WLSSD

# Western Lake Superior Sanitary District WWTF

The Western Lake Superior Sanitary District (WLSSD) serves 17 communities and four large industrial customers on the western edge of Lake Superior, providing wastewater treatment and solid waste management for 530-square mile region surrounding Duluth, MN.

WLSSD was established in 1971 by an act of the Minnesota Legislature. As a political subdivision of the state of Minnesota, WLSSD provides a single authority to address the regional collection and treatment of wastewater, thereby protecting the St. Louis River basin and Lake Superior. Solid waste authority was added in 1974 and WLSSD has a long history of innovative pollution prevention efforts that draw on the strengths of both its wastewater treatment facility and solid waste management infrastructure.

## A MIGHTY RIVER, A GREAT LAKE

WLSSD's story is also the story of the St. Louis River, the second largest of Lake Superior's tributaries and the largest American tributary. The river runs for 179 miles, draining a watershed of nearly 4,000 square miles. The mouth of the river at Lake Superior holds a 12,000-acre freshwater estuary.

For many years, pollution was regarded as the price of progress in America, and that was also true for the communities and industries along the St. Louis River. The river long-supported a variety of industrial activities, including sawmills, paper mills, pulp mills, and steel, tar and chemical production. The Duluth-Superior Harbor was historically home to flour and lumber mills, 50 shipping docks, and numerous active railways. The degradation of the lower reaches of the St. Louis River continued throughout most of the 20th century. The St. Louis Bay of Lake Superior was designated an Area of Concern (AOC) by the International Joint Commission Waster Quality Board in 1973 due to high nutrient, solids and BOD loadings.

## A REGIONAL SOLUTION

Construction of the WLSSD WWTF was completed in 1978 and dramatic water



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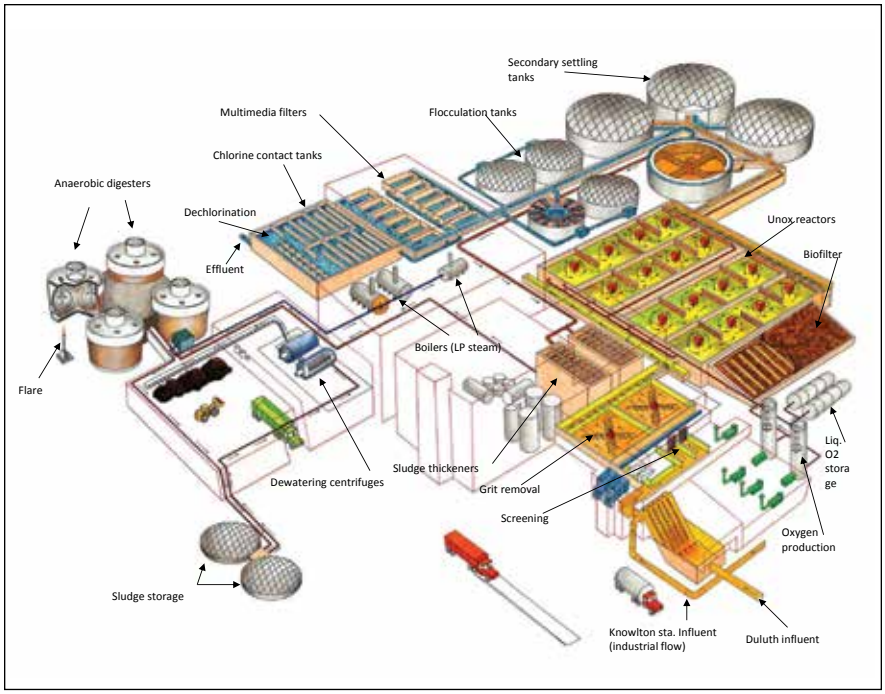
quality improvements in the St. Louis River were apparent within a year of plant operation. The facility is a High Purity Oxygen Activated Sludge system designed to treat 48 MGD of wastewater and is operating currently at an average flow of approximately 40 MGD. The plant has a peak hydraulic capacity of 160 MGD. Approximately 50% of the plant influent flow and load is industrial, primarily from the Kraft pulp and paper industry. The synergistic effect of hot influent with high solids load and low nutrient waste from industrial customers, combined with cold domestic waste with low BOD and high nutrients creates a unique operating environment.

WLSSD's wastewater conveyance system consists of 75 miles of interceptor sewer with seven metering stations and 18 pump stations, the largest of these being the Cloquet Station (36 MGD capacity, 30" forcemain); Scanlon Station (46 MGD, 42" forcemain), and Knowlton Station (49 MGD, 54" forcemain).

## PRELIMINARY AND SECONDARY TREATMENT

The facility operates on a 23-acre footprint in the heart of the city of Duluth. As a result of low influent nutrient loading, the plant was designed to operate without primary treatment and is equipped with a Union Carbide Pure Oxygen Activated Sludge (UNOX) system with two 50-ton cryogenic air separation units for onsite production of oxygen to facilitate rapid treatment. The absence of primary treatment also keeps the nutrients in the activated sludge process.

Incoming wastewater is lifted into the plant by five 40-foot long screw pumps, each driven by a 100 horsepower motor. It receives preliminary treatment with mechanically cleaned ¾-inch bar screens and grit tanks to remove debris prior to entering the activated sludge process. WLSSD has recently begun a $10.2 million headworks rehabilitation project that will be completed in 2016; the two course mechanical screens will be replaced by three continuously raked fine screens (1/4") to achieve firm screening capacity (80 MGD each). Dedicated washers and compacters will further improve screenings operation. A full grit tank mechanism replacement and rehabilitation will also include the first US installation of a floating scum screw

conveyor system. WLSSD anticipates the headworks rehab will result in significant improvement in downstream maintenance issues and contribute to a safer work environment as it eliminates manual labor as currently required for scum removal.

Following preliminary treatment, the wastewater enters the oxygenation tanks. Each of the four trains of concrete tanks in the activated sludge process contains four interconnected chambers –each 56 feet square by 18 feet deep (13 feet active). Wastewater is mixed with activated sludge and flows from chamber to chamber as mixers in each chamber dissolve the high purity oxygen into the mixed liquor. The 125 HP first stage mixers were retrofitted with VFDs in 2012 allowing speed control based on dissolved oxygen levels in the first stage reactor. Similarly, in 2010 dissolved oxygen probes were added to the fourth stage chambers to control the oxygen feed. The end result of these two improvements is an automated oxygen flow-control based on the exact amount of oxygen needed, allowing for greater efficiency and minimizing the on-site production of oxygen.



This has been a crucial improvement in lowering energy costs as mixer speeds of 60% are not uncommon. Original plant design allowed for about 160 lbs of BOD/Day/1000 cubic feet of reactor volume. The upgraded mixers are rated at a minimum of 180 lbs/day/1000 ft 3 of reactor volume. Typical low flow operations use two treatment trains with a retention time of 1.4 hours.

Next, wastewater flows into four 2.1 million gallon Temcor dome covered secondary settling tanks for solids removal. The 160 ft. diameter clarifiers contain inboard peripheral launders and a weir system. The mechanimsms of the clarifiers were replaced in 2003.

Water is then distributed to four 1.2 million gallon flocculation tanks. These tanks were originally designed for phosphorus removal, but because WLSSD experiences low influent phosphorus loadings, these tanks are only used to remove small amounts of suspended solids that are discharged from the secondary settling tanks. The mechanisms for the flocculation tanks were replaced and the design changed from radial launders to perimeter launders in 2007.

On average, 9 MGD of activated sludge is returned to the oxygenation tanks and the remainder pumped to dissolved air floatation thickeners for eventual processing into biosolids.

## DISINFECTION AND FILTRATION

The plant was originally designed to use a chlorine gas system for disinfection. As a result of safety and security concerns, this was upgraded to sodium hypochlorite in 2006. In 2011 the WLSSD operations team designed and implemented an automated sodium hypochlorite delivery system that is able to respond to the variances in chlorine demand associated with industrial flows and loads. Sodium hypochlorite is delivered by peristaltic pumps into the secondary effluent channel as water flows to one of twelve mixed media filters.

Each mixed media filter bed consists of layers of anthracite coal, sand, and gravel. Water then flows through plant-aerated contact tanks following filtration to remove carbon dioxide and sodium bisulfite is added by peristaltic pumps just before the treated effluent is discharged to the St. Louis Bay to remove any remaining chlorine residual.



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## SOLIDS PROCESSING VIA TEMPERATURE-PHASED ANAEROBIC DIGESTION (TPAD)

The plant was originally designed with fluidized bed incineration using refuse-derived fuel (municipal solid waste) to incinerate sewage solids. The system was in operation through the mid-1990s, when aging facilities, uncertainty about future sources of fuel, and increasingly protective regulation for incinerators set in the Great Lakes Initiative spurred the need to develop a new 20-year plan of operation. After extensive review of solids treatment technologies, WLSSD determined that temperature-phased anaerobic digestion offered the best solids management strategy.

Construction of the $33 million TPAD facility was completed in 2001. The original design of the four-tank TPAD system had thickened sludge (5.5 % TS) fed into a single thermophilic tank followed by the mesophilic tanks in parallel. The digesters are continuous feed/continuous mixed and have fixed, submerged covers. With each tank at one million gallons, the overall retention time is typically 26 days. Typical volatile solids reduction results were around 45%.

WLSSD made significant operational changes in the TPAD system in 2010: The thickened sludge is fed into two thermophilic digesters (130 degrees F) in series, followed by the two mesophilic digesters (99 degrees F) that operate in parallel. These changes have led to volatile solids reduction of 50-55%, producing a very stable and low odorant biosolids with very low pathogen values.

The digested sludge is stored in two 450,000-gallon tanks prior to dewatering via one of two Alfa Laval high solids centrifuges, raising the solids concentration from about 3% to 30%. Onsite storage is available for approximately 15 days production of biosolids, with another 30 days of storage available offsite.

WLSSD operates a robust land application program offering Field Green®, a class B biosolids product, to farmers in Minnesota and Wisconsin and for use in mineland reclamation projects on Minnesota's Iron Range. The program land applies an average of 22 dry tons/day on approximately 2000 acres of state-approved application sites. WLSSD operates the largest land application program in the state of Minnesota.

## CONSERVING ENERGY, CONTROLLING COSTS

Energy is at the core of WLSSD's greatest past innovations and greatest present challenges. Like all treatment works, WLSSD must remain sensitive to rate increases to reduce impacts on residents and businesses while also contending with shifts in the local paper industry that have resulted in lower flows and lower loads. An Energy Master Plan and Roadmap that outlines near-term and long-term actions throughout the organization to conserve energy and generate energy. The plan will help facilitate a stepwise process towards energy self-sufficiency.

The City of Duluth was named *Outside* magazine's "Best Town in America 2014" for its availability of outdoor recreation resources and natural beauty. WLSSD is proud of our region's incredible natural assets and our social, economic and environmental contributions that enhance our communities and protect our waters. CS