Executive Summary

Technology Selection

For the

Advanced Wastewater Treatment Plant

"EchoWater Project"

Sacramento Regional County Sanitation District

Version 5.0

April 20, 2013

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Abbreviations

AAS	air activated sludge
AER	aeration
Alk	alkalinity
ATTP	advanced treatment technology pilot
EWP	EchoWater Project
BCE	business case evaluation
BNR	biological nutrient removal
BRF	biosolids recycling facility
DLD	dedicated land disposal
lb/d	pounds per day
LCC	life cycle cost
MG	million gallons
mg/L	milligram per liter
mgd	million gallons per day
mg N/L	milligrams nitrogen per liter
N	nitrogen
NH4	ammonia
NSBR	nitrifying sequencing batch reactor
O&M	operations and maintenance
PST	primary sedimentation tank
RAS	return activated sludge
SBR	sequencing batch reactor
SRCSD	Sacramento Regional County Sanitation District
SRWTP	Sacramento Regional Wastewater Treatment Plant
SSB	solids storage basin
SST	solids sedimentation tank
TKN	total kjeldahl nitrogen
TM	technical memorandum
TSS	total suspended solids
WAS	waste activated sludge
WRF	water recycling facility
WWTP	wastewater treatment plant

1.0 Executive Summary

This memorandum summarizes progress and process selection recommendations for the permit required upgrade of the Sacramento Regional Wastewater Treatment Plant. Process selections were confirmed by pilot test results and Business Case Evaluations. A summary of the findings to date for the preferred processes are as follows:

- Ammonia / nitrate removal will be accomplished with biological nutrient removal (BNR) process that replaces the existing pure oxygen secondary treatment process.
- Filtration will be accomplished with granular media filtration technology
- Disinfection will be accomplished with liquid chlorine, and consideration should be given to early conversion from gas to liquid chlorine
- The treatment facilities layout will allow space for future ozone facilities upstream of the filters. Should UV become a disinfectant of choice at some point in the future, pre-ozonation might also be beneficial.
- Side stream treatment may be implemented and consideration should be given to implementing the process when the conversion from gas to liquid chlorine occurs.

2.0 EchoWater Projects

Based on the results of Advanced Treatment Technology Pilot (ATTP) project, the recommended EchoWater Project process train is comprised of three main processes: Biological Nutrient Removal (BNR), Tertiary Filtration, and Disinfection. All three are required to meet the new NPDES permit limits. A business case evaluation (BCE) has also shown that removal of high ammonia laden flows from solids storage basins (SSBs) and biosolids recycling facility (BRF) will be beneficial. Therefore, sidestream treatment facilities upstream of the main processes are also recommended. Discussion on these processes follows.

A final report from the pilot study recommending technologies and relevant design criteria for full-scale implementation was completed in April 2013. Attachment A provides an executive summary of the ATTP Project Report. A Phase 2 pilot study is also planned to obtain additional data for design of the new treatment processes. This phase will begin in mid-2013.

2.1 Biological Nutrient Removal Project

Compliance with the ammonia nitrogen and nitrate nitrogen limits requires a technology other than the existing high purity oxygen activated sludge process (HPOAS). The HPOAS technology, while efficient at removing BOD_5 and suspended solids, does not provide the required treatment to remove nitrogen to the limits required by the permit. The District conducted a Technology Screening effort with experts in the wastewater field and District staff, shortly after the new permit was issued. The purpose of that work was to select technologies to

be considered for full scale application and would be pilot tested. A result of the screening effort was a key decision to use an air-activated BNR process to meet the new permit requirements for ammonia and nitrate. The BNR process stabilizes the wastewater and also provides the environmental conditions to convert ammonia to nitrate and then to nitrogen gas.

Key process components of the BNR system include aeration blowers and diffusers, mixers, pumps, and necessary instrumentation and controls. The BNR process was tested in Phase 1 of the pilot study and produced effluent ammonia values that were less than the future limitations. Therefore, the BNR process is recommended for full-scale implementation.

The 24 existing secondary sedimentation tanks (SSTs) will continue to be used to settle and remove activated sludge, and recycle this material to the BNR to continue the treatment process. The existing recycle pumps will be replaced with larger units necessary for the increased demands of the new BNR system.

The draft Basis of Design Report (BODR), which provides the project description and key design parameters, has been completed for the BNR project based on preliminary sizing of the BNR basins established in the ATTP Project. The BODR included BCEs of different aeration systems, aeration blowers, mixing systems, internal recycle pump styles and BNR basin configurations.

Black and Veatch was contracted as the consultant for the BNR design in January 2013. They have begun development of the preliminary design report for BNR facilities.

2.2 Filtration System Project

The Technology Screening evaluated multiple filtration technologies and identified granular media filtration (GMF) (with or without pre-ozonation) and membrane filtration (MF), as filtration processes to pilot. The District completed pilot tests of these different filtration technologies in treatment trains to demonstrate their ability to comply with the new NPDES permit requirements. The systems were operated for 10 months from April 2012 to February 2013.

Key findings from the pilot study are as follows:

- The pilot testing of these technologies included operating the treatment trains at different hydraulic loading rates to demonstrate their ability to comply with the new NPDES permit requirements of Title 22 recycled water standards, or equivalent. For GMF the Title 22 standard is a maximum of 5.0 gallons per minute per square foot (gpm/sf). The pilot results indicated that operation of a granular media filter at loadings up to 7.5 gallons per minute per square foot (gpm/sf) met Title 22 requirements for turbidity. This higher loading rate has the potential to significantly reduce the number of filters needed.
- MF performed well in the pilot study tests; however, it is significantly more costly than GMF. It is not necessary to select MF because GMF meets the permit requirements.

Based on pilot test results and a BCE on filtration alternatives (see Attachment B), granular media filters at a maximum 7.5 gpm/sf are recommended for the filtration process.

2.3 Disinfection System Project

The Technology Screening effort identified chlorine, ultraviolet light (UV), and ozone as viable disinfection processes to pilot. The District completed pilot tests of these different technologies in treatment trains to demonstrate their ability to comply with the new NPDES permit requirements. The systems were operated for 10 months from April 2012 to February 2013.

Key findings from the pilot study are as follows:

- Ultraviolet light functions well as a disinfectant following filtration. However, UV systems are significantly more expensive to install and operate than chlorine. UV disinfection has a very large energy requirement and thus has a big greenhouse gas footprint. UV light adds some heat to the water which may be of regulatory concern. In addition the sheer size, and monitoring and control requirements for a UV system at SRWTP presents permit compliance challenges that are difficult to address.
- Chlorine functions well as a disinfectant following filtration. The pilot studies have shown that the combination of chlorine contact time and dose meet the regulatory requirements and are sufficient for coliform inactivation. Additional Phase 2 pilot testing will determine if a lower chlorine contact time/dose is appropriate.
- Chlorine creates certain disinfection by-products that are of regulatory concern. The chlorination disinfection system pilot tested resulted in elevated final effluent disinfection byproduct (DBP) concentrations. There are ongoing regulatory and legal considerations that make it appear that relief from disinfection byproduct permit requirements will be provided. Chlorine adds salt to the water, however in sufficiently low quantities which can be accommodated under the current permit.
- Ozone is not effective as a final disinfectant following filtration. However, ozone has a potential role prior to filtration. Should UV disinfection be required for future permit compliance, ozone prior to disinfection will provide additional virus and coliform inactivation that would enhance this technology. In addition, pre-ozonation broke down certain difficult to degrade organic compounds which were then further reduced as the water passed through filters.

Currently gaseous chlorine is used at the SRWTP for disinfection and gaseous sulfur dioxide is used for dechlorination. Both chemicals have significant safety concerns. Many water and wastewater utilities across the United States have converted from gas to liquid chlorine in the last decade, and there continues to be regulatory pressure at the Federal, State and local level to make this change. On a life cycle basis the liquid forms of the chemicals are slightly more expensive than the gaseous forms.

Based on the pilot test results and BCE (see Attachment C), the recommendation is liquid chlorine for disinfection and liquid bisulfite for dechlorination. When compared to UV disinfection, liquid chlorine is significantly less expensive. While liquid chlorine is slightly more expensive than gaseous chlorine, the liquid form should be pursued to alleviate safety concerns. Consideration will be given to conversion from gas to liquid relatively early in the overall project.

2.4 Side Stream Treatment Project

Analysis is underway for the possibility of separately treating some of the SRWTP recycle side streams that contain elevated ammonia nitrogen concentrations. The most important recycle side streams are return flows from the SSBs and BRF which contain significant amounts of ammonia. This project involves isolating a few high strength process streams and treating them separately before introducing the treated stream into the main flow of the plant. Side stream treatment for ammonia involves construction of a small biological treatment process that would cost effectively convert ammonia to nitrate. Another benefit of this project is that nitrate is the same active ingredient in a chemical purchased for use by SRCSD for odor control in the sewer collection system. Separate side stream treatment also provides additional flexibility for meeting the ammonia effluent permit limit.

In addition, the effluent from the side stream treatment system would be used for control of odors at the influent and primary clarifiers at SRWTP. The District currently uses chlorine gas at SRWTP for partial control of odors but the nitrate produced by the side stream treatment system would likely eliminate these costs and reduce odors in a sustainable manner. Therefore, while side stream facilities would incur capital and operation and maintenance costs such costs would be offset with savings on the main plant. Based on the BCE (see Attachment D), side stream treatment is recommended with project completion to coincide with the change in disinfection chemical from chlorine gas to chlorine liquid.

2.5 Program Process Schematic

Figure 1 is a process schematic that identifies the preferred technologies that will be constructed to meet effluent permit requirements.

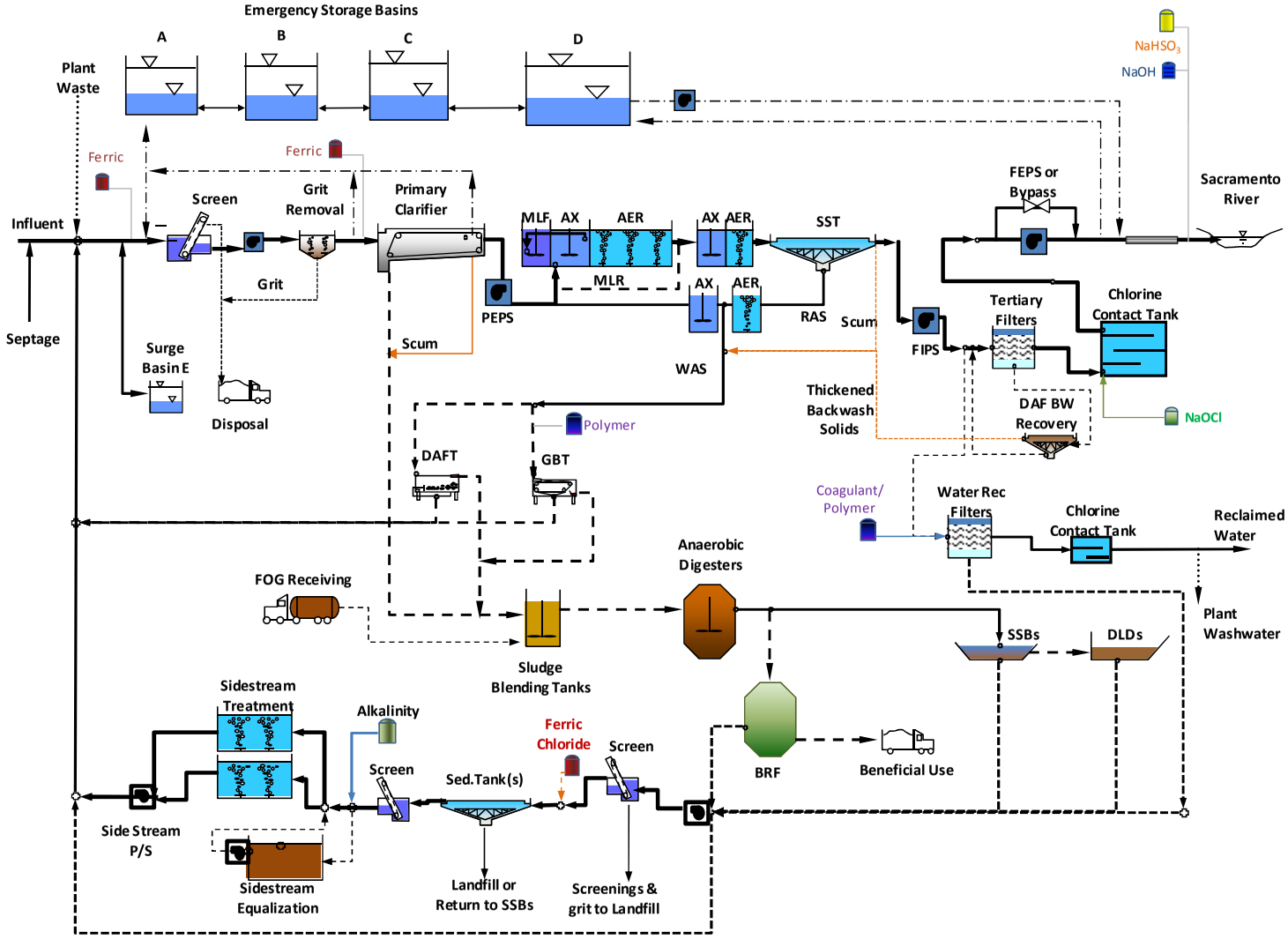

Figure 1 - Process Schematic for Future SRWTP

3.0 Program Cost and Schedule

3.1 Program Costs

The total program capital cost and amortized annual operation and maintenance cost summary for this preferred treatment train is shown below in Table 1. The program capital cost estimates are preliminary and have an accuracy range of -25% to +40%, meaning that the actual capital costs could be anywhere between 25% below to 40% above the best estimate values listed below.

Table 1 –Program Capital, Operating and Life Cycle Costs

Alternative	Program Capital Cost (estimated at the midpoint of construction, approx 2018)	Amortized Annual Operation & Maintenance (estimated in 2020/21 when facilities are expected to come on line)
BNR, Granular Media Filtration and Liquid Chlorine Disinfection	$1,520,000,000	$50,300,000

3.1 Program Schedule

The program schedule is depicted in Figure 2. However, further analysis is needed before the schedule can be updated to reflect the SWRCB Settlement Agreement that provides for a two (2) year extension for filtration and disinfection, through mid-2023.

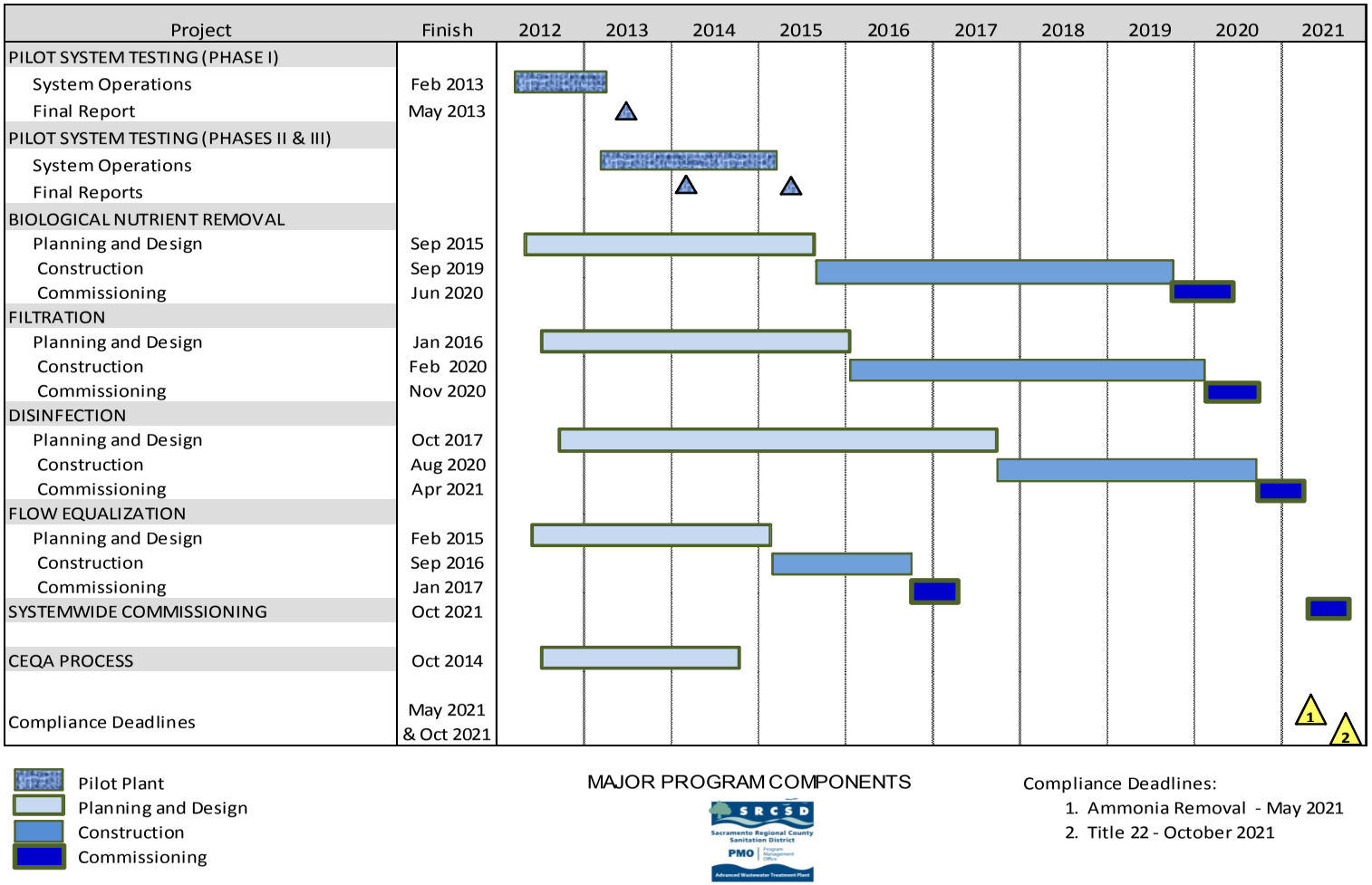

Figure 2 - Program Schedule