28th Annual

MARYLAND GROUNDWATER SYMPOSIUM

Session Guidebook

Thursday, September 26, 2019

MARYLAND DEPARTMENT OF THE ENVIRONMENT

Maryland
Department of
the Environment

Welcome to the 28th Annual Maryland Groundwater Symposium. MDE is proud to provide this excellent educational and networking opportunity for groundwater professionals. We are honored to have well-respected and renowned professionals speaking to us about their fields of expertise. We are also appreciative of the Environmental Protection Agency Region III, whose financial support allows us to keep registration costs affordable for all participants.

Many challenges arise in the protection and use of groundwater every year. Contaminants are discovered at new locations, climate variability poses uncertainty on our established water management strategies, water levels may decline in some of our major aquifers, accidental spills may occur, and conflicts may develop among competing water users. Our goal for this symposium is to provide a forum to learn from each other and be prepared to face these challenges.

Whether we are employed in Federal or State agencies, local governments, water utilities, as consultants, in private industry or academia, we all share a common goal of protecting and conserving this most valued resource. The annual Groundwater Symposium highlights the State's coordinated effort to collaborate on water resource management issues.

We sincerely hope you enjoy the Symposium today. Thank you for all the hard work you do throughout the year. We hope you realize the positive impact you are making on the preservation of the State water resources

Sincerely,

Saeid Kasraei
Administrator
Water Supply Program

Morning Plenary: Embassy Room

9:00 – 9:15 a.m.	**Welcome and Opening Remarks**
9:15 – 10 a.m.	**Managing Ground and Surface Water in an Increasingly Complex and Dynamic Environment** *Peter Goodwin, Ph.D., University of Maryland Center for Environmental Science*
10 – 10:45 a.m.	**EPA's PFAS Action Plan** *Rick Rogers, U.S. Environmental Protection Agency Region III*

Break | 10:45 – 11:05 a.m.

Morning Session One | 11:05 – 11:35 a.m.

NVF-Yorklyn Project
John G. Cargill, IV, P.G., Delaware Department of Natural Resources and Environmental Control
Maryland Room

Simulated Effects of Sea-Level Rise on the Shallow, Fresh Groundwater System of Assateague Island, Maryland and Virginia
Phillip Goodling, U.S. Geological Survey
Regency Room

Factors Affecting Bacterial Occurrence and Variability in Drinking Water Wells
Bryan Swistock, Penn State University, Department of Ecosystem Science and Management
Embassy Room

Morning Session Two | 11:45 a.m. – 12:15 p.m.

Application of Thermal Remediation at Brandywine DRMO
William Burris, P.G., Air Force Civil Engineer Center
Maryland Room

Using Groundwater Flow Model to Evaluate Impacts of Sea Level Rise on Saint Jones River Water Shed, Delaware
Changming He, Ph.D., Delaware Geological Survey
Regency Room

Road Salt Contamination in Groundwater and Surface Water in the Maryland Piedmont
Tiffany VanDerwerker, Maryland Geological Survey
Embassy Room

Lunch | 12:15 – 1:30 p.m.

CERTIFICATES FOR THE 28TH ANNUAL MARYLAND GROUNDWATER SYMPOSIUM

Thank you for attending the 28th Annual Groundwater Symposium. You will receive an e-mail from gws@mcet.org within two weeks of this event with a link to MDE's Program Evaluation Survey.

Once you complete the evaluation you will be able to download a certificate of attendance for this program. **The link will be available for three weeks and certificates will ONLY be available after completion of the survey and during this timeframe.**

Please add gws@mcet.org to your e-mail address book to ensure receipt of this e-mail.

Afternoon Session One | 1:30 – 2 p.m.

Cloud-Based, Automated Remote Monitoring and Management of Stormwater Injection Well Use in Karst Terrain: A 10-Year Case Study
Jim L. Lolcama, P.G., KCF Groundwater, Inc.
Maryland Room

Utilizing HACCP in a Carbon-Based Treatment Process for Managed Aquifer Recharge
Jeremy T. Hise, P.E., Hazen and Sawyer
Regency Room

Molecularly Characterizing Septic System Effluent to Develop New Wastewater Tracers
Michael Gonsior, Ph.D. and Katherine Martin
University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory
Embassy Room

Afternoon Session Two | 2:05 – 2:35 p.m.

Discharges in Karst Geology
Sara L. Trescott, Washington County Health Department
Maryland Room

Groundwater Level Change Management on Control of Land Subsidence in the Houston-Galveston Region, Texas
Yi Liu, D.Eng., P.G., Morgan State University, Department of Civil Engineering
Regency Room

Methodology for Data-Based Prioritization of Onsite Sewage Disposal System Upgrades for Nitrogen Load Reduction in Maryland
Jonathan Leiman and Shannon McKenrick, Maryland Department of the Environment
Embassy Room

Break | 2:35 – 2:50 p.m.

Afternoon Session Three | 2:50 – 3:20 p.m.

Cropland Irrigation Management as a Best Management Practice: Findings from a Scientific Review
Mark Dubin, University of Maryland Extension – College Park
Maryland Room

Making Abandoned Quarries Useful Again: A Tale of the Billmeyer Quarry, Bainbridge, PA
Pierre O. MaCoy, P.G., Susquehanna River Basin Commission
Regency Room

An Overview of Groundwater in Maryland
Johanna Gemperline, Maryland Geological Survey
Embassy Room

Afternoon Session Four | 3:25 – 3:55 p.m.

Agricultural Improvement Act 2018: Source Water Protection, Prioritization, and Practices
Rebecca-Ann Warns, Maryland Department of the Environment
Maryland Room

Infrastructure or Nature? Evaluating Water Incursion and Trespass in Municipally Sourced Areas
Sarah Taggart, Advanced Land and Water, LLC (A Barton and Loguidice Company)
Regency Room

Using the State Revolving Fund for Capital Improvements that Address Drinking Water Issues
Dee Settar, Elaine Dietz, and Janice Outen
Maryland Department of the Environment
Embassy Room

Need a moment to take a call or somewhere a little quieter to discuss that pressing Groundwater issue?
This year the Wayne room, upstairs, has been set up for networking and is available through-out the day.

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ABSTRACTS OF PRESENTATIONS

Morning Plenary | 9:15 – 10:45 a.m.

Managing Ground and Surface Water in an Increasingly Complex and Dynamic Environment

Peter Goodwin, Ph.D., University of Maryland Center for Environmental Science

Embassy Room

Many of the world's river basins are severely stressed due to population growth, water quality and quantity problems, emerging contaminants, vulnerability to flood and drought, and the loss of native species and cultural resources. Consequences of climate change further increase uncertainties about the future. There has been an increasing interest in conjunctive administration in an attempt to balance water supply reliability, protect communities and existing infrastructure, foster economic development while ensuring a healthy earth system.

Major advances in sensor technologies, visualization, data synthesis and data mining to assess water resources are facilitating cost-effective management of the water cycle and accelerating our experiences with traditional and nature-based solutions. However, severe challenges persist since scientific studies rarely occur on the same timeframe as management actions, policy decisions or at the pace sometimes expected by elected officials. Common challenges include the need to make decisions in the face of considerable uncertainty, ensuring research results are actionable and preventing science being used by special interests to delay or obfuscate decisions.

These major societal challenges must be addressed through innovations in governance, policy, and ways of implementing management strategies. Science plays a critical role in helping define possible alternative futures that could be achieved and the possible consequences to economic development, quality of life, and sustainability of ecosystem services.

The challenges facing groundwater are explored globally with over 300 major transboundary aquifers supporting more than 2 billion people relying on these resources. Examples of some the significant challenges being experienced in the US are described with potential lessons for the Chesapeake Bay Watershed.

EPA's PFAS Action Plan
Rick Rogers, U.S. Environmental Protection Agency, Region III
Embassy Room

The Environmental Protection Agency (EPA) developed a national plan to address the challenging issue of per- and polyfluoroalkyl substances (PFAS) in the environment. EPA's PFAS Action Plan outlines concrete steps the agency is taking to address PFAS and to protect public health; and demonstrates the agency's critical national leadership by providing both short-term solutions and long-term strategies to address this important issue. The Plan provides a multi-media, multi-program, national research, and risk communication plan to address this emerging environmental challenge. It responds to the extensive public input the agency has received over the past year during the PFAS National Leadership Summit, multiple community engagements, and through the public docket. EPA is taking a proactive, cross-agency approach to addressing PFAS under the Action Plan. This presentation will outline the work identified in the plan and accomplishments to date. A brief overview of PFAS sites across EPA Region 3 will also be provided.

Morning Session One | 11:05 – 11:35 a.m.

NVF-Yorklyn Project
John G. Cargill, IV, P.G., Delaware Department of Natural Resources and Environmental Control
Maryland Room

In the late 1800s, the Marshall Brothers Paper Mill opened for business and went on to develop deep roots in Yorklyn, Delaware. Originally producing grist, snuff, paper, and fiber, the business grew and expanded for decades until 2009, when a then called National Vulcanized Fiber (NVF) entered into the company's third bankruptcy, and the plant was subsequently closed. Later that year, carefully considering the high levels of pollutants from the industrial uses of the site, Delaware's Department of Natural Resources and Environmental Control (DNREC) began development of the Auburn Valley Master Plan that called for most of the NVF site's 119 acres being added to the 192-acre State owned property known as the Auburn Heights Preserve.

After completion of environmental investigations, waste removal and demolition activities at the site, construction/remediation crews began a major zinc removal and wetland creation project in December 2016. Approximately 170 tons (340,000 lbs.) of zinc were removed from the soil beneath the former NVF facility, among other contaminants. After a year-long monitoring period to evaluate contaminant discharges to the adjacent Red Clay Creek, DNREC has decommissioned the long-operated groundwater zinc treatment system at the site.

Yorklyn is a unique place from which the industrial history of paper mills can be traced back to a Delaware sawmill in 1763. Preservation of its historical legacy was integral to DNREC's master plan for the area. Planning teams have left certain historic buildings intact to help tell the story of the original Marshall Brothers Paper Mill. Additionally, a planned industrial history museum will delve deeper into the site's historical significance. Project managers and site developers are continuing to turn the area into a reinvented hub of recreational activity with the possibility of commercial and residential development. Under their leadership and innovative approach to revitalization, the site will maintain its historic character and provide opportunities to improve the quality of life for Yorklyn's residents and the many visitors who will come and experience the site's rebirth.

Simulated Effects of Sea-Level Rise on the Shallow, Fresh Groundwater System of Assateague Island, Maryland and Virginia
Phillip Goodling, U.S. Geological Survey
Regency Room

Phillip Goodling, Brandon Fleming, and Jeff Raffensperger
U.S. Geological Society

Sea level rise in the mid-Atlantic is expected to adversely impact barrier island ecosystems due to limited availability of fresh groundwater resources stemming from increases in mean sea level and the frequency of storm-driven overwash events.

At Assateague Island, located in Maryland and Virginia, fresh groundwater resources are crucial to maintaining a fragile ecosystem. The U.S. Geological Survey, in cooperation with the National Park Service, developed a three-dimensional groundwater flow model for Assateague Island to assess shallow groundwater response to three scenarios representing 20 cm, 40 cm, and 60 cm of sea level rise above the 1981-2001 mean sea level. The modeling approach at Assateague is consistent with models developed for the Sandy Hook Unit of Gateway National Recreation Area (New Jersey) and Fire Island National Seashore (New York). The coordinated modeling effort allows for comparisons among mid-Atlantic barrier islands during simulated sea level rise. Additionally, to document the effect of storm overwash on Assateague's fresh groundwater resources, groundwater level and specific conductivity were continuously monitored at select groundwater wells from 2014-2015 and 2017-2018.

Results show that as sea level rises, low-lying areas of Assateague Island become inundated and the freshwater-saltwater interface approaches the surface. As a consequence, the overall amount of fresh water within the groundwater system decreases during sea-level rise. Island shape and topography are found to be important controls on response to sea level rise. Both short-lived (1-3 days) and long-lived (~1 month) salinization events were observed. Ongoing work at Assateague Island seeks to understand the extent and duration of episodic salinization by storm overwash events.

Factors Affecting Bacterial Occurrence and Variability in Drinking Water Wells

Bryan Swistock, Penn State University, Department of Ecosystem Science and Management

Embassy Room

Among all measures of drinking water quality in private groundwater wells and springs, the parameter most often tested and used to determine water potability is coliform bacteria and/or *E. coli* bacteria. These indicator bacteria are used to determine if potentially disease-causing organisms may be present in the drinking water source. Bacterial contamination represents a significant health risk for private well and spring users because it occurs in approximately 30 to 40% of water wells and most homeowners are unaware of existing bacterial contamination. Coliform and *E. coli* bacteria are extremely important and powerful tests of drinking water quality, but they are notoriously variable in water wells.

We conducted three studies in Pennsylvania to quantify the role of weather, water well construction, and sampling methods on bacterial contamination. Two of the studies found that shock disinfection and/or installation of sanitary well caps had a 10 to 15% long-term success in solving bacterial contamination problems. Other data for 24 new water wells along with a larger survey of 701 water wells across the state found that the cumulative effect of numerous water well construction features were more important in reducing bacterial contamination. All these studies also found a significant correlation between coliform bacteria (or *E. coli* bacteria) and soil moisture at the time of sampling. Quality control sampling during these studies assessed the importance of sample location, collection method, and sample volume and found a small number of cases where these factors affected bacteria results. For example, the standard 100 mL sample collection volume was found to under-represent minor bacterial contamination in 8% of duplicate samples. These results demonstrate that bacterial contamination is highly variable and responsive to many factors suggesting that caution should be used when interpreting results from a single bacteria sample from a water well or spring source.

Morning Session Two | 11:45 a.m. – 12:15 p.m.

Application of Thermal Remediation at Brandywine DRMO
William Burris, P.G., Air Force Civil Engineer Center
Maryland Room

Releases of chlorinated solvents from the 8-acre Brandywine DRMO site impacted groundwater across twenty acres of the surrounding community of Brandywine Maryland. From 2008 through 2013 the U.S. Air Force team successfully reduced the plume to less than an acre through reductive dehalogenation despite adverse site conditions. This effort included a 2008 attempt (then the nation's largest) to alter aquifer pH. The remaining contamination, including a DNAPL source bound up in the clays and silts of the Calvert Formation, cannot be effectively addressed via bioremediation. The presence of an active railroad and other infrastructure directly overlying the contamination source zone limits the ability to implement other forms or remediation. In response the U.S. Air Force team installed a thermal remediation system using electrical resistive heating to remove the source area contamination. The system was activated in April 2019 and as of July 2019 several hundred pounds of contamination have been removed from the subsurface without adversely impacting the overlying critical infrastructure. The team overcame numerous logistical challenges to implement the remedy ranging from monitoring the railroad tracks for deflection or other track movement during remedial operations to ensuring site security with a series of motion detection systems.

Using Groundwater Flow Model to Evaluate Impacts of Sea Level Rise on Saint Jones River Water Shed, Delaware
Changming He, Ph.D., Delaware Geological Survey
Regency Room

Due to the low land surface and shallow water table, the Delaware Coast area is highly vulnerable to effects of sea level rise. A 3-D, transient, variable-density groundwater flow model (SEAWAT) is used to simulate the groundwater response to predicted sea level rise in the Saint Jones River watershed adjacent to the Delaware Estuary through the year 2100. Sea level rise directly leads to substantial changes in the depth of water table, and these changes can extend inland due to the long tidal rivers in this area.

This research studied the impacts of three different sea level rise scenarios (0.5m, 1.0m and 1.5m) on two concerned aspects in the area: failure of septic tank system and loss of agriculture land. Criteria number of 1.5m and 0.9m of depth to water table were selected for failure of septic tank and loss of agriculture land, respectively, based on Delaware regulations governing on-site wastewater treatment and disposal systems, and effective rooting depth of local crops. The model also considered the predicted precipitation changes in the future. To assess the uncertainty of flow model results caused by the climate model

uncertainty, Monte Carlo algorithm was applied by running 1000 simulations with varying equiprobable recharge fields. For each model run, the simulated heads are compared with those criteria to locate the impacted areas. By analyzing the total 1000 simulation results, the areas with high probability to be impacted will be assigned as critical zones. The model results indicate that 1) 10%~13% of current existing septic tank will fail as the water table rises to less than 1.5 meters from land surface, and 2) approximately 271 to 927 acres of agriculture land, which covers about 4%~13% of total current agriculture land in the study area, will be lost due to water table rise above the effective rooting depth.

Road Salt Contamination in Groundwater and Surface Water in the Maryland Piedmont
Tiffany VanDerwerker, Maryland Geological Survey
Embassy Room

Road salt has been applied to roads during winter storm events since the 1940's. As a result, chloride concentrations in Maryland streams and groundwater have increased over time. In the Maryland Piedmont, unconfined aquifers are the primary water source for people on private water wells, and these aquifers are very susceptible to surface-based contamination. Water with elevated chloride concentrations can damage plumbing fixtures, appliances, and pipes. Chloride is unreactive and therefore it does not degrade in the environment and is likely transported through groundwater by advection. Chloride is difficult to remove from water, often requiring reverse osmosis. This process is expensive and requires large amounts of water.

Chloride transport between surface water and groundwater in Maryland has not been adequately evaluated. To investigate this relationship, the Maryland Geological Survey (MGS) performed a review of the literature for road salt impacts to both groundwater and surface water. Because chloride and conductivity have a strong linear relationship, conductivity can be used as a proxy for chloride concentrations as conductivity measurements are easy to record in the field. A monitoring well in Montgomery County near a major freeway (MD Route 200) has been monitored continuously for conductivity since December 2018. These data should provide better insight into the rate of movement of chloride from road salt within the groundwater-flow system.

As part of a multi-year study (conducted by MGS) to evaluate road salt contamination in groundwater, chloride data were compiled from the following sources: U.S. Geological Survey National Water Information System, National Uranium Research Evaluation, County databases, and public water supply (transient/non-transient wells). These data were mapped in ArcGIS to evaluate spatial distribution of available data and changes in chloride concentrations over time.

Afternoon Session One | 1:30 – 2 p.m.

Cloud-Based, Automated Remote Monitoring and Management of Stormwater Injection Well Use in Karst Terrain: A 10-Year Case Study
Jim L. Lolcama, P.G., KCF Groundwater, Inc.
Maryland Room

This presentation describes the long-term performance and use of a cloud-based automated monitoring system which is relied upon by hydrogeologists to manage a first-of-its-kind high-capacity stormwater disposal system for a karst aquifer. During 10 years of continuous operation, slightly more than 385 million gallons of pre-treated stormwater have been disposed of without sinkhole occurrences. The disposal occurs between 75 feet and 135 feet below grade, at low-pressure gravity injection rates of up to 10,000 gallons per minute.

The initial concept was described in 2008 by Lolcama and Gauffreau in ASCE Geotechnical Special Publication 178. Since startup in 2010, the capabilities of the cloud have evolved from a rudimentary data collection and storage system to a sophisticated data storage, processing and decision-making system. The system enables scientists and engineers to better manage large scale high capacity treatment and injection systems for stormwater with many different beneficial outcomes.

Utilizing HACCP in a Carbon-Based Treatment Process for Managed Aquifer Recharge
Jeremy T. Hise, P.E., Hazen and Sawyer
Regency Room

Troy Walker, Erik Rosenfeldt, Jeremy Hise, and Aaron Duke
Hazen and Sawyer

The presentation will review the Hazard Analysis and Critical Control Point (HACCP) methodology and describe how it is utilized to provide continuous validation of multiple water treatment barriers in a carbon-based treatment train for HRSD's 1 mgd Advanced Water Treatment and Aquifer Recharge Research Center. The presenters will describe how the critical operating parameters were selected and how they will be used to verify that the process is protective of the aquifer and public health.

Hampton Roads Sanitation District (HRSD) is in the process of completing Phase 3 of the Sustainable Water Initiative for Tomorrow (SWIFT) program which includes the design, construction, and operation of the SWIFT Research Center; a nominal 1 mgd advanced water treatment and research facility. The objectives of the facility are to demonstrate that the advanced treatment process that was selected during the piloting phase will produce finished water that meets primary drinking water standards and is compatible with the

groundwater chemistry and to monitor the aquifer's hydraulic response. The facility will serve as a research center and outreach facility, and provide a platform for operator training and process optimization. HRSD will collect at least 18 months of treatment and aquifer hydraulic response data during the operation of the facility to optimize the design of full-scale advanced treatment and to define future permitting requirements.

The presentation will highlight how the project team used the HACCP methodology to provide a design, monitoring, and operations framework for the scale-up of the carbon-based advanced treatment process from a pilot scale system to a 1 mgd treatment system that will be recharging the aquifer with highly treated water. The (HACCP) methodology has been adopted internationally by numerous countries to manage microbial and chemical contaminants in water treatment systems, including water reuse systems. It is a logical approach to identify, evaluate, and control hazards, which are significant for human health protection. The purpose of a HACCP system is to put in place controls or actions that will prevent or detect and correct deviations in treatment processes at the earliest possible opportunity. HACCP focuses on monitoring and maintaining intermediate treatment barriers rather than relying solely on end-of-pipe sampling and testing. This provides the dual advantage of ensuring that each unit process along the treatment train is working as a barrier to targeted contaminants, and to prioritize and standardize the response to human health hazards during operation.

The presentation will include an overview of the seven principles that are used to guide the process of developing critical control points, operational response strategies, and the continuous process of verification and documentation for protecting the aquifer and public health. The application of the seven principles behind the HACCP methodology can help challenge and refine assumptions behind process selection, analytical sampling, process monitoring, and corrective actions, all of which ultimately support full-scale design, implementation, and operation of any water reuse treatment system. The seven principles are listed below:

Principle 1: Conduct a hazard analysis and water quality risk assessment
Principle 2: Determine the Critical Control Points
Principle 3: Establish critical limits (assess barrier performance)
Principle 4: Establish a system to monitor the control of a Critical Control Point
Principle 5: Establish the corrective action to be taken when Critical Control Point monitoring is out of range
Principle 6: Establish procedures for verification to confirm that the Critical Control Point system is working effectively
Principle 7: Establish documentation concerning all procedures and records appropriate to these principles and their application

The presentation will discuss the selection of the Critical Control Point treatment barriers, the on-line instrumentation and monitoring parameters used to validate the treatment

barriers, and the procedures implemented to take corrective action when monitored parameters are out of range. We will show how procedures were developed to verify that the monitoring systems work effectively and how outcomes of the HACCP methodology were integrated into process operations, operator training, and documentation standards and were tested and optimized to further refine the methodology for full scale implementation.

HRSD has the capacity to treat up to 249 mgd of wastewater and serves a population of nearly 1.7 million people in the southeastern region of Virginia. HRSD has developed and is advancing its SWIFT Program which provides an innovative solution for managing regulatory requirements while addressing many of the region's water challenges. The multi-phase SWIFT Program will add advanced treatment processes to up to seven of HRSD's wastewater treatment facilities to produce water that exceeds drinking water standards and is compatible with the receiving aquifer. At full-scale, the SWIFT program will significantly reduce nutrient loading to the sensitive Chesapeake Bay, limit saltwater intrusion into the Potomac aquifer, reduce land subsidence, and provide a sustainable source of groundwater, a necessity for continued economic expansion of the region.

Molecularly Characterizing Septic System Effluent to Develop New Wastewater Tracers

Michael Gonsior, Ph.D. and Katherine Martin
University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory
Embassy Room

Septic system wastewater contains elevated concentrations of nitrogen and phosphorous as well as household contaminants of emerging concern. These pollutants are then transported with groundwater to surface waters. To develop new ways to track the impact of this contamination, we conducted a year-long, monthly stream sampling survey of streams draining areas with high septic system densities (>80 septic systems/sq mi) and forested reference streams in Calvert and Anne Arundel County, MD. Additionally, we directly sampled wastewater from traditional septic tanks.

Using ultrahigh resolution mass spectrometry, we characterized the dissolved organic matter in these waters to identify molecular formulae unique to or highly associated with septic impacted streams and to understand the transport pathway of these potential new tracers. Most identified potential tracers had sulfur containing formula assignments and appear to be degradation and co-products of surfactants from soaps and detergents. Other identified tracers include contaminants of emerging concern. We also measured traditionally used human wastewater tracers, including chloride, nitrogen species, nitrate specific isotopes, and the artificial sweeteners sucralose and acesulfame-K to assess their performance.

Afternoon Session Two | 2:05 – 2:35 p.m.

Discharges in Karst Geology
Sara L. Trescott, Washington County Health Department
Maryland Room

On March 10, 2017, the Maryland Department of the Environment conducted a joint inspection with the Maryland Department of Agriculture based on a complaint regarding a manure discharge from a local dairy farm on February 28, 2017. Further, on March 1st, a significant rain event occurred that appeared to allow a greater transportation rate of the discharge toward the sinkhole. On the date of the inspection, it was clear due to the staining of the grassed areas, that a discharge did in fact occur towards the throat of sinkhole which is enclosed by a fence to protect livestock.

The Maryland Department of the Environment (MDE) investigated, validated the complaint and notified the Washington County Health Department, Environmental Health of the discharge. Environmental Health then notified the Maryland Department of Health, Milk Control. After much discussion between state agencies, local environmental health representatives set out to begin notifying homeowners in the vicinity of the discharge that they would perform testing of homeowners well water supply systems at no cost to the homeowner. As the investigation unfolded, it became clear that due to the karst geology in the area, MDE determined that the zone of influence may be greater than previously described. Therefore, local health agreed to expand the area for notification and well water testing.

On March 13th, preliminary results for the greatest impacted homeowner indicated >2,419 mpn colonies of coliform / E. Coil present. Local health advised the homeowner, the Town of Boonsboro (Town), and began a dialogue to discuss the possibility to allow the homeowner a connection to a dedicated public water line. The Town and MDE agreed to allow the property owner to connect to the public water line; however, the homeowner, without local health's knowledge, elected to have the well "reworked" and not connect to the public water line.

In April 2017, several state and local agencies met in Washington County to discuss this apparent manure discharge into a swale leading to a sinkhole on a dairy farm property. The meeting was well attended, but it became clear very quickly, that a breakdown in communication and authority had occurred. For example, should local health be allowed to inspect the property? Can Milk Control inspect the property? Who has jurisdiction in this situation? How do the existing delegation agreements define the situation? Many questions asked, investigated, and are still under review today.

Enforcement action was taken by MDE, a settlement was reached, and the farmer paid a fine to resolve the enforcement issue.

Groundwater Level Change Management on Control of Land Subsidence in the Houston-Galveston Region, Texas

Yi Liu, D.Eng., P.G., Morgan State University, Department of Civil Engineering

Regency Room

Yi Liu[1], Jiang Li[1], Zheng N. Fang[2], Jason Ramage[3], Mojtaba Rashvand[1], Tranell Griffin[1], and Mohamed Bah[1]
[1]Civil Engineering Department, Morgan State University
[2]Civil Engineering Department, University of Texas at Arlington
[3]Texas Water Science Center, U.S. Geological Survey

The 13 borehole extensometers installed in the Houston-Galveston region from 1962 to 1980 have measured land subsidence mostly due to compaction of the Chicot and Evangeline aquifers after the 1970's. Groundwater levels in the two aquifers were monitored in over 700 wells. For analysis of aquifer compaction in response to changes in groundwater levels, a bulk land subsidence rate is assumed in this paper to be the sum of inelastic (nonrecoverable) and elastic (recoverable) compaction rates due to groundwater withdrawal and a pseudo-constant secondary consolidation rate due to geo-historical overburden pressure. As much as 3.05 m of land subsidence was observed in 1979 in the Houston-Galveston region as a result primarily of inelastic compaction of aquitards in the Chicot and Evangeline aquifers between 1937 and 1979.

The preconsolidation pressure heads for aquitards within these two aquifers were continuously updated in response to lowering groundwater levels, which in turn was caused by continuously increasing groundwater withdrawal rates from 0.57 to 4.28 million m3/day. This land subsidence occurred without any management of changes in groundwater levels. However, the management of recovering groundwater levels from 1979 to 2000 successfully decreased inelastic compaction from ~ about 40 mm/yr in early 1980s to zero in around 2000 through decreasing groundwater withdrawal rates from 4.3 to 3.0 million m3/day. The inelastic consolidation that had existed for about 63 years roughly from 1937 to 2000 caused a land subsidence hazard in this region. Some rebounding of the land surface was achieved from groundwater level recovering management.

It is found in this paper that a pseudo-constant secondary consolidation rate of subsidence of 0.08 to 8.49 mm/yr emerged or tended to emerge at the 13 borehole extensometer station locations while the groundwater levels in the two aquifers were being managed. It is considered to remain stable in trend since 2000. This secondary consolidation subsidence is beyond the control of any groundwater level change management schemes because it is caused by geo-historical overburden pressure on the two aquifers. The 13 Borehole extensometers' compaction measurements since 1971 not only successfully corroborate the need for groundwater level change management in controlling land subsidence but also yield the first empirical findings of the occurrence of secondary consolidation subsidence in the Quaternary and Tertiary aquifer systems in the Houston-Galveston region.

Methodology for Data-Based Prioritization of Onsite Sewage Disposal System Upgrades for Nitrogen Load Reduction in Maryland

Jonathan Leiman and Shannon McKenrick, Maryland Department of the Environment
Embassy Room

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Driven by the State of Maryland's nutrient reduction obligations under the Chesapeake Bay 2000 Agreement, the State initiated a program (the Bay Restoration Fund [BRF]) to help pay for upgrades to onsite sewage disposal systems (OSDS). Decisions about which OSDS to upgrade have been made with a limited amount of spatial data to help prioritize upgrades and have focused on individual OSDS upgrades rather than projects that could reduce nitrogen loading from multiple OSDS (e.g., using sewer connections or decentralized "cluster" systems). As the Chesapeake Bay Total Maximum Daily Load (TMDL) continues to be implemented, identifying cost-effective projects at locally-refined scales is increasingly becoming the focus of planning efforts.

As a result, a report rooted in GIS was developed to leverage diverse, spatially-referenced datasets for the State of Maryland to make more robust, scientifically-based OSDS upgrade or retrofit prioritization decisions that result in favorable nitrogen load reduction/cost ratios. A key outcome of this project was the development of a decision-support methodology, which includes (1) a methodology for data pre-processing necessary to generate a "baseline" GIS layer of potential projects (focused on areas with high densities of legacy OSDS) and (2) a multi-criteria decision analysis (MCDA) tool to both prioritize potential project sites by their risk (focused on nitrogen loading, but also including other co-benefits and confounding risk factors) and upgrade/retrofit feasibility. The MCDA tool uses the spatially-referenced data inputs and generates risk ratings as well as feasibility ratings for sewer extensions and decentralized retrofits/upgrades for each potential project site. The methodologies were tested using campgrounds and mobile home parks (MHP) in Maryland as areas likely to feature high densities of legacy OSDS that could be targeted for upgrade or retrofit projects. Exploratory spatial analyses were conducted to identify other, more generic locations featuring high densities of legacy OSDS. The utility of the MCDA tool is to illuminate projects falling into a "high risk/high feasibility" category so that they could be favored for additional analyses to validate the results and move forward with implementation as warranted.

The results of this initial effort provide Maryland with a new and improved, though still draft, approach to prioritizing nitrogen load reduction projects within the OSDS sector. The approach leverages a great deal of valuable data that Maryland has been collecting through its permitting programs, and puts it to use supporting transparent, robust decision-making.

Afternoon Session Three | 2:50 – 3:20 p.m.

Cropland Irrigation Management as a Best Management Practice: Findings from a Scientific Review

Mark Dubin, University of Maryland Extension – College Park

Maryland Room

There has been strong interest on the Chesapeake Bay's Delmarva Peninsula since at least 2009 for the recognition by the Chesapeake Bay Program (CBP) of cropland irrigation systems as a potential environmental conservation practice, also known as a Best Management Practice (BMP). With the development of Watershed Implementation (WIPs) for the Chesapeake Bay Watershed as part of an historic first – the largest US-EPA Total Maximum Daily Load (TMDL) plan ever attempted, cropland irrigation management became identified in several state WIP plans as an "interim BMP". These are essentially a placeholder BMP for planning purposes with the intention of being fully recognized by the CBP partnership in the future. Interim BMPs only become fully approved BMPs with documented environmental credits toward the TMDL once they have undergone a rigorous scientific expert panel evaluation process and been approved by the CBP partnership.

The CBP's Agriculture Workgroup, a program workgroup representing the agricultural sector of the partnership, launched the Cropland Irrigation Management Expert Panel in July of 2016. The science panel was charged by the partnership to determine the water quality benefits associated with the practice of irrigation on cropland, a management system of specific importance on the Delmarva Peninsula. This region is characterized by unpredictable rainfall patterns, intensive grain and vegetable production, and course-textured sandy soils with low water retention capacity. Consequently, the primary intention of cropland irrigation is to increase crop yield and consistency over more variable dryland production systems.

The Expert Panel's extensive scientific literature review revealed limited research directly addressing the impacts of irrigation systems on respective local or regional water quality. Several multi-year research studies conducted on the Delmarva Peninsula by the University of Delaware and the US Geological Service (USGS) provided the most relevant information for the panel. Focusing on the most acreage significant cropland irrigation systems employed in the Chesapeake Bay Watershed, the Expert Panel narrowed its review to center-pivot, lateral-move, and traveling gun systems on corn as grain or silage production.

After an extensive two-year-plus scientific review, the Expert Panel released its findings in a controversial recommendation report in January of 2019. The Expert Panel determined that there was not sufficient science-based research available to indicate a reduction in nutrient or sediment losses due to cropland irrigation of corn as compared to dryland production. Consequently, BMP efficiency values for Nitrogen (N), Phosphorus (P), or Sediment (TSS) could not be established by the panel at this time.

In summation, the Expert Panel did not recommend that cropland irrigation management be recognized as an approved BMP by the CBP partnership. The panel findings did not however preclude the possibility of revisiting cropland irrigation as a BMP with a future expert panel should new scientific research literature emerge addressing cropland irrigation management and its water quality impacts. In that vein, the panel strongly endorsed further research on the impacts of cropland irrigation on nutrient and sediment loss.

Making Abandoned Quarries Useful Again: A Tale of the Billmeyer Quarry, Bainbridge, PA
Pierre O. MaCoy, P.G., Susquehanna River Basin Commission
Regency Room

Once a bustling dolomite quarry in the late 1800's, the now flooded and idle quarry was investigated as a source of Consumptive Use (CU) mitigation water. The Susquehanna River Basin Commission's CU Mitigation Plan, includes the evaluation of potential water storage assets for low flow augmentation to offset CU and avoid downstream water use conflicts and environmental impacts.

Evaluation of the 29-acre quarry required detailed investigations including geologic interpretation, volume quantification, water quality assessment, protected and endangered species surveys, and invasive species mitigation, which culminated in a 35-day pumping test with an average rate of 5,360 gallons per minute (gpm).

The final outcome of this project was the securing of 425 million gallons of storage for use during periods of low flow to mitigate for consumptive use. This multi-disciplinary approach to identifying, investigating, testing and ultimately securing water storage assets can serve as a model for repurposing other historic abandoned mines and quarries.

An Overview of Groundwater in Maryland
Johanna Gemperline, Maryland Geological Survey
Embassy Room

More than one-quarter of Marylanders depend on groundwater as their primary water source. Yet to many people, groundwater is somewhat mysterious, largely because we cannot observe it directly. This talk will introduce the fundamental concepts of groundwater, with emphasis on groundwater settings that exist 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 also will be covered. In addition, challenges to our groundwater quality and availability, including drought, drawdown, and saltwater intrusion will be discussed.

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.

Afternoon Session Four | 3:25 – 3:55 p.m.

Agricultural Improvement Act 2018: Source Water Protection, Prioritization, and Practices
Rebecca-Ann Warns, Maryland Department of the Environment
Maryland Room

Signed into law on December 20, 2018, the 2018 Agricultural Improvement Act, also known as the 2018 Farm Bill, addresses a wide range of agricultural topics, including: farmer livelihoods, local food systems, healthy food access, soil and water conservation, and equal opportunities for all farmers. Notably, the 2018 Farm Bill requires the Secretary to encourage the protection of drinking water sources through conservation programs. This presentation focuses on the source water protection language outlined in the 2018 Farm Bill and the actions needed to happen in the 2019 Fiscal Year. Source water protection deliverables outlined in the bill include: identifying priority areas, providing GIS layers of these local priorities, and creating digital copies of source water protection plans for priority areas.

Eighty-five percent of Maryland's residents are served by community water systems. Seventy percent of those residents receive water from surface water systems; fifteen percent acquire their water from community groundwater sources. The remaining fifteen percent of Maryland residents receive water from individual wells. Surface waters are more susceptible to agricultural and urban runoff, pathogen contamination, sedimentation, and algal blooms than groundwater systems. Because of the large populations they served and their greater susceptibility to contaminants associated with agricultural operations, the Water Supply Program (WSP) decided to focus our efforts on community, surface water systems and groundwater systems designated as "GUDI" (groundwater under the direct influence of surface water).

Using provisions of the Safe Drinking Water Act, GIS techniques, and watershed characteristics, the WSP, in junction with the USDA's National Resources Conservation Service (NRCS), was able to fulfill the deliverables mandated by the 2018 Farm Bill. To sort through the four hundred sixty-five community water systems in Maryland, we examined: E. coli (used as a predictor for *Cryptosporidium*), Total Organic Carbon and Disinfection Byproduct concentrations, Source Water Protection Area (SWPA) percent land use cover, SWPA animal density, and SWPA algal bloom history and susceptibility. The WSP delivered this list of priority areas to NRCS for further discussion of agricultural conservation practices to be implemented in these areas.

Infrastructure or Nature? Evaluating Water Incursion and Trespass in Municipally Sourced Areas

Sarah Taggart, Advanced Land and Water, LLC (A Barton and Loguidice Company)

Regency Room

We were retained to evaluate claims of City water supply incursion into a residential basement near Towson. A Homeowner in a dense residential area experienced a basement flood in 2012 and then again in 2015, but had not experienced floods previously. After both floods the homeowner upgraded their sump pits and deepened their French drain systems. Following the final upgrade, they reported that the sump pumps discharged much more often.

The chronically refilling sump pits led the homeowner to assume that the basement was under constant inundation and that the source must be leaking City infrastructure. One thing led to another until the homeowner sued the City for damages.

Our involvement began in 2017 after the City had already undertaken various studies to attempt to verify the homeowner assertion and to abate the water source. Results were inconclusive and somewhat misleading.

Once engaged and made familiar with past in-house investigative efforts by the City we collected and analyzed water quality samples for a diverse list of forensic analytes, we designed and oversaw shallow excavations and we sampled temporary monitoring wells constructed in those test pits. In light of the litigation, careful planning was necessary during this investigation to ensure all possible sources were evaluated from multiple angles. In particular, in-depth research and a diverse sampling parameter list were required to debunk various previous theories and interpretations made by others.

We concluded that the water entering the residents' basement at the time of our work was of natural origin. This was largely based on our water quality results, in person observations, the hydrogeologic setting and correlations with nearby comparative data. No acute leakage of City infrastructure was necessary to explain the data. When the case went to trial earlier in 2019, our expert testimony convinced a jury to find for the City of Baltimore.

Using the State Revolving Fund for Capital Improvements that Address Drinking Water Issues

Dee Settar, Elaine Dietz, and Janice Outen
Maryland Department of the Environment
Embassy Room

Public water systems can face challenges to address public health issues, such as contamination, changing drinking water regulations, or small system debilitation. Solutions frequently include expensive improvements to water sources, treatment, storage, or distribution systems; in some cases, utility consolidation is necessary. Many of these projects are eligible for grant or loan funding through the Drinking Water Revolving Loan Fund (DWRLF), which was established to encourage capital investment for drinking water projects pursuant to the Federal Safe Drinking Water Act.

MDE's Water Supply Program, Integrated Water Planning Program, and Water Quality Financing Administration collaborate to implement major water system improvements to protect public health. This presentation will characterize each program's complementary role and highlight the critical components of a successfully funded drinking water capital improvement project.

The Water Supply Program's Engineering & Technical Assistance Division works directly with utilities under provisions of the Safe Drinking Water Act. The Division performs site inspections and other support to address water quality and quantity issues; their unique relationship with utilities provides a close working relationship when a water system must undertake capital improvements to address a public health concern.

The Water Quality Financing Administration administers the DWRLF that provides grants and below market interest rate loans for drinking water projects. The Administration also provides financial advisory services that assist borrowers in determining affordable user rate structures and models the fiscal impact the proposed loan will have on the borrower's financial capacity.

The Water Resources Planning Division of the Integrated Water Planning Program oversees the review and implementation of County Water & Sewerage Plans and also ensures that drinking water projects requesting State funding are consistent with Smart Growth requirements. County Water & Sewerage Plans describe how each jurisdiction intends to serve existing and future development. Most local governments have capital improvement programs in concert with their Water & Sewerage Plans and annually publish their five-year capital budgets. In addition to overseeing County Water & Sewerage Plans, the Planning Division also requests Priority Funding Area (PFA) exceptions from the Smart Growth Coordinating Committee for projects that are not located in the PFA.

Poster Presentations

CONSERVE
A Center of Excellence at the Nexus of Sustainable Water Reuse, Food, and Health
The CONSERVE table will offer resources on water reuse for agricultural irrigation including fact sheets and written case studies on successful water reuse in Maryland.
Come find out more information about our upcoming Water Reuse Winter Workshops.

Maryland Geological Survey
MGS is a scientific-investigative organization of the State of Maryland charged with investigating the geologic and water resources of Maryland through the application of the various disciplines within earth science. Its primary mission includes investigation and monitoring of water resources, geologic, topographic, and geophysical mapping, environmental geology, mineral resources, and coastal and estuarine geology.

U.S. Geological Survey
The United States Geological Survey offices in Baltimore and Frostburg continuously monitors 29 groundwater wells in Maryland, and several ongoing projects to study our underground water resources. We will be on hand to answer any questions about groundwater in Maryland, as well as hand out recent relevant publications.

PRESENTER BIOGRAPHIES

William Burris, P.G. currently serves as an Environmental Restoration Program Manager for the Air Force Civil Engineer Center. Specifically, William manages the environmental restoration program at Joint Base Andrews and provides additional support to Joint Base Langley Eustis and Dover Air Force Base. He is a licensed professional geologist who first bailed a well in 1992. Since that time William has served as regulator, consultant, contractor, and federal environmental manager.
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John G. Cargill. IV, P.G. is a Hydrologist V with the Delaware Department of Natural Resources and Environmental Control (DNREC) located in New Castle, Delaware. Before joining DNREC in 2005, John worked as a Geologist in the private consulting industry, where he became familiar with environmental regulations and guidelines associated with contamination assessment and remediation of various media. In 2005, John relocated to Delaware and has since worked with DNREC's Remediation Section and Watershed Assessment and Management Section. Currently, John manages Delaware's Toxics in Biota Program (fish advisories) and is Co-Leader of DNREC's WATAR Team. In addition, John oversees contamination assessment and cleanup projects that have major impacts to surface water, sediments and benthic aquatic resources. Last, John designs and implements State lead assessment and remediation projects, including innovative contaminated sediment projects. John earned his Bachelor of Science degree in Geology at the University of North Carolina at Chapel Hill in 1994, and his Master of Science degree in Coastal Geology from the University of South Florida in Tampa in 1996. He is a licensed Professional Geologist and licensed Geotechnical Well Driller in the State of Delaware.
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Elaine Dietz has been with Maryland Department of the Environment since 2001 and is currently Chief of Maryland Water Quality Financing Administration's Capital Planning & Financing Division. She is responsible for capital project selection; capital budget preparation; data analysis, tracking and reporting; policy development; and program management of the two State Revolving Fund programs, as well as Maryland's Water Supply Grant and the Bay Restoration Fund – Wastewater programs. Elaine has a B.S. in Marine Biology from Fairleigh Dickinson University (New Jersey) and an M.S. in Biology from Wright State University (Ohio). She is originally from the Finger Lakes Region of New York State.
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Mark Dubin is a graduate and extension faculty member of the University of Maryland's flagship campus at College Park. He serves as a Senior Faculty Specialist for the College of Agriculture and Natural Resources and holds a position with the Chesapeake Bay Program Partnership as its first Senior Agricultural Advisor. Assisting the internationally recognized regional partnership since 2006, Mark has coordinated the scientific evaluation of nearly all agricultural Best Management Practices (BMP) currently recognized by the partnership and US-EPA for achieving nutrient and sediment reductions. Mark has formerly held multiple

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Johanna Gemperline is a hydrogeologist at the Maryland Geological Survey (MGS). Her work at MGS has included studies of both groundwater quality and quantity and has involved sampling, measuring water levels and numerical modeling. Johanna received her B.S. in Civil Engineering and M.S. in Geology from the University of Illinois at Urbana-Champaign.
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Dr. Michael Gonsior is a tenured associate professor at the University of Maryland Center for Environmental Science. He is a trained analytical chemist and his research is largely centered on aquatic biogeochemistry and environmental chemistry. His lab's interest is in characterizing complex dissolved organic matter in natural and engineered systems. Dr. Gonsior has published 60 peer-reviewed publications and was a featured scientist in the award-winning documentary "A Plastic Ocean".
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Phillip Goodling has been a U.S. Geological Survey Hydrologist with the Maryland-Delaware- District Survey since 2017. His research interests include physical hydrology, groundwater modeling, and geophysics. Prior to joining the Survey, Phillip worked as an environmental consultant and conducted ecohydrology research for the Geological Society of America's GeoCorps program. He holds a Bachelor's degree from the College of William and Mary and a Master's degree from the University of Maryland, College Park.
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Peter Goodwin, Ph.D. is the president of the University of Maryland Center for Environmental Science (UMCES), an independent institution within the University System of Maryland. UMCES is a leading research and graduate education institution focused on understanding the environment and developing the science to help inform policy and management actions for Chesapeake Bay and beyond. He recently completed a federal appointment as Lead Scientist for the Science Program of the Delta Stewardship Council in California. His research interests are in modeling physical processes in natural and disturbed ecosystems and seeking nature-based solutions. Goodwin has participated in river restoration, coastal wetland sustainability, flood risk reduction and sediment management projects throughout the US. Goodwin is just completing a 4-year term as the president of the International Association for Hydro-environment Engineering and Research (www.iahr.org).
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Dr. Changming He obtained his Ph.D. degree from University of Nevada, Reno in 2004, majoring in hydrogeology, and he joined the Delaware Geological Survey in 2007. His work involves groundwater resources management and protection. His research interests include stochastic hydrogeology, geostatistical analysis and numerical modeling of groundwater flow and contaminant transport.
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Jonathan Leiman works in the Integrated Water Planning Program (IWPP) at the Maryland Department of the Environment (MDE) in Baltimore, Maryland. He holds a B.S. from Cornell University and an M.S. from the University of Montana. Jonathan has experience working on industrial and aquaculture wastewater management issues in the Midwest and Western United State as well as Israel. He works on a variety of water management issues at MDE on behalf of the citizens of Maryland related to the development of TMDLs and watershed implementation plans.
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Dr. Yi Liu is an Assistant Professor in Department of Civil Engineering, Morgan State University (MSU). He teaches geotechnical engineering and groundwater hydrology. His research interest is land subsidence and sea level rise. He worked on geotechnical engineering, hydrogeology and land subsidence in Shanghai, China from 1988 to 2002 and agricultural hydrology in the Southwest of the United States from 2007 to 2014. He is a registered Professional Geoscientist in Texas Board of Professional Scientists. In 2018, Dr. Liu was granted with a NSF project entitled as “Identification of Urban Flood Impacts Caused by Land Subsidence and Sea Level Rise in the Houston-Galveston Region”.
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Jim Lolcama is the owner and Principal Hydrogeologist at KCF Groundwater, Inc., a groundwater consulting and services firm that is located in southern Pennsylvania to avoid the Washington and Baltimore traffic, and has served the Maryland market since 2000. Jim holds a Bachelors in Geology, a Masters in Hydrogeology, and has 30 years of consulting experience with the mining industry, commercial developers, State Highway Agencies, and the Army Corps. He writes on a variety of subjects including karst and fractured bedrock aquifers; Class V injection well use in karst terrain; nuclear waste isolation methods; geophysical applications; and chemical modeling.
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Pierre O. MaCoy, P.G. received his B.S. in Geo-Environmental studies at Shippensburg University. He worked 10 years in private consulting, in areas such as geotechnical engineering, stormwater design, and geophysical investigations with a focus on carbonate settings and innovative solutions. He also developed potable water supplies, reclaimed abandoned mines, and developed karst appropriate stormwater facilities. Pierre is currently in his 8th year in the planning and operations department at the Susquehanna River Basin Commission (SRBC), developing consumptive use mitigation water storage in abandoned quarries, coal mines and any other nooks and crannies where stored water is found.
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Katherine Martin is a doctoral student in the lab of Dr. Michael Gonsior at the Chesapeake Biological Laboratory in Solomons, MD. As part of the Maryland Sea Grant funded "Septic Tracer Project", the research group has worked on developing new chemical ways to track septic system wastewater contamination in surface waters.
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Shannon McKenrick works in the Integrated Water Planning Program at the Maryland Department of the Environment (MDE) in Baltimore, Maryland. She holds a B.S. from Shepherd University in Environmental Science and an M.S. from Towson University. Shannon currently provides technical assistance for the department's watershed planning and stormwater permitting programs.
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Janice Outen has participated in and led several Water Resources Planning initiatives at the Maryland Department of the Environment for more than 20 years. She recently joined MDE's Water Supply Program and previously served as the Manager of the Water Resources Planning Division, where she was responsible for the review and approval of County Water and Sewerage Plans. Janice also worked for Baltimore County for many years and gained extensive experience in water-quality management programs as well as in the environmental review of land development projects. She drafted two major environmental laws for Baltimore County: Article 33, Title 3 of the Baltimore County Code - Protection of Water Quality, Streams, Wetlands and Floodplains and Article 33, Title 6 - Forest Conservation. Janice holds a B.A. in Biological Sciences from Towson University and a M.H.S in Environmental Health Engineering from the Johns Hopkins University. She also attended the University of Maryland School of Law**.**
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Rick Rogers has served the American public in the U.S. Environmental Protection Agency's Mid-Atlantic Regional office since 1987. He is Chief of the Water Branch within the Enforcement and Compliance Assistance Division. His Branch is responsible for all enforcement in the Region under the Safe Drinking Water Act and Clean Water Act Programs. Prior to joining EPA, Rick was an aquatic biologist for the Philadelphia Water Department. He has Bachelor of Science degrees in marine science and biology from East

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Dee Settar is a Regulatory and Compliance Engineer Senior and has worked with MDE's Water Supply Program for almost 19 years. As part of the Engineering and Technical Assistance Division, she has worked with hundreds of water systems performing site inspections, providing compliance assistance, and offering guidance to utilities for long term sustainability. She also represents MDE on the State Board of Waterworks and Waste Systems Operators, which certifies individuals who work at utilities. Dee earned a Biochemistry and Molecular Biology degree from UMBC and an Environmental Engineering & Science degree from Johns Hopkins.
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Sarah Taggart has worked for Advanced Land and Water, Inc. since 2015 as a "staff scientist" and more recently as a "hydrogeologist" since Advanced Land and Water, Inc. was purchased by Barton and Loguidice DPC in February of this year.
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Sara Trescott began her state service with local health in Prince George's County engaged in regulatory enforcement. She later worked as an engineer/director for the Department of Natural Resources for over 24 years in the field of water resources and environmental protection. Her last 7 years has involved facility management and a return to local health. She obtained her Bachelor and Master of Arts degrees from local universities and a certificate from Harvard's JFK School of Government for *Leadership for the 21st Century*. She is a licensed environmental health specialist and recipient of the "Albert Nelson Marquis Lifetime Achievement Award."
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Tiffany VanDerwerker is a Hydrogeologist with the Maryland Geological Survey (MGS) and a licensed Professional Geologist (NC) with a focus on groundwater quality and chemistry. Some of her work at MGS includes an evaluation of baseline groundwater quality in the Appalachian Plateau, brackish water intrusion along the Mayo Peninsula (Anne Arundel County), and road salt contamination in groundwater in the Piedmont. She attended Virginia Tech where she received both her Bachelor's and Master's Degrees in Geosciences.
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Rebecca-Ann Warns recently earned her Bachelor's in Environmental Science and Biology from the University of Maryland- Baltimore County (UMBC). Starting in May 2019, she has been working with Maryland's Department of the Environment's Water Supply Program as a Natural Resources Planner. Rebecca has worked as a Hydrology intern with the National Park Service's Inventory and Monitoring Program and an Aquaculturist intern with the Institute of Marine and Environmental Technology.
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