THERE AND BACK AGAIN

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Gillette Stadium water reclamation facility and flow equalization tank

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Infiltrator wastewater disposal chambers are installed under parking lots at Gillette Stadium. Excess water is discharged below the surface of the parking lots by a series of chamber beds, allowing recharge of the local aquifer.

As demand for usable water slowly outstrips supply, reuse systems may be the solution to everyone's problem

By Dennis F. Hallahan, PE

A serious problem faces our society as the demand for clean water begins to exceed the available supply. Treating and reusing wastewater is becoming an acceptable solution to this problem. Engineers across the country are being challenged to deliver cost-effective wastewater treatment and reuse solutions that protect the public health. Many of the solutions being developed are novel approaches. In the absence of sewers, onsite wastewater treatment systems are being designed to allow high-water-usage facilities to reuse wastewater. The systems discharge to the subsurface, thereby replenishing dwindling groundwater supplies, and the system designs reuse treated wastewater to flush toilets.

Barriers to Reuse

The barriers to reuse are many. A key factor is the lack of information and understanding by the general public and the regulatory and design communities. The most significant obstacle to the acceptance of water reuse is the lasting impact of the Clean Water Act. This act focused the wastewater industry on big treatment works and sewer networks. The funding, regulatory requirements, permitting, and design knowledge that have been directed at expanding and maintaining this cumbersome infrastructure is unprecedented.

Now, however, those once steady financial resources formerly provided for under the Clean Water Act have been replaced by smaller grants that must be repaid. At the same time, the advent of technological innovation allows small-scale treatment facilities to treat to a high standard, while sophisticated new products allow more efficient disposal. The industry is experiencing a paradigm shift and realizing that there are other — and even better — alternatives.

Classifications of Reused Water

The reuse of treated water relates to water that has been used for sanitary or industrial applications and then subjected to those treatment steps necessary to allow it to be reclaimed. Reuse can be classified as either indirect or direct. Indirect reuse occurs when the water receives enough treatment to be discharged back into the ground to build up the water table or prevent seawater encroachment. Direct reuse requires that the treated wastewater be transported directly to a point of reuse. Treated or reclaimed wastewater is currently reused for many purposes, including industrial and limited domestic applications. These include:

- Recharging groundwater by directly injecting the reclaimed water into the ground or allowing it to percolate using ponds or drainage fields;
- Augmentation of surface waters used for recreational and drinking water sources;
- Creating barriers to salt water intrusion into groundwater;
- Agricultural use for irrigation of nursery stock and cropland;
- Irrigation of golf courses, parks, residential properties, roadway medians, public gardens, and other landscaped area;
- Other uses, such as toilet flushing in large buildings and stadiums, car and truck washing, dust control, and decorative fountains;
- Fire fighting; and
- Cooling tower make-up.

As part of the process of reclaiming wastewater, it is necessary for the designer to consider the wastewater treatment system and the treated wastewater disposal system.

In addition to the removal of conventional pollutants, such as total suspended solids and biochemical oxygen demand, nutrients such as total nitrogen and phosphorous may need to be reduced along with the removal of all waterborne pathogens, viruses, and any chemical compounds that impart color or taste.

Wastewater Treatment Systems for Water Reuse

In order for reclaimed sanitary wastewater to be acceptable to the regulatory agencies and the general public, it has to meet very stringent treatment standards. In addition to the removal of conventional pollutants, such as total suspended solids and biochemical oxygen demand, nutrients such as total nitrogen and phosphorous may need to be reduced along with the removal of all waterborne pathogens, viruses, and any chemical compounds that impart color or taste. Since conventional secondary wastewater technology could not achieve these rigorous standards, it became necessary to apply advanced wastewater technology.

There are many acceptable technologies available for advanced wastewater applications, including tertiary systems that treat the effluent from conventional secondary systems and standalone advanced wastewater treatment systems. Nearly all of them require multiple steps to remove organics and nutrients, and to ensure disinfection. A combination of technologies, which are often unique to the system and the requirements of state and local codes, is used to treat and recycle the wastewater.

Onsite Wastewater Disposal Methods for Treated Wastewater

Among the technologies for onsite disposal of treated wastewater are:

- Spray irrigation,
- Drip irrigation,
- Rapid infiltration basins (RIBS), and
- Subsurface drainage beds or trenches.

Onsite disposal provides many environmental benefits when compared to conventional sewer piping networks and centralized treatment plants. The environmental damage of a conventional sewer can be staggering. A leak in the piping network allows groundwater to be intercepted by the sewer and deflects it from the aquifer that is vital to maintain ecosystems. The excess groundwater inundates the treatment capacity of the centralized treatment plant and requires much more energy to treat the waste. Where groundwater levels are low, the sewer can leak wastewater to the aquifer, thereby contaminating the water supply. Wastewater treatment plants have frequent discharges of untreated waste due to malfunctions or rain events. When this occurs, it can be very damaging to the local environment because the untreated or partially treated waste is deposited directly in the receiving body (rivers, lakes, or ocean outfalls), thereby causing considerable public health risks, fish kills, shellfish bed and beach closures, algae blooms, and so on.

When onsite disposal water is recycled to the local aquifer, the necessary piping networks can be small in diameter and watertight. If there is ever a malfunction in systems with small treatment facilities located onsite, the quantity of discharge is much lower and, more importantly, the soil acts as a secondary line of defense to treat the waste and protect public health.

Case Study — Westbrook Factory Stores, Westbrook, Conn.

An absence of sewers led engineers to develop a unique solution that included the first project in Connecticut to use membrane technology with reuse for onsite wastewater management. Given the large design flow generated by the outlet mall, a conventional system of septic tanks and drainfields would have been prohibitively expensive and would have required an extensive footprint for the drainfield.

Designers selected a membrane reuse system because of its ability to produce tertiary-quality effluent and reduce discharge by 85 percent. This dramatically reduced the size of the septic drainfield, allowing for a small footprint. Permit requirements from the state Department of Environmental Protection required a minimum of 10 micrograms per liter (mg/l) of nitrogen, which the treatment system has met continuously. The system has dual-supply piping to reuse treated wastewater for the restroom facilities. The reclamation of the treated water saves approximately 13 million gallons of water per year.

The excess treated water is discharged to a subsurface drainfield with chambers placed under parking, which provides additional space for development. The highly treated wastewater is distributed within the chamber bed via a pressure-distribution piping network. This effectively distributes the wastewater over the entire surface area of the bed to ensure unsaturated conditions. With the large amount of surface area provided by the chambers, it acts as an additional safety factor to protect the environment should there be any temporary malfunctions in the treatment system.

Case Study — Gillette Stadium, Foxboro, Mass.

Gillette Stadium serves as the home of the New England Patriots, and it has the distinction of having one of the nation's largest recreational water reuse systems. When the Town of Foxboro advised the developers who built the stadium that they could not furnish enough water or treat the wastewater from the planned 68,000-seat stadium, it became apparent that reusing reclaimed water was the only answer.

Working closely with the town, the developers formulated a plan that resulted in the construction of the following facilities:

- A 250,000-gal/day membrane bioreactor facility capable of being expanded to treat 1.1 mgd,
- A 680,000-gallon, glass-lined equalization tank to capture the half-time wastewater surge,
- A 2.4-acre groundwater chamber recharge field for the excess highly treated effluent, and

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Infiltrator chambers are placed under a parking lot for an outlet mall. Highly treated wastewater is distributed within the chamber bed via a pressure distribution piping network.

■ A 500,000-gallon elevated water tank for storing reclaimed water.

In order to meet the demand for water, engineers proposed incorporating a water reclamation scheme into the design. The design would allow wastewater from the stadium and the community to be collected, treated, and reused for toilet flushing, irrigation, cooling water, and flushing of streets and sidewalks. Had water been available, the existing sewer interceptor could not have managed to transfer the volume anticipated from the stadium to the wastewater treatment facility. The distance to the sewage treatment plant from the proposed stadium site made it cost prohibitive. There was also no nearby receiving water capable of accepting the high flows if a treatment plant was constructed to service the stadium.

The solution to Foxboro's problem was to capture the wastewater from the stadium, treat it to a high degree, and store it for reuse when necessary. The treatment process is based upon the application of membrane bioreactor technology. These reactors allow the organic wastes (including ammonia) to be biologically degraded by microorganisms, minimizing the need for excess power or chemicals. The solids in the treated wastewater are separated from the liquid fraction by membranes with pores small enough to capture viruses.

Additional treatment is provided to biologically convert the nitrates formed from the destruction of the ammonia to nitrogen gas. The treated water is re-aerated and disinfected using ultraviolet radiation, eliminating the discharge of bacteria. The community keeps the treated water aerated and stored for use at the stadium or elsewhere, if necessary. Excess water is discharged below the surface of the parking lot by a series of chamber beds, allowing recharge of the local aquifer.

Conclusion

Science tells us that, based upon the water cycle, the earth has the same amount of water today that it always has. But we should be aware that we are wasting this limited resource when we follow the traditional practice of using fresh water, treating the resulting wastewater by removing contaminants, and then discharging it to a receiving water body where it drains into the ocean and becomes unavailable for reuse. In comparison, reclaimed water that is treated according to today's rigorous standards may be just as good as raw water and suitable for reuse for many applications that do not involve direct human consumption.

Even such water-rich areas as New England have expressed concern about their ability to meet the need for usable water by local communities. The case studies presented here demonstrate that we have the technology to produce a high-quality, reusable water supply, and that the option of reclamation and reuse must always be looked at before squandering this precious resource.

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