19TH Annual
Maryland Ground Water Symposium

Session Guidebook
Wednesday, September 29, 2010

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ABSTRACTS
OF
PRESENTATIONS

19TH ANNUAL
MARYLAND GROUND WATER
SYMPOSIUM

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2010 Symposium Abstracts

MORNING SESSION ONE
10:20 am – 10:50 am

Paleochannels, Lithology, and Aquifer Interaction Characterized using Surface Geophysical Methods at the Standard Chlorine of Delaware Superfund Site
Michael J. Brayton, USGS
(Embassy Room)

The U.S. Geological Survey (USGS), in cooperation with the U.S. Environmental Protection Agency (EPA), Region III and the State of Delaware is studying the water quality and hydrogeologic properties of the Columbia and Potomac aquifers and the extent of cross-aquifer contamination with benzene, chlorobenzene, 1,2-dichlorobenzene and 1,4-dichlorobenzene at the Standard Chlorine of Delaware, Inc. Superfund Site near Delaware City, Delaware. Surface geophysical surveys and well data were used to identify and correlate low-permeability units (clays) across the site and to search for high-permeability zones (sand and gravel filled paleo-channels) that are potential conduits and receptors of contaminated groundwater.

Direct current (DC) resistivity surveys were made in linear sections over large areas of the site where electrically conductive cultural features (buried pipes, fences, etc) were absent. In some areas, a decrease in measured resistivity in sediments was interpreted as groundwater having elevated (i.e., an order of magnitude difference) specific conductance (SC) over ambient conditions. Where SC data is not available for groundwater from wells, it is impossible to know if a low measured resistivity is due to the geologic material (clay) or elevated groundwater SC (in sand or gravel). Seismic surface waves that are used as part of the Multi-channel Analysis of Surface Wave (MASW) technique are not affected by water content or quality and were used to distinguish between sand and clay to a depth of approximately 20 meters, the typical maximum depth of the surficial aquifer. The maximum depth of investigation using DC resistivity surveys is approximately 70 meters, which allowed for investigation of the upper Potomac aquifer. Through concurrent interpretation of DC resistivity and MASW surveys, insight was gained about water-quality and lithology over large areas at this contaminated site.

Elevated SC is associated with contamination of the surficial (Columbia) aquifer and is a surrogate for detecting contaminated groundwater at the site. In areas where confining units are known to be absent (from drilling), resistivity measurements have shown direct evidence of groundwater mixing between aquifers, particularly to the north where the Potomac aquifer appears to sub-crop along Red Lion Creek. The effect of elevated SC pore water on resistivity measurements in sediments was further evaluated in a controlled setting by measuring the resistivity of “fresh” drill.

The Marcellus Shale Play – Water Resource Issues in Pennsylvania
Kevin J. Breen, U.S. Geological Survey
(Regency Room)

Water-resource issues are coming to the fore as rapid growth in development of unconventional shale gas sweeps across rural areas in several Mid-Atlantic States. Local infrastructure and state regulatory programs are trying to adjust to the growth. What are the most important water-resource issues for shale-gas development from a federal science perspective? This presentation will address the question by discussing the need to:

- Report water-use data in a consistent manner;

- Provide, to the extent possible, accurate stream flow data for real-time monitoring of withdrawal thresholds and improving stream flow statistics by
  1) analyzing gaps in network design for stream flow-gaging stations, and
  2) establishing "type areas" for water availability by hydrogeologic setting;

- Characterize baseline quality and quantity of groundwater and surface water in a consistent manner;

- Establish early-warning capabilities for anomalous conditions;

- Characterize gas, fluid, and rock samples from the Marcellus Shale and other bedrock and unconsolidated strata; and

- Offer continuing education on hydrologic tools available for water-management decisions.

Examples and lessons learned from the Pennsylvania perspective will be discussed.

Bay Restoration Fund and Best Available Technology for Nitrogen Removal
Shan Abeywickrama and Joshua Flatley, Maryland Department of the Environment
(Maryland Room)

There are approximately 420,000 septic systems in Maryland. Of these, 52,000 systems are located within the "Critical Area," land within 1,000 feet of tidal waters. The typical septic system does not remove nitrogen, instead delivering about 30 pounds of nitrogen per year to the groundwater. An upgraded, nitrogen-removing septic system cuts a system's nitrogen load in half. The Maryland Department of the Environment has upgraded over 2,000 septic systems to nitrogen removing Best Available Technology (BAT) through the Bay Restoration Fund (BRF) Onsite Sewer Disposal System (OSDS) grant program.

Your Well Field – Do You Really Know What You Have?"
Cameron Warlick, HydroSource Associates, Inc.
(Wayne Room)

Existing groundwater well systems are sometimes owned and operated with little understanding about their construction history, historical pumping records, and water quality. The sustainable yield of existing sources is often unknown or over exaggerated. This can lead to overproduction of the aquifer system, which can result in permanent loss of productive capacity of the wells. In other instances, existing well fields may underutilize the aquifer system within which they are installed. In these cases, existing wells may be rehabilitated, improved or new wells may be constructed to better utilize the potential of the aquifer system providing additional source capacity, and at very low cost since new pumping, treatment, storage, and land and water conveyance infrastructure is not required.

HydroSource Associates, Inc. (HSA) is a multi-disciplinary group of scientists and water resources professionals that specialize in the evaluation, development, management and protection of groundwater supplies. HSA utilizes a systematic investigative process to thoroughly evaluate the condition of existing well fields. This process involves the

verification/definition of well construction and hydraulic performance, a review of pumping and water chemistry records, well/aquifer testing and analysis of groundwater-surface water interaction, aquifer recharge, and source sustainability, as necessary. The result of this process is the quantification of the rate of extraction a well field is capable of supporting, and development of recommendations as to how to improve yield, water quality and/or efficiency of the system. This approach has been proven to be applicable to any hydrogeologic environment.

The discussion will focus on two fractured bedrock case studies. One led to substantial improvement in well field performance and water quality. In the other case, it was determined that the sketchy history led the new owner to believe the wells were high yielding. A proper assessment demonstrated that they were not. Where improvements to existing wells were determined to be possible, recommendations were used by the water system owners to conduct actual improvements that add from several hundred thousand to as much as two million gallons per day of new groundwater resources to their existing systems. Where the well field evaluations indicated full or over utilization of the groundwater source was already occurring, the results prevented wasted investment of system funds to further develop groundwater sources in these areas.

MORNING SESSION TWO
11:00 am – 11:30 am

Simulation of Groundwater Flow to Assess Future Withdrawals Associated with Base Realignment and Closure (BRAC) at Fort George G. Meade, Maryland
Jeff P. Raffensperger (presenter); David C. Andreasen, Maryland Geological Survey (co-author)
U.S. Geological Survey
(Embassy Room)

Increased groundwater withdrawals from confined aquifers in the Maryland Coastal Plain to supply anticipated growth at Fort George G. Meade and surrounding areas resulting from the Department of Defense Base Realignment and Closure Program may have adverse effects in the outcrop or near-outcrop areas. Specifically, increased pumping from the Potomac Group aquifers (principally the Patuxent aquifer) could potentially reduce base flow in small streams below rates necessary for to maintain healthy biological communities. Additionally, water levels may be lowered near, or possibly below, the top of the aquifer within the confined-unconfined transition zone near the outcrop area.

A three-dimensional groundwater flow model was created to incorporate and analyze data on water withdrawals, streamflow, and hydraulic head in the region. The model is based on an earlier model (Andreasen, 2007) developed to assess the effects of future withdrawals from well fields in Anne Arundel County, Maryland and surrounding areas, and includes some of the same features, including model extent, boundary conditions, and vertical discretization (layering). The resolution (horizontal grid discretization) of the earlier model was not designed to simulate the effects of withdrawals on the outcrop and near-outcrop areas.

The model developed for this study included a block-shaped higher-resolution local grid, referred to as the child model, centered on Fort Meade, which was coupled to the coarser-grid parent model using the shared node Local Grid Refinement capability of MODFLOW-LGR. A more detailed stream network was incorporated into the child model. In addition, for part of the transient simulation period, stress periods were reduced in length from 1 year to 3 months, to allow for simulation of the effects of seasonally varying withdrawals and recharge on the groundwater-flow system and simulated streamflow. This required revision of the database on withdrawals and estimation of seasonal variations in recharge represented in the earlier model. The model was re-calibrated by adjusting riverbed conductance within the refined part of the model. The RMSE values for the parent and child model were 8.72 and 11.91 feet, respectively. The calibrated model provides a tool for future forecasts of changes in the system under different management scenarios, and for simulating potential effects of withdrawals at Fort Meade and the surrounding area on water levels in the near-outcrop area and base

Water Resources – Issues Associated with Marcellus Gas Drilling Activity in Pennsylvania
Bryan Swistock, School of Forest Resources, Penn State University
(Regency Room)

Marcellus gas drilling activity has generated numerous questions and concerns about impacts on water resources of Pennsylvania. Unlike traditional gas well drilling in Pennsylvania, Marcellus drilling uses much larger amounts of freshwater in excess of three million gallons for each well. The location and timing of water withdrawals to meet this demand must be carefully

planned to limit impacts on aquatic biota and other water users. The large water use also results in several hundred thousand gallons of waste fluids that must be carefully collected, transported and treated to protect surface and groundwater supplies. Proper collection and disposal of waste fluids are especially important to protect the one million private water wells and springs that provide drinking water for over three million residents of the state. Finally, the location of drilling is important to protect surface streams and groundwater, especially during high flow periods. This presentation will discuss each of these issues including the current state regulations related to each topic and voluntary measures that landowners can perform to protect their water resources.

Site Evaluation and Onsite System Design Strategies for Severe Sites/Large Flows
Tom W. Ashton, American Manufacturing
(Maryland Room)

Severe soil receiver sites with minimal separation to limitations present site characterization and design challenges for wastewater dispersal often not addressed in prescriptive guidelines. The site evaluator/soil scientist/designer must consider the attributes and limitations of an individual site and the various design tools available in formulating a successful system design strategy. Large flow systems, where large volumes of wastewater are dispersed to individual landforms, have similar considerations.

Utilizing the boundary design methodology approach and the mass loadings outlined in the *On-Site Wastewater Treatment Systems Manual*, Chapter 5 Treatment System Selection, (U.S. Environmental Protection Agency. EPA/625/R-00/008 Washington, D.C.: 2002) as the format, fundamental elements of soil evaluation, site characterization, and system design will be reviewed in regards to sites with one or more limiting features.

Traditional infiltrative surface loading rates, as well as corresponding area (hydraulic footprint) loading sizing, will be calculated and presented for Maryland with comparison to the EPA loading rates and neighboring states. Instantaneous dosing will be discussed as the best mythology to apply and recycle wastewater constituents into the natural system. Summaries of recent and current research will be presented regarding nutrients, emerging chemical, and microbial constituents. The concept of landscape linear loading (gallons per topographic contour linear foot per day, saturated flow) as it is applied to shallow horizontal boundary sites will be discussed with an emphasis on utilizing the “Tyler” chart as tool in estimating the risk of the most limiting condition of a site. Evaluation of Saturated Hydraulic Conductivity data will be discussed including the three step approach as out lined in Additional Materials for Inclusion with Water Movement and Soil

Treatment Module: 1. Designing Wastewater Disposal Systems, 2. Designing Large Septic Systems and, 3. Examples of Three-Step Hydrologic Analysis, By Aziz Amoozegar, PhD, North Carolina State University Soil Science Department: CIDWT Model Decentralized Wastewater Practitioner Curriculum, Water Movement and Soil Treatment, Anderson, Gustafson and Amoozegar.

Maintaining Well and Pump System Efficiency
Neil Winner, Maryland Department of the Environment Water Supply Program
(Wayne Room)

Maintaining the efficiency of wells and pumping systems will reduce costs through efficient operations, help prevent emergency breakdowns, allow scheduling and budgeting for routine

repairs, and help to "drought-proof" your well system. This will be a "hands on" presentation that will cover the general topics of: well system efficiency, well development, step-rate and constant-rate pumping tests, operational expectations, recordkeeping, periodic maintenance, performance loss symptoms and causes, well cleaning and rehabilitation methods, and pump maintenance and repair. Well and pump system efficiency begins with appropriate well design and pump selection, continues with proper well drilling, construction and development methods, and is maintained by proactive preventive maintenance and routine service and recordkeeping.

The presentation will cover both bedrock wells and wells in unconsolidated formations. The uses and types of well pumping tests, including step-rate and constant-rate tests, will be discussed especially within the context of well efficiency and safe pumping rates. The role of good recordkeeping and periodic maintenance with respect to operational expectations will also be presented. Decreased system efficiency will result in performance loss. The symptoms of performance loss and their causes will be discussed in detail, including when it is time to do something about it and what short-term adjustments may help. A detailed discussion of well rehabilitation methods will include routine physical and chemical methods, as well as newer innovative approaches that have been used successfully in recent years. The effects of incomplete treatment will also be discussed. The last part of maintaining well system efficiency will address proper pump operations, maintenance and repairs. The presentation will demonstrate the benefits of maintaining well system efficiency, which include improved well yields and pumping levels, decreased pumping costs, improved water quality, and extended life of well and pumping equipment.

MORNING SESSION THREE
11:40 am – 12:10 pm

An Overview of Ground Water in Maryland
David W. Bolton, Maryland Geological Survey
(Embassy Room)

The occurrence of groundwater in Maryland is largely dependent on the subsurface geology in which it is found. The aquifers consisting of unconsolidated sediments of the Coastal Plain, for example, will store and transmit groundwater very differently from the fractured crystalline bedrock of the Piedmont. As a result, aquifers in the varied regions of the state will respond differently to drought and excessive pumping, and will be susceptible to contamination in different ways. This talk will introduce the fundamental concepts of groundwater, with emphasis on groundwater settings we have in Maryland. Topics for discussion will include the hydrologic cycle, porosity, permeability, recharge, water table versus confined aquifers, and cones of depression. Methods of investigation including water-level measurement, geophysical well logs, pump tests, and groundwater flow models will be covered. In addition, challenges to our groundwater supply including drought, drawdown, and saltwater intrusion will be discussed.

Drilling for Gas in the Marcellus Shale Formation in Maryland
Molly Edsall, Maryland Department of the Environment Mining Program
(Regency Room)

Natural gas drilling in the Marcellus Shale is currently very active in the Appalachian region of the country with over 1,000 wells drilled in Pennsylvania alone. There is also interest in Maryland in the western counties of Allegany and Garrett. MDE is currently reviewing four applications with at least two of them likely to come to a final decision during the summer of 2010. The permitting process in Maryland is a coordinated effort at MDE but also involves other state agencies and local government that have interest. Locations of water withdrawal and waste water discharge are primary concerns. Public safety is also an important issue. The local geology, the permit review process and the evaluation of data are current and relative topics for discussion.

Septic Systems and Wells in Karst Soils
Barry Glotfelty, Maryland Department of the Environment Wastewater Permits Program
(Maryland Room)

The presentation discusses soil and geologic conditions that occur in karst topography and their relationship to the performance of sewage disposal systems and water supplies. The vulnerability of wells to contamination in these areas is discussed along with a case study concerning the trials and tribulations in the development of an artesian well as a water supply for an individual residence.

Planning and Communicating Regulatory Approaches to Meet Drinking Water Needs
John Gray, New Jersey Department of Environmental Protection
(Wayne Room)

Groundwater supplies the drinking water needs of tens of millions of people throughout the eastern seaboard. The unending combinations of stakeholders, geologic conditions, and

demographics between urban, suburban, and rural communities make groundwater management a vital regulatory interest. Not only is groundwater a drinking water source, but it contributes to local and state economic viability. This presentation will summarize metrics and goals for gauging performance efficiency, as well as ways to better coordinate between stakeholders within water quality regulation.

AFTERNOON SESSION ONE
1:30 pm – 2:00 pm

Developments in the Groundwater Level Monitoring Networks in the Maryland Coastal Plain

Heather Quinn, Maryland Geological Survey

(Embassy Room)

A statewide groundwater monitoring network in key aquifers in Maryland has been maintained for many years to help manage and protect the State's water resources. In addition to the statewide network, there are a number of regional and county networks that have been established to provide more detailed information in these areas. Data collection and funding for the networks are handled cooperatively between State, Federal and local agencies. Water-level data are maintained in the U.S. Geological Survey, National Water Information System (NWIS) database, and are published annually. The data are used for multiple purposes, including monitoring rates of water-level decline, calibration of groundwater flow models, and drought monitoring.

In 2002, the Maryland Water Monitoring Council (MWMC) organized a multi-agency workgroup to evaluate the adequacy of the network and begin redesigning the network, as appropriate. In the same year, a statewide drought focused attention on water resources and, in response, the Governor established an Advisory Committee the Management and Protection of Maryland's Water Resources. The 2004 report by the Governor's Advisory Committee emphasized the need to have adequate monitoring data sustained. The report, which incorporated work by the MWMC workgroup, made specific recommendations regarding the location and number of wells, stating that the network should be increased from about 140 to about 240 monitoring wells.

Since 2004, several factors have highlighted the need for additional review of the Coastal Plain portion of the statewide monitoring network. In some areas, Coastal Plain aquifers need to be better characterized or defined (e.g., interconnection, extent, hydraulic characteristics); in other areas, the effects of current withdrawals need to be further evaluated. Information on the hydrogeologic framework, aquifer water levels and groundwater withdrawals is being compiled into a GIS-based Maryland Coastal Plain aquifer information system (AIS). A preliminary version of the AIS has been developed to facilitate water resource management and planning and it also helps to identify areas that need additional groundwater monitoring and aquifer data.

Potential wells that could be incorporated into the state monitoring network to fill data gaps include production wells that are coming off-line; current production wells; and unused observation wells. Existing wells will be evaluated for suitability. A number of new observation wells are being drilled, logged and pump-tested this year to evaluate aquifer characteristics in specific locations; these wells are being added to the state network. The goal is to have enough suitable wells in the state network to adequately monitor Coastal Plain aquifers over the long term and to collect at least two years of water level measurements semi-annually (nearly synoptically) for use in a regional groundwater flow model that will be developed beginning in 2011.

Enhanced Remediation of Chlorinated Solvents from Contaminated Groundwater Using a Bioreactor System
Charles Walker (presenter); Michelle M. Lorah (co-author), U.S. Geological Survey
(Regency Room)

A bench-scale test is being performed to determine the feasibility of using a bioreactor system to remove chlorinated solvents from extracted groundwater at Aberdeen Proving Ground, Maryland. To enhance biodegradation, the bioreactor supports WBC-2, an anaerobic microbial consortium developed by the U.S. Geological Survey that can degrade a wide range of common industrial chlorinated organic solvents. Previous tests have shown that bioaugmentation with WBC-2 was effective in enhancing biodegradation of chlorinated solvents in subsurface applications, but its use in an above-ground bioreactor has not been previously tested.

To enable simultaneous testing of different operational variables, two identical 3-liter experimental bioreactor systems with a polyurethane foam and polypropylene support matrix were constructed and seeded with WBC-2. Concentrations of chlorinated solvents, pH, concentrations of nutrients, and indicators of oxidation-reduction potential were measured at different points along the bioreactor system to determine the progress of biodegradation. Testing was performed to determine optimal hydraulic retention time and the electron donor and nutrient amendments needed to enhance microbial activity and efficient degradation of the chlorinated solvents in the bioreactor. To achieve lower operational costs in a full-scale treatment plant, corn syrup and corn starch packing peanuts were evaluated as alternative electron donors to replace the more costly lactate.

Negative oxidation-reduction potentials (ranging from about -300 to -500 mV) were quickly established throughout the operating bioreactors, despite the aerobic well water entering the system. Results showed that as much as 95 percent of the chlorinated solvents in the influent water were removed by the last sampling port at retention times between 14 and 16 hours in each of the bioreactor systems. Both corn syrup and corn starch packing peanuts were effective as electron donors. With influent concentrations of parent compounds ranging between 800 and 900 micrograms per liter (µg/L), the total concentrations of daughter compounds at the last sampling port in the bioreactor remained between 10 and 45 µg/L when stable chlorinated solvent degradation was attained. The total concentration of chlorinated volatile organic compounds exiting to the waste effluent was less than 100 µg/L, which would meet the National Pollutant Discharge Elimination System permit requirements for the treatment plant. The ability of WBC-2 to grow using a broad range of contaminants, donors, and substrates provides versatility for groundwater-remediation applications.

Managing Onsite Systems from Cradle to Grave
Eric Evans, OnlineRME, LLC
(Maryland Room)

All over the world, septic system installations have been subjected to a "set-it-and-forget-it" approach. Studies have shown that, in the U.S., unmanaged onsite systems fail at rates of up to 25 percent, causing adverse public health effects and costing communities millions of dollars in watershed clean-up. Yet regulators run into political opposition, logistical problems, and fiscal barriers when they try to implement sustainable management programs. And even if they succeed, onsite professionals then have to cope with differing management guidelines and logistics, from jurisdiction to jurisdiction. This presentation describes innovative approaches on how to overcome these barriers. It also describes models of successful programs that -- through

private-public partnerships -- have reduced failure rates of decentralized wastewater inventories below two percent.

A Collaborative Water Resources Element Process
Brenda Dinne, Carroll County Bureau of Comprehensive Planning
(Wayne Room)

In 2006, legislation (HB 1141) was passed which required local jurisdictions to develop and adopt a Water Resources Element (WRE) to their comprehensive plans. The purpose of the WRE is to ensure that future county and municipal comprehensive plans consider the demand and availability of public water supply and wastewater, as well as improve water quality in our streams, reservoirs, and the Chesapeake Bay. For Carroll County, this element of the Master Plan raises some very concrete challenges to address in planning for the County's future.

Carroll County and its municipalities worked together to develop one joint WRE that could be adopted by all of Carroll County's jurisdictions. Coordination on plan development occurred through the County's Water Resources Coordination Council. With calculation of existing and projected demand and capacity as base information, the jurisdictions conducted several technical assessments to identify groundwater availability, wastewater limitations, water supply options, and nonpoint source load estimates.

Strategies to address the challenges faced by Carroll County's jurisdictions in each of these areas are included in the adopted WRE plan document. A countywide section includes strategies that apply to all eight participating jurisdictions. Strategies that specifically relate to the individual systems are contained in separate sections.

The presentation will review the coordination process, the methods for estimating demand and capacity, the technical assessments conducted, and how the plan document was developed.

AFTERNOON SESSION TWO
2:10 pm – 2:40 pm

Estimating Hydraulic Capture Using Universal Kriging with Hydrologic Drift Terms
Mathew Tonkin and Rachel Shannon, S.S Papadopulos & Assoc., Inc
(Embassy Room)

The extent of hydraulic capture (capture zone) is often estimated when developing wellhead protection areas for supply wells, or as part of an evaluation the effectiveness of a pump-and-treat remedy. A common approach for these estimates is to interpolate water level measurements from wells onto a regular grid, producing a map of the groundwater elevation surface. Capture zones are then determined using particle tracking across the calculated grid. The interpolation method most frequently used for this type of analysis is kriging, in which the estimated value at a grid node is based on measured values at neighboring points, weighted by the distance to each point. The gradient across the site may also be incorporated as a linear trend. Several applications- e.g., Surfer and ArcMap- include kriging capabilities; however, they produce poor estimates in areas where water levels deviate from the overall trend. Specifically, the effects of extraction or injection wells, rivers, and ponds are not well represented, which can result in significant over- or under- estimation of capture zones.

A method is presented which combines universal kriging (kriging with a trend) with analytical expressions that describe the effects of these internal sources and sinks, and produces a more accurate groundwater elevation map. This method can be implemented using the free software application KT3D_H20, which performs both kriging and particle tracking, and provides a map-based user interface implemented in MapWindow GIS. If capture zones change over time, for example in response to seasonal groundwater level fluctuation or changes in pumping rates, multiple capture zone maps may be generated and combined into a single depiction of overall capture, a capture frequency map (CFM).

An example is presented that illustrates groundwater elevation maps, calculated capture zones, and a CFM prepared using the methods and software described.

Evaluation of Bioremediation Feasibility in a Wetland Using Passive Samplers
Michelle M. Lorah, U.S. Geological Survey
(Regency Room)

Wetland areas typically contain a high diversity of microorganisms and range in redox conditions that can allow organic contaminants to be degraded through natural or enhanced bioremediation methods. The U.S. Geological Survey used two types of passive samplers—peepers and *in situ* microcosm devices called MICRO-Tracs— to conduct a preliminary investigation of the feasibility of bioremediation for a wetland area at a Superfund site in Delaware City, Delaware, impacted by contaminated groundwater discharge and past spills of mixtures of chlorinated benzenes. The use of passive samplers is beneficial especially in finer-grained wetland sediments where the collection of pore water samples by other methods tends to disturb *in situ* conditions through groundwater/pore water pumping or physical removal of contaminated sediment. To obtain detailed vertical profiles of the redox conditions and contaminant distribution in the wetland groundwater, 4-foot long peepers that contain 22 rows of sampling ports were pushed into the wetland sediment at four sites and left to equilibrate through passive diffusion for two weeks before sampling. Three sets of MICRO-Tracs devices

were deployed for eight weeks at two sites to evaluate natural attenuation (unamended device), biostimulation (device amended with lactate as an electron donor), and bioaugmentation (device amended with lactate and the anaerobic microbial culture WBC-2 that contains known chlorobenzene degraders). Two additional MICRO-Trac devices, a natural attenuation treatment and a bioaugmented treatment, were loaded with ^{13}C-labeled monochlorobenzene and deployed at one site to evaluate its degradation and incorporation of ^{13}C in carbon dioxide or microbial cell material (biomass).

Peeper results showed that shallow groundwater in one area of the wetland had high ferrous iron, sulfide, and methane concentrations indicative of highly reducing conditions, whereas a second area was characterized by high sulfate concentrations that apparently inhibited development of reducing conditions. Relatively low concentrations of trichlorobenzenes and dichlorobenzenes compared to monochlorobenzene and benzene were evident in the area with highly reducing conditions, indicating that anaerobic biodegradation of the more chlorinated compounds to monochlorobenzene and benzene was occurring. In contrast, concentrations of trichlorobenzenes and dichlorobenzenes were relatively high in the high sulfate area where aerobic conditions were present. MICRO-Trac results from the high sulfate area showed no evidence of degradation of tri- and dichlorobenzenes in the unamended (natural attenuation treatment) or the biostimulated treatment, but bioaugmentation with WBC-2 produced methanogenic conditions and apparent degradation of the tri- and dichlorobenzenes. Loss of ^{13}C-monochlorobenzene was approximately the same under oxic conditions (66 percent loss) and under methanogenic conditions (69 percent loss) induced by the addition of lactate and WBC-2 in the bioaugmented treatment. Different degradation mechanisms for the ^{13}C-monochlorobenzene were indicated by the partitioning of ^{13}C primarily into biomass under the oxic conditions compared to more partitioning of ^{13}C into carbon dioxide under the methanogenic conditions. This study shows the utility of passive samplers and indicates that biodegradation is feasible at this site under a range of redox conditions, warranting further bioremediation investigation.

Recirculating Media Filters for Wastewater Treatment for Groundwater Protection
Mark Gross, Orenco Systems, Inc.
(Maryland Room)

This presentation addresses how modern advances in wastewater treatment understanding and microelectronics have allowed media filters to be more effective at removing organic and particulate contaminants and nutrients prior to dispersal into the soil environment. Modern media filters can be either single-pass or multiple-pass filters and in either configuration, they use micro dosing over the media. The small, frequent doses supply nutrients to the biomass attached to the media, while creating unsaturated, aerobic conditions in the filter. The result is the ability to optimize the treatment processes within the filter and within the system. Recirculating the processing tank dilutes the incoming wastewater and the filter footprint area required for treatment can be greatly reduced.

With the advent of more efficient media, the filter footprint has been reduced further; making modern recirculating media filters small, unobtrusive wastewater treatment systems for residential applications. These systems allow for the natural treatment processes that would traditionally occur in the soil to now occur and be controlled with some flexibility in the media filter container. That results in protecting the soil, and allowing the soil to not have to be used as the media for removing organic and particulate contaminants from the wastewater stream. Combining modern recirculating media filters with pressure-dosed dispersal systems protects

the groundwater and also creates the opportunity to use sites that otherwise would be unsuitable for traditional soil dispersal systems.

Water Allocation in the Piedmont Region of Maryland
Lyn Poorman, Maryland Department of Environment Water Supply Program
(Wayne Room)

In 2008, the Maryland legislature passed Senate Bill 674, which allows MDE to give priority to municipalities in Carroll, Frederick, and Washington Counties when allocating water. MDE has been working with a stakeholder group to develop regulations for implementing this law, which is intended to protect Maryland's water resources in the Piedmont region while supporting the denser growth desired in priority funding areas. This presentation will provide background on this issue, and an overview of the workgroup's proposed strategy for meeting the intent of this law.

AFTERNOON SESSION THREE
2:55 pm – 3:25 pm

Careful Hydrogeologic Evaluation May Protect Against Unfair and Baseless Domestic Supply Impact Allegations
Mark W. Eisner, P.G. and David L. Pielmeier, Advanced Land and Water, Inc.
(Embassy Room)

Natural gas reserves within the Marcellus Shale occur beneath groundwater supply aquifers often marginal in capacity and variable in quality. Water supply well owners may have lived with some combination of marginal and chronic conditions for years. Such conditions may include, but are not restricted to, drought susceptibility, low yield, surface water influence, poor natural quality and anthropogenic contamination by petroleum, bacteria and/or other sources. Not uncommonly in rural and economically stressed areas, such well owners may lack the financial means to address these chronic conditions themselves.

A new and well-capitalized exploratory drilling program in the neighborhood may be viewed as an opportunity to seek remuneration for costs to investigate and remedy a pre-existing condition. Consciously or otherwise, such groundwater supply well owners may represent their circumstance sympathetically. In some cases, the easiest solve may be for Marcellus interests to acquiesce to the allegation and assume the cost of addressing such problems.

However, dangerous precedents can be established in the eyes of local regulators, other neighbors and the public as a whole. Accepting responsibility for a truly pre-existing well problem may also entail obligations to address chronic health problems and/or property devaluation issues, which may arise consequently.

This presentation will review and discuss low-cost, minimally invasive objective methods for professionally assessing allegations of domestic water supply impacts borne of neighboring land uses, activities and resource drilling, and testing and extraction practices.

A Holistic View of Petroleum Recovery System Optimization
Forest D. Arnold, Maryland Department of the Environment Oil Control Program
(Regency Room)

Historically, petroleum recovery systems have been lengthy undertakings performed with a long period of groundwater and soil vapor extraction and treatment. Typically, when the system has reached an asymptotic level of recovery it is followed by one or more trial system shutdowns, when there is often a rebound of contamination during post remediation monitoring. Contamination that cannot be addressed with the existing recovery system is often haphazardly addressed with: addition of sparge points, enhanced fluid recovery with a vacuum truck (EFRs), surfactant treatments, wicking, and hand bailing. This process can be protracted and expensive, but does not need to be if the system operation is dynamic and takes into account lessons learned from a quarter of a century of operating these systems.

With many older systems, the initial system design was based upon limited gauging and sampling data, field readings from a small number of well logs, and possibly a short-term pilot test based upon a rudimentary site conceptual model, if at all. In many cases systems were designed around several hastily installed emergency recovery well locations that may not have

been properly spaced or have an appropriate screened interval. Typically, the remediation system is operated continuously in the hope of removing enough pore volumes to reduce the plume mass and dewater the smear zone to provide for effective soil vapor extraction. Newer polishing technologies, if used at all, are used late in the project life cycle.

The traditional approach does not take into consideration the limitations of technologies for different phases of petroleum contamination. Petroleum contaminants can be thought of in four different phases to be addressed after a release: (1) mobile liquid phase hydrocarbons (LPH); (2) residual phase where most of the LPH are bound in the formation; (3) high dissolved phase groundwater concentrations; and (4) low dissolved phase groundwater concentrations. Each of these phases require different technologies, but all of them require some type of periodic hydraulic control.

Although sampling and performance data is routinely collected during the operation of the recovery system, the patterns in the data are often not carefully assessed with an updated site conceptual model to determine when to perform targeted additional site delineation and to move on to the next remediation technology to address a different phase of petroleum contamination. Careful analysis of system performance data provides the opportunity to assess long term capture zones, the presence of dead zones and hot spots, or challenging formation intervals. This data, along with additional source zone delineation using the latest direct push tools can be used to update the site conceptual model and optimize the system performance.

Diversity of Water Use in Maryland
John Grace, Maryland Department of the Environment Water Supply Program
(Maryland Room)

Water use in Maryland varies widely across the state. This presentation will present an overview of the quantities of fresh water used for various purposes throughout the state in relationship to the available sources. Permitted quantities are compared with actual uses for 2009 by category. Surface water is the principal supply for Central and Western Maryland while groundwater use dominates in Southern Maryland and the Eastern Shore. Public supply and thermoelectric use are the largest categories of use statewide. Regionally, agricultural use is the most dominant use on the Eastern Shore while industrial use is the largest demand for Western Maryland. On an annual basis, fresh water water use in Maryland in 2009 was about three to four percent of the total fresh water inflow to the Chesapeake Bay. Permittted fresh water use is estimated to be 40 percent of the lowest monthly freshwater inflow to the Bay.

Point of Entry Disinfection Strategies
Larry Zinser, Master Water Conditioning
(Wayne Room)

This session will present, discuss and analyze current strategies to disinfect residential water treatment systems at the point of entry. The threat from microbes will be reviewed and then the utility of various disinfection strategies will be assessed (1) for efficacy as a biocide, (2) for compatible with human health, (3) for costs to consumers, and (4) for their impact upon the ecology. Included will be discussion of filtration, chemicals, ozone, ultraviolet light and heat as disinfection strategies. From this comparison, suggestions will be presented for the most effective disinfection technologies. This presentation is intended to provide the participants with current information and clear comparisons with which to make intelligent decisions for point of entry disinfection strategies.

AFTERNOON SESSION FOUR
3:30 pm – 4:00 pm

Zone of Influence, Texas Quarry
Peter A. Yencsik, Maryland Department of the Environment, Mining Program
(Embassy Room)

In 1994 The Maryland General Assembly passed legislation, which required the Maryland Department of the Environment (MDE) to establish zones of dewatering influence (ZOI) around carbonate quarries in karst terrane. Mining companies are responsible for water supply replacements of water supplies (domestic, commercial, industrial). Today, 17 of the 18 applicable quarries have had a ZOI established with only one remaining, The Lafarge Texas Quarry, located in Cockeysville Maryland. The Texas Quarry is nearly a century year old, a marble, dolomite, calcite quarry that lies within the Cockeysville Marble Geologic Formation and is situated in a very urban environment. Methods used in the compilation of the ZOI for the Texas Quarry included; Stream Gauge (Padonia Creek, Goodwin Run, Beaver Dam Creek) Data, quarry monitoring well data, field report data (sinkholes), Geologic Mapping, GIS Mapping, watershed, topographical analysis. A broad understanding of several historical literature reviews covering the local; geology, hydrology, precipitation data and historical data were also analyzed. The ZOI for the Texas Quarry is 810 acres in size. The western boundary of the ZOI is bounded by a geologic contact between the Cockeysville Marble and the Rush Brooke Member of the Loch Raven Schist. The northern boundary of the ZOI parallels the southern banks of Beaver Dam Creek, until the stream intersects the Maryland Transit Authority's Light Rail Bed. The ZOI offsets the rail beds 20 to the east until the tracks intersect Beaver Dam Road. The eastern boundary parallels Beaver Dam Road. The southern boundary of the Texas Quarry ZOI parallels Padonia Road and is underlain by several abandoned underground mine shafts.

Microconstituents on the Regulation Horizon
Simin Rezai, Maryland Department of the Environment Water Management Administration
(Regency Room)

The presence of pharmaceuticals in water was known as far back as the 1970s when lipid regulators were detected in wastewater. Due to the advent of advanced analytical instrumentation and techniques, many more pharmaceuticals have been detected in drinking water. Researchers found small amounts of medications in landfill leachate, which can eventually pollute groundwater. The results of this study indicate that even properly disposed of pharmaceuticals may find their way into the drinking water supply.

The EPA evaluated approximately 7,500 chemicals and microbes before narrowing it down to 116 substances on the latest contaminant candidate list (CCL3). The list shows the EPA recognition of the growing problem of microconstituents, which find their way into treated drinking water. For instance, there are five perfluorinated alkyl acids on the EPA third Unregulated Contaminants Monitoring Regulation (UCMR3) list, which was unveiled on April 7, 2010. In the year between 1999-2000 and 2003-2004, the geometric mean of perfluorononanoic acid (PFNA) increased from 0.5 ppb to 1.0 ppb in the U.S. population.

This is a presentation on the state of knowledge on emerging contaminants in water and innovative treatment technologies with emphasis on the recent regulatory status in this regard.

Maryland's Water Reuse Regulations
Ching-Tzone Tien, Maryland Department of the Environment Wastewater Permits Program
(Maryland Room)

Maryland Department of the Environment (MDE) is in the process of establishing regulations to promote water use. The regulation promulgation process is divided into two phases. Phase I is to amend the existing "Guidelines for Land Treatment of Municipal Wastewater" and Phase II is to establish the water reuse (purple pipe) regulations.

The Guidelines are referenced by the Code of Maryland Regulations (COMAR) and is a legally enforceable document. Phase I amendment incorporates the requirements for irrigating highly treated Class III wastewater effluent into existing guidelines. Irrigation of Class III effluent onto public access areas may include parks, play grounds, school yards, cemeteries, highway landscaping and other green open spaces. The proposed Phase II water reuse regulations include the requirements for residential and commercial water reuses such as lawn irrigation, flushing toilets and urinals in commercial buildings, fire fighting for commercial buildings, decorative fountains, commercial laundries, artificial snow making for commercial outdoor usage, commercial car wash, and landscaping.

A review committee consisting of 25 members from consulting firms, environmental groups, various State and local agencies meet regularly to discuss requirements to be included in the amendment and the water regulations. The Phase I guideline amendment was completed on May 3, 2010 with a Notice of Final Action published in the Maryland Register on April 23, 2010. Preparation of the Phase II water reuse regulations is currently in progress and is expected to be completed in 2011. The processes in establishing the regulations and the proposed regulations will be introduced in this presentation.

POSTER BOARD PRESENTATION

Maryland Coastal Plain Aquifer Information System

David Andreasen, Maryland Geological Survey
Mark Nardi, U.S. Geological Survey
Andy Staley, Maryland Geological Survey

Effective management of groundwater resources requires the ability to efficiently access and manage pertinent hydrogeological data resources. In Maryland, a considerable knowledge base exists to support management decisions. However, the information tends to be dispersed throughout numerous reports, maps, and file sources that are difficult to link together electronically. Accessing the most up-to-date and comprehensive information may be time-consuming and problematic. In 2009, the Maryland Geological Survey and the U.S. Geological Survey, with funding support from the Maryland Department of the Environment (MDE), introduced a GIS-based aquifer information system (AIS) for the Maryland Coastal Plain and adjoining areas to centralize and serve basic groundwater data to the MDE Water Supply Program for use in groundwater-appropriation permit review. The system serves an additional function by providing hydrogeological-framework data for future development of a regional Coastal Plain groundwater-flow model. The AIS and groundwater-flow model are both part of a long-term multi-phase science plan for comprehensive regional assessment of the Maryland Coastal Plain aquifer system. The plan was developed in response to recommendations of the 2004 Maryland Advisory Committee on the Management and Protection of the State's Water Resources.