MEMORANDUM

Templeton Community Services District
420 Crocker Street, Templeton, CA
Effluent Filtration Alternatives

WG Project No. 0198-0043

Date: July 27, 2021

To: Tina Mayer, P.E., Templeton CSD

From: Rob Miller, P.E., Greg Hulburd, P.E.

Subject: Effluent Filtration Technology Screening

Introduction

Wallace Group (WG) was retained by Templeton CSD to review potential technologies for addressing elevated total suspended solids (TSS) and biological oxygen demand (BOD) from the CSD's lagoon system effluent. This memorandum summarizes available technologies for reducing both parameters and presents planning level capital cost and operating cost estimates for those improvements, as well as a qualitative comparative analysis to differentiate the different options.

Background

Templeton CSD operates an advanced integrated pond system (AIPS) rated for a maximum daily flow of 600,000 gallons per day (gpd). The facility is subject to discharge limitations promulgated in Central Coast Regional Water Quality Control Board (RWQCB) Order No. R3-2007-0029.

Wastewater is treated through a series of ponds and discharged to the Selby Percolation Pond Facility (Selby Ponds), located to the east of the plant and US Highway 101 and adjacent to the Salinas River; alternatively, wastewater effluent is sent to irrigation spray fields next to the treatment plant, but their use is less frequent and generally reserved for times when infiltration through the percolation ponds is inhibited.

Typically, during the late spring and summer months (May through September), the plant experiences higher levels of BOD and TSS which exceed their waste discharge requirement limitations of 50 mg/L average and 100 mg/L maximum for both parameters. The exceedances are believed to be attributable to increased algae growth in the plant's polishing pond from which effluent is discharged.

The selected technology must be capable of reliably treating effluent to meet the BOD and TSS levels and preserve the infiltration capabilities of the Selby Ponds. To that end, the selected technologies should achieve BOD and TSS concentrations in the range of 10 to 15 mg/L.

Objective

This evaluation considers three technologies that may be used to target the algae in the pond effluent and improve water quality sent to discharge at the Selby Ponds:

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1. Suspended Air Flotation (SAF)
2. Continuous Backflow Sand Filter
3. Membrane Filtration

The selected technology must be capable of meeting the following three criteria:

1. Treated water must meet effluent permit limitations for BOD and TSS as well as Selby Pond limits of 10 to 15 mg/L.
2. The technology should rely on a relatively low level of operational complexity.
3. Potential for coagulant/flocculant carry over into treated effluent must be minimized.

Pre-treatment requirements (*e.g.*, screening) for each technology was also considered in comparing the three technologies.

Design Parameters

The following section outlines the design parameters that were discussed with manufacturer's representatives.

1. Influent water quality
   a. Feed to the new filtration system is assumed as follows:

Parameter	**Unit**	**Range**	**Average**
BOD		11-208	63
Alkalinity	ppm ($CaCO_3$)	60-320	
Hardness	ppm ($CaCO_3$)	50-350	
Total Iron	mg/L	< 2	
Manganese	mg/L	<1	
TOC	mg/L	3-20	
pH	-	7	
TSS	mg/L	17-160	73
Turbidity	NTU	10-100	
HPC	CFU/mL	6,150	

   a. BOD and TSS are based on site data from 2019-2020
   b. Other parameters are assumed values which will require further investigation during detailed design.

2. Influent Flow Rate:
    a. Target flow rate of 700,000 GPD (486 GPM).
    b. Feed would come from bottom of polishing pond – gravity or booster pump to be determined.
3. Effluent Discharge
    a. Flow by gravity to existing percolation ponds (from elevation ~794 feet at the proposed treatment location to elevation ~767 feet at Selby Ponds).
    b. Provide connection to existing irrigation spray field booster pump
4. Space Constraints
    a. Space is generally not a constraint, but minimal footprint is desired

Filtration Technology Options

Suspended Air Flotation

A suspended air flotation (SAF) system offered by Heron Industries was considered as an alternative technology to conventional dissolved air flotation (DAF) systems. DAF systems are routinely used at lagoon-based systems for removal of algae. Like DAF system, a SAF system is an air-based clarification system. It relies on a low-pressure, froth generator for production of a micro-bubble emulsion with an air by volume percentage of up to 40 percent.

If Title 22 recycled water becomes needed, a downstream filter would be needed since this technology is a clarification process. However, Templeton does not require Title 22 recycled water at this time.

Advantages

The SAF system reportedly offers the advantages of reduced footprint and lower energy use than traditional DAF systems. No pre-filtration step is required. These systems demonstrates an ability to achieve turbidity levels < 2 NTU without post-filtration. A case study at Graton CSD suggests 92% to 95% removal efficiency for BOD and TSS, respectively. These results were based on feed concentrations consistent with the average values observed at Templeton. However, no data were available to evaluate performance at higher peak concentrations like those observed at Templeton (e.g., 208 mg/L BOD, 160 mg/L TSS). If the removal efficiencies above hold and assuming most of the BOD is attributable to the algae rather than soluble organics, effluent quality would be close to the 10-15 ppm target (17 ppm BOD, and 8 ppm TSS). No post-filtration step is anticipated.

Disadvantages

SAF systems are a relatively new technology compared to the more common DAF systems. They are offered by one manufacturer, but they compete in the DAF market. The technology relies on a proprietary surfactant to help create the bubble froth which is available through Heron. Heron has stated that the surfactant may be available through limited chemical suppliers. Use of coagulant in addition to the surfactant may be required. Float sludge will be generated and must be managed. The float sludge is

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reported to be relatively dry at 6-10 percent solids (compared to 3-5 percent typical for DAF systems) and may be dewatered by gravity. A drying bed of approximately 5,700 square feet is assumed for this alternative for solids management; this area corresponds to a projected 90-days of sludge production.

This alternative is projected to require an additional 1.0 full-time equivalent (FTE) to operate and maintain the process. The additional labor may come from additional staff or through a service contract.

Other Features

Table 1 summarizes some of the other relevant criteria for this technology.

Table 1. SAF System Characteristics

Footprint	Feed Pressure (Min.)	Hydraulic Loading Rate	Sludge/ Reject Production	Estimated Labor Requirement	Other Considerations
12.6' x 8.5' x 9.4' tall	10'	13.9 gpm/sf	Sludge Production = 7,100 lbs/day (or 852 gallons @ 6% solids) Based on: Typical sludge 6-10% solids for this technology. 486 gpm influent with 73 mg/L TSS	Operations would require additional labor from District staff compared to existing system; assume additional staff labor of 1.0 FTE, or the contracted equivalent.	Potable water connection required (6 gpm @ 40 PSI continuous) Sludge collection bins/tank or sludge conveyance and drying facilities. Coagulant storage and metering

Costs

Table 2 summarizes anticipated capital and operational costs for the SAF system.

Table 2. SAF System Costs

Capital Equipment Cost	Estimated Installed Cost	Electrical Costs	Chemical Cost	Total Treatment Cost
$379,000	$950,000	$21/MG	$115/MG	$137/MG
Heron Model F50 (drying bed included)		Based on: 153 kWh/MG	Based on: Coagulant = 380 lb/day Flocculant aid (surfactant) = 1.5 gal/day	Total treatment cost includes electrical and chemical operational costs only.

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Continuous Backwash Sand Filter

Continuous backwash sand filters are commonly employed for filtration of lagoon effluent and are regarded as very simple to operate. These units and consist of deep sand filtration units where influent is fed to the bottom of the unit and is filtered as it rises through the sand media. These filters do not require backwash periods because the units are continuously backwashed through use of an air lift pump which cycles sand media through a washing unit and sends backwash water to a reject outlet. The Parkson DynaSand continuous backwash sand filter was considered for this evaluation.

Advantages

The continuous backwash sand filters primary advantages are their ease of operation with no moving internal parts. They have a compact areal footprint with a deep media bed (80 inches) promoting capture of solids. These filters are a widely used, conventional technology especially at wastewater lagoon sites. This alternative is projected to have the lowest degree of additional labor required to operate compared to the other options. An additional 0.5 full-time equivalents is assumed to be needed for this process. The additional labor may come from additional staff or through a service contract.

Disadvantages

These sand filters may not be capable of consistently delivering as high an effluent quality as the other options considered. Coagulant pretreatment is likely to improve performance, but site-specific piloting would be recommended to demonstrate effectiveness. At most sites, the filters are preceded by an upstream clarification step (e.g., DAF). In addition, the units are tall (approximately 26 feet) requiring additional head to deliver water to the units.

Other Features

Table 3 summarizes some of the other relevant criteria for this technology.

Table 3. Continuous Backwash Sand Filter System Characteristics

Footprint	Feed Pressure (Min.)	Hydraulic Loading Rate	Sludge/ Reject Production	Estimated Labor Requirement	Other Considerations
11.3' diameter x 25.8' high (per unit)	26’	2-3 gpm/sf	Backwash Waste = 24,500 gpd Based on: 3% reject, say about 17 gpm continuous backwash/ reject flow rate	Operations would require additional labor from District staff compared to existing system; assume additional staff labor of 0.5 FTE, or the contracted equivalent.	Requires air compressor for air lift (Parkson proposed duplex rotary screw air compressor, 5 HP, 12 SCFM continuous with dryer) Backwash waste collection and conveyance system required. Coagulant storage and metering

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Costs

Table 4 summarizes anticipated capital and operational costs for the continuous backwash sand filter system.

Table 4. Continuous Backwash Sand Filter System Costs

Capital Equipment Cost	Estimated Installed Cost	Electrical Costs	Chemical Cost	Total Treatment Cost
$484,000	$1,240,000	$15/MG	$89/MG	$104/MG
(2) DynaSand DSF100 DBTF Package Units	Includes $30,000 pilot testing cost.	Based on: 109 kWh/MG	Based on: Coagulant = 380 lb/day Sodium hypochlorite (NaOCl) = 2.8 gpd	Total treatment cost includes electrical and chemical operational costs only.

Membrane Filtration (Microfiltration)

Membrane microfiltration is used commonly in water and tertiary wastewater treatment systems. These membrane systems come as packaged units which include the microfilter vessels, pre-treatment strainer, a clean-in-place (CIP) system, and waste neutralization system. Influent is treated as high pressure forces water through pores in the narrow filaments separating treated effluent from contaminants and suspended solids left in the rejectate. Microfiltration is capable of reliably producing high quality effluent with turbidity less than 0.10 NTU. Process design must ensure that the feed to the membrane system is pre-treated to a level that will prevent blinding of the filters; this evaluation assumes installation of a Hellan strainer installed ahead of the membrane system to provide solids removal. For this evaluation, the Pall Aria FIT AP-6 system was selected.

Advantages

Membrane microfiltration is expected to be the most reliable technology for producing the highest quality effluent facilitating discharge at the current percolation ponds while providing compatibility with potential, future uses. It is a proven technology in the water and wastewater industry.

Disadvantages

The membrane microfiltration system is the most operationally complex among the three options considered. While the skid proposed by Pall is highly automated, there are more mechanical and instrumentation components associated with this system than the other two. The membrane system requires offline backwash and introduces the need for a separate CIP system to ensure optimal efficiency of the system and promote longevity of the membrane fibers. Membranes are susceptible to fouling which requires preventative mechanical (*e.g.*, straining) and chemical pre-treatment. More chemical inputs (sodium hydroxide, sodium hypochlorite, citric acid, sodium bisulfite, and potential coagulant) are anticipated for the membrane system than the other systems considered. This alternative is projected to have the highest degree of additional labor required to operate compared to the other options. An additional 1.5

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full-time equivalents, or the contracted equivalent, is assumed to be needed for this process.

Use of membrane microfiltration of algae-laden lagoon effluent is limited; however, it has been successfully implemented at the Monarch Dunes wastewater treatment plant in Nipomo.

Other Features

Table 5 summarizes some of the other relevant criteria for this technology.

Table 5. Membrane Microfiltration System Characteristics

Footprint	Feed Pressure (Min.)	Hydraulic Loading Rate	Sludge/ Reject Production	Estimated Labor Requirement	Other Considerations
47.5' x 35.5' x 12.75' high	20 PSI	22-25 gal/sf/day flux rate	Backwash Waste = 48,174 gal/day Cleaning/ Rinse Waste = 3,288 gal/day Based on: 1 Backwashes per 12,000 gallons filtrate produced 1 Enhanced backwash/day 1 CIP per 30 days	Operations would require additional labor from District staff compared to existing system; assume additional staff labor of 1.5 FTE, or the contracted equivalent.	Pre-treatment (strainer/filter/ clarification) required Backwash/CIP waste collection and conveyance system required Chemical storage and metering

Costs

Table 6 summarizes anticipated capital and operational costs for the membrane microfiltration system.

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Table 6. Membrane Microfiltration System Costs

Capital Equipment Cost	Estimated Installed Cost	Electrical Costs	Chemical Cost	Total Treatment Cost
$665,000	$1,665,000	$83/MG	$50/MG	$135/MG
Pall Aria FIT AP-6 (Hellan Strainer pre-treatment included)		Based on: 592 kWh/MG	Based on: Coagulant use not assumed. Additional cost required if coagulant required. NaOCl = 3,372 gal/yr NaOH = 406 gal/yr SBS = 174 gal/yr Citric Acid = 423 gal/yr	Total treatment cost includes electrical and chemical operational costs only.

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Comparison Summary

Table 7 presents a comparison of the three treatment options.

Table 7. Technology Summary

Criteria	SAF System	Continuous Backwash Sand Filter	Membrane Microfiltration
Capital Equipment Cost[1]	$379,000	$484,000	$665,000
Estimated Installed Cost	$950,000	$1,240,000*	$1,665,000
Treatment Costs	$137/MG	$104/MG	$135/MG
Footprint	12.6' x 8.5' x 9.4' tall	11.3' diameter x 25.8' high (per unit, 2 units proposed)	47.5' x 35.5' x 12.75' high
Electrical Usage	153 kWh/MG	109 kWh/MG	592 kWh/MG
Relative Chemical Usage	Medium	Low to Medium	High
Labor Requirements	1.0 FTE assumed	0.5 FTE assumed	1.5 FTE assumed
Additional Comments	Effluent quality at average BOD/TSS concentrations expected to consistently meet treatment objectives; no data were available to evaluate performance at higher peak concentrations. Use of coagulants may be required presenting risk of carryover into treated effluent. Polymer test kit recommended for periodic monitoring of effluent. Continuous potable requirement (6 gpm). Float sludge management required; a sludge drying bed is anticipated for sludge management and is included in the capital equipment cost.	May not consistently achieve required effluent limit. Use of coagulant may be required to promote treatment presenting risk of carryover into treated effluent. Would require approximate $30,000 pilot study to confirm treatment objectives can be met. Continuous reject water management required.	Membrane filtration is the least likely to require coagulant pre-treatment. This system is the most operationally complex but produces highest quality effluent. CIP, waste neutralization system, and waste management system required. Pre-treatment screening is required; a Hellan strainer is assumed to be required ahead of the membrane filtration system and is included in the capital equipment cost.

*Continuous backwash sand filter installed cost includes $30,000 for pilot testing.

[1] Note that capital equipment cost proposals were obtained in April through June of 2020 and may not reflect the most current vendor pricing.