14 June 2018

Technical Memorandum

To: Eric Hansen – Public Works Director

From: Brad Musick – Wastewater Solutions, Inc.

Subject: Process Audit of the Stevenson Wastewater Treatment Facility

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Section 1. Project Description

Wastewater Solutions, Inc. (WSI) was contracted by the City of Stevenson, WA to provide a process and operational audit of the wastewater treatment facility. The goal was to determine if operational changes could improve plant performance and/or gain capacity from now through an upcoming facility upgrade.

A site visit was conducted May 21-22, 2018. The site visit included a field evaluation. Prior to the onsite work, WSI evaluated plant operating and design data, permit, studies, drawings, and other information.

Jacobs/CH_2M is a contract operations company hired by the City to care for, operate, and maintain the treatment facility. The Jacobs' operator tasked with operating and running the plant is Andy Gates. Andy has been a plant operator about 3 years, is a Class II Operator, and has been the person in responsible charge of the facility for approximately 5 months. Andy also attended Linn Benton Community College, studying wastewater.

Andy Gates actively participated in the exchange of ideas and information. Andy seemed to know the plant equipment and had a good understanding of operations. Staff seemed willing to implement most recommended changes. The consultant relied heavily on the outstanding plant-specific knowledge of the utility staff.

Section 2. Plant Description

The City of Stevenson Wastewater Treatment Plant (Stevenson WWTP) is located on the banks of Rock Creek, on the west end of Stevenson. The plant is designed for a peak-hour flow of 1.5 million gallons per day (mgd). It uses a singular oxidation ditch for treatment and discharges treated and disinfected effluent to the Bonneville Pool of the Columbia River.

The Stevenson WWTP was constructed in 1971 and originally consisted of a Smith and Loveless Oxygest package treatment plant ("donut") with a chlorine contact tank for disinfection and a sludge lagoon.

In 1992, the original plant was upgraded with largely new current facilities, including the oxidation ditch, secondary clarifiers, and UV disinfection facility. Some components from the original plant were kept as back-up to the new facilities or for solids handling.

2.1 Treatment Processes

Wastewater enters the Rock Creek Pump Station (serving portions of the City east of the WWTP) and Fairgrounds Pump Station (serving portions of the City west of the WWTP). These serve as the WWTP's current influent pump stations.

The following are the systems and processes comprising the treatment plant:

- Headworks

  The combined force main from the influent pump stations discharges to the headworks facility. The combined raw wastewater flows are typically discharged to the south channel of the headworks, which features a mechanical bar screen to remove screenings entering the plant.

- Secondary Treatment
  - Oxidation Ditch
  - Secondary Clarifiers
  - RAS and WAS

  Screened wastewater flows by gravity to the oxidation ditch, which is aerated by one or two brush rotors. In the aeration basin, bacteria consume organic BOD and inorganic ammonia. The bacteria responsible for BOD removal build floc which is then settled in the secondary clarifiers.

  In the clarifiers, the biologically treated wastewater is separated from the biomass. The treated wastewater flows to UV disinfection. Most of the microbes are returned back to the oxidation ditch using RAS pumps. The excess microbes are wasted to the digester/solids holding.

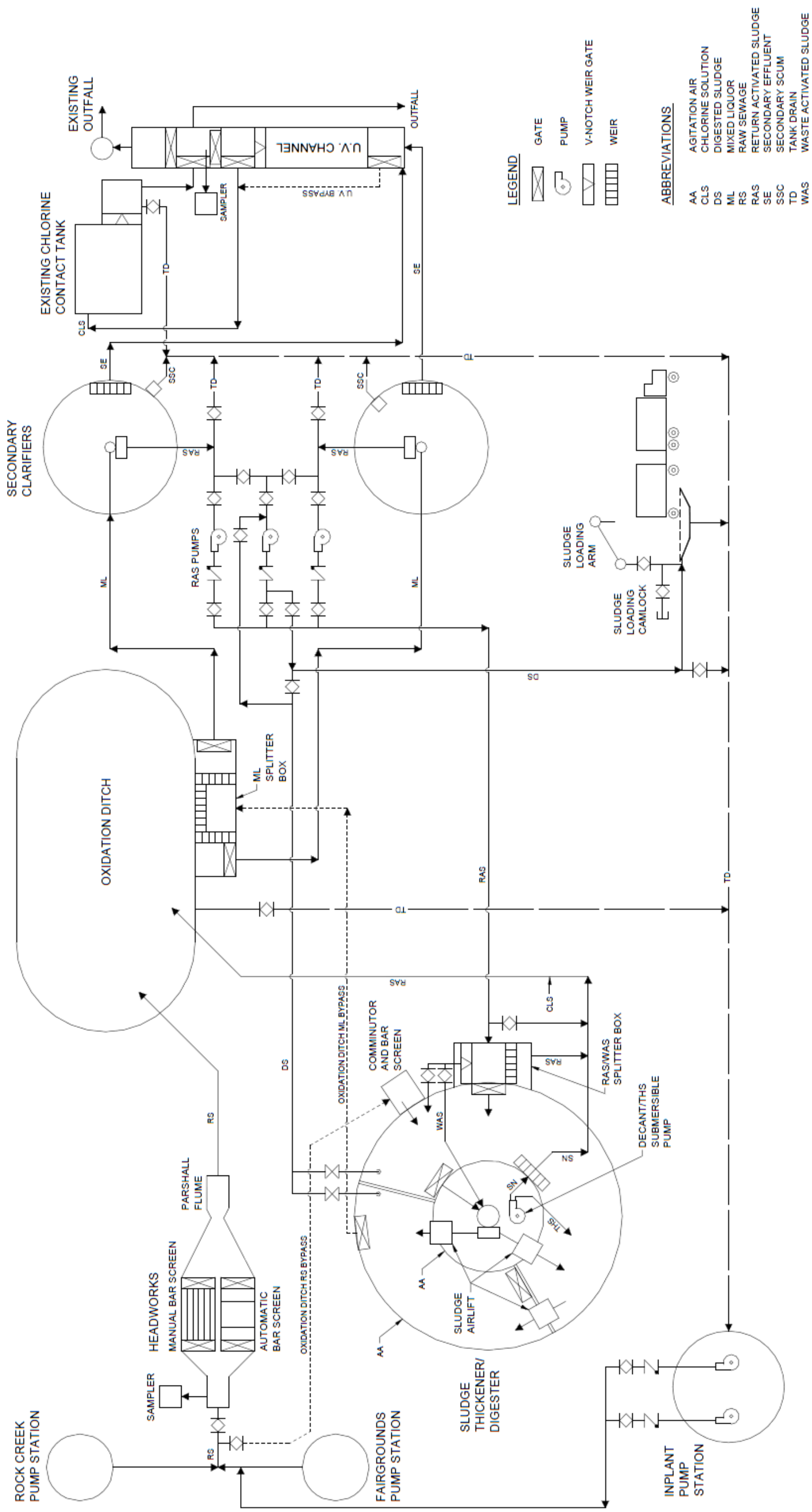
- Disinfection

  The treated wastewater is made safe for discharge to the public waterway by Ultraviolet (UV) disinfection. The disinfection process kills pathogenic bacteria.

- Solids Handling

  A pump station located between the secondary clarifiers pumps return activated sludge (RAS) and waste activated sludge (WAS) from the clarifiers to the RAS/WAS splitter box at the sludge holding tank. RAS flows to the oxidation ditch, and WAS flows to the solids holding tank.

  The biosolids are hauled offsite in tanker trucks to other treatment facilities for further treatment.

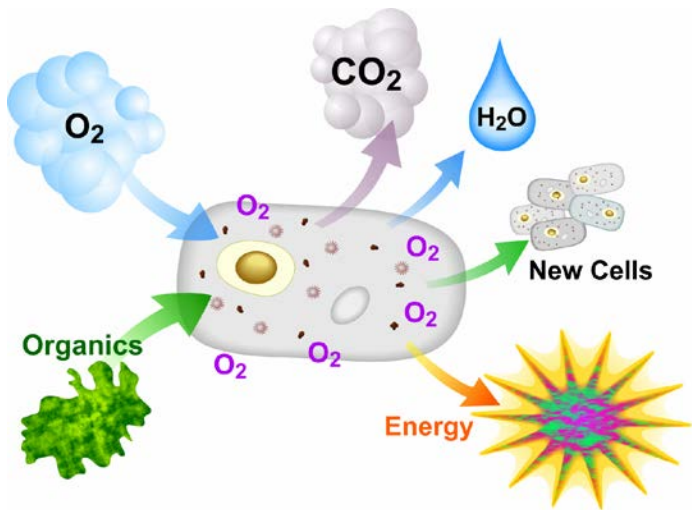


EXISTING OUTFALL
EXISTING CHLORINE CONTACT TANK
U.V. CHANNEL
SAMPLER
U.V. BYPASS
OUTFALL
LEGEND
GATE
PUMP
V-NOTCH WEIR GATE
WEIR
ABBREVIATIONS
AA AGITATION AIR
CLS CHLORINE SOLUTION
DS DIGESTED SLUDGE
ML MIXED LIQUOR
RS RAW SEWAGE
RAS RETURN ACTIVATED SLUDGE
SE SECONDARY EFFLUENT
SSC SECONDARY SCUM
TD TANK DRAIN
WAS WASTE ACTIVATED SLUDGE
SECONDARY CLARIFIERS
RAS PUMPS
SLUDGE LOADING ARM
SLUDGE LOADING CAMLOCK
OXIDATION DITCH
ML SPLITTER BOX
COMMINUTOR AND BAR SCREEN
RAS/WAS SPLITTER BOX
DECANT/THS SUBMERSIBLE PUMP
OXIDATION DITCH ML BYPASS
PARSHALL FLUME
HEADWORKS
MANUAL BAR SCREEN
AUTOMATIC BAR SCREEN
OXIDATION DITCH RS BYPASS
SAMPLER
SLUDGE AIRLIFT
SLUDGE THICKENER/ DIGESTER
ROCK CREEK PUMP STATION
FAIRGROUNDS PUMP STATION
INPLANT PUMP STATION

Section 3. Statement of the Issue(s)

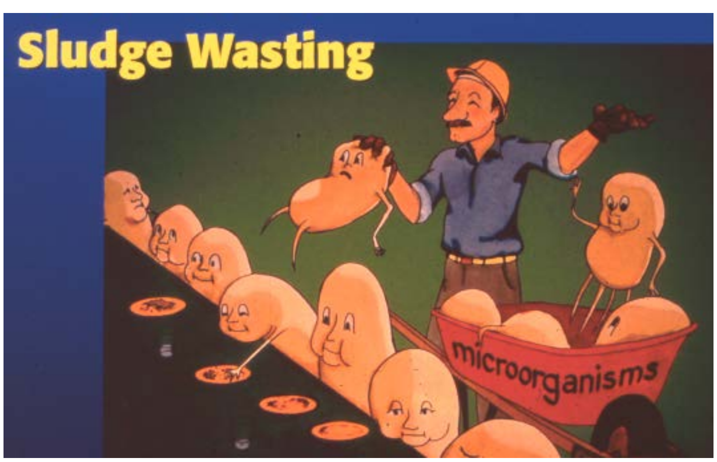
The waste water plant experiences solids and BOD permit violations. The violations generally result from slug loads of high BOD waste from industry. BOD loadings higher than permit are recorded routinely. The highly soluble (dissolved) industrial waste slug load overwhelms the oxidation ditch's ability to deliver sufficient dissolved oxygen (DO) to the bacteria.

When bacteria are presented with soluble BOD, they take the food (BOD) material up through their cell wall. A biochemical reaction occurs and the BOD is converted into energy, water, new bacterial cells, and carbon dioxide. The rate at which the bacteria convert soluble BOD into solids (new cells) is dependent on the amount of food present, time, dissolved oxygen, and other growth pressures. Given the right conditions, the heterotrophic bacteria that oxidize BOD can split in half and form new cells every 10-15 minutes. When a BOD slug enters the plant, there is a rapid rate of new cell development (log growth). If the bacteria have insufficient oxygen to oxidize the stored food, then the bacteria basically can't do anything else in the oxidation ditch. The bacteria travel, full of food, to the secondary clarifier. In most activated sludge facilities, it is important that the bacteria coming back from the clarifier (as RAS) to the oxidation ditches be hungry and ready to eat more BOD. This does not happen at Stevenson during a BOD slug load.



When experiencing a BOD slug load to the plant, the Stevenson bacteria do not come back hungry in the RAS to the ditch and are thus not readily available to consume BOD. Any solids lost from the clarifier are also full of BOD. The slugs come in quite often.

Typically in an oxidation ditch activated sludge system, the waste sludge produced (called sludge yield), is about 0.25-0.5 pounds of WAS sludge per pound of BOD in the influent. Because of the BOD slugs and low dissolved oxygen, the Stevenson sludge yield is closer to about 0.5 to 0.8 – roughly 2x the mass of secondary sludge is being produced compared to other similar plants. So Stevenson must waste more sludge and handle more biosolids than other extended aeration plants.



When not experiencing the high BOD load, the plant tends to run fairly well and stays within compliance. On days without the high BOD load, the plant does a very good job of both BOD and ammonia oxidation. This shows it has capacity for the base loads, just not the slugs.

Section 4. Findings and Recommendations

The finding and recommendations are broken down into the following categories:

1. General Findings and Recommendations
2. Quick Benefit Recommendations
3. Long Term Recommendations

The information has been compiled into the following tables to reduce read time and make for easier reference. Note that the number # does not signify priority.

General ***(No specific order)***

#	General Findings and Recommendations	Comments
1	Housekeeping	The contract operations firm has operated the facility since 1992. It was clean and all liquid treatment processes were new and in good order. Not sure much in terms of housekeeping has been performed since 1992.The contractor is responsible for cleaning as per the contract.
2	Maintenance	There is no High Speed on the ditch aeration equipment. They have not worked in years (as per operator). This is especially important since the plant experiences low DO during the BOD slugs. Repair of the aeration delivery equipment is very important. The blower(s) for the aerobic digester/holding and diffusers are also not fully functional. This too is a priority item.
3	Staffing	The half-time operator schedule may not be sufficient to perform all necessary tasks. That said, it does not relieve them of any housekeeping nor maintenance items. Some have been issues for years.
4	Micro Exam Performed	Findings from the micro exam are as follows: a. Open floc b. Filaments common c. Predominance of Stalked Ciliates d. Lots of Testate Amoeba e. Worms Shows varying F/M with both young and old.
5	Diluted Settleable Solids Test	The test showed that sludge settling is hindered by mass and reducing MLSS would improve settling in the clarifier.
6	O&M Manual last Updated 1992	Needs updated. Needs SOPs specific to dealing with high BOD slugs.
7	Staff Training	Contract staff has had little process training from Jacobs/CH2M.

Quick Benefit Recommendations

(No specific order)

#	Quick Benefit Recommendations	Comments
1	Online DO Probe Needed	The handheld DO probe does not show staff the diurnal DO in the ditch. Need to see BOD slugs and allow action when needed.
2	RAS Metering Needed	There is no RAS metering. Not sure the percentage of flow that they use really has any meaning. RAS is one of 3 controls on activated sludge (RAS, DO, and WAS). Need good info on all three to control the plant.
3	Reduce RAS Rate	The RAS rate is 110% of plant flow. This is too high. The RAS should be 3-5 x MLSS, but is currently only about 1.5 x. The high RAS robs capacity and dilutes waste sludge increasing the volume to pump. The reduced hydraulic load through the ditch will improve BOD treatment and also reduce the solids push to the clarifier. See Benefits of Lower RAS in Tech Memo.
4	Reduce MLSS Inventory	The plant has more than enough microbes to eat BOD under normal conditions. The diluted settleable solids showed improved setting with a lower mixed liquor concentration. Suggest around 3000-3500 mg/L. See Diluted Settle info in Tech Memo.
5	Repair and Run Both Ditch Rotors- High on at least one (once functional)	Due to the sporadic nature of the BOD slug loads, it is recommended that the staff run high DO's in the ditch to help meet the demand when the slugs occur. Repairing the rotors to run on HIGH speed will help with BOD treatment,
6	Add Polymer to RAS or MLSS	Add polymer to the RAS and/or the MLSS discharge to enhance solids capture. Especially recommended during BOD slugs or high flow situations.
7	Industrial Waste Equalization and pH Adjustment	Have the industry add flow equalization and pH adjustment. It would be advantageous if the BOD could be metered in at night when the plant experiences lighter loading.
8	Keep ditch weir level at max to help with oxygen transfer. Automate gate during upgrade IF they don't go with diffused air.	While using the mechanical rotor mixers, the gate weir should be at its highest to maximize DO transfer.

Intermediate to Long Term Recommendations

#	Intermediate to Long Term Findings and Recommendations	Comments
1	Add Stamford Baffles to Clarifiers	These pre-fab baffles help redirect flow and velocity and reduce clarifier solids in discharge.
2	Add Full Time Operator	Need more attention at the plant. Need to protect the City assets.
3	RAS Reaeration to Gain Aerobic Capacity	BEFORE UPGRADE. Consider gaining aerobic capacity by adding reaeration of the RAS. This could be done in the old contact tank, a banker box, or possibly in the existing solids handling. This would be an interim capacity gain until the upgrade is complete.
4	Level Weirs on Secondary Clarifiers	The weirs on the secondary clarifiers are not level. This causes higher flows over the lower weirs – pulling more solids over than necessary. Should be fixed during upgrade.
5	Selector Activated Sludge	It is important the upgrade have a biological selector to select for desirable floc formers. The type of selector (anoxic or anaerobic) should be based on the type of filaments they currently tend to grow, future permit considerations, etc.
6	SCADA	Need a SCADA system with the upgrade..

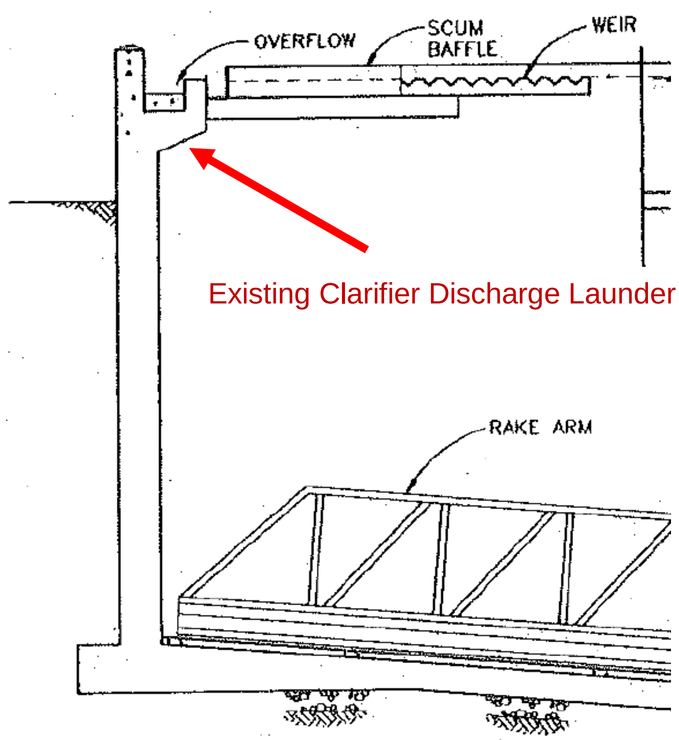
Some of the items in the tables above are discussed in more detail in the information that follows.

Stamford Baffles

The addition of Stamford baffles to the existing clarifiers and to the new one under consideration would be money well-spent. The purpose is to re-direct the current or velocity of the water in the clarifier as the flow tends to run up the sidewall and over the weirs. The Stamford baffle redirects that energy back toward the center of the clarifier, reducing the hydraulic impact on solids loss. Literature from Stamford states solids reduction up to 70% and improved wet weather treatment.

The existing clarifiers have a peripheral discharge launder. There was some discussion regarding the bottom of the launder and whether or not it acts as a density current baffle.

As the section drawing at right shows, the upward-angled launder bottom slope would be relatively ineffective redirecting the flow energy.

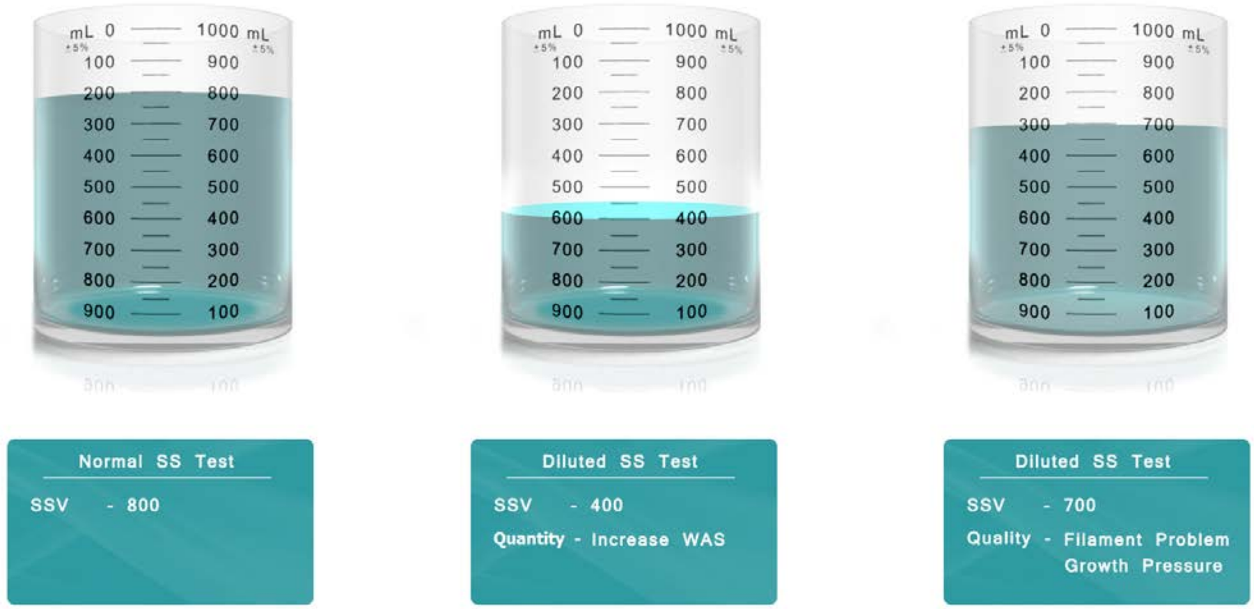


The design allows less dense solids to be carried up the sidewall and roll over the weir much more easily than a flow redirected by a downward- angled Stamford baffle shown in the above picture.

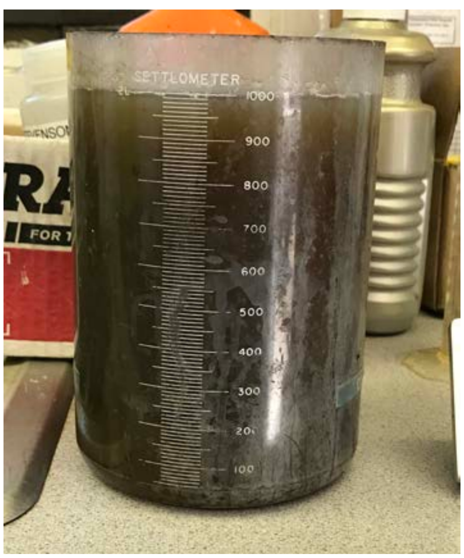
It is believed that Stamford baffles would be beneficial to the existing clarifiers. A conversation with the manufacturer would be beneficial to determine the true applicability of adding these to the clarifiers and what solids reduction would be expected.

Reduced MLSS Inventory and the Diluted Settle Solids Test

A diluted settleable solids test was performed to see the impact on filaments on the poor settling Stevenson sludge. The diluted settleable test illustrates how much of the settling problem is due to poor sludge **QUALITY** and how much of it is due to sludge **QUANTITY**.



At the Stevenson facility, the mixed liquor barely settled at all in the 30 minute settleable test.



Normal 30 Minute Stevenson Settleable

Diluted 30 Minute Settleable

Though the filaments were in the "common" range in terms of numbers, they appear to have less impact on the settleability than the MLSS concentration. So, the settling issue has more to do with too many solids (Quantity) vs. the Quality of the sludge produced.

Reducing the MLSS will have a positive impact on solids settling

Benefits of Reduced RAS Rates

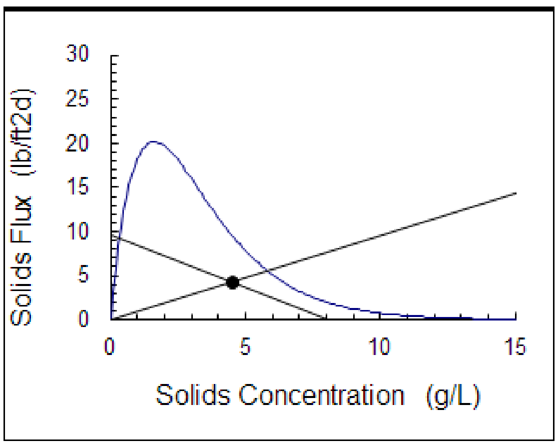
Based on a daily flow of 0.20 MGD

SVI of 211 Used Based on Historical Information

Comparing 110% RAS to 80% RAS	Total AB MGD RAS+RAW	RAS Flow MGD	RAS Conc. mg/L	WAS Sludge to Digester
Current RAS RATE @ **110% of RAW Flow**	0.42	0.22	8000	
More optimized RAS RATE @ 80% of RAW FLOW	0.38	0.16	10125	
Reductions (-) or Gains (+)	(-) 10%	(-) 0.121	(+) 21%	(-) 21%

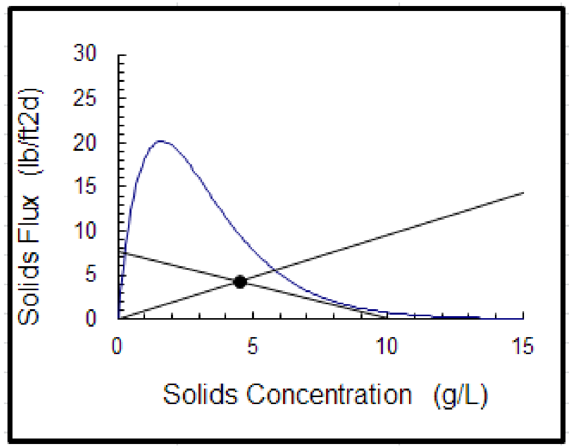
Benefits

* Pumping Energy Savings
* Better Setting in Clarifier
* 21% (approx) Reduction in WAS Sludge Volume
* 10% Reduction in Total Flow to AB
* 20% Improvement on Detention Time
* Increased digester sludge storage capacity (21%)
* Less "supeing" labor



Stated Clarifier Conditions based on 110% RAS

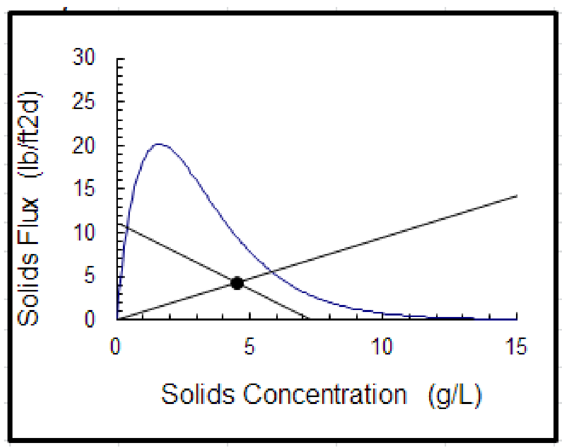
(The RAS is NOT this concentrated in real life)



Optimized RAS rate of 80%

The RAS RATE may be higher than plant staff thought.
To get SP to more closley match the plant data,
the StatePoint RAS rate had to be brough up to 190%
of plant flow, instead of the guesstimate of 110%.
Note the lack of flow measure on RAS is an issue
discussed elsewhere in the Tech Memo.

That said, if the RAS rate is higher than the 110%, then
that makes the potential savings and performance gains much
much more substantial than stated in the table above.



Possible Current Clarifier Conditions Based on 159% RAS

The table below shows the comparison of the State
Point current RAS rate vs. a more optimized RAS rate.

Comparing 190% RAS to 80% RAS	Total AB MGD RAS + RAW	RAS Flow MGD	RAS Conc. mg/L	WAS Sludge (V) to Digester
Based on Calculated 190% Current RAS flow	0.6	0.38	6800	
More optimized RAS RATE @ 80% of RAW FLOW	0.36	0.16	10125	
Reductions (-) or Gains (+)	(-) 40%	(-) 0.25	(+) 33%	(-) 33%

Section 5. Conclusion

The plant tends to meet permit during normal loads. However, when the BOD is beyond the design capacity, the plant can experience solids and BOD issues for a couple of days.

In terms of summarizing and prioritizing the short-term recommendations, they are as follows:

1. It is very important that the rotors on the ditch be repaired to allow them to operate on the HIGH setting. Since the BOD slugs cannot be predicted, it is important that the DO be maintained higher than normal to try to minimize the impact of the load. The ditch weir should also be run at or near its highest level to maximize oxygen transfer.
2. Reducing the mixed liquor solids concentration is needed to improve settling in the clarifier. It is recommended that the solids inventory be dropped from 4500 mg/L down to between 3,000-3,500 mg/L.
3. Optimizing the RAS rate will go a long way in improving both the aeration and the clarifier performance. It will also reduce the volume of sludge needed to waste by 20-30% and improve sludge storage by a comparable percentage.
4. Fixing the digester blowers and diffusers will help digest the sludge instead of allowing it to sit and ferment. The fermented decant could be adding organic acids. Coupled with the organic acids from the brewery, they are a food source for non-desirable filamentous bacteria. In addition, aerating the digester may reduce mass to be hauled.
5. Clean the plant.