Energy Efficiency in Municipal Water and Wastewater Treatment

SAVING ENERGY EQUALS SAVING MONEY

Iowa Association of Municipal Utilities

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Water Reuse: Iowa's First Application of Effluent Use for Power Plant Cooling Water

Clear Lake Sanitary District
Kevin Moler P.E., Dist. Administrator/Superintendant
Population: 8,161

What is Water Reuse?

Water reuse involves taking domestic wastewater, giving it a high degree of treatment, and using the resulting high-quality, reclaimed water for a new, beneficial purpose. Treating and reusing water that would otherwise be considered "waste" takes into consideration the energy that went into treating water to standards that exceed the quality of surface waters to which the effluent would be discharged, to allow for further utilization of the water. Reused water in other non-potable applications can also insure a long-term reliable source of water to take into consideration, especially during periods of drought or in areas where the demand for water exceeds the amount of water available from drinking water sources.

Clear Lake Sanitary District Treatment System History

A major renovation at the Clear Lake Sanitary District (CLSD) not only helped the system come into environmental compliance, but also positioned the district for an unanticipated project that is proving to be beneficial. The $23 million dollar renovation was

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started in 1995 and completed in 2001. The Clear Lake Sanitary District was contacted by Alliant Energy in 2002. Based upon the capabilities of the Clear Lake Sanitary District, due to the renovation, Alliant Energy signed a 25 year contract with CLSD to supply treated sewage to the newly constructed power plant to meet the cooling water demand.

The primary motivation for the renovation was to address the legal problems caused when the system was found inadequate to meet environmental regulations. The project allows CLSD not only to meet current requirements, but also to address future environmental issues. When the renovation was planned, however, CLSD's manager and policy-makers could not have foreseen that it would also enable them to enter into a project to use effluent to supply cooling water to the new Alliant Energy electric generation plant located a few miles away. According to Kevin Moler, CLSD Superintendent, "We would not have been selected for this project if we had not completed the $23 million dollars worth of improvements to our system. Our lack of capacity and treatment inadequacy would have made us unable to fulfill Alliant's requirements."

The CLSD was formed in 1950 to replace septic tanks in the City of Clear Lake and in the areas surrounding the lake. The prevalent septic systems were causing contamination of the lake, to the point that there was a threat to close the lake to swimming. An extensive network of piping was installed, along with a trickling filter plant for treatment.

By 1988, that system had proven inadequate for the growing population and treatment needs and CLSD came under administrative order to fix the problems. One of the major problems was excessive inflow and infiltration. Many Publicly Owned Treatment Works (POTWs) experience increased sewage flows due to infiltration and inflow during rain events. But when communities are built around a natural lake where the groundwater table is high year round, as with Clear Lake, additional sewage pipe length is required to traverse the lake perimeter thus providing more leaking joints—the Clear Lake Sanitary District

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experiences even higher flows than typically associated with storm events.

The CLSD could have simply fixed the "leaky pipes," but chose instead to construct new pumping and treatment systems large enough to handle the storm water discharges. According to Moler, "This [first] option was considered. In fact, a study of the leaky system was completed and cost effective projects were implemented, but [only] a very small portion of the leaks were fixed. The cost associated with fixing the leaks to a point that would have made a significant impact was approximately four times the cost to build the system that we did."

The $23 million dollar project, begun in 1995, consisted of several phases:

Phase I: Renovation of two lift stations, new force main pipe connecting to treatment plant, and equalization basin.

Phase II: Construction of activated sludge treatment plant using a sequencing batch reactor process.

Phase III: Construction of new force main.

Phase IV: Renovations of six additional lift stations.

Phase V: Construction of plant site storm water equalization basin.

The current system uses screens and grit removal for primary treatment followed by SBRs for secondary treatment. The existing trickling filters were converted to activated sludge-sequencing batch reactors. The reactors are operated as a batch process where reactors are filled to a certain level and then the wastewater is aerated then mixed for 30 minutes then the treated water is decanted off and solids are removed and sent to an aerobic digester. Then another basin is filled in the same manner in series. Sludge, after the digester, is sent to a rotary thickener and two times per year is land injected. The design capacity of the system is 5.7 million gallons per day (mgd) average day dry weather. While the system's current average flow is 2 mgd, it is now permitted for 9.4 mgd to be able to meet the peak flows during the busy tourist season at this popular destination.

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System improvements were completed in 2001. "While we could have put a patch on the old system, the CLSD Board had the foresight to invest in an effective new system," said Moler. "We added filtration to address our current environmental needs, but we also have a system that can address future requirements. We don't currently have to address nitrates and phosphorus, but we see that coming and we're ready when it happens," he said.

Kevin Moler, Supt. Of CLSD, explains the treatment monitoring system.

Current Treatment System Upgrade: An Investment that Paid Off

The investment in a new system not only helped CLSD meet its NPDES permit requirement but it also put them in a position to participate in an innovative and beneficial project with a new electric generation plant. Alliant Energy has constructed a new gas-fired turbine plant near Clear Lake and to supply cooling water for the plant, Alliant turned to CLSD.

Alliant had identified an area close to Clear Lake that was within close proximity to two major natural gas pipelines, the source of fuel for the plant. "Alliant needed 3,400 gallons per minute for its cooling towers, but was only going to be permitted to pump 2,000 from the Jordan aquifer at the plant site," said Moler. The natural gas pipeline connected to the plant passes by the CLSD facility, and it seemed possible to extend a water line without additional right of way issues. They were considering a water reuse option in using 1400 gallons per minute (gpm) treated effluent from the Sanitary District to supplement groundwater for cooling water. The question was

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whether or not CLSD's effluent could meet Alliant's stringent requirements for cooling water. Because of the CLSD's upgrades, there was no problem with it being able to take back Alliant's return water.

Alliant proceeded with this process by providing CLSD with information on their future water quality effluent requirements from the CLSD for cooling water. Since this was to be the first water reuse application like this in Iowa, the CLSD contacted treatment facilities in states such as California where effluent reuse is used more commonly. During their investigations they found that the following states have treatment systems that reuse effluent for cooling water at power plants: Massachusetts, Rhode Island, Maryland, New Hampshire, Oklahoma, New Jersey, Virginia and Oregon.

The CLSD decided to work with Alliant to accommodate their cooling water requirements. What followed were a series of regulatory and treatment requirements that had to be addressed during the planning process. The CLSD had to obtain approval for the water reuse from the Iowa Department of Natural Resources, the NPDES permitting authority in Iowa. The water reuse required the addition of new guidelines to the permit for the Clear Lake Sanitary District. Additional treatment is required of the CLSD effluent before it can be used for cooling water at the electric plant after further evaluation of the quality of effluent.

In order to meet Alliant's requirements, CLSD added several tertiary treatment processes for further filtering and disinfection before the effluent could be sent to the power plant for cooling water. Alliant paid for the necessary updates to the CLSD plant that have included the addition of a building to house the new cloth-media filter used to further polish the effluent and ultraviolet disinfection equipment. The building used to house the additional treatment equipment was able to be down-sized with the smaller equipment requirements of the cloth-media filter compared to other filter systems.

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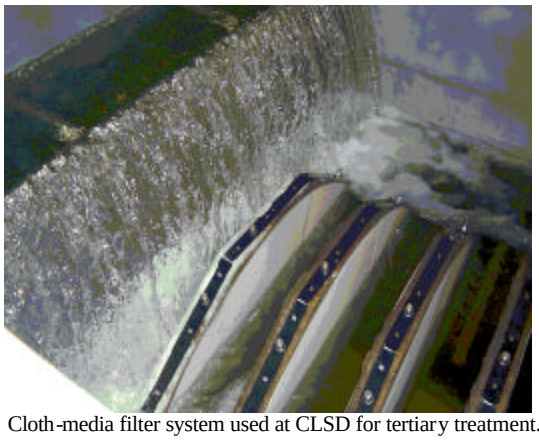

Cloth-media filter system used at CLSD for tertiary treatment.

Once Alliant receives the effluent from the CLSD it further disinfects using chlorination and is blended to a ratio of 60% groundwater and 40% effluent before it is used for cooling water. The evaporate, or the 20% of water that remains from the cooling water process, is returned to the CLSD. An in-line probe monitors the chlorine concentration of the return cooling water to determine if sodium sulfite addition is needed for de-chlorination. The effluent from the treatment plant is blended with the return cooling water prior to discharge to surface water due to the high concentration of dissolved solids. There is an in-line monitoring of the volume of return cooling water coming back to the CLSD so that if the treatment capacity of the plant is reached, the cooling water can be directed to a storm-basin and treated when the treatment plant can accept the flow.

Additional monitoring is required of the effluent sent to the power plant. Some of the parameters include: specific conductance, total dissolved solids, suspended solids, BOD, chlorides, ammonia- N, TKN, E-coli, zinc, chromium, copper, potassium, iron, silica and sodium. Alliant conducted toxicity testing of the concentrated cooling water returned to the treatment plant in order to provide data for assisting with IDNR's establishment of discharge permit limits of the returned cooling water.

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The following is a list of the additional operation requirements of the CLSD to provide cooling water to the power plant and treat the return cooling water:

1. Sampling/mandatory testing.
2. Operation of equipment.
3. Routine equipment maintenance.
4. Processing and monitoring of return cooling water.
5. Capacity for treatment.
6. Additional personnel of 1.5 employee equivalents.

The changes to the CLSD plant were completed in January 2004. Alliant has access of up to 19.2% of the CLSD's dry weather hydraulic treatment capacity, which is 5.7 million gallons per day. The electric plant will operate continuously and require a constant supplemental source of cooling water from CLSD, except during brief shut down periods in winter.

CLSD entered into a 25-year contract with Alliant to provide them with the quality of effluent needed for cooling water. Alliant pays a monthly fee to CLSD to cover the expenses required for the further polishing of effluent for cooling water and the return evaporate from the cooling process. "We think it's the right way to conduct business," says Moler, commenting on the arrangements made with Alliant Energy to provide effluent for cooling water.

Wastewater Treatment System Upgrade Provides Opportunity to Improve Energy Efficiency

The district took advantage of the opportunity to incorporate energy efficiency into their system during treatment system upgrading in the late 1990's to 2000.

- Soft start pumps with energy efficient motors replaced less efficient motors.
- A SCADA system was installed and is used to monitor and control the treatment system in as efficient a manner as possible.
- Dissolved oxygen probes were installed in the SBR tanks to monitor oxygen concentrations.

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- The information obtained from the probes is used to operate the blowers and mixers in the SBR tanks in an efficient manner.
- Back-up diesel power generation was installed.
- The District signed a contract with their energy supplier, Alliant Energy, for interruptible service.

A Worthwhile Partnership

The investment in the CLSD treatment system upgrade helped it meet the NPDES permit requirement and position itself to participate in a unique water reuse application with Alliant Energy. Moler suggests that it was the Clear Lake Sanitary District's board of trustees' foresighted approach to constructing a state-of-the-art treatment system with universal treatment capabilities that made all of this possible, "Without this extensive treatment capability, Alliant Energy and the environment would never have benefited."

Moler advises all Publicly Owned Treatment Works (POTWs) to take a positive approach when upgrading their treatment facilities. Too many times decision-makers take what they believe to be monetary short cuts. As a result, a treatment system is constructed with the inability to comply with the State issued discharge permit limits.

When upgrading a system, it is important to consider treatment options that allow the system to operate as efficiently as possible, with capabilities for accommodating possible changes in water quality standards, and for attracting industries to your community. Without adequate treatment, effluent reuse discussions or the solicitation of businesses to your community will not be possible. Not only will your community suffer but the environment will too.

Acknowledgements
We are grateful to Kevin Moler, CLSD Administrator and Superintendent, for providing us with the information needed for this case study.