How Detroit Lakes Is Tackling Stringent New Wastewater Regulations

Faced with the one of the most stringent nutrient limits in Minnesota and seven years to comply, the City of Detroit Lakes is implementing long-range plans for their wastewater treatment facilities. Like many cities, the City of Detroit Lakes is negotiating a complex nexus of aging infrastructure, population growth, new regulations, funding concerns and environmental considerations.

Facility Background

Facility Fast Facts:
Current Service Population: 8,900
Future Service Population: 15,584
Current Plant Capacity: 2 MGD
Future Plant Capacity: 2.21 MGD AWW
59 lift stations
72 miles of gravity sewer
13 miles of force main

The Detroit Lakes Wastewater Treatment Facility is currently a 2-MGD trickling filter facility. Much of the facility was constructed in 1942 with improvements in 1961 and 1996. After pretreatment and primary clarification, the effluent from the trickling filters goes through a 3.5-acre stabilization pond and through a 25-acre storage pond before being routed one of three ways. During warm seasons, the effluent is either discharged through four spray irrigation systems irrigating 54 acres of land or is discharged to 19 rapid infiltration basis (RIBs) covering 21.5 acres of land. When cold weather arrives and the ground freezes, the effluent is routed through a 1970's chemical precipitation plant to reduce the total phosphorus down to 1 mg/L for discharge to Lake St. Claire.

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Detroit Lakes Continued

94 percent reduction required

Lake St. Claire was identified on the impaired waters list due to high levels of excess nutrients causing algal blooms in the shallow lake. A Total Maximum Daily Load (TMDL) Study determined the City would need to reduce the phosphorous entering Lake St. Claire to 198 kg/yr. At future projected flows and assuming year-round discharge this equates to a 94 percent reduction — from 1 milligram per liter to 0.066 milligrams per liter.

Weighing options, arriving at a plan

Through the facility planning process, the City looked at options and identified the most cost-effective approach to meet the limits. Alternatives included:

Relocating discharge: Could limits be less stringent at a different point of discharge?	Two other discharge locations were considered. These locations still resulted in relatively stringent effluent phosphorus limits between 0.2 mg/L and 0.3 mg/L. Tertiary treatment would be required regardless of the discharge location. A new discharge location has the added cost of an 11-mile pipeline, as well as uncertainty, cost, and delays associated with a non-degradation review. Additionally, one of the discharge locations required fees and approval from the watershed district.

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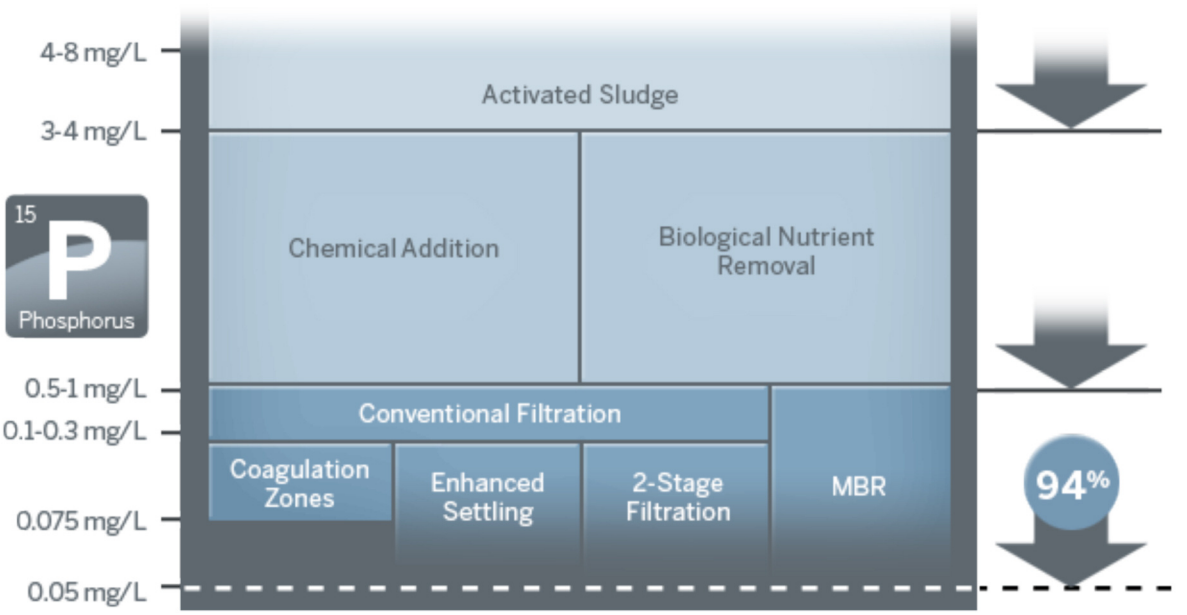
Relocating the facility site: If limits do vary with discharge location, then where is the ideal location for treatment? Is there enough room at the existing site to construct new technologies and keep the plant in operation during construction?	A new treatment facility site would require land acquisition and utilities. Given the nature of the area, a new site would also likely face some of the same challenges as the existing site, including dewatering and sheeting and shoring. The existing site can accommodate the required treatment processes.
Seasonal versus year-round discharge: Would continuing a seasonal discharge provide a cost-savings?	Due to the high groundwater, continued use of the rapid infiltration basins was not advised. The City would have to acquire much more land for spray irrigation; finding this land in lake country would be challenging and expensive.
Applying innovative treatment technology: What treatment options are available to achieve the limits at the various discharge locations?	There are several tertiary filtration options that have demonstrated the ability to meet effluent limits as low as 0.066 mg/L.

This suite of alternatives resulted in a matrix of 12 treatment options, each with an estimated capital and life cycle cost. Looking at the options side by side, the costs associated with moving the facilities or discharge were high. The long-range Facilities Plan recommended leaving the plant and discharge where they currently are, moving to year-round discharge, and getting more serious about treatment. There are treatment options with demonstrated success at meeting low-level phosphorus concentrations. The City considered in more depth two specific liquid treatment options to meet the 0.066 mg/L effluent phosphorus limit – an activated sludge system followed by filtration through Blue Water Technologies Blue PRO® filtration process and a membrane biological reactor (MBR).



Treatment options to achieve varying degrees of phosphorus removal.

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The activated sludge/Blue PRO alternative consisted of conventional pretreatment with 3-mm fine screens, an integrated fixed-film activated sludge system (IFAS) to reduce the footprint of the biological treatment, final clarifiers, and the Blue PRO tertiary filters, followed by disinfection. The Blue PRO system is a sand-media filter whereby which hydrous ferrous oxide forms a reactive coating on the sand surface preferentially adsorbing phosphorus.

An MBR system is an activated sludge system followed by membrane filters. The membrane filters serve two purposes – clarifiers and tertiary filters. Additionally, because the solids removal is by physical filtration, the activated sludge system can operate at a greater solids concentration, reducing the footprint of the activated sludge system. An MBR system must be preceded by fine screening with 1-3 mm openings, varying with the manufacturer. An MBR would be followed by disinfection, but operation of the system may not be necessary if the MBR can meet the fecal coliform treatment requirements.

The City traveled to multiple locations to see installations of these two systems and discuss operation and maintenance issues firsthand. A detailed comparison of these alternatives found the costs to be nearly equal, but the MBR alternative offered the smallest footprint (important for a site that is space constrained), a shorter construction sequencing schedule, and greater treatment reliability with a smaller filtration pore size.

The Final Selection

With the selection of MBR as the secondary/tertiary treatment process, the next task was to select which type of MBR to utilize. Membranes can be flat panel, hollow fibers, hybrids, and even ceramic. The MBR system footprints/structures vary significantly among the manufacturers. For these reasons, the design team used a preselection process to select the MBR manufacturer. The preselection process allows for a competitive selection (important for federal funding), allows the City to make the selection on their criteria not simply low cost as a Contractor might, and allows the design team to design around a single manufacturer, reducing uncertainty and changes that may arise during construction. A total of six manufacturers submitted proposals for the MBR. The proposals were evaluated by a team of five individuals including representatives from operations, utility, and engineering. The evaluators used a defined point system that distributed points for capital cost, operating cost, experience, references, system design, company stability/responsibility, and support. Along with the preselection package, the City required a 1-year performance guarantee for the effluent parameters, power use, and chemical use. The City is working through contract terms with the selected manufacturer. Final design is being completed at this time with construction scheduled to begin next fall.

Conclusion

As it progresses with its wastewater treatment facilities and prepares for the next few decades, the City of Detroit Lakes Public Utility will continue to serve as a role model for other communities affected by extremely stringent nutrient load regulations. As water quality continues to be a priority across the country, cities of all sizes will have to continue to meet more stringent regulations such as those in Detroit Lakes. Smart planning and close attention to emerging technologies will be required to meet them. When faced with new stringent regulations, it is necessary to consider all options – new discharge locations and different technologies. The City of Detroit Lakes has identified a solution that best suits their community, but the solution may be different for another community.