Northeast Plant

Urbana & Champaign Sanitary District

The History of Wastewater Treatment

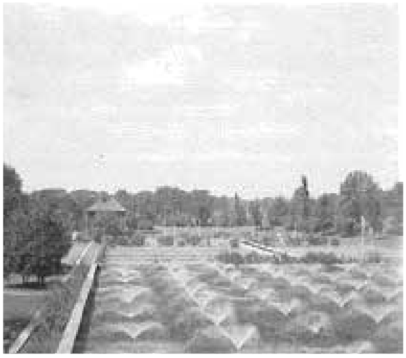
BACKGROUND

The Urbana & Champaign Sanitary District (UCSD) serves the central Illinois communities of Urbana, Champaign, Savoy and Bondville, giving it a service population of 155,000 including the 45,000 students of the University of Illinois. Since UCSD's first engineer and manager was **Gus Radebaugh**, obviously there is a rich history of wastewater treatment at UCSD.

In the 1920s, his generation of leaders established a very sound foundation for our industry. First, they guided the establishment of their own Sanitary Districts and the construction of their own treatment plants. Then, they followed that up by helping to create important local and regional organizations that became the Central States Water Environment Association, the Illinois Association of Wastewater Agencies, and the Illinois Association of Water Pollution Control Operators. It is not an accident that some of these Midwestern organizations are older than the national versions.

Staff Photo

For the second half of our plant profile, we thought we would cover a little bit of the history that generated the treatment plants we enjoy operating here in 2017.



Trickling Filter at NEP: The 1924 image shows the flow at a maximum rate.

Trickling Filter at NEP: The 2016 image shows the flows just starting to increase.

The Present:
UCSD employs 50 staff. About two-thirds of the staff has a license or certificate of training in their area of expertise. They operate and maintain two treatment facilities, 40 miles of interceptors, and 28 lift stations. The individual communities and the university own and maintain their local collector sewers. Funding for the operation and maintenance of UCSD facilities comes from a per-gallon user fee. The District left the property tax bills in the 1980s. Expansion projects and installation of new technology are both funded from the impact fees charged to new construction and rebuilt homes or businesses.

The Northeast Plant (NEP) treats an average of 14 million gallons per day (MGD) and the Southwest Plant (SWP) treats an average of 6 MGD. The Northeast Plant receives the majority of the industrial flow, including the flow from a large industrial food manufacturer with pretreatment. The SWP treats domestic and light-commercial sewage almost exclusively. All solids processing takes place at NEP with the thickened waste activated solids from SWP and the food manufacturer being trucked to NEP. The solids processing includes gravity belt thickening, anaerobic digestion, dewatering via centrifuges, and land application to farmers' fields. The NEP also receives other trucked wastes, including those from restaurant grease traps, septic tanks, portable toilets, bus and mobile homes, and leachate from a municipal landfill.

The digestion process generates enough biogas to run one or two combined-heat-and-power generators (co-gens) continuously. This produces an average of 350 kW, or roughly 30% of the electrical needs of NEP. The heat from the co-gens provides more than enough heat to heat the digesters in a typical year. The value of biogas for plant processes is not a recent discovery for UCSD. The first biogas-driven engines were installed in the 1950s. These were used to drive the aeration blowers.

Besides the solids handling, the other major difference between the plants is that SWP performs biological phosphorous removal using the A/O Process. The yearly average effluent P level is 0.3 mg/L, well below the permit requirement of 1.0 mg/L.

Both plants use excess flow clarifiers to treat the high flows that occur during storms. A recent innovation at NEP is the use of 10 MGD of unused primary clarifier capacity to pretreat the influent prior to any flow being sent to the excess flow clarifiers directly. This double dose of settling improves the capture of the first flush of solids seen from storms. A coagulant to aid settling of solids is fed along with sodium hypochlorite into the influent of the excess flow clarifiers. Any remaining residual chlorine is neutralized using sodium bisulfite prior to discharge into the receiving stream.

The large student population regularly impacts the NEP. During school breaks, the migration of 40,000 students over the course of a few days changes everything. Staff adjusts process flows in anticipation of the decrease and increase in loadings. Mixed liquor solids concentrations are monitored closely and wasting rates are adjusted as needed.

Another somewhat unusual feature of UCSD is the fixed nozzle trickling filter that has been in continuous operation since November of 1924. This was originally referred to as a sprinkling filter. It is 1.6 acres in area with a rock depth of 10 ft. The trickling filter and its associated clarifiers can be used as a parallel secondary treatment line, or as a roughing filter with the effluent recirculated back through the activated sludge process. Although over 90 years old, the trickling filter can outperform activated sludge during the summer months. Unfortunately, performance decreases markedly in the winter due to the large surface area and the cooler temperature of the sewage flowing over the rocks.

The activated sludge aeration basins are only designed to treat carbonaceous biochemical oxygen demand (C-BOD) and have a short detention time of 2.3 hours at design average flow. Nitrogenous biochemical oxygen demand (N-BOD) is designed to be treated in the nitrifying towers.

Most recently, staff has experimented with operating the aeration basins in a modified biological phosphorus removal mode. In this mode, the first aeration tanks are operated in an anaerobic mode and the remaining tanks are run at low dissolved oxygen. This has resulted

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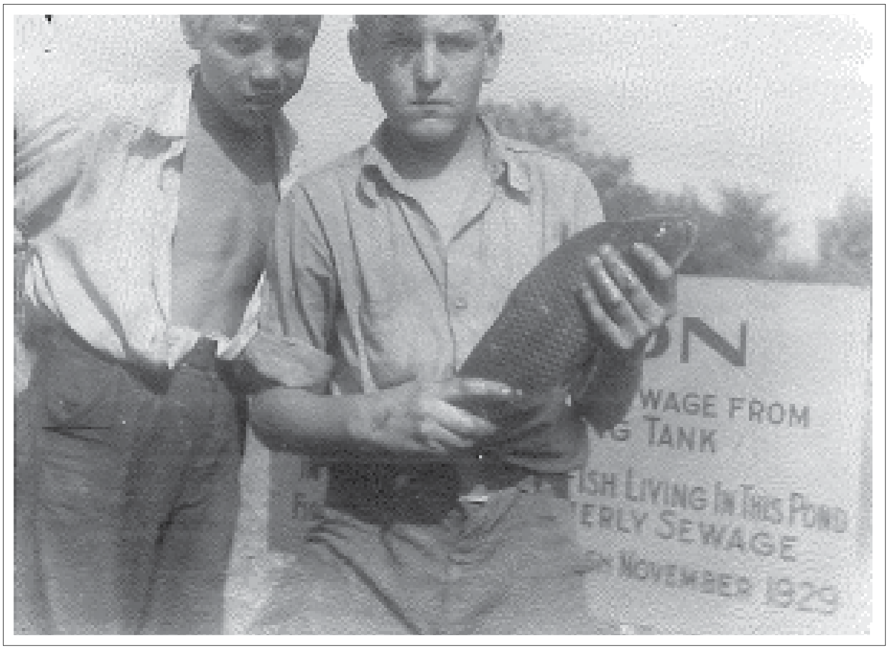
Dr. Bartow's activated sludge experiment, 1913.

in the removal of up to 75% of total phosphorus during normal flows, resulting in concentrations of between 1.3 and 2.0 mg/L phosphorous on most days. Also, the total nitrogen has been reduced due to the increased denitrification that is now occurring in the aeration tanks.

It should be noted that the NEP does not have a phosphorus limit and the aeration basins are not designed for phosphorus removal. So when performance of the overall plant begins to degrade, we return to conventional operation. However, the voluntary phosphorus removal and denitrification produces the ancillary benefit of better settling activated sludge solids, which contributes to a higher quality secondary effluent.

The very tall nitrifying towers make both UCSD plants somewhat unique. The plastic media trickling filters are placed after secondary treatment. Their purpose is to host a large population of nitrifers to efficiently and reliably allow nitrification to occur after activated sludge has removed



The catch of the day from the NEP Final Settling Tank in 1931.

the C-BOD. This has produced more stable nitrification operation over the years with very small aeration tanks. Effluent ammonia concentrations over the last year averaged under 0.1 mg/L at SWP and 0.3 mg/L at NEP.

But, that's not how it's always been…

The PAST: The early years, up to 1916

Prior to 1894, no sanitary sewers or wastewater treatment plant existed in the Urbana- Champaign area. Most homes were without bathrooms and primitive outdoor privies were numerous. As a result, conditions in closely built-up neighborhoods became unbearable. Public sentiment was aroused and a movement was made to construct sanitary sewers first in Urbana and then in Champaign. However, because there was no continuously flowing river nearby, conditions in the nearby creek were still horrible, especially in dry weather. It was a septic mess for miles downstream.

Professor Arthur N. Talbot of the University of Illinois was put in charge of the design and construction of the work in 1894 and began to evaluate what method of sewage treatment would be added after the sewers. He designed a large sewage settling tank which was placed into service in November of 1894, concurrent with the new Urbana sanitary sewer system. This was essentially a community septic tank. It was located at the site of the current Northeast Plant. A second generation settling tank was built on the same site when the Champaign sewer system was built. That was placed into operation in November of 1897. It was believed both were among the first of their kind in the United States. The larger tank was 37 feet long, 16 feet wide and 7 feet deep, giving it a treatment volume of 30,000 gallon. The tank was enclosed in a brick building and a centrifugal pump powered by a steam engine was provided for periodically pumping out the settled solids into a shallow earthen pit.

A study was made of the chemical and biological action occurring and the nature of the effluent. Articles about the plant were published in early engineering journals. Many engineers and city officials visited the plant to inspect its operation. For a few years, these two tanks proved to be very useful and met their intended purpose. However, with the rapid growth of the two towns and heavier usage of the sewer systems, the original tanks became inadequate.

During the period between 1913 and 1916, Dr. Edward Bartow and his associates from the University of Illinois carried out experiments on the first continuous-flow, activated sludge process in this country. The results obtained here were confirmed by other investigators in the United States, Canada, and England. While the activated sludge process was not initially selected for the further treatment of sewage in Urbana and Champaign, the work conducted in Urbana helped pioneer the waste activated sludge process and provided valuable information to engineers and municipal authorities considering the use of this process.

1917-1930s

While the need for better sewage treatment was becoming more and more apparent, the laws of the Illinois prohibited cities or communities from incurring bonded indebtedness above a certain sum. Most of the communities in the state were already bonded to the limit. Essentially, the communities faced a real need, but also had a tax cap that did not allow them to provide services beyond what they already were doing. In 1896 legislation permitting specifically the formation of what is now the Metropolitan Water Reclamation District of Greater Chicago was passed. In 1911, similarly specific legislation allowed the North Shore Water Reclamation District to come into existence. This agency serves the communities north of Chicago. In 1917, the State Sanitary District Act of 1917 allowed UCSD and other agencies across Illinois to come into existence. These single-purpose governmental bodies were charged with the task of cleaning up their community's sewage and thereby protect the residents' health.

On May 21, 1921, in response to a petition from large groups of citizens, Urbana and Champaign voters went to the polls to establish the new Urbana & Champaign Sanitary District. The proposal was approved 443-370, with Champaign voters generally favoring it and Urbana voters opposing it. There is some chance that the vote reflects a NIMBY attitude of that era since Urbana was the downstream community and known to be the expected site for the new treatment plant.

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More than a year later the UCSD Board of Trustees proposed a $500,000 project to build new sewers and a sewage treatment plant for both Champaign and Urbana. The sewage treatment plant would be built for a potential residential population of 75,000. This was expected to be adequate for the communities through 1940.

The bond issue was approved November 28, 1922, by a margin of 1,439 to 518. It was estimated that it would cost the typical residential property owner no more than $5 a year (approximately $70/year in 2017 dollars). Construction of the plant at 1100 East University Avenue in Urbana began in May of 1923. The original district included an area of 8.56 square miles, serving a population of approximately 30,000, including the University of Illinois.

The new treatment plant was dedicated on November 21, 1924. It consisted of screening and grit removal, Imhoff (primary settling) tanks, fixed nozzle sprinkling (trickling) filters, final settling tanks, and sludge drying beds – the best available technology at that time. During the dedication ceremony, Dr. Talbot stated that:

"It should be understood that the plant will require intelligent operation and maintenance. The community of Urbana and Champaign in this step has taken on the duty which a civilized people owe to civilization – to make proper disposition of its wastes."

The strong emphasis upon operations and maintenance was at least partly attributed to the experience from the original septic tanks. They failed after the regular cleaning of the solids was stopped.

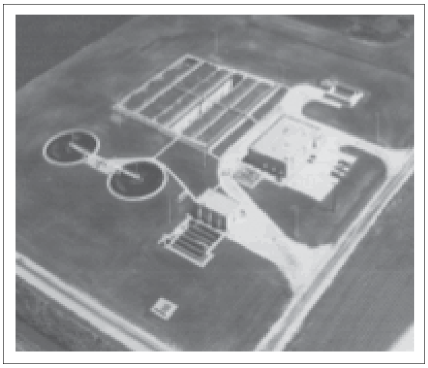
1940s-1980s

As anticipated, population growth continued in the communities into the 1940s. The 1945 expansion project included a rectangular primary sedimentation tank and an anaerobic digester. Between 1945 and 1957 an additional grit tank, a second anaerobic digester and additional sludge drying beds were constructed.

In 1957, NEP was further expanded to accommodate an increasing population and industrial development. This construction included an additional primary sedimentation tank and the conversion of the original Imhoff tanks into aeration tanks for the newly installed waste activated sludge process. Also included were secondary clarifiers, two more anaerobic digesters, and engines using the digester gas to drive blowers for supplying air to the aeration tanks. This version of "green" technology was chasing the original green color of US dollars.

As the physical expansion of the communities continued, the problem of the NEP's limitations became increasingly obvious. The growth of Champaign was westward into the Mississippi River watershed, whereas the existing sewers all flowed easterly into the Ohio River watershed. The UCSD Board decided that the long-range solution was construction of the Southwest Treatment Plant (SWP) and the associated sewer system following the lay of the land in the southern and

The expanded SWP, completed in 2006.



The original SWP, constructed in 1968.

western edges of Champaign. The SWP was completed in 1968. The first Southwest facility consisted of grit removal, comminutation, aeration tanks, secondary clarifiers, aerobic digestion and sludge lagoons.

With the passage of the *Clean Water Act* in 1972, the more stringent EPA regulations that followed, and continued growth of the Champaign-Urbana area, both the NEP and the SWP were extensively upgraded and expanded between 1977 and 1982. These expansions included the need for nitrification at both facilities, which resulted in the nitrifying towers being built. In addition, excess flow facilities were added (instead of allowing high flows to bypass the treatment plant). At the SWP, chemical phosphorous removal was added due to the existence of a lake impoundment downstream of that plant.

2000 to present

A Long Range Facility Plan (LRFP) was adopted in 2002, which recommended the most recent series of improvements for both plants. These were to be implemented in four phases over a fifteen-year period. Construction of Phase I and II began in 2002 and was completed in 2005. Phase I consisted primarily of consolidation of all sludge handling and processing at the NEP. This project included Komline Sanderson gravity belt thickeners, Alfa Laval centrifuges, a new metal roof over the sludge storage pad, Vaughn digester mixing, and Caterpillar co-generation equipment. Other major improvements to this facility during this project included Sanitaire fine bubble membrane diffusers; Turblex high-efficiently, single-stage, aeration blowers; and a new SCADA system designed by SCADAware.

Phase II's 2005 Project modifications and improvements were completed at the SWP. These increased the Design Average Flow from 5.9 MGD to 7.98 MGD and converted the chemical P removal process into Illinois' first A/O Process biological P removal system. The expansion included new Waste-Tech influent fine screens, larger ITT Flygt raw wastewater pumps, a second excess flow clarifier, a seventh aeration tank, and a fifth secondary clarifier. In addition, the tertiary sand filters were replaced with Aqua-Aerobic cloth disk filters that could treat substantially more flow in the same footprint. To create the A/O Process, two existing aerated contact basins were converted to anaerobic basins for biological phosphorus removal. New Turblex high-efficiency blowers were also installed, along with new Komline Sanderson gravity belt thickeners. SCADA was also brought to the SWP, allowing regular staffing to be only 40 hours per week. Thickened waste activated sludge (TWAS) is stored in a new steel storage tank. A loading station facilitates hauling of the TWAS to NEP for processing.

The initial 2002 LRFP was updated in 2007 before proceeding with the Phase III and IV improvements. The revised plan concluded that both plants had adequate reserve capacity to meet the needs of the service area until at least 2019. Construction of Phase III and most of the Phase IV recommendations were completed in 2012. These improvements were all at NEP and included converting the disinfection system to a sodium hypochlorite and sodium bisulfite system, converting the existing tertiary sand filters to Aqua-Aerobic cloth disk filters, the construction of a new plant headworks building; an additional excess flow pumping station and clarifier; a new digested sludge transfer tank; and a new employee facility. Throughout the improvement over the years, the 1924 rock trickling filter still remains an important part of treatment.

We hope you found this history interesting, and are interested in hearing about how you and your predecessors have taken on the challenge of making a proper disposition of your community's wastes. CS

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