

Rochester Water Reclamation Plant



2004 Plant

The Rochester Water Reclamation Plant (WRP) serves the City of Rochester, located in the southeast corner of Minnesota and home to world renowned Mayo Clinic. The Rochester WRP serves a population of approximately 120,000 plus the numerous visitors that come on behalf of Mayo each year. The WRP treats about 14 MGD and has a design capacity of 24 MGD. The plant is operated 24 hours per day, seven days per week, 365 days a year by 29 staff members that include management, engineers, lab and environmental compliance staff, operators, maintenance staff, and support staff.

HISTORY

In the early 1900's, Rochester, like most cities, simply conveyed sewage to nearby fields or local waterways. As Rochester grew, the proportion of sewage entering the local waterway increased causing

downstream pollution and in 1916 downstream farmers began to complain about the condition of the river indicating that their cows, pigs, and chickens were dying from drinking polluted river water. An emergency election was held and bonds were passed to approve a wastewater treatment plant.

In 1926, Rochester's first wastewater treatment plant was built and sewer lines that were partially installed as far back as 1894 were connected to the plant to begin treatment. The mechanical activated sludge plant was designed for a flow of 2.2 million gallons per day at a cost of \$276,000 and was the largest of its kind in the US at that time. The process included screening, aeration tanks where sewage was drawn from the bottom of the tanks and sprayed over the surface for aeration, and clarifiers where settled sludge was pumped to digestion tanks. Sludge from the digestion tanks was sent into drying beds until dried at which point it was used as a fertilizer.

Rochester continued to grow as a community and soon the plant became overloaded. The City confines had also expanded and now surrounded the wastewater plant. In 1945, land was purchased two miles north of the City where the current facility is located. Although the plant was constructed several miles from Rochester, due to continued growth, the plant site is again surrounded by the Rochester Community. The original 1926 plant was decommissioned after construction of the new plant.

The 1952 wastewater treatment plant consisted of bar screens, grit collection, fine screens, trickling filters, settling tanks, and chlorination. Trickling filters were selected as the technology provided low operating costs and simple operation. The total cost for the new treatment facility was \$1,900,000. Shortly after construction, it was realized that the sludge treatment process was inadequate. In 1957 two anaerobic digesters were constructed to reduce sludge volumes and further treat the solids.



1926 Plant



1957 Plant



1967 Plant



1980 Plant



1992 Plant

In 1967, an activated sludge treatment process was added to the facility. The new process consisted of grit removal, preaeration tanks, primary settling tanks, aeration tanks, final settling tanks, a blower building, additional chlorinating tankage, a sludge thickening tank, sludge lagoons and sludge drying beds. The expanded plant was rated for 12 million gallons a day and cost \$2,700,000. The project was the first major expansion and required work to be performed with existing processes online. This expansion also added a tunnel system, which allowed the majority of operations to exist underground.

On July 5, 1978 the City of Rochester received 6" of rain that caused major flooding throughout the City. The Water Reclamation Plant did not escape its wrath when the South Fork of the Zumbro River banks overflowed. With water flooding the sub-basement of the plant, the staff had to cut power to the facility. Temporary treatment of sewage was done with six 2,000 gallons per minute submersible pumps, which pumped the sewage through a one inch bar screen and into final settling tanks before discharging to the South Fork of the Zumbro River. Transportation to and from the plant during the flood was achieved by using an employee's fishing boat as all roads were flooded. Repair costs for the 1978 flood damage totaled \$240,000.

A second treatment plant expansion was started in 1980 due to stricter MPCA effluent standards and increasing wastewater flows. The expansion added an administration building, equalization basin, high purity oxygen plant, primary clarifiers, intermediate clarifiers, final clarifiers, thickening building with centrifuges, pho-strip phosphorus removal system, gas compression building with storage sphere, chlorination treatment facility, extensive odor control facilities, and computer control for the entire plant. Part of the stricter MPCA regulations required Rochester to be the first wastewater treatment facility in the state to have an effluent phosphorous limit. This upgrade also included an energy recovery system, which included methane gas collection, boilers, two 400 HP engines, and final effluent water heat recovery system for process equipment and HVAC. The expanded plant was designed to treat 19.1 million gallons a day and cost \$56,000,000. 95% of the treatment plant upgrade cost was paid for by the Federal Government under the Clean Water Act.

In 1988, a chemical storage facility was added to house chemicals used for phosphorus removal shortly followed by a Solids Handling Improvements Project in 1992. The solids handling project included two new anaerobic digesters, two gravity belts replaced three centrifuges for sludge thickening, and a 4.7 million gallon biosolids storage tank was constructed to increase the overall storage capacity. This improvement cost \$14,600,000.

In 2004, the aeration basin complex (ABC) plant was constructed to run parallel to the existing high purity oxygen (HPO) plant and increased the plant's capacity to 23.9 million gallons per day. The new ABC plant consisted of a primary clarifier, two aeration basins, and a final clarifier. In addition to the new ABC plant, a new headworks was installed that included a new pump station, fine screens, and vortex grit removal. A third gravity belt was added to the solids handling facility and a second 2.5 million gallon biosolids tank was also added. Total cost for the expansion and upgrade was \$75,000,000.

RECENT HISTORY

In 2015 the MPCA indicated the Rochester WRP would be required to reduce their phosphorous discharge to Lake Zumbro below their current limit of 1 mg/L. At the same time it was becoming apparent that the cryogenic air plant used to generate high purity oxygen for the HPO plant was reaching the end of its useful life. Leadership decided it was time develop a Facilities Plan that addressed new limits, the cryogenic air plant, and other aging infrastructure. Several overarching goals were included into the facilities plan including reducing energy demand, clean design, decrease maintenance costs, consider innovative approaches, and have a long term holistic approach.

Rochester selected Brown and Caldwell for the Facility Plan work, which was completed in 2020. Brown and Caldwell evaluated most components of the facility including the liquid stream, the solids stream, and auxiliary gas handling and heat recovery systems. The finalized report included recommendations for a three-phased approach to implement the upgrades.

Phase 1 was primarily an administration upgrade. Due to restructuring within the City, it was decided to create an Environmental Services Department that would include the water reclamation plant, collection systems, storm water, and flood control. All these groups are to be located at the WRP site and thus new office space, shop areas and storage space was required. Several abandoned buildings and unutilized process spaces will be converted for the needed amenities, reducing the footprint of any new buildings. Phase 1 is currently under construction and had a cost of \$13,500,000.

Phase 2 is the upgrade to liquid stream and includes the modification of the HPO Plant to a conventional aeration treatment process. The existing HPO basins will be retrofitted for conventional treatment with the first stage being converted to anaerobic volume and second stage being converted to aerobic volume. Additional tankage will be required to convert to fully conventional

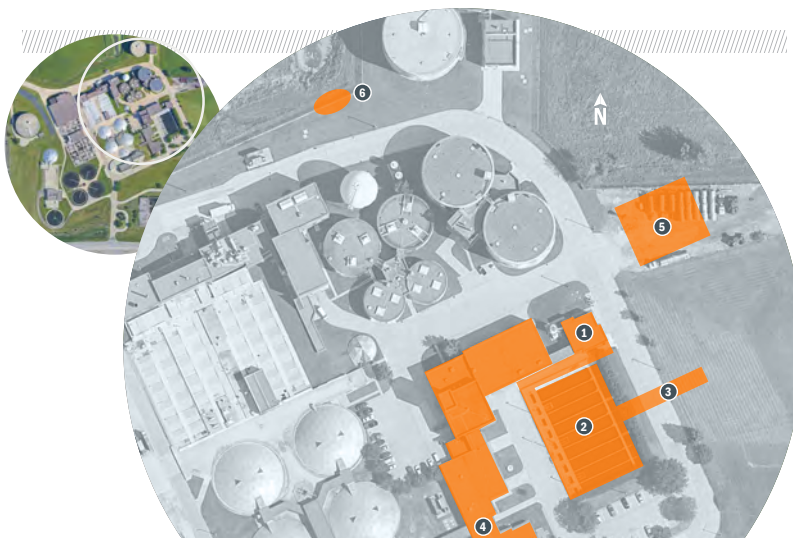
PHASE 1 Remodel and Effluent Upgrade

CAPITAL COST \$10,000,000

ENERGY SAVINGS \$47,000/year

CHEMICAL SAVINGS \$23,800/year

Remodel and effluent treatment upgrade to address aging equipment, improve collaboration, and meet regulatory requirements.



air and a new splitter structure will be added to allow a single mixed liquor to create a single plant concept. Estimated cost for Phase 2 is \$54,000,000 and engineering is expected to start in 2022.

Phase 3 is the upgrade to the solids treatment stream. This phase includes the addition of a primary thickener, modifications to the solids handling process, modification to abandoned tankage for storage, a second load out facility and upgrades to the odor control system. The estimated cost for Phase 3 is \$15,000,000 and would occur in the late 2020s. However, near the

end of the completion of the facilities plan, three significant industrial users in Rochester closed their doors resulting in noteworthy drop in loadings to the WRP. It is believed many of the projects for Phase 3 can be reduced or eliminated due to the decreased loadings.

The facilities plan also considered some innovating technologies including granular sludge. While this technology was not selected, sludge densification was singled out as a potential opportunity for Rochester when looking forward to design of Phase 2. With Rochester's facility plan goal of looking for innovative



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PHASE 2 Liquid Treatment Upgrade



CAPITAL COST
\$62,000,000



ENERGY SAVINGS
\$210,000/year



CHEMICAL SAVINGS
\$70,000/year

Liquid treatment upgrade replaces 40 year old unreliable equipment and provides treatment to meet new regulatory requirements.



PHASE 3 Solids Treatment Upgrade



CAPITAL COST
\$15,000,000

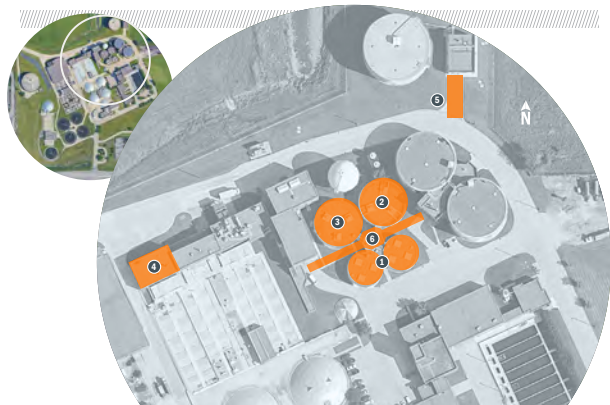


ENERGY SAVINGS
\$22,000/year



HEAT SAVINGS
3 Billion Btu/year

Solids treatment upgrade using existing tankage to meet biosolids regulatory requirements and reducing energy, heat, and liquid treatment costs.



opportunities that could potentially reduce capital and operation costs, decided to pilot this technology.

Granular sludge or densified sludge are similar in they are trying to increase the density of normal flocs found in

activated sludge with the goal of faster settling sludge. This in turn means clarifier capacity is increased and higher mixed liquor concentrations can be achieved within the existing basins, increasing overall capacity of the system.

The densification can happen solely by gradient pressures within the basin but often-external pressures are also applied. One of the external pressures that is common for sludge densification is the use of hydroclones on the return activated sludge (RAS) stream. This involves sending a portion of the MLSS or RAS to the hydrocyclone, which will retain the denser sludge while wasting the lighter poor settling material.

This concept of densified sludge pairs well with simultaneous nitrification denitrification as the densified sludge creates zones where aerobic, anoxic, and anaerobic environments can all exist within a single densified floc. Simultaneous nitrification denitrification also requires dissolved oxygen to be reduced from typical values of around 2 mg/L down to 0.3-0.7 mg/L, which reduces aeration requirements, and energy costs. If successful, this could mean short term gains in reduced energy for Phase 2 and assist in achieving future total nitrogen limits with less capital and operational costs compared to that of traditional denitrification methods.

Rochester Water Reclamation Plant has undergone many changes over the last century and will need to continue to change well into the future as our world evolves. The common link in all these changes is the dedicated professionals who have a passion to serve the Rochester community and environment so that area natural resources are available for future generations to enjoy. **CS**

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