SUMMARY: ENERGIZED PROCESSES FOR ONSITE TREATMENT OF LEACHATE

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FAU has pioneered the advancement of landfill leachate treatment systems using the photochemical iron-mediated aeration process and the TiO_2 photocatalytic process at lab scale in previous research funded by the Hinkley Center. This proposal describes the development of the next logical step, which is the development of pilot scale onsite treatment systems capable of detoxifying leachate with the power of ultraviolet light and advanced oxidation. The objective of the proposed research is to test photooxidative processes at pilot scale for the removal of COD/BOD, ammonia, heavy metals, color, and pathogens.

Leachate management options include on-site treatment, municipal sewer discharge, natural attenuation (including deep well injection), hauling offsite, or a combination approach. Typically, some form of aerobic treatment is employed to reduce leachate strength prior to discharge. However, biological systems are not well-suited for removal of bio-toxics from water and are inefficient in dealing with wastes of varying quality, such as leachate. Thus post-treatment, using constructed wetlands, combined physical/chemical/biological treatment, or evaporative systems, is generally required. Unfortunately, activated carbon and certain advanced treatment processes, such as ozone or ultraviolet light, do not adequately address inorganics, and membrane systems or air stripping merely transfer organics to another phase. Furthermore, multiple barrier systems are complicated to operate, costly, and generally inefficient. Unfortunately, most current processes cannot adequately address inorganics and organics simultaneously. From our previous work funded by the HCSHWM, our research team evaluated 23 different engineering alternatives for long-term leachate management. The results indicated that the most effective and sustainable strategies for the future would involve technologies that can destroy different classes of harmful contaminants all at once, without producing adverse byproducts and residuals. **So the question is: "Can we develop systems to treat landfill leachate at the source, cost effectively?"**

If energized processes work as well in the field (at pilot scale) as they do in the laboratory, then the answer is **"yes,"** because energized processes are: 1) designed to use the power of sunlight, which is free and requires no additional energy input, 2) easy to operate because they just require sufficient contact time and do not rely on complex precipitation reactions or biochemical processes, 3) not subject to biological upsets because they are physico-chemical processes that create broad spectrum oxidants to remove aqueous contaminants, and 4) designed to avoid merely transferring the pollutant to another medium (i.e. air or sludge).

This research will address a major technological need for sustainable, economical options for routine leachate treatment and safe discharge to the environment by investigating energized processes, such as photochemical oxidation (which includes photochemical iron-mediated aeration, TiO_2, and UV/peroxide). Two of these emerging technologies are currently being developed at FAU. These include: photochemical iron-mediated aeration (PIMA) and magnetic-photocatalytic oxidation. These new and innovative processes work by using ultraviolet light

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(energy from sunlight) to activate the surface of a semi-conductor (i.e. titanium dioxide or metallic iron) to produce highly reactive substances derived from water. These reactive radicals rapidly destroy man-made organic chemicals, breaking them down into carbon dioxide, water, and innocuous salts. In addition, it has been discovered recently by a UM-FAU partnership (funded by HCSHWM) that these processes can also remove heavy metals and reduce nitrogen-containing constituents. Thus it may now be possible to eliminate impurities in water all at once using a single process.

The objective of the proposed research is to pilot test up to three energized treatment options for the removal of parameters of interest (such as COD/BOD, ammonia, heavy metals, color, pathogens, and others mutually agreed upon by FAU and the TAG) using non-biological methods that landfill operators with little training can routinely and reliably employ without spending too much time on the task.

PROGRESS REPORT
(November 2009)

Project Title: Energized Processes for Onsite Treatment Of Leachate
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Progress to Date:

- **Task 1**. Literature review. This work is underway and ongoing. Due to the hard work of Richard Reichenbach, Anthony Ruffini, and Andre McBarnette, the literature review of landfill leachate treatment process efficiency with photocatalytic oxidation and other novel advanced oxidation processes is mostly complete. The main focus of the literature review topics has been to identify precedents using energized processes such as UV/peroxide, PIMA, photo-Fenton, and TiO_2 for water treatment applications. In these studies, specific questions were targeted, such as the following: 1) efficacy for various pollutants (in particular those targeted for this study), 2) appropriate UV intensity range using the new UV fluence determination methods, 3) appropriate testing conditions, 4) appropriate range of reactant or catalyst dose (in grams or m^2), 5) appropriate hydraulic retention times or reaction/exposure times for certain pollutants, 6) appropriate mixing regimes, 7) appropriate pilot reactor design and scale-up. In addition, any factors that can impact the efficiency of the process such as catalyst poisoning, pH/temperature effects, etc. were identified.

- **Task 2. Conduct baseline leachate quality characterization.** Approval and permission for sampling raw leachate has been obtained from Jeff Roccapriore, District Manager, Broward County Central Disposal, Waste Management Inc. of Florida for the landfill facility located on Sample Road and Florida's Turnpike. We are targeting sample collection to begin in late December 2009.

- **Task 3. Concept testing for reactor configuration/design.** Using a prototype photocatalytic reactor module for aquarium testing, we have started preparations for mock scale up experiments with simulated and real leachates. Also, bench scale tests with simulated leachates have been performed to determine optimum dosing requirements as a starting point for scale-up testing.

Research planned for the upcoming months:

- Testing of photocatalysis with artificial leachates is underway to replicate the conditions of successful previous lab scale experiments in preparation for scale-up
- Testing of photocatalysis with actual leachates is underway
- Conceptual design of scale-up for pilot testing is underway
- Solicit feedback from TAG meeting scheduled for January 2010

- Reach out to Geosyntec Consultants and Heyward Inc. for assistance in prototype development

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