

Health Effects of Shale Gas Extraction

What is known and
what can we
predict?

Conference hosted by
the University of Pittsburgh Graduate School of Public Health
November 19, 2010 at the University Club, Oakland

Introduction

This conference will explore the science and methodological approaches behind understanding environmental health impacts associated with increasing development of natural gas extraction from shale deposits found under wide geographical areas of the United States.

Natural gas plays a key role in the nation's clean energy future and energy independence. Over the past few years, several key technical, economic, and energy policy developments have spurred increased gas extraction and especially the use of hydraulic fracturing to recover gas over a wider diversity of geographic regions and geologic formations. However, as with any technology that involves management of potentially toxic substances, there have been increasing concerns about the impact of increased hydraulic fracturing and other associated gas extraction procedures on drinking water resources, air quality, public health, and the environment in the vicinity of gas extraction facilities. The United States government has identified a lack of critical research on these impacts and gaps in basic research pertaining to the mobilization of toxic hazards, regional differences in hazards generated, pathways of human exposure, and amounts of exposures that hamper full assessment of health risks from the hazards released during current gas extraction methodologies.

This conference will present the scientific challenges and issues that are being explored by government and academic investigators, as well novel methodologies being employed to assess the health impacts and reduce the hazards produced by gas extraction, refining, and delivery operations.

Conference Agenda

8–8:30 a.m. Check-in and refreshments

8:30–8:40 a.m. Introduction (Donald Burke, MD)

8:40–noon Presentations

8:40 a.m. “Health and Safety Considerations in the Extraction of Fossil Fuels”
(Bernard Goldstein, MD)

9 a.m. “Inorganic Geochemistry of Marcellus Shale Hydrofracturing Waters”
(Carl Kirby, PhD)

9:30 a.m. “Trace Metal Chemistry of the Marcellus Shale”
(Tracy Bank, PhD)

10 a.m. “Unconventional Gas Extraction in Legacy, Energy Production Landscapes: Uncertainties in History, Contamination, and Interactions”
(Dan Bain, PhD)

10:30 a.m. “Water Management Challenges in Marcellus Shale Gas Production”
(John Veil)

11 a.m. “Long-Term and Cumulative Assessment of the Impact of Marcellus Shale Drilling”
(Michel Boufadel, PhD, PE, PHydro)

11:30 Conversation with participants about the gaps in the science and future directions from the morning speakers
(Radisav Vidic, PhD, PE)

Noon–1 p.m. Lunch served in the Gold Room

1–5:30 p.m. Presentations

- 1 p.m. “Air Monitoring Strategies”
(Robert Field, PhD)
- 1:30 p.m. “Addressing Combined Effects of Air Pollution and Social Stressors Exposures on Health in Communities Affected by Natural Gas Fracturing”
(Jane Clougherty, MSc, ScD)
- 2 p.m. “Short-Term Air Quality Impacts from Marcellus Shale Operations in Southwest PA”
(Nick Lazor)
- 2:30 p.m. “Use of Health Impact Assessment (HIA) to Help Inform Decision Making Regarding Natural Gas Drilling Permits in Colorado”
(Roxana Witter, MD, MSPH; John Adgate, PhD; and Jim Rada)
- 3:30 p.m. “Spatial Data Infrastructure for Evaluating the Health Impact of Gas Well Drilling in North Texas”
(David Sterling, PhD, CIH)
- 4 p.m. “Research Methods and Results of the Baseline Socioeconomic Study of the Impact of Marcellus in Pennsylvania”
(Teri Ooms)
- 4:30 p.m. “How Should We Think About the Economic Consequences of Shale Gas Drilling?”
(Susan Christopherson, PhD)
- 5 p.m. Conversation with participants about the gaps in science and future directions in research
(Conrad Dan Volz, DrPH, MPH)

5:30–6:30 p.m. Reception in the Gold Room

Speaker and Moderator Biographies

(in alphabetical order)



JOHN L. ADGATE, *PhD, professor and chair, Department of Environmental and Occupational Health, Colorado School of Public Health, University of Colorado Denver*

John L. Adgate's research on exposure science, risk analysis, and children's environmental health has focused on improving exposure estimation in epidemiologic studies by documenting the magnitude and variability of human exposures to chemical and biological stressors. He has taught graduate-level courses in environmental health, risk analysis, and advanced methods in exposure science. Adgate has served on multiple science advisory panels for the U.S. Environmental Protection Agency as well as NRC/IOM committees exploring technical and policy issues related to residential exposure, air pollution, and public health. He received a BA from Calvin College, an MSPH in environmental science from the School of Public Health of the University of North Carolina at Chapel Hill, and a PhD in environmental health sciences granted jointly by the University of Medicine and Dentistry of New Jersey and Rutgers University.

Presentation title: "Use of Health Impact Assessment (HIA) to Help Inform Decision Making Regarding Natural Gas Drilling Permits in Colorado" (co-presenter with Jim Rada and Roxana Witter)

Abstract: Continued efforts to increase domestic energy supplies has led, in many areas of the United States, to developing natural gas reserves in close proximity to areas of urban density. Garfield County is the epicenter of Colorado natural gas development, with more than 6,000 wells developed during the past seven years as well as continuing exploration. In response to citizen concerns about a proposed natural gas development plan within the town of Battlement Mesa, the Garfield County Board of County Commissioners authorized the Colorado School of Public Health (CSPH) to conduct a Health Impact Assessment (HIA). Building upon previous work and in collaboration with Garfield County Public Health, the CSPH HIA focused on health impacts associated with potential chemical, physical, and social hazards associated with natural gas development. The HIA team utilized stakeholder input, county environmental and social data, and the scientific literature to identify eight areas of health concern, including air quality, water quality, traffic, noise, economic and social conditions, health infrastructure, and accidents/ malfunctions. Recommendations to mitigate the multiple exposures related to gas development were provided to the county decision makers. In addition to the HIA, a pilot study is scheduled that will look at air emissions from a variety of set back distances from drilling and production sites. This pilot builds upon the findings of several studies conducted by Garfield County and will explore exposures at current Colorado regulatory set backs as well as set backs suggested by county citizens. Garfield County serves as an example of how citizens, local public health officials, county government, industry, and academic researchers can develop relationships to facilitate the inclusion of public health into energy policy decision-making.



DAN BAIN, *PhD, assistant professor, University of Pittsburgh, Department of Geology and Planetary Science*

Daniel J. Bain is an assistant professor in the Department of Geology and Planetary Science at the University of Pittsburgh. Before joining the faculty at Pitt, he received his PhD from the Department of Geography and Environmental Engineering at Johns Hopkins University and worked as a National Research Council post-doctoral fellow at the U.S. Geological Survey in Menlo Park, Calif. In general, his research focuses on human-environment interactions and metal cycling, particularly in

urban and fluvial environments.

Presentation title: “Unconventional Gas Extraction in Legacy, Energy Production Landscapes: Uncertainties in History, Contamination, and Interactions”

Abstract: The interactions between environmental systems and natural gas extraction from the Marcellus Shale remain under-characterized. Some of this uncertainty arises from deliberate intent (e.g., the uncertain composition of fracturing fluids), though most uncertainty results from our limited understanding of both the ecological and industrial systems. In particular, landscape managers across the globe are only beginning to understand “legacy effects” that result from historic events or human activities and exacerbate impacts from contemporary activity. This is particularly important in the Marcellus play, as it spatially intersects an area with a long history of energy and industrial production. This production activity substantially alters material fluxes and leaves pockets of contamination throughout the landscape. However, our understanding of how shale-gas-related activities will interact with this legacy is almost nonexistent. For example, what can we predict about the interactions between increasingly saline waters and waste coal deposits? Further, does this interaction pose risks that we need to address? This presentation will explore these complexities in Southwestern Pennsylvania and suggest fundamental steps necessary in characterizing this legacy landscape and understanding the risks generated by these landscape scale manipulations.



TRACY BANK, *PhD, assistant professor, Department of Geology, University at Buffalo*

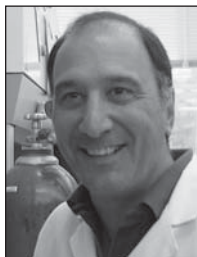
Tracy Bank is an assistant professor in geology at the University at Buffalo. She received her BSc degrees in geology and chemistry from St. Francis Xavier University, an MS degree in economic geology from the University of Nevada, Las Vegas, and a PhD in geochemistry from Virginia Tech. She was employed as a post-doctoral research scientist at Oak Ridge National Lab in the Environmental Sciences Division where she studied geochemical and bioremediation of uranium associated with

cold-war era waste disposal.

Presentation title: “Trace Metal Chemistry of the Marcellus Shale”

Abstract: The Marcellus Shale is naturally enriched in redox sensitive elements such as uranium and zinc. These elements, when exposed to new fluids such as fracking fluids and drilling fluids, may become soluble and mobile. My research investigates the fundamental science of these elements in the Marcellus Shale. I am investigating the physical and

chemical relationships between metals and hydrocarbons in the Marcellus Shale. In particular, my research focuses on water-rock interactions and metal mobilization.



AARON BARCHOWSKY, *PhD, associate professor, Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health*

Moderator

Aaron Barchowsky is also associate professor of pharmacology and chemical biology in the University of Pittsburgh School of Medicine. Barchowsky holds a BS in zoology from North Carolina State University, Raleigh, N.C., and a PhD in pharmacology from Duke University, Durham N.C. He performed a toxicology fellowship at Duke and held faculty positions in clinical pharmacology and pharmacology/toxicology at Thomas Jefferson University, Philadelphia, Pa. (1988–91), and Dartmouth Medical School, Hanover, N.H. (1991–03). The emphasis of his research and teaching is on cellular and molecular signaling in metal-induced pathogenesis and environmental health and disease. Barchowsky's professional and research interests include cell signaling, vascular and pulmonary pathogenesis, mechanistic studies of metal-induced gene and protein expression, mechanistic basis for arsenic action in non-cancer disease, arsenic-induced cardiovascular disease, chromium and nickel pathogenic signaling in the pulmonary epithelium, and free-radical biology and medicine. His work focuses on health impacts of contaminated drinking water and has been supported by the NIEHS to investigate the mechanisms of arsenic induced vascular disease since 2000. He has published numerous articles in leading biomedical and toxicology journals, reviews on vascular effects of arsenic, and book chapters including the chapter on metals and cardiovascular disease in volume 6 of the second edition of *Comprehensive Toxicology* (Elsevier Oxford UK, 2010). He is an associate editor of *Toxicological Sciences* (2007–) and has served on a number of NIH review committees as well as on the U.S. Environmental Protection Agency's Science Advisory Board Arsenic Special Emphasis Panel for Cancer (2005–09).



MICHEL BOUFADEL, *PhD, PE, PHydro, professor and chair, Department of Civil and Environmental Engineering; director, Center for Natural Resources Development and Protection, Temple University*

Michel Boufadel is a professional engineer (environmental engineering) in the Commonwealth of Pennsylvania, and a professional hydrologist as accredited by the American Institute of Hydrology. Boufadel's area of expertise is environmental hydrology and hydraulics, where he develops methods to understand the behavior of complex hydrologic and environmental systems. He has been the lead researcher on various projects funded by the Oil Spill Research program within the U.S. Environmental Protection Agency. He is currently investigating the lingering effects of the Exxon Valdez oil (1989) in the beaches of Prince William Sound, where he and his team conducted field studies on various beaches and are exploring remediation technologies for dealing with the

20-year old spill. He is associate editor of the *Journal of Water Quality, Exposure and Health*. The work of Boufadel has been reported in various media outlets such as the *New York Times*, the *Washington Post*, and the BBC World News, Fox news, CBS, and numerous international media outlets. Boufadel is author of numerous articles in publications such as *NATURE Geoscience*, *Environmental Science and Technology*, *Journal of Geophysical Research*, *Journal of Environmental Engineering* (ASCE), *Environmental Geology*, *Journal of the American Water Resources Association*, *Journal of Contaminant Hydrology*, and *Journal of Stochastic Environmental Research and Risk Assessment*.

Presentation title: “Long-Term and Cumulative Assessment of the Impact of Marcellus Shale Drilling”

Abstract: The Marcellus Shale formation is around 7,500 feet deep and underlies 60 percent of Pennsylvania along with the neighboring states of West Virginia, Maryland, and New York. The extraction of natural gas from the formation has attracted great attention within the past year due to the expected wealth and environmental concerns. This prompted various responses in terms of aggressive monitoring and regulations. We argue that while such measures are necessary, they might not be sufficient, and that one needs to consider also the long-term and cumulative impact of hydrofracking. We present hydrogeologic scenarios to illustrate our viewpoint.



DONALD S. BURKE, MD, dean, University of Pittsburgh Graduate School of Public Health, and UPMC-Jonas Salk Chair in Global Health

Host

Donald Burke is dean of the Graduate School of Public Health, director of the Center for Vaccine Research, and associate vice chancellor for global health at the University of Pittsburgh. He is also first occupant of the UPMC-Jonas Salk Chair in Global Health. A native of Cleveland, Ohio, Burke received his BA from Western Reserve University and his MD from Harvard Medical School. He trained in medicine at Boston City Hospital and Massachusetts General Hospital and in infectious diseases at the Walter Reed Army Medical Center. Throughout his professional life he has studied prevention and control of infectious diseases of global concern, including HIV/AIDS, influenza, dengue, and emerging infectious diseases. He lived for six years in Thailand, worked extensively in Cameroon, and conducted field epidemiology and vaccine studies in numerous other developing countries. He has approached epidemic control using strategies “from the bench to the bush.” Burke has been at the University of Pittsburgh for four years. He now leads a trans-disciplinary team that develops computational models and simulations of epidemic infectious diseases and uses these simulations to evaluate prevention and control strategies. He also serves on the Allegheny County Board of Health where he chairs the Air Toxics Guidelines Committee. Last year he was elected to membership in the Institute of Medicine of the National Academies.



SUSAN CHRISTOPHERSON, *PhD, professor, city and regional planning, Cornell University*

Susan Christopherson is J. Thomas Clark Professor in the Department of City and Regional Planning at Cornell University. She is an economic geographer (PhD from the University of California Berkeley) whose research focuses on economic policy and economic development.

Her recent book, *Re-making Regional Economies: Labor, Power and Firm Strategies in the Knowledge Economy* (Routledge, 2007, coauthored with Jennifer Clark) addresses barriers to regional economic development in the U.S. economy. It won the 2009 best book award from the Regional Studies Association. Her work in the field of economic development has focused on strategies for revitalizing the New York State economy. In the past five years, she has completed policy studies on: (1) economic development via targeted workforce development; (2) a clusters strategy to build the photonics industry; (3) the role of universities and colleges in revitalizing regional economies; and (4) production trends affecting media industries in New York City. She is currently directing a study of the economic consequences of natural gas drilling in New York and Pennsylvania, funded by the Park Foundation and the Heinz Foundation. She is a consultant to the Organization for Economic Cooperation and Development (OECD) program on higher education and regional economic development and has carried out international economic development research in Mexico, Israel, China, Jordan, Italy, and Spain. Christopherson frequently speaks to civic groups about economic development issues, and her work has been cited in the *New York Times*, *Boston Herald*, *Chicago Reader*, *Rochester Democrat and Chronicle*, *Rochester Business Journal*, and *Albany Times Union* as well as through interviews on U.S. national and local radio and television.

Presentation title: “How Should We Think About the Economic Consequences of Shale Gas Drilling?”

Abstract: In New York and Pennsylvania, public concerns about shale gas drilling for natural gas have revolved primarily around its environmental impact, particularly its effects on water quality. This is the central issue addressed in the Supplemental Generic Environmental Impact Statement (SGEIS) being developed by the New York State Department of Environmental Conservation. The draft SGEIS, released in 2009, takes as given that, while environmental protections are important, natural gas is an asset that will produce significant economic benefits for New York’s economy, reducing natural gas costs and providing for long-term economic development. To fully understand the economic consequences of shale gas drilling, I focus on a set of questions regarding the pace, scale, and geographic distribution of natural gas drilling. The pace and scale of drilling will affect the cost of natural gas in Pennsylvania and New York and in the United States as a whole. They will also affect the costs to local communities where drilling occurs and the capacity of those communities to respond to the demands on local services produced by drilling. Finally, the speed and scale of the production cycle associated with shale drilling will affect the ability of the state and the drilling region to capture any of the economic expenditures and job creation that may derive from shale gas drilling. The ability to derive long-term economic development benefits is critical to justifying the economic costs and environmental risks associated with drilling.



JANE CLOUGHERTY, MSc, ScD, *assistant professor, Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health*

Jane Clougherty joined the faculty of the Department of Environmental and Occupational Health in October 2010. She completed her doctoral work at the Harvard School of Public Health in 2006, and held a joint post-doctoral position with HSPH and the Yale School of Medicine. Prior to joining the GSPH faculty, she worked as the senior air quality scientist at the New York City Department of Health and Mental Hygiene, managing a large study on year-round intra-urban variation in multiple pollutants throughout New York City communities. Her work focuses on the interface between chronic stressors and air pollution exposures in both community and occupational settings.

Presentation title: “Addressing Combined Effects of Air Pollution and Social Stressors Exposures on Health in Communities Affected by Natural Gas Fracturing”

Abstract: Natural gas fracturing activity in rural communities can lead to a range of distributed air pollution exposures. In addition to direct emissions from natural gas sources, changes in land use and traffic activity in affected communities may increase exposures to diesel exhaust and related air pollutants. Finally, the rapidly changing character of affected communities, given rapid population increase and uncertainty about pollution exposures, may increase stress experiences within affected communities. Nascent research in the field of environmental epidemiology suggests that chronic stress exposures may alter individual susceptibility to pollution exposures. I will discuss recent research findings related to the combined effects of stressor and pollution exposures on health, and suggest methods for examining the combined distributions of air pollution and stressor exposures across a community.



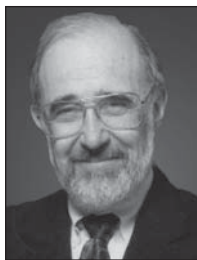
ROBERT FIELD, PhD, *associate research scientist, Department of Atmospheric Science, University of Wyoming*

Robert Field obtained his PhD at Imperial College, London, in 1995. His thesis, “The Sources and Behavior of Selected Urban Air Pollutants,” was used to inform the establishment of the United Kingdom’s National Ambient Air Quality Standards for benzene and 1,3-butadiene. In the late 1990s at the National Environmental Technology Center he helped to develop the UK National Hydrocarbon Network. This work saw the creation of a cradle to grave approach for handling, validating, and publishing real time concentrations of volatile organic compounds. This data was used to determine national control strategies for ozone pollution levels. He was also a UK government representative on a European working group that considered equivalence of diffusive sampling. In 2002, after helping to develop the curriculum of the School of Environment and Natural Resources at the University of Wyoming (UW), he returned to Europe to work for the European Reference Laboratory of Air Pollution based in Italy. He co-managed, along with national health and environment agencies, the Population Exposure to Air Pollutants in Europe (PEOPLE) project. This research at the European Commission’s Institute for Environment and Sustainability assessed the applicability of

regulatory monitoring sites as indicators of population exposure to air pollution. In 2006 he returned to UW and established a mobile laboratory to assess the emerging issue of wintertime ozone in Sublette County. This ongoing work initially considered the scope of ozone episodes, but is now focused on ambient methane behavior and the spatial and temporal trends of ozone precursors.

Presentation title: “Air Monitoring Strategies”

Abstract: Volatile organic compounds (VOCs) in ambient air are of concern due to their potential toxicity and their role as ozone precursors. Although precursors themselves are not regulated through the Clean Air Act, acceptable ambient levels of ozone and other pollutants are determined through National Ambient Air Quality Standards. Non-compliance necessitates development of corrective air quality management. Elevated ozone levels are a function of meteorological conditions and emission sources and have been most often associated with urban areas in the summer. In 2005 wintertime ozone was found to be a new phenomenon in Sublette County, Wyoming. Ozone episodes are associated with specific meteorological conditions and local oil and gas development. The Wyoming Department of Environmental Quality has instigated a wide range of monitoring and modeling studies. The University of Wyoming helped determine the scope of ozone episodes through large-scale passive sampling surveys performed through collaboration with stakeholders, including local, county, state, and federal authorities along with energy companies and citizens. A mobile laboratory has also provided important information at locations not covered by established monitoring sites. This laboratory is equipped with an on-line gas chromatographic system for measuring trace levels of VOC species. A two-year project started on November 1 will determine spatial and temporal variations to inform emission inventories and input data for ozone models. Assessment of air quality issues related to the Marcellus shale development will require a consideration of the impact of pollutant emissions upon background air quality levels and should incorporate monitoring and modeling approaches.



BERNARD GOLDSTEIN, MD, professor, Department of Environmental and Occupational Health, and past dean, University of Pittsburgh Graduate School of Public Health

Bernard Goldstein a physician, board certified in internal medicine, hematology, and toxicology. Goldstein is author or co-author of more than 150 publications in the peer-reviewed literature. He is an elected member of the National Academies of Science Institute of Medicine and of the American Society for Clinical Investigation. His experience includes appointment as assistant administrator for research and development of the U.S. Environmental Protection Agency, 1983-1985. He has chaired more than a dozen National Research Council and IOM committees, including currently serving as the chair of the NRC Committee on Sustainability at EPA. He has been president of the Society for Risk Analysis, is currently editor-in-chief of the Scientific Committee on Problems of the Environment (SCOPE), and has served as a member or chairperson of numerous U.S. government and WHO committees, including chairperson of the NIH Toxicology Study Section and EPA’s Clean Air Scientific Advisory Committee.

Presentation title: “Health and Safety Considerations in the Extraction of Fossil Fuels”

Abstract: The public health approach to fossil fuel extraction begins with the precautionary assumption that we humans eventually will use virtually all fossil fuel resources on the planet, with the only limitation being technical feasibility and competitive costs with other sources of energy. Incorporating full regard to the health and safety of workers and the public requires much more attention that has yet been given. I will review some of the international and national problems with fossil fuel extraction, including disasters and the insidious longer term effects of exposure to fossil fuel components as a result of extraction processes. I will also consider the interface between ecological and human health.

The Gulf oil disaster provides many lessons pertinent to exploring the Marcellus Shale. In the lingo of public health, what happened in the Gulf was an incident, not an accident. It was fully preventable not only by the appropriate use of technology but, of greater importance, by a safety culture that was egregiously lacking. Although the oil may have stopped flowing, the impact will continue. The direct toxicological consequences of worker and public exposure to crude oil will be less than the psychosocial impact and the longer term ecological effects that also impose human health risks. Particularly pertinent to Marcellus Shale activities, and to overall reform of the U.S. Toxic Substances Control Act, is the negative impact on the public and on governmental decision making of the lack of information about the dispersant. A repetitive overall theme from fossil fuel extraction throughout the world is that this activity occurs not just in a specific geographical area but in a social and cultural milieu.



CARL KIRBY, PhD, professor, Department of Geology, Bucknell University
Carl S. Kirby is the department chair and leads the Bucknell University Marcellus Shale Initiative (MSI). He is an aqueous environmental geochemist and has taught at Bucknell since 1993. Kirby's research has focused on municipal solid waste ash, mine drainage chemistry and treatment, and acid deposition and its interactions with rock and soils, with a special emphasis on geochemical modeling. Kirby and his undergraduate research students have recently focused on Marcellus Shale fracwater chemistry, and they will submit this work for peer review soon.

He is cooperating with U.S. Geological Survey personnel to publish data on radioactivity of brines associated with the Marcellus formation. The MSI is nearly ready to launch a Web site initially dedicated to providing the scientific community and the public with a comprehensive list of references (peer-reviewed articles, conference proceedings, industry and government reports) with brief summaries and availability information. This list will include a guide to understanding the weight and reliability of different types of publications. The MSI also plans to significantly expand this Web site into an up-to-date clearinghouse on numerous Marcellus-related issues. Kirby is in demand as a speaker with an objective scientific view of numerous Marcellus-related issues. He has spoken extensively at meetings and conferences designed to better inform the public about the risks and benefits of drilling for Marcellus Shale gas reserves.

Presentation title: "Inorganic Geochemistry of Marcellus Shale Hydrofracturing Waters"

Abstract: Hydrofracturing of the Marcellus formation shale for production of natural

gas requires large volumes of water for injection fluids, and it produces large volumes of very saline flowback or frac water that requires deep well injection for disposal or non-conventional wastewater treatment and sludge collection before discharge into the environment. Injected water mixes with oil-field brines and/or dissolves salts from the shale, dramatically changing the original water chemistry. We analyzed inorganic chemicals in five flowback water samples and gathered 85 chemical analyses (from PA Department of Environmental Protection, private sources, conference proceedings, and the Marcellus Shale Coalition) of flowback water. The waters are pH 5 to 8 Na/Ca/Cl dominated brines with TDS ranging from 1,850 to 345,000 mg/L. Salinity usually increases with flowback time. Titrations lacking distinct inflection points suggest that most alkalinity is due to naturally-occurring organic acids. Ba and Sr concentrations are as high as 26,800 and 5,230 mg/L, respectively. Positive correlations with TDS follow the order: Cl > Na > Ca > Br > Mg ≈ Spec Cond ≈ Sr > Hardness > K ≈ Li. SO₄, acidity, and alkalinity range from 5 to 2920, -210 to 1230, and 24 to 800 mg/L, respectively and show no correlation with TDS. These waters have a wide range of radioactive constituents, with gross alpha and 226Ra as high as 19,200 and 4,180 pCi/L. Durov diagrams comparing major cation/anion constituents, pH, and TDS are presented, as are spatial distribution maps of 15 parameters for flowback water collected at > 90 days after hydrofracturing.

NICK LAZOR, *chief, Air Quality Monitoring Division, Pennsylvania Department of Environmental Protection*

Nick Lazor has 16 years of environmental experience in the air quality field, including several years in air toxics monitoring. He has a BS in environmental science from Slippery Rock University. He currently manages a staff of 32 and is responsible for the operations and maintenance of the Commonwealth of Pennsylvania Ambient Air Monitoring Network.

Presentation title: “Short-Term Air Quality Impacts from Marcellus Shale Operations in Southwest PA”



TERI OOMS, *executive director, The Institute for Public Policy and Economic Development*

Teri Ooms was appointed executive director of the Institute for Public Policy and Economic Development (Joint Urban Studies Center—JUSC) in 2004. The institute is a think tank that provides essential research, analysis, and consultation to cities, counties, non-profits, school districts, institutions, and businesses. The principal purpose of the institute is to increase the capacity of organizations to solve their own problems and become thriving and sustaining entities. The ultimate goal is to create a better quality of life and standard of living for the community. In 2006, Ooms was appointed as an associate research fellow with the Pennsylvania State Legislature Office of Research. Her appointment was renewed in 2008. From 1997 to 2004, Ooms served as president/CEO of the Inland Empire Economic Partnership (IEEP), Riverside, Calif., and of its two sister companies. IEEP is responsible for the regional marketing, attraction, and recruitment of new business to the region; the expansion and retention of existing business; film, tourism, and high tech regional development; and workforce collaborative, research center, legislative

advocacy, and the Small Business Center (SBDC). While she was president/CEO, IEEP produced more than \$1 billion in new investments to the community and created more than 10,000 new jobs. Ooms is a cum laude graduate of the University of Scranton with a BS in public administration and an MBA in finance.

Presentation title: “Research Methods and Results of the Baseline Socioeconomic Study of the Impact of Marcellus in Pennsylvania”

Abstract: The purpose of this project was to assess the current social and economic conditions relating to gas well development in the Marcellus Shale formation in Pennsylvania, with the goal of obtaining baseline data for future longitudinal assessment of subsequent community changes that occur in Appalachian counties. The study consisted of: (1) A survey of residents living in the Marcellus region that was mailed to a sample of households within selected Appalachian counties in Pennsylvania to ascertain current views of residents concerning gas industry development in their areas and to obtain information about their perceptions of their communities; (2) Interviews with key informants, consisting of approximately 60 elected and appointed leaders, representatives of human service and educational agencies, and civic organizations, in five Pennsylvania counties (Lackawanna, Luzerne, Westmoreland, Greene, and Susquehanna) and five counties in other shale-rich states (Texas and Arkansas) to ascertain their perceptions of current and future economic, social, and environmental impacts associated with large scale natural gas development.



JIM RADA, *public health manager, Garfield County, Colorado*

Jim Rada has worked as a local public health official for almost 30 years. As a registered environmental health specialist, his career has taken him from his beginnings in suburban Chicago through metropolitan Denver to the tourism community of Summit County, Colorado, and on to his current assignment as environmental health manager for Garfield County Public Health in Western Colorado. Garfield County immediately presented Rada with many new challenges. In 2005, as a community that previously had no environmental health component to its public health department, Garfield County faced enormous environmental health challenges resulting from a rapidly expanding natural gas industry, along with the impacts of the associated community growth. The community began to raise many questions about the environmental and community health impacts of this burgeoning industry in a previously rural area of Western Colorado. Rada’s work over the past five years has focused on gaining a greater understanding of these impacts, including establishing an ambient air quality monitoring network, managing a community health risk analysis of oil and gas industry impacts, and implementing a health impact assessment project to assist local land use officials and elected leaders in incorporating health impacts into local land use decision making processes.

Presentation title: “Use of Health Impact Assessment (HIA) to Help Inform Decision Making Regarding Natural Gas Drilling Permits in Colorado” (co-presenter with John Adgate and Roxana Witter)

Abstract: Please see description under John L. Adgate.



DAVID STERLING, PhD, CIH, chair, Department of Environmental and Occupational Health, University of North Texas Health Science Center School of Public Health

David Sterling has been the department chair at UNTHSC in Fort Worth, Texas, for the past two years. Prior to that he was at the Saint Louis University School of Public Health since 1993, and was the director for the Division of Environmental and Occupational Health since 2000. He has more than 25 years of experience as a principal and co-investigator

on federally, state, and foundation funded projects working in low income and diverse communities such as the St. Louis metropolitan area; Herculaneum, Joplin, and St. Francis counties of Missouri; and internationally in La Oroya, the Mantaro River Valley of Peru, and a monastery in Greece. The majority of these studies were for establishing methodologies for environmental exposure assessment, developing sampling protocols and collection instrument design, and performing program evaluation. Additional recent research areas have been related to air pollution and asthma in children utilizing EPA Supersite monitoring and hospital emergency department discharge data in St. Louis, Mo.; the association of welding and manganese exposure with Parkinsonism; and asbestos exposure and disease progression outcomes.

Presentation title: “Spatial Data Infrastructure for Evaluating the Health Impact of Gas Well Drilling in North Texas”

Abstract: The Barnett Shale is a geological formation that the Texas Railroad Commission (TRC) estimates to extend 5,000 square miles in parts of at least 21 Texas counties.

Prominent regions of this are in densely populated urban and suburban metropolitan areas of North Texas. Although drilling for gas began as early as the 1970s mostly in rural locations, much of the drilling operations for gas since 1999 have been in these populated areas, which now consists of more than 12,000 wells and the associated operations. In the past two years there has been a quickly growing controversy on the impact of these operations in densely populated areas. Although there were indications of uncontrolled air releases in 2007, the first documented measurements of potential chemical air releases, such as benzene, outside of the drilling site were in May 2009. A series of private and local city sporadic monitoring followed of air, water, and potential health outcome measures. These sporadic activities continue. To enable a more systematic approach for evaluating potential environmental and health impacts, an interdisciplinary team from the University of North Texas (UNT), and the UNT Health Science Center (UNTHSC) are developing a spatial data infrastructure that links disparate spatio-temporal data obtained from a variety of federal state agencies and private sources. This system will improve the ability for evidence-based decision-making by providing access to multiple linked data resources and spatial data services including query, visualization, and data analysis capabilities. This presentation discusses the history leading up to this development and the challenges for using existing information for evaluating impact and decision-making.



JOHN VEIL, *manager and senior scientist, Water Policy Program, Argonne National Laboratory*

John Veil analyzes a variety of energy industry water and waste issues for the Department of Energy. Veil has a BA in earth and planetary science from Johns Hopkins University, and two MS degrees—in zoology and civil engineering—from the University of Maryland. Before joining Argonne, Veil managed Maryland’s programs for industrial water pollution control permitting through the National Pollutant Discharge Elimination System (NPDES) and Underground Injection Control (UIC).

Veil also served as a faculty member of the University of Maryland, Department of Zoology for several years. Veil has been recognized by the Society of Petroleum Engineers as a distinguished lecturer in 2008–09, and as the recipient of the 2009 International Award for Health, Safety, Security, Environment and Social Responsibility. Veil has published many articles and reports and is frequently invited to make presentations on environmental and energy issues.

Presentation title: “Water Management Challenges in Marcellus Shale Gas Production”

Abstract: Natural gas production in the Marcellus Shale region is expanding rapidly. The Marcellus offers hope of substantial energy resources and economic benefits, but also creates various environmental and societal issues. State agencies face new challenges in managing and regulating a growing number of wells. New policies and regulations continue to evolve (e.g., Pennsylvania’s August 2010 revisions to discharge regulations for oil and gas wastewater). The regulatory environment is contentious and evolving. Opponents of gas drilling, landowners hoping to gain substantial income from leasing mineral rights, gas companies, and politicians seeking jobs for their constituents will continue to debate how and where gas should be produced within the Marcellus region. This presentation describes several types of water issues that arise from shale gas development in the Marcellus Shale. Those issues include controlling the stormwater runoff from disturbed areas, obtaining sufficient freshwater supply to conduct hydraulic fracturing (frac jobs) on new wells, and managing the flowback water and produced water from the well. The presentation includes data, where available, and many photographs taken during visits to several well sites.



RADISAV D. VIDIC, *PhD, PE, professor of environmental engineering, civil and environmental engineering, Environmental Engineering Group, University of Pittsburgh*

Moderator

Radisav D. Vidic is William Kepler Whiteford Professor of Environmental Engineering and chairman of the Department of Civil and Environmental Engineering at the Swanson School of Engineering, University of Pittsburgh. Vidic holds a BS in civil engineering from the University of Belgrade (1987) and received his graduate education in civil and environmental engineering from the University of Illinois (MS 1989) and University of Cincinnati (PhD 1992).

His research efforts focus on advancing the applications of surface science by providing fundamental understanding of molecular-level interactions at interfaces, development of novel physical/chemical water treatment technologies, water management for Marcellus shale development, and reuse of impaired waters for cooling systems in coal-fired power plants. Vidic has published more than 150 journal papers and conference proceedings on these topics. He received the 2000 Professional Research Award from the Pennsylvania Water Environment Federation for his research accomplishments and dedication to the profession, was a Fulbright Scholar in 2003–04 and was elected by the Pittsburgh section of American Society of Civil Engineers as 2008 Professor of the Year.



CONRAD DAN VOLZ, *DrPH, MPH, director and principal investigator, Center for Healthy Environments and Communities; director of the Environmental Health Risk Assessment Certificate; and assistant professor, Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health*

Moderator

Conrad Dan Volz has a secondary appointment as an assistant professor in the School of Law and is a technical consultant to the University of Pittsburgh Environmental Law Clinic. Volz has more than 30 years of experience in occupational-environmental health. He received his initial training in public and occupational health in the Department of Occupational Health at GSPH on a fellowship from the U.S. National Institute for Occupational Safety and Health. Volz holds MPH and DrPH degrees from GSPH. After holding progressively responsible posts in private industry (National Steel Corporation), government (California OSHA Consultation Service), and non-governmental agencies (Western Institute for Occupational and Environmental Health Sciences, Berkeley, Calif.), Volz started an environmental health consulting company in 1984. He has worked in 24 countries on five continents performing radionuclide transport studies, occupational/environmental contaminant/toxin exposure pathway analysis, exposure assessments, environmental risk assessments, and engineer and policymaker training. He joined the faculty of GSPH in May 2004. The Center for Healthy Environments and Communities is conducting research in the Marcellus Shale region to determine levels of metals, anions, and organic chemicals in effluent from sewage treatment plants accepting gas production brine water; and organic chemicals in air volatilized from gas production operations. The center has co-developed a Web-based, geo-located tool to track public health, environmental, ecological, social, and behavioral impacts from oil and gas production called fractracker.org. FracTracker is being piloted in the Marcellus Shale region but is being used throughout the country where stimulation technology is currently used to produce oil and gas.



ROXANA WITTER, MD, MSPH, *assistant research professor,
Department of Environmental and Occupational Health, Colorado School of
Public Health*

Roxana Witter is the principal investigator for the Health Impact Assessment for Natural Gas Drilling in Battlement Mesa, Colo., and was the principal author of a white paper and literature review looking at potential exposure-related health effects of gas development. Witter is the course director of Environmental and Occupational Toxicology in CSPH. In the past, she has worked in the community as a clinician in occupational medicine and as medical director for a Denver-based international corporation.

Presentation title: “Use of Health Impact Assessment (HIA) to Help Inform Decision Making Regarding Natural Gas Drilling Permits in Colorado” (co-presenter with John Adgate and Jim Rada)

Abstract: Please see description under John L. Adgate.

Steering Committee

- Aaron Barchowsky, PhD, associate professor, Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health
- Conrad Dan Volz, DrPH, MPH, director and principal investigator, Center for Healthy Environments and Communities; director of the Environmental Health Risk Assessment Certificate; and assistant professor, Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health
- John Stolz, PhD, professor, Department of Biological Sciences, Duquesne University; director, Center for Environmental Research and Education (CERE), Duquesne University

Conference Planners

- Charles Christen, DrPH, MEd, director of operations, Center for Healthy Environments and Communities, University of Pittsburgh Graduate School of Public Health
- Samantha Malone, MPH, CPH, communications specialist, Center for Healthy Environments and Communities, University of Pittsburgh Graduate School of Public Health; doctoral student, University of Pittsburgh Graduate School of Public Health
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