Environmental Sustainability: A New AAEE Certification

Environmental Engineer: Applied Research & Practice
GUARANTEED Municipal & Industrial
MAINTENANCE SERVICES

SEWER CLEANING: High-Pressure Jetting / Power Bucketing: Single and double-pump, jet-vac combination units with line jetting capabilities of 175 gpm / 2,500 psi literally scour sewers clean. Specifically sized buckets quickly and thoroughly remove all debris from severely clogged sewer lines.

SEWER TELEVISION INSPECTION
We have the CCTV equipment powered by the latest computers and software and the experienced technicians to precisely locate problems in mainlines and service laterals. Completely eliminates costly guesswork and unnecessary excavation.

WET/DRY VACUUMING
Jobs that used to take days are completed in hours. Our custom-built vacuum vehicles can quickly clean up the toughest, dirtiest material, no matter where it's located.

Other Services Available:
- Sewer Joint/Lateral Sealing
- GPS/GIS Data Collection
- No-Dig Cipp Point Repairs
- Manhole Rehabilitation
- Digester/Tank Cleaning
- Pit, Pond & Lagoon Cleaning
- Sludge Dewatering
- Water Blast Cleaning
and much more.

All Work Is Available Nationwide and Is Backed by Our Unmatched Guarantee:
You must be satisfied or you pay absolutely NOTHING for our services.

Call Toll Free 1-800-621-4342
CARYLON CORPORATION
2500 W. Arthington Street • Chicago, IL 60612 • Fax: 312-666-5810
Visit Us On the Web: www.carylontech.com
Environmental Sustainability: A New AAEE Certification

2010 Kappe Lecturer:
Morton A. Barlaz, Ph.D., P.E., BCEEM

Class of 2009

Farkas & Berkowitz

Environmental Engineer: Applied Research and Practice
Sustainability and the Environmental Engineer: Implications for Education, Research and Practice
James R. Mihelcic, Ph.D., BCEEM, and Maya A. Trott, Ph.D.

Do your part for the environment – reuse and recycle.
Am I Good Enough?

As you turn to the next issue, I will give a hint on why I joined, what I have gained, why I feel enriched, my thoughts for the organization and some comments about the Class of 2009.

The pride of being elected President and the privilege to serve AAEE as its President for the year 2010 is at once humbling, rewarding, and challenging. Humbling because of the honor it bestows, rewarding because of the opportunity it offers to contribute, and challenging because of the important work that lies ahead.

The Academy has just completed a successful and productive year which, in no short measure, is the result of the efforts and dedication of a large number of individuals. First, thanks are due to outgoing President Debbie Reinhart for her amiable, efficient, and effective style of governance of the organization this past year. Her leadership was firm, but always courteous and mission oriented, and we will treasure the lessons learned from her approach to governance. Thanks are also due to outgoing Past President Bill Dee for his sage advice and counsel throughout the year, and to the committee chairs and their contingent of motivated committee members and volunteers, whose personal donation of time and resources contribute so much to the proper functioning of the Academy. Finally, no professional organization such as AAEE can operate effectively without a competent and dedicated staff, and the Academy is very fortunate to be served by such a group of individuals headed by Executive Director Joe Cavarretta, and ably supported by staffers Sammi Olmo, Joyce Downen, Yolanda Moulden, and Pat Violetta. Our thanks to them also; we very much appreciate their service.

I was first introduced to AAEE in the Summer of 1980 by the only colleague that I then knew who was an AAEE “Diplomate,” today, an AAEE Board Certified Environmental Engineer. After some additional discussion with my colleague, he persuaded me to take a look at the roster of Diplomates, and I was most impressed by the lineup which represented the giants of the profession in academia – Dan Okun, Gerry Rolich, Earnie Gloyna, Ray Loehr, Fred Pohland, and in practice – Roy Weston, Bill Carroll, Joe Ling, Wes Eckenfelder, Paul Busch, and including also the founding Diplomates.

“You should join up” he said, and I muttered, “I will think about it.” However, having said that, a few questions immediately surfaced in my mind, e.g., “Am I good enough to be in the company of the really big boys on the roster?” “Why should I join?” “Will I benefit personally?” “Will I benefit professionally?” (My career is already on the fast track – so I figured), and “Will joining improve my situation?” “How do I measure the benefits?” While I respected my colleague, and took some comfort in the fact that we both held important and equivalent positions in our organization, both being department heads, I was still haunted by the question – “am I good enough?” Not being one to shy away from joining professional groups – WEF, AWWA etc., I decided to pursue the idea of joining AAEE, and began my research into what it would take for me to join.

Not far into my research, I realized that I needed to show proof of graduation from a reputable engineering program, proof of a P.E., in active status, many years of relevant experience in the practice of Environmental Engineering, and even a record of good character. And to add insult to injury, I also had to sit for an examination. This was near devastating, and it slowly began to dawn on me that this was not any simple “joining” but rather a critical evaluation of me and my professional experience and skills, or a professional gauntlet that I would be voluntarily committing to run. This caused me to quickly reflect on the events of my joining other professional organizations, and I found those experiences by comparison to be hardly memorable. This, “joining” I concluded, was punishment that I can very well do without. Notwithstanding all of this anxiety, uncertainty, and fatigue, my colleague would not give up, would not leave me alone, would not go away, and finally persuaded me to “join” up. After all, what was so bad about a little “exam?”

As you turn to the next issue, I will give a hint on why I joined, what I have gained, why I feel enriched, my thoughts for the organization and some comments about the Class of 2009.
Membership Growth
134 new Board Certified individuals were approved at the Annual Board of Trustees Meeting. The 127 new Board Certified Environmental Engineers (BCEEs) and 7 Board Certified Environmental Engineering Members (BCEEMs) are profiled in this issue of Environmental Engineer.

We would like to thank all of our members who take the time to recruit new applicants. Word of mouth and personal encouragement are still our best tools for recruiting new members. If you have a colleague who is not yet Board Certified, encourage them to apply for Specialty Certification. The next AAEE application cycle ends on March 31, 2010.

New Officers and Trustees
Congratulations to the new Officers and Trustees for 2010 who were installed during the Annual Meeting on October 15 and will take office January 1, 2010. They are:

- Cecil Lue-Hing .................. President
- Brian P. Flynn .................. President-Elect
- Michael W. Selna ............. Vice President
- Howard B. LaFever ............ Treasurer
- Debra R. Reinhart ............. Past President
- Gary S. Gasperino .......... A&WMA Trustee
- Pasquale S. Canzano .......... AIChE Trustee
- Edward Butts .................. APHA Trustee
- Lamont W. Curtis .......... APWA Trustee
- Paul A. Bizier ................. ASCE Trustee
- Jason C. Lynch ............... ASEE Trustee
- Richard S. Magee .......... ASME Trustee
- Steven J. Quail ............. AWWA Trustee
- Hector R. Fuentes ........ AEESP Trustee
- Dan Wittliff ................ NSPE Trustee
- Stephen G. Lippy .......... SWANA Trustee
- Richard D. Kuchenreither ...... WEF Trustee
- C. Robert Baillod ............ Trustee-at-Large
- Gary S. Logsdon ............. Trustee-at-Large
- Otis J. Sproul ............... Trustee-at-Large
- Sandra L. Tripp ............ Trustee-at-Large
- R. Tim Haug .................. Trustee-at-Large
- James F. Stahl ............... Trustee-at-Large

Invitation to All Members
AAEE is seeking volunteers to serve on its many committees and work groups. Gain valuable industry-wide perspective, build your network, and be recognized. The required commitment varies, depending on specific activities. Committees include:

- Bylaws/POP,
- Admissions,
- Eminence,
- Membership/Development & Outreach,
- Recertification,
- Air Pollution Control,
- Environmental Sustainability,
- General Environmental Engineering,
- Hazardous Waste Management,
- Industrial Hygiene,
- Radiation Protection,
- Solid Waste Management,
- Water Supply/Wastewater,
- Engineering Education,
- Excellence in Environmental Engineering Award,
- International Relations,
- K-12 & Beyond,
- Planning, and
- Publications.

Work Groups include Workshops & Seminars, and Web Site/Social Media.

For more information, email JSOlmo at aaee.net. Volunteer, and help AAEE carry out its mission and reach its goals!

2010 Excellence In Environmental Engineering (E3 Awards)
The Excellence in Environmental Engineering Awards Committee of the American Academy of Environmental Engineers is pleased to announce a new category for 2010: Environmental Sustainability. Entries for the Excellence in Environmental Engineering Competition may now be submitted in eight categories: Research, Planning, Design, Operations/Management, University Research, Small Projects, Small Firms, and Environmental Sustainability.

For complete entry guidelines, go to www.aaee.net. Remember, the entry deadline is February 1, 2010.

AAEE Calendar of Events
Please mark your calendar now with these important AAEE dates:

- February 1, 2010
  Excellence in Environmental Engineering Entries are due
- March 1, 2010
  Petitions for Officer Nominees
- April 1, 2010
  Mid-year Committee Reports are due
- April 28, 2010
  AAEE Awards Luncheon
- April 28-29, 2010
  Board of Trustees Spring Meeting
- November 3-4, 2010
  Board of Trustees Annual Meeting
The Make a Difference Challenge

My former association CEO and good friend Elissa M. Myers, CAE, is presently on a gutsy consulting engagement in the Republic of Georgia, which is bordered by Russia, Armenia and Turkey, Azerbaijan, and the Black Sea (N.S.E.W., respectively). Two of her tasks are to help municipalities organize and to set the stage for effective environmentally sustainable waste management and water supply strategies. At some point, she will turn to USAID or other agencies for funding to finance environmental engineering expertise. All around the world, nations, states, regions, cities, and villages are in dire need of qualified environmental engineers and sustainable practices. Ladies and gentlemen, there is a call out there and here, in the United States of America, for environmental engineering experts.

The Good News
Based on my experience with AAEE members, you, the practitioners, are rising to the challenges with fierce passion, dedication, and enthusiasm to ensure the health of this planet and its inhabitants. What a career and a reward, to know that your work and research are so important to human-kind. Thanks to those founders of AAEE who saw the need for a national focus on environmental engineering to advance the practice and to provide the nation with qualified environmental engineers.

The Bad News
The bad news is there are NOT ENOUGH of you to go around. According to the U.S. Bureau of Labor Statistics, demand for environmental engineers is expected to surpass 25% annually in the next 10 years. According to Anil Mehrotra, director of the Centre for Environmental Engineering Research and Education at the University of Calgary’s Schulich School of Engineering, demand for environmental engineers in Canada is outstripping supply. It’s the same in many parts of the world. Given this global shortage, identifying and engaging experts such as BCEEs and BCEEMs will be difficult at best. What keeps me up at night is how urgent this matter is of building a sustainable world for future generations. The only role I can play is to motivate AAEE members to Make A Difference in the world by building the Academy, the profession, and the practice.

“Make A Difference”
“Make a Difference” is our rallying cry for this membership drive. The deadline is March 31! I believe that each and every member knows at least one qualified environmental engineer or engineering practitioner who will apply for certification if encouraged. Many more of you have great networks to get the word out.

Goal: 320 New Members
If only one of every seven Board Certified Environmental Engineers and Board Certified Environmental Engineering Members brings in one new applicant, AAEE will reach its goal. It will also build the Academy’s ability to initiate more activities that assist you in your career and practice. The AAEE Membership Committee has designed a Membership Stimulus Package to further encourage your participation.

Join the Campaign
I am asking for your help on several levels to stimulate colleagues to join the Academy. There are three ways you can help Make a Difference:
1. Spread the word in your professional associations. Use your contacts to provide notices about the Academy’s membership drive. Contact me at jcava@aaee.net to receive flyers, ads, or notices that could be placed in a newsletter or magazine.
2. Persuade colleagues individually. Take five minutes each week to call a colleague between now and March 1, 2010. Here are five points to discuss:
   • Tell your colleague why you decided to become certified.
   • Share with them the names of other BCEEs and BCEEMs who you know.
   • Relate how board certification enhances your career and the profession.
   • Explain the application process and offer to be a referral. Follow up with your colleague often, and offer assistance with applying.
   • Use the Membership Drive at www.AAEE.net to download information you can forward to colleagues.
3. Encourage groups via e-mail. Construct an e-mail that has your touch, and distribute it to people in your workplace and your professional organization who you think would be good candidates. Attach the Membership Drive information from AAEE.net.

AAEE’s Make A Difference Stimulus Package
Beyond improving the profession and practice, this is where AAEE rewards you for your efforts.

Membership Drive Rewards
• Five new members: 50 AAEE dollars*
• Ten new members: 100 AAEE dollars*
• Grand Prize: Highest total above 20 new members: $500 (cash)*

If we work together to help grow the Academy, we can Make a Difference in the profession, the practice, and ultimately in the lives of millions of people, including our own families, who increasingly depend on a sustainable world.

* AAEE dollars may be used for AAEE merchandise, specialty certification, dues, and workshops. Rewards apply for new BCEEs, BCEEMs, or regular Members.
Awards & Honors
Glen T. Daigger, Ph.D., P.E., BCEE, has been elected President-Elect of the International Water Association. He will take the office as President in September 2010 at the IWA World Water Congress. Dr. Daigger, Senior Vice President of CH2M Hill (Englewood, CO), has been board certified since 1995 in Water Supply & Wastewater Engineering.

Johannes van Leeuwen, D.Eng., P.E., BCEE, has been named as the 2009 R&D Innovator of the Year for his Mycofuel Process. Within the Mycofuel process, van Leeuwen uses a two-stage bioconversion process with diverse fungal species to make bio-oil or biofuel. Dr. van Leeuwen, Professor of Environmental Engineering at Iowa State University, has been board certified in Water Supply and Wastewater Engineering since 2003. He has also previously won AAEE’s Excellence in Environmental Engineering (E3) Grand Prize Award in University Research (2007, 2008, and 2009) for his innovative projects.

Specialty Certification
Makson A. Esan, P.E., BCEE, was recently board certified in a second specialty. Mr. Makson, Project Manager for Georgia-Pacific Corporation (Atlanta, GA), has been board certified in Water Supply & Wastewater Engineering since 1995. His second specialty is Air Pollution Control.

David E. Schaad, Ph.D., P.E., BCEE, was recently board certified in a second specialty. Dr. Schaad, Associate Professor and Chair for Duke University (Durham, NC), has been board certified in Hazardous Waste Management since 2005. His second specialty is in Water Supply & Wastewater Engineering.

In Memoriam
Jack Kroop, P.E., BCEE, of New York, NY, passed away on March 23, 2009. Mr. Kroop was a Life Member of AAEE. He had been board certified in Sanitary Engineering since 1965.

DID YOU KNOW?
LeRoy C. Feusner, P.E., BCEE, was AAEE’s first board certified Hazardous Waste Management Engineer, a specialty which was first made available in 1987. Mr. Feusner, who is currently Administrator, Waste Management, of the Wyoming Department of Environmental Quality, was first certified in 1983 in Water Supply/Wastewater Engineering.
Environmental Sustainability: A New AAEE Certification

Brian P. Flynn, P.E., BCEE, Mario G. Cora, P.E., BCEE, and Phillip Dixon

Background
The sustainable use of the Earth’s resources has become an extremely important concern for engineers, corporations, governmental agencies, and policy makers. This is driven by the multiplier effect of simultaneous population increase and economic development. Environmental engineers have assumed a huge role in conceptualizing, designing, operating, and trouble-shooting environmental facilities that make it possible to live in harmony with nature in our only home: earth.

Realizing this, the Board of Trustees of the American Academy of Environmental Engineers authorized the creation of a Sustainability Workgroup in November of 2008 with the charge of exploring the need for a new specialty certification in Environmental Sustainability. Based on the Workgroup’s findings, the BOT authorized it in May 2009 to develop the certification and make it available to individuals practicing Environmental Engineering. It has done so. An application for the upcoming exam cycle is available at www.aaee.net; hit the button “How to Apply” in the upper right area of the home page and download an application form.

What is It?
For the purpose of the Academy’s certification purposes, sustainability is defined as:

Sustainability is the supporting of the quality of life while living within the carrying capacity of all systems. A long term balance of environmental stewardship, economic development, and social well being must be achieved.

To add some detail to this definition, the Academy has added a short mission statement:

Environmental engineers work transparently with stakeholders towards the following sustainability goals:
1. Renewable resources are not consumed faster than they regenerate
2. Non-renewable resources are replaced by renewable substitutes faster than they are depleted, and
3. Harmful substances are not released faster than they can be absorbed or rendered harmless.

The Sustainability Workgroup developed a list of 94 competencies to serve as the basis for developing a 100 question written multiple choice exam and 6 complex oral questions.

The workgroup also decided that the application of sustainability to environmental engineering is so broad that the written exam will have two parts: a general section that every applicant must take, and a set of optional sections (by subject area) that will round out the exam to 100 questions for each individual. The subject areas include: Air, Energy, Water and Wastewater, Solid and Hazardous Waste, and Development.

This certification is being added to the existing lineup:
• Air Pollution Control
• General Environmental Engineering
• Hazardous Waste Management
• Industrial Hygiene
• Radiation Protection
• Solid Waste Management
• Water Supply and Wastewater Engineering

The Exam
The written portion of the exam is a closed book examination consisting of multiple choice questions with 4 or 5 possible answers, only one of which is correct. Questions were developed consistent with the types of knowledge that a specialist in the practice area would possess. Most of the questions try to assess specific knowledge of facts, the application and use of information, or insight into basic relationships. The oral portion of the test involves a question and answer session in which the candidate sits before a small panel of BCEEs. Each examinee is given two fairly complex questions involving realistic situations related to sustainability concepts. The objective of this portion of the test is to evaluate the professional maturity and experience of the candidate. The answers are somewhat open ended: there is no one correct response.

In developing the written questions, the normal characteristics for Academy exams were used:
1. Questions must be clear, such that if there were no choices offered, someone could answer the question correctly.
2. The closed book format required that relevant facts and data be included, so that memorization is not required.
3. Questions were structured to avoid negatives and double-negatives (no “trick” questions).
4. Some questions involve calculations; they must be simple enough to allow completion of the written exam within three hours.
5. The correct answer to each question should be documented such that it would be accepted by competent authorities in the sustainability field.

Draft questions (written and oral) were developed, edited, and then transmitted to a small army of field test volunteers (approximately 4 dozen). Each field tester was given only a small section of the exam. They provided valuable feedback on the validity, wording, and correctness of answers to questions. Based on this feedback, the written and oral exams were modified and turned over to Academy staff for use in the next examination cycle, beginning March 31, 2010.

Basic Qualifications
Just a reminder of the Academy's major basic qualifications to become a Board Certified Environmental Engineer (BCEE) or Board Certified Environmental Engineering Member (BCEEM):

• Possess a Baccalaureate degree or higher in engineering (or related field acceptable to the Board) from a college or university of recognized standing.
• Hold a valid P. E. license (US) or valid certificate of registration or license issued by a foreign country, provided it meets standards established by the Board of Trustees of AAEE.
• Be professionally engaged in environmental engineering activities on a full-time basis.
• Have at least eight years of engineering experience, at least four of which are in responsible charge. If more than 16 years, the Academy's written exam may be waived, providing there are at least 12 years in responsible charge. The second requirement does not apply to the BCEEM category. You should consult the Academy's website and the annual Who's Who for more details about certification requirements.

It should be noted that a member of AAEE can hold more than one specialty certification. So, if you are already certified but want to add Environmental Sustainability, make an application! And remember that many environmental engineers have been practicing sustainability but not classifying it as such.

Potential Users
The need for engineers with a unique set of skills to plan, organize, implement, and control projects with sustainable components is increasing. One only needs to take a look at message boards, career search engines, magazines, and newspapers to see this. It is evident that sustainability concepts will be used in the development of new projects, ideas, and products across all sectors of the economy.

Environmental consulting firms are increasingly being asked to consider, develop, and implement more sustainable approaches in their projects for their clients. The requested scope of services ranges from design and construction projects to regulatory compliance. Many of them involve energy efficiency and renewable energy concepts, involving the creation, banking, and selling of carbon credits and renewable energy credits. Many organizations are involved in projects aimed to determine their carbon footprint and other energy minimization strategies.

Consulting firms with engineers who possess AAEE’s Environmental Sustainability board certification will be in a great position to attain and execute engagements in this field. Until now, the lack of an available certification for environmental engineers has even led some clients to specifying LEEDS certification in RFPs for sustainability projects outside the scope of LEEDS – because it is perceived as the only game in town!

There are many drivers in the Sustainability marketplace.

They include such things as:
• The “Regional Greenhouse Gas Initiative (RGGI).” This is an agreement signed by 10 Northeastern and Mid-Atlantic states with the aim of capping and then reducing CO2 emissions from the power sector by 10% by 2018. This is the first mandatory, market-based effort in the United States to reduce greenhouse gas emissions.
• Efforts are being taken also by the local governments. Recently, the City of Cleveland held a conference entitled, “Sustainable Cleveland 2019 Summit: Building an Economic Engine to Empower a Green City on a Blue Lake.” The City's commitment to creating a sustainable city and economy is being highlighted by the appointment of a new Chief of Sustainability position and a 25-person Sustainable Cleveland 2019 Council.
• At present, more financial management companies are using or implementing a wide variety of products in which environmental sustainability concepts are included.
• Educational institutions are also expanding their offerings and rethinking their engineering programs. James Madison University is developing a unique engineering program focused on sustainable societies. Researchers at the Center for Sustainable Engineering, a consortium consisting of Arizona State University, Carnegie Mellon University, and the University of Texas at Austin, has been exploring the idea of sustainable engineering as rigorous methodology so that it can be applied by professionals and taught to engineering students (Allen, Murphy, Allen, and Davidson, 2009). In another article by Ashford (2004), the author discusses major challenges to engineering education for sustainable development in relation to creativity, effectiveness, and acceptability to the established disciplines.
• A significant number of states are now taking the lead and forming initiatives that will require reduced emissions and an increase in the use of more renewable energy.

As stated in an article by Crittenden et al. (2003), “Perhaps the most critical endeavors that must be undertaken in ensuring the viability of the sustainability metadiscipline are in the area of education and human resource development.” The profession of environmental engineering and the American Academy of Environmental Engineers will be in the leading edge of this change.

What’s in it for Me?

Everyone’s time and resources are limited. The Academy’s Environmental Sustainability certification has to pass the “What’s In It For Me?” test. Here is how:

• It demonstrates to others your expertise in this new discipline.
• It provides a competitive advantage over non-certified practitioners. This applies to competing for consulting engagements and for employment.
• It provides personal credibility with the public and outside organizations with which you have built a relationship.
• It is another distinction of personal professionalism.

Environmental sustainability is a fundamental requirement in the design, construction, and operation of virtually all industrial and non-industrial facilities. The marketplace is looking for environmental professionals who can demonstrate their expertise in this area. Be one of them. Apply today at www.aace.net (Go to How To Apply and download an application). If you get your application in by March 31, 2010, you will be in the first class to be tested, and if successful, certified.

Many thanks to the two dozen members of the Sustainability Workgroup who developed this new certification and the additional four dozen volunteer field testers. Without the eager and effective participation of both groups, this certification would not be possible.

About the Authors

Mr. Flynn is the President Elect of AAEE and chair of the Environmental Sustainability Workgroup. Mr. Cora is a member of the workgroup and serves as a public health engineer with ARMA-MDE. Philip Dixon is also a member of the workgroup employed by CDM.

References


For more information visit us online at: www.wiley.com/college/mihelcic
The 2010 Kappe Lecturer

Morton A. Barlaz, Ph.D., P.E., BCEE
Professor, Civil Engineering, North Carolina State University

Education
University of Michigan-Ann Arbor 1978 BS Chemical Engineering
University of Wisconsin-Madison 1985 MS Civil & Environmental Engineering
University of Wisconsin-Madison 1988 Ph.D. Civil & Environmental Engineering

Professional Credentials
Registered Professional Engineer in North Carolina
Board Certified Environmental Engineer, American Academy of Environmental Engineers

Professional Associations
American Society of Civil Engineers
American Society for Microbiology
American Chemical Society
Sigma Xi
Association of Environmental Engineering and Science Professors
International Solid Waste Management Association
Solid Waste Association of North America

Professional Awards
Distinguished Service Award, AEESP, 2003 & 2009
Distinguished Individual Achievement Award, SWANA, 2004
Outstanding Paper, 7th International Waste Management & Landfill Symposium, Cagliari, Italy, 1999
Samuel Arnold Greeley Award, ASCE, 1997
National Science Foundation Presidential Faculty Fellow, 1992-1997
Department of Energy Junior Faculty Enhancement Award, 1992
American Chemical Society Graduate Student Award, 1987
Dr. Morton A. Barlaz is a Professor in the Department of Civil, Construction, and Environmental Engineering at North Carolina State University. He received a B.S. in Chemical Engineering from the University of Michigan and an M.S. and Ph.D. in Civil and Environmental Engineering from the University of Wisconsin. He has been involved in research on various aspects of solid waste since 1983. Over this time, he has conducted research on biological refuse decomposition, methane production, and the biodegradation of hazardous wastes in landfills. He has participated in two state-of-the-practice reviews of bioreactor landfills. His research forms the basis for much of the work done to assess the impact of landfills on methane emissions inventories.

Dr. Barlaz also conducts research on the use of life-cycle analysis to evaluate environmental emissions associated with alternate solid waste management strategies. Dr. Barlaz is the author of over 75 peer-reviewed publications and has made over 150 presentations at conferences throughout the world. In 1992, he was awarded a Presidential Faculty Fellowship from the National Science Foundation.

Dr. Barlaz has been active in service throughout his career. He is an Associate Editor for two journals (Waste Management and *Journal of Environmental Engineering*) and serves as co-chair of the bi-annual Intercontinental Landfill Research Symposium. He has served as chair of the Government Affairs Committee and the Lectures Committee for the Association of Environmental Engineering and Science Professors. Finally, he serves on the Science Advisory Committee for the International Waste Working Group.

**Abstracts of Lectures Offered**

**Development of a Carbon Footprint Model for Landfill Disposal of Solid Waste**

Over half of all solid waste generated in the U.S. is disposed of in landfills, and landfills are likely to be a dominant factor in solid waste management for the foreseeable future. Landfills are an anaerobic ecosystem in which biogenic carbon decomposes to methane and carbon dioxide. As a result, landfills are scrutinized as a leading source of anthropogenic methane emissions in the U.S. and globally. A landfill carbon balance includes gas production and collection, the biological oxidation of methane in landfill cover soils, fugitive emissions, carbon sequestration and avoided emissions when methane is recovered for beneficial reuse. The state-of-knowledge for each aspect of a landfill carbon balance will be presented, including the results of current research and how this information can be utilized in practice. Methane production modeling is uncertain, in part due to the difficulty in obtaining reliable field data for model verification. This uncertainty is exacerbated by the lack of detailed information on waste composition and field-scale biodegradability. While numerous methods are available for measurement of fugitive emissions, each method has its own limitations and here, too, there remains uncertainty in the measured values. A fraction of landfill methane that is not collected is oxidized by methanotrophic bacteria in landfill cover soils and this fraction will vary as a function of both climatic factors and the methane flux. Thus, there is also uncertainty in the appropriate oxidation factor for a landfill carbon balance. Biogenic carbon that does not decompose is said to be sequestered, and landfills represent a sink for some biogenic carbon. Finally, methane is utilized as an energy source at about 500 landfills in the U.S., and it is estimated that there are an additional 500 landfills at which energy recovery is viable. Energy recovery results in avoided emissions. A spreadsheet model was developed to explore the sensitivity of various input parameters to the overall carbon footprint. Realistic ranges for key inputs will be presented along with the results of model simulations.

**The Use of Life-Cycle Analysis for the Study of Alternatives for End of Life Materials Management**

Solid waste management (SWM) is an integral component of civil infrastructure. The cost and environmental implications (e.g., energy consumption, greenhouse gas (GHG) emissions) of SWM are important societal issues. SWM costs are borne by the public, either through use fees or taxes. SWM has environmental impacts resulting from waste collection, separation, treatment processes such as composting and waste-to-energy combustion, and landfill disposal. The beneficial use of waste, either for energy recovery or material recovery, can result in both revenue and avoided emissions. Thus, policymakers face the challenge of developing and implementing integrated SWM programs that represent an appropriate use of public funds in consideration of emissions and energy consumption. Mathematical models of integrated SWM are important planning tools given the complexity of the solid waste system, the interactions among the numerous components that constitute the system, and the number of potential SWM alternatives. Over the past decade, we have used an integrated solid waste management life-cycle model to evaluate waste management alternatives for a variety of cases. In one application, alternative plans for integrated SWM in the State of Delaware were evaluated considering cost and environmental performance, particularly GHG emissions. In a second study, three alternatives for the management of commercial food waste were evaluated including aerobic composting, landfill disposal, and in-vessel anaerobic digestion. Each case study presents unique challenges due to constraints associated with the solid waste system under study. This presentation will describe the SWM life-cycle model and present key results from two case studies. Model results will be put into the context of SWM practice.
The Class of 2009

These individuals were Board Certified in October 2009.

From the first applicants in 1956 to the 134 Board Certified Environmental Engineers and Board Certified Environmental Engineering Members listed on the following pages, the Academy has undergone growth and changes, but has never wavered from its core objective to “identify and credential persons with special capabilities in environmental engineering.”

Today, there are nearly 2,500 Board Certified Environmental Engineers and Board Certified Environmental Engineering Members in the Academy and interest continues to grow on an annual basis.

A brief description of the specialty certification process follows:

To be included in an annual class, the application for specialty certification must be submitted to the Academy by March 31. Any application received after that date is held over to the next class. The applications received by March 31 are then reviewed by the Admissions Committee for adequacy of education and qualifying experience in April and May. Examinations are administered to the qualified applicants during July and August at convenient locations throughout the country. The examination results are reviewed by the Admissions Committee in September and recommendations for each candidate are presented to the Board of Trustees. Each person’s history is reviewed by the Board members at the Academy’s Annual Meeting and decisions made to certify or not.

The Academy announces the issuance of specialty certificates and Board Certified Environmental Engineers and Board Certified Environmental Engineering Members status to those individuals portrayed in this special section of the Environmental Engineer®. These persons have demonstrated to their peers that they possess the requisite formal education and environmental engineering practical experience and have successfully completed the Academy’s examinations to be Board-Certified environmental engineering specialists. The special capability of each person is shown after their name using the following codes:

AP Air Pollution Control,
GE General Environmental Engineering,
HW Hazardous Waste Management,
IH Industrial Hygiene,
RP Radiation Protection,
SW Solid Waste Management,
WW Water Supply and Wastewater Engineering.

Avner Adin, DS.c., BCEEM
WW
Professor & Head, Hebrew University of Jerusalem, Environmental Sciences Division Jerusalem, Israel 91904
Dr. Adin received his B.S. degree in Civil Engineering and M.S. degree in Sanitary Engineering, and D.Sc in Environmental Engineering from Technion Israel Institute of Technology. He has more than 45 years experience.

Haidar Abdul-Malik Al-Rawi, P.E., BCEEM AP
Environmental Protection Specialist, Tennessee Environment & Conservation 9th Floor L&C Annex 401 Church Street, Nashville, TN 37243
Mr. Al-Rawi received his B.S. degree in Civil Engineering from the University of Alabama and M.S. in Environmental Engineering from Mississippi State University. He is a licensed P.E. in Alabama with more than 19 years experience.

James E. Alleman, Ph.D., P.E., BCEEM GE
Department Chair & Professor, Iowa State University
394 Town Engineering Civil & Environmental Engineering Ames, IA 50011
Dr. Alleman received his B.S., M.S. and Ph.D. degrees in Civil Engineering from the University of Notre Dame. He is a licensed P.E. in Indiana and has more than 36 years experience.

Cynthia A. Baumann, P.E., BCEEM WW
Project Manager, CDM 56 Exchange Terrace, Providence, RI 02903
Ms. Baumann received her B.S. in Civil Engineering from Valparaiso University. She is a licensed P.E. in Illinois with more than 18 years experience.

Nancy K. Beaton, P.E., BCEEM WW
Project Manager, CDM 56 Exchange Terrace, Providence, RI 02903
Ms. Beaton received her B.S. in Civil Engineering from Northeastern University. She is a licensed P.E. in Massachusetts with more than 25 years experience.

Katherine Y. Bell, Ph.D., P.E., PCS, BCEEM WW
Environmental Engineer, CDM 210 25th Avenue North #1102, Nashville, TN 37203
Dr. Bell received her B.S. in Biochemistry from the University of Dallas-Irving, M.S. degrees in Biology and Civil Engineering from Tennessee Tech University and Ph.D. in Environmental Engineering from Vanderbilt University. She is a licensed P.E. in Ohio with more than 18 years experience.

Christopher J. Berch, P.E., BCEEM WW
Manager of Operations, Inland Empire Utilities Agency PO Box 9020, Chino Hills, CA 91709
Mr. Berch received his BS degree in Environmental Engineering from the University of California-Riverside and MPA in Public Administration from the California State University. He is a licensed P.E. in California and has more than 11 years experience.

Rodney G. Brauer, P.E., BCEEM WW
Senior Project Manager, CH2M Hill 9130 South Jamaica Street, Englewood, CO 80112
Mr. Brauer received his B.S. and M.S. degrees in Civil Engineering from the University of Wyoming. He is a licensed P.E. in Colorado, Nevada, California, Utah and Wyoming and has more than 24 years experience.
William M. Brincheck, P.E., BCEE SW
Project Engineer/Manager, CDM
5400 Glenwood Avenue #300, Raleigh, NC 27612
Mr. Brincheck received his B.S. and M.S. degrees in Environmental Engineering from North Carolina State University. He is a licensed P.E. in North Carolina with more than 11 years experience.

David P. Cabral, P.E., BCEE WW
100 Matheson Drive, Marlborough, MA 01752-4597
Mr. Cabral received his B.S. in Civil Engineering from the University of Massachusetts and his M.S. in Environmental Engineering from the University of Michigan-Ann Arbor. He is a licensed P.E. in Massachusetts and Rhode Island with more than 10 years experience.

Mark P. Cal, Ph.D., P.E., BCEE AP
Professor & Chair, Civil & Environmental Department, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801
Dr. Cal received his B.S. degree in Chemical Engineering, M.S. and Ph.D. degrees CivilEnvironmental and Ph.D from the University of Illinois at Urbana. He is a licensed P.E. in New Mexico with more than 18 years experience.

Lt Col Lawrence A. Calabro, P.E., BCEE GE
Chief, BE Force Development, AFMSA/Space & Ground Systems
1400 Key Boulevard, Rosslyn, VA 22209
Lt Col Calabro received his B.S. in Civil Engineering from the University of Rhode Island and M.S. in Environmental Engineering from Syracuse University. He is a licensed P.E. in Rhode Island with more than 20 years experience.

Krista M. Caron, P.E., BCEE AP
Environmental Engineer, Mississippi DEQ
515 East Amite Street, Jackson, MS 39201
Ms. Caron received a B.S. in Biology from Mississippi State University, B.S. in Chemical Engineering from the University of South Alabama and her M.S. degree in Environmental Engineering from the University of Mississippi. She is a licensed P.E. in Mississippi with more than 8 years experience.

Jere S. Carr, P.E., BCEE WW
Principal/Project Manager, CDM, 9200 Ward Parkway #500, Kansas City, MO 64114
Mr. Carr received his B.S. degree in Agricultural Engineering from Auburn University and M.S degree in Environmental Engineering from Clemson University. He is a licensed P.E. in Massachusetts and North Carolina with more than 22 years experience.

Lori Ann Carriero, P.E., BCEE WW
Senior Project Manager, GHD, 35 Corporate Drive #1000, Trumbull, CT 06610
Ms. Carriero received her B.S. in Civil Engineering from the University of New Hampshire and MBA in Business Administration from the University of Connecticut. She is a licensed engineer in Connecticut and has more than 22 years experience.

Angela C. Chang, P.E., BCEE WW
Senior Engineer, LA County Sanitation Districts, 1965 Workman Mill Road, Whittier, CA 90601
Ms. Chang received her B.S. in Civil Engineering from the University of Southern California and M.S. degree in Environmental Engineering from the University of California. She is a licensed P.E. in California with more than 9 years experience.

Richard W. Chapin, P.E., BCEE HW
President, Chapin Engineering, 27 Quincy Road, Basking Ridge, NJ 07920
Mr. Chapin received his B.S. in Forest Engineering and M.S. degree in Water Resources Engineering from the SUNY. He is a licensed P.E. in New Jersey and New York with more than 32 years experience.

Lizette R. Chevalier, Ph.D., P.E., BCEE HW
Assistant Professor, Southern Illinois University, 107 South Parrish Lane, Carbondale, IL 62901
Dr. Chevalier received her B.S. in Civil Engineering from Wayne State University and M.S. and Ph.D. degrees in Civil & Environmental Engineering from Michigan State University. She is a licensed P.E. in Illinois with more than 21 years experience.

Mr. Ching received his B.S. in Civil Engineering from Cal Poly Pomona and M.S degree in Civil & Environmental Engineering from Stanford University. He is a licensed P.E. in California with more than 8 years experience.

Suad Cisic, P.E., BCEE WW
Project Manager, Parsons Water and Infrastructure, 100 West Walnut Street, C3 01-A, Pasadena, CA 91124
Mr. Cisic received his B.S. in Civil Engineering from the University of Sarajevo and M.S. degree in Civil Engineering from the University of Zagreb. He is a licensed P.E. in California and has more than 16 years experience.

Ronald J. Ciucci, P.E., BCEE WW
Project Manager Michael Baker Jr., Inc. Tower #2010, 650 Smithfield Street Pittsburgh, PA 15222
Mr. Ciucci received his B.S. in Civil Engineering from The Pennsylvania State University. He is a licensed P.E. in Pennsylvania with more than 16 years experience.

Ivan A. Cooper, P.E., BCEE WW
Program Manager, WPC, Inc., 2401 Nevada Boulevard, Charlotte, NC 28273
Mr. Cooper received his B.S. in Civil Engineering from Union College and M.S degree in Environmental Health from Northwestern University. He is a licensed P.E. in Wisconsin, South Carolina, Pennsylvania, West Virginia, Georgia, Florida, Texas, Missouri, Montana, Colorado, and Michigan with more than 37 years experience.

Philip A. Cooper, P.E., BCEE WW
Associate, Whitman Requardt & Associates, 801 South Caroline Street, Baltimore, MD 21231
Mr. Cooper received his B.S. in Chemical Engineering from the University of Maryland, and M.S. degree in Environmental Engineering from The Johns Hopkins University. He is a licensed P.E. in Maryland with more than 20 years experience.

Mr. Dill received his B.S. in Civil Engineering from the University of Notre Dame and M.S. in Environmental Engineering from the University of Illinois. He is a licensed P.E. in Pennsylvania with more than 14 years experience.
Aaron W. Duke, P.E., BCEE WW  
Senior Associate, Hazen & Sawyer  
11242 Walples Mill Rd, Fairfax, VA 22030  
Mr. Duke received his B.S. in Civil/Environmental and M.S. degree in Environmental Engineering from the University of Michigan. He is a licensed P.E. in Virginia, Maryland and District of Columbia and has more than 10 years experience.

Keith S. Dunbar, P.E., BCEE WW  
CEO, K.S. Dunbar & Associates, 3035 Calle Frontera, San Clemente, CA 92673-3012  
Mr. Dunbar received his B.S. in Civil Engineering from the University of Maine, Orono. He is a licensed P.E. in California, Idaho, Oregon and Nevada with more than 41 years experience.

Matthew Easterbrook, P.E., BCEE WW  
Project Manager, Malcolm Pirnie, Inc.  
1100 Welbome Dr, #300, Richmond, VA 23229  
Mr. Easterbrook received his B.S. in Civil Engineering from the University of Waterloo. He is a licensed P.E. in Virginia and Colorado and has more than 25 years experience.

Findlay G. Edwards, Ph.D., P.E., BCEE WW  
Associate Professor, University of Arkansas, 4190 Bell Engineering Center, Fayetteville, AR 72701  
Dr. Edwards received his B.S. and M.S. degrees in Civil Engineering from New Mexico University and Ph.D. in Engineering from New Mexico University. He is a licensed P.E. in New Mexico with more than 21 years experience.

Lee E. Ferrell, Jr., P.E., BCEE WW  
Engineering Manager, Schneider Electric  
1900 Sandifer Blvd, Seneca, SC 29678  
Mr. Ferrell received his B.S. in Electrical Engineering and M.S. in Environmental Engineering from Clemson University. He is a licensed P.E. in South Carolina with more than 18 years experience.

Steven D. Folson, P.E., BCEE HW  
Project Engineer, HSA Engineers & Scientists,  
4019 East Fowler Avenue, Tampa, FL 33617  
Mr. Folson received his B.S. in Environmental Engineering from the University of Florida. He is a licensed P.E. in Florida with more than 10 years experience.

Aaron R. Frantz, P.E., BCEE HW  
Senior Engineer CDM, 933 Old Eagle School Road  
Wayne, PA 19087  
Mr. Frantz received his B.S. in Geology from Lehigh University and M.S. degree in Environmental Engineering from Drexel University. He is a licensed P.E. in Pennsylvania with more than 16 years experience.

David L. Freedman, Ph.D., BCEE SW  
Professor, Department of Environmental & Earth Sciences, Clemson University, Clemson, SC 29634-0919  
Dr. Freedman received his B.S. in Science & Environmental Engineering from the University of Wisconsin; his M.S. in Environmental Engineering from the University of Cincinnati and Ph.D. in Environmental Engineering from Cornell University. He has more than 30 years experience.

Robert H. French, P.E., BCEE SW  
Senior Associate Malcolm Pirnie, Inc.  
8201 Peters Road #3400, Plantation, FL 33324  
Mr. French received his B.S. in Civil Engineering from West Virginia University. He is a licensed P.E. in Florida with more than 34 years experience.

Denise R. Funk, P.E., BCEE WW  
Environmental Engineer, City of Bowie  
3715 Northside NW, Building 300 #400  
Atlanta, GA 30327  
Ms. Funk received her B.S. and M.S. degrees in Civil Engineering from the Georgia Tech. She is a licensed P.E. in Georgia with more than 9 years experience.

John W. Gahrning, Jr., P.E., BCEE WW  
Project Engineer, Neel-Schaffer, 125 South Congress Street #1100, Jackson, MS 30201-3395  
Mr. Gahrning received his B.S. in Civil Engineering from Tennessee Tech University. He is a licensed P.E. in Mississippi with more than 9 years experience.

Gregory S. Games, P.E., BCEE WW  
Senior Project Engineer, Malcolm Pirnie, Inc., 5975 Castle Creek Parkway, IN 46250  
Mr. Games received his B.S. in Civil Engineering from Bradley University. He is a licensed P.E. in Illinois and has more than 20 years experience.

William S. Gettings, P.E., BCEE WW  
Principal, CDM  
110 Fieldcrest Avenue, 6th Floor, Edison, NJ 08837  
Mr. Gettings received his B.S. in Civil Engineering from the University of Rhode Island and MBA in Finance from Montclair State University. He is a licensed P.E. in Virginia and New Jersey with more than 16 years experience.

Jeff T. Greene, P.E., BCEE HW  
3002 North Racine Avenue #1, Chicago, IL 60657  
Mr. Greene received his B.S. in Industrial Engineering from Auburn University and M.J. degree in Business Law from Loyola University. He is a licensed P.E. in Tennessee with more than 18 years experience.

Ryan Gross, P.E., BCEE WW  
District Engineer, Lake Arrowhead Community Services District, P.O Box 700, Lake Arrowhead, CA 92352  
Mr. Gross received his B.S. in Environmental Engineering from the University of California and M.S. degree in Engineering from California State University. He is a licensed P.E. in California with more than 12 years experience.

Robert M. Hart, P.E., BCEE WW  
Director, Engineering Division, Arkansas Department of Health, 4815 West Markham, Slot 37, Little Rock, AR 72205  
Mr. Hart received his B.S. and M.S. degrees in Civil Engineering from the University of Arkansas. He is a licensed P.E. in Arkansas with more than 31 years experience.
David R. Hokanson, Ph.D., P.E., BCEE WW
Supervising Engineer, III, Trussell Technologies, Inc.
232 North Lake Avenue #300
Pasadena, CA 91101-1862
Dr. Hokanson received his B.S. and Ph.D. degrees in Environmental Engineering and M.S. degree in Civil Engineering from the Michigan Technological University. He is a licensed P.E. in Michigan with more than 12 years experience.

Bonnie Mae Jones, P.E., BCEE WW
Senior Engineer
City and County of San Francisco
1145 Market Street
Fifth Floor, San Francisco, CA 94103
Ms. Jones received a B.S. in Zoology and M.S. in Biology and Genetics from the University of Michigan and M.S. in Civil/Sanitary Engineering from UC Berkeley. She is a licensed P.E. in California with more than 35 years experience.

Roger O. Hart, P.E., BCEE WW
Project Manager
Malcolm Pirnie, Inc.
1100 Wellesbee Dr, #100,
Richmond, VA 23229
Mr. Hart received his B.S. in Civil Engineering from the Virginia Military Institute. He is a licensed P.E. in Virginia with more than 30 years experience.

Dennis J. Hasson, P.E., BCEE WW
Partner, Whitman Requardt & Associates
801 South Caroline St,
Baltimore, MD 21231
Mr. Hasson received his B.S. in Ocean Engineering from the U.S. Naval Academy and M.S. in Environmental Engineering from the University of Maryland. He is a licensed P.E. in Virginia, Maryland, Delaware and Pennsylvania with more than 21 years experience.

Jennifer K. Lachmayr, P.E., BCEE WW
Senior Associate
Malcolm Pirnie, Inc.
601 Edgewater Blvd, #1000, Kansas City, MO 64108
Ms. Lachmayr received her B.S. degree in Mechanical Engineering from the Cornell University. She is a licensed P.E. in Massachusetts with more than 25 years experience.

Sudarshan T. Kurwadkar, Ph.D., P.E., BCEE WW
Assistant Professor of Environmental Enginy
Virginia Tech, Blacksburg, VA
Box-T03090, Department Engineeing & Physics, Stephenville, TX 76402
Dr. Kurwadkar received his B.S. in Civil Engrg. from the Amravati Univ., M.S. in Civil Engrg. from the Univ. of Pune, M.S. in Civil Engrg. from Indian Institute of Technology and Ph.D. in Env. Engrg. from the Missouri Univ. of Science and Technology. He is a licensed P.E. in Ohio and Missouri with more than 9 years experience.

Valerie A. Hudson, Ph.D., P.E., BCEE GE
Deputy Commissioner, Kentucky Energy & Environment Cabinet - Department for Environmental Protection,
300 Fair Oaks Lane, Frankfort, KY 40601
Ms. Hudson received her B.S. in Environmental Engineering from the University of Florida. She is a licensed P.E. in Kentucky with more than 28 years experience.

Michael J. MacPhee, Ph.D., BCEEM WW
Vice President, Malcolm Pirnie, Inc.
100 Fillmore Street #200, Denver, CO 80206
Dr. MacPhee received his B.S. in Chemistry from the St. Francis Xavier University and M.S. and Ph.D. degrees in Civil Engineering from Technical University of Nova Scotia. He has more than 18 years experience.

Scott Haynes, P.E., BCEE WW
Associate, Malcolm Pirnie, Inc., 601 Edgewater Boulevard #512, Charlotte, NC 28204
Mr. Haynes received his B.S. in Civil Engineering from the University of Notre Dame and M.S. degree in Civil/Environmental Engineering from Tufts University. He is a licensed P.E. in Massachusetts with more than 21 years experience.

justin D. Mahon, Jr., P.E., BCEE WW
Senior Project Engineer
Malcolm Pirnie, Inc.
17-17 Route 208 North
Fair Lawn, NJ 07410
Mr. Mahon received his B.S. in Engineering from Brown University and M.S. in Civil Engineering from NJIT, Newark. He is a licensed P.E. in New Jersey with more than 35 years experience.

Robert S. Johnston, P.E., BCEE HW
President, Malcolm Pirnie, Inc., 17-17 Route 208 North, Fair Lawn, NJ 07410
Mr. Johnston received his B.S. in Civil Engineering from Rutgers College of Engineering and M.S. in Civil/Environmental from the University of California at Davis. He is a licensed P.E. in California and New Jersey with more than 23 years experience.

Matthew J. Marko, P.E., BCEE WW
Vice President, CH2M Hill, 290 Elwood David Road #290, Liverpool, NY 13088
Mr. Marko received his B.S. in Civil Engineering from State University of New York at Buffalo. He is a licensed P.E. in New York and has more than 16 years experience.

Hasson, P.E., BCEE WW
Senior Engineer
LA County Sanitation Districts
1955 Workman Mill Rd,
Whittier, CA 90601
Mr. Haug received his B.S. degree in Civil Engineering from Loyola Marymount University and M.S. in Civil Engineering from the University of California at Davis. He is a licensed P.E. in California with more than 14 years experience.

David A. Haug, P.E., BCEE WW
Senior Engineer
Malcolm Pirnie, Inc.
17-17 Route 208 North
Fair Lawn, MA 01880
Mr. Haug received his B.S. degree in Civil Engineering from Kansas State University and M.S. in Environmental Engineering from the University of Kansas. He is a licensed P.E. in Kansas with more than 25 years experience.

David L. Hauser, P.E., BCEE GE
Senior Associate, AE-COM Water, Midwest Region, 2405 Grand Blvd, #1000, Kansas City, MO 64108
Mr. Hauser received his B.S. in Civil Engineering from Kansas State University and M.S. in Environmental Engineering from the University of Kansas. He is a licensed P.E. in Kansas with more than 25 years experience.

Jennifer A. Kennedy, P.E., BCEE WW
Environmental Engineer, CDM,
301 South McDowell #512, Charlotte, NC 28204
Ms. Kennedy received a B.S. in Textile Management, a B.S. in Civil Engineering and M.E. in Environmental Engineering from Clemson University. She is a licensed P.E. in South Carolina and North Carolina with more than 8 years experience.

Dr. Kommalapati received his B.S. in Civil Engineering from State University of New York at Buffalo. He is a licensed P.E. in New York and has more than 16 years experience.

Satish Kamath, P.E., BCEE WW
SW Business Development Manager, Parsons, 100 West Walnut Street
Pasadena, CA 91104
Mr. Kamath received his B.S. in Civil Engineering from Bangalore University, India, M.S. in Civil Engineering from the University of Oklahoma and MBA in Business Administration from the University of California. He is a licensed P.E. in California with more than 19 years experience.

Valerie A. Hudson, Ph.D., P.E., BCEE GE
Deputy Commissioner, Kentucky Energy & Environment Cabinet - Department for Environmental Protection, 300 Fair Oaks Lane, Frankfort, KY 40601
Ms. Hudson received her B.S. in Environmental Engineering from the University of Florida. She is a licensed P.E. in Kentucky with more than 28 years experience.

Gary L. Hunter, P.E., BCEE WW
Engineer 6, Black & Veatch, 8400 Ward Parkway, Kansas City, MO 64114
Mr. Hunter received his B.S. and Masters degrees in Civil Engineering from Brigham Young University. He is a licensed P.E. in Kansas with more than 24 years experience.

Dr. Kurwadkar received his B.S. in Civil Engrg. from the Amravati Univ., M.S. in Civil Engrg. from the Univ. of Pune, M.S. in Civil Engrg. from Indian Institute of Technology and Ph.D. in Env. Engrg. from the Missouri Univ. of Science and Technology. He is a licensed P.E. in Ohio and Missouri with more than 9 years experience.

Laurin B. Kennedy, P.E., BCEE WW
Environmental Engineer, CDM,
301 South McDowell #512, Charlotte, NC 28204
Ms. Kennedy received a B.S. in Textile Management, a B.S. in Civil Engineering and M.E. in Environmental Engineering from Clemson University. She is a licensed P.E. in South Carolina and North Carolina with more than 8 years experience.

Jennifer K. Lachmayr, P.E., BCEE WW
Senior Associate
Malcolm Pirnie, Inc.
601 Edgewater Blvd, #1000, Kansas City, MO 64108
Ms. Lachmayr received her B.S. degree in Mechanical Engineering from the Cornell University. She is a licensed P.E. in Massachusetts with more than 25 years experience.

Dr. MacPhee received his B.S. in Chemistry from the St. Francis Xavier University and M.S. and Ph.D. degrees in Civil Engineering from Technical University of Nova Scotia. He has more than 18 years experience.

Justin D. Mahon, Jr., P.E., BCEE WW
Senior Project Engineer
Malcolm Pirnie, Inc.
17-17 Route 208 North
Fair Lawn, NJ 07410
Mr. Mahon received his B.S. in Engineering from Brown University and M.S. in Civil Engineering from NJIT, Newark. He is a licensed P.E. in New Jersey with more than 35 years experience.

Robert S. Johnston, P.E., BCEE HW
President, Malcolm Pirnie, Inc., 17-17 Route 208 North
Fair Lawn, NJ 07410
Mr. Johnston received his B.S. in Civil Engineering from Rutgers College of Engineering and M.S. in Civil/Environmental from the University of California at Davis. He is a licensed P.E. in California and New Jersey with more than 23 years experience.

Raghuva R. Kommalapati, Ph.D., P.E., BCEE HW
Professor, Dept. of Civil/Environmental Engineering, Prairie View University, MS 2510, PO Box 519, Prairie View, TX 77446
Dr. Kommalapati received his B.S. in Civil Engrg. from Nagpur Anna University, India, M.S. in Structures from Kalkiya Univ., India, M.S. in Civil/Env. from Louisiana State Univ. and Ph.D. in Civil/Env. Engrg. from the Louisiana State Univ. He is a licensed P.E. in Texas with more than 20 years experience.

Laurin B. Kennedy, P.E., BCEE WW
Environmental Engineer, CDM,
301 South McDowell #512, Charlotte, NC 28204
Ms. Kennedy received a B.S. in Textile Management, a B.S. in Civil Engineering and M.E. in Environmental Engineering from Clemson University. She is a licensed P.E. in South Carolina and North Carolina with more than 8 years experience.

Scott Haynes, P.E., BCEE WW
Associate, Malcolm Pirnie, Inc., 601 Edgewater Boulevard #512, Charlotte, NC 28204
Mr. Haynes received his B.S. in Civil Engineering from the University of Notre Dame and M.S. degree in Civil/Environmental Engineering from Tufts University. He is a licensed P.E. in Massachusetts with more than 21 years experience.

David R. Hiss, P.E., BCEE HW
Senior Project Engineer, Malcolm Pirnie, Inc., 43 British American Boulevard #12110, New York, NY 12110
Mr. Hiss received his B.S. in Civil Engineering from Syracuse University. He is a licensed P.E. in New York with more than 22 years experience.
William L. Marten, P.E., BCEE WW
Senior Engineer/Project Manager, Donohue & Associates, 3311 Weedon Creek Road, Sheboygan, WI 53081
Mr. Marten received his B.S. and M.S. degrees in Civil Engineering from the University of Wisconsin-Madison. He is a licensed P.E. in Wisconsin with more than 25 years experience.

Howard S. Matteson, P.E., BCEE WW
Project Manager, CDM 110 Fieldcrest Avenue, 6th Floor Edison, NJ 08837
Mr. Matteson received his B.S. in Liberal Arts from Colgate University and M.S. degree in Civil Engineering from Northeastern University. He is a licensed P.E. in New Jersey with more than 15 years experience.

Mark D. McIntire, P.E., BCEE WW
Project Manager, 15010 OH 3128 Highwoods Boulevard #140 Raleigh, NC 27604
Mr. McIntire received his B.S. in Environmental Engineering and M.S. in Civil Engineering from NCSU, Raleigh. He is a licensed P.E. in North Carolina with more than 13 years experience.

Marla L. Miller, P.E., BCEE HW
Senior Engineer, Malcolm Pirnie, Inc., 4646 East Van Buren, #400, Phoenix, AZ 85008
Ms. Miller received her B.S. in Biology from Loyola Marymount University and M.S. degree in Environmental Engineering from UC Berkeley. She is a licensed P.E. in Arizona and has more than 15 years experience.

Matthew D. Millias, P.E., BCEE HW
Senior Project Manager, CDM, One General Motor Drive, Syracuse, NY 13206
Mr. Millias received his B.S. in Civil Engineering and M.S. in Economics from Syracuse University. He is a licensed P.E. in New York and New Jersey with more than 15 years experience.

John A. Minnett, P.E., BCEE WW
Senior Project Engineer, Malcolm Pirnie, Inc., 17-17 Route 208 North, Fair Lawn, NJ 07410
Mr. Minnett received his B.S. in Civil Engineering from Michigan State University and M.S. in Environmental Engineering from Villanova University. He is a licensed P.E. in Pennsylvania and New Jersey with more than 24 years experience.

Indra N. Mitra, Ph.D., P.E., BCEE WW
Project Engineer, CH2M Hill, 15010 Conference Center #200, Chantilly, VA
20151 Dr. Mitra received his B.S. in Chemical Engineering from the Indian Institute of Technology, M.S. degree in Environmental Engineering from Vanderbilt University and Ph.D. in Environmental Engineering from Lehigh University. He is a licensed P.E. in Virginia with more than 18 years experience.

Howard S. Matteson, P.E., BCEE WW
Senior Environmental Engineer, US EPA 26 West Martin Luther King (MS 689), Cincinnati, OH 45288
Mr. Murray received his B.S. in Environmental from Merrimack College, and M.S. degree in Environmental from Northeastern University. He is a licensed P.E. in Ohio with more than 32 years experience.

Prahllad Murthy, Ph.D., P.E., BCEE AP
Associate Professor Wilkes University, 84 West South St, Wilkes-Barre, PA 18706
Dr. Murthy received his B.S. in Civil Engineering from Bangalore University, India, M.S. degree in Environmental Engineering from Anna University, India and Ph.D. in Civil/Environmental from Texas A&M University. He is a licensed P.E. in Delaware and Pennsylvania with more than 23 years experience.

Michael H. Navabi, P.E., BCEE WW
Senior Project Manager, Prime Engineering & Architecture, 3000 Corporate Exchange Drive #600, Columbus, OH 43231
Mr. Navabi received his B.S. and M.S. degrees in Civil Engineering from Lamar University. He is a licensed P.E. in Indiana and Ohio with more than 24 years experience.

Jeff L. Noelle, Ph.D., P.E., BCEE WW
Senior Engineer, Inland Empire Utilities Agency, 6075 E. Ramona Ave, Ontario, CA 91761
Dr. Noelle received his B.S. in Environmental Science from the University of California, and M.S. and Ph.D. degrees in Environmental Engineering from the California Institute of Technology, Pasadena. He is a licensed P.E. in California with more than 11 years experience.

Siva S. Nedic, P.E., BCEE WW
Project Manager, CDM, 111 Academy, Irvine, CA 92617
Mr. Nedic received his B.S. in Civil/Structural from the University of Belgrade and M.S. degree in Environmental Engineering from the University of Illinois. He is a licensed P.E. in California with more than 34 years experience.

Terry F. Neimeyer, P.E., BCEE WW
Chairman of the Board & CEO, KCI Technologies/Holdings, 936 Ridgebrook Road Sparks, MD 21152
Mr. Neimeyer received his B.S. in Civil Engineering from the University of Delaware, M.S. in Environmental Engineering from The Johns Hopkins University, and MBA from Wilmington College. He is a licensed P.E. in Maryland and five other states with more than 32 years experience.

Adrienne D. Nemura, P.E., BCEE WW
Vice President, LimnoTech, 501 Arvis Drive Ann Arbor, MI 48108
Ms. Nemura received her B.S. and M.S. degrees in Civil Engineering from Virginia Polytech. She is a licensed P.E. in Michigan and has more than 25 years experience.

Jay H. Niec, P.E., BCEE WW
Associate/Project Manager, Greely and Hansen, LLC 567 South Lake Street, Gary, IN 46403
Mr. Niec received his B.S. in Liberal Studies from Purdue University and M.S. degrees in Environmental Engineering from the Illinois Institute of Technology. He is a licensed P.E. in Indiana with more than 16 years experience.

Jeffrey A. Pittman, P.E., BCEE WW
Engineering Coordinator, PR Aqueduct & Sewer Authority, PO Box 7066, San Juan, PR 00916
Mr. Pittman received his B.S. in Civil Engineering from the University of Puerto Rico and has more than 12 years experience.

James G. Pimblett, P.E., BCEE WW
Associate, Malcolm Pirnie, Inc., 701 Tower Road #600, Newport News, VA 23606
Mr. Pimblett received his B.S. in Civil Engineering from the University of Virginia and M.S. degrees in Environmental Engineering from Old Dominion University. He is a licensed P.E. in Virginia and has more than 21 years experience.

Jeffrey A. Pittman, P.E., BCEE WW
Engineering Coordinator, Mississippi DEQ, 515 East Amite Street, Jackson, MS 39219
Mr. Pittman received his B.S. in Civil Engineering from Mississippi State University. He is a licensed P.E. in the Mississippi with more than 25 years experience.
Michael W. Ports, P.E., BCEE WW
Principal Water Resources Engineer
Bergmann Associates
8655 Bayside Road
#100, Jacksonville, FL 32256

Mr. Ports received his B.S. in Civil Engineering and M.S. degree in Water Resources Engineering from the University of Maryland. He is a licensed P.E. in Texas and one other state with more than 39 years experience.

Lisa M. Prieto, P.E., BCEE WW
Project Engineer, CDM
2301 Mattland Center Parkway #300
Mattland, FL 32251

Ms. Prieto received her B.S. in Civil Engineering from Vanderbilt University. She is a licensed P.E. in Florida has more than 8 years experience.

Timothy J. Prince, P.E., BCEE AP
Principal Owner/Principal Engineer
2405 Indian Trail
Austin, TX 78703

Mr. Prince received his B.S. in Mathematics from Northeastern University and M.S. in engineering from the University of Texas at Austin. He is a licensed P.E. in Texas with more than 29 years experience.

David S. Pyzoha, BCEE GE
Principal Water Services
Gresham, Smith & Partners, 4555 Lake Forest Drive #100
Cincinnati, OH 45242

Mr. Pyzoha received his B.S. in Civil Engineering from Cleveland State University. He has more than 38 years of experience.

Jose R. Quinones, P.E., BCEE WW
Environmental Specialist II, Ohio EPA
50 West Town Street
Suite 700, Columbus, OH 43216-1049

Mr. Quinones received his B.S. in Mechanical Engineering from Ohio Northern University. He is a licensed P.E. in Ohio with more than 19 years of experience.

Gary B. Rabalais, P.E., BCEE WW
Senior Project Engineer, Malcolm Pirnie, Inc.
1700 West Loop South #1450, Houston, TX 77027-3924

Mr. Rabalais received his B.S. in Civil Engineering from Louisiana State University. He is a licensed P.E. in Louisiana and Texas with more than 26 years of experience.

James P. Raleigh, P.E., BCEE WW
Senior Project Engineer, Malcolm Pirnie, Inc.
50 Fountain Plaza #600, Buffalo, NY 14202

Mr. Raleigh received his B.S. in Physics and M.S. in Civil Engineering from SUNY, Buffalo. He is a licensed P.E. in New York with more than 31 years of experience.

Christopher J. Ranck, P.E., BCEE WW
Project Manager R.W. Armstrong & Associates, 300 South Meridian Street, Indianapolis, IN 46225

Mr. Ranck received his B.S. in Civil Engineering and M.S. in Environmental Engineering from the University of Michigan. He is a licensed P.E. in Indiana with more than 8 years of experience.

Graham W. Rich, P.E., BCEE WW
Chief Executive Officer, Central Arkansas Water, 221 East Capitol Avenue, POB 1789, Little Rock, AR 72203

Mr. Rich received his B.S. and M.S. degrees in Civil Engineering from Clemson University. He is a licensed P.E. in South Carolina with more than 24 years of experience.

Steven C. Richards, Ph.D., P.E., BCEE WW
Environmental Engineer, US Army Center for Health Promotion and Environmental Health, 5158 Blackhawk Road, E-1675, APG, MD 21010-5403

Dr. Richards received his B.S. in Civil Engineering from the University of Texas, M.S. in Civil Engineering from the University of Utah and Ph.D. in Environmental Engineering from Kennedy Western University. He is a licensed P.E. in Texas with more than 26 years of experience.

James C. Robinson, P.E., BCEE WW
Senior Water Technology Engineer, Oxidane Environmental, 12126 Canyon Mills Drive, Houston, TX 77035

Mr. Robinson received his B.S. in Civil Engineering from Louisiana State University and M.S. degree in Environmental Engineering from Rice University. He is a licensed P.E. in Texas with more than 18 years of experience.

Jeffrey D. Sharon, P.E., BCEE WW
Vice President, Brown and Caldwell
4700 Lakehurst Court #100, Columbus, OH 43016

Mr. Sharon received his B.S. in Civil Engineering from Bucknell University and M.S. degree in Environmental Engineering from the University of Cincinnati. He is a licensed P.E. in Ohio with more than 37 years of experience.

Andrew P. Romanek, P.E., BCEE WW
Principal, CDM
3715 Northside Parkway, Building 300 #400, Atlanta, GA 30327

Mr. Romanek received his B.S. in Civil Engineering from the University of Notre Dame and M.S. degree in Environmental Engineering from the University of Texas. He is a licensed P.E. in Georgia, South Carolina, Tennessee and Mississippi with more than 9 years of experience.

Christopher J. Rozza, P.E., BCEE WW
Senior Water Resources Engineer
The Coca-Cola Company, One Coca Cola Plaza, Atlanta, GA 30313

Mr. Rozza received his B.S. in Environmental Engineering from the University of Central Florida. He is a licensed P.E. in Georgia with more than 15 years of experience.

Martin D. Sanford, P.E., BCEE SW
Project Manager, CDM
POB 512, Charlotte, NC 28204

Mr. Sanford received his B.S. in Civil Engineering from North Carolina State University and MBA in Business from George Washington University. He is a licensed P.E. in Maryland with more than 18 years of experience.

Kraig R. Schenkelberg, P.E., BCEE WW
Project Manager, CDM
825 Diligence Drive #205, Newport News, VA 23606

Mr. Schenkelberg received his B.S. in Civil Engineering from Old Dominion University and M.S. degree in Architecture from Thomas Nelson Community College. He is a licensed P.E. in Virginia with more than 15 years of experience.

John Scheri, P.E., BCEE WW
Vice President, Hatch Mott MacDonald
38 Bleeker Street Millburn, NJ 07041

Mr. Scheri received his B.S. in Civil Engineering from New Jersey Institute of Technology and his M.S. and Ph.D. degrees in Chemical Engineering from Stevens Institute of Technology. He has more than 30 years of experience.

Robert C.A. Siemak, P.E., BCEE WW
Chief of Engineering & Planning, Water Replenishment District, 4040 Paramount Boulevard, Lakewood, CA 90712

Mr. Siemak received his B.S. in Civil Engineering from Loyola University of LA and M.S. degree in Environmental from the University of California, Berkeley. He is a licensed P.E. in California with more than 32 years of experience.

James A. Smith, Ph.D., P.E., BCEE GE
Professor Civil & Environmental Engineering, University of Virginia, PO Box 400742, Charlottesville, VA 22904-4742

Dr. Smith received his B.S. and M.S. degrees in Civil Engineering from Virginia Tech and M.S. and Ph.D. degrees in Civil Engineering from Princeton University. He is a licensed P.E. in Virginia with more than 26 years of experience.
James E. Smith, Jr., D.Sc., BCEE WW
Senior Environmental Engineer, EPA, 26 West Martin Luther King Drive, Cincinnati, OH 45228
Mr. Smith received his B.S. in Engineering Physics and M.S. in Civil/Environmental Engineering from the University of Cincinnati and D.Sc. degree in Civil/Environmental Engineering from Washington University. He has more than 46 years experience.

Robert C. Smith, P.E., BCEE WW
Project Engineer Malcolm Pirnie, Inc. 1900 Polaris Parkway #200, Columbus, OH 43240
Mr. Smith received his B.S. and M.S. degrees in Civil Engineering from the University of Toledo. He is a licensed P.E. in Ohio with more than 12 years experience.

Aamod S. Sonawane, P.E., BCEE SW
Environmental Engineer, CDM, 1715 North Westshore Boulevard #875, Tampa, FL 33607
Mr. Sonawane received his B.S. in Civil from the College of Engineering, Pune, M.E. in Civil from the University of Mumbai, India and M.S. degree in Environmental from the University of Central Florida. He is a licensed P.E. in Florida with more than 8 years experience.

Phillip M. Steams, P.E., BCEE WW
Senior Associate, Malcolm Pirnie, Inc. 1600 Carmody Court #403, Stowcaley, PA 15143
Mr. Steams received his B.S. in Chemical Engineering from Carnegie-Mellon University. He is a licensed P.E. in Pennsylvania with more than 20 years experience.

Darrel M. Stordahl, P.E., BCEE HW
Principal, CDM 50 West 14th Street #200, Helena, MT 59601
Mr. Stordahl received his B.S. in Mining Engineering and M.S. degree in Environmental Engineering from Montana College of Mineral Science. He is a licensed P.E. in Montana with more than 20 years experience.

Janet L. Strickland, P.E., BCEE WW
Project Manager/ Group Leader, CDM 9200 Ward Parkway #600, Kansas City, MO 64114
Ms. Strickland received her B.S. in Chemical Engineering from Kansas State University and M.S. degree in Environmental Engineering from the University of Kansas. She is a licensed P.E. in Kansas, Missouri and Iowa with more than 12 years experience.

Michael E. Tatalovich, P.E., BCEE WW
Supervising Engineer, CDM 715 Grantham Lane, New Castle, DE 19720
Mr. Tatalovich received his B.S. and M.S. degrees in Civil Engineering from the University of California at Irvine. He is a licensed P.E. in California with more than 11 years experience.

Shaikh Tayeb, Ph.D., P.E., BCEE AP
Environmental Engineer, DAREC 715 Grantham Lane, New Castle, DE 19720
Dr. Tayeb received his B.S. in Chemical Engineering and Ph.D. in Chemical Technology from the Moscow Technological Institute and M.S. degree in Environmental Technology from the New York Institute of Technology. He is a licensed P.E. in Virginia and Maryland with more than 14 years experience.

Chorfan (Frank) Tsang, P.E., BCEE HW
Project Manager, CDM Federal, 125 Maiden Lane 5th Floor New York, NY 10038
Mr. Tsang received his B.S. in Chemical Engineering from Polytechnic University, Brooklyn and M.S. degree in Chemical Engineering from the University of Massachusetts. He is a licensed P.E. in Virginia and New York with more than 21 years experience.

K.C. Upendrakumar, P.E., BCEE WW
Director, WW Engineering, Veolia Water North America, 101 West Washington Street #1400 East, Indianapolis, IN 46204
Mr. Upendrakumar received his B.S. in Civil Engineering from Banaglore University, India and M.S. degree in Civil/Environmental from Marquette University. He is a licensed P.E. in Wisconsin and Indiana with more than 25 years experience.

Steven G. Vanderbrook, P.E., BCEE WW
Senior Project Manager, CDM, 9175 North French Road, Amherst, OH 44001
Mr. Vanderbrook received his B.S. in Civil Engineering from the University of Texas at El Paso. He is a licensed P.E. in Texas with more than 37 years experience.

William D. Vandertulip, P.E., BCEE WW
Principal, CDM 1777 NE Loop 410 #500, San Antonio, TX 78217
Mr. Vandertulip received his B.S. in Civil Engineering and M.S. degree in Sanitary Engineering from the University of Texas at El Paso. He is a licensed P.E. in Texas with more than 37 years experience.

Nikolaos A. Veriotes, P.E., BCEE AP
Senior Environmental Engineer, SunCor Energy, Inc., PO Box 4001, Mail Drop 801 Ft. Mcmurray, Alberta, Canada T9H 3E3
Mr. Veriotes received his B.S. degree in Environmental Engineering from the University of Guelph. He is a licensed P.E. in Ontario with more than 16 years experience.

Nancy O. Vigneault, P.E., BCEE WW
Project Manager, CDM One General Motors Drive, Syracuse, NY 13206
Ms. Vigneault received her B.S. in Civil Engineering from Clarkson University and M.S. degree in Environmental Engineering from the University of New Haven. She is a licensed P.E. in Connecticut with more than 11 years experience.

Christopher J. Waters, P.E., BCEE WW
Senior Project Manager, CDM, 1715 North Westshore Boulevard #875, Tampa, FL 33607
Mr. Waters received his B.S. in Chemistry and M.S. degree in Environmental Engineering from the University of Florida. He is a licensed P.E. in Florida and Virginia with more than 10 years experience.

Marc R. Weinberger, P.E., BCEE WW
Senior Associate, Malcolm Pirnie, Inc. 1525 Faraday Avenue #290, Carlsbad, CA 92008
Mr. Weinberger received his B.S. in Civil Engineering from California State Polytechnic. He is a licensed P.E. in California with more than 34 years experience.

James E. Welp, P.E., BCEE GE
Project Director Black & Veatch 11500 Northlake Drive #205 Cincinnati, OH 45069
Mr. Welp received his B.S. and M.S. degrees in Mechanical Engineering from the University of Iowa. He is a licensed P.E. in Missouri and one other state with more than 26 years experience.

Kristin G. Wheaton, P.E., BCEE WW
Senior Project Manager, Malcolm Pirnie, Inc., 17-17 Route 208 North, 2nd Floor Fair Lawn, NJ 07410
Mr. Wheaton received his B.S. in Civil Engineering from Worcester Polytechnic Institute. She is a licensed P.E. in New Jersey with more than 20 years experience.

Kevin C. Wood, P.E., BCEE WW
Director of Engineering, M.E. Companies, Inc., 835 Brookside Boulevard Westerville, OH 43081
Mr. Wood received his B.S. in Civil Engineering from Ohio University, Athens. He is a licensed P.E. in Ohio with more than 23 years experience.

Mark W. Wurschmidt, P.E., BCEE WW
Assistant GM & Director of Engineering Sanitation District No. 1 of Northern Kentucky, 1045 Eaton Drive, Ft. Wright, KY 41017
Mr. Wurschmidt received his B.S. in Civil Engineering from Ohio State University. He is a licensed P.E. in Kentucky with more than 23 years experience.
Design and construction markets related to environment, infrastructure, and facilities chalked up another growth year in 2008, in spite of deteriorating market conditions during the second half of the year. Most of these markets will not grow in 2009.

Designers for transportation, power and water infrastructure, as well as remediation, and facilities in the U.S. saw billings increase by 9 percent in 2008, and construction firms serving those same markets enjoyed a 10 percent increase in aggregate revenues. Although some of these markets began to weaken in the first half of 2008, all of them were slowing considerably by the last quarter of 2008. For engineers and architects, growth has slowed from 15 percent in 2006 to 12 percent in 2007 to 9 percent in 2008, and we project that these markets, in aggregate, are unlikely to grow at all in 2009. Our growth rate estimates and forecasts do not account for inflation. Exhibit 1 shows the growth of the U.S. engineering market. Exhibit 2 shows the distribution of the engineering market among the major segments.

For all of the hype surrounding the infrastructure funding in the American Recovery and Reinvestment Act (ARRA), only highway and bridge contractors will see a boost to their top lines in 2009. Highway/bridge engineers should see some stimulus dollars in 2010. Based on our analysis of ARRA, architects, engineers, and contractors have a potential claim on as much as $150 billion of the stimulus bill's $789 billion in authorizations. In addition to the funding provided for transportation contractors and engineers, some large engineering firms will realize windfalls from the acceleration of cleanup programs at the Department of Energy (DOE), but most stimulus dollars should benefit smaller engineering and construction firms that serve small to medium sized municipal water and wastewater utilities or that have the capability to renovate government buildings.

We expect to see growth return to most design and construction markets during 2010, but we will likely have to wait several years for a return to double digit design and construction growth across environment, infrastructure, and facilities markets.

**WATER INFRASTRUCTURE ENGINEERING AND CONSTRUCTION**

The water infrastructure market consists of two principal segments and two client groups. The two segments include water and wastewater treatment facilities and associated infrastructure and water resources projects. Water resources includes such projects as flood control, habitat restoration, and the development of new water supplies. The two major client groups are municipalities and the federal government, which is a major client for water resources projects. Water resources management is included in the estimated market size.

The water infrastructure engineering market grew 10 percent in 2008, while the value of construction put in place for water and wastewater increased by 6 percent. We have seen double digit growth in the water infrastructure engineering market for the last six years except for 2007. That growth was slightly less than 7 percent.

The surprisingly strong 10 percent growth rate for engineers in 2008 masks a slowing of the market during the second half of the year. We forecast a declining market this year and next, with recovery not likely until 2011.

Engineers enjoyed a strong market until the third quarter of 2008. A confluence of variables weakened the market by the fourth quarter of last year. These variables all impacted funding sources. Funding of most water infrastructure design and construction comes from a mix of federal and state and local government sources including user rates, hookup fees, municipal bonds, and State Revolving Funds. The market was negatively impacted by the U.S. recession. Multiple effects of the recession led to cancelled or delayed projects. These drivers included:

- The housing crisis: The housing crisis led to lower population growth in the Sunbelt states. These were the states that reported the fastest market growth in recent years. Many projects were delayed or cancelled because the expansion of water and wastewater services was no longer urgently needed.
- The reduction in tax revenue: Along with the housing crisis, tax revenue and hook-up fees decreased for municipalities. This further limited their ability to invest in water and wastewater infrastructure.
- The meltdown of the municipal bond market: Municipalities float municipal bonds to fund water and wastewater infrastructure. A confluence of factors depressed the bond market in late 2008. These factors included: the lack of availability of bond insurance, hedge funds insurance companies selling their stake in long-term bonds therefore increasing the interest rates municipalities have to pay on their bonds, and shrinking tax revenue at the state and local levels increasing the credit risks. In fact, in the fourth quarter of 2008, we saw the lowest sales of new bonds by dollar value in a single quarter since before 2006. And, looking at the number of new bonds being issued, we saw 35 percent fewer bonds being issued in the fourth quarter of 2008 than in the fourth quarter of 2007.
- The hope for stimulus dollars: Once the rumors began flying about the stimulus bill, many municipalities delayed their projects in hope that they would get “free” money.
Municipalities even delayed projects for which they had the funding. Market participants believe this delay negatively impacted the market in late 2008. While the stimulus bill provides $6 billion to state revolving loan fund programs, few large municipalities are sufficiently motivated to tap that source of funding.

The competitive landscape seems to be changing in the marketplace, but most of the big players remain the same. AECOM is new to the “big player” list as a result of its acquisitions of Earth Tech and Boyle Engineering in 2008. Looking at worldwide gross revenues, the top five firms in this market grew more quickly in 2008 than the other firms in the market. The top five firms grew 15 percent, while the next ten firms grew at a 6 percent rate. All other firms in the water segment grew at 9 percent. The top five firms in 2008, including revenue from U.S. and foreign projects, in order of market share, are: CH2M HILL, Tetra Tech, MWH Global, AECOM, and URS.

Market participants see more competitors going after each opportunity. Participants report seeing both major engineering and construction firms bidding on smaller projects than they would have in the past. These larger firms are lowering their fee threshold because of a lack of opportunities. In addition, participants report seeing small local civil engineers and contractors bidding on projects. In many cases, these firms have never done a water or wastewater project. Again, they are bidding because of a lack of opportunities in their own core markets. These smaller firms seem to be bidding on the projects in the $25 million to $100 million range. Some report seeing the number of competitors for projects in this value range increase from about 10 to 30.

Engineering led design-build projects chalked up sales in excess of $2.2 billion in 2008 according to data collected by the Water Design-Build Council. Unfortunately for many design-builders, many of the projects sold were later postponed or cancelled. However, interest at all levels of government in quickly stimulating the economy will increase the percentage of water and wastewater projects that will go to design-build.

Four states account for 65 percent of the $6.4 billion in engineer-led design-build sales value from 2005–2008. These states are Florida (26 percent), Arizona (15 percent), California (14 percent), and Texas (10 percent). These top states are driven by population growth and requirements to meet new standards for drinking and wastewater. Even states like Florida and Arizona that have a housing crisis will still be good markets for design-build because they will continue to need to meet regulations and will have water resources challenges. They are not, however, great markets for traditional water/wastewater engineering. One participant believes that California has over $1.5 billion in opportunities.

We see fewer competitors on larger projects because the cost of bidding is so high, but we are seeing more competitors for smaller projects due to the depressed conditions in other markets.

We see a trend towards CM@Risk over traditional and progressive design-build. CM@Risk allows the municipality to choose both their engineer and contractor on a qualifications basis and allows the contractor and engineer to work together early in the process. However, the municipalities get to choose the engineer and contractor independently of each other and contract separately with each. From 2005 – 2008, CM@Risk only accounted for 34 percent of the $6.4 billion in engineer-led design-build sales value. In 2008 alone, it accounted for 68 percent of the $2.2 billion in engineer-led design-build sales value.

WATER PUBLIC PRIVATE PARTNERSHIPS
Based on a survey recently reported in Public Works Financing magazine, we find that the water public-private partnership market has remained essentially constant since
2005, at just under $1.3 billion. Renewal rates have also remained constant at around 95 percent.

Inquiries seem to have increased significantly in 2009. Market participants report seeing the greatest activity in the first quarter of 2009 than they have seen in the last two years. Some municipalities are looking at O&M to help them reduce financial burdens including health insurance and pensions. Municipalities are also short on staff. Some of these opportunities are just for short-term or the replacement of an operator. At the same time, participants have reported to us that they are increasing their business development budgets. Between renewed interest and a focus on marketing, the partnership market could restart this year. In the meantime, competitors are broadening the scope of services they offer. Most participants are interested in DBOs and offering additional municipal services, although the number of these opportunities is decreasing as a result of slower population growth. Less population growth means fewer new cities that will need the support.

**REMEDIATION CONSULTING AND ENGINEERING**

The remediation consulting market grew 12 percent in 2008 after contracting 2 percent in 2007. This is the strongest remediation consulting and engineering market that we have seen in a very long time. The strong growth can be explained principally by the substantial pick up in Department of Defense (DOD) spending on remediation. The industrial market was also strong through the third quarter of 2008, but tanked in the fourth quarter. We forecast a steady DOD market over the next two years but a weakening industrial market. Overall we project a contraction in the remediation market of 5 percent in 2009 and again in 2010.

The industrial market was hit hard at the end of 2008. Cost cutting among nearly all industries, the collapse of the brownfields market, and a sharp reduction in merger and acquisition activity all contributed to a sudden down-turn in the industrial remediation market in the fourth quarter. For example, most industries, especially manufacturing, chemical, and mining, stopped most discretionary spending on cleanup.

The DOD remediation market grew approximately 10 percent in 2008 and is still growing in 2009. After appropriations of approximately $1.3 billion per year during federal fiscal years 2003-2006, the Defense Environmental Restoration Account (DERA) dipped by 20 percent in 2007 and then increased 33 percent in FY2008. Emphasis on low price continues to pervade the contracting practices of the Army, Air Force, and Navy. At the same time performance-based design-build contracts are favored. A combination of the increased risks of performance contracts, fixed-price against approved site closure, and greater emphasis on price rather than relationships and past performance has driven some successful competitors to shun this market. Those firms that have stayed in the market report that competition has become less fierce. We see the Army Corps of Engineers lead in new contracting. In addition, we see small businesses continue to increase share. For example, the Navy and the Air Force Center for Environmental Excellence (AFCEE) target 50 percent of work to small businesses. In addition, DOD is pushing for 75 percent of subcontracts to go to small businesses or 30 percent of contract values. Unlike in the past, with more work to go around, complaints about the small business focus are less.

The Department of Energy (DOE) clean-up market was extremely active in 2008, with over 50 percent of the environmental management budget at stake in a series of re-competes. More contracts were awarded in 2008 than in the last 10 years. The five firms that have dominated this market for the last 10 years or more successfully protected their turf. Fluor, URS, and CH2M Hill led teams to major wins, with Bechtel and Babcock & Wilcox playing important supporting roles on winning teams. URS was the most successful of
all, winning three of six major DOE contracts and walking away with the coveted $9.6 billion clean-up of the Sellafield complex for the United Kingdom Nuclear Decommissioning Authority.

The stimulus will pump $6 billion into cleanup over FY 2010 and 2011 increasing the Office of Environmental Management budget by 50 percent each year. These funds will go to existing contract vehicles, with $1.6 billion to the Savannah River Site and $1.9 billion to Hanford. URS and CH2M are the major beneficiaries of this windfall. An additional $7.5 billion will go into energy R&D. DOE will use these funds directly for projects and service providers to advance clean coal, renewable energy, energy efficiency, and study climate change.

About the Authors
Farkas Berkowitz & Company is a management consulting firm serving companies that provide design, construction, and operational services for government and industry. Established in 1983, the firm assists clients with strategy, mergers and acquisitions, and organizational development. Inquiries should be addressed to Alan Farkas at 202-833-7530 or farkas@farkasberkowitz.com or visit their website: www.farkasberkowitz.com.
SUSTAINABILITY AND THE ENVIRONMENTAL ENGINEER: IMPLICATIONS FOR EDUCATION, RESEARCH, AND PRACTICE
James R. Mihelcic, Ph.D., BCEEM, and Maya A. Trotz, Ph.D. ......................................................... 27
Instructions to Contributors

PURPOSE AND SCOPE

Environmental Engineer: Applied Research and Practice, is a peer-reviewed journal focused on practical research and useful case studies related to the multi-disciplinary field of environmental engineering. The journal strives to publish useful papers emphasizing technical, real-world detail. Practical reports, interesting designs and evaluations of engineering processes and systems are examples of appropriate topics. Papers relating to all environmental engineering specialties will be considered.

MANUSCRIPT REQUIREMENTS:

Manuscripts should follow the general requirements of the ASCE authors’ guide (http://www.pubs.asce.org/authors/index.html#1) and should be submitted electronically in WORD format to the Editor and Assistant Editor.

Editor
C. Robert Baillod, Ph.D., P.E., BCEE
email: baillod@mtu.edu

Assistant Editor
Yolanda Moulden
Email: YMoulden@aaee.net

For questions or hard copy submission, please contact:
Yolanda Moulden, AAEE
Assistant Editor
130 Holiday Court, Suite 100
Annapolis, MD 21401
ATTN: Yolanda Moulden
Tel: (410) 266-3311
Fax: (410) 266-7653

REVIEW PROCESS

All papers submitted to the journal are subject to critical peer review by three referees, who have special expertise in a particular subject. The Editor will have final authority over a paper’s suitability for publication.

CATEGORIES

Papers may be submitted in the following areas:

Applied Research
Original work presented with careful attention to objectives, experimental design, objective data analysis, and reference to the literature. Practical implications should be discussed.

Review
Broad coverage of an environmental engineering application or a related practice with critical summary of other investigators’ or practitioners’ work.

Practical Notes
Novel methods that the author(s) have found to be sufficiently successful and worth recommending.

Case Studies
Recently completed projects or studies in progress that emphasize novel approaches or significant results.

Design/Operation
Conceptual or physical design or operation of engineering systems based on new models or techniques.

Management
Papers describing novel approaches to problems in environmental management, or to the global, sustainability or business aspects of environmental engineering.

ABSTRACT

An abstract of up to 200 words should be provided, including a statement of the problem, method of study, results, and conclusions. References, tables, and figures should not be cited in the abstract. Up to six key words or terms should be included for use by referencing sources.

PHOTOGRAPHIC CONSENTS

A letter of consent must accompany all photographs of persons in which the possibility of identification exists. It is not sufficient to cover the eyes to mask identity.

COPYRIGHT AND LICENSE TO PUBLISH

Authors retain copyright but are required to grant AAEE the license and right to be the first publisher of the paper and to have an ongoing continuing world-wide license to reproduce the paper in print form and on-line.
SUSTAINABILITY AND THE ENVIRONMENTAL ENGINEER: IMPLICATIONS FOR EDUCATION, RESEARCH, AND PRACTICE

James R. Mihelcic, Ph.D., BCEEM, and Maya A. Trotz, Ph.D.

ABSTRACT
Three case studies (Bolivia, Guyana, Florida) are presented that demonstrate how sustainability can be incorporated into environmental engineering education, research, and practice. They demonstrate how traditional measures of performance (e.g., function, economics, and safety) can be enhanced with additional measures of performance that integrate societal needs and a global perspective. The case studies also show how engineering practice can apply sustainability to an “engineering project” to transcend beyond the physical structure and include the social setting in which the project is located and importantly, the people who will operate, manage, and benefit from the project. This fits with the vision of the Environmental Engineering Body of Knowledge that “environmental engineering problem formulation and solution must be accomplished in the context of sustainability, must meet societal needs and must be sensitive to global implications.” Furthermore, adding the learning outcomes of caring and a human dimension to education is critical if sustainability is to become inherent in all environmental engineering practice.

INTRODUCTION
Since the release of Limits to Growth (Meadows et al., 1972) there has been increased global discussion on issues relating to sustainability. One definition of sustainable engineering is “the design of human and industrial systems to ensure that humankind’s use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health, and the environment” (Mihelcic et al., 2003). This is often practically interpreted as mutually advancing the long-term goals of environmental protection, societal prosperity, and economic growth (Mihelcic and Zimmerman, 2010).

The Environmental Engineering Body of Knowledge (BOK) (AAEE, 2009) describes the knowledge and core competencies important for the understanding and practice of environmental engineering and recognizes sustainability as an essential competence for environmental engineers. The BOK further asserts that “environmental engineering problem formulation and solution must be accomplished in the context of sustainability, must meet societal needs and must be sensitive to global implications.” To recognize this competence, AAEE has created a new certification category in sustainability.

Unfortunately, sustainability has been a difficult concept for many engineering educators, researchers, and practitioners to integrate into their professional activities. One problem is that an Internet search performed on the words “sustainability” or “sustainable development” will result in hundreds of definitions. Additionally, many challenges to implementing engineering solutions such as providing safe drinking water around the world are not technical, but instead relate to social, economic, and environmental limitations that have geographical and cultural context (Hokanson et al., 2007).

Most can agree that definitions of sustainability seek some type of balance between environmental, social, and economic components. However, traditional environmental engineering education, research, and practice have not always emphasized the social and global implications of a specific engineering solution. Another problem has been that many engineers gravitate towards solutions that arise from an educational system that emphasizes learning fundamental knowledge and applications of fundamental skills. This can lead to an overemphasis to substitute technology and economic considerations at the expense of other innovative solutions that may be more economically competitive and better integrated with societal and environmental concerns.

Application of sustainability to engineering projects thus requires more emphasis on integrating and balancing human and societal considerations with technological and economic considerations. In this view, the word project transcends beyond the physical structure and includes the social setting of people who will operate, manage, and benefit from the project and includes long term life cycle implications (Mihelcic et al., 2009). Importantly, community participation (Selener et al., 1999; Chambers, 2002; Ratner and Gutierrez, 2004) and gender considerations are often critical to project success (Coles and Wallace, 2005; Fisher, 2006).
OBJECTIVES
The objective of this paper is to demonstrate, through three case studies, how sustainability can be incorporated into environmental engineering education, research, and practice. In some cases, readers will readily see how their current approach to projects already fits into the overarching theme of sustainability. Others will see how to expand their existing approach to incorporate sustainability. All the case studies expand the list of additional measures of performance which have historically focused on quality and cost of environmental emissions. They also demonstrate how the project fits the BOK vision of meeting societal needs and is sensitive to global implications.

The case studies engage undergraduate and graduate students, with engineering practitioners to design and implement projects for municipalities or nongovernmental organizations (NGOs). Common to all the case studies is development of partnerships that connect the environmental engineer with households, neighborhoods, and institutions of governance. Another commonality is demonstrating that integrating a caring and human dimension (Catalano and Baillie, 2006) with technical competence is important for project success.

Two case studies are located outside of North America, in Bolivia and Guyana. Bolivia and Guyana rank 113th and 114th respectively on the Human Development Index (HDI) with values of 0.729 and GDP per capita of $4,206 and $2,782 respectively (UNDP, 2009). The concepts presented in these case studies are still applicable to engineering problems encountered in more developed parts of the world. In addition, though the scale of the problems addressed here are at the community level, we believe that incorporating sustainability into a particular problem’s unique context is scalable to more complex and larger situations. The manuscript concludes with observations on how environmental engineering education and practice needs to go beyond learning outcomes of foundational knowledge and application by adding a human dimension and empathy.

Case Study # 1: Bolivia
We identified six rural communities (population of < 2,700) in the eastern La Paz Department of Bolivia (Figure 1) where there are different sanitation technologies, levels of social organization, and economic capacities to support a particular system (Table 1). In these six communities, water and sanitation systems are typically managed together by local community water committees.

One question we are attempting to answer is “what is the appropriate sanitation expansion path for a community beyond a simple pit latrine?” (Fuchs and Mihelcic, 2009). Appropriate technology...
is defined here as the use of materials and technology that are culturally, economically, and socially suitable to the area in which they are implemented (Mihelcic et al., 2009). Through user and water committee surveys and detailed analysis of engineering reports, we have determined that the successful operation and maintenance of a particular technology is related to how well community members understand the operation and maintenance of a particular technology, and that is in turn related to how much funds were allocated for training of beneficiaries during the pre- and post-construction phases. In this setting, an appropriate sanitation technology also has characteristics of the decentralized absorption pits found in the community of Sararia. The modularity of this particular technology allows it to adjust to dynamic changes occurring in the area related to population growth, urbanization, land use changes on water availability, and seasonal employment activities that are influenced by country and global policies. Here, an appropriate sanitation technology also has minimal demands for human/financial/natural resources, and does not overburden local water committees with excessive management requirements (Fuchs and Mihelcic, 2009).

The technologies employed in all six communities have very low water and energy footprints over their life cycle (ongoing research). Recovery of water, energy, and nutrients is a key consideration in any discussion of what makes a particular wastewater treatment technology sustainable (Guest et al., 2009). The water requirements of specific sanitation technologies ranges from 0 L/capita-day for a double vault urine diversion composting latrine to 2-10 L/capita-day for a pour flush toilet, to over 70 L/capita-day for a traditional flush toilet connected to a sewer (Fry et al., 2008). In Sapecho, the low level of water usage has limited the sewer’s ability to transport solids. Thus, a second gravity flow water supply system that consists of a mountain spring-box connected to a several km long transmission line is being considered to improve operation of the existing sanitation technology. In this case, the low population density combined with the reality of financial and human resources required to construct and manage an additional water supply system cause the sanitation technology in Sapecho to be less appropriate. Important, because the majority of community residents work long hours as subsistence farmers in fields that can be far from their primary residence, the additional financial and human resources required of the community to support the existing technology, may be beyond their collective capacity.

Table 2 shows the project objectives along with traditional measures of performance, and additional measures of performance that integrate sustainability concepts into the project. In a typical case, the traditional measures of performance for environmental engineering might be focused on effluent quality of a particular treatment technology, the associated cost of treatment, and issues of worker safety. The additional measures of performance presented in Table 2 take into consideration social issues, e.g., specific measures of health, interface of humans with technology, community management and issues of governance.

Interestingly, if one was to base an assessment of the technology primarily on environmental indicators of improved water quality, nutrient recovery, and lowering the technology’s energy footprint, the Sapecho sanitation technology would rate very well. It does an excellent job of improving human health, protecting water quality, and sludge from the anaerobic reactor is recovered and applied to a small garden located on the plant’s property. In terms of energy use, facultative wastewater lagoons use wind mixing and photosynthetic algae to provide oxygen to the wastewater and our field measurements indicate the upflow anaerobic reactor produces gas which is 66% methane and has an average flow rate of 30.8 L/min, resulting in a potential energy content of 9.33 x 10^3 kJ/day.

In Bolivia, the student teams consist of U.S. and Bolivian engineering students. The U.S. students include doctoral students integrating the international experience with their dissertation research. They in turn mentor a group that consists of one U.S. undergraduate researcher and several undergraduate Bolivian students majoring in ecological engineering. The U.S. undergraduate researchers are combining their research experience with an International Capstone Design course situated in Bolivia that takes place the following summer (Trotz et al., 2009).

Student feedback was solicited through a survey consisting of three parts, including multiple choice questions and two essay type questions (Trotz et al., 2009). Besides these topics, the last day assessment included additional questions to further evaluate the impacts of this research experience. Out of the 18 U.S. and Bolivian engineering students participating in the 2009 Bolivia Research Project: 89% believe that their understanding of sustainability issues related to household/community level increased over the course of the research program; 89% believe that their understanding of sustainability issues related to regional (e.g. watershed) level increased over the course of the research program; 78% believe that their understanding of sustainability issues related to global level increased over the course of the research program; 94% believe they have increased their research skills to solve sustainability problems; 83% believe their understanding of career options have increased; and 100% said they are more likely to continue their education because of this experience.

In terms of gaining a global perspective, one doctoral student commented that “for sustainable development to be a global partnership, it must include developed and developing people/communities, and the partnership should ensure mutual knowledge transfer.” They went on to comment that they were “truly beginning to see a positive-impact cycle in the concepts of education, sustainability and diversity” because this research program “formally ties these concepts together, so students learn to do sustainable development in diverse environments.”

A second doctoral student commented that “direct, practical learning deeply impacts students’ thinking. Because they are immersed in the research projects, they are forced to understand the issues holistically. The emotional connections forged with their international team members, the work region, and the information they seek provokes both analytical and emotional analysis of the experience. Because of the significant time, energy and emotion invested in the project, students are more likely to view this as a formative experience and to apply what they have learned in the future.”
Case Study #2: Guyana

Guyana is situated between Suriname, Brazil and Venezuela on the northeastern coast of South America. We have been working along the densely populated low lying coastal region around the capital, Georgetown, as well as in the forested interior near Mahdia where small to medium scale gold mining is rampant (Figure 2). With a population of roughly 770,000, the major exports are sugar, gold, bauxite, rice, shrimp, rum, and timber. The country currently faces several environmental issues; for example, water pollution from untreated sewage and agricultural and industrial chemicals, improper solid waste management, and deforestation.

In developing countries like Guyana where democracy and governance remain focal points for agencies like USAID, partnerships with NGOs and civic organizations are crucial and seen as essential for local development (Trotz, 2008). Since 2005, we have developed education and research projects with several NGOs on projects that center around mercury use in gold mining communities (with WWF-Guianas and Conservation International-Guyana) and household water storage tanks (with Guyana Citizen’s Initiative (GCI)).

Based on a 2002 census, 66% of Guyana’s population receives water piped into their homes, dwellings or yard from either a public or private supply or from rainwater (Guyana Bureau of Statistics, 2009). This piped water is received primarily from the country’s water authority, Guyana Water Incorporated (GWI). Inconsistent supply from GWI has led many people to invest in black 450-gallon polyethylene storage tanks which, if operated correctly, can provide water throughout the day even when the supply from the water main is low or zero. In general, ground level tanks are filled when water pressure is high and that water is pumped to an elevated tank where it is then distributed to the household. While these individual systems help to guarantee a more constant supply of water (and thus improve health through sanitation and hygiene), they increase the residence time of the water supply and may adversely impact water quality at the household tap. If not properly maintained and cleaned, these tanks could become breeding grounds for vectors that cause disease (Chadee and Rahaman, 2000). They may also affect the concentration of bacteria, heavy metals, and organics in the water supply (see references in Mihelcic et al., 2009).

In 2006, GCI received a grant from the Pan American Health Organization (PAHO) to implement community water projects in Guyana. This resulted in the construction of a tank system to collect city water when it was available and share it among households. Through a graduate research project, we partnered with GCI to determine water quality changes resulting from storage tanks and household practices. The goal of this ongoing project is to develop improved maintenance and treatment routines such as tank cleaning and disinfection and to improve the human interface with this technology. Student research includes water quality measurements.

![Image](https://example.com/guyana_map.png)

**Figure 2: Map of Guyana Showing Locations Where Research is Underway with WWF (Mahdia), Ivokrama International Center for Rainforest Conservation (Ivokrama), and Guyana Citizen’s Initiative (Georgetown).**

**Table 3: Water quality in storage tanks (n = 42) sampled in April 2009 in 5 different coastal neighborhoods in Guyana. Main water sources were: piped from main (64%), rain (31%).**

<table>
<thead>
<tr>
<th>pH</th>
<th>Temperature (°C)</th>
<th>DOC (mg/L)</th>
<th>Turbidity (NTU)</th>
<th>% with Total Coliforms</th>
<th>% with Fecal Coliforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>5.1-9.5</td>
<td>27.1-41.8</td>
<td>1.0-7.0</td>
<td>10.3-20.2</td>
<td>48</td>
</tr>
<tr>
<td>Average</td>
<td>6.9</td>
<td>30.8</td>
<td>5.0</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>Stdev</td>
<td>1.2</td>
<td>2.7</td>
<td>1.9</td>
<td>3.6</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Traditional Measures and Sustainable Measures of Performance for the Bolivia Case Study**

<table>
<thead>
<tr>
<th>Project Objectives</th>
<th>Traditional Measure(s) of Performance</th>
<th>Additional Measures of Sustainable Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess water quality in household water storage containers</td>
<td>Water quality at end of treatment plant</td>
<td>• Impact of household water storage containers and storage practices on human health and water quality.</td>
</tr>
<tr>
<td>Evaluate the impact of mercury use in small and medium scale gold mining</td>
<td>Quantity and environmental fate of mercury releases</td>
<td>• Compare mercury releases from human activities (mining and non-mining) that occur in two distinct geographical settings (Guyana and Florida).</td>
</tr>
</tbody>
</table>

**Table 2: Measures of Sustainable Performance**

<table>
<thead>
<tr>
<th>Project Objectives</th>
<th>Traditional Measure(s) of Performance</th>
<th>Additional Measures of Sustainable Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess water quality in household water storage containers</td>
<td>Water quality at end of treatment plant</td>
<td>• Impact of household water storage containers and storage practices on human health and water quality.</td>
</tr>
<tr>
<td>Evaluate the impact of mercury use in small and medium scale gold mining</td>
<td>Quantity and environmental fate of mercury releases</td>
<td>• Compare mercury releases from human activities (mining and non-mining) that occur in two distinct geographical settings (Guyana and Florida).</td>
</tr>
</tbody>
</table>

**Table 3: Water quality in storage tanks (n = 42) sampled in April 2009 in 5 different coastal neighborhoods in Guyana. Main water sources were: piped from main (64%), rain (31%).**

<table>
<thead>
<tr>
<th>pH</th>
<th>Temperature (°C)</th>
<th>DOC (mg/L)</th>
<th>Turbidity (NTU)</th>
<th>% with Total Coliforms</th>
<th>% with Fecal Coliforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>5.1-9.5</td>
<td>27.1-41.8</td>
<td>1.0-7.0</td>
<td>10.3-20.2</td>
<td>48</td>
</tr>
<tr>
<td>Average</td>
<td>6.9</td>
<td>30.8</td>
<td>5.0</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>Stdev</td>
<td>1.2</td>
<td>2.7</td>
<td>1.9</td>
<td>3.6</td>
<td></td>
</tr>
</tbody>
</table>
accessing public health records, and household surveys on water use, treatment, time and money spent on systems, hygiene practices, gender roles and access to information.

Table 3 summarizes water quality data from tanks in five coastal neighborhoods in Guyana. Twelve percent of tanks tested positive for fecal coliform, and 48% tested positive for total coliform with all of the fecal coliform cases coming from tanks filled with piped water supplied by GWI. Household surveys show that water from these tanks is used for various purposes, including drinking, and that point of use treatment varies by household and includes the addition of bleach, boiling and nothing. High tank temperatures, combined with very little cleaning over the tank lifetime (up to 20 years in some cases) could contribute to unwanted microbiological and chemical water quality with implications for human health (Batté et al., 2006). These tank systems (of varying composition and style) can be seen throughout the Caribbean and Latin America, and the concept of household intervention is similar to commercial point of use filters common in US households. Traditionally, engineers have been concerned with water quality at the treatment plant, however, studies from large scale distribution systems show that water quality changes are influenced by a variety of factors like residence time in the distribution system, water chemistry, disinfection processes used, breaks in the system, piping materials, and flowrate (LeChevallier et al., 1996; Bessner et al., 2002). This Guyana project shows that in addition to these very technical areas, engineers must also consider household practices and assess member roles in communicating information and setting habits. A recent example of this in the US is captured by Edwards et al. (2009) where a change in the utility's disinfectant resulted in increased lead levels seen in some Washington D.C. households, and this was followed by the widespread distribution of filters and campaigns encouraging residents to flush tap water for 10 minutes prior to use for drinking or cooking.

Interdisciplinary teaming is critically important for implementation of sustainable projects. We formed interdisciplinary teams of graduate students from several disciplines: environmental and civil engineering, public health and geography. This led to a two-course sequence of graduate level classes that integrate teaching of sustainability with research using inquiry-based and experiential learning (Trotz et al., 2009). In Spring 2008, the course focused on “Mercury Issues in Tampa Bay” and, in Spring 2009, the course was “Mercury Issues in Guyana.” The second course included a one-week field experience in Guyana for 10 students, two of whom also included the active gold mining area visited (Mahdia) for their graduate research. Students also visited a biodiversity conservation area whilst in Guyana.

In both classes, students gathered data needed to model this complex human/environmental system through population surveys to evaluate perceived risks from mercury exposure, the sampling and analysis of water quality and sediment samples for mercury loadings, and the collection of social and economic data related to mercury flows into and out of the study areas. In Guyana, previously funded efforts have been undertaken to improve mercury handling at mining sites and WWF-Guianas had recently initiated a vegetation recovery project at a mined out area. When we visited, land recovery efforts were minimal and there was evidence of releases of mine water to local waterways. Survey results are currently being analyzed for separate publication, however they indicate varying degrees of management and worker awareness and attention to handling of mercury at the five mines visited, though the mine managers and/or owners interviewed all stated that retorts were used during recovery to minimize mercury releases. Sediment and surface soil mercury loadings around the five mining sites studied ranged from 29 to 601 ng/g with differences seen between mines which could be attributed to mineralogy of ore and/or management practices. No significant differences were seen between average loadings in mining areas and conservation areas. Continuing work will look at appropriate interventions for improving health and reducing environmental impact of both mining activities and activities of forest communities in conservation areas.

Table 4 shows the project objectives, the traditional measures of performance and additional measures of performance that integrate measures of sustainability into the Guyana projects. For the water supply aspect, the traditional measure of performance is the water quality as the water leaves the treatment plant. Additional measures of performance include impact of storage, cost, education, funding and gender roles. For the mercury project, the traditional measure is the quantity and environmental fate of mercury released. Additional measures compare mercury releases in different areas, assess reduction in human exposure, and evaluate land use changes from mining and other activities given naturally high background levels.

In terms of educational value, one student commented during the assessment that “working [in] interdisciplinary teams did contribute to the learning of sustainability as it allowed for different perspectives to be highlighted that might have ordinarily been missed in a typical Geography, Public Health, or Engineering class. It also allowed [me] to see how different disciplines assess the same issue of sustainability.”

Case Study #3: East Tampa, Florida

East Tampa is a diverse, historically African-American neighborhood located northeast of downtown Tampa (Florida). It encompasses approximately seven square miles, and has approximately 30,000 residents. Primarily residential, it is surrounded by interstate highways and has thirteen neighborhood associations, more than a dozen nonprofit organizations, several hundred small businesses and over a hundred churches. Thirty three percent of the population lies below the poverty line and 48.8% have less than a high school education. In 2004, the City established the East Tampa Community Redevelopment Area (CRA), a tax-increment district created to fund redevelopment of blighted areas and improve the community. Community leaders who serve on the East Tampa Community Revitalization Partnership (ETCRP) recommend ways to invest these funds and are personally involved in improving the quality of life for residents and businesses in the neighborhood.

One of the projects selected for fund-
Many of the ponds were constructed in the 1970’s for flood control with outfalls into McKay Bay or the Hillsborough River (see Figure 3). The beautification project was designed to address social issues, creating community friendly open spaces with exercise paths and seating areas. Stormwater ponds are vital for the control of floodwaters and reducing pollution loads reaching larger water bodies and many community awareness programs strive to reduce pollution in runoff from the built environment (Lehner et al., 1999). Through EPA-funded People, Prosperity and the Planet (P3) Phase I and Phase II grants, Water Awareness Research and Education in East Tampa (WARE) has helped to create a mechanism for building environmental awareness in East Tampa using the stormwater ponds as focal points for K-12, community, and university science and engineering curricula.

WARE includes educational, research and outreach components for both undergraduate and graduate students. Stormwater pond monitoring is integrated into a required upper level undergraduate environmental engineering laboratory each semester and involves the testing of water quality parameters of ponds in East Tampa and on the university campus (Thomas and Trotz, 2009). The data are used to explain various phenomena related to aquatic systems. In order to tie in issues of sustainability, students are placed in the context of the larger project which addresses community engagement and awareness of a local asset – something that all students can personalize given the widespread use of stormwater ponds in Florida and increased interest of students in their immediate surroundings.

Undergraduate and graduate research examines the effectiveness of the ponds in East Tampa on stormwater quantity and quality and the ultimate impact on Tampa Bay, and their data uses and extends the information collected by the undergraduate class. Dissolved orthophosphate concentrations have ranged from 0.8 – 1.7 mg/L and DO levels below 2 mg/L have been observed in some ponds. While connections between high nutrient loads and low DO are well understood, translating that into household practices that reduce nutrient inputs remains a challenge. Dissolved total mercury and copper concentrations were found to be less than 3 ppt and less than 5 ppb respectively, with up to an order of magnitude difference seen in copper concentrations between some ponds. Mercury loadings in sediments of the three East Tampa ponds ranged from 317 to 512 ng/g which is higher than loadings observed for sediments of the Hillsborough river (68 ± 18 ng/g for 18 different sample points) and could have implications for fish concentrations though this has not been measured in the ponds to date. The beautification process has increased access to the ponds and renamed them as community lakes which could encourage residents to fish there. The research students also interact with the local community through attendance at monthly community meetings, weekly classroom visits at elementary schools, local workshops, meetings with government agencies and annual outreach events. Finally, with the assistance of the community and university students, school science teachers are...
developing curricula for their classes. Hence, while a traditional outcome might be improved water quality entering the bay, this project shows that other measures include community awareness and reduced exposure to potential hazards (e.g., mercury) through personal activities (fishing for consumption).

The group is designing educational kiosks for the pond areas that will increase community awareness. Although the ponds are required for controlling stormwater, low impact development (LID) strategies like pervious pavements, green roofs, rain gardens, and rainwater collection have additional potential to reduce stormwater runoff and pollutant loads. Pilot projects testing these strategies have been proposed for future research and their success will depend on the participation of the community members.

Table 5 summarizes some of the additional measures of sustainable performance for current and potential WARE projects which expand the traditional educational and research components of university training. In this case study the traditional measures of performance are related to protecting water quality and dampening the impact of wet weather events on local flooding. Additional measures of performance include linking students involved with the projects with their own personal actions and communities, assessing creation of green space on sustainability social indicators such as community health and happiness, and integrating the community into development and implementation of the project.

The graduate students involved with the WARE project were asked how it influenced their PhD research and career plans, especially in terms of thinking about sustainability. One student said, “The WARE project has reinforced my belief for environmental justice along with the importance of environmental awareness and community involvement. By promoting and implementing sustainability initiatives at the household level, residents can collectively reduce environmental health effects seen in their community. This notion is important in my research in household water treatment and environmental health.” Another student said, “When examining my career goals, I wish to encourage our youth to develop healthy lifestyles through fitness, education, and environmental stewardship. Through my participation in the WARE project, I have been able to effectively communicate concepts that may seem complex to a variety of audiences and recognize the importance of education and engagement starting from students at the primary level who effectively convey information to their home environments.”

<table>
<thead>
<tr>
<th>Category of Significant Learning</th>
<th>Description</th>
<th>Special Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundational Knowledge</td>
<td>Understanding and remembering information and ideas</td>
<td>Provides the basic understanding that is necessary for other kinds of learning.</td>
</tr>
<tr>
<td>Applications</td>
<td>Skills, thinking (critical, creative, and practical thinking), managing projects</td>
<td>Allows other kinds of learning to become useful.</td>
</tr>
<tr>
<td>Integration</td>
<td>Connecting ideas, people, realms of life</td>
<td>The act of making new connections gives learners a new form of power, especially intellectual power.</td>
</tr>
<tr>
<td>Human Dimension</td>
<td>Learning about oneself and others</td>
<td>Informs engineers about the human significance of what they are learning.</td>
</tr>
<tr>
<td>Caring</td>
<td>Developing new feelings, interests, values</td>
<td>When engineers care about something, they then have the energy they need for learning more about it and making it a part of their lives. Without the energy for learning, nothing significant happens.</td>
</tr>
<tr>
<td>Learning how to Learn</td>
<td>Becoming a better student, inquiring about a subject, self-directing learners</td>
<td>Enables engineers to continue learning in the future and to do so with greater effectiveness.</td>
</tr>
</tbody>
</table>

**Table 6: Fink’s Taxonomy of Significant Learning (Fink, 2009)**

**IMPLICATIONS FOR ENVIRONMENTAL ENGINEERING EDUCATION**

The creation of the Environmental Engineering BOK (AAEE, 2009) is a major milestone in integration of sustainability into environmental engineering education and practice. Also important are AAEEs efforts to create a new certification category in sustainability. Importantly, the BOK identified that environmental engineering problems must meet social needs and be sensitive to global implications. The BOK asserts that the document is not static. And thus, the development of the BOK is best considered a continuous process of testing and improvement. The authors of the BOK suggested that as it was implemented, “practitioners and educators evaluate it and determine whether all issues necessary to the practice of environmental engineering have been addressed and whether the outcomes can be achieved at the level recommended at the point in professional development indicated.” Though discussed in some of the case studies, our discussion of sustainability would not be complete without additional discussion of how environmental engineering education must be continuously improved to meet the challenges of local and global sustainability.

In the Environmental Engineering BOK (and other BOKs such as ASCEs, 2008)), learning outcomes are broadly classified as either: 1) fundamental (related to abilities in science, mathematics and areas of discovery and design), 2) essential to the problem-solving process, or 3) professional skills (knowledge and attributes needed to be a successful engineer). In an NSF research grant related to integrating sustainability into environmental and civil engineering curriculum, Zhang et al. (2008) propose that Fink’s Taxonomy of Significant Learning (Table 6) is highly relevant to learning concepts and goals of sustainability. Fink’s taxonomy asks the educator and student learner to take foundational knowledge and apply it to critical, creative problem solving while integrating social system concepts. The taxonomy also acknowledges that to learn, students must change. This emphasis on change is very important because achieving a –sustain-
able future will require that our discipline change how we educate, learn, and practice environmental engineering.

Typical educational learning outcomes are based on foundational knowledge; the understanding and remembering information and ideas and application of this knowledge (that is, skills, creative and practical thinking, and managing projects). Adding the learning outcomes of caring and a human dimension is critical if a balance of societal issues is to become inherent in all environmental engineering education and practice. Caring means that students develop new feelings, interests, and values. The human dimension means learning about oneself and others. To meet the need for educational resources that adopt this new method of learning, a new introductory text for environmental engineering (Mihelcic and Zimmerman, 2010) includes foundational concepts and applications of sustainability, and also includes learning objectives in each chapter that address caring and a human dimension.

Related to the case studies presented here, creating a human dimension and empathy in engineering problem solving is critical to achieving a balance of sustainability that integrates environmental, social, and economic systems. Accordingly, those engaged in sustainable design, where conditions and definition of success may change with time, geography, and culture, will have to continually adapt their designs to new information and often generate new, innovative solutions for a particular situation.

SUMMARY AND CONCLUSIONS

Sustainability is often practically interpreted as mutually advancing the long-term goals of economic growth, societal prosperity, and environmental protection. However, traditional environmental engineering education, research, and practice has not always emphasized the global implications of a specific engineering solution or provided an integrated and balanced social component and human dimension with environmental and economic considerations. Three case studies (Bolivia, Guyana, East Tampa) were presented that show how traditional measures of performance (e.g., function, economics, safety) can be enhanced with integration and balance of societal needs and a global outlook. In the Bolivian case study, appropriate sanitation technology was identified to make minimal demands on human/financial/natural resources, not overburden local water committees, have a negligible energy and water footprint, and be easy to integrate with substantial training of beneficiaries and operators. In the Guyana case study, coupling water quality assessment at the household level with household dynamics and practices were identified as important initial steps to understand potential health implications and interventions needed to improve potable water quality. An interdisciplinary systems level approach was taken to understand the complex human/environmental system dynamics affecting mercury use and human exposure in a developing country and highlighted the need for further work on land use changes on human exposure to mercury. In the East Tampa case study the traditional measures of performance such as protecting water quality and controlling water quantity during storm events were linked to personal actions of students involved with the project in relation to their own communities, the assessment of urban green space creation on sustainability social indicators such as community health and happiness, and the engagement of the local community into development and implementation of the project.

ACKNOWLEDGEMENTS

The National Science Foundation provided support for the Bolivia International Sustainable Development Engineering Research Experience (OISE-0623558). The University of South Florida Graduate School has provided support for the Sustainable Healthy Communities – Mercury in Tampa Bay and Guyana project. The Environmental Protection Agency has provided support for the Water Awareness Research and Education in East Tampa project (P3-SU833946).

LITERATURE CITED


Environmental Engineers

Make a Difference

In the World

The American Academy of Environmental Engineers

Makes a Difference

In Your Career

Join the 2010 Make a Difference Campaign

Encourage a Colleague, Young Professional, or Student to Join the Academy

Membership Drive Rewards

• Five new applicants: 50 AAEE $*

• Ten new applicants: 100 AAEE $*

• Grand Prize: Highest total above 20 new members: $500 (cash)*

*AAEE $s may be redeemed for AAEE merchandise, specialty certification, or dues. New applicants must be “Members”, BCEEs, or BCEEMs. Rewards available to existing “Members”, BCEEs, or BCEEMs. See AAEE.net.

Student Memberships are excluded from Membership Drive Rewards.

Academy Membership Categories

• Board Certified Environmental Engineer (BCEE): Requires PE

• Board Certified Environmental Engineering Member (BCEEM): No PE

• Member: Bachelor’s degree in environmental or related engineering

• Student: Enrolled in environmental or related engineering (free membership)

How to Join

• Download forms at AAEE.net

• Call 410-266-3311

• Application deadline: March 31, 2010
Building A Global Low Carbon Economy

Over the past twenty years, the GLOBE™ Conference & Trade Fair has grown to become one of North America’s largest and longest-running events dedicated to the business of the environment.

Join international business executives, government decision-makers and leaders in environmental innovation in Vancouver this March to address the issues at the heart of sustainable development and environmental management.

Conference Themes:
• Corporate Sustainability Innovation
• Climate Change + Carbon Management
• The Future of Energy
• Financing the Low Carbon Economy
• The Urban Infrastructure Revolution

With sub-themes for:
• Spotlight on Retail
• Water
• Clean Technology
• Auto FutureTech

Sponsors and supporters:

SAVE $200
Register by February 19, 2010

globe2010.com