Wastewater System Improved in Subarctic Community

Historic Alaskan town receives a sewage treatment upgrade that is not only cost-effective, but will be able to function well in rapidly changing environmental conditions.

A series of upgrades last summer to the Talkeetna, AK, sewer system corrected deficiencies that were causing intermittent groundwater contamination. Other small towns in the Far North might learn from the innovative combination of improvements applied at this subarctic community that some claim inspired the popular television series, "Northern Exposure."

The $2.6-million upgrade was completed last summer before the paralyzing onset of winter and corrected contamination detected by state regulators two years prior in the town's groundwater monitoring wells. In an unrelated measure, the installation of a pump station management system (PSMS) should improve the remote monitoring and management of the utility's lift stations. More powerful pumps were installed at the three stations in tandem with an innovative upgrade of electrical service. Other work retrofitted and replaced collection infrastructure.

The original Talkeetna system was not unlike those serving many other small communities in the subarctic region of the state. The first phase of the

The Town of Talkeetna has evolved into an active aviation center for individuals and groups headed out on climbing and "flightseeing" expeditions to picturesque Mt. McKinley.

sewer system entered service in 1989, followed by the portion serving the other side of town in 1993. The system consisted of five miles of ductile iron collector lines with three lift stations, two facultative lagoons, and a percolation cell for primary and secondary treatment. The system handled about 40,000 gpd. During the past ten years, the population has increased from 500 to 770 permanent residents. When summer visitors head to a national park around Mount McKinley and the region's prime fishing streams, the flow increases to 60,000 gpd, estimates Chuck Jacobs, the sole operator for the Talkeetna system.

"We had evident capacity and other problems that needed to be corrected," Jacobs said. "Now we have monitoring and control capabilities that were absent in the past. I live 30 miles away from Talkeetna using the only available roads and the capabilities of the pump station management system make my work a lot more efficient."

The modest system serving Talkeetna operates under harsh conditions much of the year. January temperatures in the area can range from -33° to 33° F, and from 42° to 83° F in July. The corrosive sewage, freeze/thaw cycles, permafrost, and unstable seismic conditions combined in the past to steadily attack the pipe joints and damage the manhole at the major lift station immediately downline from the lagoons. The mounting leakage admitted enough II to eventually penalize the storage capacity before the upgrades.

Mandated Changes

The Alaska Department of Environmental Conservation (ADEC) notified Matanuska-Susitna Borough (MSB), owner and operator of the town's water and wastewater utilities, citing deficiencies after monitoring wells detected fecal coliform in the groundwater in 2001. The agency attributed the problem to the infiltration cell releasing discharge below quality standards from the two-cell facultative lagoon system. In addition to II penalizing winter storage capacity, ADEC identified a number of other interrelated problems at the lift stations, lagoon system, and a drain in the wellhouse for the town's drinking water supply. The contamination was most pronounced during the early spring release immediately after the thaw.

View into the wet well showing the larger, replacement ITT Flygt pumps now in operation at the duplex lift stations.

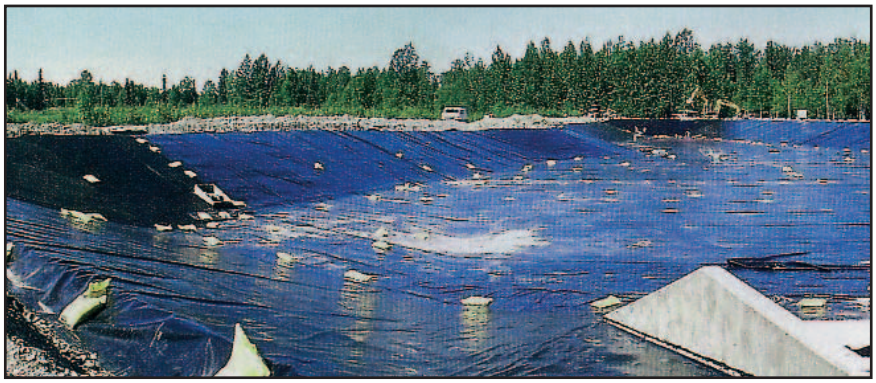
Months of assessments, engineering, and planning eventually translated into the project funded by USDA and EPA grants. The scope of work covered by the contract included:

- Replacement of groundwater discharge with a surface water discharge scheme. This enabled conversion of the percolation cell into a third facultative lagoon, thereby increasing winter storage capacity by at least 25 percent. A constructed wetlands was built as an additional link in the treatment chain before the effluent discharges to a river slough. The capacity increase responds both to the contamination problem and the town's anticipated growth.
- The leaking manhole for the main lift station upline from the lagoons was converted to flow-through and repaired. It was replaced by a new lift station built 50 ft outside the right of way. A small building shelters it from the area's heavy snowfall and houses the PSMS control panel. The other two lift stations also received repairs.
- The original 3-hp pumps in the smaller lift stations were replaced with 7 1/2- and 5-hp ITT Flygt pumps (www.flygt.com), and the original 7 1/2-hp pumps replaced at the main lift station with 18-hp ITT Flygt pumps. The heavy-duty submersible pumps are equipped with the manufacturer's standard VFD capable motors and high-performance self-cleaning N-impellers that resist clogging and deliver sustained high operating energy efficiency.

In another innovation, converters were used to change the single-phase power to three-phase, 230-volt power required for the larger pumps. Three-phase current delivers the necessary higher startup torque and should offer greater long-term reliability. Most of Alaska's small, remote towns have only single-phase service and could benefit from the upgraded power delivery and higher horsepower pumps.

The state-of-the-art MultiTrode® Outpost PSMS (MultiTrode Inc., www.multitrode.com.au) system now remotely monitors and controls the lift stations over leased telephone lines. A landline offered a more expedient approach than the customary wireless communications.

Upgraded lagoon flow controls, a re-insulated shallow stretch of sewer line, and elimination of the sanitary sewer drain in the domestic water supply wellhouse completed the work.



The former percolative cell was lined and converted into a third facultative lagoon, upping winter storage capacity by 25 percent.

Veteran Team

Following the customary RFP process, the borough selected a project team judged most qualified to perform the design and construction work. Participants included: Arctic Slope Consulting Group, Inc. (ASCG), Bob Gilfilian Engineering as the prime consultant, and Dave Maddux, PhD, with Applied Wetlands Technology.

Construction Unlimited, Inc. and Alaska Pump & Supply, Inc. performed the retrofit and equipment installations. The companies worked closely with the team to adapt the pump station management system and the series of larger submersible pumps to the mission. The pump specialist, Terry Gorlick, applied the pioneering conversion of the power service from single- to three-phase at the lift stations.

ADEC issued a new wastewater permit with a one-time discharge so workers could drain and convert the percolation cell and perform other repairs. These and other phases of the work demanded a carefully coordinated schedule to ensure completion before winter. Biweekly meetings updated the fast track schedule and addressed any immediate problems.

Located in the center of a roadway, the largest of the three lift stations presented the most obstacles to the rehab crew. Groundwater at this location stood only 6 ft below grade, but the base of the lift station was 25 ft down. This facility became a flow-through manhole connected by 12-in. ductile iron pipe to the replacement lift station outside the right-of-way. Extensive sheet piling created an accessible work area during the conversion.

Once the new lift station became operational, raw sewage could be bypassed temporarily around the old manhole to the new facility as the predecessor underwent the retrofit. The 16- by 18-ft shelter access over the new duplex station is equipped with a rail hoist for inspecting the two pumps, a circulating water service for wash down, and an electrical room for the PSMS control panel. The new lift station itself has a 6-ft manway and 10-ft diameter wet well for the two new 18-hp model NP-3153 submersible pumps from ITT Flygt.

Talkeetna now provides a model application of a constructed wetlands to wastewater treatment.

"While the project was still in the design phase, I urged the borough to include the most advanced equipment we could find to eliminate the need for another upgrade in the foreseeable future," Jacobs said. "SCADA was high on my list of recommendations."

Using a laptop computer, Jacobs now uses the PSMS to remotely diagnose an alarm and often correct the problem without a site response. As examples, he can troubleshoot alarm conditions, start/stop the pumps, maintain an accurate record of flows, and perform a range of other management functions. The high-tech system can even help identify sources of II along the collection system for future repairs.

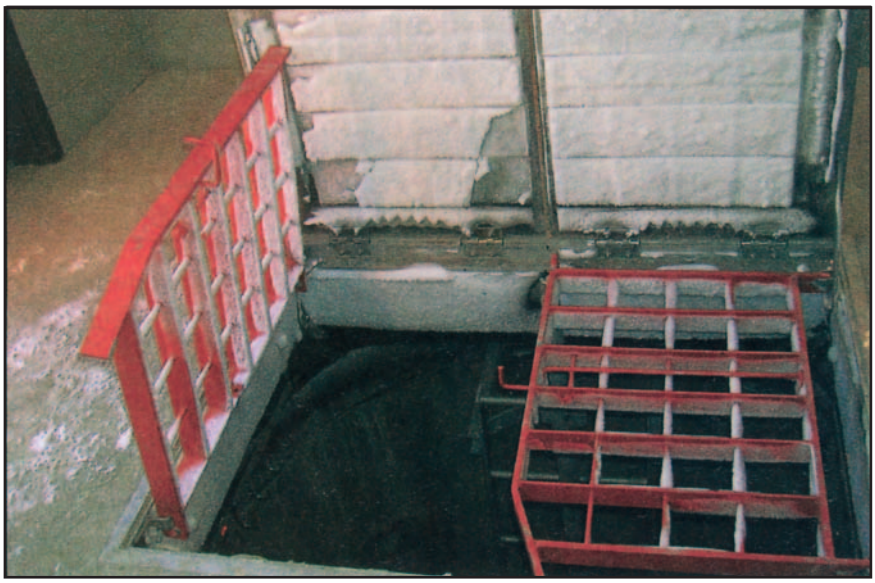
The PSMS also offered an off-the-shelf, pre-programmed pump station management and software package that reduced future dependence on already scarce system integrators. The simplicity and operational capabilities strongly favored the technology. Although the Talkeetna installation communicates over dedicated telephone lines, MultriTrode field units normally communicate with a central station via wireless telemetry. Terrain and other conditions ruled that out as an option.

Finished Treatment

The addition of a constructed wetlands at Talkeetna for finished treatment represented the largest application yet in Alaska. Coupled with the altered lagoon system, the higher treatment capacity should correct the previous overloading that led to groundwater contamination. Wastewater stored over winter now decomposes naturally before flowing at 40 to 125 gpm to the constructed wetlands for a final polish by specialized plants.

The percolative cell converted into a third storage lagoon was lined with impermeable 40-mil polypropylene sheeting between non-woven geotextile and covered with 12 in. of ballast comprised of the excavated material. In addition, HDPE pipe replaced the previous transfer line from the two facultative cells.

The constructed wetlands subdivide into six, 34- by 140-ft cells. This latest



Before the upgrade, access to lift stations could be covered by deep snow in the winter. The borough had the main lift station moved out of the street and sheltered in a small, hoist-equipped building also housing the MultiTrode control panel.

design has proven as efficient—and more economical—than adding a package treatment plant. The construction was rather simple, incorporating a 30-mil polypropylene liner between nonwoven geotextiles covered by a nominal 1 ft of topsoil. This created a root zone for the cattails, soft-stem bullrush, sedge, calla lily, and sedges in the last two cells.

A constructed wetlands in Alaska confronts seasonal limitations and slower decomposition due to the cooler and shorter duration summers, but should offer the additional polish to comply with the discharge permit. Dr. Maddux emphasizes that some constructed wetlands have performed in the Lower 48 states for 30 years without signs of diminished treatment capability.

"The benefits are many, especially in the operating and maintenance costs accrued," Dr. Maddux said. "First, constructed wetlands are less costly to build than a package sewage treatment plant and the operation and maintenance costs are at least one-tenth of a package plant. Second, this approach does not require a highly trained individual and there are no required inputs of chemicals or mechanical part replacements."

The enhanced treatment by the facultative lagoons and constructed wetland should maintain water quality parameters even during the early spring release. Fecal coliforms were reduced soon after completion by 99.9 percent with other parameters, such as BOD and TSS, not far behind.

Five indigenous plants achieve the natural disinfection and scrubbing: *Typha latifolia, Scirpus validus, Carex aquatilis, Carex rostrata, and Calla palustris,* a rooted but floating macrophyte that is a new addition to the normal mix prescribed by Dr. Maddux. Each plant was selected for either high tolerance to concentrated ammonia and heavy metals, the surface area provided for periphyton, or their ability to reduce concentrations of pollutants.

The biodegradable action of the enhanced treatment chain, combined with additional detention time gained from the converted lagoon, quickly produced flows that consistently met the stringent standards set by the ADEC discharge permit.

Many villages currently dump their sewage into surrounding wetlands, but with no design, no thought as to how well suited the natural wetland might be for removing pollutants from the wastewater," Dr. Maddux reflected. "This is the only on-road constructed wetlands currently in use in Alaska for treating sewage wastewater. This type of system would prove applicable in the many off-road villages throughout the subarctic part of the state, as well.

"There are over 200 rural, off-road village communities in the state and almost all of them need some worth of secondary sewage wastewater treatment," he added. "Numerous on-road rural locations also would benefit."

The historic town, located some 70 air miles north of Anchorage, in the Matanuska-Susitna Borough, has thus gained a cost-effective upgrade that restored the local sewage treatment to compliance. A growing number of people now gather in Talkeetna for the panoramic view of "The Mountain" and some are electing to stay. The wastewater system can now accept that population growth and function efficiently in the perpetually challenging environmental conditions. GE

Overview of the Town of Talkeetna.