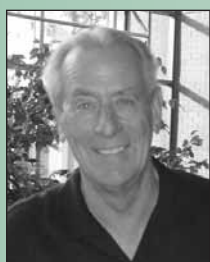


FROM THE PRESIDENT
MICHAEL J. CAGNEY



In December 2005, the EREF board of directors authorized a capital campaign entitled: *Shaping the Future: The Campaign for the Environmental Research and*

Education Foundation. The goal for this campaign is to increase the foundation's portfolio to the \$10 million level. This will generate \$1 million a year for research that will advance our knowledge of the management of municipal solid waste and fund scholarships for master's level engineering students as well as for Ph.D. environmental scientists.

Since the campaign began we have raised \$4,313,600 toward our objective of \$10,000,000 and our portfolio is currently valued at \$8,000,000. The campaign will end in December 2010.

Many, many thanks to all of you who have participated in *Shaping the Future*, your generosity and belief in the value of empirical science to develop and evaluate new approaches to manage solid waste is gratefully acknowledged!

EREF FALL CLASSIC GOLF TOURNAMENT RAISES OVER \$150,000



Champions Rob Brown, Danny Dye, Brian Houston, and Kim Hennig with tournament host Jim O'Connor

Republic Services Inc., and Allied Waste Industries hosted a wonderfully successful fundraising event in October, raising over \$150,000 for the Environmental Research and Education Foundation. The annual Fall Classic Golf Tournament was held at the Heron Bay Golf Club, in Coral Springs, Florida, proximate to Republic's Ft. Lauderdale headquarters. Approximately twenty-eight foursomes dominated the course on a perfect Florida day.

continued on page 2

CHARACTERIZATION OF MUNICIPAL SOLID WASTE LANDFILL LEACHATE

Because long term trends in leachate quality are not widely available, EREF funded Dr. Robert Gibbons (University of Illinois), Terra-Dynamics Consulting, and Geosyntec Consultants to characterize leachate from municipal solid waste (MSW) landfills located in various climates to determine if leachate constitute trends for a select group of organic and inorganic indicator parameters were affected by operational practices, waste type, waste age, and other physical factors.



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EREF Equipment Auction

Donations now being accepted for the
EREF Equipment Auction

May 9th, 2008 - WasteExpo Chicago

Don't miss out on this great opportunity!

Details on page 11



continued from page 1

CONGRATULATIONS 2007 WINNERS!

Players and sponsors mingled at an evening reception prior to the tournament, where veteran players reunited with each other and first time players were introduced. A new Corvette sat atop Hole 16, waiting for a Hole-in-One winner (who should arrive any time now). The golf tournament is the second largest annual fundraiser for the foundation; the Annual Equipment Auction at WasteExpo is the largest. Many thanks to all participants and sponsors for contributing to the success of this event, and for helping to further EREF's goal of improving solid waste management practices through the application of science. We look forward to those who will tee one up for science in fall of 2008!



Second Place Team: Tournament host Jim O'Connor with Scott Dols, Sean O'Brian, Geoff Mather and B.J. Harvey



Longest Drive women's - Karen Knaub



Longest Drive men's - Harry Gladfelter



Longest Putt - George Moorehead



Closest to the Pin - Bob Gardener



Special Thanks

Special thanks to all those who made the 2007 EREF Fall Classic possible. EREF is especially grateful for the generous support of:



Tournament Co-Hosts

REPUBLIC SERVICES, INC. Courtesy of Jim O'Connor &
ALLIED WASTE INDUSTRIES Courtesy of John Zillmer

Welcome Reception Sponsor
Don and George Moorehead

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RJM Waste Equipment

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Golf Balls courtesy of
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Hole Sponsors:

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Marathon Equipment Company
McNeilus Truck
Michelin
Perkins Manufacturing
US Trust/Bank of America
Waste Management
Wastequip
Weaver Boos

NEW PROJECTS

As of October 2007, EREF awarded more than \$830,000 for 7 new research projects. Each research project is briefly described below.

Microbial Fuel Cells in Landfill Applications

The University of New Hampshire was awarded \$121,515 to thoroughly examine landfill leachate as a substrate for microbial fuel cells (MFC), further research the use of less expensive materials for construction of MFC, and expand applications of the MFC to other areas of the landfill. The project could provide numerous benefits to landfill owners including making electricity directly from leachate while providing leachate pre-treatment and operating sensors at closed landfills to reduce costs.

Development of a Reusable To-Go System

Eckerd College was awarded \$32,000 to develop and implement a reusable container system for use by students that carry food out of cafeterias instead of using the typical disposal containers. The project has the potential to eliminate 10,800 disposable containers a year at Eckerd College alone. The project is co-sponsored by Bon Appetit which operates college food services across the country.

Field-Scale Assessment of Evapotranspirative Methane Oxidation Caps

Michigan State University was awarded \$145,000 to construct, instrument, monitor, and evaluate the performance of two field-scale earthen caps designed as evapotranspirative methane oxidation caps to reduce water infiltration into the landfill and reduce air emissions from the landfill. These caps have the potential to save landfill owners substantial costs during closure and post-closure care.

Modeling H₂S Generation from Processed C&D Materials

The University of New Hampshire was awarded \$147,558 to develop a hydrogen sulfide (H₂S) generation model that predicts generation on a mass flow basis resulting from construction and demolition (C&D) fines deposited in municipal solid waste landfills. The results of the research will provide landfill owners and regulators a tool to evaluate the proper intake and handling of C&D fines and the economic benefits of accepting these wastes can be weighed against any potential landfill gas control and treatment costs.

Determining Critical Data Needs for Implementing the EPCC Methodology

Geosyntec Consultants was awarded \$100,000 to evaluate the critical data requirements for implementing the Evaluation of Post-Closure Care (EPCC) Methodology tool that was previously developed by EREF. In order to use the tool, prerequisite data needs to be collected so that each element of post-closure care (i.e., leachate collection system, landfill gas monitoring system, groundwater monitoring system, and landfill cover system) can be evaluated. The outcome of the project will be to understand how available the data are for performing the evaluation and validate whether users (e.g., regulators, landfill owners, consultants, etc.) can readily understand and use the tool. The EPCC has the potential to adjust the post-closure care period and save owners money.

Driver Safety Program

The National Solid Wastes Management Association was awarded a grant of \$183,000 to perform refuse driver safety training for work-related motor vehicle accidents and fatalities. The training will consist of both a classroom and driving simulator

component and expects to train some 400 refuse drivers at 12 locations.

Roadmap for Landfill Gas Management

North Carolina State University and University of Central Florida received \$102,363 to identify and prioritize areas of landfill gas management that required funding. The goal is to provide EREF with a roadmap for directing research in the areas that are most pressing. Areas to be evaluated include gas modeling, collection systems, fugitive emissions, odors, and carbon footprint of the landfill.

COMPLETED PROJECTS

Field Testing of Landfill Gas



Concerns have been expressed by industry and others regarding the need for more up-to-date emission factors than those contained in the document *Compilation of Air Pollutant Emissions Factors* commonly referred to as AP-42 because these factors are used for regulatory purposes. Through a cooperative research program between the U.S. Environmental Protection Agency (EPA) and EREF comprehensive landfill gas data were collected pre- and post-combustion at five newer municipal solid waste (MSW) landfills.

The results of the research showed



that for raw landfill gas half of the tested constituents were at least one order (10^{-1}) of magnitude less, with some being three orders, (10^{-3}) of magnitude less, than their corresponding AP-42 values. In fact, five compounds usually attributed to MSW landfills, including acrylonitrile, in the EPA's Urban Air Toxics program, were not detected.

The final report titled *Field Test Measurements at Five Municipal Solid Waste Landfills with Gas Control Technology* is available on the EPA website at <http://epa.gov/ORD/NRMRL/publications.html> or by contacting Sarah Stancliff at 703.299.5139 extension 10.

Characterization of Municipal Solid Waste Landfill Leachate

continued from page 1

The primary findings and conclusions of this study were threefold:

- The subtle differences in chemistry between leachates from the three MSW waste cell types (i.e., MSW only, MSW and C&D, and MSW and special waste) cannot be reliably differentiated, therefore it is reasonable to evaluate all MSW landfill leachates on a combined basis for future statistical analysis;
- Time after landfill closure and cap-

ping with a low permeability cover system has the greatest effect on leachate quality as compared to age of waste at the time of closure, capping, and active LFG collection; and

- The effect of time indicates a decreasing average annual rate of change for all constituents and compound classes over the post-closure period, with many found to be statistically significant.

These findings provide additional validation to previous studies conducted in laboratory settings

and with short subsets of indicator parameters. This study reinforces the concept that MSW leachate quality trends are predictable and, in general, the concentrations of many constituents of concern decrease over time following landfill closure. The evaluations increase the knowledge base related to MSW leachate characterization, long-term changes in leachate quality with time, and the factors that impact that change, especially in the post-closure care period. This allows chemical trends in leachate quality over time to begin to be confidently identified and trend behavior to be established, including how different landfill components affect leachate quality (i.e., cover system type, whether leachate recirculation was practiced, operation of an LFG collection system, etc.). This information should allow decision makers to more accurately anticipate the effect that different landfill design features, management options, and components will have on leachate quality with time that in turn will support future operational changes (e.g., leachate recirculation and liquids addition, green energy opportunities, etc.) as well as long-term management strategies for closed landfills (e.g., application of all soil covers or phytocaps, use of passive or low-energy control elements, etc.).

Copies of final report are available by contacting Sarah Stancliff at 703.299.5139 extension 10.

HONORARIUMS AND MEMORIALS

**In Memory of
David A. Baratti**

—EREF

**In Memory of
Grace Cekander, mother
of Greg Cekander**

—Michael J. Cagney

The due date for mention of your honorariums or memorials in our spring issue is May 8, 2008. Call 703-299-5139 x10 for a donor form or download at www.erefndn.org/donor.pdf

EREF CALENDAR

**Research Council Meeting
Washington DC
January 8, 2008**

**Auction Reprise Meeting
Chicago O'Hare
January 23, 2008**

**Scholarships Due
April 30, 2008**

**EREF Auction at WasteExpo
Chicago, IL
May 9, 2008**

**Grant proposals due
May 15, 2008**

**Board of Directors Meeting
Quebec, Canada
June 2008**

FROM THE CHAIRMAN KEVIN WALBRIDGE



I am pleased to report that in 2007 the EREF continued its collegial relationship with the US Environmental Protection Agency with a project to collect up-to-date air emissions data at newer municipal solid waste landfills. Prior to this study regulators were relying on data from sites tested in the 1980s to establish air permits, develop emission inventories, and evaluate residual risk.

The results of the EPA/EREF study showed that the quality of raw gas from MSW landfills is 10 to 1000 times lower than previously reported. Landfill owners and operators can use the data from this research project which may result in some landfills being excluded from regulatory compliance.

This research is evidence that the EREF works to promote regulatory change, rather than reacting to it and the EREF board is committed to continue these important efforts. For further information on this and other projects, contact Dr. Edward Repa, EREF's Vice President of Environmental Programs at 703-299-5139 or erepa@erefndn.org.

In closing I want to thank John Zillmer, Chairman and CEO of Allied Waste Industries, Inc. for joining with Republic Services and Jim O'Connor to host another very successful golf outing in Coral Springs, Florida on October 12th. Thanks to generous donations from members of the waste management industry, the EREF Fall Classic Golf Tournament raised \$155,000!

Since the golf tournaments began in 2004, more than \$745,000 has been raised through industry wide support! Thank you all so very much!

Kevin Walbridge
EREF Chairman

FROM THE NOMINATING CHAIRMAN, LONNIE C. POOLE, JR



Nothing is more important to an organization than recruiting talent. This has been a great year for EREF in that arena. The board of directors welcomed three new members, representing both the service and manufacturing communities in the waste industry. We are confident that these valuable additions will add perspective and merit to foundation's mission as we proceed with our industrious research and education agenda.

Elected in 2007 were: Scott Edelbach of McNeilus, Richard Burke of Veolia Environmental Services, and Jim Dowland of Waste Management. Scott is Vice President of Refuse at McNeilus and brings twelve years of industry experience and a valuable manufacturer's perspective to EREF. Richard Burke serves as President and COO of Veolia Environmental, one of the largest providers of waste management services in North America. Jim Dowland offers perspective on landfill needs, having served as Landfill Operations Director and currently as the Vice President of Disposal Operations Support at Waste Management.

We warmly welcome these additions to the EREF community, and look forward to the inclusion of their talents and ideas in developing environmental and solid waste management solutions for the future.



Scott Edelbach Vice President, Refuse McNeilus Truck

Scott Edelbach began working for McNeilus part-time while in college in 1989 and went to work full-time in 1994 after obtaining a business degree from Southwestern University. He is currently Vice President and General Manager of the refuse division at McNeilus, a family company founded in 1975, now owned by Oshkosh Truck Corp. In addition to their manufacturing, McNeilus is praised for its safety initiatives, implementing the "Slow Down, Get Around" program, which received honors within the waste industry.



Kevin Walbridge, Ron McCracken and Max Goodrich



Richard Burke
President and COO
Veolia ES Solid Waste, Inc.

Richard Burke joined Veolia Environmental Services in 1999 as Area Manager for the Southeast Wisconsin and was soon promoted to Regional Vice President for the Eastern and Southern markets. Prior to that he spent 12 years with Waste Management as Director of Operations for the State of New York. He is a member of the Rotary Club for the Greater Richmond Area and is past Chairman of the Mary Cariola Childrens Center, a school dedicated to educating children with special needs.

Headquartered in Milwaukee, Veolia ES Solid Waste, Inc. is one of the largest providers of waste management services in North America. Veolia ES serves over 1.3 million customers, providing solid waste collection, transportation, disposal and recycling for industrial, commercial, residential and municipal customers.



James H. (Jim) Dowland, Jr.
Vice President – Disposal
Operations Support
Waste Management

Jim Dowland is currently responsible for providing new tools, training, and resources to improve WM's landfill and transfer station operations, increasing disposal airspace, improving airspace and equipment utilization, standardizing landfill and transfer station construction process and project management, optimizing heavy equipment procurement, standardizing heavy equipment preventative maintenance, continuing environmental compliance leadership, growing renewable landfill gas-to-energy business, continuing development of new disposal technologies, and supporting landfill pricing excellence efforts. Jim also works closely with the Sr. VP – Government Affairs & Communications to develop new tools and lead a cross-functional team to help support and improve landfill expansion and Greenfield development efforts.

Jim joined Waste Management in 2000 as Director of Landfill Operations for the Southern Group. Prior to that time, he served in various roles for almost twenty years with Browning-Ferris Industries and McClelland Engineers. Jim received his B.S. in Civil Engineering and his M.S. in Civil Engineering from the University of Illinois, and his M.B.A. from the University of Houston. He is also a registered Professional Engineer in the State of Texas.



Ron McCracken with Richard and Debbie Reinhart



Bob and Anne Riethmiller



Lonnie Poole, Ted Flood and Richard Burke



Ed Repa, Debbie Reinhart, Paul Mitchener, Henri Saint Bris, and Michael Jobe engaged in board discussion

FIRST MASTER'S SCHOLARS AWARDED!

EREF voted last year to expand its scholarship program to include master's degree awards. Robert P. Stearns, Past-chairman of EREF and current Chairman of SCS Engineers, volunteered to fund a scholarship specific to master's degree seeking scholars. This addition expands EREF's scholarship program beyond the doctorate and post-doctorate levels for the first since the scholarship programs inception in 1998. After careful review of candidates, the following two master's scholars were chosen as recipients of the Robert P. Stearns/SCS Engineers Scholarship:



Roberta J. Niemietz

Roberta is attending Virginia Tech and is seeking her master's degree in environmental engineering. She

plans to study waste degradation by attempting to characterize the intermediate lignin degradation products through chromatography and spectroscopy. Roberta received her undergraduate degree in Environmental Science at Washington University, St. Louis.



Anne-Marie P. Armstrong

Anne-Marie is seeking her Master of Architecture degree at Yale University. She is focusing on construction ecologies,

specifically the relationship between waste management and architecture, exploring implementing an effective 'green' building movement. Anne-Marie received an Honours Bachelor of Architectural Studies degree from the

University of Waterloo.

Roberta and Anne-Marie will each receive \$5,000 per year for up to two years. Additional master's students will be awarded by the Robert Riethmiller/PTR Scholarship Fund in 2008.

New 2007 Scholars

EREF awarded two scholarships to doctoral students in 2007. Junbeum Kim was awarded the EREF Scholarship. Mohan Dangi was named the 2007 Fiessinger Scholar.



Junbeum Kim

Junbeum is seeking his Ph.D. through the Civil and Environmental Department at Arizona State University. He is currently studying issues

of sustainability engineering and industrial ecology; E-waste recycling system; and industry network theory and model. Junbeum received a B. S. from Cheongju University in 2000, an M.S. from Inha University, and an M.S. from Carnegie Mellon University in 2004.



Mohan B. Dangi

Mohan is seeking his Ph.D. from Johns Hopkins University, in the department of Geography and

Environmental Engineering. He is currently investigating past failures of solid waste management in developing countries, analyzing the relationships of institutional and socio-technical issues. Mohan received a B.S. from Colorado School of Mines in 1999, and an M.S. from Colorado School of

Mines in 2002.

Applications for both master's and doctoral scholarships are due April 30, 2008. For more details on scholarship awards, visit www.erefndn.org/scholar.

Scholar Updates

Monica Danon-Schaeffer Awarded 2005



The summer of 2006 was spent doing Polybrominated Diphenyl Ethers (PBDE) research in 11 Northern Canadian (north of parallel 60) landfills – collecting soil, effluent, leachate, and background water samples. This turned out to be quite extensive in scope and interpretation of the results this fall was time consuming. Wrapping up experimental work from the lab also took place in the fall. The bulk of my time in the fall and into the 2006 winter months was spent developing the mass balance model for PBDEs leaching from e-waste in landfills. This work represents two chapters of my thesis in addition to preparing the modeling work for publication. The purpose of the model is to track PBDEs originating with e-wastes. Model simulations are ongoing but should be finalized soon.

The remainder of my time has been spent writing my thesis, which includes the development and simulation of various PBDE/e-waste scenarios at a landfill: what do the concentrations look like currently?, with ~25 years of flame retardant use and disposal in landfills?, a complete ban on PBDEs and no more enter the landfills,

and another scenario that deals with the accumulation of electronic waste over time eventually reaching landfills even though PBDEs have been banned. I am in the 'bullet-proofing' and 'button-holing stage of my thesis (aka 'flame-retarding') and hope to have my oral defense very soon. The title of the thesis is "*Polybrominated Diphenyl Ethers in Landfills from Electronic Waste.*"

I presented my research at three conferences between August and December 2006; Dioxin conference on Persistent Organic Pollutants (August) where I discussed the implications of e-waste leaching from landfills. The next conference I presented was at "E-scrap" (October) where I discussed the potential environmental problems resulting from plastics discarded from electronic equipment. The third and last conference of the year was related to my results from the Canadian Arctic (December) where I presented data on PBDE concentrations from soil, leachate, sewage effluent and background water samples collected over the summer.

I also presented updates on my research at two PhD committee meetings that took place in October 2006 and April 2007. I also prepared a publication for Resource Recycling that was published in February. The TV interview that took place in the fall was aired between February and March 2007 (Knowledge Network/The Leading Edge Innovation in BC).

I was the first author on a major report on the results of our research in the Canadian Arctic to submit to the agency that funded the project, Environment Canada (March 2007). I then presented my updated research with an emphasis on the growing e-waste problem at a conference in May 2007.

Shahzeen Attari Awarded 2005

This past year has been quite busy. In January I took my Engineering and Public Policy qualifier exam and am



pleased to report I passed. I also completed the first experiment I had planned (see abstract below). I am now about to submit the manuscript for

publication to the journal:
Environment and Behavior.

Paper Title: *Decreasing Demand: Attempting to Facilitate Energy Conservation by Changing Individual Behavior*

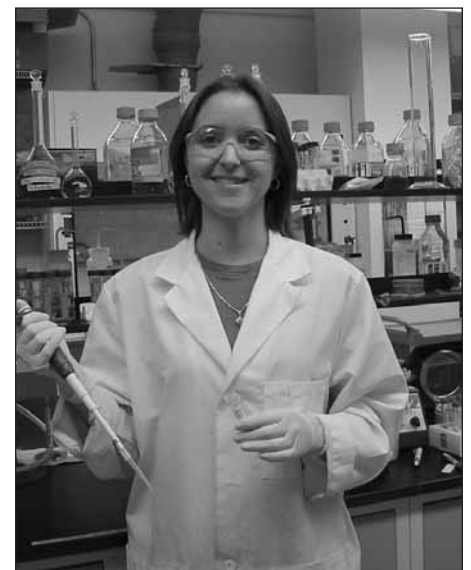
Abstract:

The effect of a weak intervention on energy conserving behavior was investigated by using surveys and telephone interviews (N=100). The intervention asked participants for reasons why they did or did not engage in energy conserving behaviors, with questions focusing on household operations, transportation, and food purchases. Results show that the intervention did not facilitate behavior change in these sectors. However, one behavior had a significant positive change with a relatively large effect size: after the intervention, the treatment group stated that they consciously paid more attention to the packaging of the products they bought compared with two control groups. Additionally, participants perceived there is not much difference in how much energy is saved when asked about several different behaviors. Furthermore, 60% of the participants perceived a change in their own behavior over the course of the study even though results show no overall behavior change occurred. This could imply that participants have optimistic illusions of their own behavior change.

Keeping in mind the overall lack of behavior change seen in my results, and the fact that I had originally set

out to try and decrease individual energy consumption behavior, I am now looking at regulating behaviors rather than promoting voluntary actions. I have moved on to trying to understand when and why individuals will accept hard and soft regulations to mitigate climate change. In order to answer this question, I designed a survey with the help of a behavioral economist, Professor George Lowenstein at Carnegie Mellon University and have thus far collected 200 surveys from the Pittsburgh community. Initial analysis shows that individuals in the Pittsburgh community prefer soft regulations i.e. incentivized behaviors like subsidies and taxes rather than hard regulations like banning SUVs in order to mitigate climate change. We are now beginning to analyze the reasons individuals provided for their preferences.

Susan DeLong Awarded 2006



Bioreactor landfills offer many benefits over traditional landfills including faster decomposition of biodegradable materials, reduced leachate disposal, and increased landfill life. However, optimizing biological decomposition is challenging because landfills contain diverse materials that are degraded by different microbial reactions. Molecular biology tools for investigating biologi-

continued on page 10

cal treatment are becoming popular because they allow researchers to study biodegradation at a fundamental level, offering new insights into what factors lead to successful treatment. While molecular biology tools are increasingly applied to biological water and hazardous waste treatment, they have rarely been applied to biological processes associated with solid waste.

To apply molecular biology tools to assess microbial waste decomposition, the sequences of genes involved in waste decomposition must be known. Although an increasing number of environmentally relevant genomes are being fully sequenced, the availability of sequences for waste decomposition genes remains limited. This has hindered the application of molecular biology tools to monitor biodegradation in landfills. Given that it is not currently economically feasible to sequence the genomes of all bacteria relevant to waste treatment, tools are needed that can isolate and sequence the key functional genes associated with successful biological waste treatment. The objective of my work has been to develop such a focused gene sequencing tool, Prokaryotic SSH PCR cDNA Subtraction (hereafter referred to as Gene Subtraction), that can be applied to efficiently isolate and sequence key genes involved in a given treatment process.

During the previous year, I have completed development of the Gene Subtraction method using a model system to verify that the method functions as intended. The Gene Subtraction method isolates genes that are used by a microorganism under specific conditions (e.g., growth on a specific waste material), thereby identifying key genes without sequencing the microorganism's entire genome. The model system used for development was *Pseudomonas putida mt-2*, a fully sequenced bacterium, growing on toluene (model pollutant). The Gene Subtraction method developed successfully isolated and identi-

fied genes involved in toluene degradation, even though the *P. putida mt-2* genome contains approximately 5500 genes, most of which are not related to toluene degradation. Sequences were obtained for 20 genes known to be involved in toluene degradation. Therefore, Gene Subtraction shows promise for rapidly obtaining the sequences of genes involved in waste degradation. A manuscript has been prepared for publication to make this new tool available to the scientific community.

Upon the completion of the Gene Subtraction method development, I began work to apply this tool to unsequenced bacteria that are important for microbial degradation processes. I am working with a number of *Proteobacterium*, which are ubiquitous in the environment, and, therefore, are likely to be found in landfills. They have also been used to treat landfill leachate.

The development of the Gene Subtraction method has made it possible for researchers to quickly obtain functional gene sequences from any culturable bacteria. Access to functional gene sequences will enable researchers to harness the power of the sophisticated molecular biology tools becoming available for monitoring biological waste treatment processes. Understanding how the fundamental processes responsible for waste biodegradation are affected by operational decisions has the potential to transform the way we manage solid waste.



Nicole Berge Awarded 2004

I have just completed my first year as a Postdoctoral Associate at Tufts University working in the Integrated Multiphase Environmental Systems Laboratory. My

current research at Tufts focuses on developing and evaluating methods to deliver nanoscale zero valent iron (nZVI) to dense non-aqueous phase liquid (DNAPL) source zones.

Although reactive nZVI particles have been shown to be effective at reducing such contaminants, application of iron-based destruction technologies is currently limited by poor delivery of the particles (i.e., lack of contact between the iron particles and the DNAPL) and consumption of the reactive material by non-target solutes as the iron migrates through the subsurface. Encapsulation of the reactive particles within the oil-phase of an oil-in-water emulsion is a novel approach that may facilitate particle delivery to DNAPL source zones while minimizing non-target reactions. I am in the process of conducting laboratory experiments aimed at developing kinetically stable emulsions that may serve as effective iron carriers.

I am also continuing a project I began while at the University of Central Florida (UCF). Along with collaborators at UCF, I am investigating how operating a bioreactor landfill influences overall project economics. The objectives of this work are to (1) evaluate the costs and benefits associated with both as-built and retrofit bioreactor landfills and determine how they influence overall landfill economics, (2) compare bioreactor landfill economics to those of traditional (dry tomb) landfills, (3) determine how varying air addition times when operating hybrid bioreactor landfills influences total costs, and (4) evaluate the sensitivity of operational parameters (e.g., electricity costs) and/or anticipated benefits (e.g., amount of settlement) on bioreactor landfill economics. To meet these objectives, we have developed a spreadsheet-based model incorporating all economic factors (costs and benefits) related to bioreactor landfill operation. Costs associated with landfill construction, operation and maintenance, gas collection and utilization, leachate treatment, closure, post-closure, and monitoring costs are all

accounted for in the model. The model also quantifies potential economic benefits associated with air-space recovery, reduced leachate treatment costs, and increased gas generation rates. We currently in the process of running model simulations and plan to submit a manuscript for publication in late 2007.

I am extremely grateful to EREF for their financial support over the past three years.



Bryan Staley Awarded 2004

I have recently completed my third year as a Fiessinger scholar at N.C. State University where my research objectives are aimed

at enhancing refuse degradation relative to traditional practices via the control or manipulation of landfill microbiology. Research has been completed on a sample processing method to extract nucleic acids (e.g. DNA, RNA) that was optimized for solid waste. I have found that blending refuse in a phosphate buffer and squeezing the blended slurry through a mesh screen was optimal for the recovery of DNA. The research also showed that sample processing can affect DNA yield and how well extracted DNA represents the microbial community. The results of this research were submitted for journal publication in late 2006. The sample processing method developed has since been employed to study landfill microbiology in refuse at various stages of decomposition and compare leachate to the solid fraction of refuse. Individual waste components such as food waste, paper and yard waste were also compared. Results showed that total DNA levels, an indicator of microbial population, varied widely among the different samples. This suggest that population size may not be a good indicator of degradative activity because metabolic capability

can change remarkably depending on the individual microorganisms.

My research also evaluated the mechanisms leading to the initiation of methane formation in refuse. Methane production and microbial community structure were evaluated from refuse in the acid and well-decomposed phases to determine the effect of these variables on methanogen metabolism. Results suggest that pH is a promising indicator of methanogenic activity in refuse and pH change occurs over millimeter scales when particulate size is small.

I am also evaluating microbial community dynamics in response to periodic

and one-time shock loads of a special waste with a high COD and low pH. Molecular work is currently underway to evaluate community structure and initial results show that relative RNA levels, an indicator of microbial metabolism, clearly increase in response to shock loads. The study will strengthen our understanding of how complex microbial communities interact with environmental variables over time.

The research performed thus far continues to reveal new and exciting information. Ultimately, the encompassing goal of these studies is to prepare the landfill industry for the next generation of techniques to optimize gas production and airspace recovery.

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2008 Auction at WasteExpo

May 9, 2008 at McCormick Place - Chicago, IL

Industry donors last year helping to raise over \$1 million for the foundation included: Autocar, LLC; Bayne Premium Lift Systems; BP Barker Products, Cram-A-Lot/J.V. Manufacturing; E-Z Pack; Galbreath, Inc. a Wastequip Co.; Heil Environmental Industries; K-PAC Equipment; Labrie Environmental Group; Link Manufacturing; Lonnie C. Poole, Jr., Waste Industries; Mack Trucks, Inc.; Marathon Equipment Company; McNeilus Truck & Manufacturing; Penton Business Media; Perkins Manufacturing; Pioneer Cover-All, a Wastequip Co.; PTR Baler and Compactor; RDK Truck Sales & Rentals; Jim O'Connor, Republic Services, Inc.; Kevin Walbridge, Republic Services, Inc.; Ron McCracken, RJM Waste Equipment; Schaefer System International, Inc.; Wastequip; Wastequip Accurate, A Wastequip Co.; Ameri-Kan; BOMAG; Rudco Products, Inc.; SP Industries, Ritchie Bros Auctioneers, GES Exposition Services; and WASTEC.

Donations now being accepted for 2008. Please contact Sarah Stancliff at 703-299-5139 x10 or sstancliff@erefdn.org or visit www.erefdn.org/auction for more details.

2008 Raffle Car

2000 Corvette Convertible
Tickets to be sold at WasteExpo and through Penton's registration process.
Only \$100 each, limit of 600
Someone will drive home in this beauty, it could be you!



Donors Who Have Made Substantial Financial Commitments as of November, 2007

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(donations of \$250,000.00 or more)

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