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Memorandum

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Subject	**Transition from 2 to 1 Aeration Basins in Service**
Project Name	Ridgefield Wastewater Treatment Plant
Attention	Rich Ludlow
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Reviewed By	William Leaf/Jacobs Robin Krause/Jacobs
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1. Background

The Ridgefield Wastewater Treatment Plant (RTP) is a 0.7 million gallon per day (MGD) wastewater treatment plant located in Ridgefield, Washington, owned by the Discovery Clean Water Alliance and operated by Clark Regional Wastewater District (District). It has two completely mixed aeration basins and two secondary clarifiers. The District has requested a plan to transition from two aeration basins in service to one aeration basin in service during the dry-weather season to facilitate offline repairs and basin rehabilitation.

2. Model and Process Review

A Pro2D process model of the secondary treatment system confirmed that the proposed transition from two aeration basins to one aeration basin in service could be achieved without disrupting nitrification and biological ammonia removal. The model demonstrated that taking one basin offline would likely require the plant to decrease the mean-cell residence time (MCRT) of the basin still in service, in order to reduce the mixed liquor suspended solids (MLSS) concentration feeding the secondary clarifiers to prevent clarifier overload. Reducing the MCRT in the aeration basin would reduce the level of conservatism related to biological ammonia removal. However, the MCRT would likely still remain above the minimum threshold recommended by the Washington Department of Ecology's *Criteria for Sewage Works Design* to achieve full nitrification, which is five days. The target MCRT after the transition should therefore be no less than five days and ideally would be at least in the six to seven-day range.

Table 1. Existing Conditions
Transition from 2 to 1 Aeration Basins

Parameter	Value
Aeration Basin Volume, each (mg)	174,000
Secondary Clarifier Surface Area, each (sf)	1,963
Secondary Clarifier Diameter, each (ft)	50

Prior to the transition operation, plant staff should ensure that sludge volume index (SVI) of the MLSS remains below 150 to 200, which will ensure that the excess MLSS can settle in the secondary clarifiers. Following the operation, the MLSS concentration will be expected to rise if the activated sludge wasting rate is not adjusted. The MLSS should be allowed to rise until reaching the maximum desired concentration or until significant secondary clarifier blanket buildup occurs, at which point the wasting rate can be increased to stop the increase in MLSS concentration. No design criteria for MLSS concentration is provided in the plant's design drawings. According to the Department of Ecology's *Criteria for Sewage Works Design*, the maximum recommended MLSS concentration for a typical activated sludge plant is 3,500 milligrams per liter. Wasting should be adjusted to maintain a target MLSS at which the plant can demonstrate effective operation.

Another parameter that is useful to monitor during aeration basin transition would be maintaining a F:M ratio below 0.4 while the inventory is being moved from one basin to the other. The "F" is influent biomass and the "M" is the mixed liquor inventory. Ridgefield's current design F:M ratio is 0.09, with a range of 0.05 to 0.15 from page 4-27 of the *Wastewater Treatment Facility Operation and Maintenance Manual* (Gary & Osborne, Inc., 2007). At current operation in August 2019, the plant was operating successfully with a 0.16 average daily F:M. The idea would be to gradually shift the aeration basin influent away from the offline basin over to the operating basin, while making sure that the inventory ("M") is high enough so that the influent BOD5 ("F") doesn't get too high. This guideline helps ensure that treatment will be maintained and limits the potential for foaming or other nuisance conditions.

Maintaining aeration basin influent to the offline basin for a short time during the start of the transition would help ensure there is adequate food source for the biomass remaining in the offline basin. RAS would be gradually shifted to the online basin in proportion to the aeration basin influent being sent over (e.g. – move 10% of the aeration basin influent, move an additional 10% of the RAS flow over).

Blowers will need to be monitored during the transition phase to ensure the aeration provides a dissolved oxygen concentration of at least two milligrams per liter and also the associated mixing during the expedited ML transfer stage. The blowers should be controlled to provide the associated balance between mixing, process DO, and limiting conditions of over-aeration. Preliminary process calculations indicate that at least 410 standard cubic feet per minute (SCFM) of blower aeration would be required in the online basin once the second basin has been taken offline.

Other considerations would be time of day to start the transition, it would be recommended during the low-flow diurnal period, which is typically the middle of the night. Temperature of each basin should be within 2-degrees Celsius of each other prior to basin transition. Basins should be kept in the same operating mode as they were prior to the transition. As the basin is emptied, probes and monitoring devices should be covered to protect from UV exposure.

Since nitrifying autotroph growth rates are slow relative to heterotrophic organisms and are very sensitive to temperature, transition to one basin is only recommended during the dry-weather season when wastewater temperatures are highest. One-basin operation should not be in use when basin temperatures fall below 18 degrees Celsius. Figure 1 presents effluent wastewater temperatures from 2018 and 2019.

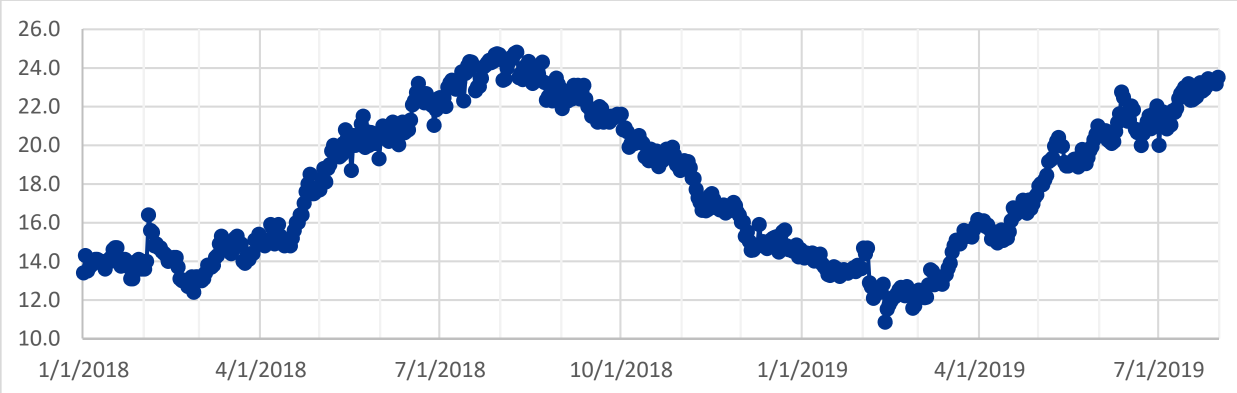

Figure 1. Effluent wastewater temperature, degrees Celsius.

3. Transition Pumps

The drain pump(s) or the mixed liquor recycle (MLR) pump could be used to transfer MLSS and would not overload the secondary clarifiers based on its peak design criteria, as shown in Table 2. Surface overflow rates (SOR) and solids loading rates (SLR) would fall below peak design criteria, as indicated in the 2000 RTP Plant Expansion drawings.

Table 2. Time to Drain

Transition from 2 to 1 Aeration Basins

Drain Pump Flowrate (gpm)	Time to Drain (hours)	Surface Overflow Rate (gpd/sf)[1]	Solids Loading Rate (lb/d/sf)[1]
226 (1x drain pump)	12.8	342	17.8
450 (2x drain pump)	6.4	506	21.3
1,100 (MLR pump)	2.4	983	32.7

[1] Estimated SOR assumes plant flow of 0.345 MGD, which was the average daily flow in August 2019.
Estimated SLR assumes MLSS concentration of 2,500 mg/L, which is the dry-weather season average.

Using either both of the drain pumps or the MLR pump would be preferred to a single drain pump, since the time to transfer would be significantly lower with those options. If the MLR pump is used, flow rate should be maintained at or below 1,100 gpm to avoid exceeding the design peak hour surface overflow rate of the secondary clarifier, rated at 983 gallons per day per square foot of clarifier surface area.

Plant staff should continue aerating the basin being taken offline while it is being drained, as excessive downtime without feeding or aeration will damage the microbial community and lead to potential disruptions of treatment in the active basin.

4. Monitoring

4.1 Prior to Transition

Sampling of online aeration basins one week prior to transition would provide baseline target values for the basin that will be kept online. Recommended daily samples for:

- Aeration Basin Effluent Ammonia- Nitrogen (NH_3-N)
- Aeration Basin Effluent Nitrate-Nitrogen (NO_x-N)
- Secondary Effluent COD

4.2 At Transition

- Temperature – above 18-deg C
- SVI – below 150
- RAS Rate – as RAS pumping is reduced in offline basin, RAS for online basin should be increased
- F:M – below 0.4 during transition if possible, then stabilize within normal operational range, 0.05-0.15
- MCRT – above 5 days
- MLSS – below 3,500 mg/L, or as high as plant performance allows historically
- Aeration supply – increase in online basin as second basin is taken offline
- DO – maintain DO concentration of 2 mg/L

4.3 After Transition

Monitor Aeration Basin process parameters (daily):

- Aeration Basin Flow
- BOD_5
- TSS
- pH
- SVI
- MLSS concentration
- DO concentration
- HACH spectrophotometer (DR3900 or equivalent) can provide periodic measurements of aeration basin performance indicators (e.g. COD, Ammonia-nitrogen, Nitrate-Nitrogen)
    - Aeration basin effluent chemical oxygen demand (COD)
    - Ammonia Nitrogen
    - Nitrate Nitrogen
- If available, ORP (Oxidation Reduction Potential) Probe can be used to determine if Anoxic, Anaerobic, or Aerobic conditions are being developed in the aeration basin. Sample each zone.

5. Next Steps

Contingency plans should be evaluated to prepare for unforeseen circumstances during basin transition. See Table 3 for example contingencies.

If the District would like to proceed with basin transition, we recommend generation of a detailed plan that includes clear step by step instructions that starts with prerequisites for basin transition, order of valves/gates to be turned, and process values to monitored.

TABLE 3 - EXAMPLE

CONTINGENCY PLANS

Description	Potential Concern	Contingency Plans	Notes/Alarms
Wet Weather Event During Transition	An extreme wet weather event may warrant deferring the aeration basin transition		
Dark diluted color of MLSS; sometimes white, sudsy foam in aeration zone.	MLSS potentially too low		
Odors in selectors	Underloading of aeration basin(s)		
Low DO in aeration zones	Poor bioreactor performance, nuisance foam/scum formation		
High DO in aeration zones	Underloading of aeration basin(s)		
Significant DO in non-aerated zones	Too much DO carry-over from internal recycle		
ML Pump Fail	If nitrifying, excessive denitrification occurring in the secondary clarifiers (resulting in high effluent TSS)		
Blower Failure	Low DO (see above)		
Blower System Failure	Low DO (see above)		
Foaming/Scum	Transition conditions (e.g. – varying loads to aeration basins, etc.) can result in foam/scum formation. Typically, this is more of a nuisance, but needs to be addressed so that this does not compromise treatment performance.		
Diffuser failure	Unlikely, but rare occurrence of diffuser system failure during transition		
Instrumentation Calibration	Poor instrument calibration leads to control/operational issues.		