CITY OF PORTLAND
ENVIRONMENTAL SERVICES

Columbia Boulevard Wastewater Treatment Plant

5001 N Columbia Boulevard, Portland, Oregon 97203 ▪ Nick Fish, Commissioner ▪ Michael Jordan, Director

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Subject: CBWTP Biosolids Inventory Excess – Preliminary Findings and Recommendations

Date: August 31, 2018

Purpose

In July of this year, plant performance issues were encountered and eventually traced back to an excess of biosolids in the lagoon, which have led to solids returning to the plant's liquid streams, impairing treatment performance and putting effluent permit compliance at risk. TPS engineering staff, as part of a newly formed Biosolids Reduction Plan Charter Team, is supporting the Wastewater Group's investigations of root cause and, most importantly in the short term, development of risk-reduction solutions. This memo summarizes preliminary findings, outlines alternatives evaluated and provides recommendations for action along with order of magnitude costs. Two previous versions of this memorandum were issued; this version intended as a final recommendation to bring clarity towards next steps to reduce operational and potential public health risks related to the biosolids management urgency currently experienced at the CBWTP.

Status

The plant is virtually full of solids. Lagoon cells 3 and 4 have been confirmed to be full of solids beyond design capacity; no continuous water cap is maintained, the freeboard is at minimum level, and solids are visible over large surface areas of each cell. The cells are essentially operating as open-air sludge storage tanks as opposed to facultative treatment lagoon cells. There are no other readily available storage capabilities in the plant, and the lagoon cells have little hydraulic capacity to contain more solids without impairing liquid stream treatment.

Risks

Permit compliance

Introducing more solids to the lagoon cells risks returning digested solids to the treatment plant process, in the primary clarifiers. These solids impair liquid stream process performance and discharge permit compliance due to increased loads and instrumentation malfunctions. The dry weather has helped thus far, but as we enter the wet season with increased loads from miles of CSO tunnels which haven't been flushed with rain in months, Operations staff have very little margin and flexibility to mitigate this risk. Approaching the wet season with no action is considered a high likelihood, high consequence risk.

Spill/Overflow and Public Health

Currently, the plant accepts more solids than it hauls away. The status quo will eventually lead to biosolids overflowing somewhere, posing public health risk, and trigger DEQ notifications and subject the Bureau to fines.

As we enter the wet season with increased loads from the tunnels, Operations staff have little margin and flexibility to mitigate this risk. With no action, this is considered a high likelihood, high consequence risk.

Odors and Public Perception

The lagoon is next to the Heron Lakes Golf Course and a public trail. While no significant odors or complaints have been associated with cells 3 and 4, operating them as open-air storage tanks may eventually develop odor issues which would be difficult to mitigate once they have developed. As we enter the wet season and colder temperatures, the risk of odor generation may be lessened. This risk is considered to present a low likelihood, but moderately high public perception consequences if realized, with no easy and short-term fixes available.

Background and Data Analysis

Overall Mass Balance

Biosolids are generated at CBWTP from settling of primary sludge (PS) in the primary clarifiers and from the biological conversion of wastewater contaminants into waste activated sludge (WAS) in the secondary clarifiers. These two types of sludges are sent to the primary digesters (D5-10) for stabilization and solids reduction. From the primary digesters, solids can then flow either to the secondary digesters (D1-D2 and D4) or to the lagoons. Solids from D4 and any dredged material from the lagoon are combined into D3 and dewatered to be trucked away for land application. The figure below shows the general solids process flow.

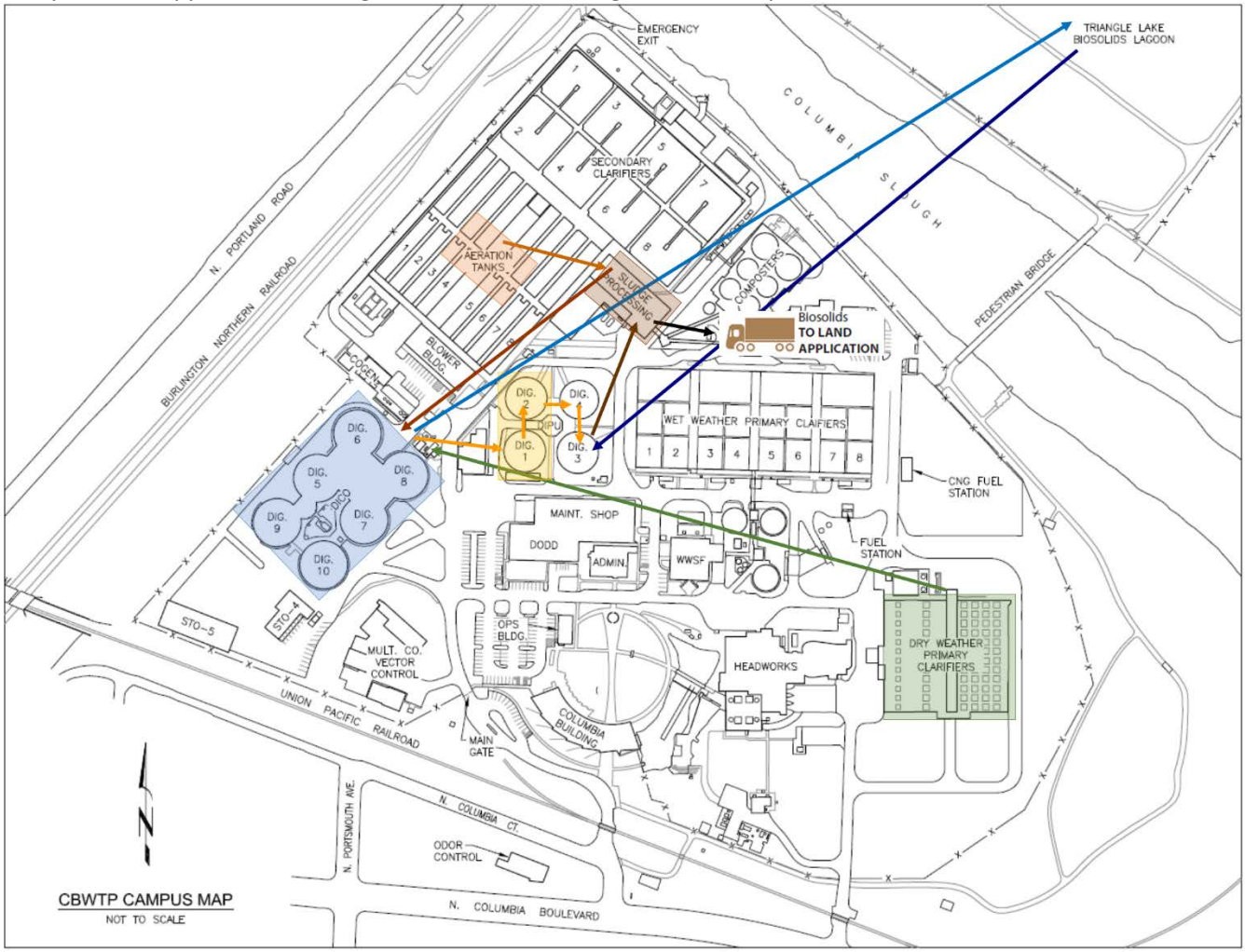

Figure 1– CBWTP solids process flow diagram.

Figure 2 illustrates solids flows into and out of CBWTP and the biosolids hauling trucks over time. On a yearly basis, the CBWTP receives between 32,000 and 33,000 dry tons (dT) of total solids. After treatment and digestion, this load is significantly reduced to between 15,000 and 16,000 dT per year, or about 41 to 44 dry tons per day (Est. Solids Production). The total solids into CBWTP values were calculated using flow into the headworks and total suspended solids data. The estimated solids production values were calculated based on flow leaving the primary digesters and assuming around 18% more reduction of total solids and about 90% capture efficiency of the belt presses. Data was taken out to year 2010 to represent a time before the Eastside CSO system was online. 2018 is a projected number for the entire year based from data from January through June.

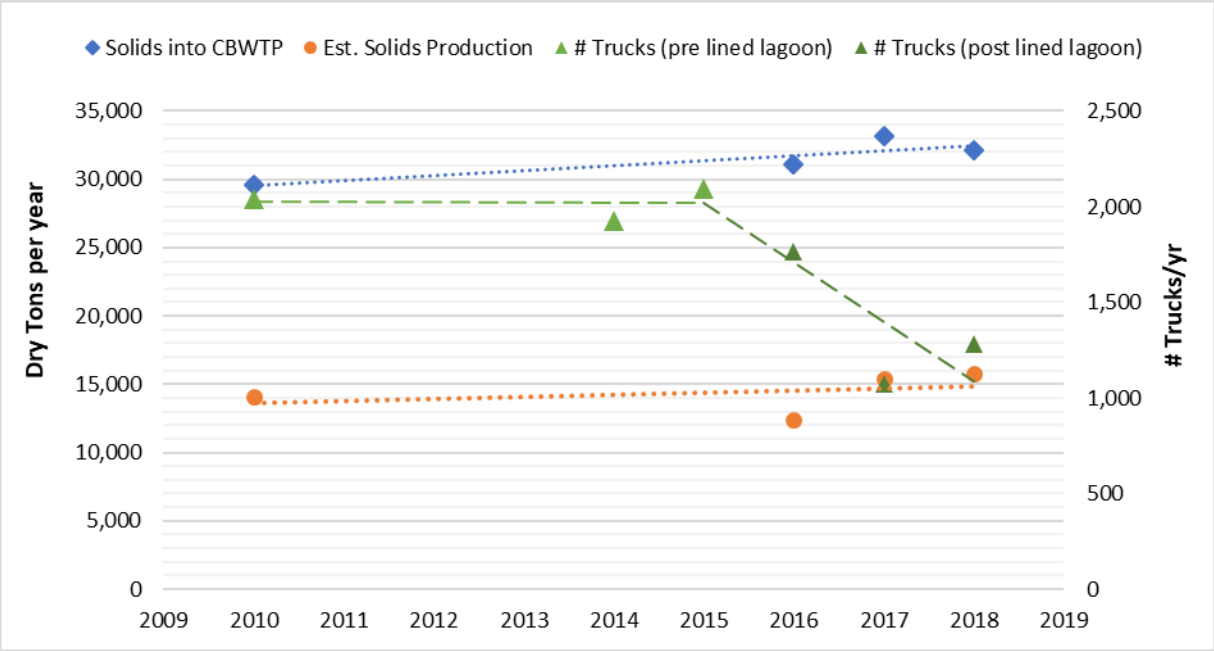

Figure 2 - Dry Tons of solids brought into CBWTP, estimated biosolids production, and number or trucks hauled out of the CBWTP plant on a yearly basis. Note: 2018 data is extrapolated to the end of the year based on data collected from January through June.

Figure 2 shows that before 2016, solids loading and solids generation followed the same trend. Also at this time, approximately 2,000 biosolids trucks were hauled away for land application per year. A reduction of trucks was expected starting in 2016 while the newly lined lagoon cells 3 and 4 were being reseeded and until their loading capacity is reached. This was anticipated to be a 2 year process to address the reduction of solids while the lagoon is being seeded. However, the data shows a greater decrease in biosolids hauling (output) to land application than the intended (or design capacity) seeding input to the lagoon. As a result, solids have been accumulating in the plant beyond the buildup associated with lagoon cells 3 and 4 seeding.

Lagoon Cells 3&4 Startup and Inventory

Emptying the lagoon of its accumulated biosolids started in 2012 as part of the lagoon reconstruction program. The primary driver for the program is lining the lagoon and providing discrete cells for operational flexibility. Emptying the lagoons was incidental to the project in order to install an impermeable liner. The south half of the lagoon was emptied by 2015 with newly created cells 3 and 4 brought into operation in January of 2016. While cells 3 and 4 were empty and available for seeding, plant operations was directed to stop use of the

northern half of the lagoon as it was being put under Contractor control for the northern half reconstruction. Based on lagoon operations strategy, the impact of cells 3&4 startup was to halt lagoon dredging for at least two years to allow solids consolidation.

Design data for the new lagoon cells indicate a solids loading capacity of about 5,000 dry tons per cell (Lagoon O&M manual, dated November 7, 2014). Using operating records since the new cells 3 & 4 have started filling, we estimate that the amount of surplus biosolids (in excess of the loading capacity) accumulated in cells 3 and 4 from January 2016 through June 2018, was about 7,500 to 9,000 dry tons (Table 1). An additional 520 dry tons is estimated to have been added since then. This represents about two thirds of a year of total solids production from the CBWTP plant (which includes solids trucked from Tryon Creek).

Table 1 - Lagoon cells 3 and 4 design capacity compared to the amount of stored solids (dT=Dry Tons) as of July 1, 2018 and the resulting surplus (in excess of the loading capacity)

Description	**Cell #**	**Low Estimate (dT)**	**High Estimate (dT)**	**Cell #**	**Low Estimate (dT)**	**High Estimate (dT)**
Design Capacity	3	4,826	5,403	4	4,882	5,405
Current State		10,686	12,696		6,501	7,094
Surplus Biosolids		5,860	7,293		1,619	1,689

What has changed?

Increased proportion of total solids sent to lagoon.

The lagoon Operations and Maintenance manual indicates a lagoon loading capacity of about a quarter (25%) of the daily digested sludge production to the lagoon for additional stabilization and solids reduction. Using this maximum rate, it would take about 1 year to fill a cell. Operating records from early 2016, when the lagoon was operating as usual, show that the solids flows sent to the lagoon were under the 25% threshold, where a cell would take longer to fill to capacity. However, by the fall of 2016, the proportion of solids sent to the lagoon increased significantly (Figure 3). Some of this increase is due to equipment failures in sludge processing, truck cancellations due to extended winter weather, a major fire in the Gorge that closed transportation routes, and lack of drivers, but it is unclear to what extent. Additionally, lagoon dredging stopped in relations with the lagoon reconstruction project and startup of new cells 3 and 4 meaning no solids were leaving the lagoons. As a result, the lagoon rate of filling accelerated significantly in the planned two years of lagoon seeding, but it is unclear if this information was clearly visible to operations staff, or what has triggered the change.

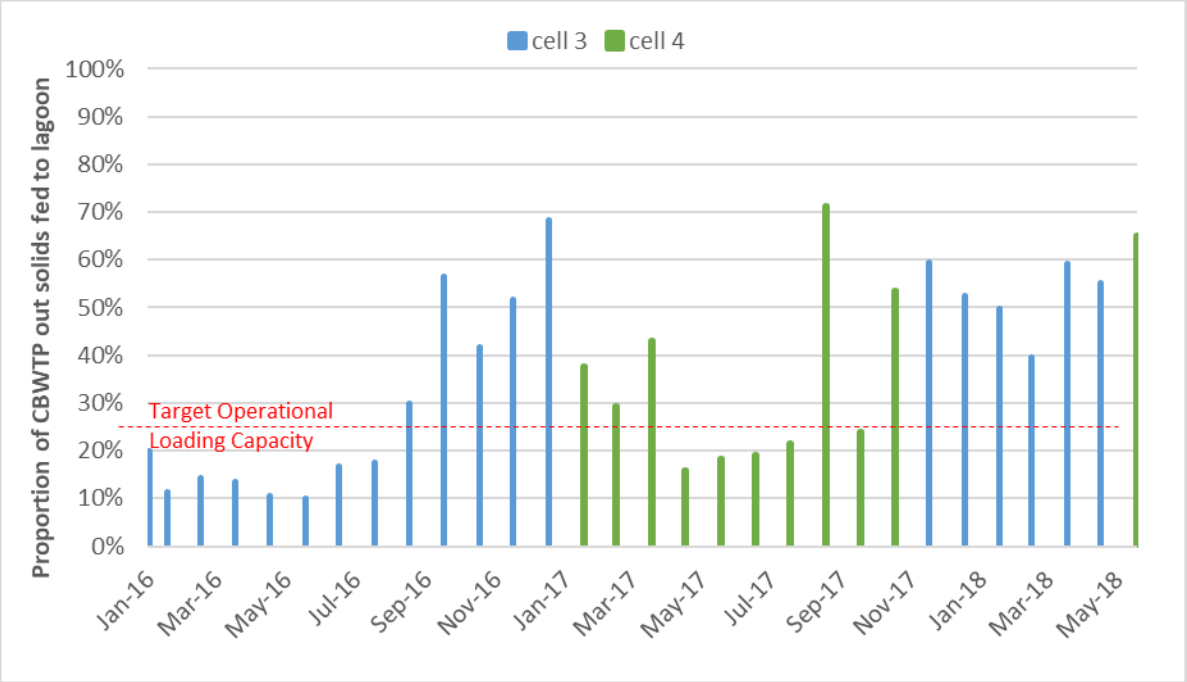

Figure 3 - Proportion of Digested Sludge sent to the lagoon cells 3 and 4

Reduced hauling and reduced dewatering performance.

In 2014 and 2015, truck hauling records were about 2,000 trucks per year averaging 21% solids. Once cells 3 and 4 were put into commission in 2016, the total solids hauled dropped due to lagoon cells 3 and 4 being in seeding mode (e.g. no dredging) and the north cell being under reconstruction (e.g. also no dredging). However, additional reduction in solids hauling was due to a decline in the cake %TS from 22% to 18.2% (Figure 5). **A reduction in percent solids means that each truck hauled away contains less net biosolids, so that if truck hauling is maintained constant, a net reduction of solids leaving the plant is seen, resulting in accumulation in the plant.** This type of information has not been tracked to date or linked with an overall solids mass balance.

Reduced Dewatering Equipment Uptime

The average total feed to the belt presses (gallons per minute, or gpm) has steadily decreased over the last years as seen in Figure 5. The decrease indicates a reduced equipment uptime and/or processing rate. This may be due in part to struvite blockage in the feed lines which was recently improved with line jetting. However, increases in annual maintenance and down time on the presses and solids transfer equipment has also been reported. Further investigations would need to be made to confirm if the reductions are entirely attributed to breakdowns of the aged equipment or for other reasons. Another cause of reduced uptime is related to hauling cancellations.

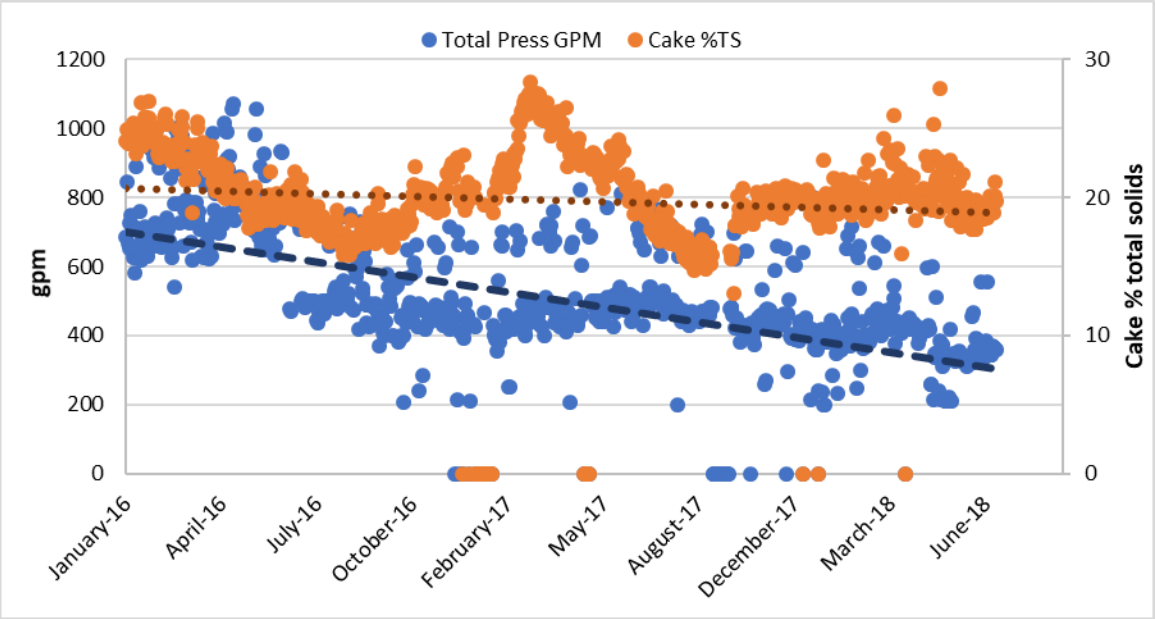

Figure 4 – Belt Press Filter performance from 2016 through current.

Aggravating Factors

A few elements exacerbate the current biosolids management situation, including:

- The aged condition of our solids handling equipment (scheduled for replacement by 2024 as part of the Secondary Treatment Expansion Program) which has challenges handling the solids generated and cannot sustain a large increase in production schedule to remove solids. Despite the best efforts of our maintenance staff, breakdowns are frequent.
- The efficiency of our thickening and dewatering equipment results in biosolids containing more water, reducing storage capacity and decreasing the net solids content of each truck deliveries; truck deliveries are scheduled based on a number of trucks, rather than a net solids hauling schedule.
- An apparent industry-wide shortage in truck drivers with our hauling contractor impacts our ability to expediently increase biosolids truck deliveries.
- While the north half of the lagoon was planned to be out of service until April 2019, delays to the lagoon reconstruction project Phase 3/4 mean that the north cell will remain unavailable until December 2020. This construction delay has impacted the operations plan to manage solids during this period of reduced lagoon capacity.
- A series of failures and projects to remediate them, at our oldest digesters, units 1 through 4, making these digester volumes unavailable for reliable storage.

Preliminary Screening of Alternatives to Reduce Inventory

Initial estimates to restoring the biosolids handling and storage capacity require the removal of approximately 10,000 dry tons of solids. Table 2 describes a range of options and removals that were conceptually evaluated, including some for optimizing current operations, which will be further developed and expanded through the Charter.

Table 2 – Solids handling options evaluated

Implementation Timeline	Description	Internal need	External Components	Risk Reduction	Cost	Pros	Cons
A. Immediate	1. Increased trucking and land application	• Solids handling at capacity	• Hauling increased and land application	Limited and insufficient	$273/dT to Madison, $207/dT to Sherman assuming 18%TS	• Immediate • Sufficient budget exists	• limited capacity at Madison • will not cover all of solids generated (will still be in accumulation mode)
B. Short term (<1Mo)	1. Utilize contract with Synagro at the secondary digesters	• Dredging • use of a secondary digester	• Dewatering • Hauling • Disposal	Limited and insufficient	For ~350dT based on remaining contract amount and %TS, ~$0.5M ($1,300/dT based on current contract)	• Contract in place • Quick; could start in September • Helps with the solids balance • Sufficient budget	• Relies on our dredge equipment and our dredging schedule • May impact contracts for projects at D2 and D3
C. Short term (1 Mo)	1. Contract out lagoon solids removal at the secondary digesters, dewatering, and disposal	• Dredging • use of a secondary digester	• Dewatering • Hauling • Disposal	Moderate, depending on quantities, and if supplemental solids capabilities are implemented	Assuming 10,000 dT removed from cell 3 ;$5.4M ($540/dT based on verbal quotes)	• Restores capacity until new cells come online	• Relies on our dredge equipment and schedule • limited based on our dredge (60-150 DT/d) • Requires additional budget appropriation and contract

Implementation Timeline	Description	Internal need	External Components	Risk Reduction	Cost	Pros	Cons
	2. Contract out lagoon solids removal at the lagoon via dredging, dewatering, and disposal	• None	• Dredging • Dewatering • Hauling • Disposal	Moderate, depending on quantities, and if supplemental solids capabilities are implemented	Assuming 10,000dT removed from cell 3; $6M ($600/dT based on above verbal quote and consultant estimate)	• Frees dredge • Restores capacity until new cells come online • Allows for any removal rate based on contractor	• Impacts lagoon construction • Increased truck traffic from lagoons
C. Medium to long term (10 mo to 2 years out)	1. Rent mobile unit to supplement solids handling	• Operators to run rental	• Rental unit and truck filling connections	In combination with excess solids reduction, optimal	Assuming 4-5,000 dT/yr (Difference between internal capacity and est. Production), $90/dT dewatering; ~$0.5M/yr	• Backup to our aging BFPs • Allows achieving no net accumulation until new solids handling facilities are built	• Need space and operators for rented equipment
	2. Increased hauling with Gresham Hauling or future partner	• Operators to fill trucks	• Hauling • Land application		Assuming 3,700 dT/yr (Difference between internal capacity and current land application permit) at current hauling and land app rates; ~$1M/yr	• Contract is in place with Gresham hauling or would diversify hauling options with other future partner	• this would be limited to 15,000 dry tons/yr unless capacity is increased

Implementation Timeline	Description	Internal need	External Components	Risk Reduction	Cost	Pros	Cons
	3. Increase land application capacity	• Permitting/ contracting	• Land and application equipment	In combination with excess solids reduction and processing, optimal	Current hauling rates for 200-1,200 dT/yr (Difference between internal capacity and full production rates); $200-500k/yr	• Least expensive disposal option; provides long term stability as increased population and biosolids production are expected	• None, other than it requiring some time to put in place
	4. Supplemental trucking with Waste Management or other if land app is not incr.	• Operators to fill trucks	• Hauling • Disposal	Reduces risk of hauling cancelation impacts	$315/dT haul and dispose 200-1,200 dT/yr (Difference between internal capacity and full production rates) if land application couldn't be expanded; $250-550k/yr	• Would ensure that we could haul solids and not accumulate • Diversifies hauling options and contracting	• More expensive than land application • No beneficial reuse

Recommendations

A - Short Term (<1 month)

1. Biosolids Processing Optimization

- A number of optimization improvements are being developed jointly as part of the Charter, including polymer optimization, increased maintenance on dewatering equipment, and the development of tools to assist Operations staff in assessing the comprehensive solids management status at CBWTP. These are not repeated here, as these efforts, while absolutely necessary due to the critical solids accumulation status, will have limited overall risk reduction impacts if no other action is taken.

2. Solids Reduction Action Plan Implementation (<1 month)

- Declare Emergency due to permit and potential public health risk from overflowing solids potential
- Draft contract for dewatering, hauling, and disposal of biosolids from D3 and D4. Expected contract duration of 6 to 9 months, relying on CBWTP dredging and solids operations to send solids to Digesters 3 or 4 for dewatering and hauling off site.

B -Medium Term (6 mo to 1.5 year)

1. Increase and Diversify Truck Hauling Capability

- Will increase truck hauling reliability and reduce risks of cancellations. See Charter.

2. Diversify Disposal Options

- Due to limited land application availability, add landfill disposal permitting. See Charter.

3. Supplement Biosolids Processing Capacity

- With current equipment and condition, a net accumulation of approximately 10 to 15 DT per day is anticipated until new solids handling equipment is installed as part of the Secondary Treatment Expansion Program, scheduled in 2024. As a result, supplemental solids processing capacity is advised as an alternative to recurrent solids dewatering, hauling, and disposal contracting.

C -Medium to Long Term (1.5 year +)

1. Increase Land Application Portfolio

- With past and continued growth in the Portland area, biosolids quantities will continue increasing. It would be prudent to start the permitting process for additional land application sites.

2. Develop Comprehensive Biosolids Facilities Plan

- Findings to date point to the need for a comprehensive Biosolids System Operating Plan. While the Charter is tasked with preparing a plan, a comprehensive effort should be scheduled in the coming years, most likely combined with the next CBWTP Facilities Plan edition.

Options until Implementation

Use the lagoon as needed: while full from a normal operating standpoint, Cell 4 does have small pockets of “green water” available for emergency solids placement. The floating boom distribution piping was extended to these pockets yet cell4 is not tolerating additional loads and is short circuiting solids. Currently, Cell 3, with close supervision for the solids feed line and supernatant outflow, is being used as a last effort to store solids until increased dewatering and hauling is in place, especially during the digester pipe condition assessment.

As a last resort, dispose of solids into Cell 2, currently under Contractor control; keeping a track record of quantities transferred to the cell will be essential in the negotiation of the ensuing change order. We estimate only about 10 days of solids production could be stored in the actual available volume in cell 2. The Lagoon reconstruction project contract has already been amended to the point that this change order would most likely require Council action.

Anticipated Impacts

This memorandum is intended to provide a first look at the data and options envisioned. The data is not exact and with relatively high variability, however facts and observations confirm that the plant is operating under high risk conditions, and warrant prompt action. An emergency declaration is recommended to reduce imminent risks to public health from biosolids overflows. Cost ranges are listed below in Table 3.

Table 3 – Solids removal plans

dT removed	Notes	Estimated Cost
Solids Reduction Contract (SRC)		
1) 12,000 DT	Empties Cell 3; Cell 4 remains full and operating as storage tank, but could be emptied next. However, net accumulation over the duration of contract would almost bring Cell 3 at design capacity at end of contract, so this would be an incomplete solution.	$6,500,000 ($540/dT)
2) 15,800 DT	Empties Cell 3 and anticipated net accumulation until June 2019 (anticipate 10 month period until contract completion). Cell 4 remains full until plant operations reduces inventory.	$8,500,000 ($540/dT)
3) 24,300 DT	Empties cells 3 and 4 and anticipated net accumulation over a contract completion period of 14 months (November 2019). This will provide a little over a year of storage capacity until cells 1 and 2 are available (December 2020).	$13,100,000 ($540/dT)
Supplemental Solids Processing/hauling/disposal (SSPHD)		
4,500 DT/Yr (assumes 12.5 dT/d excess over current equipment processing capacity)	Provides redundancy to existing equipment and adds capacity to dewater/haul/dispose of the shortcoming of the existing processing capacity. Equipment is necessary for construction of new Solids Handling Facilities and would provide opportunity for staff to experience centrifuge technology. Operation may not be needed continuously.	$1,420,000/YR ($315/dT - to landfill)
Full Solutions		
SRC 1 + SSPHD (5 Yrs) 34,500 dT processed	Does not provide buffer capacity; cells would be full until Cells 1 and 2 are available. 5 years of supplemental dewatering until new Solids Handling	$13,600,000

	Capacity is added via Secondary Expansion Program. This option ensures no net accumulation, but no storage or operational relief.	
SRC 2 + SSPHD (5 YRs) 38,300 dT processed	Ensures no net accumulation and provides 5,000 dT of storage capacity. This would be the normal operating state of the plant.	$15,600,000
SRC 3 + SSPHD (4 YRS) 42,300 dT processed	Ensures no net accumulation and provides 10,000 dT of storage capacity. This may support the construction efforts for the solids handling building.	$18,800,000

With these range of costs, it should be noted that the solids accumulation represents deferred operating costs. There is no current cost of operation estimate for solids handling; capital, chemical, hauling and disposal costs have been compiled for this effort, totaling $273/dT. However, estimation of deferred costs should be expanded further, particularly to include processing labor hours (dredging and ops specs) and capital equipment (though our equipment is fully depreciated), to provide a closer basis for comparison.

END