State University System of Florida
Hinkley Center for Solid and Hazardous Waste Management
PROJECT SUMMARY

TITLE: Current Environmental Topics Related to Construction and Demolition Debris Management in Florida

COMPLETION DATE: July 31, 2008

PRINCIPAL INVESTIGATOR: Timothy Townsend

AFFILIATION: University of Florida, Department of Environmental Engineering Sciences

CO-PRINCIPAL INVESTIGATOR: Brajesh Dubey

AFFILIATION: University of Florida, Department of Environmental Engineering Sciences

OBJECTIVES: This research proposes to address specific project objectives relevant to current environmental topics related to construction and demolition (C&D) debris management in Florida. Project objectives include (1) updating the C&D debris landfill groundwater database; (2) providing an updated risk assessment of the reuse and disposal of several asphalt waste materials (pavements and shingles); (3) reviewing fire incidents at C&D debris landfills in Florida and other locations and preparing a document that summarize the current state of knowledge regarding cause, prevention, and remediation of such fires; and (4) evaluating the issue of elevated iron concentrations in groundwater at C&D debris landfills by operating and analyzing an ongoing set of experiments.

METHODOLOGY: The existing C&D debris disposal facility groundwater database, which includes data up through the first quarter of 2003, will be updated with the help of available data at the Florida Department of Environmental Protection (FDEP) solid waste section, Tallahassee and additional data that are only available in the district offices. Representative reclaimed asphalt pavement (RAP) and asphalt shingles samples will be collected from different sites, leached, and analyzed for Polycyclic Aromatic Hydrocarbon (PAH) and heavy metal concentrations in the leachate. C&D debris landfill sites with known fire issues from around the US (and beyond if available) will be identified and existing information will be reviewed. For the elevated iron issue, one of the ongoing columns leaching experiment evaluating the iron release under reducing condition and its impact on arsenic mobility will be continued in next year to evaluate the impact of time on these processes.

RATIONALE: Disposal of heavy metal and other pollutant-containing waste in C&D debris landfill and the trend of increasing concentrations of several pollutants in groundwater monitoring wells suggest a need for close observation of the data from groundwater monitoring wells. The leaching of PAH from RAP and shingles is a possible obstacle to the beneficial reuse of RAP and shingles. One of the major focus areas in recent years has been incidences of fire at C&D debris facilities in Florida and elsewhere. Several landfill sites in Florida are experiencing elevated iron concentrations in groundwater wells. The iron rich soil is being hypothesized as a source of iron. The fate of As is very much tied to the chemistry of iron; iron soils have a strong ability to adsorb arsenic from water. The fact that reducing conditions under landfills may cause iron to be released suggests that As will also be released and might be more mobile than expected.

ACCOMPLISHMENTS: The principal investigator, Dr. Tim Townsend, has considerable research experience in the field of C&D debris management. He has conducted previous research for the center on various issues related to C&D debris management. His group compiled the C&D debris facility groundwater database in 2003. Earlier risk assessment of RAP was also carried out by Townsend's group a few years back as part of a center-funded project.

Recently, Dr. Townsend's group is involved with projects related to iron issues at different landfill sites in Florida. Dr. Brajesh Dubey has been working on different C&D debris management projects with Dr. Townsend first as his graduate student and now as a post-doctoral associate.

Current Environmental Topics Related to Construction and Demolition Debris Management in Florida

Introduction and Background

Research is proposed to address several current environmental topics related to the management of construction and demolition (C&D) debris in Florida. This proposal addresses Topics 1, 3, and 7 on the Hinkley Center for Solid and Hazardous Waste Management's 2006-2007 research agenda. The study area selected is relevant to current environmental topics related to C&D debris management in Florida.

Groundwater monitoring data at C&D debris disposal facilities: C&D debris landfills in Florida are unlined. Disposal of heavy metal (e.g., treated wood) and other pollutant-containing waste raises a concern for potential groundwater contamination from the leachate at these sites. In 1996, the Florida Solid Waste Rule was amended to require that all C&D debris landfills implement a groundwater monitoring program for certain parameters by 1997. Many landfills closed because of the capital required to install and sample wells. The number of C&D debris landfills in Florida dropped from 120 to the current 81. Typically, landfills completed the first round of monitoring in early 1997. In 2001, the solid waste rule was further defined by amendments that required a minimum of one upgradient and two downgradient wells be dedicated to groundwater monitoring. Downgradient wells may be detection wells, intermediate wells, or compliance wells. The groundwater monitoring network (both background and downgradient wells) is required to be sampled semi-annually, which is typically completed in March and October.

Generally, the landfill hires an environmental consultant to sample the monitoring well network twice a year. This same consultant often prepares the semi-annual monitoring report, which provides a map of the monitoring network, well elevations and groundwater flow direction, and laboratory analyses results. These reports are sent to the FDEP district where the landfill is located. The sampling and semi-annual reports may also be prepared by landfill personnel; however samples need to be analyzed by an FDEP-approved laboratory.

Table 1 provides the parameters that are required to be sampled for the various wells at the C&D debris landfills in Florida. The following types of wells are found at the landfills:

Background wells – wells that are upgradient of the landfill. "Background" as defined by FAC 62-502.2 means the condition of waters in the absence of the activity or discharge under consideration, based on the best scientific information available to the Department (FAC, 2003). These wells are sampled to establish background concentrations of contaminants in the groundwater at the site. These samples represent groundwater that is not influenced by landfill leachate. Background wells are sampled semi-annually every time detection wells are sampled (for the same parameters), but they are also sampled for more parameters initially and again before each permit renewal.

Detection wells – wells that are in the zone of discharge of the landfill. "Zone of Discharge" as defined by FAC 62-502.2 means a volume underlying or surrounding the site and extending to the base of a specifically designated aquifer or aquifers, within which an opportunity for the treatment, mixture, or dispersion of wastes into receiving groundwater is afforded (FAC, 2003). These wells are downgradient of the landfill and reflect groundwater that is impacted by landfill leachate. These wells are sampled semi-annually for a prescribed set of parameters.

Intermediate wells – another name for detection wells.

Compliance wells – the compliance point for C&D debris landfills is 100 feet from the edge of waste (toe of landfill). These well points are where groundwater standards must be met or the landfill would be out of compliance. These wells are sampled semi-annually for a prescribed set of parameters (same as detection wells).

Other wells – some landfills have other wells on-site that are not background, detection, or compliance wells. Groundwater levels and flows are variable and often these wells can be used to help map groundwater flows. Samples from these wells are often taken as well and included with the other groundwater monitoring results.

Table 1. Parameters for which C&D debris landfill monitoring wells must be sampled in Florida

Parameter	Background wells (initially and at permit renewal)	Background, detection, intermediate wells, and compliance wells (semi-annually)
PH	X	X
Turbidity	X	X
Temperature	X	X
Specific conductivity	X	X
Dissolved oxygen	X	X
Water elevation/level	X	X
Colors and sheens (by observation)	X	X
Total ammonia-N	X	X
Chlorides	X	X
Iron	X	X
Mercury	X	X
Nitrate	X	X
Sodium	X	X
Total dissolved solids (TDS)	X	X
Sulfate	X	X
Aluminum	X	X
Phenols	X	X
Antimony	X	
Arsenic	X	X
Barium	X	
Beryllium	X	
Cadmium	X	X
Chromium	X	X
Cobalt	X	
Copper	X	
Lead	X	X
Nickel	X	
Selenium	X	
Silver	X	
Thallium	X	
Vanadium	X	
Zinc	X	
Acetone	X	
Acrylonitrile	X	
Benzene	X	X
Bromochloromethane	X	
Bromodichloromethane	X	X

Parameter	Background wells (initially and at permit renewal)	Background, detection, intermediate wells, and compliance wells (semi-annually)
Bromoform	X	X
Carbon disulfide	X	
Carbon tetrachloride	X	X
Chlorobenzene	X	X
Chloroethane	X	X
Chloroform	X	X
Dibromochloromethane	X	X
1,2-Dibromo-3-chloropropane	X	
1,2-Dibromoethane	X	
o-Dichlorobenzene	X	X
p-Dichlorobenzene	X	X
1,3-Dichlorobenzene		X
trans–1,4-Dichloro-2-butene	X	
Dichlorodifluoromethane		X
1,1-Dichloroethane	X	X
1,2-Dichloroethane	X	X
1,1-Dichloroethylene	X	X
cis-1,2-Dichloroethylene	X	
trans-1,2-Dichloroethylene	X	X
1,2-Dichloropropane	X	X
cis-1,3-Dichloropropene	X	X
trans-1,3-Dichloropropene	X	X
Methylene Chloride		X
Ethylbenzene	X	X
2-Hexanone	X	
Methyl bromide	X	X
Methyl chloride	X	X
Methyl ethyl ketone	X	
Methyl iodide	X	
4-Methyl-2-pentanone	X	
Styrene	X	
1,1,1,2-Tetrachloroethane	X	
1,1,2,2-Tetrachloroethane	X	X
Tetrachloroethylene	X	X
Toluene	X	X
1,1,1-Trichloroethane	X	X
1,1,2-Trichloroethane	X	X
Trichloroethylene	X	
Trichlorofluoromethane	X	X
1,2,3-Trichloropropane	X	
Vinyl acetate	X	
Vinyl chloride	X	X
Xylenes	X	
2-Chloroethylvinyl ether		X

Source: FAC, 2003 (Chapter 62-701)

The authors previously collected and compiled C&D debris disposal facility groundwater data for landfills in Florida (Townsend et al., 2004). This previous data was gathered by updating FDEP's database of C&D debris groundwater monitoring well results and supplementing it with additional data collected from the six FDEP districts. A few pollutants of concern (e.g., As, Mn, Fe etc) were found to have an increasing concentration trend in the groundwater samples. The existing database (nearly 5 years old) will be updated with the newer data.

Risk assessment of the reuse and disposal of several asphalt waste materials: The United States has more than 2.5 million miles of paved road (www.hotmix.org accessed on March 28, 2007). Due to daily wear and tear, roadway expansion, and construction-related activity, these roadways sometimes need to be removed and repaired. During reconstruction or removal of a road surface, reclaimed asphalt pavement (RAP) is commonly obtained by milling or removing the existing pavement. RAP is typically recycled into new hot mix asphalt, but in some instances all of it cannot be reused. A proposed alternative for management of RAP is to use it as fill material.

Dr. Timothy Townsend has previously studied the leaching of reclaimed asphalt pavement (RAP) and its potential impact on the environment (Brantley and Townsend, 1999). In the previous study, RAP was leached using the regulatory tests of toxicity characteristic leaching procedure (TCLP) and synthetic precipitation leaching procedure (SPLP) and the results were compared to groundwater cleanup target levels (GWCTLs). Columns (leaching lysimeters) containing RAP was also evaluated with respect to leaching in a more realistic setting. Elevated lead concentrations were observed for a short duration in leachates from columns containing older RAP samples, but the TCLP and SPLP results showed that all of the concentrations of target pollutants were below the GWCTLs. Limitations to the application of these results include (1) some of the polycyclic aromatic hydrocarbon (PAH) detection limits as originally tested were greater than the revised GWCTLs and (2) recent literature indicates that PAHs do leach from RAP at low concentrations (Legret et al., 2005; Norin and Stormvall, 2004; Brandt and Groot, 2001), lower than the detection limits of the first study (Brantley and Townsend, 1999).

Table-2 US EPA list of PAHs as priority pollutants and their respective FL-GWCTL

Parameter	FL-GWCTL (μg/L)	Parameter	FL-GWCTL (μg/L)
Acenaphthene	20	Chrysene	5
Acenaphtylene	10	Dibenz[a,h]anthracene	7.5
Anthracene	2100	Fluoranthene	280
Benz[a]anthracene	4	Fluorine	280
Benzo[a]pyrene	0.2	Indeno[1,2,3-cd]pyrene	7.5
Benzo[b]fluorathene	4	Napthalene	6.8
Benzo[ghi]perylene	10	Phenanthrene	10
Benzo[k]	4	Pyrene	210

PAH is a group of chemicals formed primarily during the incomplete burning of coal, oil and gas, or other organic substances. It has been reported that sources of PAHs have included vehicle exhaust, weathered material from asphalt roads, lubricating oils, gasoline, diesel fuel, and tire particles (Takada et al., 1990). PAHs are also present throughout the environment in the air, water, and soil. In the environment one is exposed to PAH vapors or PAHs that are attached to the dust and other particles in the air. There are more than 100 PAH compounds. The US Environmental Protection Agency (USEPA) has characterized 16 PAHs as priority pollutants and these are listed in Table-2. This research will target these compounds. The US Department of Health and Human Services has determined that many of these PAHs may be considered carcinogenic (ATSDR, 2001). Several of the PAHs have caused tumors in laboratory animals upon ingestion, when applied to skin, or when inhaled. Reports in humans have demonstrated that exposure to PAHs for a long period has been associated with cancer. Since PAHs are among the highest molecular weight organic compounds and asphalt has a high molecular weight, there is a concern that these compounds may be present in RAP and asphalt shingles.

Review of fire incidents at C&D landfills: The growing problem of fires and C&D debris landfills has received heightened attention in the solid waste community as a result of several high-profile fires at C&D debris sites in Florida (Saufley landfill, Coyote Navarre landfill) and elsewhere (Warren Ohio C&D landfill,). The fires in Florida have, in part, been attributed to the large amount of disaster debris recently disposed of. C&D debris landfills are often more prone to fires because of their bulky nature (more void space for air to enter and initiate spontaneous combustion) and because they are not required to place cover material as frequently (thus allowing more air to enter). C&D debris landfills contain a large volume of wood, especially when land clearing debris or hurricane debris is included. These facilities have the added problem of H_2S odors; H_2S is a result of an anaerobic process, but the fires result in more pathways for water to enter the landfill and for H_2S to escape (cover material is critical for H_2S attenuation).

In December 2001, as part of the tropical fire research series program, the U.S. Fire Administration published a report on landfill fires in the US. The study included C&D and MSW landfills. The following were among the major findings of the report (USFA, 2001):

- Each year, an average of 8,300 landfill fires causes up to $8 million in property loss. Few casualties result from these fires.
- Landfill fires are most prevalent in the spring and summer, when there is a greater chance of spontaneous combustion.
- Landfill fires include not only refuse but vehicles, structures, and surrounding brush and grass.
- Fires at discarded tire sites produce large amounts of oil and smoke and are difficult to contain and extinguish.
- Matches, open fire, and hot embers/ashes are the leading forms of heat ignition.
- The cause of more than half of landfill fires is not reported; 40% are attributed to arson.

It has also been reported that most landfill fires occur from March through August, with July as the peak month. This is likely due to the hotter temperatures in these months, when there is a greater chance of spontaneous combustion and hot and smoldering discarded products ignite in landfills. In this proposed project, the authors review current science and management strategies for fires with a major focus on C&D debris landfills.

Issue of elevated iron concentration in groundwater wells: The elevation of iron concentrations in groundwater monitoring wells at landfill sites has been noted at a growing number of facilities in the state, both lined and unlined. The hypothesis that has been proposed by many is that the source of this iron is not the landfill leachate, but the native soils beneath the landfill. It is speculated that the iron becomes mobilized as a result of changing pH and/or redox conditions in the groundwater beneath the landfill. In the case of unlined (C&D debris) disposal facilities, reducing conditions can develop as a result of leachate migration into the groundwater. In the case of lined landfills, the reducing conditions are thought to develop as a result of changes to the natural hydrology that result from the use of a liner and possibly from other site changes such as the installation of stormwater control ponds. Iron is a naturally occurring element in many Florida soils. As a chemical species, iron can exist in the environment in many forms. Iron in soils typically occurs in the more oxidized Fe^{+3} form as opposed to the Fe^{+2} form. In the oxidized form, the iron is relatively immobile and stays as part of the soil matrix. When reducing conditions convert some of the oxidized iron to a more reduced form ($Fe^{+3} \rightarrow Fe^{+2}$), the iron may become liberated from the native soil matrix into groundwater (Pedersen et al. 2005; Benner et al. 2002; Zachara et al. 2001).

As part of the ongoing center project titled "Soils Underneath Florida Landfills and their Role in the Occurrence and Fate of Iron and Arsenic in Groundwater" with Prof Dean Rhue, several experiments are being designed and conducted to assess the potential leachability of iron from different Florida soils under reducing conditions. The impact of Arsenic mobility in these soils due to iron reduction is also being examined in the ongoing study. Additional funds are sought to continue several of the experiments for an additional year of monitoring. This experiment consists of several simulated C&D debris landfill columns that are underlain by a layer of iron-bearing soil. Details of this column experiment are presented later in the Methods section. The initial results from the study suggest that the iron is being liberated from the soil below the simulated landfill section (Figure 1). During this initial period iron in the soil is mobilizing arsenic and although As concentration is elevated in the simulated C&D column (containing CCA) leachates, after these leachate passes through the soil layer As concentrations measured in the eluent is below detection limit. The experiment has been running for several months. It would be of great value to continue this experiment to study the effect of time on the different processes involved in this study.

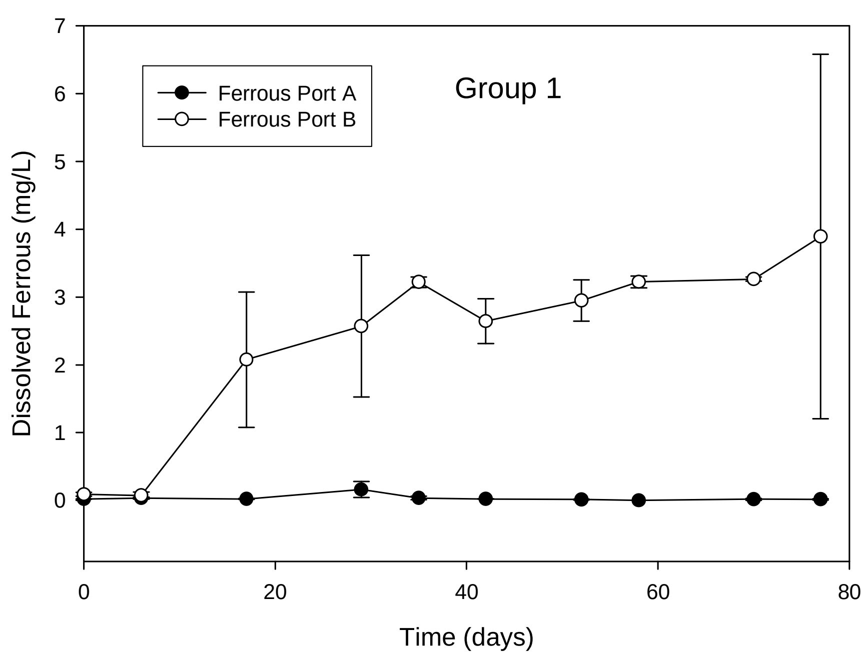

Figure 1. Ferrous Concentrations in Leachate from the Columns Containing a Simulated C&D Landfill and a Soil Layer beneath it (see methods for details). Port A indicates the Sample below the C&D Landfill Layer and Port B is the Sampling Point below the Iron rich Soil Layer.

<u>Objectives</u>

This research proposes to address the following specific project objectives:

1. Update the C&D debris disposal facility groundwater database (available with the investigator) with the latest data collected from different active C&D sites in Florida and analyze this data.
2. Conduct leaching tests on several asphalt waste materials (pavement and shingles), analyze the leachate for PAH and heavy metal concentrations, and provide an updated risk assessment of the reuse and disposal of these materials.
3. Review fire incidents at C&D landfills in Florida and other locations and prepare a document that summarize the current state of knowledge regarding cause, prevention, and remediation of such fires.
4. Continue to evaluate the issue of elevated iron concentrations in groundwater at C&D debris landfills by maintaining and analyzing an ongoing set of experiments.

<u>Research Team</u>

Dr. Timothy Townsend will serve as the principal investigator for the proposed research. Dr. Townsend's research area is solid and hazardous waste management; he has specialized in C&D-debris-related environmental issues. A major research area for Dr. Townsend has been the evaluation of environmental issues related to C&D debris disposal and recycling. He has published several journal articles and reports on this topic, including the C&D training manual for the Solid Waste Association of North America. Dr. Brajesh Dubey will serve as a co-principal investigator. Dr. Dubey has been investigating the impact of various treated wood products on the environment for 6 years. Dr. Dubey has also been involved in several previous Hinkley center sponsored C&D debris-related projects as a graduate student and now as a post-doctoral fellow in Dr. Townsend's group.

<u>Methods</u>

C&D Groundwater Database

In the proposed project, the database will be updated and the results will be statistically analyzed. Two specific tasks that will be focused on will assess the following questions:

(1) Has arsenic migration from suspect facilities continued and are new facilities experiencing arsenic issues?

(2) How prevalent are exceedances of iron and manganese?

The pertinent questions will be evaluated using input from the project TAG and the FDEP.

The existing database includes data up through the first quarter of 2003. To update this database,, the researchers will first coordinate with the FDEP solid waste section staff in Tallahassee to determine which additional data exist in the centralized database. Additional data that are only available in the district offices will be gathered by visiting and compiling appropriate annual monitoring reports. Appropriate statistical tools (following previous US EPA methodology for evaluating groundwater monitoring data) will be employed following the approached used in the previous study (for details please refer to Townsend et al., 2004; see.

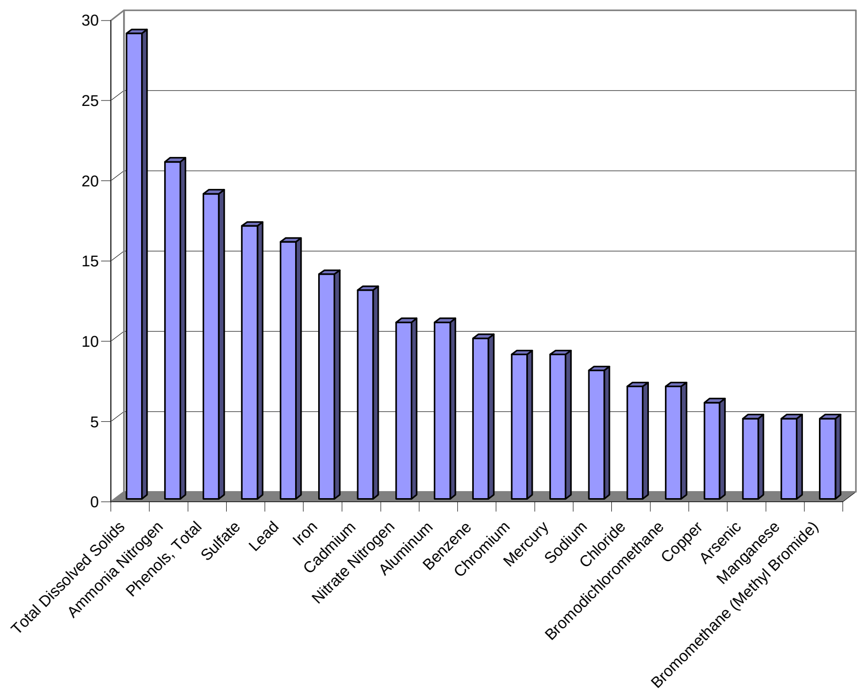

Figure 2. Example of Results of C&D Debris Facility Groundwater Monitoring Well Evaluation Results from Previous Study: Number of Sites where a Down-gradient Elevation of a GWCTL was Observed where Up-gradient Elevation was Not Observed (Townsend et al., 2004)

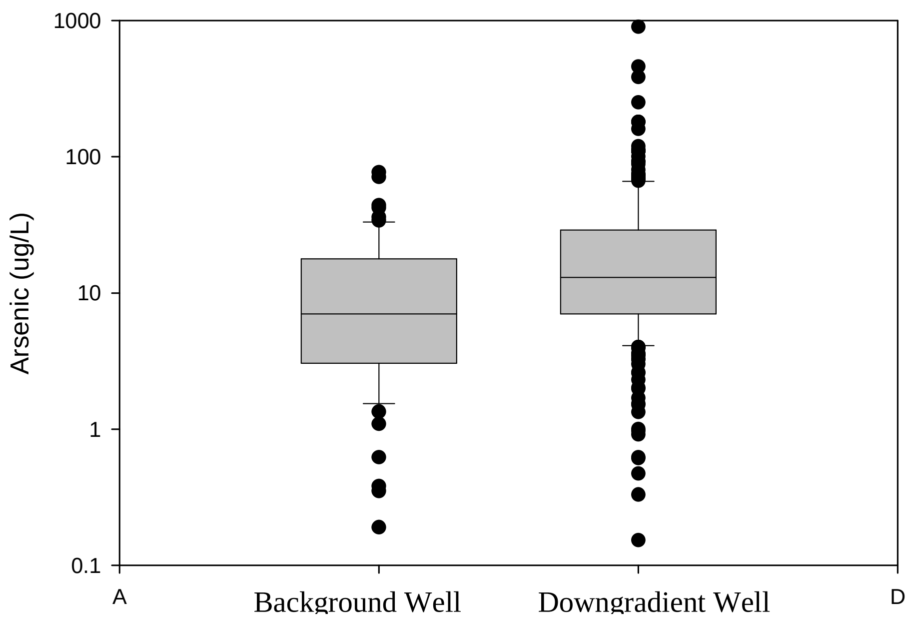

Figure 3. Example of Results of C&D Debris Facility Groundwater Monitoring Well Evaluation Results from Previous Study: Box plot comparing the As concentration in Background Well and Down gradient Well (Townsend et al., 2004)

Figure 2 and Figure-3 for an example of the type of output from this work). Special emphasis will be placed on looking at the changes in concentration of such elements as manganese, iron and arsenic recently appearing in the news

Leaching of RAP and Asphalt Shingles

Representative RAP and asphalt shingles samples will be collected from different sites. A minimum of six RAP samples and three shingle samples will be tested. As a first step, the samples will be leached using the synthetic precipitation leaching procedure (SPLP) in accordance with the US EPA method (SW 846, Method 1312, EPA, 2003). Previous methodology used GC/MS techniques, but this did not allow for sufficient detection levels. Thus a high-performance liquid chromatography (HPLC) technique will be developed using known procedures (SW 846 Method 8310, EPA, 2003). As appropriate, heavy metal concentrations will also be measured on the leachate samples. In addition to the SPLP, several other leaching tests will be conducted to evaluate the impact of specific environmental chemical conditions, such as pH and solution chemistry. These additional tests will be selected based upon the base results and feedback from the project's Technical Advisory Group (TAG) and the FDEP. This work falls within the bigger context of an issue being discussed around the country: Do PAH compounds leach from asphalt roofing shingles? This topic will also be evaluated.

Fires at C&D Landfills

The topic of fires at landfills has been the focus of evaluation by other researchers in recent years, with a large focus being placed on MSW landfills. Since C&D debris landfills represent a unique set of conditions, this part of the proposed study will focus on gathering information and summarizing lessons learned from fires at C&D debris landfills. The problem sites from around the US (and beyond if available) with respect to C&D debris fires will be identified and reviewed. Data collection will include contacting all of the state regulatory agencies for potential problem sites; the others who have worked with many regulatory agencies around the US on issues with C&D debris landfill pollution issues, including fires. The data to be collected and summarized will include (1) causes of the fires, (2) monitoring results from the sites, (3) control strategies for prevention and remediation of fires, and (4) potential environmental issues and health impacts resulting from these occurrences. In addition to being included in the report, this part of the work will be published as a stand-alone document that could be downloaded by interested parties from the Hinkley Center's website.

Elevated Iron Concentration in Groundwater Monitoring Wells

The ongoing experiment proposed to be continued consists of studying several leaching columns simulating C&D debris landfill conditions as a top layer followed by a layer of iron rich soil (see Figure-4). In one set of columns, the waste consists of typical C&D debris, including chromate copper arsenate (CCA) treated wood. In a second set of columns, no CCA-treated wood has been included. In a third set of columns, CCA-treated wood is included but in the absence of typical C&D debris components responsible for the cause of biological reducing conditions (e.g., gypsum drywall which provides an electronic acceptor for sulfate reducing bacteria). The goals of this experiment are (1) to evaluate whether C&D debris landfill leachate can cause sufficient reducing conditions to cause iron to leach from the soil at elevated levels, (2) to assess the impact of reducing conditions from C&D debris landfills on arsenic mobility in the soil and groundwater, and (3) to evaluate the impact of time on these processes.

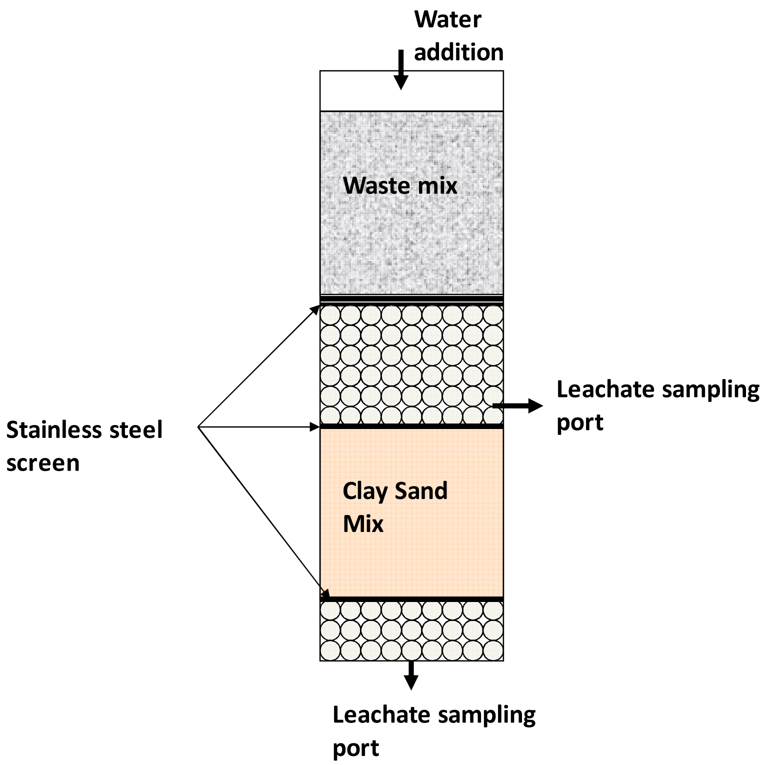

Figure 4 A Typical Leaching Column Simulating C&D Debris Landfill Condition and Passing the Generated Leachate through a Soil Layer

The leaching columns were installed in triplicate for each set of conditions. De-ionized water is added to these columns in periodic intervals (weekly) to simulate the precipitation. Samples of leachate are collected from the two sampling ports as shown in Figure-4 above. The collected leachate sample is immediately analyzed for ORP, ferrous, and pH. The total As, Fe, and Mn is also measured on these samples by first digesting it using USEPA SW846 method 3010B and then analyzing on inductively coupled plasma-atomic emission spectroscopy (ICP-AES) using US EPA Method 6010B. In addition, other parameters such as conductivity, total dissolved solids, and anions are also monitored on these samples.

As stated earlier in the document, presently the arsenic concentrations in the leachate sample from below the soil layer is not detectable. The As concentrations in the leachate from C&D debris containing CCA was elevated. This suggests that the iron present in the soil layer is attenuating the As coming from the C&D debris column. As shown in Figure-1, iron from the soil layer is becoming mobilized as it is getting reduced due to reducing leachate. On reduction iron gets soluble leading to high concentration of it in the leachate phase. During this period of support sought by this proposal, the effect of time on these processes will be studied. One important item to know from this experiment is the time at which enough iron leaches from soil, creating a lack of available iron in the soil to attenuate As leaching from CCA-treated wood in simulated C&D debris columns.

Timeline/Milestones

The project is proposed to begin on August 1, 2007 and to end on July 31, 2008, 12 months. The proposed timeline for the project is broken down as follows:

	A	S	O	N	D	J	F	M	A	M	J	J
Project Kickoff	X	X										
Literature Update	X	X	X									
Data Gathering, Information Collection, Conduct Experiments		X	X	X	X	X	X	X	X	X	X	
Final Document Preparation										X	X	X

Benefits

The issues proposed for research are important to landfill operators and the regulatory community in Florida. Upgrading the groundwater database of C&D debris disposal facilities will help the FDEP understand the potential for groundwater contamination from unlined C&D debris landfills. This would also help in the big picture discussion of whether the C&D debris landfill should be a lined landfill. Updating RAP and shingles risk assessment will be useful for assessing the beneficial reuse potential of these recyclable materials. Landfill fires and elevated iron concentration in groundwater monitoring wells is of immediate concern to the environmental community. FDEP, landfill operators, and the environmental community as a whole will benefit by better understanding the science behind these issues. The data derived will be valuable for future rulemaking activities and policy making

Deliverables

Deliverables for the proposed work include progress reports to the Center, a final technical report, and any manuscripts or thesis chapters completed by students working on this project as part of their degree requirements. The results from the four tasks indentified in this proposal will be presented as individual chapters in the final technical report. A stand-alone document will be prepared on the landfill fire issue and any other tasks as appropriate. All other deliverables required by the Center will be met. A project website will be maintained.

Possible Follow-up

Possible follow-up research to this project could include the design, installation, and monitoring of iron contamination remediation systems on site. The data collected during upgrading the C&D debris disposal facility groundwater database can be used for detailed risk analysis in terms of potential groundwater contamination. Implementing recommendations concerning landfill fires can be implemented on actual fire-prone Florida landfill sites to validate the recommendations.

APPENDIX C
PEER REVIEWERS FOR FINAL REPORT

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John Ladner
CDM, Orlando

Bill Krumbholz
Florida Department of Environmental Protection
South District

APPENDIX D
TAG MEMBERS

The following TAG members have shown interest in participating the TAG meeting on the proposed project or have participated in TAG meetings on similar projects.

Richard Tedder, Florida Department of Environmental Protection
Charles Goddard, Florida Department of Environmental Protection
Lee Martin, Florida Department of Environmental Protection
Greg Helms, US EPA
Thabet Tolaymat, US EPA
Jim Bradner, Florida Department of Environmental Protection
Bill Krumbholz, Florida Department of Environmental Protection
Susan Pelz, Florida Department of Environmental Protection
Kevin Leo, Camp, Dresser and McKee
Sam Levine, S2Li
Mark Swallow, Golder and Associates
Steve Laux, Jones, Edmunds and Associates
Ken Cargill, Geosyntec
Sermin Unsal, Broward County DPEP
Ram Tewari, Broward County DPEP
K S Prasad, Okaloosa County, FL
Ron Bishop/David Wood, Alachua County, FL

Other parties will be invited from the FDOT, county/city public works departments, and the demolition industry.

APPENDIX E

LITERATURE CITED

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