd. To meet this future condition will require additional digester capacity. As a somewhat conservative approach, we have assumed an 80 percent overall effective volume assuming that the digesters are cleaned, the existing mixers are repaired or replaced, and mixing performance is improved to the original design level. A program to periodically withdraw a portion of the digester contents from the bottom of the digesters will also help with grit accumulation. Additionally, it is expected that the volumetric efficiency of the new digesters can be much better (90 percent or more depending on design), however, given the uncertainty in the available solids data and future design decisions, we believe that this is a reasonable approach.

As noted previously, all of the existing primary digesters have an available gross volume of 9.45 MG. For the 76 mgd MMF equivalent blended solids flow of 0.510 mgd and 171,800 lb VS/day, and 80 percent overall volumetric efficiency, the required minimum gross additional capacity for 3 new primary digesters is 3.60 MG with a firm capacity of 2.40 MG. This additional capacity would result in a 14-day maximum HRT of 17.7 days and a 0.14 lb/d-ft^3 load. It should be emphasized that this is the minimum additional volume, as additional margin on the loading criterion or building only 2 new digesters would require substantially more gross volume (for two digesters, an estimated 1.2 MG additional; for a total of 4.8 MG).

Table 7-10. 76 mgd Maximum Month Capacity Loadings and HRTs in Existing Digesters

Loading Condition		Sludge Parameters		Digester Parameters[2,3]	
		Blended Sludge[1]	Ratio to Max Month	HRT, day	VSS Loading lb/d-ft^3
Annual Average	Flow, MGD	0.465	0.915	20	0.099
	VSS Loading, lb/d	125,000	0.727		
Maximum Day	Flow, MGD	0.767	1.51	12	0.171
	VSS Loading, lb/d	216,000	1.26		
Maximum Month	Flow, MGD	0.512	1.00	19	0.136
	VSS Loading, lb/d	172,000	1.00		
Maximum Two-Weeks	Flow, MGD	0.535	1.05	18	0.140
	VSS Loading, lb/d	177,000	1.03		

[1] Blended sludge is combined Primary and TWAS

[2] For digester volume of 9.45 MG capacity

7.3.2.4 Sludge Blending Tank and Pumps Capacity

This section presents an assessment of the capacity of the existing Sludge Blending Tank and the associated pumps that deliver the blended sludge to the digesters.

The flow values presented in Table 7-10 are based on the BioWin™ modeling. For the purpose of the pumping capacity evaluation, the BioWin™ data for solids streams were adjusted with the peaking factors from the 2008 plant solids data. The future maximum day sludge blending flow was calculated from the 2008 plant data and factored from the predicted maximum month flow in BioWin™. The calculated peak day sludge blending flow is conservatively higher than what is predicted in BioWin™ but is assumed to better reflect the peak fluctuations experienced at the plant. A comparison of these values is presented in Table 7-11 and the solids flow peaking factors and projections are presented in Appendix A.

Table 7-11. Comparison of Blended Sludge Flow Projections		
	BioWin™	BioWin™ adjusted with Plant Data
Maximum Month Flow, mgd	0.512	0.512
Peak Day Flow, mgd	0.767	0.85

While the Blending Tank does serve as a means to equalize the flow of solids to digestion, its principal value is for blending the various solids streams prior to distribution to the primary digesters. Brown and Caldwell designs have included a tank with this function with detention times as low as approximately 30 minutes with comparable mixing and prompt conveyance of solids to the digesters. The capacity of the Sludge Blending Tank and related pumps are shown in Table 7-12.

Table 7-12. Sludge Blending Tank and Pumps Design Data								
	Number	Diameter (ft)	Unit Capacity (mgd) [1]	Firm PDF Capacity (mgd)	Firm MMF Capacity (mgd)	Design MMF[3] (mgd)	Capacity Deficiency (mgd)	Additional Units Required[5]
Sludge Blending Tank	1	40	0.190 MG	5.7 (note 4)	3.43 (note 4)	1.53[2]		
Blending Pumps	3		0.36	0.72	0.43	1.02[3]	0.59	2

Notes: 1 – Design capacity as described in the 2009 Basic Design Data

2 – Assume 8-hrs operation of blended pump to accommodate peaks from TWAS and primary sludge. The daily peak flow has been increased by a factor of 3 (0.51 mgd x 3).

3 – Assumes12-hrs operating time for the sludge pumps. The flow has been increased by a factor of 2 (0.51 mgd x 2).

4 – Assumes 30 minute HDT

5 – Three additional pumps are required if evaluated on a peak day basis.

7.3.2.5 Digester Capacity

As noted above, the primary digester capacity is below the desired 76 mgd MMF condition and the accumulation of material in the digesters and lack of adequate mixing reduces the effective volume of the primary digesters for the near term. The capacities of the primary digesters are shown in Table 7-13 along with the necessary additional primary digester capacity to achieve the 76 mgd MMF condition. Also as discussed, the proposed three digester addition represents the minimum recommended volume.

Table 7-13. Primary Digesters Design Data

	Number	Diameter (ft)	Unit Capacity (MG) [1]	Firm Capacity (MG)	Future Required Capacity (MG) [2]	Capacity Deficiency (MG)	Additional Units Required
Digesters 1,3,5,7,9	5	75	0.847	4.24			
Digesters 2, 8	2	75	0.947	1.89			
Digesters 11, 13, 14	3	85	1.106	2.21			
Total	10		9.45	8.34	11.81	3.47	3 @ 1.2 MG
New Digesters 15, 16, 17	3	75	1.2	2.4			
Totals	13		13.05	11.812	11.81	0	0

Notes: 1 – Design capacity as described in the 2009 Basic Design Data

2 – Gross capacity assuming 80% volumetric efficiency of total volume 9.45 MG.

3 – Firm Capacity assumes that only one of the new larger digesters is offline.

The capacity of the secondary digesters and digested sludge pumps are shown in Table 7-14. Assuming three days' storage of the projected peak day peak solids flow (0.85*3=2.55 MG) results in a required capacity of 2.7 MG. This compares favorably with the available volume with one large secondary digester out of service (2.54 MG). The peak requirement for the digested sludge pumps is assuming capacity to manage the peak day solids flow in 8-hours. In Table 7-14 the sludge pump capacity results are presented in terms of an equivalent MMF (based on the appropriate digested sludge peaking factors presented in Table 1-2).

Table 7-14. Secondary Digesters and Digested Sludge Pumps Design Data

	Number	Diameter (ft)	Unit Capacity (MG or mgd) [1]	Firm PDF Capacity (MG or mgd)	Firm MMF Capacity (MG or mgd)	Design MMF (mgd)[2]	Capacity Deficiency (mgd)	Additional Units Required
Digesters 4,6, 10	3	75	0.847 MG	2.54 MG	1.53 MG	1.53 MG	0	0
Digester 12	1	85	1.106 MG	0 MG	0 MG			
Digested Sludge Pumps(Dig 4 and 6)	2		0.865 mgd	0.865 mgd	0.52 mgd	0.77 mgd	0.25	1
Digested Sludge Pumps(Dig 10 and 12)	1		1.081 mgd	0	0	0.77 mgd	0.77	1[3]

Notes: 1 – Design capacity as described in the 2009 Basic Design Data

2 – Assumes 8-hrs operating time for the sludge pumps and half to each complex. The flow has been increased by a factor of 3 (0.51 mgd x 3).

3 – Two additional pumps are needed for Digs 10 and 12 if evaluated on a peak day basis.

7.3.2.6 Summary

The capacity analysis shows that the digester process is at or near its current capability and both near term repair and construction of new capacity for the longer term are required. Additionally, sludge blending pump capacity and transfer pump capacity short falls should be addressed.

7.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The final clarifier assets were evaluated based on a number of factors to determine overall risk, which was based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the digester asset risk assessment are presented in Table 7-15.

Table 7-15. Anaerobic Digesters Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
AD 1-8 Structures & AD Sludge Blending	Digester Support Building	50	50	5	3	1	3.2	0	3	1	3	0.755	1	0	0	0.163	3	1	3	0.731	1.649	4	4.7	31	
	Sludge Blending Tank	75	22	2	1	1	1.3	1	3	1	3	0.86	3	3	3	0.975	3	3	5	0.969	2.804	3	2.7	34	Age - Reconditioned in FY 99 project
	Sludge Blending Building	50	22	3	2	1	2.1	0	3	1	3	0.755	1	0	0	0.163	1	1	3	0.391	1.309	2	1.4	36	
AD 1-8 Digester Structures & AD Sludge Blending	Primary Digesters	75	45-50	4	4	3	3.8	5	5	3	5	1.842	5	3	1	1.137	5	3	5	1.309	4.288	5	16.3	3	Capacity shortfall - estimated total of 2MG minimum additional capacity required for 76 mgd max month condition
	Primary Digester Covers/Gas/OF systems	40	45-50	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	5	5	5	1.445	4.052	5	18.2	1	
AD 1-8 Digester Structures & AD Sludge Blending	Secondary Digesters	75	45-50	4	3	1	2.9	3	5	3	3	1.422	1	3	1	0.485	3	3	5	0.969	2.876	3	6.3	24	
	Secondary Digester Covers/Gas/OF systems	40	45-50	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	3	3	5	0.969	3.576	5	16.1	8	Condition essentially equal to primary dig.
AD 1-8 EI&C & AD Sludge Blending	Power	20	30-40	5	3	4	3.8	3	5	3	3	1.422	5	5	3	1.461	5	5	5	1.445	4.328	4	14.8	18	Level of service presumes sludge back-up without power
	Instrumentation & Controls	15	30-40	5	3	4	3.8	3	5	1	1	1.124	5	3	1	1.137	5	3	5	1.309	3.57	4	12.2	19	Permit compliance - solids treatment; H&S potentially haz atmosphere.
AD 1-8 Pumping System & AD Sludge Blending	Sludge Withdrawal Pumps	25	20	4	3	3	3.3	3	1	0	3	0.762	3	3	3	0.975	5	3	5	1.309	3.046	2	5.0	26	Pumps have been replaced
	Digester HEX Recirculation Pumps	25	8	2	2	3	2.2	1	1	0	3	0.552	3	0	0	0.489	5	1	3	1.071	2.112	5	4.6	32	
	Sludge Grinders	25	4	1	2	3	1.9	1	3	0	3	0.816	1	1	0	0.243	3	3	3	0.867	1.926	2	1.8	35	
	Blending Pumps	25	4	1	2	4	2.1	1	3	0	3	0.816	3	1	3	0.815	5	3	3	1.207	2.838	3	4.5	33	
AD 1-8 Digester System & AD Sludge Blending	Sludge Heat Exchangers	30	50	5	3	2	3.4	3	1	0	5	0.972	3	1	0	0.569	5	1	3	1.071	2.612	5	8.9	21	

Table 7-15. Anaerobic Digesters Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
AD 1-8 Misc. Mechanical	Mixers	20	28-50	5	5	5	5	3	3	1	5	1.28	3	0	1	0.571	5	3	5	1.309	3.16	5	15.8	12	Redundancy does not consider current maintenance effort on existing mixers
	Low Pressure Gas System	30	45-50	5	4	3	4.1	1	5	1	5	1.334	5	1	3	1.141	5	3	5	1.309	3.784	5	15.5	14	
	Heat Loop - Building Hot Water	30	23	4	5	5	4.7	3	1	0	5	0.972	5	1	1	0.977	5	5	5	1.445	3.394	5	16.0	10	Problem in main loop piping - insufficient hot water for winter.
AD 1-8 Misc. Mechanical	HVAC	20	18	5	5	4	4.8	1	5	0	5	1.29	3	0	3	0.735	5	3	3	1.207	3.232	5	15.5	15	LOS - freezing of gas system and H&S Implications; Damage and aesthetics - costs due to uncontrolled release of gas through PVRV and odor.
	Valves	40	4	1	4	4	3.1	1	3	0	3	0.816	1	1	0	0.243	3	1	3	0.731	1.79	4	5.0	27	
	Piping	40	23-50	4	3	3	3.3	1	3	0	3	0.816	1	1	0	0.243	3	3	5	0.969	2.028	4	6.0	25	
AD 9-14 Structures	Digester Support Building	50	35	4	3	1	2.9	0	3	1	3	0.755	1	0	0	0.163	3	3	5	0.969	1.887	4	4.9	30	
AD 9-14 Structures	Primary Digesters	75	19-35	4	4	3	3.8	5	5	3	5	1.842	5	3	1	1.137	5	3	5	1.309	4.288	5	16.3	3	Capacity shortfall - estimated total of 2MG minimum additional capacity required for 76 mgd max month condition
	Primary Digester Covers/Gas/OF systems	40	25-35	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	5	5	5	1.445	4.052	5	18.2	1	
AD 9-14 Structures	Secondary Digesters	75	25-35	5	4	5	4.5	3	5	3	1	1.212	1	3	1	0.485	3	3	5	0.969	2.666	3	9.0	20	
	Secondary Digester Covers/Gas/OF systems	40	25-35	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	3	3	5	0.969	3.576	5	16.1	8	Condition essentially equal to primary dig.
AD 9-14 EI&C	Power	20	25-35	5	5	4	4.8	3	5	3	1	1.212	5	5	3	1.461	5	1	3	1.071	3.744	4	16.2	7	Level of service presumes sludge back-up without power
	Instrumentation & Controls	15	25-35	5	5	4	4.8	3	5	1	1	1.124	5	3	1	1.137	5	3	5	1.309	3.57	4	15.4	17	Permit compliance - solids treatment; H&S potentially haz atmosphere.
AD 9-14 Pumping Systems	Sludge Withdrawal Pumps	25		5	5	5	5	3	1	0	5	0.972	3	3	3	0.975	5	3	5	1.309	3.256	5	16.3	5	Single pump - no spare. Pumping into single line to Dewatering
	Digester HEX Recirculation Pumps	25		3	2	3	2.5	1	1	0	1	0.342	3	1	0	0.569	5	1	3	1.071	1.982	5	5.0	29	

Table 7-15. Anaerobic Digesters Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
	Sludge Heat Exchangers	30	20-25	4	3	3	3.3	3	1	0	3	0.762	3	1	0	0.569	5	1	3	1.071	2.402	4	7.1	22	
AD 9-14 Misc. Mechanical	Mixers	20	25-35	5	5	5	5	3	3	1	5	1.28	3	1	1	0.651	5	3	5	1.309	3.24	5	16.2	6	Redundancy does not consider current maintenance effort on existing mixers
	Low Pressure Gas System	30	22	4	4	3	3.8	3	5	1	5	1.544	5	1	3	1.141	5	5	5	1.445	4.13	5	15.7	13	
	Heat Loop - Building Hot Water	30	23	4	5	5	4.7	3	1	0	5	0.972	5	1	1	0.977	5	5	5	1.445	3.394	5	16.0	10	
AD 9-14 Misc. Mechanical	HVAC	20	25	5	5	4	4.8	1	5	0	5	1.29	3	0	3	0.735	5	3	3	1.207	3.232	5	15.5	15	LOS - freezing of gas system and H&S Implications; Damage and aesthetics - costs due to uncontrolled release of gas through PVRV and odor.
	Valves	40	4	1	4	4	3.1	1	3	0	3	0.816	1	1	0	0.243	3	1	3	0.731	1.79	4	5.0	27	
	Piping	40	25-35	5	3	3	3.6	1	3	0	3	0.816	1	1	0	0.243	3	3	5	0.969	2.028	4	6.6	23	

7.4.1 General Equipment

As discussed in the previous sections, capacity is a serious concern for the anaerobic digesters in both the near and longer-term. The condition and integrity of the anaerobic digester is also of concern. The most crucial issues were identified as the following:

7.4.1.1 Primary Digester/Cover/ Gas System

These systems were evaluated in the Final DAR "Southside Water Reclamation Plant Digester Rehabilitation," June 2008 CH2MHill. The domes on the digesters are cracked and the covers have exceeded their useful life. Additionally, the mixers are supported from the covers and their structural integrity, leaking of gas and lack of assured function are creating safety issues and are nearing the point of compromising digester performance. Pressure and vacuum relieve valve (PVRV) functions must be good in working condition for safety and structural integrity reasons.

7.4.1.2 Primary Digester Capacity

The existing anaerobic digestion process is stressed and capacity limited. Based upon effective volume, the digester detention time has decreased significantly and current plant data show potential deviation from Class B biosolids requirements for HRT in the primary digesters. Even with clean digesters and a full compliment of mixers and excellent mixing, the estimated available capacity is estimated at only 3 percent above current utilization. New digesters are needed to alleviate the capacity constraints and allow for the existing digesters to be rehabilitated. The size of the new digester will have to be coordinated with the available capacity from the existing digesters in either their current or future configuration.

7.4.1.3 Sludge Withdrawal Pumps

There is no redundancy for the sludge pumps for secondary digesters #10 and #12 (Digesters 9-14). There are reported problems with both the pumps and related valves. Additionally, pumps from both digester complexes discharge into a single line to sludge dewatering (no redundancy). There is a single point of failure in each case.

7.4.1.4 Mixing

The existing mixers have been experiencing problems with the lower bearings and the supports are deteriorating. The lower bearings on the mixers have failed repeatedly and parts have to be machined to continue service. Many of the mixers are out of service, hindering the performance of the digesters. Proper mixing is needed to assure even heating and improved process performance so that available digester volume can be fully utilized. Adequate mixing will also help to reduce scum mats and grit accumulation (when combined with periodic discharge from the bottom of the digesters) that can reduce available volume and create maintenance issues within the digester complex and at sludge dewatering. Current estimates are that each digester is at not more than 70% effective volume.

7.4.1.5 Secondary Digester/Cover/Gas System

These systems were evaluated in the Final DAR "Southside Water Reclamation Plant Digester Rehabilitation," June 2008 CH2MHill. Existing covers are old and should be replaced due to deterioration. Floating covers can be maintenance-intensive and foaming can result in wedging of the lids that can require expensive efforts involving cranes in order to un-jam or relieve the wedge. Unused equipment provides potential deterioration pathway. The PVRV system is a vital system which should be rehabilitated to maximize system safety and structural integrity.

7.4.1.6 Building Hot Water System

Inadequate hot water for digester heating and degrade process efficiency and inadequate building heating can result in freezing of smaller diameter pipes (e.g. drains from the LSG system). The plant staff is aware of leaks in the current system that results in high make-up water use and loss of conditioning chemicals.

7.4.1.7 Low Pressure Gas System

The low pressure gas system has the potential for leaks and needs to be inspected. Leaks and inadequate traps on drain lines pose safety issues. Additionally, inadequate moisture removal performance results in excess moisture to the cogeneration system.

7.4.1.8 HVAC

There is inadequate ventilation and heating in the Digester Complex. Successful process operation, worker safety and electrical code issues are all tied to adequate ventilation and heating systems. Loss of heat in winter can result in freezing of digester gas systems and result in uncontrolled gas release. Gas rooms should be isolated from other parts of the buildings for NFPA 820 compliance and electrical equipment ratings.

7.4.1.9 Digester Feed Improvements

At present, there is a complex control scheme for feeding digesters that requires extensive operator intervention. Unbalanced and erratic feeding can contribute to process upset. Automation of valves and appropriate flow metering can lessen operator intervention time and lessen load fluctuations.

7.4.1.10 Digester Piping and Valves

Existing piping and valves are old and in poor condition. Valves are reportedly failing and undergoing as-needed replacements. Potential for pipe deterioration and/or reduced capacity due to deposits can affect operations.

7.4.2 Electrical Equipment

7.4.2.1 General

Electrical systems within the digester gallery areas are only partially constructed with explosion-proof methods. An analysis of NFPA is needed to determine which areas of this facility require explosion-proof construction methods. Areas that are non-compliant present a risk of explosion and should be addressed.

In general, aging electrical equipment should be subjected to major overhaul or complete replacement to address safety and obsolescence. Only partial redundancy exists at peak conditions. A prolonged power would back-up the solids handling process until a repair or work around was implemented. Modern equipment would be more readily serviced without process disruptions.

PCU controllers are remote from the digester area with long control circuits having multiple interface points leading to unreliability and high maintenance levels.

7.4.2.2 North Digesters 1-8

North Digesters 1-8 are fed from a primary selective switch and unit-substation with provisions for a portable standby generator. Portions of the system are very old and near the end of their useful life. Some portions of this system may present personnel hazards due to their age and condition.

7.4.2.3 South Digesters 9-14

South Digesters 9-14 are fed from the DAFT building covered in Section 6. As stated in that section, there are substantial problems related to the age and condition of the equipment and the building.

7.4.2.4 Blended Sludge Pump Station

The blended sludge pump station is powered from the north digesters electrical room. The equipment in this area is old, but in fair condition. Due to the age, this equipment is nearing the end of its useful life

7.4.3 Instrumentation and Controls

7.4.3.1 North Digesters 1-8

Controls for the north digesters are antiquated and ineffective. Many of the instruments are obsolete.

Control of digester temperatures is difficult due to poor instrumentation, ineffective control valves, and inadequate available heat.

I/O for the North Digesters is remotely located in the main control building, making troubleshooting of circuits difficult.

7.4.3.2 South Digesters 9-14

Controls for the south digesters are antiquated and ineffective. Many of the instruments are obsolete.

Control of digester temperatures is difficult due to poor instrumentation, ineffective control valves, and inadequate available heat.

I/O for the South Digesters is remotely located in the DAFT building, making troubleshooting of circuits difficult.

7.4.3.3 Blended Sludge Pump Station

Controls for the blended sludge pump station are in fair condition. Control for distribution of sludge to digesters is manually controlled and could be substantially improved through more automation.

I/O for the blended sludge pump station is remotely located in the main control building, making troubleshooting of circuits difficult.

7.5 Digester Alternatives and Concepts

This section identifies and assesses viable options to address the existing digester capacity and future considerations. Also included within this section is a cursory review of the biogas available and its usage related to the existing cogeneration system and recommendations.

7.5.1 Temperature-Phased Anaerobic Digestion

One potential option for providing effective solids treatment, but in a lower volume, is temperature-phased anaerobic digestion (TPAD). TPAD, as a simple two-phase system of thermophilic (55 degrees C) and mesophilic (35 degrees C) vessels, can provide class B solids in a reduced process volume. Benefits of TPAD include:

- Increased gas production

- Reduced odors
- Improved dewaterability of solids

The required volume for this type of system is generally considered to be about 25 percent less than a conventional mesophilic digestion system, due to a 5 day HRT in the thermophilic stage and 15 day HRT in the mesophilic stage. Theoretically, given an unlikely 100 percent effective volume, the existing digesters would be able to treat 76 mgd equivalent solids (9.45 MG).

In our opinion, a more successful system is likely to have not less 6 days HRT in the thermophilic phase and a minimum of 10 days HRT in the mesophilic phase, based upon the peak 14 days loading. Consistent solids in the range of 5.5-6 percent would contribute to overall energy efficiency.

For a peak 14-day blended solids loading rate of 0.535 mgd (maximum month of 0.510 mgd x 1.05 = 0.535 mgd), the resulting active volume for the two phases would be:

- Active Thermophilic volume = 3.21 MG
- Active Mesophilic volume = 5.35 MG

For an overall 80 percent effective system, the resulting active volume would be 10.7 MG. Adding the active required volume of 1.25MG, with 80 percent efficiency would require at least 1.56 MG and at least one more digester of comparable volume for “firm capacity”.

Given the support systems required for thermophilic digestion, we would recommend providing the new thermophilic capacity in new digesters and locate these new support systems in an adjacent new building. Providing 3.21 MG of active thermophilic volume, and utilizing an effective operating volume of 90 percent for suitably designed and operated digesters, results in a new gross volume of 3.56 MG. One possibility is for 75 foot diameters digesters, with a 36 foot sidewater depth. Three digesters could provide the 3.56 MG and one additional digester would be provided for redundancy (4 digesters with total gross volume addition of 4.8 MG).

For the mesophilic phase, utilizing 80 percent effective capacity, the resultant volume would be 6.7 MG. This is well within the currently available digester capacity. For Class A biosolids, a more complicated flow arrangement and additional vessels and volume would be necessary.

7.5.2 Cover Options

7.5.2.1 Existing systems

The existing primary digesters have concrete flat and domed fixed covers and the secondary digesters have steel and one wood (Digester #6) floating cover. As described in the FDAR (CH2MHill, June 2008), the existing covers need major renovation or replacement. Additionally, when the covers are rehabilitated, we recommend performing a detailed review of the gas handling system such that adequate capacity is provided..

7.5.2.2 Cover Types

The two types of covers which are currently most commonly used for anaerobic digesters are fixed covers and floating covers. Fixed covers are structurally fixed to the wall of the digester tank. Fixed covers allow a constant tank volume which helps to maximize the use of the digester volume.

Floating covers allow variations in sludge volume and hold the digester gas pressure within a desired operating range. Floating covers are ballasted to balance the buoyant forces of the digester fluid, the cover weight, and the gas dome pressure. There are a number of types of floating covers including the standard Downes floating cover, a BC designed Downes floating cover (small surface interface), and a Downes floating gasholder cover.

Fixed covers include a number of domed and flat configurations in concrete and domed configurations in steel. BC has developed a design called the "submerged fixed" cover that has a number of features that provide for improved operation and maintenance.

The advantages and disadvantage of digester floating and fixed covers are shown in Table 7-16.

Table 7-16. Advantages and Disadvantages of Fixed and Floating Covers

Advantages	Disadvantages
Floating Cover	
• Allow for changes in inventory and reduces possibility of overfilling or over –withdrawing sludge from the tank (which can result in structural problems).	• Potential for condensate and foam accumulation in cover
	• Cover life between coating-less than 20 years
	• Condensate or rain within attic space accelerates corrosion
	• No significant gas storage
• Operate with all types of mixing	• Inventory control limited to cover travel
	• Annular space contributes to odors.
Fixed Cover	
• No odor or foam release.	• Minimized gas storage
• Wide liquid level range allows for maximum inventory control	• If cover and exposed wall PVC lined-life 40+ years; no lining - life 20+ years
• More digester volume is available with a given tank configuration compared to that available with the floating cover	• Structural damage can occur if the digester is overfilled. However, provision of an emergency overflow system can be made to prevent overfilling
• Operate with all types of mixing.	• Foam and debris can accumulate under cover, if provisions for control are not provided.

Replacement of the existing floating covers, for secondary digester service, with comparable steel floating covers can be an economical choice. However, floating covers will require periodic inspection and recoating at approximately 10 years of service.

7.5.2.3 Primary Digester Covers

For primary digester service, BC recommends fixed covers to address the shortcomings of the floating covers.

There are two basic types of fixed covers:

- Submerged Fixed Cover
- Unsubmerged Fixed Cover.

In a submerged fixed digester cover, the cover and the center gas dome are above the top of wall elevation and the operating liquid level is also above the top of the wall. The small liquid/gas interface area in the digester dome, coupled with normal withdrawal of digested sludge from the dome, results in continuous control of scum and foam. An emergency overflow weir and discharge pipe are provided in the dome to prevent overfilling or pressurizing the digester.

The unsubmerged fixed digester covers are structurally fixed to the walls of the tank. The cover and the center gas dome extend above the top of the wall, but the liquid level does not. A large liquid /gas interface area exists in the unsubmerged fixed cover resulting in the potential for scum and floatable accumulation and corrosion.

Features of submerged and unsubmerged fixed covers are shown in Table 7-17.

Table 7-17. Features of Submerged and Unsubmerged Fixed Covers

Submerged Fixed Cover	Unsubmerged Fixed Cover
• Positive foam and scum control with gas/liquid dome gravity overflow system	• Accumulation of scum and foam with no positive means of control
• No danger of cover hydraulic overload with properly designed gas atmosphere overflow	• Dangerous cover hydraulic overload if overflow plugged by digester sludge
• Cover and exposed wall PVC lined-life 40+years	• Cover life can be compromised due to corrosive environment; some steel covers can provide less than 10 years of service because of extremes in tank corrosion. Unprotected concrete also has a shorter life
• Short circuiting minimized with bottom feed and top withdrawal	• Short circuiting somewhat minimized with top feed and bottom center withdrawal
• Compatible with all types of mixing system	• Compatible with all types of mixing systems
• No gas storage	• No odor or foam release
• No odor or foam release	• Annular space sealing requires careful attention during design and construction

Comparisons of submerged and unsubmerged fixed covers are given in Table 7-18.

Table 7-18. Comparisons of Submerged and Unsubmerged Fixed Covers

Parameter	Submerged Fixed Covers	Unsubmerged Fixed Covers
Material	Reinforced concrete	Concrete or Welded steel
Life Expectance	+50 years	40 yrs w/maintenance, 20+ yrs w/o
Coating/Lining	PVC lining	PVC lining (conc.) or Epoxy Coating (steel)
Coating/Lining Maintenance	Minimal: 10 year inspections	Extensive; 5 year inspections; 12 year spot repair; 25 year major recoating/ replacement
Liquid Surface Accumulations	Minimal, continuous removal	Potentially significant, no surface removal. Rely on mixing system to breakup
Operational Flexibility	Submerged or unsubmerged	Unsubmerged only
Capital cost	Higher than unsubmerged	Lower than submerged.

Submerged fixed cover minimizes the foam and scum accumulation due to the small liquid surface area maintained. From an operation and maintenance (O&M) standpoint, submerged fixed covers provide the flexibility to operate the system submerged or unsubmerged with reduced O&M attention.

For new digesters, when comparing the available volume for similar sized digesters with submerged fixed covers and unsubmerged fixed covers, the submerged fixed covers provide an additional percent volume over the unsubmerged fixed covers. This is due to the freeboard required in unsubmerged fixed covers, as opposed to submerged fixed covers which require little or no freeboard.

For existing digesters, a structural analysis is required to determine if a higher liquid level of a submerged fixed cover is possible. If need be, the additional height can be accommodated with additional wall reinforcing.

Submerged fixed covers offer operational and long term maintenance advantages over unsubmerged fixed covers. Primarily these advantages are in the form of reduced foam, scum and debris accumulations on the liquid surface, and reduced long term maintenance requirements associated with corrosion protection of the cover. We recommend further consideration of the submerged fixed cover design for new and retrofitted digesters.

7.5.3 Mixing

7.5.3.1 Existing systems

The existing primary digesters are provided with internal and external draft tube mixing. Many of the mixers have failed and the WUA is currently undertaking a major maintenance program for this equipment. The gas mixing systems have been removed from the secondary digesters and they are currently unmixed. The condition of the digesters and the mixing systems are addressed in the FDAR (CH2MHill, June, 2008). A report on potential mixing options is also presented in the FDAR. The existing mixing systems should be rehabilitated to keep up with even modest load growth in the near term and to meet the plant's liquid stream design capacity.

Currently, the primary digesters have either 4 or 5 draft tube mixers of either 10 or 20 motor horsepower (Hp) each for 40 to 80 Hp per digester. The draft tubes are founded on the tank bottoms, are secured to the digester covers and the mixers sit on mounting flanges on either the covers or the external draft tubes.

Mixing energy for the 75 ft. and 85 ft. digesters ranges from 0.316 Hp per 1,000 cubic feet (0.316 Hp/kcf) to 0.541 Hp/kcf.

7.5.3.2 Mixing Criteria

Digester mixing design criteria is typically empirical and based on experience of what has worked and not worked in other installations. Typical anaerobic digester mixing system design criteria as following:

- Unit Power: Unit power is based on the relationship between mixing effectiveness and the total power input. It is defined as the horsepower of the mixing equipment divided by the volume of the digester. Typical values of unit power are in the ranges of 0.2 to 0.3 hp/1000 ft3, although newer technologies and techniques are yielding lower values.
- Velocity Gradient G: Velocity Gradient is the relation of power input, viscosity of the sludge and the digester volume. Typical G values are in the range of 50 to 80 sec-1.
- Turnover time: The time required to recirculate the entire volume of the digester and is calculated as the total volume of the digester divided by the pump rate through the mixing device. Typical values are 20 to 30 minutes. Again, newer technologies and techniques are allowing deviations from these ranges.

7.5.3.3 Potential Mixing Systems

The FDAR describes and evaluates several mixing systems. WUA personnel have expressed interest in getting rid of the existing draft tube mixing systems due, in large part, to the extensive effort required to maintain them. Additionally, the existing system is not particularly energy efficient.

The systems proposed in the FDAR are 30 to 75 Hp per digester and are therefore comparable to existing systems. WUA staff have expressed interest in a Philadelphia Mixer system for which preliminary data show that six to nine horsepower (6-9 Hp) per digester may be possible. Another recent technology, that uses potentially less energy for a given mixing efficiency is the Linear Motion mixer marketed by Eimco.

The choice of any new cover-mounted mixing system will require removal of a digester from service for retrofit. Given the condition of the existing covers, for energy efficiency, we recommend replacement of the covers and incorporation of efficient cover-mounted mixing systems.

7.5.4 Digester Gas Utilization

7.5.4.1 Estimated Current Gas Generation

The estimated 2008 quantity of digester gas, energy yield and equivalent generator capacity is presented in Table 7-19. The analysis is based upon the Cooper cogeneration units with a 1,132 kilowatt (kW) rating and a required heat input of 10,800 Btu/kWh). As shown, for an estimated yield of 15 standard cubic feet per pound of volatile solids destroyed (15 scf/lb VS Dest.) and a lower heating value of 550 British thermal units per scf (550 Btu/scf), the amount of gas is sufficient to power one Cooper-ized cogenerator at as little at 60 percent capacity up to two units for a maximum month condition (over 2 for a maximum day).

Table 7-19. Estimated Current Gas Generation

	Estimated LSG Flow (cf/day)	Energy (mmBtu/day)	Energy (mmBtu/hr)	Generated Power (kWH)	Equivalent No. of cogenerators
Annual Avg	693,000	381	15.9	1540	1.4
Max Day	1,244,000	684	28.5	2770	2.4
Max Month	1,000,500	550	22.9	2220	2
Min Day	314,000	173	7.2	700	0.6

7.5.4.2 Estimated Future Gas Generation

The estimated 2008 quantity of digester gas from Table 7-19 was increased by the ratio of the maximum month flows (76/58.4) to yield the projected equivalents for a 76 mgd maximum month conditions. As shown in Table 7-20, based upon the assumptions from above and a Cooper-sized unit, the amount of gas is sufficient to power one Cooper-sized cogenerator at as little at 80 percent capacity up to over two units for a maximum month condition (over 3 for a maximum day).

Table 7-20. Estimated Future Gas Generation

	Estimated LSG Flow (cf/day)	Energy (mmBtu/day)	Energy (mmBtu/hr)	Generated Power (kWH)	Equivalent No. of cogenerators
Annual Avg	902,000	496	20.7	2010	1.8
Max Day	1,619,000	890	37.1	3600	3.2
Max Month	1,302,000	716	29.8	2890	2.6
Min Day	409,000	225	9.4	910	0.8

7.6 Recommendations/Conceptual Workplan

Based upon our evaluation, we recommend substantial rehabilitation efforts in the digestion system in the near-term and a system expansion to provide adequate capacity for the plant's liquid stream design capacity. As the current condition of the digestion system is very poor and at almost full capacity utilization for the current liquid stream flow treated by the plant, all renovations will have to limited or staged so that the available capacity is not further reduced during the rehabilitation efforts. Accordingly, we recommend that planning for additional digester capacity be started as soon as possible.

Additional information for projects beyond those listed and additional assumptions and the costs estimates for the listed projects are provided in Chapter 13.

7.6.1 Interim Phase Projects

The following projects should be undertaken in the near term to provide for near-term process capacity and safety and long-term vessel integrity:

- **Interim Improvement -** Primary Digester Cover Improvements (Dig 1-8; Dig 9-14)
- **Interim Improvement -** Primary Digester Mixing, Cleaning and Heating Improvements (Dig 1-8; Dig 9-14)
- **Interim Improvements -** Secondary Digester Cover Equipment Improvements (Dig 1-8; Dig 9-14)

ABCWUA has and will continue to perform these interim improvements in-house and as such, these improvements are not included in the project schedule or cash flow for the RRAMP.

7.6.1.1 Primary Digester Cover Improvements

This proposed project applies to all of the primary digesters. It involves a step-wise rehabilitation of all covers, low pressure sludge gas (LSG) and overflow (OF) systems. Consistent with the recommendations of the FDAR, gas leaks in covers, mixer and piping connections and OF box covers should be sealed with modified grout materials.

To provide for ease of regular maintenance, replace PVRVs with duplex arrangement of PVRVs and 3-way valves suitable for future vessel capacity.

As part of this project, perform structural retrofit feasibility study for future capacity with submerged fixed covers and sizing of gas system components.

7.6.1.2 Primary Digester Mixing, Cleaning and Heating Improvements

The existing mixing configuration for the primary digesters cannot be readily changed without digester cover modifications. For this project, we recommend that the existing mixing equipment be repaired or replaced for 3 to 10 years of life.

While proceeding with on-going repairs, we recommend conducting an initial study of existing equipment and evaluation of suitable replacements. If equipment cannot be cost-effectively salvaged, we recommend replacement units. Other manufacturers' equipment could be configured to match existing draft tubes, if necessary.

Rehabilitation should include contracted cleaning and interior inspection of digesters and connected piping and pumps, and disassembly, inspection and refitting of the corresponding HEX prior to refit with mixers.

7.6.1.3 Secondary Digester Cover Equipment Improvements

Project involves a step-wise improvement of all PVRVs, on all four secondary digesters, to restore safe and assured operation. Replace PVRVs with duplex arrangement of PVRVs and three-way valves suitable for future vessel capacity.

Perform structural retrofit feasibility study for future capacity with submerged fixed covers and sizing of gas system components. Once the evaluation is performed the preferred solution will be designed and constructed.

Rehabilitation should include contracted cleaning and simple interior inspection of digesters and connected piping and pumps.

7.6.2 Long-term Projects

The following projects should be undertaken over the longer term to provide for process capacity, system integrity and improved operation and maintenance:

- Primary Digester Covers and Rehabilitation (Dig 1-8; Dig 9-14)
- Digester Capacity Improvements (Dig 1-8; Dig 9-14)
- Digester Sludge Withdrawal Pump Improvements (Dig 1-8; Dig 9-14)
- Primary Digester Mixing Improvements (Dig 1-8; Dig 9-14)
- Digester EI&C Improvements (Dig 1-8; Dig 9-14)
- Secondary Digester Covers and Rehabilitation
- Digester Building Hot Water Loop Improvements (Dig 1-8; Dig 9-14)
- Digester Low Pressure Gas System (Dig 1-8; Dig 9-14)
- Digester HVAC Improvements (Dig 1-8; Dig 9-14)
- Digester Feed Improvements (Dig 1-8; Dig 9-14)
- Digester Piping and Valves (Dig 1-8; dig 9-14)

7.6.2.1 Primary Digester Covers and Rehabilitation

The proposed project involves the inspection of the covers of all the primary digesters to confirm/update findings of the FDAR and consider the feasibility of constructing a submerged-fixed cover configuration and at what capacity (either with or without additional circumferential reinforcing).

New sludge heat exchanger (HEX) equipment and associated hot water pumps, piping/valve and automation modifications and repairs and new mixing equipment should also be evaluated. The basis of design will detail the rehabilitation needs.

Construction should start once the new digesters have been commissioned.

7.6.2.2 Digester Capacity Improvements

This project will initially evaluate the addition of three (3) new digesters to bring the available firm digester capacity to 76 mgd MMF capacity for mesophilic digestion (gross planning volume of 3.6 MG in 3 Digesters). Proposed concept would include all support systems and a stand-alone building with two new boilers with sufficient heating capacity to help support the existing digesters (via new interconnection piping). This building is also the proposed site of a new MCC for the North Digesters. The proposed concept is to design, construct and commission the new conventional digesters with submerged-fixed covers prior to major retrofit construction of existing digesters.

7.6.2.3 Digester Sludge Withdrawal Pump Improvements

This proposed project will initially evaluate the sludge pumping system capacity and a proposed control system (required to for improved flow balance to sludge dewatering). This will include addressing redundancy for the sludge pumps for secondary digesters #10 and #12 (Digesters 9-14) and redundancy in the feed line to sludge dewatering. The conceptual plan is to provide (2) pumps and (2) parallel feed lines to the dewatering building.

7.6.2.4 Primary Digester Mixing Improvements

This proposed project involves an initial evaluation of alternatives to improve digester mixing. Slow speed Philadelphia mixers will be considered as an alternative. Once the evaluation is performed, the preferred solution will be designed and constructed in conjunction with revised cover design as the existing mixing configuration cannot be readily changed without digester cover modifications.

7.6.2.5 Digester EI&C Improvements

For this proposed project element, Electrical, Instrumentation and Control (EI&C) upgrades will be developed with process/mechanical upgrades along with the results of the Electrical Power System Study project. It has been assumed that there will be a new north electrical room and full replacement of North MCCs, North Switchgear, DCU cabinets, and instrumentation.

7.6.2.6 Secondary Digester Covers and Rehabilitation

The proposed project involves the inspection of the digesters to confirm/update findings of the FDAR and consider the feasibility of constructing a submerged-fixed cover configuration on all digesters and at what capacity (either with or without additional circumferential reinforcing - assumed required for estimating). Fixed covers will require an adequate reservoir of digester gas (LSG) so as not to affect low pressure uses and compression and cogeneration systems. At this time, the approach assumes the existing gas holders will remain. The feasibility of piping/valve and automation modifications and repairs and new mixing equipment should also be evaluated. The basis of design will detail the rehabilitation needs. Following this, the project will design and construct these improvements. Construction should start once the new digesters have been commissioned.

Given the extended outage associated with replacement, two of the four secondary digesters could be retrofitted as swing digesters by sharing circulation and HEX equipment with an adjacent primary digester. Related piping/valve and automation modifications and repairs and new mixing equipment should be implemented for the swing digesters.

7.6.2.7 Digester Building Hot Water Loop Improvements

The proposed project includes an initial evaluation of the building hot water loop to determine the recommended design and construction that should take place to rehabilitate this system. Given the age and history of this system a full parallel system may be required.

7.6.2.8 Digester Low Pressure Gas System

The proposed project involves the investigation of materials of construction, inspection of low pressure gas system, estimation of future requirements and then preparation of a basis of design which will detail what repairs are required and exactly what requires replacement.

Because of the critical need for active digester volume, it is anticipated that only improvements from individual digesters to isolation at headers could be accomplished prior to bringing new digesters on-line. Again to retain digester capacity, it is assumed that that a new gas room will be constructed (perhaps as an extension of the existing) for each group of digesters and buried or encased piping will be replaced with stainless steel (SST) exposed piping within the digester complex transitioning to new buried HDPE piping in the yard.

7.6.2.9 Digester HVAC Improvements

The proposed project involves the investigation for requirements for physical isolation of the gas rooms and appropriate heating and ventilation. We have assumed concrete block fill of existing doors and/or louvers to digester gallery; rerouting of any ventilation to/from the gallery; separate ventilation and explosion-proof heating of the gas rooms; and repair and/or replacement of exterior doors and windows. Detection instrumentation and go-no-go panels should also be included

7.6.2.10 Digester Feed Improvements

The proposed project involves the investigation of sludge feed piping for appropriate routing and valve placement/replacement. Automated vales and manual isolation valves will be considered. In our opinion, redundancy should be an important consideration. The suggested approach includes one new feed line , with a magnetic flow meter, valves and bypass pipe on the piping from the sludge blending pumps; rehabilitation of the existing feed line with a new magnetic flow meter, three valves and bypass pipe, and one automated valve and two isolation valves for each primary digester (10).

7.6.2.11 Digester Piping and Valves

The proposed project involves the investigation of sludge piping materials and condition and inventory of valves for replacement. Piping will be considered for future capacity requirements. Cases of obvious failures and conflicts will be identified for changes.

Once the design approach is accepted, proceed through construction in a step-wise manner in conjunction with other digester modification work.

7.6.3 Other Improvements

Other potential improvements considered for the digester area, are described in Table 7-15.

8. SLUDGE DEWATERING

8.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the Sludge Dewatering Building. In terms of risk, this process area ranks as critical among the SWRP facilities because of capacity and safety issues within the building. Safety is a significant concern in the Sludge Dewatering Building as the building lacks proper HVAC and odor control, the biosolids conveyor lacks proper safety isolation, and there are numerous slip and trip hazards throughout the building. This process is critical for processing the digested solids and there is a significant lack of near and long term future capacity with this process area. Presently, the SWRP staff is struggling to keep up with demand as one centrifuge is out of service. In general, this facility is in poor condition and should be rehabilitated as quickly as possible.

A few of the assets ranked as high priorities for replacement (Risk Score greater than 12) and a majority of the risk scores ranked as moderate priorities (Risk Score between 8 and 12). A summary table of the top risk score assets is presented in Table 8-1 and justification for these rankings is described in the following sections.

Due to the number of high priority issues at the Sludge Dewatering Building and potential safety and capacity concerns with rehabilitating the Building, a new facility should be constructed to provide better performance, safety, and reliability.

Table 8-1. Sludge Dewatering Process Area Summary

Asset Classification	Total Risk	Assessment Implications
Centrifuges	13.2	Critical for capacity and performance
Centrate Tank and Pumping System	12.9	Critical for capacity and staff safety
HVAC	11.7	Critical for staff safety and integrity of equipment
Power	11.5	Critical for capacity and performance
Instrumentation and Controls	10.1	Essential for performance
Hoppers	9.9	Essential for capacity
Conveyor	9.5	Essential for staff safety and performance
Dry Polymer Feed System & Mixing Tanks	8.7	Essential for staff safety and performance
Sludge Feed Tank and Pumping System	8.2	Essential for performance and operation flexibility
Polymer Feed Pumps and Piping	7.9	Essential for performance and operation flexibility

8.2 Introduction

The digested sludge from the secondary digesters is transferred via three (3) sludge withdrawal pumps to the sludge feed tank. The sludge feed pumps then transfer the sludge to the centrifuges in the Sludge Dewatering

Building. There are a total of four (4) sludge feed pumps and three (3) centrifuges. Polymer is added in the pipeline prior to the centrifuges to enhance sludge dewaterability. The dewatered sludge from the centrifuges is discharged to a conveyor and then to a sludge auger for deposit into four (4) sludge storage bins. The centrate stream flows to a centrate storage tank and can either flow by gravity to Interceptor 142A or it can be pumped to Junction Box #8 where it combines with the RAS stream.

8.3 Capacity Evaluation Results

The sludge dewatering criteria are based on the peak day flow conditions and the rated capacities of the major sludge dewatering assets were evaluated against this treatment flow rate but the results are presented in terms of an equivalent maximum monthly flow (MMF). The sludge dewatering capacity evaluation includes the following systems:

- Sludge Feed Pumps
- Centrifuges

8.3.1 Assumptions

The sludge dewatering system was analyzed on a peak day condition basis, utilizing the plants liquid stream design capacity as discussed in previous sections. The peak design day digested sludge flow to the dewatering system was determined to be 0.85 mgd and the maximum month flow was determined to be 0.51 mgd from the BioWin™ modeling and historical peaking factors. Additional details were provided regarding these flow and loading assumptions and determinations in Section 1.2. Solids projection data are provided in Appendix A.

8.3.2 Capacity

The sludge feed tank has limited volume and is generally used as a surge tank. At peak day flow, the detention time within the sludge tank is approximately eight minutes. However, the rate of flow is dependent on how the digester pumps are operated. There are four feed sludge pumps that can pump between 100 to 400 gpm each. The capacity evaluation results for the sludge feed pumps are shown in Table 8-2. Since the feed pumps and the centrifuges work together as a system, the centrifuge capacity was evaluated under similar conditions as the feed pumps. The centrifuges were assumed to operating 8 hours a day which calculates to a peak flow of 2.55 mgd (0.85 mgd x 3=2.55 mgd) or a MMF of 1.53 mgd (0.51 mgd x 3=1.53 mgd). The capacity of the centrifuges is presented in Table 8-3. If the centrifuge and their associated feed pumps and ancillary support systems are operated constantly (24 hours a day), the firm capacities of the sludge dewatering system appears to be adequate for the estimated peak daily sludge flow of 0.85 mgd. According to the CDM Memo, the daily operation of the two centrifuges was 14 hours per day (two shifts minus startup/shutdown time). If the centrifuges were to operate in this manner, the each centrifuges could process 0.42 mgd (assuming two units online) – and this is approximately half of the peak design daily sludge flow of 0.85 mgd. If the centrifuges were run during one long shift per day or 8 hours/day, a total of six (6) centrifuges (five (5) duty and one off-line) would be required.

Table 8-2. Sludge Feed Pumps Design Data							
	Number	Unit Capacity (mgd) [1]	Firm PDF Capacity[2] (mgd)	Firm MMF Capacity (mgd)	Design MMF[3] (mgd)	Capacity Deficiency (mgd)	Additional Units Required
Sludge Feed Pumps	4	0.576	1.73	1.04	1.53	0.49	1

Notes: 1 – Design capacity stated in the 2009 Basic Design Data. Assumed high end pump capacity of 400 gpm.

2 – Assumes one pump is offline.

3 –Operating 8 hours a day.

Table 8-3. Centrifuge Design Data							
	Number	Unit Capacity (mgd) [1]	Firm PDF Capacity[2] (mgd)	Firm MMF Capacity (mgd)	Design MMF[3] (mgd)	Capacity Deficiency (mgd)	Additional Units Required[4]
Centrifuges	3	0.50	1.0	0.6	1.53	0.93	2

Notes: 1 – Design capacity stated in the 2009 Basic Design Data is 400 gpm. SWRP staff stated that they can only reach 350 gpm so this was used as the unit capacity.

2 – Assumes one unit is offline.

3 – Operating 8 hours a day.

4 – Three additional units are required if evaluated on a peak day basis.

8.3.3 Summary

The capacity evaluation results indicate that at least two additional centrifuges (three are needed if evaluated on a peak day basis) and one additional sludge feed pump will be required to meet the peak day sludge flow. Currently, only two centrifuges are available and online and this lack of capacity is stressing the solids processing operations.

8.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The Sludge Dewatering Building assets were evaluated based on a number of factors to determine overall risk which was based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the Sludge Dewatering Building asset risk assessment are presented in Table 8-4.

Table 8-4. Sludge Dewatering Building Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
Structure	Building	50	23	3	4	4	3.7	0	3	0	0	0.396	1	1	3	0.489	3	3	3	0.867	1.752	3	4.9	12	
EI&C	Power	20	mixed	4	5	4	4.5	1	3	1	0	0.545	3	3	3	0.975	5	3	5	1.309	2.829	4	11.5	4	
	Instrumentation & Controls	15	mixed	4	5	4	4.5	1	3	1	0	0.545	3	3	3	0.975	3	3	5	0.969	2.489	4	10.1	5	
Mechanical	Centrifuges	20	12	3	4	4	3.7	3	3	1	5	1.28	3	3	3	0.975	5	3	5	1.309	3.564	5	13.2	1	
	Centrate Tank & Pumping System	25	mixed	3	4	4	3.7	3	3	1	3	1.07	3	3	3	0.975	5	5	5	1.445	3.49	5	12.9	2	
Sludge Pumping System	Sludge Feed Tank & Pumping System	25	mixed	4	3	4	3.5	1	1	1	3	0.596	3	1	1	0.651	3	5	5	1.105	2.352	5	8.2	9	See Digester section for additional information on Dig. 9-14 sludge pumping (Withdrawal Pumps)
Polymer System	Dry Polymer Feed System & Mixing Tanks	20	mixed	4	4	4	4	1	3	1	0	0.545	3	1	1	0.651	3	3	5	0.969	2.165	5	8.7	8	
	Polymer Feed Pumps & Piping	15	12	4	4	4	4	1	3	1	0	0.545	3	1	1	0.651	3	1	4	0.782	1.978	5	7.9	10	
Materials Handling	Conveyor	20	1	1	4	5	3.3	1	5	1	0	0.809	3	3	3	0.975	3	5	5	1.105	2.889	5	9.5	7	
	Hoppers	20	mixed	4	4	4	4	1	5	1	0	0.809	3	3	3	0.975	3	3	5	0.969	2.753	4	9.9	6	
Misc. Mechanical	HVAC	20	16	4	4	4	4	1	5	1	0	0.809	5	1	3	1.141	3	3	5	0.969	2.919	5	11.7	3	
	Odor Control	15	9	3	4	4	3.7	3	3	3	0	0.843	3	1	5	0.979	1	3	3	0.527	2.349	4	7.8	11	

8.4.1 General

The majority of the sludge dewatering equipment is in adequate condition though there are numerous ancillary and support mechanical components which should be rehabilitated due to wear, age and poor condition. The most crucial issues were identified as the following:

8.4.1.1 Centrifuges

The centrifuges are currently operating constantly to keep up with demand and additional centrifuges will be needed in the future to meet demands. Currently, one of the three centrifuges is offline and this lack of redundancy is stressing the solids processing operations. In terms of condition, the centrifuges have antiquated controls systems and show wear from the presence of grit in the solids which is likely due to the inadequate grit removal at the PTF.

8.4.1.2 Centrate Tank and Pumping System

The centrate tank is located inside the building and does not have proper ventilation and odor control. This causes extreme odor problems within the building and increases the building's interior humidity which causes accelerated corrosion of the mechanical and electrical equipment as well as the structural elements of the system and is also a human health concern.

8.4.1.3 HVAC

The HVAC system is not functioning and thus the building lacks proper air exchange and humidity control. This causes a hazardous environment for both plant staff and accelerated deterioration of mechanical and electrical equipment as well as the structural elements within the building.

8.4.1.4 Hopper

The hopper gates do not function properly and often freeze in position. The hydraulic system does not function in cold weather and the bottom of the hoppers clog.

8.4.1.5 Conveyor

The conveyor is a long, single belt that is located near a main stairwell with frequent plant staff traffic. The slippery floors around the conveyor compounded with its location so near to a plant staff thoroughfare causes this system to be a safety hazard. As there is only one conveyor without redundancy, this system is comprised of a single point of failure. The conveyor is also uncovered and is a significant source of odors and humidity.

8.4.1.6 Polymer System

The humidity in the building causes operational issues with the polymer and hinders the transfer of the polymer for batching. There is also a lack of hot water to make up the polymer solution. The dry polymer system is located such that it is difficult to transport and store the bulk polymer. There is also a lack of redundancy in the system, specifically with the polymer tanks and pumps. The polymer piping feed the centrifuges often clogs,

8.4.1.7 Sludge Feed Tank and Pumping System

There is no redundancy for the sludge feed tank and the tank lacks mixing. There is also only one line that can be used to transfer digested sludge from the secondary digesters to this tank. There are reports of struvite buildup on the discharge lines and the valving in the pipeline does not function. The VFDs on the pumps are aged, the seals on the pumps are wearing out, and there are leaks from the pumps and piping which cause slip hazards and exacerbates the odor problems within the building.

8.4.2 Electrical Equipment

The 5th Avenue medium-voltage switching station feeds three transformers the dewatering building. While the medium-voltage switches and transformers appear to be in fair condition, we were unable to remove them from service to inspect the interior working parts and terminations.

Medium-voltage power has proven unreliable, mostly due to the complexities of the cogeneration system (See Section 10 for more detail on these issues). While the medium voltage switches and transformers appear to be in fair condition, we were unable to remove them from service to inspect the interior working parts and terminations.

Each transformer feeds a motor control center dedicated to a centrifuge train. Most of the electrical equipment in this building is only about 12 years old and appears to be in fair condition, but there is some water damage that has occurred in the MCC room. The variable frequency drives are old and have been problematic. Some redundancy is provided by the three electrical feeds to the building, but electrical outages result in time-consuming cleaning of centrifuges.

8.4.3 Instrumentation and Controls

Instrumentation and controls for this building are antiquated and difficult to keep functioning. There are a number of specific problems:

- The sludge feed program is overly complicated and does not work well.
- Polymer batching and feed systems do not operate properly.
- Truck loading is controlled manually by operators visually estimating truck weight/fill. This makes it nearly impossible to optimize sludge transportation, because trucks are either way under or way over weight.
- Antiquated control panels are very difficult maintain.

8.5 Recommendations/Conceptual Workplan

The Sludge Dewatering Building is in critical need of rehabilitation due to serious health and safety concerns that exist in that facility. In addition to these concerns, the system does not have enough capacity to meet its current sludge inflow without significantly stressing the system and its operations and maintenance staff and much of the equipment should be replaced due its aged and poor condition.

Two workplan alternatives were evaluated to determine the best option for providing the SWRP with a safe, reliable and adequately sized sludge dewatering facility. These two alternatives included 1) rehabilitating and reusing the existing building and as much of the existing equipment as possible and 2) construction of a new facility while reusing to the greatest extent possible the major system mechanical components located in the existing building. Due to space constraints, safety issues, and potential operational constraints during rehabilitation, the construction of a new sludge dewatering facility was determined to be the preferred alternative. Further details on the project and cost estimates are provided in Chapter 13.

Table 8-5. Sludge Dewatering Building Alternatives		
Alternative 1	Pros	Cons
Improve existing Sludge Dewatering Facility (see figure 1, 2, & 3)	Utilize existing facilities that have no issues	Limited space for centrifuge addition and digested sludge
	Time to complete improvements will be less than new	Construction sequence would be intrusive to operations & dewatering capacity
	Less cost than new facility	Existing facility will need to be thoroughly evaluated to assure Alternative 1 is possible.
	Infrastructure components can be reutilized	Limited space for electrical and controls modifications
		Polymer loading area will need to be added
Alternative 2	Pros	Cons
Provide New Sludge Dewatering Facility	Layout facility to best suit operations and maintenance	More costly than improving existing
	Construction sequence issues will be less intrusive to operations and dewatering capacity	Time to complete improvements will be more than improving existing
	Could relocate reliable existing equipment to new facility	New infrastructure improvements will be required
	New facility location is very flexible	

9. PLANT-WIDE WATER SYSTEMS

9.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the plant-wide water systems. In terms of risk, this process area ranks as moderately among the SWRP facilities because of its adequate performance and condition. The SWRP is in need of reliable plant-wide water systems that can provide adequate pressure, capacity, and flow to its facilities for process uses, washdowns, and auxiliary uses. The existing reuse system cannot provide all the facilities' reuse water needs and the effluent washwater (EWW) is not a reliable backup system source. The existing plant-wide distribution piping is old and in poor shape. With a new reuse facility set to come online in the near future, the existing water distribution loop and system should be rehabilitated as needed to provide a reliable non-potable water system for the SWRP.

The reuse system and EWW system piping and valves ranked as a high priority asset for replacement (Risk Score greater than 12); however, the other assets in this process system ranked as lower priorities (Risk Score less than 8).

A summary table of the top risk score assets is presented in Table 9-1 and justification for these rankings is described in the following sections.

Table 9-1. Plant-Wide Non-Potable Water System Process Area Summary

Asset Classification	Total Risk	Assessment Implications
Reuse Pipes/Valves/Hydrants	12.9	Critical for plant performance
EWW Pipe/Valves	12.5	Critical backup system
Process/Seal Water System Pipes/Valves	4.7	Necessary for equipment integrity
EWW Pumps	4.1	Necessary for capacity and performance
EWW Wetwell and Drywell	2.7	Necessary for system integrity
Fire Pump	2.6	Necessary for plant safety
Potable Water System Pipes/Valves/Hydrants	2.6	Necessary for plant safety
Reuse Distribution Pumps	2.4	Necessary for capacity and performance
EWW Strainers	1.5	Necessary for system performance
EWW Power	1.3	Necessary for system performance

9.2 Introduction

The plant-wide water system is comprised of three sources: reuse water (non-potable), EWW (non-potable), and potable (City) water. There is a reuse water system onsite that delivers 1 mgd of filtered plant effluent water. This is the primary source for plant process uses and washdown water. EWW is secondary effluent water (from Final Clarifiers #1-4) that is generally used as a backup system. The EWW is cross connected to the reuse water at an unknown buried location in the plant water loop. The EWW also serves as low pressure water supply in the DAF Building. In the DAF Building, the EWW is strained and pumped as cooling water for the Cogeneration Facilities. The SWRP also has a separate City water distribution system with the possibility to cross connect to the reuse system by physically installing a spool piece between the two non-potable water systems.

9.3 Capacity Evaluation Results

There is limited information on the existing plant-wide water systems to provide a capacity evaluation of these systems. It is known that an additional reuse facility will be constructed in the near future to provide an additional 2 mgd of non-potable water for the SWRP's uses. A detailed evaluation of the existing plant loop and inventory of all the plant process uses are needed to determine what capacity of plant water is sufficient for present and future needs.

9.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The Plant-Wide Water Systems assets were evaluated based on a number of factors to determine overall risk which is based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the Plant-Wide Water Systems asset risk assessment are presented in Table 9-2.

Table 9-2. Plant-Wide Water Systems Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
Reuse Structures	Effluent Reuse Building	50	10	2	2	2	2	0	0	1	0	0.044	1	1	0	0.243	1	1	1	0.289	0.576	3	0.9	14	Ranking does not include reuse improvements in FY 2003 Project
	Effluent Reuse Storage Tank	75	10	2	2	1	1.8	0	0	1	0	0.044	1	1	0	0.243	1	1	1	0.289	0.576	3	0.8	15	Ranking does not include reuse improvements in FY 2003 Project
Reuse EI&C	Power	20	10	3	2	1	2.1	0	0	1		0.044	1	1	0	0.243	5	1	1	0.969	1.256	2	1.3	11	Ranking does not include reuse improvements in FY 2003 Project
	Instrumentation & Controls	15	10	4	2	1	2.4	0	0	1		0.044	1	1	0	0.243	1	1	1	0.289	0.576	2	0.7	16	Ranking does not include reuse improvements in FY 2003 Project
Reuse Mechanical	Pressure Filters	20	10	3	2	1	2.1	0	0	0	0	0	1	1	0	0.243	3	1	1	0.629	0.872	2	0.9	13	Ranking does not include reuse improvements in FY 2003 Project
	Distribution Pumps	25	10	3	3	4	3.2	0	3	0	1	0.501	1	1	0	0.243	3	1	3	0.731	1.475	2	2.4	8	Ranking does not include reuse improvements in FY 2003 Project
	Fire Pump	25	10	3	2	2	2.3	0	5	0	0	0.66	5	1	0	0.895	3	1	3	0.731	2.286	2	2.6	6	Ranking does not include reuse improvements in FY 2003 Project
	Pipes /Valves /Hydrants	25	40	5	5	5	5	0	5	0	0	0.66	5	1	0	0.895	5	3	5	1.309	2.864	4	12.9	1	Ranking considers impacts to all served process areas and fire protection
EWW Structure	Wetwell and Drywell	75	25	3	3	3	3	0	3	1	0	0.44	1	1	0	0.243	1	3	3	0.527	1.21	3	2.7	5	
EWW EI&C	Power	20	30	5	2	2	2.9	0	0	1		0.044	1	1	0	0.243	3	1	1	0.629	0.916	2	1.3	10	
	Instrumentation & Controls	15	30	5	2	2	2.9	0	0	1		0.044	1	1	0	0.243	1	1	1	0.289	0.576	3	1.3	12	
EWW Mechanical	Strainers	20	30	5	2	2	2.9	0	0	1	1	0.149	1	1	0	0.243	3	1	1	0.629	1.021	2	1.5	9	
	Pumps	25	30	5	3	3	3.6	0	0	1	1	0.149	1	1	0	0.243	3	3	3	0.867	1.259	4	4.1	4	
	Pipe /Valves	25	40	5	5	5	5	0	3	0	3	0.711	5	1	0	0.895	5	1	5	1.173	2.779	4	12.5	2	Ranking considers impacts to all served process areas
Process/Seal Water Systems	Pipe /Valves/Backup	25		3	3	3	3	0	3	0	3	0.711	3	0	0	0.489	3	3	3	0.867	2.067	3	4.7	3	Ranking considers no backup system existing
Potable Water System Misc. Mechanical	Pipes /Valves /Hydrants	25	40	5	2	2	2.9	0	3	0	2	0.606	3	1	0	0.569	3	1	1	0.629	1.804	2	2.6	7	

9.4.1 General

The existing plant water loop is old and does not serve all the plant water system needs. The backup water system (EWW system) is old, unreliable, and in poor condition. Other mechanical components will need repair to ensure process stability. The major issues were identified as the following:

9.4.1.1 Effluent Wash Water (EWW) System

The EWW system has served as the SWRP's primary backup water source for years. The piping and valves are in poor condition. The pumps are inefficient, aged and in poor condition. The nature of the secondary effluent used as EWW causes fouling at the North Cogeneration facilities.

9.4.1.2 Reuse System

The reuse water is the primary source of plant water for the SWRP facilities. The pumps require significant maintenance due to wear. The plant-wide loop is over 40 years old and the valves cause pressure problems throughout the loop.

9.4.1.3 Process and Seal Water Systems

The SWRP primarily uses reuse water as process water and seal water for equipment. If the reuse system fails, the equipment components can be damaged and the equipment can fail. Another issue is that some equipment may require water that has better quality than non-potable water. According to SWRP, they are considering have packing boxes in lieu of seal water as the loss of seal water can cause damage to the mechanical equipment.

9.4.1.4 Potable Water System

The SWRP prefers not to use City water for non-potable water backup. City water is required to provide potable water uses throughout the plant.

9.4.2 Electrical Equipment

The reuse pump station is fed from a primary selective switch and transformer. While there are no provisions for a standby generator, there is a standby diesel-engine-driven pump.

The electrical equipment in this building is less than 15 years old and in good condition. No specific issues were noted.

9.4.3 Instrumentation and Controls

The instrumentation for this facility is in fair condition. No specific issues were noted.

9.5 Recommendations/Conceptual Workplan

Since construction of a new reuse facility is underway, it is recommended that the plant-wide loop be inspected for pipe failures, valve failures, and leaks to ensure adequate flow when the new system is available. We also recommend that the new reuse system be considered as the primary non-potable source water and the existing reuse system be used as backup. New piping, valves, facility tie-ins, and "in-building distribution piping systems will also be constructed to ensure the reuse system can feed and distribute all the non-potable water needs of the plant. Rehabilitation of the EWW system is also recommended to improve this system's reliability as an additional backup source. Project details and cost estimates are provided in Chapter 13.

10. COGENERATION FACILITIES

10.1 Process Area Summary

This chapter describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the North and South Cogeneration Facilities. In terms of risk, the Cogeneration assets rank as low priorities because most of the assets are in good working condition. However, there are some safety and performance concerns regarding the Cogeneration Facilities.

The overall risk scores for the Cogeneration Facility assets were below a Risk Score of 8 which signifies that these assets are considered low priority for replacement. A summary of the ten higher risk score assets is presented in Table 10-1 and justification for these rankings is described in the following sections. Note that due to the low overall ranking the two HVAC proposed projects were eliminated by WUA staff in favor of proposed projects to address sound attenuation and replacement machines for the aging South cogenerators.

Because the overall risk scores are low, the proposed projects are generally not time-critical, with the exception of those related to the gas sphere, gas holder and South Cogeneration power systems. The principal reason for the prioritization of the gas sphere and gas holder projects is that the condition of these systems is unknown and that there are safety, permit and odor concerns than cannot be quantified without additional study. The proposed South Cogeneration power equipment project will help address both a safety hazard and potential for loss of digester heating capacity.

The remaining proposed projects are a mixture of relatively minor, inexpensive repair or replacement projects and more significant large-capital projects. The minor projects may be considered for either capital or operation and maintenance budgeting and may be reasonable add-ons to larger projects. The large-capital projects should be subjected to further study and assessment for alignment with WUA goals. Of particular note is the gas cleaning project which could both improve the efficiency and operations of the cogeneration equipment. Depending on the technology and configuration of equipment ultimately selected, this could also provide WUA with a source of pipeline-quality natural gas that could be used for future building heating or vehicle fuel.

Table 10-1. Cogeneration Facilities Process Area Summary		
Asset Classification	Total Risk	Assessment Implications
Gas Sphere – Structure	6.5	Necessary for safety and capacity. There is the potential for gas leaks that could pose a safety concern and may cause an air permit violation. Loss would also result in reduced cogeneration output during low pressure sludge gas (LSG) periods.
Gas Sphere – Equipment	6.5	Necessary for safety and capacity. There is the potential for gas leaks that could pose a safety concern and may cause an air permit violation. Loss would also result in reduced cogeneration output during low LSG periods.
South Cogen – Power	5.7	Necessary for system performance and operator safety. Load shed system doesn't function causing loss of cogeneration power. Synchronizing circuit breaker operation poses a hazard to operators.
North Cogen – HVAC[1]	5.4	Necessary to improve operator comfort and system integrity. Loss of MCC room cooling would necessitate a system shutdown.
South Cogen – HVAC[1]	5.0	Necessary for safety and system integrity. Older equipment is nearing end of useful life.
South Cogen – Instrumentation and Controls	4.8	Necessary for system performance
Gas Holders – Equipment	4.6	Provide additional gas equalization for ultimate use by cogeneration system. Necessary for system performance
North Cogen – Power	4.1	Necessary for system performance. Complex distribution equipment and interlocking is difficult to operate. Synchronization panel works in one mode only.
Gas Holders - Structure	4.0	Necessary for safety and capacity. There is the potential for gas leaks that could pose a safety concern and may cause an air permit violation. Loss could also result in reduced cogeneration output during low low pressure sludge gas (LSG) periods.
North Cogen – Instrumentation and Controls	3.9	Necessary for system performance
North & South Cogen Building Sound Attenuation Improvements[2]	NR	The cogenerators create excessive noise within the generator rooms and this noise travels outdoors and can disturb neighbors offsite. Additionally it is uncomfortable to work within these rooms and over time may cause hearing damage.
Remove and Replace South Cogen Generators[2]	NR	The existing south cogenerators are approximately 30 years old, lack the capacity the plant staff requests, and do not work efficiently.

[1] Project eliminated per WUA staff request during Workshop 2

[2] Project added per WUA staff request during Workshop 2. This project is not ranked.

10.2 Introduction

There are two Cogeneration Facilities at the SWRP. The cogeneration equipment and support systems, like switchgear, are enclosed in a single building at each facility. The South Cogeneration Facility is the older facility and is undergoing some reconstruction this year. The South Cogeneration Facility has two 480V 1.1MW generators and the North Cogeneration Facility has two 4160V 2.2MW generators. The North facility also includes a cooling tower system for waste heat. While both cogeneration facilities are connected to the building heat loop, the South Cogeneration facility is the larger contributor for process heat to the Digester Complex.

Digester gas is stored on-site in two systems. Low pressure sludge gas (LSG or "digester gas") storage is provided by two 60 foot diameter gas holders with 26 foot sliding sections that operate at the nominal digester gas pressure. The second is a 40 foot diameter high pressure digester gas sphere, originally designed for 120 pounds per square inch (psig), but currently operated at 80 psi.

10.3 Capacity Evaluation Results

The Cogeneration Facilities were not evaluated in terms of capacity; only liquid and solids stream process systems were evaluated in terms of capacity. A more detailed evaluation is needed to determine if the additional generators are needed in the future.

10.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The Cogeneration Facilities assets were estimated on a number of factors to determine overall risk based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the Cogeneration Facilities asset risk assessment are presented in Table 10-2.

Table 10-2. Cogeneration Facilities and Hot Water System Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
North Structures	Cogen Building	50	5	1	2	1	1.5	0	3	1	0	0.44	0	1	1	0.162	3	1	1	0.629	1.231	4	1.7	24	Sound attenuation to improve working conditions
North EI&C	Power	20	5	2	2	2	2	1	5	3	1	1.002	3	1	1	0.651	3	5	4	1.054	2.707	3	4.1	8	Air permit compliance risk (digester gas); redundancy partial at peak
	Instrumentation & Controls	15	5	3	2	4	2.7	0	1	0	1	0.237	3	1	1	0.651	3	5	4	1.054	1.942	3	3.9	10	Load-shed not effective in keeping engines running (economic damage); Air permit compliance risk; flow meters on gas systems
North Mechanical	Engines	40	5	1	2	2	1.7	0	3	0	1	0.501	3	1	1	0.651	3	5	3	1.003	2.155	3	2.7	16	Redundancy - partial at peak
North Hot Water System	Boiler	40	0	1	1	1	1	1	1	0	1	0.342	1	0	0	0.163	1	0	0	0.17	0.675	4	0.6	30	Potential new construction - new LSG (dual) - fired boiler for heat reliability and maintenance flexibility; connected to building HW loop.
	Heat Exchangers	30	5	2	2	3	2.2	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	5	3.4	12	Loss of heat to digester would result in potential permit issue on digested solids quality.
	Pumps	25	5	2	2	2	2	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	2.3	18	
	Pipe/ Valves	40	5	2	2	1	1.8	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	4	2.5	17	Potential new construction - connect to Building Hot Water System
North Misc Mechanical	Cooling Water System	30	5	2	2	2	2	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	2.3	18	Air permit compliance risk
	Cogen Bldg HVAC	20	5	2	3	4	2.9	1	3	1	1	0.65	3	0	0	0.489	3	1	3	0.731	1.87	5	5.4	4	Air permit compliance risk; risk of engine shutdown
South Structures	Cogen Bldg	50	23	3	2	1	2.1	0	3	1	0	0.44	0	1	1	0.162	3	1	1	0.629	1.231	4	2.3	21	Sound attenuation to improve working conditions
South Structures	Compressor Building	50	0	1	2	1	1.5	0	3	1	0	0.44	0	1	1	0.162	3	1	1	0.629	1.231	4	1.7	24	Ranking considers improvements in FY 2003 project
South EI&C	Power	20	23	5	2	2	2.9	0	5	3	1	0.897	3	1	1	0.651	3	5	4	1.054	2.602	3	5.7	3	Load-shed (economic damage); CB operation; difficult cable access; Air permit compliance risk

Table 10-2. Cogeneration Facilities and Hot Water System Asset Risk Assessment Results

				Probability of Failure				Consequence of Failure																	
								Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
	Instrumentation & Controls	15	23	5	2	4	3.3	0	1	0	1	0.237	3	1	1	0.651	3	5	4	1.054	1.942	3	4.8	6	Load-shed not effective in keeping engines running (economic damage); Air permit compliance risk; flow meters on gas systems
South Mechanical	Engines	40	3	1	2	3	1.9	0	3	0	1	0.501	3	1	1	0.651	3	5	3	1.003	2.155	3	3.1	14	Ranking considers recent cogen rebuilds (#3 - 2007; #4 - 2008); partial redundancy at peak
South Gas System	Gas Compressor	20	0	1	1	1	1	1	1	0	1	0.342	3	1	1	0.651	3	1	3	0.731	1.724	2	0.9	28	Reconstruction pending (2009)
	Gas Dryers	20	0	1	1	1	1	1	1	0	1	0.342	3	1	1	0.651	3	1	3	0.731	1.724	2	0.9	28	Reconstruction pending (2009)
	Gas Cleaning	20	0	1	1	1	1	1	1	0	1	0.342	3	0	0	0.489	3	3	3	0.867	1.698	4	1.5	27	Potential future project - Improved gas quality reduces maintenance on engine
	Pipe/ Valves	40	23	3	3	3	3	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	2	2.3	18	
Gas Holders	Structure	40	23	3	2	1	2.1	1	5	1	1	0.914	3	1	3	0.815	3	1	5	0.833	2.562	3	4.0	9	Potential for uncontrolled digester gas leak (Air Permit); Unknown condition of sphere and related piping
	Equipment	30	23	4	2	1	2.4	1	5	1	1	0.914	3	1	3	0.815	3	1	5	0.833	2.562	3	4.6	7	
Gas Sphere	Structure	40	23	4	2	2	2.6	1	5	1	3	1.124	3	1	3	0.815	3	1	5	0.833	2.772	4	6.5	1	Potential for uncontrolled digester gas leak (Air Permit); Unknown condition of sphere and related piping
	Equipment	30	23	4	2	2	2.6	1	5	1	3	1.124	3	1	3	0.815	3	1	5	0.833	2.772	4	6.5	1	Unknown condition of sphere and related piping; potential for high pressure leak
South Hot Water System	Boiler	40	3	1	1	3	1.4	1	1	0	1	0.342	1	1	0	0.243	3	1	1	0.629	1.214	4	1.5	26	New boiler in 2006 - Natural gas only
	Heat Exchangers	30	23	4	2	2	2.6	1	1	0	3	0.552	3	0	0	0.489	3	1	3	0.731	1.772	3	3.5	11	
	Pumps	25	23	5	2	2	2.9	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	3.4	13	
	Pipe/ Valves	40	23	4	2	1	2.4	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	2	1.9	22	

Table 10-2. Cogeneration Facilities and Hot Water System Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
South Misc Mechanical	Cooling Water System	30	23	4	2	2	2.6	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	3.0	15	Potential future construction - cooling water system would permit maximum use of LSG for electricity generation regardless of process need.
	HVAC	20	16	4	3	4	3.5	1	3	1	0	0.545	1	0	0	0.163	3	1	3	0.731	1.439	5	5.0	5	
	Compressor Bldg HVAC	20	0	1	1	1	1	1	3	1	0	0.545	3	0	0	0.489	3	1	3	0.731	1.765	5	1.8	23	Address in pending reconstruction project

10.4.1 General Equipment

The cogeneration facilities were generally found to be in good condition. The equipment in the South is older than the North, and many are approaching their useful life. The most crucial issues were identified as the following:

10.4.1.1 Gas Sphere

The condition of the gas sphere and related piping is unknown. Without inspection and a condition assessment, there is a potential for uncontrolled digester gas leaks that could violate the SWRP's air permit and may create a safety issue. Odors would also be generated from a leak. The sphere has never been evaluated and its condition (including piping) is unknown. A condition assessment would provide the information necessary to gauge the necessity and extent of rehabilitation to provide for continued service. Additionally, there is no real redundancy and loss would require throttling of cogeneration operations during periods of low LSG availability.

10.4.1.2 HVAC

A cooling system is needed for the North Cogeneration Building engine area because the conditions are hot and uncomfortable for the SWRP staff. The air conditioning system in the MCC room is unreliable and could potentially cause the electrical equipment to fail. The South Cogeneration Building HVAC equipment is nearing it useful life and will need replacement. Also, additional exhaust fans would help improve the air circulation in the South Cogeneration Building.

HVAC-related projects have been eliminated from further consideration per WUA staff direction at Workshop 2.

10.4.1.3 Gas Holders

The condition of the gas holders and related piping is unknown. Operators report at least one gas holder cannot be used over the full range of travel due to wedging of the steel top. Without inspection and a condition assessment, there is a potential for uncontrolled digester gas leaks could violate the SWRP's air permit and may create a safety issue. Odors would also be generated from a leak. A condition assessment would provide the information necessary to gauge the necessity and extent of rehabilitation to provide for continued service.

10.4.1.4 Cogeneration Digester Gas Quality Improvements

Excessive moisture in compressed digester gas is affecting combustion, contributes to corrosion, and can increase siloxane deposits in the engines which substantially increases maintenance requirements.

10.4.1.5 Fuel Gas Metering Improvements

Gas flow meters are not correctly located and there are not enough of them to accurately measure compressed digester gas and natural gas (NG) usage.

10.4.1.6 North & South Cogeneration Building Sound Attenuation Improvements

The cogenerators create a significant amount of noise (well above standards requiring hearing protection for worker exposure) within the generator rooms. While a hazard for those working within the building, the noise is so loud that it also travels beyond the building and beyond the fence line of the plant. It was reported that that the noise from the Cogeneration Building disturbs the neighbors off the plant site.

10.4.1.7 Remove and Replace South Cogeneration Generators

The existing south Cogenerators are approximately 30 years old, lack the capacity the plant staff requests, and do not function efficiently.

10.4.2 Electrical Equipment

10.4.2.1 General

Electrical systems within the digester gallery areas are only partially constructed with explosion-proof methods. An analysis of NFPA is needed to determine which areas of this facility require explosion-proof construction methods. Areas that are non-compliant present a risk of explosion and should be addressed.

10.4.2.2 North Cogeneration

The two 4160V 2.2MW generators are connected via transformer and 12.47kV synchronizing circuit breakers to medium-voltage switchgear G12SS. The MCCs are connected to automatic-transfer switches to facilitate black-starting activities. A small portable generator can be connected as an emergency black-start power source.

The main Feeder Isolation Switch (FIS) that connects the treatment plant to the electric utility can be remotely operated from this location.

The room is congested, but equipment is in good condition.

10.4.2.3 South Cogeneration

The two 480V 1.1MW generators are connected via synchronizing circuit breakers to switchgear. In addition to station-power MCCS, the cogeneration switchgear provides alternate 480V power feeders for the south blower building, activated pump station, and DAFT building.

The main Feeder Isolation Switch (FIS) that connects the treatment plant to the electric utility can be remotely operated from this location.

The electrical systems are old, but in fair condition. Due to age, the equipment is nearing the end of its useful life. The following specific problems were noted:

- Arrangement of the switchgear prohibits access to switchgear terminations.
- Manual synchronization of generators requires personnel to stand in front of 1200A switchgear. This creates an arc-flash risk.

10.4.3 Instrumentation and Controls

10.4.3.1 North Cogeneration

- The FIS dead-bus close (used to restore utility power when cogeneration is offline) does not work properly from this location. According to personnel, the automatic synchronization function of the FIS works properly, but manual synchronization does not.
- The units often fail to remain online when the FIS trips or is opened by the load-shed program. This complicated issue is discussed in more detail in Chapter 11.

10.4.3.2 South Cogeneration

- The FIS automatic synchronization does not work properly from this location. According to personnel, the dead-bus and manual synchronization functions of the FIS works properly.
- The units often fail to remain online when the FIS trips or is opened by the load-shed program. This complicated issue is discussed in more detail in Chapter 11.
- Automatic synchronization of generators is not possible.
- Failure of the controls UPS has resulted in difficulty keeping the FIS closed, causing substantial process disruption.

10.5 Recommendations/Conceptual Workplan

10.5.1 General Facilities and Equipment

The gas spheres and gas holders structures should be investigated and rehabilitated provided as may be indicated by the investigation. More specific information is provided below. Additional information and costs are provided in Chapter 13.

10.5.1.1 Gas Sphere

The proposed project involves the investigation of materials of construction, inspection of the gas sphere system, estimation of future requirements and preparation of a basis of design which will detail what repairs are required and what requires replacement.

Because of the need for adequate process heating capacity (normally from cogeneration), it is suggested that this work be undertaken when enough firm LSG- or NG-fired boiler capacity is available.

As part of the proposed project, we have assumed that the recommended inspection of this vessel will find them to be in need of structural rehabilitation and as such have included as a project blasting and recoating of the interior and exterior portions of the gas spheres. Piping associated with the gas systems that is buried, presumed to be steel, is also presumed to be in questionable condition, and as such, its replacement with HDPE pipe is included in the project list. Additional minor piping sections are also included in the projects such that exposed gas piping in poor condition will be replaced with 316L SST.

10.5.1.2 HVAC

HVAC-related projects to improve cooling and air movement within the Cogeneration facilities have been eliminated from further consideration per WUA staff direction at Workshop 2.

10.5.1.3 Gas Holders

The proposed project involves the investigation of materials of construction, inspection of the gas holder system, estimation of current and future requirements and then preparation of a basis of design which will detail what repairs are required and what requires replacement.

Because there are two vessels it is suggested that the inspection and construction be performed sequentially.

As part of the proposed project, we have assumed that the recommended inspection of these vessels will find them to be in need of structural rehabilitation and as such have included as a project blasting and coating of the interior and the exterior of the steel gas holders. Piping that is buried will be replaced with HDPE and exposed will be 316L SST. Also included in this estimate is concrete repair and recoating of the interior of the gas holders.

10.5.1.4 Cogeneration Digester Gas Quality Improvements

This proposed project will initially evaluate the digester gas system and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. Digester gas treatment systems to remove moisture and contaminants vary in complexity and cost. Depending on the technology and configuration of equipment ultimately selected, gas treatment systems can provide substantial improvements up to, and including, making pipeline-quality gas suitable for use in NG-fired vehicles and equipment. The conceptual design adds (3) digester gas scrubbers/dryers to the existing system.

10.5.1.5 Fuel Gas Metering Improvements

This proposed project will initially evaluate the existing gas piping systems, estimate future requirements and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. It has been assumed that the existing meter will be replaced and thermal mass flow meters provided for the LSG systems and turbine type flow meters provided for the NG systems.

10.5.1.6 North & South Cogeneration Building Sound Attenuation Improvements

The proposed project will evaluate the existing facilities, perform basis of design, detailed design and construction of new sound attention systems at both the North and South Cogeneration Buildings. Interior modifications will center around the application of attenuation panels. Exterior modifications can include, redirected stacks, stack shielding, berms and landscaping.

10.5.1.7 Remove and Replace South Cogenerators

The proposed project will initially evaluate the existing generators and supporting systems, then a basis of design, design and construction of the recommended improvements will take place. The conceptual plan at this time is to remove the two (2) 1.1 MW generators and replace with two (2) 1.5 MW generators.

10.5.2 Power Improvements

10.5.2.1 South Cogeneration

Evaluation of Cogeneration power performance will take place under the Plant-Wide Electrical Systems study. This proposed project will design and construct the rehabilitation measures consistent with the plant wide plan. Alternatives for load shedding and synchronization will be explored in addition to physical and electrical improvements.

10.5.2.2 North Cogeneration

Evaluation of Cogeneration power performance will take place under the Plant-Wide Electrical Systems study. This proposed project will design and construct the rehabilitation measures consistent with the plant wide plan. Alternatives for load shedding and synchronization will be explored in addition to physical and electrical improvements. Assume repair to sync panel and correction of interlocking.

10.5.3 Other Projects

Other potential projects considered for the Cogeneration area are presented in Table 10-2.

11. ELECTRICAL DISTRIBUTION

11.1 Process Area Summary

This chapter describes the results from the asset risk assessment for the major assets associated with the electrical distribution system. In terms of risk, this system ranks high among the SWRP facilities due to system failures that are integral to all process systems and their performance. Reliability of power to key facilities has been an ongoing problem. Outages last unacceptably long times and have resulted in violations. The existing system is very complex, difficult to operate and is reported to have several safety issues for O&M staff.

A majority of the assets ranked as high priorities for replacement (Risk Score greater than 12) and a few ranked as moderate priorities (Risk Score between 8 and 12). A summary table of these assets is presented in Table 11-1 and justification for these rankings is described in the following sections.

Upgrades of individual process areas will be done within the area projects, guided by the results of a plant-wide power system study. Also, alternatives for providing reliable power to critical systems will be evaluated.

Table 11-1. Electrical Distribution Process Area Summary

Asset Classification	Total Risk	Assessment Implications
Critical Power Systems	17.7	
Feeder Isolation Switch (FIS)	15.2	Failure to reclose has caused extended plant-wide outages and violations. Operation entails Arc-Flash hazards.
Cogeneration Systems Interconnection	13.3	Failure to remain online during a utility outage has caused plant-wide outages and violations.
Load-Shed System	12.9	Has caused cascading failures of Cogeneration and Feeder Isolation switch, resulting in plant-wide outages and violations.
Lightning Protection Systems	12.5	Failures can cause full or partial localized outages. Operation entails Arc-Flash hazards.
Facility Electrical Equipment	10.3	Failures have resulted in damage to electrical and electronic components resulting in loss of automation systems.
Outdoor Pad-Mount Switchgear	6.7	
Primary Selective and Loop Feeder	6.0	Failures can cause full or partial localized outages. In some cases, switching is possible to isolate failures and return processes to services. Operation entails Arc-Flash hazards.
Outdoor Metal-Enclosed Switchgear	5.5	Failures can cause full or partial localized or widespread outages. In some cases, switching is possible to isolate failures and return processes to services.
Underground Cable Systems	0.8	Failures can cause full or partial localized outages. In some cases, switching is possible to isolate failures and return processes to services.

11.2 Introduction

The electrical distribution system is fed from two 12.47 kV utility sources from PNM's Sewer Plant Substation. One of the utility sources powers the main underground distribution system for the facility. The other provides service to the Administration building and an alternate utility service to the Laboratory and Lift Station 11. A third utility service from PNM's Anderson Substation is no longer in use, but could be placed back in service to power in-plant underground feeder #2.

Several main underground feeders and many 12.47 kV switches provide power to loads throughout the facility. The arrangement of the underground feeders is quite complicated, and includes some radial-feed, primary-selective, and some loop-fed facilities

Two cogeneration facilities with two generators each feed the underground distribution system. The cogeneration systems reduce the plant utility energy requirements, and at times provide power back to the utility grid.

11.3 Capacity Evaluation Results

Evaluation of the electrical system capacity is not included in this report. There are, however, several important topics which should be discussed for future considerations:

11.3.1.1 Fault Analysis

A fault occurs when an electrical power component experiences a short circuit, either phase-to-phase or phase-to-ground. A fault can result in the release of a significant amount of energy, causing equipment damage, and/or personnel injury or death.

Each electrical equipment item is rated to withstand or interrupt a certain amperage during a fault event. If the rating of the equipment is lower than the available energy, catastrophic failure could be caused by a fault.

System Fault Analysis includes developing a computer model to calculate the amount of energy that would be released by a fault at all major electrical equipment. The calculations are then compared to equipment ratings, and any deficient equipment is identified for mitigation.

Due to the age and condition of some the electrical equipment at the treatment plant, some equipment is likely to be under-rated and at significant risk of catastrophic failure.

11.3.1.2 System Coordination

Electrical circuit breakers and fuses are provided with time-delay features to allow selective tripping to isolate a fault. A properly coordinated system results in localized tripping of failed circuits. This is possible because larger circuit breakers or fuses (higher up in the system) have longer time delays, allowing smaller units closer to the fault to isolate the problem. If not properly coordinated, a relatively minor fault can result in widespread outages. This can cause substantial process disruption and can cause troubleshooting to be more difficult.

Plant personnel has indicated that at lease one coordination failure resulted in significant disruption: When a blower motor failed, the blower starter, MCC main, and MCC feeder fuse all failed to isolate the problem. Instead, a fuse at the Generator Selective Switch (GSS) isolated the problem. If properly coordinated, the blower starter would have isolated the problem without causing an outage on other blowers on the MCC.

11.3.1.3 Arc-Flash Hazard Analysis

An Arc-Flash produced by an electrical fault presents a significant personnel hazard. Proper personal protective equipment (PPE) must be used during certain maintenance activities such as switching or troubleshooting of live circuits.

An Arc-Flash analysis estimates the potential hazard and makes PPE recommendations for certain activities based on the available energy (from the fault analysis above).

11.3.1.4 System Load Analysis

While no issues have been identified with the load-carrying capabilities of the electrical distribution system, an analysis of the loading of system components is necessary to plan for future additions and modifications.

11.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The electrical distribution system assets were estimated on a number of factors to determine overall risk based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the electrical distribution system asset risk assessment are presented in Table 11-2.

Table 11-2. Power Distribution System Facility Asset Risk Assessment Results

								Consequence of Failure																	
				Probability of Failure				Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
Energy Automation Features	Load-Shed System	N/A	28	5	5	5	5	3	3	1		0.755	4	4	2	1.136	3	4	4	0.986	2.877	4	12.9	4	
	Cogeneration Systems Interconnection	30	5-23	5	5	4.7	5	3	5	1		1.019	4	4	2	1.136	3	4	4	0.986	3.141	4	13.3	3	
General Equipment	Feeder Isolation Switch (FIS)	30	24	5	5	4.7	5	4	5	1		1.124	4	4	2	1.136	5	4	4	1.326	3.586	4	15.2	2	
	Primary Selective and Loop Feeder Arrangements	N/A	10	3	3	3.6	3	3	5	0		0.975	2	2	1	0.568	3	1	2	0.68	2.223	3	6.0	8	
	Outdoor Metal-Enclosed Switchgear	30	24	2	2	2.6	2	5	5	0		1.185	2	2	1	0.568	5	2	2	1.088	2.841	3	5.5	9	
	Outdoor Pad-Mount Switchgear	30	5-30	2	2	2.6	2	3	5	1		1.019	3	3	1	0.811	4	3	3	1.037	2.867	4	6.7	7	
	Underground Cable Systems	30	5-30	2	2	2.3	2	3	3	0		0.711	1	1	1	0.325	3	1	2	0.68	1.716	1	0.8	10	
	Facility Electrical Equipment	30	5-30	3	4	3.5	3	4	5	1		1.124	4	4	4	1.3	3	2	4	0.85	3.274	4	10.3	6	
	Lightning Protection Systems	30	5-30	5	5	5	5	3	5	3		1.107	3	3	1	0.811	2	2	2	0.578	2.496	5	12.5	5	
Critical Power Systems	Critical Power Systems	30	5-30	5	5	5	5	5	4	1		1.097	5	4	1	1.217	5	4	2	1.224	3.538	5	17.7	1	

11.4.1 System Management and Capacity

Much of the distribution system consists of manually-operated switches that can be used to remove portions of the system for maintenance or isolate faulted cables. There is some automation related to load-shedding and cogeneration. Operation of these automated systems is based on two capacity limitations as described below. Although these are not physical assets, they play a major role in the overall reliability of the electrical distribution system, and how it is managed.

11.4.1.1 Utility Capacity

Plant personnel report that peak plant load is about 5,000kW, of which about 700kW is typically imported from PNM with the other 4,300kW coming from cogeneration. Per the December 2008 utility bill, average generation was 2,701kW and average power import was 474kW, resulting in an average plant load of 3,175kW. Peak power import was 2,415kW, with a demand (max minus min) of 1,495kW.

The PNM utility metering agreement includes a Backup Demand Requirement of 2,200kW. This is the capacity that the facility has purchased from PNM. The Backup Demand Requirement results in a $10.18 per kW penalty for exceeding 2,200kW (this effectively doubles the $10.18 demand charge above 2,200kW).

This information is based on the 1/5/2009 Utility bill, where a demand overage of 215kW resulted in an additional demand charge of $2,188 plus a Backup Demand penalty of $2,188 (18.8% of the $23,276 utility bill).

If the facility approaches the load-shed limit of 3,150kW, an overage of 950kW, the additional demand charge would increase to $9,670 plus a Backup Demand penalty of $9,670. For the utility bill analyzed, this would increase the bill to around $38,000. Thus, the increase from the agreed 2,200kW to the high limit of 3,150kW effectively doubles the utility bill.

11.4.1.2 EnerNOC Agreement

The EnerNOC agreement requires that the plant import no power during an EnerNOC demand period. The EnerNOC agreement allows PNM to manage customer loads during times of high system demand. When PNM makes the request, the facility must shed as required to eliminate demand.

11.4.2 General Equipment

The electrical distribution system is quite large and complex, with some areas in better condition than others. The most crucial issues were identified as the following:

11.4.2.1 Energy automation features

There are several major assets that work together to deliver power to the loads while managing electric utility monthly costs. Failure of these assets has immediate and significant effects on the treatment processes, as well as electrical utility costs. While each component of energy performance is discussed below, some discussion of how the systems inter-relate is important.

The system is designed to limit electric utility costs by shedding loads and, when required, isolate the treatment plant from the electric utility. While isolated from the utility, the cogeneration system should provide power to many critical loads (primary treatment facility, influent pumps, and Lift Station 11, and others). The cogeneration facility often fails to remain online when the utility breaker opens, resulting in power outages to the critical facilities.

Many of the major plant events have started with such an outage. Typical examples cited by personnel include:

- Power failures result in clogging of barscreens and overflow onto the street. Barscreens often fail to recover or break after the power outage due to inability to remove the accumulation of material.
- Grit systems become clogged during and after power outages.
- Power failures or load-shedding result in dewatering centrifuges stopping without being properly cleaned. This requires significant personnel activity to clean the centrifuge and return the unit to service.

11.4.2.1.1 Load-shed system

The load-shed system is designed to cut power from non-essential facilities to avoid excessive utility bills and comply with the EnerNOC agreement. Based on input from plant personnel and Load Shed Controls Sht. 6 provided in Workshop 1, loads included in the load-shedding program are Blowers, Activated Pump Station, DAF, and Aeration Mixers, Dewatering. Per plant personnel, the load shedding program alarms at 2,750kW, sheds loads at 2,900kW, and trips the utility breaker (FIS) at 3,150kW.

Plant personnel indicates that portions of the load-shed system may be disabled, and that failure to shed loads in a timely manner may be causing the cogeneration system to trip.

11.4.2.1.2 Cogeneration Systems Interconnection

The cogeneration generators consist of two north (2,200kW) and two south (1,100kW) generators. These generators reduce the utility demand and provide backup power for critical loads within the plant. The discussion under this section relates only to how the system connects to and affects the overall distribution system. For a more detailed discussion of these systems, see Chapters 9 and 10 – Digesters and Cogeneration respectively.

The cogenerations systems are unable to operate at rated capacity. This results in premature activation load-shedding and/or disconnection from the electric utility. These results are very disruptive to critical plant processes, and may have been the cause of some electrical outages resulting in permit violations.

The cogeneration systems fail to remain online when the FIS utility circuit breaker opens, resulting in a complete plant power outage. This may be caused by the load-shedding tripping the breaker at 3,150kW of plant import power, or tripping the breaker for an EnerNOC event. When opened, all utility import power would transfer to the generator, and almost certainly trip the cogeneration system offline.

11.4.2.2 General Equipment

11.4.2.2.1 Feeder Isolation Switch (FIS)

The FIS is located on the west side of the property and contains the main utility circuit breaker, which can be opened by either PNM or the plant. This breaker is typically opened during load-shedding or EnerNOC demand periods. The breaker is typically re-closed from one of the cogeneration facilities on the east side of the property.

While manual and automatic reclosing controls are provided at both the North and South cogeneration facilities, there are problems with both systems, sometimes resulting in local/manual operation required at the FIS. These control problems can cause significant delays in restoring power to plant loads.

Per plant personnel, the FIS utility breaker trips 12-20 times per year, and typically remains open for 30-60 minutes. Outages of up to 8 hours have resulted from problems with the FIS circuit breaker.

11.4.2.2.2 Primary Selective and Loop Feeder Arrangements

The ultimate goal of the distribution system is to deliver reliable power to the loads. There several basic approaches to distribution system design. Each approach provides a higher degree of reliability while also increasing system cost. While a full reliability analysis is not included in the scope of this report, some examples from the IEEE Recommended Practice for Design of Reliable Industrial and Commercial Power Systems are included in Table 11-3:

Table 11-3. Reliability and Availability for several power distribution systems

Distribution Type	Failures per Year	Forced Downtime hrs/Year	Explanation
Simple Radial	1.9896	4.3033	This is a basic system with no redundancy features.
Primary Selective with 1 hour recovery (manual)	1. 9896	2.9424	This is a system with two independent utility sources to the primary of the transformer.
Primary Selective with 5s recovery (auto)[1]	.3456	1.8835	This is the same as the above Primary Selective system, but with automatic transfer controls.
Secondary Selective with 1 hour recovery (manual)	1.9822	1.3735	This is a system with two independent utility sources the 480V switchgear level, using a tie breaker.
Secondary selective with 5s recovery (auto)	0.3175	0.2210	This is the same as the above Secondary Selective system, but with automatic transfer controls.

[1] *Power Loss for less than 5 seconds at 480V is not considered a power loss.*

In each of the systems in Table 11-3, the most common source of failures is loss of utility power. In all but the Simple Radial configuration, frequency and/or duration of failures is reduced through the addition of a second electric utility power source. The least disruptive power systems provide for a second utility source and automatic transfer capabilities. The automatic transfer approach dramatically improves system availability.

The treatment plant distribution system one-line diagram is very-complex and includes a mix of equipment configured in Primary Selective, Secondary Selective, Primary Loop, and other arrangements. A second utility supply is not available, but onsite cogeneration could mitigate the effects of utility supply loss if it was reliable. The following are some issues that were identified:

- There are parts of the system that have Primary Selective components, but lack the second power source or automatic transfer schemes needed to increase the reliability.
- All switching operations are manual, leading to significant time delays for recovery from failure.
- The system is overly complex, leading to confusion in finding and mitigating failures. The combination of loop-fed and primary selective features adds to the confusion without necessarily increasing reliability.
- The second utility source (Anderson) has been removed from service, increasing reliance on the single utility feeder.
- Some critical loads (Primary Treatment, Lift Station 11), are fed from a Primary Loop that is downstream of a Primary Selective system. There could be up to 15 devices and cables between these loads and the utility supply, increasing the probability of failures.
- For the blower systems, Primary Selective switches 89-7 and 89-24 tie both supply sources to a common bus, creating a single point of failure in what would otherwise be a Secondary Selective system.

11.4.2.2.3 Outdoor Metal-Enclosed Switchgear

There are several major lineups of Outdoor Metal-Enclosed Switchgear, all approximately 23 years old. Each lineup feeds a major geographic area of the plant.

While the equipment appears to be in good condition, plant personnel have indicated that it has never been taken down for service or inspection other than when failures occur. There is the possibility of an arc-flash hazard since the internal condition of much of this equipment is unknown. This equipment has some redundancy features allowing for inspection or maintenance, but will result in some outages.

- **89-G – T**he Generator Switching Station (GSS) is the main tie in point for cogeneration to feed power to the plant power grid. In addition, this station supplies power to the south plant loads such as the South Blowers, AS Pump Station, and DAF.
- **89-5 –** The 5th Avenue Switching Station supplies power to northeast loads such as the Dewatering and Chlorine Buildings.
- **89-P –** The Primary Switching Station (PSS) provides power to northwest plant loads such as Primary Treatment, Lift Station 11, and Clarifiers 1-4. Several of these are critical plant loads, and are fed from PSS via a Primary Selective Loop. Even though this is one of the most critical areas of the plant, it has one of the least reliable distribution arrangements due to the loop being subfed from the Primary Selective system.

11.4.2.2.4 Outdoor Pad-mount Switches

Outdoor padmount switches (about 15) are used in many areas of the plant. The switches range from 10 to 25 years old. In all cases, the switches are part of a Primary Selective or Primary Loop arrangement designed to provide some flexibility in recovering from underground cable faults or working with Outdoor Metal-Enclosed Switchgear outages. Switch 89-14 is a Primary Selective with subfed continuation of Feeder #3, and switch 89-10 provides an alternate connection to the North Cogeneration system.

While the equipment appears to be in good condition, plant personnel have indicated that it has never been taken down for service or inspection other than when failures occur. There is the possibility of an arc-flash hazard since the internal condition of much of this equipment is unknown. One of these switches has already failed, causing personnel injury. This equipment has no redundancy features allowing for inspection or maintenance without de-energizing the loads.

11.4.2.2.5 Underground Cable Systems

Some underground cables were replaced in a recent upgrade. Other cables are of varying age, and possibly reaching the end of their useful life. The arrangement of the distribution switches allows for isolation of most cables in the plant for replacement if they fail.

11.4.2.2.6 Facility Electrical Equipment

Electrical equipment is distributed throughout the facility. For the most part, equipment dedicated to a particular process or building is discussed under the section for that process. It is important to note that several critical facilities are equipped with standby generators which have been removed or are no longer operable. In some cases, provisions for a portable generator still exist, but no such generator is available. Personnel indicate that plant-wide power outages are resolved by either repairing the electric utility supply or bringing cogeneration up from a black-start. No cases in recent memory have been mitigated with standby generation.

Since the overall utility and cogeneration power systems have proven unreliable, significant disruption to processes, and some violations have resulted due to lack of reliable standby power.

11.4.2.2.7 Lightning Protection Systems

The plant has a history of sustaining damage to electrical and electronic systems due to lightning or other electrical transient activity. A combination of lightning protection, lightning arrestors, and surge suppression are typically employed to protect against such failures, but the facility has little or no protection.

11.5 Recommendations/Conceptual Workplan

11.5.1 Distribution System Short Circuit, Coordination Load Flow and Arc Flash Study

A complete study of the existing distribution system is an essential step in developing a full understanding of current issues and hazards is recommended. In addition, the computer model that results from this study will serve as a tool for evaluation of various alternative configurations of the power system. Multiple arrangements can be configured, tested and results evaluated using the existing model as a base. The model should include all power components down to at least the 480V MCC level. A complete arc flash analysis should include all system components operating at voltages above 240VAC to comply with NFPA 70E study requirements.

11.5.2 Evaluate Alternatives for Power Reliability for Critical Processes

EPA design guidelines require that at least two reliable sources power be provided to certain critical processes. A clear determination will be required of which process areas are "critical" or "vital" as defined by EPA as well as facilities that are critical based on the specifics of this plant. At present, the cogen system is considered to be the second source for these purposes. However, experience has shown that there are situations in which the cogen system cannot be relied upon without considerable operator intervention and associated down time. In many similar wastewater facilities cogen is not considered a reliable alternate power source for purposes of process continuity. Therefore an evaluation of alternative strategies for providing reliable power to critical facilities is recommended. Recommended alternatives include:

- Providing a separate NMP utility feed with automatic transfer to critical facilities to minimize operator workload during periods of upset. Reactivating and/or upgrading the Anderson feeder is one possibility for consideration.
- Develop a "critical power bus" energized by a centralized diesel fuel powered standby generator. This bus would connect to all critical facilities through automatic transfer switches.
- Develop a concept of multiple, small standby generator and automatic transfer switch for specific facilities or co-located facilities as appropriate.

For each alternative, conceptual one-line diagrams, preliminary sizing of major equipment, preliminary plan layouts and Class 4 cost estimates will be developed. A memo summarizing the alternatives and pros and cons to support decision making will be prepared.

This project will also include the replacement of the old FIS.

12. INSTRUMENTATION AND CONTROLS

12.1 Process Area Summary

This chapter describes the results from the asset risk assessment for the major assets associated with the SWRP's instrumentation and controls system. In terms of risk, this process area ranks moderately among the SWRP facilities.

The system software and communication assets ranked as high priorities (Risk Score greater than 12) and the remaining assets ranked as moderate priorities replacement (Risk Score between 8 and 12). A summary table of these assets is presented in Table 12-1 and justification for these rankings is described in the following sections

Since much of the control system hardware and software systems will be replaced, upgraded, or modified over the next 10 years, a clear vision of the systems future should be developed. The plant is positioned to begin extensive upgrades to the plant control system. Establishing high level expectations from a business perspective as well as for users should be done to provide guidance for the details of how the upgrade is developed to insure that future needs are provided for.

Table 12-1. Instrumentation and controls System Summary

Asset Classification	Total Risk	Assessment Implications
System Software	12.5	Software systems will only be supported by the manufacturer for about four more years. After this time, system maintenance and expansion will be difficult or impossible.
System Communications	12.5	Lack of flexibility and features limits operational performance and increases maintenance requirements.
Uninterruptible Power Supplies	11.5	Failures due to age and condition have resulted in controls and electrical outages.
System Control Cabinets	9.8	Hardware deterioration due to age and corrosive environments causes failures.

12.2 Introduction

There are two main discussion threads associated with the process control system. First: does the system have the features and capabilities needed to meet the organization's goals? This issue is discussed in the Capacity Evaluation Results. Second: does the physical design and condition of the system perform the desired functions reliably and adequately? This issue is discussed in System Condition.

This section describes the results from the capacity evaluation and asset risk assessment for the major assets associated with the instrumentation and controls system. A summary of these findings and recommendations for addressing the critical components of this process area are provided at the end.

An ABB Harmony/INFI 90 distributed control system provides process monitoring, automation, and historical archiving for the treatment plant processes. This system consists of 16 PCUs distributed throughout the facility and interconnected through a redundant twinax communication network.

A Motorola Moscad telemetry system provides communication to Allen-Bradley PLCs located at off-site lift stations, storm stations, and vacuum stations. These off-site systems utilize a separate GE Proficy iFix software system at the treatment plant control room, with some data being transmitted to the ABB Harmony/INFI 90 DCS system.

12.3 Capacity Evaluation Results

If brought up to current firmware and software revisions, The ABB Harmony DCS system has the capability and capacity to meet future needs of the facility. There are, however, several important topics which should be discussed for future considerations:

12.3.1 DCS Software Systems

While plant staff has upgraded most of the controller hardware systems, The DCS software systems have reached the end of their useful life and must be upgraded or replaced.

A 2009 study by Flatirons Engineering, Inc. evaluates four potential alternatives, including doing nothing, continuing along the ABB migration path, replacing the current system with hardware and software used by the Water Treatment plant, and a hybrid ABB/Telvent system. The study contains detailed discussion of advantages and disadvantages of each approach.

12.3.2 Site-wide networking

The existing twinax INFI 90 network supports display of plant operations data at Operator Interface Stations throughout the plant, but has no flexibility to allow centralized system upgrades, access to maintenance and other plant data, or implementation of other technologies such as security cameras, Ethernet, or internet-based applications.

This basic lack of communications infrastructure results in increased effort for system maintenance activities.

12.3.3 System Architecture and Integration

There are some features of the existing system architecture that increase system costs and management requirements.

While the GE Proficy iFix software system is adequate to meet the needs for monitoring off-site systems, a second monitoring and control software system results in increased system management requirements.

Integration of control system data with other technology systems such as computerized maintenance, reporting systems, truck hauling, laboratory information management systems, and other systems is sporadic and problematic at times. This is due in part to a system that has grown and changed over the years without any unified planning approach. While many of these systems meet the basic needs of the plant, they can be cumbersome and difficult to maintain.

12.3.4 Physical System Design

Most of the control system components were installed based on 1980s technology and installation techniques. This results in many control signals being terminated at several locations between the control system I/O module and the field device. While the systems were consistent with current practices at the time of their installation, they can be difficult to troubleshoot and have more failure points than are necessary.

12.4 Asset Risk Assessment Results

As detailed in Section 1.3, all process areas were evaluated in terms of asset risk. The instrumentation and controls system assets were estimated on a number of factors to determine overall risk based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. Each of these factors is weighted differently based on importance. The consequence of failure for an asset is related to the "triple bottom line" based of three categories of service: social, environmental, and economic. Within each of these service areas there are a number of weighted factors that each asset was rated for. Each asset was rated on a 1-5 scale with 1 representing the best and 5 representing the worst rating.

The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy. Results from the instrumentation and controls system asset risk assessment are presented in Table 12-2.

Table 12-2. SCADA, Instrumentation, and Control Systems Asset Risk Assessment Results

Classification	Asset(s)	Expected Life		Probability of Failure				Consequence of Failure														Redundancy Factor	Risk Score	Rank No.	Notes
								Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
			Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence				
Overall System	Software	5	5	5	4	3	4.1	5	3	1	3	1.28	3	3	1	0.811	5	3	5	1.309	3.4	4	12.5	1	Supported for only four more years.
	Communications Networks	15	25	5	4	3	4.1	5	3	1	3	1.28	3	3	1	0.811	5	3	5	1.309	3.4	4	12.5	1	
Process Area Control Systems	Control Cabinets	25	25	5	4	3	4.1	3	3	3	3	1.158	3	3	1	0.811	5	3	3	1.207	3.176	3	9.8	4	Scoring based on oldest infrastructure components
	Uninterruptible Power Supplies	10	15	5	5	3	4.6	5	3	3	3	1.368	3	3	1	0.811	5	3	2	1.156	3.335	3	11.5	3	Scoring based on oldest infrastructure components

12.4.1 System Condition

Instrumentation and control equipment is distributed throughout the facility. For the most part, equipment dedicated to a particular process or building is discussed under the section for that process. Some discussion of the overall system is provided here to demonstrate the overall health of the control system.

12.4.1.1 System Software

As discussed above in the Capacity Assessment, the software systems will only be supported by the manufacturer for about four more years. As such, they are in critical need of upgrade to maintain performance of the overall system.

12.4.1.2 System Control Cabinets

While many of the I/O and controller modules have been upgraded by plant staff, there are many PCU control cabinets with degraded wiring due to poor initial installation, age, and corrosive environments. Failures in these cabinets are difficult to troubleshoot and often cause process disruptions.

PCU cabinets for some processes (PS1&2, Digester 1-8) are located in a remote building, further complicating the maintenance and troubleshooting of these facilities.

12.4.1.3 Uninterruptible Power Supplies

Uninterruptible Power Supply (UPS) systems are a critical component of the control systems. Power loss or fluctuation can cause significant disruption in control system performance and operation. Some of the UPS systems have been upgraded, but many are antiquated and in danger of causing control system failures.

12.4.1.4 System Communications

As discussed in the Capacity Assessment above, the existing twinax cabling system does not provide needed noise/lightning immunity or flexibility required for operation and maintenance of the facility.

12.5 Recommendations/Conceptual Workplan

12.5.1.1 Visioning process

Since much of the control system hardware and software systems will be replaced, upgraded, or modified over the next 10 years, a clear vision of the systems future should be developed. This vision should include a diverse range of issues including physical system design characteristics, use of advanced field devices, software systems design, integration of off-site control systems, and integration with 3rd party systems.

Brown and Caldwell recommends that the vision be established through a series of workshops that develop specific goals for the control system and explore alternative features and approaches to achieve those goals. The workshops should include the following topics:

- Establish the business goals for the control system.
  - Is the control system expected to support decision making beyond daily process control?
  - Clearly identify who the entire user community includes.
  - Determine which business needs, if any, will not be addressed by the control system.
- System integration issues

  - How should the network be designed to include features for reliability and ease of maintenance? What activities should be allowed from where (i.e. email, web, or CMMS access from the field?)
  - How should new control panels be designed to include features for reliability and ease of maintenance?
  - How should remote sites be integrated to simplify operations and maintenance of the system?
  - How will package panels integrate into the overall system?
- System usability issues
  - Data needs – who needs what data, where, and when?
  - What is the desired look and feel of the new graphics interface? How do links to other system appear to system users?
  - What alarm management features are needed to support decision-making by plant staff?
  - Diagnostics features, who needs access, where, and when?
  - Historian interface – who needs access to historical data, where, and when? Which points should be logged and how long should data be kept?
  - Operations notes – how should operators track what is happening in the plant, how should operations notes be integrated with the control or maintenance systems?
  - CMMS Interface – how is the computerized maintenance management system tied to the control system. How can the control system support preventative or predictive maintenance? How do operators and maintenance staff manage maintenance work?
  - How should laboratory and manual data be collected and integrated with process control data? What types of reports are needed, and how should they be accessed?
  - What other features or discussions do plant staff feel need to be included in the vision?
- Select software and hardware platforms for the future. It is expected that future projects will continue using ABB. If, however, the visioning process results in a compelling reason for moving away from the ABB DCS system, a new hardware and software platform will be recommended based on the needs assessment.

12.5.1.2 DCS Software Systems

The short-term recommendations of the Flatirons Engineering, Inc. study included completing the transition to ABB Process Portal software systems. Brown and Caldwell concurs with this initial approach of keeping the existing system on a viable support path. Caution should be taken to limit costs associated with redevelopment of process control screens pending the outcome of the visioning process recommended above.

12.5.1.3 System Control Cabinets

Replacement or upgrade of system control cabinets is necessary in many areas, but must be planned in conjunction with other process upgrades and construction activity. The decision whether to upgrade or replace the control system in any given area will include consideration of age, condition, expandability, location, and the degree to which facility equipment and instrumentation is being modified.

New control system cabinets should be designed in accordance with the visioning process recommended above.

12.5.1.4 Uninterruptible Power Supplies

Existing Uninterruptible Power Supply (UPS) systems should be tested by plant staff and upgraded as required. Replacement of additional units should be considered on an as-needed basis as part of construction projects.

12.5.1.5 System Communications

A new plant-wide fiber-optic cabling system should be implemented plant-wide. The existing INFI 90 communications networks should be converted to use the new fiber-optics. In addition, fiber-optics should be utilized to implement a fault-tolerant Ethernet network capable of supporting operations and maintenance activities identified in the visioning process recommended above.

13. CONCLUSIONS

The preceding chapters have defined the issues and recommendations for improvements at the SWRP. Many assets within the plant have exceeded their useful life, lack redundancy or need additional capacity for future conditions. Other assets are in poor condition and are not functioning as intended. Safety is also a serious concern at some of these facilities due to corrosive or hazardous environments. The plant staff have done their best to maintain equipment and keep processes performing but the results from the asset assessment indicate that a number of facilities are in critical need of rehabilitation.

13.1 Capacity Evaluation

The capacity of the SWRP's process systems were evaluated with BioWin™ modeling and using standard methods. Each process area chapter within this RRAMP includes details and assumptions that provided the basis for the capacity evaluation. Results from the BioWin™ modeling concluded that there is a lack of aeration capacity for the future flow of 76 mgd and that a carbon source will be needed in the future to meet the most stringent total inorganic nitrogen permit limits.

For the liquid and solids stream capacities, an equivalent influent flow was calculated for each process area. The capacity results for both the liquid and solids streams are provided in Figures 13-1 and 13-2 respectively.

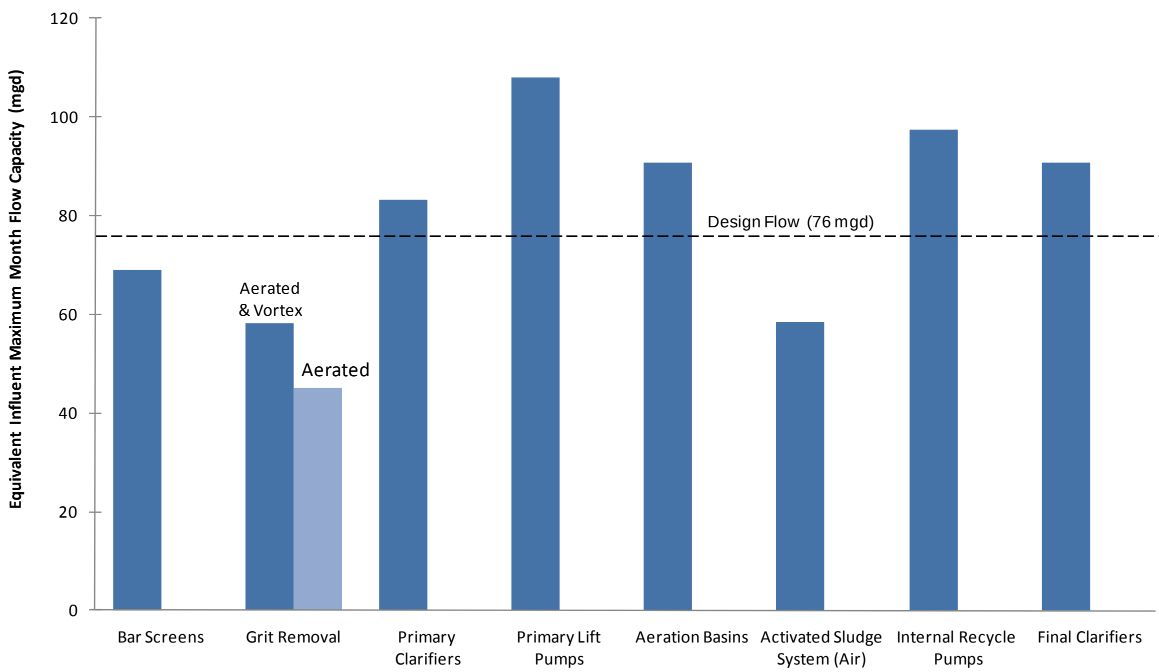

Figure 13-1. Liquid Stream Capacity Results

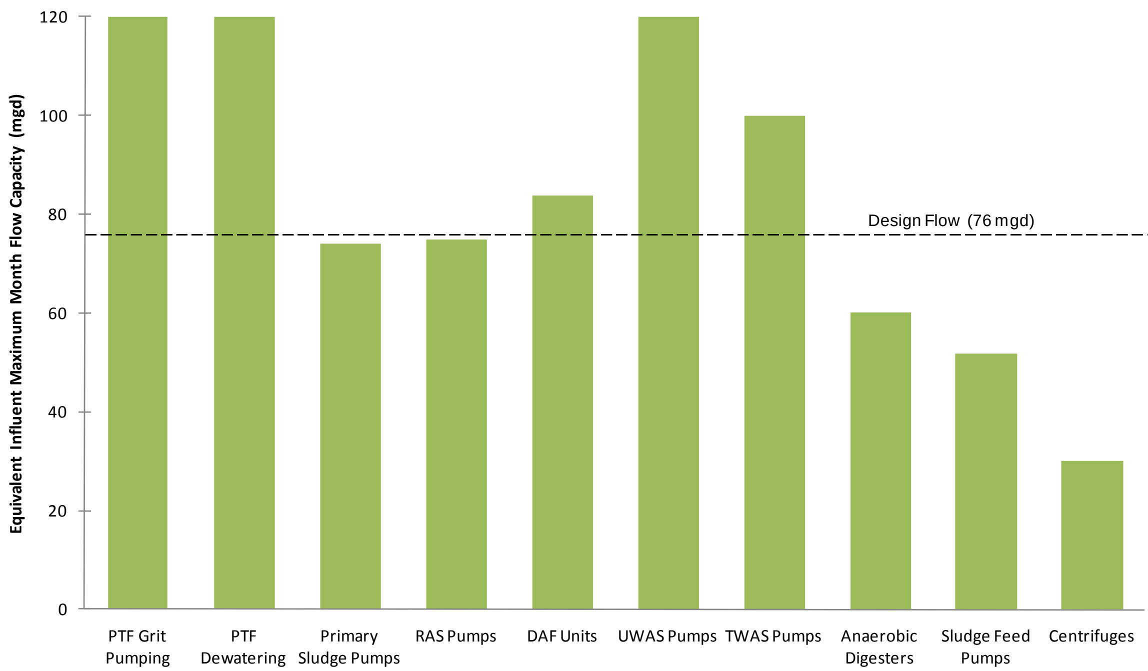

Figure 13-2. Solids Stream Capacity Results

The activated sludge system capacity, shown on Figure 13-1, is limited because there is a lack of adequate blower capacity to meet the most stringent total inorganic requirements at future conditions. However, the aeration basins do have adequate capacity despite the blower deficiency. The grit removal systems include both the aerated and vortex equipment and would appear to have adequate capacity; however, only the aerated system is currently functional and it cannot meet the peak flow capacity as shown in Figure 13-1. As presented in Figures 13-1 and 13-2 the following major process systems have capacity deficiencies:

- Bar Screens,
- Grit Removal System,
- Primary Sludge Pumps,
- Aeration Blowers,
- Anaerobic Digester Systems, and
- Sludge Dewatering Systems.

In addition to the above noted systems, the RAS pumps are just under capacity and an additional pump is recommended to provide the recommended level of redundancy for the system.

13.2 Asset Assessment

The SWRP facility assets were evaluated in terms of consequence of failure, risk of failure, and redundancy. Risk scores were calculated for each asset based on these parameters and this value defined the criticality of that particular asset. High risk scores indicate an urgent need for replacement and these assets were combined into critical projects. The highest priority assets (top ten) are presented in Table 13-1.

Table 13-1. High Priority Assets			
Risk Score	Process Area	Asset Classification	Asset
18.2	Anaerobic Digesters	AD 1-8 Digester System & AD Sludge Blending	Primary Digester Covers/Gas/OF systems
18.2	Anaerobic Digesters	AD 9-14 Structures	Primary Digester Covers/Gas/OF systems
18.2	Preliminary Treatment	Vortex Grit System - Pista Grit	Vortex Grit Chamber
17.9	Preliminary Treatment	Screening	Bar screens
17.7	Electrical Distribution System	Critical Power Systems	Critical Power Systems
17.6	Final Clarifiers	Other Assets	Algae Removal
17.5	Preliminary Treatment	EI&C	Power
17.5	Aeration Basins/ Blower Bldgs/Lift Pumps/Activated Pump Station	South Aeration System	Blowers
17.2	Preliminary Treatment	Vortex Grit System - Pista Grit	Pumps
16.3	Anaerobic Digesters	AD 1-8 Digester System & AD Sludge Blending	Primary Digesters

In terms of process areas, the Preliminary Treatment Facility, Anaerobic Digesters, the plant's Electrical Distribution system, and the Sludge Dewatering Building had a number of assets which had high or moderate risk scores. These results indicate that these facilities should be considered as critical projects in the RRAMP.

13.3 Recommended Projects

Projects were initially developed based on individual asset risk scores, engineering logic, and collaboration with the WUA. Initially, a complete list of all potential projects was developed. This was performed prior to Workshop 2 and was based on evaluation of the asset assessment results. An average project risk score was then calculated for each project based on the assets described in the project workplans. The prioritized list of projects and average project risk scores are discussed in Chapter 14.

During Workshop 2, BC and WUA staff discussed the initial project list and reprioritized the projects. The project descriptions were finalized during these discussions and construction cost estimates were then generated by BC. The construction cost estimates are based on AACE criteria for Class 5 estimates Class 5. Class 5 estimates are considered conceptual estimates and in this case, are used to prepare long range capital improvements planning for the RRAMP. The expected accuracy for a Class 5 estimate can range from -50 to +100 percent depending on the basis of the cost estimate. The project costs were estimated in the following manner:

- Engineering Cost = 7.5 percent of the construction cost
    - Basis of Design Cost =1.4 percent of the construction cost
    - Design Cost = 6.1 percent of the construction cost
- Construction Management Cost = 7.5 percent of the construction cost

Project descriptions and cost estimates are provided in Table 13-2 for all the recommended projects. This table is divided by plant process area and includes the following information:

- **Project Number.** Each project was assigned a project number based on the initial prioritization list. This is simply a unique reference number that links the prioritized project list to the project descriptions.

- **Project Name.** A short project name was provided and serves to briefly summarize the intent of the project.
- **Project Justification.** A brief justification is provided describing the supporting background for the project.
- **Project Description.** A brief description of the project is provided describing the major elements of the project and general basis for the construction cost estimate.
- **Project Type.** Typically each project includes three phases: 1) a basis of design report, 2) a final design phase, and 3) a construction and construction management phase. There are additionally a few projects which do not lead to design; for example, the site security and landscaping projects. However; the majority of the projects follow the traditional three step approach to ensure that the project is coordinated with the short and long term needs of the plant and are well developed before moving into detail design and construction.
- **Project Costs.** The construction cost estimates are based on Association for the Advancement of Cost Engineering International (AACE) criteria for Class 5 estimates. All construction management costs were estimated as 5 percent of the project's construction cost. The basis of design costs were estimated as 1.4 percent of the project's construction costs and the design costs were estimated as 6.1 percent of the project's construction costs. The total engineering costs or sum of basis of design and design costs is equal to 7.5 percent of the project's construction costs.

Project Number	Project Name	Project Justification	Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
Table 13-2. SWRP Summary of Recommended Projects							
Preliminary Treatment							
1.2	New Preliminary Treatment Facility	The capacity of the PTF has been exceeded and the existing footprint and adjacent open land area cannot accommodate the additional facilities required to meet current or future demands. Existing mechanical and electrical components are not working as intended and pose safety concerns. The existing Grit Removal System is failed and grit bypasses the PTF and has damaged processes and equipment throughout both the liquids and solids process systems. The sequence of construction required to maintain PTF operation during construction would be extremely costly and put the plant at major risk of overflows.	Project will perform the basis of design, detail design and construction of a new preliminary treatment facility designed for a maximum month flow of 76 mgd and a peak instantaneous flow of 151 mgd. Process equipment will be provided for current flow conditions first, with provisions for additional process equipment in the future as needed. The facility will include force main and interceptor sewer extensions/junction structures, bar screens, screenings dewatering, grit removal system, grit classifiers, materials handling, HVAC, odor control and electrical and instrumentation. Design may include an upstream grit removal system. Conceptual estimate does not include a new lift station.	Basis of Design Report	$280,000		
				Design	$1,220,000		
				Construction		$1,500,000	$20,050,000
Primary Clarifiers							
12.1	Primary Clarifier Capacity Improvements Construction of two new Primary Clarifiers and two Gravity Thickeners	The existing sludge thickening operation of the primary clarifiers is affecting capacity and hindering performance of this process. Additional primary clarifiers will alleviate capacity concerns and allow for the existing clarifiers to be rehabilitated. New gravity thickeners will also allow the SWRP to separately thicken the primary sludge.	Project initially involves the evaluation of alternatives to improve primary clarification and separate thickening of the sludge. Demolition of older primary clarifiers and construction of gravity thickeners will be considered. Once the evaluation is performed, the preferred solution will be designed and constructed. Project construction cost estimate is based on addition of (4) Primary Clarifiers with a new Primary Sludge Pump Station, demolition of (2) existing Primary Clarifiers, addition of (2) new Gravity Thickeners and (3) new thickened sludge pumps.	Basis of Design Report	$220,000		
				Design	$980,000		
				Construction		$1,200,000	$16,060,000
12.2	Primary Clarifier Tank and Mechanism Improvements	There are corrosion issues at the primary clarifiers' concrete structures and steel mechanisms and a lack of effective cathodic protection. The clarifier mechanisms on PCs #1-2 are 50 years old and need rehabilitation.	Project includes the preparation of basis of design plan for investigating structural and mechanism issues and identifying needed repairs/replacement of selected primary clarifiers followed by detail design and construction of these rehabilitations. The project includes mechanism replacement at PC 1-2, mechanism rehabilitation at PC 5-8, concrete repairs and cathodic protection at all Primary Clarifiers.	Basis of Design Report	$20,000		
				Design	$110,000		
				Construction		$130,000	$1,780,000
12.3	Primary Clarifier Spray Water and Wash Water Improvements	The existing spray water and wash water systems at the Primary Clarifiers are broken, barely functioning and need repair and system improvements.	Project includes basis of design plan, detailed design and construction of improvements. Project includes complete removal and replacement of existing non-potable spray water system with new distribution pipe and spray nozzles. New yard hydrants will be provided at each clarifier.	Basis of Design Report	$2,000		
				Design	$10,000		
				Construction		$10,000	$170,000
12.4	Primary Clarifier EI&C Improvements	There is a lack of reliable standby power for the primary treatment process. Primary treatment is considered a "vital" process under EPA guidelines and requires at least two separate power sources.	Evaluation of standby power alternatives will take place under the Plant-Wide Electrical Systems study. This project will design and construct the rehabilitation measures consistent with the plant wide plan. Additional improvements will be made in accordance with overall process improvements.	Basis of Design Report	$50,000		
				Design	$230,000		
				Construction		$290,000	$3,830,000
19.1	Primary Clarifier Draining Improvements	The draining of primary clarifiers requires excessive manpower and time for the operations staff. A portable pump is required to drain a clarifier	Project includes the preparation of basis of design plan to investigate	Basis of Design Report	$2,000		

Table 13-2. SWRP Summary of Recommended Projects

Project Number	Project Name	Project Justification	Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
		and can only be powered through the mechanism drive box which poses a serious safety hazard.	improving the clarifier draining systems followed by detail design and construction of these rehabilitations. Conceptual project includes (1) drain pump addition at Primary Pump Station 1 with piping modifications to hard pipe suction out of clarifier and hard pipe/hose discharge into adjacent clarifier. Also includes repairs and/or replacement of pumps at existing tank drain systems at PC 5-8.	Design	$10,000		
				Construction		$10,000	$160,000
19.2	Primary Sludge Pumping, Process Piping and Valving Improvements	Pumping of the primary sludge is wearing down the pumps and causing premature failure due to the high solids concentration. Sludge piping often gets plugged up and some sludge lines may be undersized. Many process valves are inoperable including bypass valves which impact the flexibility of operations. The sludge is often "thinned out" to pump. Scum pumping improvements are also required and will be addressed with sludge pumping improvements.	BC recommends modifying the primary clarifier process from sludge thickening to thin sludge pumping. The existing sludge thickening operation of the primary clarifiers is affecting capacity and hindering process performance. A change in the operational process to thin sludge pumping will improve clarifier performance and minimize sludge pumping issues. A decision will be made in pre-design as to whether or not this approach will be taken into design and construction. Conceptual project estimated includes sludge pump replacement (with 1 added backup) and piping/valving replacement/rehabilitation at each Primary Pump Station, and new upsized sludge withdrawal pipe installed at each Primary Clarifier.	Basis of Design Report	$10,000		
				Design	$50,000		
				Construction		$60,000	$770,000
19.3	Primary Clarifier Pump House #1,#2 and #3 Improvements	All three pump houses are in relatively poor condition. There are slip and trip hazards, roof leaks, no secondary means of egress, concrete deterioration, access congestion, and a lack of proper HVAC. The structure of PH #2 dates back to the late 1960's.	Project initially involves the inspection of the pump houses. A basis of design will be prepared detailing recommended rehabilitation strategies for these issues. Following this, the project will design and construct these improvements. The conceptual project estimate includes roof replacement, pump station floor re-surfacing, HVAC replacements at each pump station, and concrete repair in the wetwells. Also a secondary means of egress has been included at PS #3.	Basis of Design Report	$3,000		
				Design	$10,000		
				Construction		$20,000	$240,000
19.4	Primary Clarifier Odor Control Rehabilitation	In sludge thickening mode, the primary clarifiers are serving to ferment the solids which encourages the production of odors. The effluent weirs of the primary clarifiers are currently covered and the trapped air is pulled and treated with individual biofilters. However, this odor control system does not appear to be sufficient and there's evidence that suggests a build-up of H_2S gas in the covered weirs is corroding the concrete. Pieces of concrete are reportedly falling into the effluent water.	BC recommends modifying the primary clarifier process from sludge thickening to thin sludge pumping. The existing sludge thickening operation of the primary clarifiers is affecting capacity and hindering performance of this process. A change in the operational process to thin sludge pumping will reduce odors and H_2S gas. A decision will be made in predesign as to whether or not this approach will be taken into design and construction. Conceptual project consists of covering the clarifiers with domes, and improvements to the blower/biofilter systems.	Basis of Design Report	$40,000		
				Design	$170,000		
				Construction		$210,000	$2,740,000
19.5	Primary Clarifier Pump House #1,#2, #3 EI&C Improvements	There is a lack of standby power which has resulted in overflows and permit violations for Pump Houses #1 and #2. Both pump stations are fed from a single transformer which is a single point of failure. Because the HVAC system is not working properly, the electrical equipment is beginning to corrode. Most of the electrical equipment have exceeded their expected life and should be replaced.	Project includes the preparation of basis of design plan to investigate improving the EI&C systems followed by detail design and construction of these rehabilitations. Estimates are based on new power distribution at P.S. #1 and #2, new MCCs at all pump stations, new DCU cabinets at all pump stations and new instrumentation at all pump stations.	Basis of Design Report	$40,000		
				Design	$180,000		
				Construction		$220,000	$2,950,000

Table 13-2. SWRP Summary of Recommended Projects

Project Number	Project Name	Project Justification	Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
Aeration Basins							
2A	Aeration Blower Improvements Phase 1 - North Blower and HVAC Improvements	The existing north blowers lack capacity for existing and future air requirements. The existing building lacks the required area to add the same type of blowers. (6) Turbo Blowers can be installed in the existing building where (4) now reside. The new Turbo blowers will be significantly more efficient and less costly to operate and maintain. The lack of proper HVAC in the North Blower Building MCC room and process areas may be contributing to blower failure because of excessively high temperatures.	Project initially involves an evaluation of the existing North blower facility to determine full scope of required changes. Then preparation of a basis of design, a design and a construction project that will conceptually provide for removal of existing (4) blowers and installation of (6) new blowers and supporting systems. Project involves the inspection of the HVAC system and then preparation of a basis of design which will detail what improvements are needed. Following this, the project will design and construct these improvements. At this time the conceptual plan is to provide a new air conditioning unit at the MCC room with a purafil prefilter system and to add cooling capabilities at the blower room.	Basis of Design Report	$60,000		
				Design	$280,000		
				Construction		$340,000	$4,550,000
2B	Aeration Blower Improvements Phase 2 - South Blowers and Blower Building	The existing south blowers are located in an older building that appears to be experiencing geotechnical issues and is settling. The blower equipment bases have settled and have required costly repairs. Only a fraction of the blowers are in working condition. The blower air intake system performs poorly, is unreliable, and is a safety concern. The recommendation is to construct a new blower building and possibly install a combination of existing and new blowers within this building.	Project initially involves an evaluation of existing blowers to determine which are salvageable for the new building and determine the type and capacity of new blowers. Once the evaluation is performed, new blowers, supporting systems and a new building will be designed and constructed. Conceptual project estimate includes (8) new blowers in a new building.	Basis of Design Report	$120,000		
				Design	$530,000		
				Construction		$660,000	$8,760,000
17	Aeration Basin Foam Removal System	Foam is being trapped within the aeration basins and is building up on equipment. The foaming is hindering performance, causing maintenance repairs and causing safety concerns. The recommendation is to improve transport of the foam within the basins and provide collection points in the effluent channels to eliminate foam buildup.	Project initially involves a thorough hydraulic evaluation of the basins. Then, appropriate solutions for transporting and removing the foam will be evaluated. Once the evaluation is performed, the preferred solution will be designed and constructed. The estimated project scope includes (5) new classifying selectors added to the AB Effluent Channels. Classifying selectors will include submersible pumps, baffle walls and a concrete weir walls.	Basis of Design Report	$10,000		
				Design	$50,000		
				Construction		$60,000	$770,000
29.1	Aeration Basin Miscellaneous Improvements	There is a lack of proper connection of the aeration control valves to the control system so these valves must be manually operated and controlled which hinders the aeration system performance. The air valves are submerged and do not work properly. Some tank drain valves do not function.	Project initially involves identification of problematic AB Drain valves and air valves, and determine a recommended solution. Project will then design and construct the rehabilitation. The conceptual project includes relocation of all air valves and selective replacement of actuators and controls. Also, there will be removal and selective replacement of some of the AB tank drain valves.	Basis of Design Report	$10,000		
				Design	$30,000		
				Construction		$40,000	$490,000
29.2	Aeration Basin Spray Water and Wash Water Improvements	The existing spray water and wash water systems at the Aeration Basins are broken, barely functioning and need replacement and system improvements.	Project involves the inspection of the wash/spray water systems and then preparation of a basis of design which will detail what improvements are required. Following this, the project will design and construct these improvements. Conceptual project includes complete removal and replacement of existing spray water system with new distribution pipe and spray nozzles. Two new hose stations will be provided at each AB walkway.	Basis of Design Report	$10,000		
				Design	$20,000		
				Construction		$30,000	$400,000
29.3	Aeration Basin and Activated Sludge Pump Station EI&C	Lack of separation of incoming power feeders compromises intended source redundancy. Lack of standby VFDs and pumps has led to	EI&C upgrades will be developed with process/mechanical upgrades along	Basis of Design Report	$10,000		

Table 13-2. SWRP Summary of Recommended Projects							
Project Number	Project Name	Project Justification	Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
	Improvements	violations when VFDs fail. Some control panels, instruments and field wiring have deteriorated and become unreliable.	with the results of the Electrical Power System Study project. This project involves initially the basis of design effort which will delineate the exact electrical and instrumentation equipment which should be replaced. Following the basis of design effort, the project would involve the design and construction of these improvements. Estimates are based on new valves, actuators, and flow meters for all RAS withdrawal, RAS distribution, and Primary distribution lines.	Design	$40,000		
				Construction		$50,000	$730,000
29.4	Aeration Basin Diffuser Improvements	The SWRP has replaced the ceramic diffusers in at some for the Aeration Basins with membrane diffusers and are considering replacement of the remaining ceramic diffusers. The ceramic diffusers require regular cleaning with an HCl solution which is maintenance intensive and poses a safety concern. Additionally membrane diffusers that exist now will begin to require staged replacement due to their age.	Ultimately this project will be completed in stages that best suite the condition of the ceramic diffusers coordinated with the ages of the membrane diffusers and coordinated with other Aeration Basin Improvement projects. Conceptual project involves the design and construction of these improvements. Estimated improvements include removal and replacement of diffusers at 14 Aeration Basins.	Basis of Design Report	$30,000		
				Design	$130,000		
				Construction		$160,000	$2,100,000
29.5	RAS Pumping Improvements	Staff are operating all four RAS pumps with no redundancy. There is also a lack of spare parts for these pumps.	Project involves the inspection of the RAS pumps and then preparation of a basis of design which will detail what improvements are needed. Following this, the project will design and construct these improvements. The conceptual project includes a (2) phase improvement approach, the first phase is to remove and replace one poorly operating RAS pump and the second phase will add one additional RAS pump and expand the pump station.	Basis of Design Report	$30,000		
				Design	$110,000		
				Construction		$140,000	$1,830,000
Final Clarifiers							
9	Final Clarifier Improvements	Flow Distribution - There is currently no reliable method of controlling flow to the secondary clarifiers which causes some clarifiers to receive a different amount of flow than the others. This causes the clarifiers to perform very poorly as some are overloaded while others are under loaded. This could lead to effluent water quality problems as the secondary clarifiers are the last major water clarification step at this facility.	Project involves initially the basis of design effort which would determine appropriate modifications which could be made to facilitate even flow distribution. Project would then design and construct these modifications. For the conceptual level estimate it is assumed that the three existing distribution boxes can be expanded and improved to resolve this issue.	Basis of Design Report	$110,000		
		Tanks and Mechanisms - The final clarifiers require upgrade and rehabilitation of their structures and mechanical components to varying degrees There is a lack of effective cathodic protection for these clarifiers and corrosion is visible on the mechanisms and draft tubes, scum removal systems and many of the flocculation wells are in disrepair.	Project initially involves the inspection of the final clarifier structures and mechanisms and then preparation of a basis of design which will detail what repairs are required and exactly what mechanical mechanisms require replacement. Following this, the project will design and construct these improvements. The conceptual project cost estimate includes removal and replacement of mechanisms at South FC #1-4 and mechanical localized rehabilitation at the balance of the final clarifiers. Also addition of cathodic protection systems and localized concrete repairs for all final clarifiers is included.	Design	$490,000		
		Spray and Wash Water - The existing spray water and wash water systems at the final clarifiers are broken, barely functioning and need repair and system improvements.	Project involves the inspection of the wash/spray water systems and then preparation of a basis of design which will detail what repairs and/or improvements are required. Following this, the project will design and construct these improvements. Project concept at this time includes complete	Construction		$600,000	$8,010,000

Table 13-2. SWRP Summary of Recommended Projects							
Project Number	Project Name	Project Justification	Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
			removal and replacement of existing spray water system with new distribution pipe and spray nozzles. Two new hose stations will be added at each clarifier. Scum box automated spray systems will also be added.				
		EI&C - There is a safety issue with the existing electrical components. The equipment is antiquated and the staff would like additional capabilities with instrumentation.	EI&C upgrades will be developed with process/mechanical upgrades along with the results of the Electrical Power System Study project. This project involves initially the basis of design effort which will delineate the exact electrical and instrumentation equipment which should be replaced. Following the basis of design effort, the project would involve the design and construction of these improvements. Estimates are based on new drive and sludge blanket instruments and replacement of all the clarifier drive disconnects with NEMA 4X devices.				
21	Final Clarifier Algae Removal System Improvements	Buildup of algae is a major problem in the final clarifiers because there is no existing means to remove it at the plant. This will become a very critical issue when UV disinfection is online as algae can negatively affect effluent quality and reduce the operational effectiveness of the UV system.	Project involves initially the evaluation of options to improve algae removal in the final clarifiers. Once the evaluation is performed, the preferred solution will be designed and constructed. The cost estimate is based on the conceptual plan to provide launder covers.	Basis of Design Report	$30,000		
				Design	$130,000		
				Construction		$160,000	$2,140,000
DAFs							
13	DAF EI&C Improvements	DAF power distribution equipment is very old and has reached the end of useful life. The roof of the MCC room leaks and causes a dangerous safety hazard. Controls and instruments are also old and wiring is in poor condition and unreliable. Polymer system is operated manually resulting in excess operating costs.	EI&C upgrades will be developed with process/mechanical upgrades along with the results of the Electrical Power System Study project. This project involves initially the basis of design effort which will delineate the exact electrical and instrumentation equipment which should be replaced. Following the basis of design effort, the project would involve the design and construction of these improvements. Estimates are based on electrical room expansions and replacement of 50% North MCCs, 100% South MCCs, South Switchgear, DCU cabinets, and 100% instrumentation. This work includes EI&C improvements for the south digesters that are fed from the DAF Complex.	Basis of Design Report	$60,000		
				Design	$250,000		
				Construction		$310,000	$4,110,000
15	DAF HVAC & Foul Air Improvements	The HVAC system is not working properly and there is a lack of adequate air changes and heat in the building. The MCC rooms and compressor room also lack cooling which has led to equipment overheating in those areas.	This project will initially evaluate the HVAC and foul air systems and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. Following this, the project will design and construct the rehabilitations. Conceptual plan is to provide new air conditioning units to serve the MCC rooms and the compressor room with Purafil Prefilters and then rehabilitate the existing air handling units, hot water system and duct systems for the process areas. Also the existing foul air system will be rehabilitated using new fans and new scrubbers.	Basis of Design Report	$10,000		
				Design	$30,000		
				Construction		$30,000	$410,000
16	DAF Comprehensive Valve/Piping Improvements	The valving, piping and control valves, and instrumentation for many portions of all the process systems, including TWAS, bottom sludge, scum, UWAS, recirculation, and polymer lines are plugged and/or non-functioning, and as such, operation of these systems lack redundancy and flexibility of operation.	Project involves the inspection of the valves and piping and then preparation of a basis of design which will detail what repairs are required and exactly what requires replacement. Following this, the project will design and construct these improvements. Conceptual plan removes and replaces approximately 25% of the piping, valves, and appurtenances, including control valves and other instruments. Also process flushing systems will be	Basis of Design Report	$10,000		
				Design	$50,000		
				Construction		$60,000	$780,000

Table 13-2. SWRP Summary of Recommended Projects

Project Number	Project Name	Project Justification		Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
				added.				
24B	DAF TWAS, UWAS and Scum Pumping Improvements	There is no redundancy for the TWAS pumps. If one is down, two DAF units have to be taken out of service. UWAS/scum pumps continuously lose prime and then do not function.		Project involves the inspection of the pumping systems and then preparation of a basis of design which will detail what repairs are required and exactly what requires replacement. Following this, the project will design and construct these improvements. Conceptual project includes (4) additional new TWAS pumps, improvements to the UWAS/Scum piping system and replacement and /or addition of grinders on the UWAS piping.	Basis of Design Report	$10,000		
					Design	$50,000		
					Construction		$60,000	$850,000
25	DAF Saturation System Improvements	The air compressors are old and one has failed and as such the system lacks redundancy. The pressure vessels have never been inspected and pose a safety concern. The air control panels are in disrepair and often do not function properly.		Project involves the inspection of the saturation system and then preparation of a basis of design which will detail what repairs are required and exactly what requires replacement. Following this, the project will design and construct these improvements. Conceptual project involves removal and replacement of existing compressors with (2) duplex compressors and rehabilitates (7) saturation system pressure vessels and (7) air control panels.	Basis of Design Report	$3,000		
					Design	$10,000		
					Construction		$20,000	$200,000
26	DAF Tank and Mechanism Rehabilitation	DAF Units #1-3 are the oldest units (30 years) that rely on manual control and require the most maintenance. Some rehab of units has been completed in the recent past but further evaluation is needed. DAF Units #4-7 are also old (25 years) and are experiencing corrosion on their mechanisms and have never been rehabilitated.		Project involves the inspection of the DAF tanks and mechanisms and then preparation of a basis of design which will detail what repairs are required and exactly what requires replacement. Following this, the project will design and construct these improvements. Conceptual plan is to rehabilitate DAF #1-3 and to remove and replace mechanisms at DAF # 4-7.	Basis of Design Report	$10,000		
					Design	$60,000		
					Construction		$70,000	$910,000
27	DAF Polymer Batch and Feed System Improvements	The polymer pumps have burnt up motors and are out of service frequently. The pumps are manually controlled and polymer feed is irregular. Piping and valving is clogged and non-functional. The existing buried tanks and piping have freezing and access issues.		Project involves inspection of polymer storage, batching, pumping, pipe, valving and control systems. Project concept at this time is replacement of the transfer pumps, feed pumps, and a majority of the piping and appurtenances. The buried storage system will be removed and a new addition to the DAF building will be added and will contain new dry polymer storage, batching and mixing system.	Basis of Design Report	$20,000		
					Design	$80,000		
					Construction		$90,000	$1,250,000
Anaerobic Digesters								
3.2	Digester Capacity Improvements (Dig 1-8; Dig 9-14)	The existing anaerobic digestion process is stressed and capacity limited. <u>The digester detention time has decreased significantly and permit violation is imminent.</u> New digesters are needed to alleviate the capacity		This project will initially evaluate the addition of (3) new digesters to bring the available firm digester capacity to 76 mgd maximum month equivalent capacity for mesophilic digestion (gross planning volume of 3.6 MG in 3	Basis of Design Report	$330,000		
					Design	$1,420,000		

Table 13-2. SWRP Summary of Recommended Projects								
Project Number	Project Name	Project Justification		Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
		restraints and allow for the existing digesters to be rehabilitated. The size of the new digester will have to be coordinated with the available capacity from the existing digesters in either their current or future configuration.		Digesters). Proposed concept would include all support systems and a stand-alone building with two new boilers with sufficient capacity to help support the existing digesters (via new interconnection piping). This building is also the proposed site of a new MCC for the North Digesters. The proposed concept is to design, construct and commission the new conventional digesters with submerged-fixed covers prior to major retrofit construction of existing digesters. Once the evaluation is performed, the preferred solution will be designed and constructed.	Construction		$1,750,000	$23,300,000
3.3	Primary Digester Mixing Improvements (Dig 1-8; Dig 9-14)	The existing mixers have been experiencing problems with the lower bearings and the supports are deteriorating. Many of the mixers are out of service, hindering the performance of the digesters. Proper mixing is needed to assure even heating and improved process performance so that available digester volume can be fully utilized. Adequate mixing will also help to reduce scum mats that can reduce available volume and create maintenance issues.		Project involves initially the evaluation of alternatives to improve digester mixing. Philadelphia mixers will be considered as an alternative. Once the evaluation is performed, the preferred solution will be designed and constructed in conjunction with revised cover design as the existing mixing configuration cannot be readily changed without roof modifications.	Basis of Design Report	$70,000		
					Design	$300,000		
					Construction		$370,000	$4,910,000
3.4	Primary Digester Covers and Rehabilitation (Dig 1-8; Dig 9-14)	The existing covers are old, deteriorating and are in need of replacement. There are potential gas leaks and deterioration that need to be addressed. Interim measures are not expected to result in a 20-year operating life and so they should be replaced. Also, the cover configuration, with the full-diameter top surface, encourages a scum mat formation that robs capacity and creates cleaning challenges. Additionally, the design will have to be changed to accept a new style of mixer. Given the extended outage, new sludge HEX equipment and associated hot water pump, piping/valve and automation modifications and repairs and new mixing equipment should be implemented.		Project involves the inspection of the digesters to confirm/update findings of the FDAR and consider the feasibility of constructing a Submerged-Fixed cover configuration and at what capacity (either with or without additional circumferential reinforcing - assumed required for estimating). New sludge HEX equipment and associated hot water pump, piping/valve and automation modifications and repairs and new mixing equipment should also be evaluated. The basis of design will detail the rehabilitation needs. Following this, the project will design and construct these improvements. Construction should start once the new digesters have been commissioned.	Basis of Design Report	$180,000		
					Design	$780,000		
					Construction		$960,000	$12,760,000
3.5	Secondary Digester Covers and Rehabilitation	Secondary covers/GAS/Overflow systems - These systems were evaluated in the Final DAR "Southside Water Reclamation Plant Digester Rehabilitation," June 2008 CH2MHill. Existing covers are old and should be replaced due to deterioration. Floating covers can be maintenance-intensive and foaming can result in wedging of lids that requires a crane or other measures to resolve. Unused equipment provides potential deterioration pathway. PVRV functions must be assured for safety and structural integrity. Given the extended outage associated with replacement, two of the four secondary digesters could be retrofitted as swing digesters by sharing circulation and HEX equipment with an adjacent primary digester. Related piping/valve and automation modifications and repairs and new mixing equipment should be implemented for the swing digesters.		Project involves the inspection of the digesters to confirm/update findings of the FDAR and consider the feasibility of constructing a Submerged-Fixed cover configuration on all digesters and at what capacity (either with or without additional circumferential reinforcing - assumed required for estimating). Fixed covers will require an adequate reservoir of digester gas (LSG) so as not to affect low pressure uses and compression and cogen systems. At this time, the approach assumes the existing gas holders will remain. The feasibility of piping/valve and automation modifications and repairs and new mixing equipment should also be evaluated. The basis of design will detail the rehabilitation needs. Following this, the project will design and construct these improvements. Construction should start once the new digesters have been commissioned.	Basis of Design Report	$60,000		
					Design	$270,000		
					Construction		$340,000	$4,470,000
3.6	Digester Sludge Withdrawal Pump Improvements (Dig 1-8; Dig 9-14)	There is a lack of redundancy for the sludge withdrawal pumps from Secondary Digesters 10 and 12 and the line of transfer to the sludge dewatering system. This lack of redundancy allows for a single point of failure that can disrupt the solids handling process. At least one additional pump and sludge line are recommended.		This project will initially evaluate the sludge pumping system capacity and a proposed control system (required to for improved flow balance to Dewatering). The basis of design will summarize the recommended design and construction required to rehabilitate this system. The conceptual plan is to provide (2) pumps and (2) parallel feed lines to the dewatering building.	Basis of Design Report	$4,000		
					Design	$20,000		
					Construction		$20,000	$320,000

Table 13-2. SWRP Summary of Recommended Projects								
Project Number	Project Name	Project Justification		Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
3.7	Digester Low Pressure Gas System (Dig 1-8; Dig 9-14)	The current system is leaking gas and has inadequate traps. LSG is corrosive and extensive deterioration of piping would not be unexpected. This not only poses a safety issue for SWRP staff but also wastes gas that could be used in the cogeneration facility.		Project involves the investigation of materials of construction, inspection of low pressure gas system, estimation of future requirements and then preparation of a basis of design which will detail what repairs are required and exactly what requires replacement. Following this, the project will design and construct these improvements. Because of the need for active digester volume, it is anticipated that only improvements from individual digesters to isolation at headers could be accomplished prior to bringing new digesters on-line. For estimation purposes, we will assume that a new gas room will be constructed (perhaps as an extension of the existing) for each group of digesters and buried or encased piping will be replaced with SST exposed piping within the digester complex transitioning to new buried HDPE piping in the yard.	Basis of Design Report	$10,000		
					Design	$60,000		
					Construction		$80,000	$1,040,000
3.8	Digester EI&C Improvements(Dig 1-8; Dig 9-14)	Aging electrical equipment should be subjected to major overhaul or complete replacement to address safety and obsolescence. Only partial redundancy exists at peak conditions. A prolonged power would back-up the solids handling process until a repair or work around was implemented. Modern equipment would be more readily serviced without process disruptions.PCU controllers are remote from the digester area with long control circuits having multiple interface points leading to unreliability and high maintenance levels. Area classification requirements (explosion proof construction) require review.		E, I &C upgrades will be developed with process/mechanical upgrades along with the results of the Electrical Power System Study project. This project involves initially the basis of design effort which will delineate the exact electrical and instrumentation equipment which should be replaced. Following the basis of design effort, the project would involve the design and construction of these improvements.Estimates are based on a new north electrical room and replacement of 100% North MCCs, North Switchgear, DCU cabinets, and 100% instrumentation.	Basis of Design Report	$80,000		
					Design	$330,000		
					Construction		$410,000	$5,450,000
4.1	Digester Building Hot Water Loop Improvements (Dig 1-8; Dig 9-14)	Currently, there is a lack of heat transfer for Digesters # 1-8 in the winter months. It is possible that the poor heating is related to problems with the Building Hot Water loop and Digester Hot Water loop pipe and valves. Adequate heating is needed for sustained, high rate digester operation.		This project will initially evaluate the building hot water loop and basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. Given the age and history of this system a full parallel system may be required. Following the evaluation, the project would proceed with design and construction of the indicated improvements.	Basis of Design Report	$5,000		
					Design	$20,000		
					Construction		$30,000	$340,000
4.4	Digester Piping & Valves (Dig 1-8; Dig 9-14)	Existing piping and valves are old. Valves are reportedly failing and undergoing as-needed replacements. Potential for pipe deterioration and/or reduced capacity due to deposits can affect operations.		Project involves the investigation of sludge piping materials and condition and inventory of valves for replacement. Piping will be considered for future capacity requirements. Cases of obvious failures and conflicts will be identified for changes. For the purposes of estimation, assume removal and replacement in kind of 1000 LF of piping and repair/re-support of 1000 LF of existing piping. Once the design approach is accepted, proceed through construction in a step-wise manner in conjunction with other on-going work.	Basis of Design Report	$2,000		
					Design	$10,000		
					Construction		$10,000	$160,000
4.5	Digester HVAC Improvements(Dig 1-8; Dig 9-14)	Current gas rooms are not physically isolated from balance of building which is contrary to current practice (NFPA 820). Interconnection to balance of space would necessitate the institution of explosion-proof equipment. Inadequate heating systems can result in freezing of gas system and health and safety implications due to uncontrolled release of gas through PVRVs. Odors would also be associated with uncontrolled release.		Project involves the investigation for requirements for physical isolation of the gas rooms and appropriate heating and ventilation. For the purposes of estimation, assume: a concrete block fill of existing doors and/or louvers to digester gallery; rerouting of any ventilation to/from the gallery; separate ventilation and explosion-proof heating of the gas rooms; repair and/or replacement of exterior doors and windows. Detection instrumentation and go-no-go panels should be includedOnce the design approach is accepted,	Basis of Design Report	$10,000		
					Design	$60,000		
					Construction		$80,000	$1,020,000

Table 13-2. SWRP Summary of Recommended Projects

Project Number	Project Name	Project Justification		Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
				proceed through construction in conjunction with other on-going work.				
4.6	Digester Feed Improvements (Dig 1-8; Dig 9-14)	Complex control scheme for feeding digesters require extensive operator intervention. Unbalanced and erratic feeding can contribute to process upset. Automation of valving and appropriate flow metering can lessen operator intervention and lessen load fluctuations		Project involves the investigation of sludge feed piping for appropriate routing and valve placement/replacement. Automated vales and manual isolation valves will be considered. For purposes of estimation, assume: one new feed line , with a magnetic flow meter and three valves and bypass pipe on the piping from the sludge blending pumps; rehabilitation of existing feed line with a new magnetic flow meter, three valves and bypass pipe, one automated valve and two isolation valves for each primary digester (10).	Basis of Design Report	$4,000		
					Design	$20,000		
					Construction		$20,000	$290,000
Sludge Dewatering								
6.2	New Sludge Dewatering Facility	The capacity of the Sludge Dewatering Facility has been exceeded and the existing footprint cannot accommodate the additional facilities required to meet current or future demands. The building structure and equipment layout is not suited for the addition of centrifuges. Existing mechanical and electrical components are not working as intended and pose serious safety concerns. Construction sequence required to maintain sludge dewatering during construction would be extremely costly and put the plant at risk of having to contract out sludge disposal for long durations.		Project will perform the basis of design, detail design and construction of a new sludge dewatering facility. The facility will include yard piping, centrifuges, polymer system, dewatered sludge pumping system, centrate pumping and storage, materials handling, HVAC, odor control and electrical and instrumentation. Process equipment will be provided for current flow conditions first with provisions for additional process equipment in the future as needed.	Basis of Design Report	$150,000		
					Design	$670,000		
					Construction		$830,000	$11,000,000
Cogeneration Facilities								
28.1	Gas Sphere Improvements	There is a potential for uncontrolled digester gas leaks which could violate the SWRP's air permit and may create a safety issue. Odors would also be generated from a leak. The sphere has never been evaluated and its condition (including piping) is unknown. There is no real redundancy and loss would require throttling of cogen operation during periods of low gas availability.		Project involves the investigation of materials of construction, inspection of the gas sphere system, estimation of future requirements then preparation of a basis of design which will detail what repairs are required and what requires replacement. Following this, the project will design and construct these improvements. Because of the need for adequate heating capacity (normally from cogen), it is suggested that this work be undertaken when enough firm LSG- or NG-fired boiler capacity is available. For estimation purposes, we will assume that the sphere exterior is blasted and recoated and the interior is blasted and recoated. Piping that is buried will be replaced with HDPE and exposed will be replaced with 316L SST.	Basis of Design Report	$4,000		
					Design	$20,000		
					Construction		$20,000	$320,000
28.2	South Cogen Power Improvements	System fails to load shed and stay online when 52-UT CB (at FIS) opens. Operating CBs for synchronizing equipment is a safety hazard. Cable access at main switchgear makes maintenance difficult.		Evaluation of cogen power performance will take place under the Plant-Wide Electrical Systems study. This project will design and construct the rehabilitation measures consistent with the plant wide plan. Alternatives for load shedding and synchronization will be explored in addition to physical and electrical improvements.	Basis of Design Report	$2,000		
					Design	$10,000		
					Construction		$10,000	$110,000

Table 13-2. SWRP Summary of Recommended Projects

Project Number	Project Name	Project Justification	Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
28.3	North Cogen Power Improvements	Complex distribution equipment and interlocking is difficult to operate. Synchronization panel works in one mode only.	Evaluation of cogen power performance will take place under the Plant-Wide Electrical Systems study. This project will design and construct the rehabilitation measures consistent with the plant wide plan. Alternatives for load shedding and synchronization will be explored in addition to physical and electrical improvements. Assume repair to sync panel and correction of interlocking.	Basis of Design Report	$2,000		
				Design	$10,000		
				Construction		$10,000	$110,000
28.4	Gas Holder Improvements	There is a potential for uncontrolled digester gas leaks that could violate the SWRP's air permit. The gas holder has never been evaluated and its condition (including piping) is unknown.	Project involves the investigation of materials of construction, inspection of the gas holder system, estimation of current (construction phase) and future requirements, then preparation of a basis of design which will detail what repairs are required and what requires replacement. Following this, the project will design and construct these improvements. Because of there are two vessels it is suggested that the inspection and construction could be managed one at a time. For estimation purposes, we will assume that the gas holder exterior is blasted and recoated and the interior is blasted and recoated. Piping that is buried will be replaced with HDPE and exposed will be 316L SST. Also included in this estimate is concrete repair to the interior of the gas holders.	Basis of Design Report	$10,000		
				Design	$50,000		
				Construction		$60,000	$750,000
28.5	Cogen Digester Gas Quality Improvements	Excessive moisture in compressed digester gas is affecting combustion, contributes to corrosion, and can increase siloxane deposits in the engines which substantially increases maintenance requirements.	This project will initially evaluate the digester gas system and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. Following this, the project will design and construct the rehabilitation. The conceptual design adds (3) digester gas scrubbers/dryers to the existing system.	Basis of Design Report	$140,000		
				Design	$590,000		
				Construction		$730,000	$9,730,000
28.6	Fuel Gas Metering Improvements (North and South)	There are no meters to accurately gauge how much gas is being used.	This project will initially evaluate the existing gas piping systems, estimate future requirements and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. Following this, the project will design and construct the recommended project. Load shed instrumentation is addressed under power.	Basis of Design Report	$1,000		
				Design	$5,000		
				Construction		$10,000	$80,000
28.7	North & South Cogen Building Sound Attenuation Improvements	The Cogen generators create excessive noise within the generator rooms and this noise travels outdoors and can disturb neighbors offsite. Additionally it is uncomfortable to work within these rooms and over time may cause hearing damage.	Project will evaluate the existing facilities, perform basis of design, detailed design and construction of new sound attention systems at both the North and South Cogen Buildings.	Basis of Design Report	$2,000		
				Design	$10,000		
				Construction		$10,000	$150,000
28.8	Remove and Replace South Cogen Generators	The existing south Cogen generators are approximately 30 years old, lack the capacity the plant staff requests, and do not work efficiently.	This project will initially evaluate the existing generators and supporting systems, then a basis of design, design and construction of the recommended improvements will take place. The conceptual plan at this time is to remove the (2) 1.1 MW generators and replace with (2) 1.5 MW generators.	Basis of Design Report	$20,000		
				Design	$70,000		
				Construction		$90,000	$1,150,000

Table 13-2. SWRP Summary of Recommended Projects

Project Number	Project Name	Project Justification	Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
Plant-Wide Non-Potable Water System							
7	Plant Wide Non-Potable Water System Improvements	The SWRP is currently expanding their reuse water system to 2 mgd for plant use. Unfortunately, the current distribution system at the plant is over 40 years old, has seized valves, failed pipe, and poor pressure consistency caused by these valve and pipe issues. The plant does not have a proper backup system for the reuse water as this water is required to maintain functionality of many plant process systems. In the event that the reuse system is down, SWRP staff must physically plumb a spool piece in the piping to use non-potable water from the City. The existing effluent emergency wash water (EWW) system is antiquated, fatigued and unreliable and should be rehabilitated.	This project will initially evaluate the existing supply and distribution system and determine plant water needs in each facility. Recommendations for rehabilitation of the distribution system and installation of back-up water systems will be determined. Following this, the project will design and construct the rehabilitations. Project construction cost estimate is based on a large amount of the existing distribution piping and valving to be removed and replaced. Additionally the EWW system will be rehabilitated, and the existing process yard hydrant system will be rehabilitated. Additional distribution pipe will be added to serve and distribute to a majority of the plants process buildings and facilities.	Basis of Design Report	$20,000		
				Design	$80,000		
				Construction		$100,000	$1,380,000
Plant-Wide Electrical Systems							
5.1	Electrical Distribution System Improvements Plant-Wide Power System Study and Upgrades	A complete plant power distribution system study is required to model the system and identify risks, hazards and opportunities for improvements. The existing system is very complex, difficult to operate and is reported to have several safety issues for O&M staff. Final analysis of electrical assets and projects cannot be completed until this study is complete. As such, an estimated construction cost range is all that is presented at this time.	This project will gather data from existing documents and physical inspection of equipment to form the basis for a computerized short circuit, coordination and arc-flash study. In addition, the study model will provide the basis for designing and simulating distribution alternatives and modifications to the system. Upgrades of individual process areas will be done within the area projects, guided by the results of this study. System level upgrades will be completed based on the results of this study. The system level upgrades will address issues at assets under both Energy Automation Features and General Equipment classifications.	Study	$40,000		
				Design	$150,000		
				Construction		$190,000	$2,500,000
5.2	Electrical Distribution System Improvements Critical Power System Alternatives	Reliability of power to key facilities has been an ongoing problem. Outages last unacceptably long times and have resulted in violations. Power to facilities identified as "vital" by EPA or critical based on plant needs is required.	This project will study alternatives to relying on cogen for critical power requirements. Three major alternatives will be evaluated with consideration of reliability, maintainability, and overall cost. The selected alternative will then be designed and constructed. In addition, the old Feeder Isolation Switch will be replaced.	Study	$20,000		
				Design	$80,000		
				Construction		$90,000	$2,250,000
Plant Wide - Miscellaneous							
31	Lightning Protection System Upgrade	The SWRP does not have a functioning lightning protection system. This leaves the plant vulnerable to lightning strikes. Lightening strikes have knocked out electrical systems and caused injury to staff.	This project will initially evaluate lightning protection systems and make a recommendation during the basis of design phase. Following this, the selected lightning protection system will be designed and constructed.	Basis of Design Report	$3,000		
				Design	$10,000		
				Construction		$10,000	$180,000
32	Cogen Heat Recovery Utilization Improvements	To fully utilize the digester gas and Cogen hot water, the SWRP would like to consider an expanded hot water service to facilities near the Cogen facilities.	This project will initially evaluate Cogen hot water systems and HVAC systems near the (2) Cogen facilities. Following this, the project will design and construct the recommended improvements. Conceptual plan will include heat exchangers, hot water loop pumps, distribution pumps, a glycol system, hot water and glycol piping, and work to retrofit existing HVAC equipment.	Basis of Design Report	$4,000		
				Design	$20,000		
				Construction		$20,000	$320,000
33	Site Security	The SWRP has experienced thefts on site and undocumented septage	The addition of video cameras, and man door card readers to select areas	Other	$40,000	$40,000	$530,000

Table 13-2. SWRP Summary of Recommended Projects								
Project Number	Project Name	Project Justification		Project Description	Project Type	Engineering Costs	Construction Management Costs	Class V Construction Cost Estimate
		from dischargers. The SWRP staff would like to keep the facility secure throughout the site.		will be evaluated with the site-wide installation of fiber optic cable. Additionally the east and south fence removal and replacement with a more secure type of fence will be evaluated.				
34	Storm water	Currently, the storm water drainage goes to the nearby ditch. The SWRP would like to improve storm water runoff during peak rain water events to prevent building flooding. Additionally the 10 year of improvements upcoming at the SWRP will have significant impacts to the storm water drainage.		An evaluation of site-wide storm water will be required either in phases or "globally" site-wide. Following this the project will design and construct improvements. The conceptual estimate is based on a "global" site-wide storm water improvement project.	Other	$20,000	$20,000	$220,000
35	New Facilities	The SWRP needs new facilities for O&M, offices, training, warehouse/storage, and maintenance/safety equipment. Presently these departments and building uses are cohabitating and/or in congested spaces. The existing facilities are old and have either roof leaking issues and/or HVAC issues.		This project will initially evaluate the existing buildings for potential rehabilitation. In addition, the soon to be abandoned facilities like the PTF and Sludge Dewatering Building will be evaluated for reuse. Recommended alternatives for building rehab or construction of new facilities will be determined. Following this, the project will design and construct selected improvements. The conceptual estimate is broken into (3) projects: NTF-1 Modify existing abandoned PTF for use as warehouse. NTF-2 Modify existing abandoned SDB for use as maintenance facility. NTF-3 Demolish and replace the existing Operations and Maintenance facility.	Other	$920,000	$920,000	$12,320,000
36	Landscaping	The existing site landscaping is minimal and consists primarily of dirt and rocks. The staff would like to have more grass and trees to improve the appearance of the facility and help in reducing sand/grit from blowing into open process areas.		This project could be incorporated in phases with specific process area projects or comprehensively late in the 10-year rehabilitation plan. The conceptual plan provides a berm at the SWRP's East and South property limits, landscaping adjacent the entrance road from the entrance to the existing O&M buildings, and removal of the old "filter rock" areas throughout the plant and replacement with irrigated/landscape ground cover.	Other	$130,000	$130,000	$1,740,000
37	Drying Bed Demolition and Rehabilitation	The old drying beds are unusable. Only a few are lined, and they are unsightly. The plant would like to have a majority of these demolished and a small amount rehabilitated for temporary materials storage.		A majority of the existing beds will conceptually be demolished and a small amount of them will be improved to be used as an on-site temporary storage area with waterproof lining and a sump for run-off and process material drainage pumping.	Other	$80,000	$80,000	$1,080,000
				Totals		$13,948,000	$13,970,000	$187,020,000
				Grand Total			$214,938,000	

14. PRIORITIZATION PLAN

This chapter identifies and prioritizes the recommended projects developed from the asset assessment results discussed in previous chapters. Priority of these projects was determined with the SWRP staff and is based on the asset risk scores, cost estimates, and criticality. The project descriptions, including the basis of the costs estimates, are presented in Chapter 13. The prioritized list of projects and preliminary project costs are presented in Table 14-1. The risk score is an average of the asset risk scores related to the specific project. Projects were prioritized based on these scores and discussions during Workshop 2.

For projects that involved an entire process area or facility (i.e. PTF) the top 5 risk score assets were averaged - not the entire asset list since most projects only involve 1 to 5 assets at the most. Assets were selected, to the best extent possible, to fit with the project description and workplan. For example, capacity improvements projects may only average the process tank structure asset risk scores. Some projects were related to similar assets like the new PTF and PTF interim improvements. In those cases, the projects assumed the same assets in calculating the risk score. The risk scores of the project assets were averaged and classified in a similar manner as the individual process area assets: a score greater than 12 is considered a high priority, a score between 8 and 12 is considered moderate priority, and a score less than 8 is considered a low priority and miscellaneous projects were not scored and given the lowest priority. Some low or moderate projects for the anaerobic digesters and primary clarifiers were incorporated with higher priority projects since they will be included during the overall process area projects. There were a few miscellaneous projects included in this prioritization list but since no assets were assessed, a risk score was not calculated for these projects and they all assume the lowest priority.

Table 14-1. Prioritized List of Recommended Projects

Priority	Project Number	Project Name	Risk Score	Total Project Cost
High	1.2	New PTF	17	$ 23,050,000
High	21	Final Clarifier Algae Removal System Improvements	18	$ 2,460,000
High	6.2	New SDB	12	$ 12,660,000
High	17	Aeration Basin Foam Removal System Improvements	14	$ 890,000
High	2A	Aeration Blower Improvements Phase 1- North Blower and HVAC Improvements	12	$ 5,220,000
High	3.2	Digester Capacity Improvements	16	$ 26,800,000
High	3.3	Primary Digester Mixing Improvements	16	$ 5,650,000
High	3.4	Primary Digester Covers and Rehabilitation	17	$ 14,680,000
Moderate	3.5	Secondary Digester Covers and Rehabilitation	11	$ 5,150,000
Moderate	3.6	Sludge Withdrawal Pump Improvements	11	$ 360,000

Table 14-1. Prioritized List of Recommended Projects				
Priority	Project Number	Project Name	Risk Score	Total Project Cost
High	3.7	Digester Low Pressure Gas System Improvements	16	$ 1,200,000
High	3.8	Digester EI&C Improvements	15	$ 6,270,000
High	5.1	Plant Wide Power System Study and Upgrades	12	$ 2,880,000
High	5.2	Critical Power System Alternatives	18	$ 2,590,000
High	4.1	Digester Building Hot Water Loop Improvements	16	$ 400,000
High	4.4	Digester Piping and Valving Improvements (moved up in priority w/rehab)	10	$ 180,000
High	4.5	Digester HVAC Improvements	16	$ 1,180,000
High	4.6	Digester Feed Improvements	9	$ 330,000
High	2B	Aeration Blower Improvements Phase 2 - South Blowers and Building	15	$ 10,080,000
High	31	Lightning Protection System Upgrade	12	$ 200,000
High	7	Plant-Wide Non Potable Water System Improvements - all process areas	8	$ 1,580,000
Low	12.1	Primary Clarifier Capacity Improvements – New Clarifiers and Gravity Thickeners	7	$ 18,460,000
Moderate	12.2	Primary Clarifier Tank and Mechanism Improvements	8	$ 2,040,000
Low	12.3	Primary Clarifier Spray Water and Wash Water Improvements	6	$ 190,000
Moderate	12.4	Primary Clarifier EI&C Improvements	10	$ 4,410,000
Low	19.1	Primary Clarifier Draining Improvements	7	$ 180,000
Low	19.2	Primary Clarifier Sludge Pumping, Process Piping, and Valving Improvements	7	$ 890,000
Low	19.3	Pump House #1, #2 & #3 Improvements	3	$ 280,000
Low	19.4	Primary Clarifier Odor Control Rehabilitation	7	$ 3,160,000
Low	19.5	Primary Clarifier Pump House #1, #2, #3 EI&C Improvements	7	$ 3,390,000
Low	9	Final Clarifier Improvements	6	$ 9,210,000
Low	26	DAF Tank and Mechanism Rehabilitation	3	$ 1,050,000
Low	16	DAF Comprehensive Valve/Piping Improvements	7	$ 900,000
Low	15	DAF HVAC and Foul Air Improvements	6	$ 470,000
Low	25	DAF Saturation System Improvements	6	$ 240,000
Low	24B	DAF TWAS, UWAS and Scum Pumping Improvements	3	$ 970,000
Low	13	DAF EI&C Improvements	7	$ 4,730,000
Low	28.1	Gas Sphere Improvements	6	$ 360,000
Low	28.2	South Cogen Power Improvements	5	$ 130,000
Low	28.3	North Cogen Power Improvements	4	$ 130,000

Table 14-1. Prioritized List of Recommended Projects				
Priority	Project Number	Project Name	Risk Score	Total Project Cost
Low	28.4	Gas Holder Improvements	4	$ 870,000
Low	28.5	Digester Gas Quality Improvements	1	$ 11,190,000
Low	28.6	Fuel Gas Metering	2	$ 100,000
Low	28.7	N & S Cogen Sound Attenuation Improvements	2	$ 170,000
Low	28.8	Remove and Replace South Cogen Generators	3	$ 1,330,000
Low	29.1	Aeration Basin Miscellaneous Improvements	6	$ 570,000
Low	29.2	Spray and Wash Water System Improvements	7	$ 460,000
Low	29.3	Aeration Basin and ASPS EI&C Improvements	3	$ 830,000
Low	29.4	Diffuser Improvements	5	$ 2,420,000
Low	29.5	RAS Pump Improvements	2	$ 2,110,000
Low	27	DAF Polymer Batch and Feed System Improvements	3	$ 1,430,000
Lowest	32	Cogen Heat Recovery Utilization Improvements	-	$ 360,000
Lowest	33	Site Security	-	$ 610,000
Lowest	34	Stormwater	-	$ 260,000
Lowest	35.1	NF -1 Modify Abandoned PTF to be Warehouse Facility	-	$ 940,000
Lowest	35.2	NF -2 Modify Abandoned SDB to be Maintenance Facility	-	$ 1,250,000
Lowest	35.3	NF -3 Demo Old O&M Office Bldg and Provide New O&M Office Bldg.	-	$ 11,970,000
Lowest	36	Landscaping	-	$ 2,000,000
Lowest	37	Drying Bed Demolition and Rehabilitation	-	$ 1,240,000
			Total	$ 215,110,000

15. RRAMP

The RRAMP is a ten to twelve year plan that identifies renewal and replacement improvements projects at the SWRP. These projects were developed using asset management principles and criteria established by the WUA. The WUA is utilizing a modified WERF SIMPLE approach to asset management based on the 'triple bottom line criteria' for municipal services as applied to the SWRP. Assets within each process area at the SWRP, with exception to the disinfection process, were assessed in terms of consequence of failure, probability of failure, and redundancy. A risk score was calculated for each asset based on these parameters with a high score indicating a critical need for replacement or other action. Projects were then developed from the asset assessment results and prioritization was determined based on criticality and total project costs.

15.1 Budget Schedule

The duration of this program is dependant on the project costs and available funding. A cost schedule has been prepared through year 2027. Total costs include construction costs (AACE Class 5) along with engineering and construction management costs which were assumed to be 7.5 percent and 7.5 percent respectively of the construction costs. The basis of the construction costs are provided in Appendix E. An annual cash flow schedule for these recommended projects was determined from the total project costs and preliminary schedule. The projects costs were equally distributed over the duration of the project's time frame for design and construction. The projects costs are provided in the WUA Cash Flow bar graph shown on Figure 15-1.

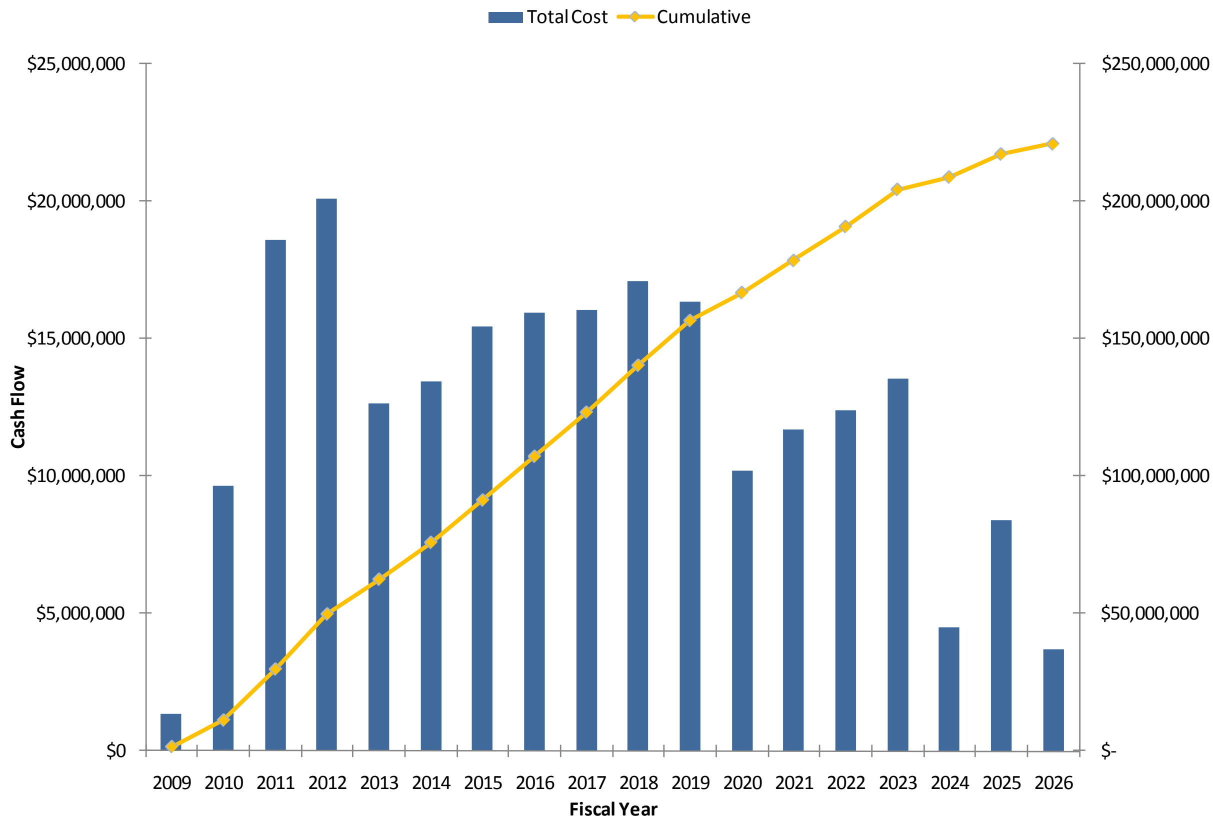

Figure 15-1. Annual and Cumulative Cash Flow

15.2 Project Schedule

The project schedule shows the projects for the 2010 to 2027 timeline based on an annual scale. The design phase, including all design and study tasks, was assumed to take place during the first 25 percent of the overall project duration. Bidding was assumed to be three months in duration for each project. Construction was assumed to be the remainder or about 75 percent of the project duration. The improvements project schedule and annual costs are presented in Table 15.1.

Table 15-1. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1.2	New PTF	$23,050,000	7/1/2010	5/1/2011	7/1/2011	9/1/2013	$1,020,000	$4,680,000	$9,600,000	$7,200,000														
21	Final Clarifier Algae Removal System Improvements	$ 2,460,000	1/1/2010	5/1/2010	7/1/2010	3/1/2011	$1,500,000	$780,000																
6.2	New SDB	$12,660,000	1/1/2010	11/1/2010	1/1/2011	3/1/2013	$900,000	$4,840,000	$5,280,000	$1,320,000														
17	Aeration Basin Foam Removal System Improvements	$ 890,000	1/1/2010	8/1/2010	10/1/2010	3/1/2012	$170,000	$600,000	$150,000															
2A	Aeration Blower Improvements Phase 1- North Blower/HVAC Improvements	$ 5,220,000	1/1/2011	8/1/2011	10/1/2011	3/1/2013		$960,000	$3,240,000	$810,000														
3.2	Digester Capacity Improvements	$26,800,000	7/1/2013	8/1/2014	10/1/2014	9/1/2017				$900,000	$2,450,000	$8,400,000	$8,400,000	$6,300,000										
3.3	Primary Digester Mixing Improvements	$ 5,650,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$154,167	$30,833		$540,000	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000	$180,000							
3.4	Primary Digester Covers and Rehabilitation	$14,680,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$400,000	$80,000		$1,440,000	$1,920,000	$1,920,000	$1,920,000	$1,920,000	$1,920,000	$1,920,000	$480,000							
3.5	Secondary Digester Covers and Rehabilitation	$ 5,150,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$141,667	$28,333		$540,000	$720,000	$720,000	$720,000	$720,000	$720,000	$720,000	$180,000							
3.6	Sludge Withdrawal Pump Improvements	$ 360,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$8,333	$1,667		$36,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$12,000							
3.7	Digester Low Pressure Gas System Improvements	$ 1,200,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$33,333	$6,667		$90,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$30,000							

Table 15-1. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
3.8	Digester EI&C Improvements	$ 6,270,000	8/1/2010	1/1/2013	3/1/2013	3/11/2020	$170,833	$34,167		$630,000	$840,000	$840,000	$840,000	$840,000	$840,000	$840,000	$210,000							
4.1	Digester Building Hot Water Loop Improvements	$ 400,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$25,000	$5,000		$180,000	$180,000													
4.4	Digester Piping and Valving Improvements	$ 180,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$8,333	$1,667		$90,000	$90,000													
4.5	Digester HVAC Improvements	$ 1,180,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$66,667	$13,333		$540,000	$540,000													
4.6	Digester Feed Improvements	$ 330,000	8/1/2010	1/1/2013	3/1/2013	9/11/2014	$16,667	$3,333		$180,000	$180,000													
5.1	Plant Wide Power System Study and Upgrades	$ 2,880,000	1/1/2011	2/1/2012	4/1/2012	3/1/2016		$240,000	$500,000	$720,000	$720,000	$720,000	$180,000											
5.2	Critical Power System Alternatives	$ 2,590,000	1/1/2011	2/1/2012	4/1/2012	3/1/2016		$120,000	$410,000	$600,000	$600,000	$600,000	$150,000											
2B	Aeration Blower Improvements Phase 2 - South Blowers and Building	$10,080,000	1/1/2020	11/1/2020	1/1/2021	3/1/2023											$700,000	$3,850,000	$4,200,000	$1,050,000				
31	Lightning Protection System Upgrade	$ 200,000	1/1/2010	8/1/2010	10/1/2010	3/1/2012	$20,000	$120,000	$30,000															
7	Plant-Wide Non Potable Water System Improvements - all process areas	$ 1,580,000	7/1/2011	8/1/2012	10/1/2012	9/1/2021		$60,000	$90,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$90,000						
12.1	Primary Clarifier Capacity Improvements (New PCs)	$18,460,000	9/1/2016	10/1/2017	12/1/2017	11/1/2020							$400,000	$900,000	$5,760,000	$5,760,000	$5,280,000							

Table 15-1. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
12.2	Primary Clarifier Tank and Mechanism Improvements	$ 2,040,000	9/1/2016	4/1/2017	6/1/2017	11/1/2018							$80,000	$720,000	$1,210,000									
12.3	Primary Clarifier Spray Water and Wash Water Improvements	$ 190,000	9/1/2016	4/1/2017	6/1/2017	11/1/2018								$60,000	$110,000									
12.4	Primary Clarifier EI&C Improvements	$ 4,410,000	9/1/2016	4/1/2017	6/1/2017	11/1/2018							$200,000	$1,530,000	$2,530,000									
19.1	Primary Clarifier Draining Improvements	$ 180,000	1/1/2018	11/1/2018	1/1/2019	3/1/2021										$110,000	$120,000	$30,000						
19.2	Primary Clarifier Sludge Pumping, Process Piping, and Valving Improvements	$ 890,000	1/1/2018	8/1/2018	10/1/2018	3/1/2020									$170,000	$600,000	$150,000							
19.3	Pump House #1, #2 & #3 Improvements	$ 280,000	1/1/2018	11/1/2018	1/1/2019	3/1/2021										$110,000	$120,000	$30,000						
19.4	Primary Clarifier Odor Control Rehabilitation	$ 3,160,000	1/1/2018	8/1/2018	10/1/2018	3/1/2020									$600,000	$1,920,000	$480,000							
19.5	Primary Clarifier Pump House #1, #2, #3 EI&C Improvements	$ 3,390,000	1/1/2018	8/1/2018	10/1/2018	3/1/2020									$640,000	$2,160,000	$540,000							
9	Final Clarifier Improvements	$ 9,210,000	10/1/2019	11/1/2020	1/1/2021	12/1/2023										$150,000	$500,000	$2,640,000	$2,880,000	$2,880,000				
26	DAF Tank and Mechanism Rehabilitation	$ 1,050,000	1/1/2020	8/1/2020	10/1/2020	3/1/2022											$170,000	$600,000	$150,000					

Table 15-1. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
16	DAF Comprehensive Valve/Piping Improvements	$ 900,000	1/1/2019	2/1/2020	4/1/2020	3/1/2023										$120,000	$170,000	$240,000	$240,000	$60,000				
15	DAF HVAC and Foul Air Improvements	$ 470,000	10/1/2020	11/1/2021	1/1/2022	12/1/2024													$110,000	$120,000	$120,000			
25	DAF Saturation System Improvements	$ 240,000	10/1/2020	11/1/2021	1/1/2022	12/1/2024													$110,000	$120,000	$120,000			
24B	DAF TWAS, UWAS and Scum Pumping Improvements	$ 970,000	10/1/2020	8/1/2021	10/1/2021	12/1/2023											$30,000	$130,000	$360,000	$360,000				
13	DAF EI&C Improvements	$ 4,730,000	1/1/2019	11/1/2019	1/1/2020	3/1/2022										$300,000	$1,760,000	$1,920,000	$480,000					
28.1	Gas Sphere Improvements	$ 360,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024														$100,000	$240,000			
28.2	South Cogen Power Improvements	$ 130,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024														$50,000	$120,000			
28.3	North Cogen Power Improvements	$ 130,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024														$50,000	$120,000			
28.4	Gas Holder Improvements	$ 870,000	10/1/2021	8/1/2022	10/1/2022	12/1/2024												$30,000	$130,000	$360,000	$360,000			
28.5	Digester Gas Quality Improvements	$11,190,000	4/1/2022	11/1/2022	1/1/2023	6/1/2024													$840,000	$6,380,000	$3,480,000			
28.6	Fuel Gas Metering	$ 100,000	10/1/2022	2/1/2023	4/1/2023	12/1/2023														$80,000				
28.7	N & S Cogen Sound Attenuation Improvements	$ 170,000	10/1/2022	2/1/2023	4/1/2023	12/1/2023														$160,000				

Table 15-1. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
28.8	Remove and Replace South Cogen Generators	$ 1,330,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024													$60,000	$430,000	$840,000			
29.1	Aeration Basin Miscellaneous Improvements	$ 570,000	10/1/2023	2/1/2024	4/1/2024	12/1/2024														$30,000	$490,000			
29.2	Spray and Wash Water System Improvements	$ 460,000	10/1/2023	2/1/2024	4/1/2024	12/1/2024														$30,000	$410,000			
29.3	Aeration Basin and ASPS EI&C Improvements	$ 830,000	10/1/2023	2/1/2024	4/1/2024	12/1/2024														$60,000	$740,000			
29.4	Diffuser Improvements	$ 2,420,000	1/1/2013	2/1/2014	4/1/2014	3/1/2020				$120,000	$250,000	$360,000	$360,000	$360,000	$360,000	$360,000	$90,000							
29.5.1	Remove and Replace Existing RAS Pump	$ 750,000	10/1/2021	2/1/2022	4/1/2022	12/1/2022												$60,000	$660,000					
29.5.2	Expand RAS Pump Station	$ 1,360,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024													$60,000	$430,000	$840,000			
27	DAF Polymer Batch and Feed System Improvements	$ 1,430,000	10/1/2022	5/1/2023	7/1/2023	12/1/2024													$60,000	$430,000	$840,000			
32	Cogen Heat Recovery Utilization Improvements	$ 360,000	10/1/2021	5/1/2022	7/1/2022	12/1/2023													$100,000	$240,000				
33	Site Security	$ 610,000	10/1/2020	2/1/2021	4/1/2021	12/1/2021											$30,000	$490,000						
34	Stormwater	$ 260,000	10/1/2020	2/1/2021	4/1/2021	12/1/2021											$30,000	$250,000						
35.1	NF -1 Modify Abandoned PTF to be Warehouse Facility	$ 940,000	1/1/2024	5/1/2024	7/1/2024	3/1/2025															$580,000	$300,000		

Table 15-1. Annual Project Cost Schedule

Project #	Project Name	Total Costs	Start Design	End Design /Start Bid	End Bid/ Start Construct	End Construct	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
35.2	NF -2 Modify Abandoned SDB to be Maintenance Facility	$ 1,250,000	1/1/2024	5/1/2024	7/1/2024	3/1/2025															$770,000	$390,000		
35.3	NF -3 Demo Old O&M Office Bldg and Provide New O&M Office Bldg.	$11,970,000	1/1/2024	11/1/2024	1/1/2025	3/1/2027															$900,000	$4,510,000	$4,920,000	$1,230,000
36	Landscaping	$ 2,000,000	1/1/2010	2/1/2011	4/1/2011	3/1/2021	$120,000	$170,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$240,000	$60,000						
37	Drying Bed Demolition and Rehabilitation	$ 1,240,000	10/1/2021	2/1/2022	4/1/2022	12/1/2022												$90,000	$1,070,000					
	General Miscellaneous Tasks	$12,000,000	1/1/2010			12/1/2021	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000	$960,000						
Total Cost							$5,715,000	$13,735,000	$20,500,000	$17,256,000	$10,698,000	$15,768,000	$15,458,000	$15,558,000	$17,068,000	$17,278,000	$12,582,000	$11,470,000	$11,510,000	$13,420,000	$10,970,000	$5,200,000	$4,920,000	$1,230,000

15.3 Business Case Evaluations

The objective of the business case evaluation is to provide documentation and justification of proposed capital projects, primarily for decision makers who may not know or understand the technical requirements of the facility. The basic business case process includes identification of the need or 'drivers' for the project, the problem statement, the evaluation of alternatives, and description of the recommended project. A business case evaluation (BCE) template was developed in conjunction with WUA to set a standard procedure by which the WUA will evaluate and justify the SWRP's capital improvements projects. The BCE evaluates failure modes, risk, and alternative costs.

Two critical projects from the prioritization list were chosen as examples for defining this approach: Preliminary Treatment Facility and Sludge Dewatering Building. The WUA will continue the development of the BCE process for the other capital improvement projects in the SWRP and other WUA facilities. The executive summaries from Preliminary Treatment Facility and Sludge Dewatering Building BCEs are provided in the following sections. The full evaluations of the PTF and SDB are provided in Appendix F.

15.3.1 Preliminary Treatment Facility

The Southside Water Reclamation Plant Preliminary Treatment Facility (PTF) Project consists of designing and constructing a new PTF on the plant site and abandoning the existing PTF. The estimated project costs total approximately $20 million and will take 3 years to complete. The new facility will be designed for future plant flows of 151 mgd peak capacity and for effective, reliable and sustainable removal and handling of influent grit and screenings. The project will correct existing problems and failures of the PTF and provide protection of the treatment plant assets and continued performance of the treatment plant as required and for the benefit of the community.

Current Issues and Needs

The existing PTF has experienced a high number of failures and has a high probability of continued failures and consequences to the Water Utility Authority (WUA) triple bottom line. These include:

- Lack of adequate capacity and service disruption (Social Impacts)
- Inadequate performance and treatment plant disruption (Environmental Impacts)
- Limited remaining life and poor condition (Economic Impacts)
- Inefficient operation and high cost (Economic Impacts)
- Safety hazards (Social Impacts)
- Increasing risk of treatment plant failures and impacts on the community (Environmental and Social Impacts)

Due to the age and condition of the existing facility and processes, failure to address these issues and risks now will result in continued failures, higher costs, and ultimately the inability for the treatment plant to meet the community's social, environmental, and economic expectations for wastewater services.

Project Benefits

This project is expected to address and resolve the current failure issues and provide future capacity along with enhanced performance, up-to-date equipment and control systems for efficient and safe operation, and environmental systems to sustain the equipment, provide a safe working environment, and protect the community from adverse impacts.

The results of improved performance and reliability of the PTF will be protection and cost efficiency of the downstream treatment plant processes and continued reliable treatment plant performance.

Appropriate Project Costs

A range of project alternatives were considered to address the PTF issues and needs. Two alternatives were considered feasible. In addition, a Do Nothing alternative was evaluated for comparison and to indicate the continuing costs of the current and potential PTF failures.

Figure1 shows the relative costs of the three alternatives. It should be noted that the Do Nothing costs are for a 10 year life cycle, at which time the life cycle costs will continue or a new capital project must be undertaken. Alternative 2 will address and resolve all the current PTF risks and failures. Alternative 1 will address some of the risks and failures.

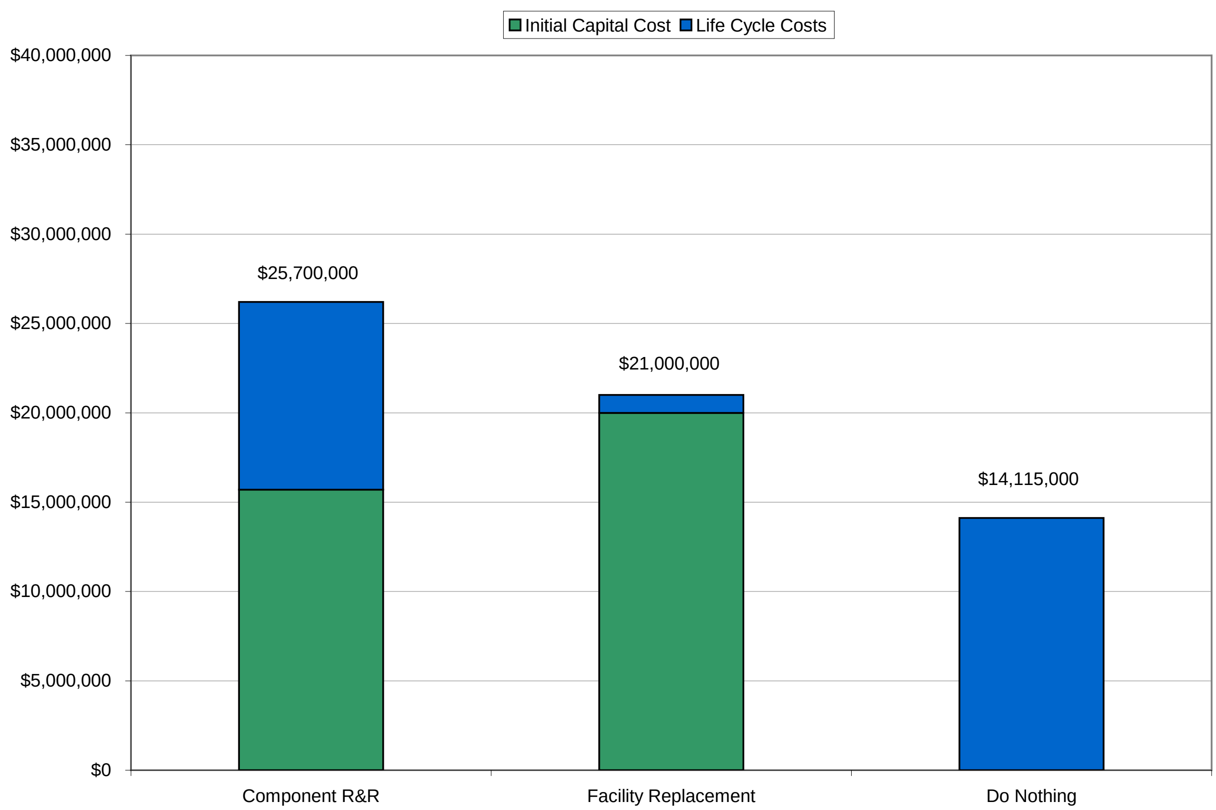

Figure 15-2. PTF Alternative Costs

[1]Costs are for comparison only and should not be considered total for planning or budgeting.
[2]Life cycle costs are present worth for 20 years for Alternatives 1 and 2, 10 years for alternative 3

Based on the evaluation of feasible alternatives, and the need to address current failures issues and risks of the existing PTF, the recommended project to replace the existing PTF is the most appropriate alternative and is recommended to proceed immediately.

15.3.2 Sludge Dewatering Building

The Southside Water Reclamation Plant Sludge Dewatering Building (SDB) Project consists of designing and constructing a new SDB on the plant site and abandoning the existing SDB. The estimated project costs total approximately $12 million and will take 3 years to complete. The new facility will be designed for the future treatment plant solids loading and for effective, reliable and sustainable biosolids dewatering. The project will correct existing problems and risks of the SDB and provide protection of the treatment plant performance as well as the continued operation of the Soil Amendment Facility (SAF) to compost and recycle biosolids for the benefit of the community.

Current Issues and Needs

The existing SDB has experienced some failures and has a high probability of continued failures and consequences to the Water Utility Authority (WUA) triple bottom line. These include:

- Lack of adequate capacity and service disruption (Social Impacts)
- Inadequate dewatering performance and treatment plant upsets (Environmental Impacts)
- Limited remaining life and poor condition of equipment (Economic Impacts)
- Inefficient operation and high costs (Economic Impacts)
- Safety hazards (Social Impacts)
- Increasing risk of treatment plant failures and impacts on the community (Environmental and Social Impacts)

Due to the age and condition of the existing facility and processes, failure to address these issues and risks now will result in continued failures, higher costs, and ultimately the inability of the treatment plant to meet the community's social, environmental, and economic expectations for wastewater services.

Project Benefits

This project is expected to address and resolve the current failure issues and provide reliable capacity along with enhanced performance, up-to-date equipment, and modern control systems for efficient and safe operation, and environmental systems to sustain the equipment, provide a safe working environment, and protect the community from adverse impacts.

The results of improved performance and reliability of the SDB will be protection and cost efficiency of the treatment plant and continued ability to safely and economically recycle treatment plant biosolids.

Appropriate Project Costs

A range of project alternatives were considered to address the SDB issues and needs. Two alternatives were considered feasible. In addition, a Do Nothing alternative was evaluated for comparison and to indicate the continuing costs of the current and potential SDB failures and risks.

Figure 1 shows the relative costs of the three alternatives based on a 10 year life analysis for comparison. Alternative 2 will address and resolve all the current SDB risks and failures. Alternative 1 will address some of the risks and failures. There is a tradeoff between the higher costs of Alternative 2 and increased benefits. It may be worthwhile to consider another alternative that makes use of the existing facility along with new facilities to provide the majority of benefits at a lower cost.

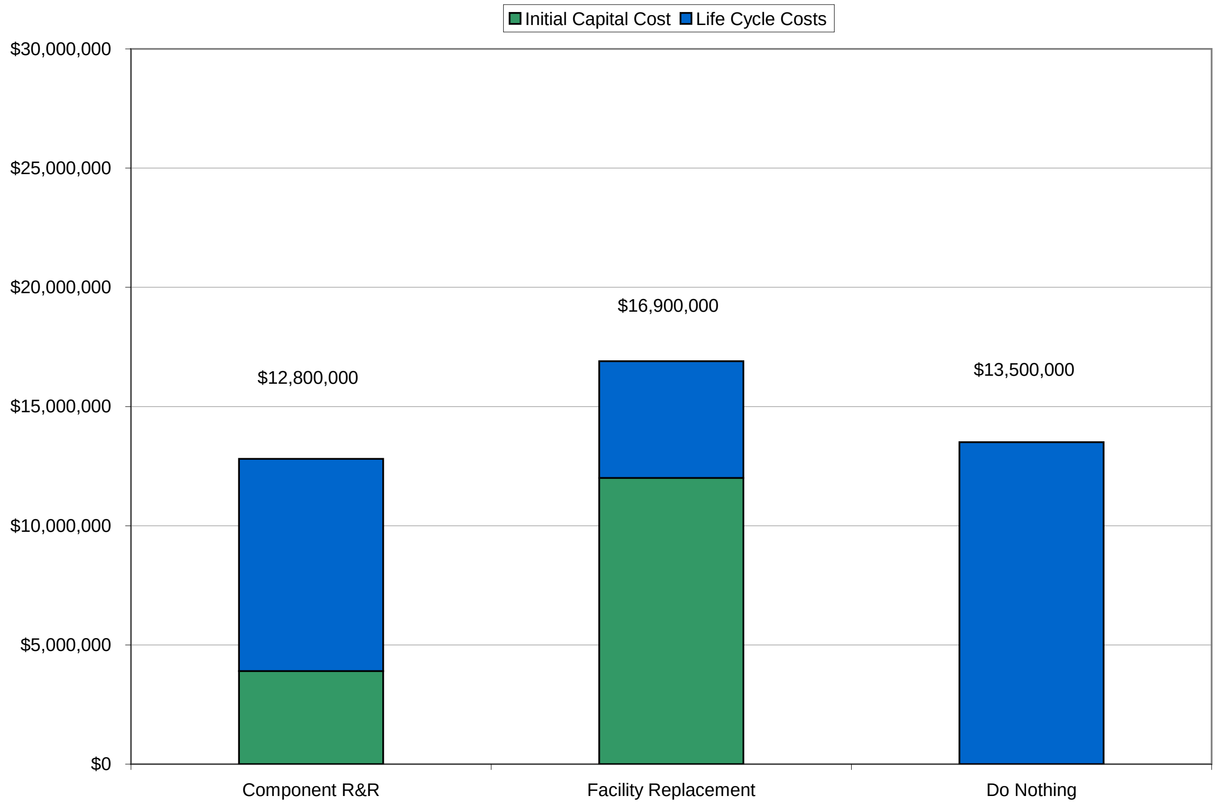

Figure 15-3. SDB Alternative Costs

[1]Costs are for comparison only and should not be considered total for planning or budgeting.
[2]Life cycle costs are present worth for 10 years

Based on the evaluation of feasible alternatives, and the need to address current issues and risks of the existing SDB, the recommended project to replace the existing SDB (Facility Replacement) is the most appropriate alternative. Further evaluation and development of the optimum project is recommended.

16. LIMITATIONS

Report Limitations

This document was prepared solely for ABCWUA in accordance with professional standards at the time the services were performed and in accordance with the contract between ABCWUA and Brown and Caldwell. This document is governed by the specific scope of work authorized by ABCWUA; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by ABCWUA and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

BROWN AND CALDWELL
Denver Office:

1697 Cole Boulevard, Suite 200
Golden, Colorado 80401
P 303.239.5400

BrownandCaldwell.com

Brown AND Caldwell