A Changing Industry: On-site Phytoremediation of Landfill Leachate Using Trees and Grasses – Case Studies

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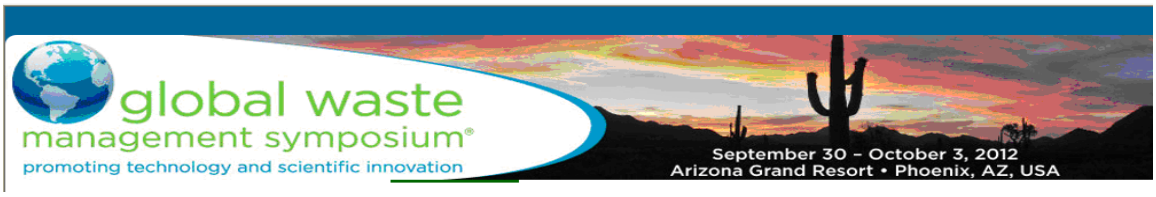

The on-site utilization of landfill leachate using phytoremediation systems is transforming the way the solid waste industry handles facility-generated liquid waste. The change not only replaces the age-old 'load, haul and dump' process where the technology fits, but also represents a truly GREEN, carbon negative, and sustainable approach using trees and grasses. In addition, the approach saves millions of dollars at each site where it is implemented. Leggette, Brashears & Graham, Inc. (LBG) has partnered with Republic Services, Inc. on a number of phytoremediation projects with great success. This presentation will review the industry-changing process in action at full-scale sites across the U.S., as well as at additional landfills for Promotora Ambiental S.A.B. de C.V (PASA), the largest solid waste company in Mexico.

Phytoremediation is defined by McCutcheon and Schnoor (2003) as "the use of vascular plants… to either remove and control contaminants, or to spur contaminant breakdown by microorganisms in the rhizosphere." The "removal" process described above consists of contaminants being utilized by the plants as micro and macro nutrients (note that non-essential nutrients are removed and/or degraded by the same mechanisms). Phytoremediation systems use specifically selected, fast-growing plants that have a huge demand for nutrients and moisture, making the technology a natural fit to utilize leachate on-site as a resource to the plant-based system rather than disposing as a waste. This advancement greatly reduces the financial burden and environmental problems associated with leachate disposal, which is one of the most persistent and expensive problems within the solid waste industry. The technology can be applied at both open and closed landfills.

Phytoremediation is grounded in science. It is a combination of expertise drawn from numerous specialty disciplines including, but not limited to: engineering, agronomy, soil science, chemistry, hydrology, and biology. Decades of research and activity conducted by all three arms of scientific development (academic, governmental, and private industry) have advanced the

technology past laboratory experiments and field trials to successful, full-scale field applications such as those described below.

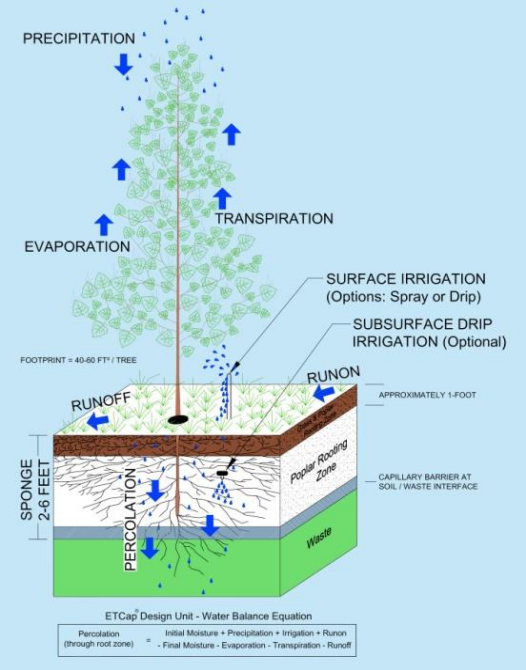

Figure 1 – Evapotranspiration Model

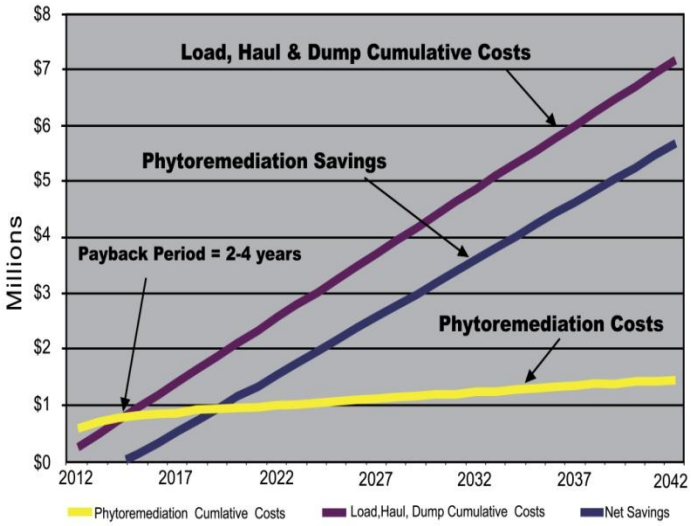

Figure 2 – Typical Phytoremediation Savings Graph

Case Studies:

Hybrid Poplar Site – St. Louis, MO

The phytoremediation system installed at the Republic Jeffco landfill has been in place through four growing seasons. Approximately 2,100 hybrid poplar trees were planted over a 5.5 acre area in December of 2007. Since then, over 14 million gallons of leachate have been processed on site rather than being hauled by trucks to a wastewater treatment plant. A total cost avoidance of $810,000 has already been realized by eliminating the transportation and disposal process. The phytoremediation system paid for itself in less than two years, and due to the reduction in annual O&M by 80%, the annual cost of long-term financial assurance policy premiums has also been significantly reduced. In addition, this first of its kind project allowed for the year-round utilization of leachate in a cold weather climate through the use of a specialty subsurface drip irrigation system. The innovative project was honored with four awards, including being named to the top 25 engineering projects in the USA in 2009 by the American Council of Engineering Companies (ACEC) Engineering Excellence Competition.

Figure 3 – Jeffco Tree Growth Photos (counterclockwise – 2008, 2010, 2011)

Hybrid Poplar Site – Chicago, IL

Building on the success of the St. Louis project, the northern limits of the technology were further tested at another Republic landfill located in the Chicago metropolitan area. Over 4,000 hybrid poplar trees were installed over a 7.5 acre area to process an average of 1.5 million gallons of leachate per year, with an ability to increase utilization to three to four million gallons per year in the future. Expectations were exceeded when the first year goal of processing 500,000 gallons of leachate was accomplished after only five months of system operation. Since full system startup, not a single load of leachate has left the site and over 2.7 million gallons have been processed, avoiding $350,000 in leachate disposal costs in two years and cutting annual O&M by 75%.

Vetiver Grass Site – Biloxi, MS

The Republic Gulf Pines landfill became a first-of-its-kind project in the western hemisphere when vetiver grass was used for phytoremediation of leachate at this Gulf Coast location. In addition to having a huge demand for moisture and nutrients, this unique plant has amazing characteristics which make it an excellent choice for leachate utilization in applicable climates.

It is very tolerant to pests, disease, and also to high levels of numerous contaminants (metals, ammonia, VOCs, nitrogen, salts, and many other compounds). It is tolerant to drought and flooding, grows well in a variety of soils, and is USDA non-invasive. Three acres of vetiver were planted on top of this pre-subtitle D landfill to process approximately three million gallons of leachate per year. The per gallon disposal cost was cut from $0.13 to less than $0.015 per gallon. The project is expected to save $8 million over a standard accrual period compared to traditional off-site disposal methods. This project was recently honored as a national Grand Prize winner in the American Academy of Environmental Engineers – National Engineering Excellence Competition.

Figure 4 – Vetiver Growth – Initial Planting, Week 10 Root System, and Growth Chart

Vetiver Grass Sites – Mexico: Leon, Poza Rica, and Villahermosa

The first three projects of their kind in Latin America using vetiver grass for phytoremediation of landfill leachate are underway for the largest solid waste company in Mexico, and each pose numerous, site-specific challenges. The Leon landfill is a recently acquired facility in great need of numerous improvements that were left undone by the previous owner. One enormous problem is handling of very strong, fresh domestic / industrial leachate from this active facility. In addition to the 25,000 gallons of leachate produced daily, an additional 15 million gallons is currently stored in lagoons awaiting treatment. The owner is under great political pressure to quickly bring the landfill to acceptable standards. The use of phytoremediation to resolve these issues has already eased some pressure and has been a significant step forward towards overall site success. The Poza Rica facility includes using vetiver for three main purposes: stabilization of very steep, highly erodible slopes, the on-site utilization of fresh leachate, and control of leachate outbreaks. Villahermosa is similar to Poza Rica, but the design and operation of an effective system was further complicated due to the extreme rainfall at this facility, which is located along the southern coast of the Gulf of Mexico.

The observed results at the above facilities have shown that phytoremediation can effectively utilize landfill leachate on site as a resource rather than disposing as a waste. Because the approach is both environmentally friendly and saves millions of dollars at each site where it is implemented, it is fully expected that the innovative technology will continue to change the way the solid waste industry handles landfill leachate long into the future.