Davenport

IA8222003

Plant Description:

2606 S Concord St
Davenport, IA
52802

26 MGD design flow

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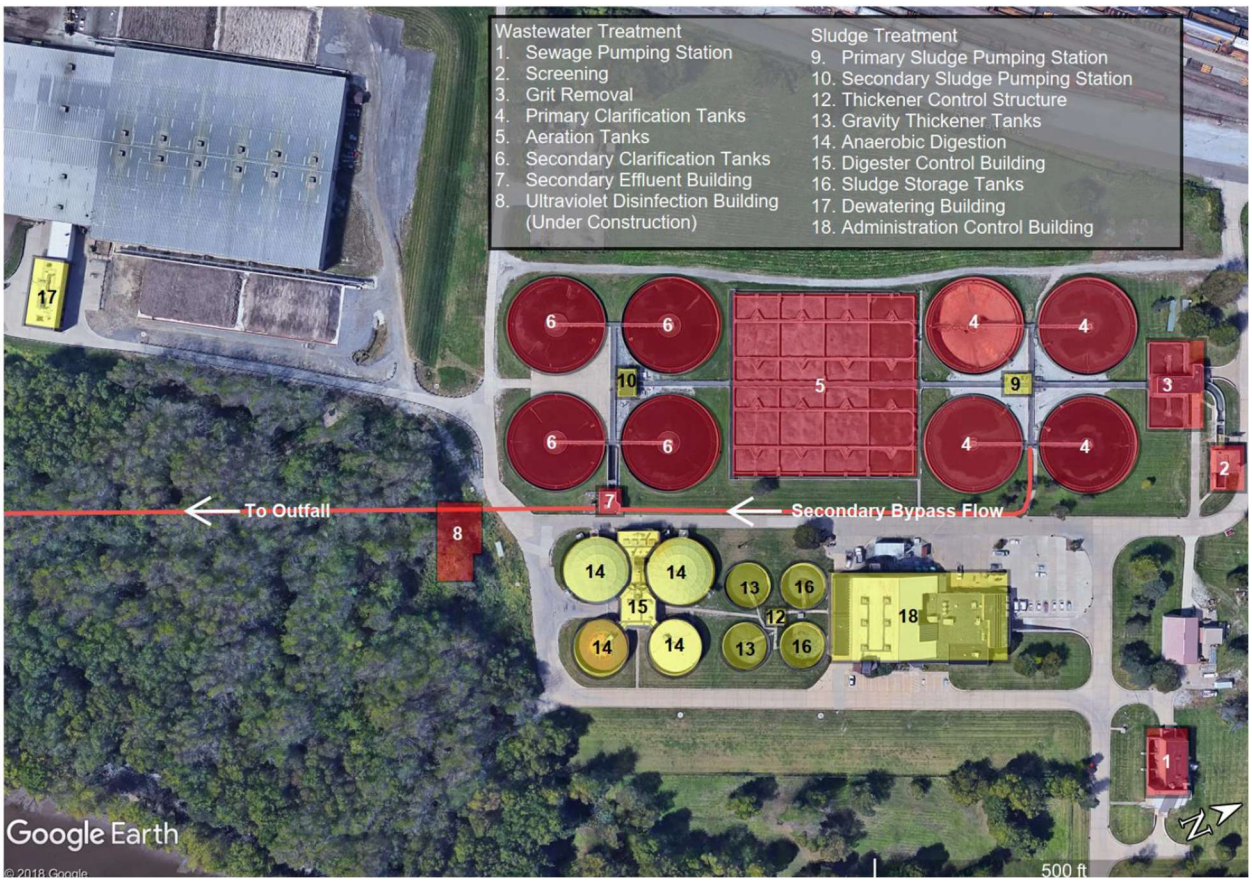
The plant treats domestic and industrial sewage, typically about 24.5 MGD. Headworks followed by primary clarifiers feed an Anaerobic/Oxic (A/O) process, upgraded from conventional BOD removal in 2016. Two plug-flow trains each with four, in-series activated sludge basins aerated by one or two of the three 600 HP single speed centrifugal blowers. Manual inlet vanes and automatic butterfly valves can target a specific SCFM without DO control; DO reportedly swings widely throughout the day.

The first of four basins in each train is anaerobic with subsurface Advent mixers. The aeration diffusers were removed from these basins and installed in the downstream aerated basins. During wet weather plant can step-feed to basins 1 and 3.

Primary solids and WAS are mixed with secondary effluent and fed to a thickener, then fed to anaerobic digesters. Digested solids are dewatered with a belt press and composted for beneficial use. Plant staff struggle with struvite formation in digesters.

With an activated sludge volume of 6.4 MG (8.0 MG including the anaerobic zones), the aerobic hydraulic retention time is about 6 hours at typical flows. The anaerobic hydraulic retention is about 2 hours. The facility is operated with a less than 5-day MCRT (mean cell residence time) to minimize nitrification.

The effluent total-Nitrogen concentration averages 29 mg/L, of which the Ammonia concentration averages 20 mg/L. Phosphorus removal of ~75% to a concentration averaging 0.7 mg/L is routine but not universal.



Historical Performance (2023-2024 averages):

Average Flow: 24.8 MGD
BOD_5: influent 180 mg/L / $cBOD_5$ effluent 6 mg/L
TSS: influent 180 mg/L / effluent 7.3 mg/L
Ammonia: avg 20 mg/L; limit >55 mg/L

Total Nitrogen:
influent 39 mg/L
effluent 29 mg/L, ~65% as ammonia
no permit limit

Total Phosphorus:
influent 4.2 mg/L average
effluent 0.7 mg/L
no permit limit

Pre-Optimization Data Summary:

	Influent				Effluent				
	BOD	TSS	tN	tP	Flow	BOD	TSS	tN	tP
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	MGD	(mg/L)	(mg/L)	(mg/L)	(mg/L)
2023	198	181	42.0	4.7	25.60	7.7	7.9	27.5	0.7
2024	173	171	36.2	3.6	27.08	5.5	7.1	30.3	0.7

- Davenport's effluent is permit compliant.
- 30.3 mg/L effluent TN in 2024 is above Iowa DNR's target of 10 mg/L or 67% removal.
- 0.7 mg/L effluent TP in 2024 meets Iowa DNR's target of 1.0 mg/L or 75% removal.

Optimization Objectives:

The goal for the year-long effort is to: (a) maintain permit compliance (b) maintain excellent BOD, TSS and TP removal, while (c) explore options for introducing Ammonia removal and eventually total nitrogen and (d) gaining an understanding of Phosphorus removal – is it removed biologically or chemically?

Optimization Strategy (post-Initial Site Visit):

Phosphorus

Collect data to gain an understanding of Phosphorus removal to determine whether Phosphorus is removed biologically or chemically.

On three or more occasions, collect grab samples of the primary effluent and test for orthophosphate. If the Phosphorus concentration in the primary effluent is less than 1.0 mg/L, Phosphorus is being removed chemically by water treatment plant backwash or some constituent discharged into the collection system. The influent aluminum concentration averages 0.5 mg/L, enough to remove up to 0.6 mg/L of Phosphorus chemically. Suggesting that Phosphorus is being biologically removed.

If the orthophosphate in the primary effluent is greater than 1.0 mg/L, on three or more occasions grab samples can be collected in two locations and compared to confirm biological removal. The locations being: (a) a blend of primary effluent and return sludge going into one or both of the anaerobic basins and (b) the flow exiting the anaerobic zones. Biological Phosphorus removal will be confirmed if the orthophosphate concentration in the flow leaving the anaerobic zone is measurably higher than the orthophosphate concentration going into the anaerobic zone.

Nitrogen

Two strategies for implementing Nitrogen removal available to the Davenport staff were discussed during the October 8 site visit: (a) cycling aeration in the aerobic zones of the aeration basins and (b) recirculating mixed liquor to one or more of the four primary clarifiers. Given the condition of the aeration blowers and the low aeration basin HRT, plant staff favor the option of creating anoxic conditions ahead of aeration.

For any Nitrogen removal strategy to be successful, Ammonia must first be converted to Nitrate for total-Nitrogen to occur. For this to happen, it will be necessary to increase the MCRT from 5 days (current setting) to 10 or more days.

A strategy for documenting "proof of concept" Nitrogen removal was developed during the site visit. "Proof of concept" because it is unlikely that the effluent total-Nitrogen concentration can be reduced sufficiently to meet target concentration without over 24 MGD of flow from the aeration basins being recycled to primary clarifiers.

Next Steps:

In advance of our 10 AM Thursday, November 12 video call:

- Collect orthophosphate samples as described above
- Confirm an ability and interest in increasing the MCRT from 5 to 10+ days, including increasing RAS rate as necessary to minimize rising solids in the final clarifiers
- Prepare for recirculating approximately 2 MGD of nitrified activated sludge to one of four primaries for Nitrate removal

During our call we will discuss the above and come up with a recommended sampling strategy to monitor total-Nitrogen removal.