Application of New Leaching Protocols for Assessing Beneficial Use of Solid Wastes in Florida

Timothy Townsend, Professor
Department of Environmental Engineering Sciences, University of Florida
Lena Ma, Professor
Department of Soil and Water Sciences, University of Florida

ABSTRACT

When assessing the potential for the beneficial use of a solid waste, the typical practice is to evaluate two pathways of risk: direct human exposure and leaching to groundwater (or possibly surface water). In Florida, as with many other US States, leaching risk is assessed by comparing concentrations obtained using the synthetic precipitation leaching procedure (SPLP; EPA Method 1312) to risk-based water quality thresholds (e.g., Florida's groundwater cleanup target levels (GCTLs)). The US EPA has supported the development of a new suite of leaching procedures, generally referred to as the LEAF methods (Leaching Environmental Assessment Framework). While the LEAF methods provide a much greater amount of data with regard to how chemical constituents leach from a waste under different environmental conditions, questions have been raised such as:

- How should the LEAF methods be applied to beneficial use demonstrations (BUD)?
- Do all of the LEAF methods need to be performed as part of a BUD, or just a subset?
- How will the results from LEAF methods compare to results of historically applied leaching protocols?

The proposed research will examine the LEAF methods in the context of historic and current beneficial use assessments in Florida and will develop guidance for the Florida solid waste industry and regulatory community on the appropriate use of available leaching protocols for solid waste management risk assessment and decision making.

INTRODUCTION AND BACKGROUND

The SPLP was developed as an analog to the toxicity characteristic leaching procedure (TCLP), the EPA test used to determine whether a solid waste is a toxicity characteristic (TC) hazardous waste. Both of these methods are batch leaching tests conducted at a fixed liquid to solid ratio (20:1) for a specified time (18 hours). The pH of the leaching environment that the waste is exposed to depends on the chemistry of the leaching solution (TCLP simulates acidic landfill leachate and SPLP simulates acid rainfall) and the waste. An earlier Hinkley Center project (Townsend et al. 2006) provided a comparison between TCLP and SPLP and also examined the role of a variety of factors including pH, liquid to solid ratio, and leaching time. A major outcome of this work was an assessment of how to interpret SPLP results when assessing beneficial of solid wastes (Townsend et al., 2006). The SPLP has been used as a tool in multiple Hinkley Center projects assessing the beneficial use of different waste materials in Florida (Jain et al., 2005; Tolaymat et al., 2008; Jang et al., 2009 a, b) and this work has been used in the development of FDEP policy.

While researchers have for many years utilized a variety of different leaching protocols to assess contaminant mobility from waste, there was not a uniform standardized methodology for conducting such tests until recently. The US EPA supported researchers at the Vanderbilt University in coordination with European experts to develop a standardized suite of leaching protocols that allow users to examine a much broader range of potential disposal or reuse conditions – the LEAF protocols (Garrabrants et al., 2010). These protocols include EPA Methods 1313, 1314, 1315, and 1316.

Method 1313 is a batch test that examines chemical leachability as a function of pH. The leachability of many metals and metalloids is very strongly dictated by the pH of the leaching environment and the pH encountered in the SPLP is not always similar to those found in beneficial use applications. An example of this would be the reuse of a waste in contact with a water body, where the pH of the reuse scenario would be more adequately represented by the natural pH of the water than the pH found in an SPLP. Other beneficial use applications, such as the land application of a waste as a soil amendment, would also produce leaching conditions differing from SPLP. Method 1314 is an up-flow percolation column leaching test under saturated conditions that allows for an examination of chemical leaching as a function of liquid to solid ratio. A potential limitation of the SPLP is that it is conducted at a fixed liquid to solid ratio (20:1), which may not be representative of the conditions a waste is subjected to when beneficially used. Leachate concentrations at low liquid to solid ratios may be more representative of pore water concentrations of granular wastes placed in a beneficial use scenario (e.g use as an embankment fill material). Method 1314 provides information on the mobility of elements from a solid waste including an indication of which elements are washed from the surface of the material and quickly depleted, and which elements diffuse at a constant rate. Method 1315 is a tank leaching test assessing contaminant mass transfer from a monolithic or compacted granular waste into the surrounding water. In many beneficial use applications, wastes are compacted or integrated into a solidified product, and since SPLP requires size reduction Method 1315 may provide a more realistic assessment of mass release. Because 1315 is conducted over a longer duration (63 days) it allows for the measurement of mass flux and the analysis of trace element mobility, helping to predict a wastes long term leaching. Method 1316 is a batch leaching test which is conducted at different liquid to solid ratios; this test provides similar information as 1314, but can be conducted more rapidly. Relationships between methods 1314 and 1316 for specific wastes have yet to be developed.

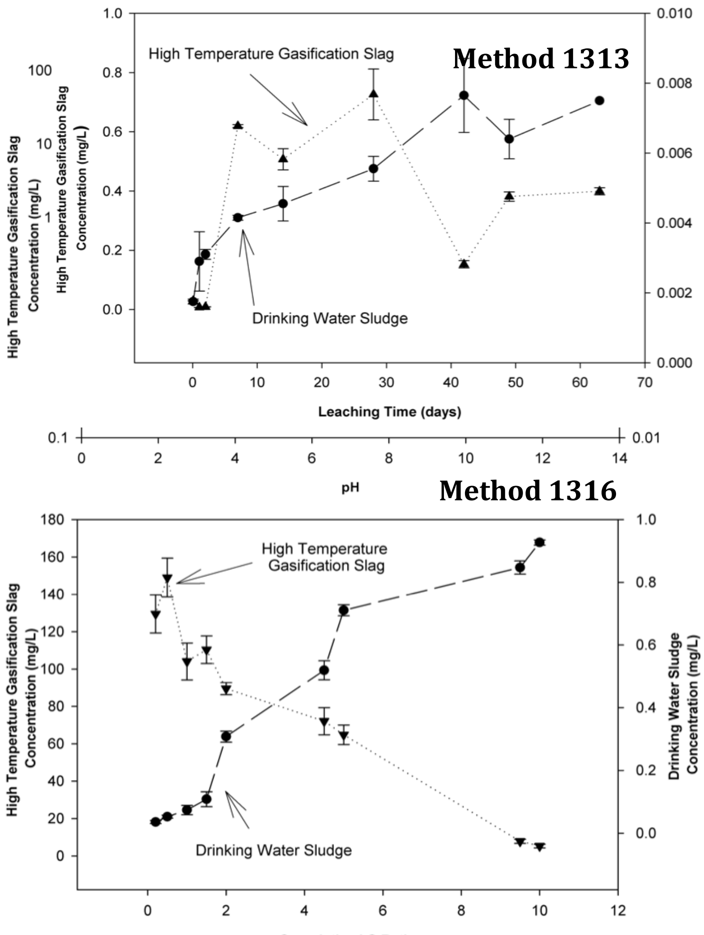
In recent years, the investigators have conducted the LEAF methods as part of the examination of several different waste streams, and they are familiar with the methodology. Figure 1 presents examples of LEAF outcomes for some of these wastes. These results highlight the potential utility of LEAF for evaluating chemical constituent leachability under a variety of different environmental conditions. While the added suite of leaching tests provides additional tools to evaluate potential beneficial applications, questions have been raised with regard to their application as well as differences between currently utilized tests. This was illustrated in recent Hinkley Center research by the investigators. A recently completed project, *Exploring Pathways and Limitations to Recycling Combustion Residuals in Florida*, brought professionals together from both the industry and the regulatory community to discuss recycling of fuel combustion residuals in Florida. Industry representatives from the utility industry raised concerns that LEAF protocols were being suggested as a requirement for future testing of coal combustion products as a part of proposed federal regulation. Concerns were raised regarding the potential costs associated with the testing and how the tests might be used or interpreted. One such example would be Method 1313 results from the highly acidic region (pH 2), a scenario not typically encountered in a beneficial use application. These results would typically be elevated with respect to other pH values, as many metals are highly soluble at this pH. However, guidance as to how these results might be interpreted when assessing beneficial use is unclear.

As part of the dialogue with the project's working group focused on the recycling of combustion residuals in applications such as roads, uncertainties regarding the interpretation of leaching test results with respect to regulated points of compliance were discussed. Consider Figure 2, for example, which illustrates a waste that has been applied to the land. Issues that were raised in the discussions included:

- Location of the point of compliance (see Figure 2; potential points of compliance are the pore water leaving the waste, the groundwater directly underneath the waste, and the groundwater some distance away from the applied waste).
- The ability of each leaching procedure to estimate the pore water concentration (the column tests (1314) would likely provide the most accurate simulation of the expected pore water

concentration; this raises questions regarding the utility of the other batch leaching procedures).

- The incorporation of dilution and attenuation (pollutants would certainly become attenuated in the soil under the applied waste and diluted in the groundwater; models could be used to estimate dilution and attenuation, but this process would require additional efforts beyond leaching tests).
- The pH regime that would be expected to dominate the system (1313 provides a method for assessing pH, but in many scenarios the pH of the pore water will likely be controlled by the waste chemistry; if so, a simple batch test such as SPLP might be best suited).
- Temporal changes in leaching with increased exposure to water and waste aging (1314 and 1315 allow the leaching of constituents after prolonged water exposure to be assessed, but a method would be needed to incorporate the changing releases into the groundwater risk assessment).
- Application of the monolithic test (method 1315 provides an estimate of mass release from a monolithic form or compacted granular form; it is uncertain how these results might be applied to applications such as compacted road base or wastes incorporated into a concrete product as an aggregate replacement).



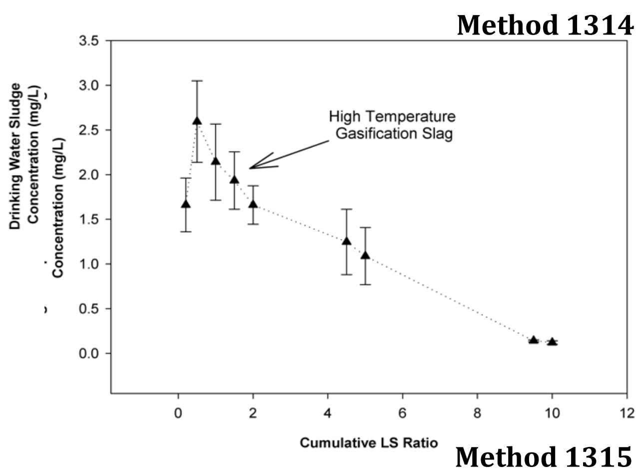


Figure 1. Example LEAF Results

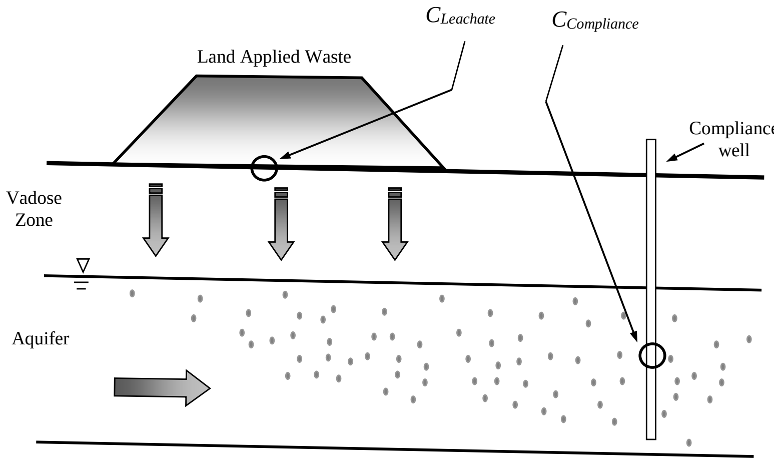


Figure 2. Conceptual illustration of points of compliance that might be considered when assessing leaching risk from land application of a waste

INVESTIGATORS

The investigators for the proposed research are Timothy Townsend, a Professor in the Department of Environmental Engineering Sciences and Lena Ma, a Professor in the Department of Soil and Water Science, both at the University of Florida. Dr. Townsend's area of specialization is solid and hazardous waste management and engineering. He has done research on numerous areas of solid waste management in the last 15 years, including specific projects on waste leaching and characterization of wastes for beneficial use. Dr. Ma's area of specialization is trace metal chemistry of soils, soil remediation, and beneficial use of waste materials through land application. The investigators have collaborated on several Hinkley Center projects related to waste characterization, leaching and beneficial use.

OBJECTIVES

- Fully document the LEAF leaching procedure and develop a simple guidance document or tutorial that provides an overview of the different methods and utility for practitioners in Florida. This document will serve as a tool to better illustrate the intent of the LEAF methods and how these new tools can be applied when assessing a wastes options for beneficial use.
- Examine previous beneficial use assessments conducted in Florida where leaching was evaluated, and gauge how the incorporation of LEAF testing may have impacted the outcome of a beneficial use assessment decision. Candidate materials include street sweepings, catch basin sediments, stormwater pond sediments, milled asphalt pavement, coal combustion products, recovered screened materials, drinking water sludge, wood ash, contaminated soil, treated wood residuals, waste-amended concrete, and waste-to-energy ash.
- Perform specific testing on three wastes from the identified group by conducting the LEAF methods, SPLP, TCLP and total metals analysis.

METHODOLOGY

Task 1. Literature Review. Current literature with regard to the application of leaching protocols such as LEAF will be compiled. This will include an evaluation of the refereed literature, industry and government documents, and international experience with application of leaching protocols. The literature review will serve as the framework in developing the background document, and identifying potential candidates for LEAF testing.

Task 2. Florida Beneficial Use Leaching Assessment. The results of previous beneficial use projects in Florida, both from Hinkley Center work and other sources, will be critically evaluated with respect to how leaching test results were used in decision making. Investigators will assess how the application of the LEAF protocols might have influenced the outcomes of such decisions by identifying scenario specific conditions that could have been better evaluated through the use of the LEAF methods.

Task 3. LEAF Testing. A complete suite of LEAF tests (as well as total concentration and SPLP) will be conducted on three waste streams selected based on task 2 as well as feedback from the project TAG. These tests will be used to address the questions raised in tasks 1 and 2 to support the development of a guidance document for the Florida solid waste community.

Task 4. Guidance Document A final report will be prepared in accordance with the Center requirements. This report will be written in a manner to provide the reader with guidance as to the utility of LEAF methodology for beneficial use decision making in the state. In addition, a separate standalone guidance tool will be developed for posting on the Hinkley Center's website that provides interested parties a tutorial on the LEAF methods, how they differ from existing procedures, and how they may be applied.

A 12-month project is proposed with the following timeline:

Task	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Literature review	X	X	X									
2. Florida Beneficial Use Leaching Assessment			X	X	X	X						
3. LEAF			X	X	X	X	X	X	X	X		
4. Tutorial and Guidance Development						X	X	X	X	X		
TAG Meeting			X								X	
Final report												X

BENEFITS

The solid waste community in Florida will benefit from a better understanding of the applications of the EPA's new leaching procedures with respect to beneficial use. This research will allow the industry and the regulatory community to better assess environmentally safe recycling of waste materials in the most cost efficient manner possible.

REFERENCES

Garrabrants, A., Kosson, D., van der Sloot, H. A., Sanchez, F., & Hjelmar, O. (2010). Background information for the leaching environmental assessment framework (LEAF) test method. United States Environmental Protection Agency (U.S EPA).

Jain, P., Jang, Y., Tolaymat, T., Witwer, M., Townsend, T. (2005) "Recycling of Water Treatment Plant Sludge via Land Application: Assessment of Risk." Journal of Residuals Science and Technology. 2(1), 13-23.

Jang, Y, Jain, P., Tolaymat, T., Dubey, B., Singh, S., Townsend, T. (2009a). "Characterization of Roadway Stormwater System Residuals for Reuse and Disposal Options." Science of the Total Environment. 408, 1878-1887. doi:10.1016/j.scitotenv.2010.01.036.

Jang, Y., Jain, P., Tolaymat, T., Dubey, B., Townsend, T. (2009b). "Characterization of pollutants in Florida street sweepings for management and reuse." Journal of Environmental Management. 91(2):320-327. doi:10.1016/j.jenvman.2009.08.018.

Kosson, D.S., Van der Sloot, H., Sanchez, F., Garrabrants, A.C., 2002. An integrated framework for evaluating leaching in waste management and utilization of secondary materials. Environmental Engineering Science 19, 159–204.

Tolaymat, T., Dubey, B., Townsend, T. (2008). "Assessing Risk Posed by Land Application of Ash from the Combustion of Wood and Tires." Journal of Residual Science and Technology. 5(2).

Townsend, T., Jang, Y., Tolaymat, T. (2003) "Leaching tests for evaluating risk in solid waste management decision making." Report for the Florida Center for Solid and Hazardous Waste Management, Gainesville, FL.

Townsend, T., Dubey, B., Tolaymat, T. (2006) "Interpretation of SPLP Results for assessing Risk to Groundwater from Land-applied Granular Waste." Environmental Engineering Science. 23(1): 236-248.

Van der Sloot, H., Heasman, L., Quevauviller, P., 1997. Harmonization of leaching/extraction tests, in: Studies in Environmental Science. Elsevier, pp. 239–261.