Biological Leachate Treatment

by Clarissa Morawski

As an alternative to conventional methods for processing organically contaminated wastewater, businesses and small municipalities may use systems modelled on natural ecosystems. Biological wastewater systems or artificial aquatic filtration systems are effective and cost-effective, but their application has only recently been extended to the treatment of landfill leachate.

In the first bed, the leachate is aerated to encourage bacterial growth.

The systems are essentially natural wetlands housed in energy efficient greenhouses. These "living machines" mimic a natural ecosystem in which biological waste materials are synergistically processed by a web of bacteria, algae, plants, snails and fish. They convert organic wastes into the living tissue of organisms within the treatment system. (The remainder is bound in gases associated with the respiration of the plants and animals within the system).

In the summer of 1997, Essex-Windsor Solid Waste Authority (EWSWA) received a certificate of approval from the Ontario Ministry of Environment for an experimental onsite leachate treatment facility at its regional landfill in the Township of Colchester North. A certificate of approval was issued for pilot studies for three years.

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In 1998, the EWSWA used this natural technology to treat one quarter of the leachate generated that year (7,300 m^3) at its landfill. The system can discharge 1,820 litres of water per hour or 43.7 m^3 per day (16,000 m^3 per year). At full capacity, the discharge potential is 5,455 litres per hour or 131 m^3 per day (48,000 m^3 per year).

The system was co-designed by Todd Pepper, the general manager of EWSWA and Boardwalk Aquatics. It's a freestanding greenhouse approximately 30 metres by 9 metres in size. Within the facility there are 3 one-metre-wide channels, each of which is 23 metres in length. Lined with a polypropylene geomembrane, these concrete channels contain the biological materials that comprise the aquatic ecosystem.

As with natural ecosystems, biological activity requires light, water circulation, and ventilation—all of which are provided by a 200 amp, single-phase electrical service. A complete lighting system allows photosynthesis to be extended during the winter months. Two natural gas units heat a closed hot water heating system that also warms the ambient air with forced air coils. Influent is received from a well pump capable of delivering between 1,514 and 4,542 litres of leachate per hour. Leachate entering the system passes through a heat exchanger that elevates its temperature to 25°C before introducing it into the first channel.

Hyacinths (commonly referred to as "nature's purifiers") populate the first channel where they actively consume phosphates, nitrates, and some chlorides as nutrients. At this point, the leachate is also aerated to encourage bacterial growth.

The second channel is coated with algae and microorganisms that convert complex molecules into simple nutrients. Oxygenating plants that also reside in the second channel immediately absorb these nutrients.

The third (and final) channel includes a mixture of floating plants, fish, and other aquatic biota from which the leachate flows to a marsh/bog area that contains a natural filter comprised of 103 square metres of pea stone bound with root fibres from hundreds of plants. Once discharged from the marsh, the former leachate is nearly potable water.

"The second channel (of three) is coated with algae and microorganisms that convert complex molecules into simple nutrients."

Water quality monitoring is performed by a flow calibrated automatic sampler installed at the final stage of the system. Weekly analysis is car-

Leachate Treatment Expenses

	Artificial Aquatic Filtration System		Offsite
	half capacity 7,300m^3	full capacity 16,000m^3	11,300m^3
Monitoring	$15,000	$15,000	Essex-Windsor pays a flat rate per cubic metre of treated leachate
Utilities	$6,000	$6,000	
Labour, parts, re-stocking of plants etc.	$10,000	$10,000	
Total / m^3	$4.25	$1.94	$8.82
Transportation/m^3	$-	$-	$3.80
Total cost/ m^3	**$4.25**	**$1.94**	**$12.62**

ried out by the EWSWA for the following discharge parameters: BOD5, suspended solids, phosphorus, ammonia, *E. coli*, dissolved oxygen, pH, and temperature. Monthly composite samples are analyzed for nitrate, chloride, heavy metals, and organic materials.

If the effluent meets the environment ministry's discharge criteria, it's released into the storm water management facility located on the site. If it doesn't meet the criteria, it's either directed back into the front end of the process, discharged into a retention pond used for a leachate land application system (utilized in the summer months), or recirculated through a bioreactor.

Last year's monitoring results were very favorable. Except for three occassions, all major leachate constituents (except chloride) showed significant reductions after passing through the system and met the discharge criteria for all parameters. (It's important to note that low precipitation will result in elevated concentrations of certain discharge parameters in treated leachate.)

The system cost $150,000 to build,

Heat exchange boiler influent received from the well pump.

and can potentially treat 16,000 m^3 each year. With little precipitation and less-than-normal leachate generation, Essex-Windsor's system operated at only half capacity in 1998. The system's 1997-98 annual operating cost was $31,000 including monitoring, utilities, labour, and parts (*see chart*).

With moving parts largely supplied by Mother Nature, the cost to treat a cubic metre of leachate using

"With moving parts largely supplied by Mother Nature, the cost to treat a cubic metre of leachate using the system at full capacity is $1.94."

the system at full capacity is $1.94 versus an offsite conventional treatment cost of $12.62. Essex-Windsor is now working to achieve zero offsite discharge through the use of its biological system and other onsite leachate treatment systems. An annual report on the system's first year of operation is being prepared.

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