CASE STUDY: WESTON, MASSACHUSETTS, SOLAR AQUATIC SYSTEM

SYSTEM DESCRIPTION

Location: Weston, Massachusetts (latitude: 42°21’59” N; longitude: 71°18’10” W)

Collection: Gravity sewers from each building feed three e-One grinder pump stations that then transfer sewage to the treatment plant. Grease traps, which are owned by the building owners, provide preliminary treatment at each building.

Treatment: Solar aquatics systems (SAS) are a hybrid activated-sludge/ engineered-ecosystem process. Influent wastewater from grinder pumps is introduced into an aerated flow equalization/blending tank, which also receives return activated sludge. From the equalization tank, mixed liquor is pumped to a dual-train configuration of transparent-walled tanks that support the growth of aquatic vegetation, algae, zooplankton, and snails that digest contaminants and extract nutrients. Gravity separation of solids occurs in a settling tank and the solids are recirculated while the treated water is further treated using sand filtration, subsurface anoxic wetlands, and finally disinfection.

Product disposition: Treated water recharges the groundwater via a soil absorption system. This system consists of recharge trenches beneath a stone driveway.

Flowrate: Designed to serve 38 to 45 m^3/d (10,000 to 12,000 gpd); current average flow is 23 m^3/d (6000 gpd).

Service area: Commercial business area, including supermarkets, restaurants, banks, medical and commercial offices, and retail stores.

Case study type: Commercial cluster for independent community.

Management type: Private (partnership) ownership and management.

Cost: Actual cost was $750,000, including leach field for dispersal, which was within the margin for error of the estimated cost.

DESCRIPTION

The solar aquatic system (SAS) was constructed to provide wastewater service to a core commercial area in the town of Weston, Massachusetts, because of failing septic systems. The commercial businesses had grease traps that did not adequately protect the septic systems, which was causing system failure. The Massachusetts Department of Environmental Protection (MADEP) stepped in and required property owners who were in violation of onsite wastewater treatment regulations to upgrade their systems. Property owners formed a limited partnership to design, build, own, and manage the system.

Photo courtesy of AIDG Inc. (www.aidg.org) under Creative Commons License http://creativecommons.org/licenses/by/3.0/.

The treatment system consists of several natural treatment stages including aeration, plant and animal aquaculture, solar radiation, clarification, sand filtration, subsurface flow anoxic wetlands and UV disinfection and is divided into three stages:

(1) Aerated equalization and pretreatment buffers flow variations and provides approximately 47% reduction of biological oxygen demand (BOD). This process takes place in buried concrete tanks beneath a sidewalk that adjoins the commercial building.

(2) A four-train configuration of 16 transparent-walled tanks supports growth of aquatic vegetation, algae, zooplankton, and snails that digest contaminants and extract nutrients for plant growth. Gravity separation of solids occurs in a settling tank, and the solids are recirculated while the treated water is further refined through sand filtration. (Solids produced in this stage consist largely of algae microorganisms, which could possibly be dried for energy production purposes.)

(3) A subsurface, anoxic wetland provides denitrification and further treatment and is followed by UV disinfection. Decomposing roots are a carbon source and help support the denitrification process. The need for additional carbon in the form of acetate or methanol/ethanol is variable over the seasons; the feed rate is adjusted based on process control sampling. Typically, more supplemental carbon is needed in winter when light levels are lower and there is less plant photosynthesis for root exudates production and root growth. All treated water is recharged to the subsurface groundwater, and some is recirculated to the head of the plant to maintain a consistent hydraulic flow.

The system is contained in a greenhouse, which allows year-round growth of vegetation under controlled environmental conditions. As a hybrid system, it uses well-established technology such as aerated activated sludge treatment along with natural processes to the greatest extent practical to create a bucolic and functional wastewater process that is located among the buildings served.

While groundwater dispersal of treated effluent at the site is limited to 27 m^3/d (7000 gpd), the pretreatment system is designed for a capacity of 38 to 45 m^3/d (10,000 to 12,000 gpd), because MADEP wanted the treatment plant overdesigned. Redundancy in the treatment plant design does help if and when rehabilitation work is needed, such as changing the bags in the inside the solar tanks. Approximately two-thirds of the tanks can be taken offline, and the system can still function.

Photo courtesy of AIDG Inc. (www.aidg.org) under Creative Commons License http://creativecommons.org/licenses/by/3.0/.

It is possible that by reusing effluent for flushing toilets and irrigation, the same soil absorption system could service more users, which could be added as members of the limited partnership. The town is considering extending the service area, which is entirely owned by the partnership, although this would require appropriate zoning approvals for new development based on the local land use regulations. If the sewer collection pipes have to cross public right-of-ways, however, then a public wastewater utility may need to be established. This could prove complicated because there is no enabling legislation for private wastewater systems in Massachusetts.

PROJECT GOALS

The goal of this project was to provide a natural system that would add beauty to the community while providing vital water quality and public health services. The system also serves as an educational tool and is visited routinely by local school classes.

TIMELINE

After decades of discussion, the MADEP ultimately required property owners to provide a design by 1996 with system to be operational 1997. The system was put into service in 1997.

DECISION MAKING

Based on groundwater sampling and testing and observed failures of existing systems, the local board of health determined that failing onsite septic systems in Weston's business district were adversely affecting an adjacent natural wetland. The MADEP determined that grease trap maintenance and the overall wastewater management approach, which relied on individual septic systems, was inadequate. The MADEP rules require at least a 15 m (50 ft) buffer between wastewater systems and wetlands; the existing systems did not meet this requirement and were deemed to be inadequate for protecting the wetland.

As a result, MADEP required affected properties owners to upgrade their systems. The department pressed for a municipally owned conventional wastewater treatment plant. Local residents fought against that plan for years, however, based on the experiences of other towns where centralized sewer systems led to unrestricted development that negatively affected the character of the town. Additionally, a suitable location could not be established.

After a municipally owned and operated system option fell through, the MADEP and affected property owners agreed to go with a decentralized approach. Property owners hired an engineering consultant to evaluate alternatives, which led to the recommendation to use the SAS approach because of its low impact to the community and ability to meet MADEP effluent requirements. In addition to the SAS, packaged treatment systems that used traditional treatment mechanisms were considered. Ultimately, preservation of community character and control of growth were the primary reasons why a traditional municipal wastewater system was not proposed. The SAS system was selected as a way to provide a neighborhood-friendly wastewater treatment system that could meet stringent groundwater discharge requirements.

CHALLENGES

The biggest challenge was that there were no SAS or other larger, similar systems in use in Massachusetts at the time, so the technology was considered innovative. Although SAS had been tested as pilot systems, this was a first implementation of this technology in a large-scale, private application. As a new, innovative technology, the system was difficult to permit, and the process was fraught with state and local regulatory roadblocks. Now that the system has been in use for 12 years, comfort and confidence among state and local regulators is good. In addition, less redundancy would be required in the system designs, which will help lower capital costs going forward.

Maintenance of grease traps is still an issue, even with the community system, because failure to maintain them may clog the downstream grinder pumps and other mechanical equipment.

FINANCING

A limited partnership of property owners was formed and no sophisticated form of bank financing was used. The entire project was funded privately, including investment of property owners' capital and user fees for investment recapture, future system replacement, and operating and maintenance costs. By law, there is a sinking fund for system maintenance; by design, user fees are based upon water usage with the operating costs distributed accordingly.

MANAGEMENT

The property owners that suffered from the failing septic system conditions came together and formed a limited partnership to finance, build, own, and operate the wastewater system. The system is contract operated by Ecological Engineering Group, which provides routine labor and system monitoring in accordance with MADEP operator license requirements. Capital and operating expenses are funded by the partnership.

Only one entity could be permitted by the MADEP to have responsibility for system performance. Municipal ownership alternatives were rejected because town residents did not want a public entity involved. The public did not oppose formation of a limited partnership. Because the system has been operational for more than a decade and confidence is higher, a town would be more likely to consider a municipal ownership and/or operation model. There is no reason now, however, for Weston to take this system over.

All costs are recovered monthly by charging a user fee based on water meter readings. The limited partnership also handles billing and collections, and customer complaints are handled through the licensed operators because most are associated with blocked grinder pumps.

PERMITS

The MADEP administers the groundwater discharge permit, which is enforced based on effluent flow and quality. Monthly water quality (effluent and groundwater monitoring) reports are filed with the MADEP. The MADEP evaluates performance by reviewing the monthly reports and through periodic unannounced inspections, typically on an annual basis.

PERFORMANCE

The system is meeting water quality objectives and stated project goals. The natural system approach conformed to the town's cultural character. Conservation of energy and chemicals, although sustainable, was achieved by default rather than design.

The process is working and improvements are being made to boost efficiency of the plant to lower the operations and maintenance costs to the owner. Improved control mechanisms and different plant species will help reduce power consumption. The plants used are tropical in nature, whereas evergreens seem to serve these purposes adequately and would eliminate the need for heating.

CONTACT INFORMATION

David Del Porto, Ecological Engineering Group, 978-369-9440 x 101; e-mail: delporto@ecological-engineering.com.

Wendy Diotalevi, RS, Town of Weston Board of Health, 781-893-7320 x 332; e-mail: diotalevi.w@westonmass.org.

WEBSITES

www.ecological-engineering.com