DAY 1

Assessing Opportunities for Improving Community Water Systems through Increased Infrastructure Funding in Texas

Bridget R. Scanlon, Justin Thompson, Robert C. Reedy, and **Sarah Fakhreddine**

Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin

The US has allocated $50 billion over the next five years through the Bipartisan Infrastructure Law (BIL) to improving water infrastructure to address Safe Drinking Water Act (SDWA) and Clean Water Act violations. This funding provides an excellent opportunity for Texas to improve our community water systems. Approximately 4,500 community water systems (CWSs) serve about 98% of the population (~29 million people). The dominant water source for CWSs is groundwater accounting for 72% of all CWSs and serving 19% of the total population with CWSs.

About one in 10 people in the US has been exposed to a health-based violation over the past few years (2018 – 2020). Texas ranked 1st among all states for SDWA violations of any health-based regulation, nitrate, radionuclides, lead and copper rule, and disinfectants and disinfection byproducts rule (DBPR) and ranked 2nd for violations of the arsenic rule and revised total coliform rule (RTCR). The majority of violating CWSs serve small rural disadvantaged communities. A variety of approaches can be developed to address noncompliant systems, including alternative water sources, blending different water sources, consolidating systems, and/or treating water.

Arsenic and radionuclide violations are linked to the geology and found in the High Plains, Gulf Coast, and Central Texas. Nitrate contamination is related to agricultural activity. DBPR violations are found mostly in surface water sourced systems related to treatment operations.

BIL funding will allow systems to achieve compliance using a variety of approaches. Approaches that will be considered include developing new water sources, blending water of different types, consolidating systems, and installing treatment systems. The BIL mandates that approximately 50% of the funding has to be applied to disadvantaged communities. Understanding linkages between CWS noncompliance and social vulnerability parameters will be important to improve CWS compliance for disadvantaged communities.

It will be important for future systems to be resilient to climate extremes (floods and droughts), cyberattacks and other risks. Improving CWSs for the future will also need to consider projected population growth/decline in various communities to optimize the CWSs.

Bridget Scanlon, Ph.D., is a Senior Research Scientist at the Bureau of Economic Geology, Jackson School of Geosciences, Univ. of Texas at Austin. Her current research focuses on water quality issues related to community water systems in the US, with particular focus on Texas. She has (co)authored ~175 publications. Dr. Scanlon is a member of the National Academy of Engineering.

GEOTHERMAL ENERGY; CLEAN, BASELOAD ELECTRICITY GENERATED OFF THE HEAT OF THE EARTH, HAS BEEN A SMALL PART OF THE US AND WORLD ENERGY PICTURE FOR A HUNDRED YEARS

THAT IS ABOUT TO CHANGE!

Ken Wisian, Ph.D. Associate Director, Environmental Division, Bureau of Economic Geology, Austin, TX

The core of the Earth is approximately the same temperature as the surface of the sun. The heat from the core, along with additional heat from radioactive decay in the mantle and crust, combine to produce a total outflow of heat through the surface of the Earth of approximately 44 terawatts. While it is not feasible to tap all this heat flow, even a small part would change the world energy picture. However, the upper ten kilometers of the crust is a superb heat storage unit and the accessible heat stored in the upper crust of the U.S. is much larger than the continuous heat flow – estimated to be more than 2000 times the U.S. annual energy consumption!

What exactly is a geothermal system? In general, it is a system drawing the internal heat of the Earth to or near the surface via fluid circulation and then using that heat to drive a turbine and generate electricity. We are not talking about ground source heat pumps for a home. Fossil fuel and nuclear plants work the same as a geothermal plant except instead of using the Earth's heat, they burn a fuel to heat a fluid to drive a turbine. Traditional "conventional" geothermal systems tap (drill into) a natural hot water flow or steam system, typically a kilometer or more underground. This flow system is driven either by current or past volcanic activity or very deep circulation of the water in the crust of the Earth. This close coupling between location (tectonically active zones) and the resource has been a major limiting factor in the development of geothermal power, along with high up-front costs of drilling and construction.

Advances in exploration, drilling and well construction, and heat to electricity production technologies are poised to revolutionize the accessibility of geothermal energy. These novel developments will break the geographic constraint of only being able to generate geothermal power where nature concentrates the resource and allow for ubiquitous geothermal power generation. This, in turn will allow for zero-carbon, baseload energy to be generated in most locations on Earth and substantially improve our energy future.

Ken Wisian, Ph.D., Major General USAF (retired), is Associate Director, Environmental Division, Bureau of Economic Geology, Jackson School of Geoscience, The University of Texas at Austin. He is a geophysicist whose main research is in geothermal energy. Other current research includes sensors, planetary geology/space exploration, SETI, infrastructure resiliency and international relations. He also holds appointments in the Center for Space Research and Geologic Sciences Departments at the University of Texas at Austin and is a Fellow of the British Interplanetary Society. Previously, Dr. Wisian was a senior state executive responsible for disaster recovery, oil spill prevention and response, and coastal infrastructure and environmental protection for Texas. Militarily, General Wisian, a navigator/bombardier, flew bombers, transports and fighters, is a graduate of the USAF Test Pilot School, and commanded the 147th Reconnaissance Wing flying the MQ-1 Predator. General Wisian participated in or led military disaster response efforts for the Shuttle Columbia crash and multiple hurricanes. Ken is a graduate of the US Air Force Test Pilot School and has more than 70 hours of medium and high-risk test flights. General Wisian has combat time in Iraq, Afghanistan and the Balkans, and his combat medals include the Bronze Star and Air Medal.

GEOLOGIC STORAGE AS PART OF CARBON DIOXIDE MANAGEMENT

Susan Hovorka, Sr. Research Scientist, Gulf Coast Carbon Center, Bureau of Economic Geology, Austin, TX

In order to reduce atmospheric build-up of CO_2, mechanisms are need to return CO_2 that is released from the earth back to long-term storage within the earth. Processes that liberate CO_2 include combustion of any carbon-based fuel, agricultural activities that release carbon from storage in soil and plants, calcination as part of cement manufacture, production of ethanol via fermentation, production of “blue” hydrogen, and many other types of product manufacturing. Options to return CO_2 to long term storage include the weathering of CO_2-reactive rocks and precipitation of carbonates, efforts to return carbon to soil storage, or injection into deep saline formation (DSF). In this talk we will consider the DSF options because they can accept large volumes and have a high technical readiness level.

Injection of CO_2 into DSF in many ways mimics the way that hydrocarbons accumulate in the subsurface and requires that the geotechnical skills used to explore for trapped oil and gas can be “inverted” to identify locations where CO_2 can be injected and trapped for geologic periods of time. In addition, geotechnical knowledge is required to design injection, to document that storage is effective, and to close the injection site.

The work done at the GCCC by our geologist-engineer-social science team started in 1998 and has expanded to the present team of 20 researchers and 15 sponsors. We conduct research funded by the DOE’s National Energy Technology Lab, by a diverse group of industries who have an interest in a lower carbon footprint, and by government agencies considering the social and financial value of carbon capture and storage (CCS). We consider where large volumes of CO_2 can be stored in short time frames, how the effectiveness of storage can be optimized, and how its permanence can be monitored.

Susan Hovorka, Ph. D., is a sedimentologist who works on fluid flow in diverse applications, including water resource protection, oil production, and waste storage. She has led a team working on geologic storage of CO_2 since 1998, with a focus on field studies, monitoring, and capacity estimation. Projects include saline injection at the Frio Test site and Cranfield Field and EOR studies at the SACROC oil field, Cranfield, Hastings and West Ranch industrial CO_2 utilization projects, and the GoMCARB offshore charaterization study. She specializes in monitoring to document retention. The Gulf Coast Carbon Center is leading efforts to develop offshore storage capacity in the the US and globally. She has a long-term commitment to public and educational outreach. She has a BA from Earlham College and a PhD in Geology from The University of Texas at Austin.

Hydrogen at Scale – Why Geology Matters

Mark W. Shuster Deputy Director, Research Bureau of Economic Geology (mark.shuster@beg.utexas.edu)

Energy deployment and long-duration energy storage are major challenges for a low carbon economy. Hydrogen (H_2) offers the potential for a transportable, storable energy carrier to realize a low carbon economy in the United States (U.S.). Hydrogen can be generated renewably using electrolysis, or from fossil fuels including natural gas and coal, which when combined with carbon capture and storage (CCS) can reduce greenhouse gas emissions. Natural gas is the main source of hydrogen from steam-methane reforming in the United States. Approximately 95% of the current US hydrogen production is generated from natural gas for petrochemical processing and industrial use. Technology developments in electrolysis using power from wind, solar, and nuclear sources offer the potential for cost-competitive hydrogen generation in the future. Regardless of the source of hydrogen, the use of hydrogen as an energy carrier at urban, regional or national scales will require development of a robust supply network integrating storage, transportation, and distribution infrastructure with potential markets.

Large-scale geological hydrogen storage is essential given the large volumes of hydrogen that will be required for even a partial hydrogen economy. In the U.S., an extensive natural gas pipeline and storage network provides an excellent starting point for considering hydrogen transportation and distribution options, including low percentage (e.g. 10%) admixtures of hydrogen with natural gas. Hydrogen has been stored for decades in salt (dissolution) caverns in the Texas Gulf Coast to supply petrochemical processing. However, salt caverns are limited to geologic basins with thick salt deposits. In addition, intra-salt heterogeneities and intercalated non-halite lithologies and potential impacts on hydrogen storage are not well understood. Porous-media reservoirs in saline aquifers and depleted hydrocarbon fields offer much greater geographic coverage in the United States and internationally. Saline aquifers and depleted hydrocarbon fields are used extensively for natural gas storage, but have not been tested and developed for hydrogen storage. The physical properties of hydrogen such as its low density and viscosity make it more mobile in subsurface reservoirs than natural gas. Additionally, hydrogen interactions with reservoir rocks, sealing caprocks, and existing reservoir fluids, require additional research to constrain uncertainties and risks, for example leakage, and inform geological storage developments.

Because of the importance of geological storage for large-scale utilization of hydrogen as an energy carrier, we have developed a hydrogen program called GeoH2, which is funded by industry, government and non-government organizations. The objectives of the GeoH2 research program are to improve the understanding of geological storage options for hydrogen storage to allow for integrated hydrogen systems and infrastructure to be developed for a range of potential markets.

Mark Shuster, Ph.D., (mark.shuster@beg.utexas.edu) is the Principal Investigator for the GeoH2 Industrial Affiliates Program, a consortium funded by BP, Equinor, GTI, OMV, Petrochina, Repsol, Saudi Aramco, Shell, Sinopec, the US Department of Energy, the Environment Defense Fund, and the State of Texas Advanced Resource Recovery (STARR) program at the Bureau of Economic Geology. Mark has a PhD in Geology from the University of Wyoming. He has 30 years of experience with Shell in oil and gas exploration and research and has been at the Bureau of Economic Geology since 2016 after retiring from Shell.

Near-surface geophysics and remote sensing

Jeffrey G. Paine, Ph.D., Senior Research Scientist
Bureau of Economic Geology, The University of Texas at Austin

The Near Surface Observatory (NSO) at the Bureau of Economic Geology is an aggregation of several research groups and individuals who apply modern geophysical, geologic, and remote-sensing methods to conduct studies focused on the surface and near-surface environment. Augmenting the efforts of the researchers and students is a suite of airborne, surface, and borehole instruments that provide information on the physical properties of the near surface. Individual studies are sponsored by a variety of federal, state, regional, and local governmental agencies and some private companies.

Active Research Areas

- Near-surface geophysics applied to geologic, hydrologic, and engineering issues
- Geologic mapping (regional and detailed)
- Geohazards assessment and monitoring(sinkholes, surface faulting, and subsidence)
- Soil and water salinization
- Groundwater resource assessments
- Transportation infrastructure
- Coastal studies

Research Assets and Applications

Airborne lidar (topographic and bathymetric), digital photogrammetry, and radar interferometry: Airborne- and satellite-based instruments are routinely employed to determine elevation and elevation change over time. These tools are useful for nearly every surface and near-surface application, including geologic mapping, subsidence studies, fault and sinkhole mapping, coastal erosion, and storm impacts and recovery.

Drones and drone-mounted cameras: Unmanned aerial drones carry RGB and infrared cameras to rapidly survey small areas and generate high-resolution imagery and digital elevation models. This method complements airborne lidar surveying of larger areas.

Electromagnetic induction (frequency and time domain): EM instruments measure apparent ground conductivity noninvasively from the ground surface to depths as great as a few hundred meters. These instruments are used to produce conductivity profiles along the ground surface as well as vertical conductivity profiles and cross sections. Knowledge of the lateral and vertical variations in ground conductivity are useful for characterizing surficial deposits and bedrock lithology, water-saturation trends, and pore-fluid salinity, among many other applications.

Slim-hole borehole geophysical logging system: This trailer-mounted logging suite consists of spectral natural gamma, electrical conductivity, and magnetic susceptibility probes, a motorized winch wound with 400 m of logging cable, and log analysis software. These tools produce high-resolution gamma and conductivity logs in boreholes and water wells. They are useful for determining site-specific lithology, water saturation, and groundwater salinity.

Shallow reflection, refraction, and passive seismic instruments: The AnySeis seismic data acquisition system includes 50 12-Hz horizontal and vertical geophones and seismic processing software to produce 2D and 3D images of the subsurface. This system explores geologic structure and stratal features at depths of a few to a few hundred meters. The Tromino passive seismic system uses natural, background seismic energy to determine depths to rigid bedrock.

Ground-penetrating radar: The GSSI SIR-4000 system with 200 and 350 MHz antennas is used to explore the ultra-shallow (surface to a few meters) subsurface, complementing the deeper exploration depth range of the seismic system. Applications include fault mapping, shallow-water bathymetry, geological stratification, and archaeological, architectural, and historical investigations.

Airborne geophysics: high-resolution electromagnetic induction and magnetometer surveys from helicopters and fixed-wing aircraft. These surveys produce high-resolution maps, cross sections, and volumes that allow sophisticated interpretation of near-surface lithology, structure, water content, and salinity. Rather than apply a single favorite tool or all available methods to a near-surface geological, hydrologic, or engineering issue, we seek to fully understand the problem or issue before selecting a tool or method, identify relevant physical properties that can serve as a reliable proxy for the problem or issue, select the appropriate instruments and platforms (airborne, surface, or borehole), and then design a measurement campaign to address the lateral and vertical scale of the problem. The next step is to analyze and interpret the proxy measurements in a manner that gives insight into the geologic, hydrologic, or engineering issue. The final step is to translate the results in a meaningful way to those who are affected by the problem or issue.

Jeffrey G. Paine, Ph.D., is a Senior Research Scientist at the Bureau of Economic Geology, The University of Texas at Austin, where he leads Near Surface Observatory activities in near-surface environmental and engineering geophysics, geologic hazards, geologic mapping, and applications of airborne lidar and imagery. He specializes in applying borehole, surface, and airborne geophysical and remote-sensing methods to help solve geological, hydrological, environmental, and engineering problems in the shallow subsurface. He is past president of the Environmental and Engineering Geophysical Society and the Division of Environmental Geosciences of AAPG, and, is a Fellow of GSA.

An Unmanned Aerial Vehicle (UAV) Magnetic Survey to Locate Plugged and Abandoned O&G Wells Prior to Construction of an Industrial Facility in Southeast Texas

Doug Laymon, Geophysicist, Collier Geophysics, LLC

A magnetic survey was conducted over a property under development for the construction of an industrial facility using an unmanned aerial vehicle (UAV) equipped with a Cesium vapor optically pumped magnetometer. The 247.5 acre area of investigation is located in southeast Texas. The objective of the survey was to determine the precise longitude and latitude f two abandoned oil and gas wells located at the site and scan the site for undocumented wells, pipelines, and buried metallic debris. This work was completed to assist in limiting the potential hazard of the presence of these features to a planned industrial development on the site.

A total of eight sorties or flights were required over a seven hours to collect 23.5 line miles of magnetic data. A ground Cesium magnetometer was deployed at a stationary location to measure the diurnal variations of the inducing magnetic field once every 30 seconds. The data were processed to correct for the diurnal variations of the inducing magnetic field, remove non-essential data, correct for line-to-line amplitude shifts in the data, and remove the international geophysical reference field (IGRF) before applying a correction to remove the effects of declination and inclination of the earth's magnetic field, a process known as reduction to the pole (RTP).

Color contour maps of the reduced to pole total magnetic intensity (RTP TMI) were created and interpreted to obtain the latitude and longitude of the two abandoned wells located on site. The depths to the top of the wells were estimated using a graphical analysis method. The location of a pipeline(s) parallel to a State Highway was also interpreted from the magnetic data. Confirmatory excavation of the wells was completed using the results of this investigation.

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Doug Laymon, M.S., P.G. Mr. Laymon is the manager of geophysical services and a Senior Geophysicist/ Hydrogeologist with Collier Geophysics, LLC. Mr. Laymon has over 35 years' experience in project management, hydrogeology, groundwater availability, mining, environmental sciences, and engineering geophysics. Mr. Laymon has conducted and overseen a variety of site hydrogeologic investigations in various locations and hydrogeologic environments. He has designed and managed numerous surface and downhole geophysical investigations and utilized geophysical techniques for site geotechnical and hydrogeological characterizations. He has a MS in geology, specializing in geophysics, and is a registered professional geologist in the State of Texas.

Bureau of Economic Geology – Austin Core Research Center Workshop and Tour

Linda Ruiz McCall and **Kelly Hattori**

Texas Bureau of Economic Geology

The **Bureau of Economic Geology** is the oldest research unit at The University of Texas at Austin and serves as the State Geological Survey of Texas. The Bureau conducts research on subjects of high interest to the energy industry and environmental firms, and a broad spectrum of companies actively participate in its **research consortia.** These unique industry partnerships study research subjects as diverse as salt tectonics, carbonate reservoir characterization, natural fractures and geophysics, carbon storage, nanotechnology, quantitative clastics, computational seismology, mudrock reservoirs, and energy economics.

The Bureau's **State of Texas Advanced Resource Recovery (STARR)** program has a mission to conduct geoscience and engineering research to increase the production and profitability of Earth resources, including oil, natural gas, hydrogen, geothermal and minerals, within Texas, while encouraging responsible economic development and supporting education and environmental stewardship.

The Bureau houses the largest collection of geologic material in the country in its three core repositories in Austin, Houston, and Midland. The three repositories hold more than 2 million boxes of specimens. These cuttings and core samples are fundamental for research in oil and gas, mineral, and geothermal exploration, as well as in hydrogeology and other fields. Safeguarding this collection ensures that the rocks are preserved so that future generations can read their story.

The **Austin Core Research Center (CRC),** located adjacent to Bureau headquarters, is the Bureau's main core repository for core and rock material donated to the University. More than 700,000 boxes of core and cuttings from wells drilled throughout Texas, the U.S., and the world are available at this facility for public viewing and research

Linda Ruiz McCall is a geologist, educator, and businesswoman with experience in government service, private industry, and public education. She holds a Bachelor of Science in Geological Sciences and a Master's in Business Administration from The University of Texas at Austin, and a Master of Arts in Secondary Science Education from Teachers College of Columbia University. Linda currently serves as the Information Geologist for the Bureau of Economic Geology which functions as the state geologic survey of Texas. Linda's experience includes project management and communication with an emphasis on geology, water, and energy resources. Linda leads the Bureau's Texas GeoSign Project which promotes the appreciation of geoheritage sites across the state. She has extensive speaking experience and is committed to helping to build understanding about natural resources.

Kelly Hattori is a carbonate sedimentologist and stratigrapher in the State of Texas Advanced Resource Recovery (STARR) research program at the Bureau of Economic Geology. She holds dual Marine Biology and Geology bachelor's degrees from the University of North Carolina at Wilmington, and a MSc in Geosciences from the University of Texas at Austin. Her research career is focused on carbonate stratigraphy and sedimentology of Paleozoic to Mesozoic formations in Texas. In particular, she works on reconstructing depositional systems and assessing the interaction of local, regional, and global controls on patterns of carbonate deposition.

Lorena Moscardelli, Ph.D., is a Research Scientist and leader of the State of Texas Advanced Resource Recovery (STARR) program at BEG. Her expertise is in seismic geomorphology and interpretation, sedimentology and stratigraphy and geoscience data integration. She received a degree in Geological Engineering from Central University of Venezuela (2000) and a PhD in Geological Sciences from The University of Texas at Austin (2007). She specializes in the study of deep-water deposits with emphasis on subaqueous landslides, deep-water mixed siliciclastic-carbonate systems and planetary geology. She started her career as an exploration geologist working for PDVSA (2000 – 2003). Prior to her current position at STARR, Dr. Moscardelli was a Principal Researcher at Equinor (2013 – 2021) where she performed a wide range of activities from research in the Americas to field development in the Norwegian Continental Shelf. Her BEG career includes the co-funding and co-direction of the Quantitative Clastic Laboratory (QCL) (2007-2013) and her actual involvement as leader of STARR.

Toti Larson, Ph.D., is a Research Scientist at the Bureau of Economic Geology and PI of the Mudrock Systems Research Laboratory (MSRL) research consortium. His research focuses on reservoir characterization by integrating and upscaling core measurements and observations with wireline log response curves and drill cuttings. Toti's research integrates geochemistry, geology, and petrophysics through machine learning, and he has applied his research to a wide range of mudrock systems.

DAY 2

THERE WILL BE A 2-HOUR INTERVIEW TO BE RECORDED LIVE AT GEODAYZ, FRIDAY AUGUST 5.

BEYOND SCIENCE: PROTECTING BARTON CREEK AND BARTON SPRINGS WITH GEOLOGY AND HYDROLOGY, PUBLIC ENGAGEMENT, AND ADVOCACY

Key Individuals Who Helped Initiate and Continue to Support the Save Barton Creek Movement

Raymond Slade

Certified Professional Hydrologist has contributed more than most to not only the science but also to the advocacy that has protected Barton Springs. Referring to the very important city council meeting in 1990, Raymond recalled, "Just before the meeting, I remember Dr. Kent Butler telling me that the council vote stood 4 to 3 to approve the development—no doubt the energy of the many attendees changed the mind of 4 council members. I was totally frustrated that I could not testify because, I had authored more reports about the hydrology of Barton Springs than anybody but was prohibited from testifying because I worked for the U.S. Geological Survey (USGS). I was especially upset hearing Jim Bob Moffett (advocate for development in the Barton Creek Watershed) state that he knew more about Barton Creek than anybody--I would have loved to debate him regarding such knowledge. There is no doubt that this Council meeting was "a" if not "the" major milestone to energize environmental protection for Barton Springs." Because of Raymond's lasting impression, deep friendships, and the environmental community 's great respect for his work and understanding of geology, hydrology, and environmental sensitivity of the Barton Creek Watershed, he was recently honored by the Save Barton Creek Association with the "Lifetime Groundwater Protector Award." As this award was being presented, Dr. Roger Lee and the staff at SBCA imagined and have collaborated to create this field day at Barton Springs, and interview of key community members from the Save Barton Springs movement to be presented in the workshop for American Institute of Professional Geologists-GEODAYZ Conference August 3-5, 2022. The Save Barton Creek Association has been working to protect Barton Creek for more than 40 years. They have created this session to demonstrate the local citizen participation, government and legal actions, media outreach and influence that has shaped the protection of the Barton Creek watershed and Barton Springs.

Homework: Earlier this year, the Barton Creek Timestream was officially launched. This is an incredible virtual resource and journey through time documenting public actions that have shaped the protection of Barton Creek and Barton Springs since the 1950's. You can stroll through the timeline at the Beverley Sheffield Education Center at Barton Springs or go online to read about the people and events that shaped this work.

Our panel will be moderated by Matt Curtis and includes: Commissioner Brigid Shea, Commissioner Jeff Travillion, Conservationist George Cofer, and Journalist and former City of Austin Councilman Daryl Slusher.

Brigid Shea

Brigid came to Austin in 1988 to start the Texas chapter of Clean Water Action. Prior to that she had been an award-winning journalist at NPR stations in Minnesota and Philadelphia. In Austin, she was a leader in the Save Our Springs movement of 1992 which resulted in Austin's historic SOS law to save Barton Springs. Shea was elected to and served on the Austin city council from 1993 to 1996 where she championed consumer, electoral, and environmental reforms. She has been an advisor to the LCRA, Seton Hospital, and the City of Austin. Her carbon-reduction work won the TCEQ Environmental Excellence award in 2010. In 2014 she was elected to the Travis County Commissioners Court. Currently, Shea is the USA Board Chair of ICLEI, Local Governments for Sustainability, the oldest UN recognized, non-governmental organization representing local governments; Chair of Air Quality subcommittee of the NACo EELU Committee. Shea serves on the national board of Clean Water Action, is a member of the state board of Texas Campaign for the Environment and is a former member of the Austin Chamber of Commerce Clean Energy Council. She was selected for the 2019 Women in Government Leadership Program of *Governing* magazine. Shea was recently given a Lifetime Achievement award by the Texas Energy Summit.

Jeff Travillion

Jeff has lived a life dedicated to public service, whether in state or local government at the Texas General Land Office, the City of Austin or standing up for civil rights as the President of the Austin Chapter of the NAACP. Jeff received his Bachelors degree from Jackson State University, where he was selected as an Alfred P. Sloan Fellow allowing him to study at Carnegie-Mellon University and Harvard University. Jeff then came to Austin where he attended the University of Texas LBJ School of Public Affairs graduating with his Master's in Public Administration. Jeff has been a leader in social and economic justice, education, labor, youth development, affordability, the environment, and overall quality of life issues. While serving on the 2011 Travis County Bond Committee, he led the effort to fund more than 50 road improvement projects in Northeast Travis County. Jeff puts people first and fights to ensure everyone's voices are heard—and will carry that with him as a County Commissioner.
Precinct 1 is where Jeff and his wife Perri have raised their three children. From youth sports boards to church youth groups and as advocates for public education, their life has been centered in East and Northeast Travis County. Throughout this time, Jeff has fought for the community to make sure no one was left out and as a member of the Commissioners Court he will do the same.

George Cofer

Mr. Cofer traces his conservation interests back to childhood summers on his family ranch on the Frio River, and to his outdoor experiences as an Eagle Scout. He is the founding CEO of the Hill Country Conservancy. The Conservancy has been active since 1999 in acquiring and protecting land in the central Texas area, including tracts in Travis, Hays, Blanco, Llano, San Saba and Burnet Counties. In 1992, he served as the founding Chair of Earth Share of Texas, which represents 70 environmental non-profits in workplace giving campaigns in the state. As early as 1990, he was active with Save Barton Creek Association, and over the years has also participated in the creation of the 1000-acre Barton

Creek Wilderness Park and the Sheffield Environmental Education Center; the Violet Crown Trail and helping preserve 45,000 acres in central Texas. For his many contributions in the conservation arena, he has been recognized by the Nature Conservancy of Texas, Travis Audubon Society, and the City of Austin Parks and Recreation Department.

Daryl Slusher

Daryl Slusher has lived in Austin since 1976 and has been involved in Austin government and politics since 1981. Throughout he emphasized that a strong economy, social equity, and environmental protection are connected. For example, throughout the 1980s Slusher worked closely with East Austin neighborhood and social justice activists. He also played a leadership role in successfully opposing building the convention center near the South Shore — helping to preserve the Hike and Bike Trail in the form so many enjoy today. In 1985 Slusher began a decade as a local journalist, first as co-editor of the *Daryl Herald* then, beginning in 1989, with the *Austin Chronicle*. *Texas Monthly* called Slusher, "the best and most entertaining writer on local politics." They also credited his June 1990 cover story on the Barton Creek PUD with setting off a massive uprising that culminated in an all-night public hearing and unanimous Council rejection of that project. Slusher left the *Chronicle* in November 1995 to run for City Council. He won, served three terms (1996-2005), then chose not to run again. Slusher's work on the Council included leadership in the purchase of thousands of acres to protect Barton Springs, and successful constitutional challenges to state laws that severely limited Austin's water quality protection powers. In 2007 Slusher was hired as an Assistant Director at Austin Water. There he led conservation efforts which resulted in the lowest per capita water use since the City began keeping records, helped guide Austin through an historic drought, oversaw climate initiatives, and led management of water quality protection lands. Slusher retired from Austin Water in December 2019 and in March 2020 reentered local journalism as publisher and editor of the *Austin Independent*.

Matt Curtis

This panel discussion will be moderated by Matt Curtis. Matt Curtis is close to being a native Austinite – he's lived in the area since he was 8 years old. He is a former right hand to the immediate past two Austin mayors, Matt has decades of experience working on municipal initiatives and best practices in a rapidly changing city. Most recently, Matt served as Head of Global Affairs and Public Policy for HomeAway and Expedia where he collaborated with government officials and community leaders around the world to create best practices and broadly beneficial regulatory and compliance policies for short-term rentals. In 2017 he formed Smart City Policy Group with other former policy makers to bridge the divide between the innovation economy and local government. From short-term rentals to ride-hailing apps, people are working and traveling in fundamentally new ways, and local and state governments are struggling to adapt regulations. Smart City Policy Group works closely with both corporate and community leaders to collaborate on systems that deliver the broadest benefit to all stakeholders. Matt has served on the United States Conference of Mayors Business Council, the National League of Cities Corporate Council, the Sharing Economy Advisory Network, the Travel Technology Association board and the Vacation Rental Management Association board. Matt also is a trained facilitator with 15 years of experience helping to connect and resolve potentially conflicting interests. Smart City Policy Group is the culmination of Matt's experience, skills and passion.

BARTON SPRINGS: HYDROLOGY, GEOLOGY, AND MANAGEMENT OF AN AUSTIN ICON

Brian A. Smith, Ph.D., P.G., **Jeff Watson**, P.G., and **Justin Camp**
Barton Springs/Edwards Aquifer Conservation District, Austin, Texas, www.bseacd.org

ABSTRACT
Barton Springs is a major recreational feature and a historical icon for Austin, Texas, that is also the main habitat for two species of federally listed endangered salamanders. Barton Springs receives discharge from the karstic Edwards Aquifer, and is an important groundwater resource for municipal, industrial, domestic, recreational, and ecological needs. The Barton Springs segment is located partly in south Austin, south of the Colorado River, extending south into Hays County to the city of Kyle, and between Interstate 35 and FM 1826 to the east and west, respectively. Approximately 60,000 people depend on water from the Barton Springs segment. Barton Springs is the lowest point of spring discharge from the Barton Springs and San Antonio segments of the Edwards Aquifer.

Hydrogeology
The Edwards Aquifer occurs in faulted and fractured Cretaceous limestone and dolomite, deposited on a shallow marine shelf with periodic clastic sediment input from the Llano uplift. The prolific karstic Edwards Aquifer system lies within the Miocene Balcones Fault Zone and provides water for ≈ 2 million people. Hydrologic divides separate the Edwards Aquifer into three segments, San Antonio, Barton Springs, and Northern (Ryder, 1996, Barker et al., 1994, Lindgren et al., 2004).

A groundwater divide between the Barton Springs and San Antonio segments of the Edwards Aquifer is situated in the vicinity of Hwy. 50 that extends to the west of Kyle. The Barton Springs/Edwards Aquifer Conservation District (BSEACD) is responsible for studying and managing this segment of the Edwards Aquifer. BSEACD also regulates pumping from the aquifer but has no direct authority for regulating any activities that can affect water quality. Aquifer studies, including numerical modeling, have shown that with high rates of pumping and extreme drought conditions, spring-flow from Barton Springs could decrease to the point that the endangered salamanders will be threatened. Decreased flow will lead to degradation of water quality. The most significant impact will be from decreased levels of dissolved oxygen.

Sources of Water
Because the Barton Springs segment of the Edwards Aquifer is a karst aquifer, recharge features such as sinkholes, caves, and enlarged fractures strongly influence how water recharges and moves through the aquifer. Most of the recharge to the aquifer occurs where streams flow across the Edwards recharge zone. Surface water derived from the contributing zone west of the Edwards outcrop enters the aquifer through these karst features resulting in total recharge to the aquifer ranging from 39% to 75% (Hunt et al., 2019). Recharge in the upland areas within the recharge zone situated above the stream beds is estimated as about 25% to 61% of total recharge. Depending on aquifer levels, some amount of recharge to the Barton Springs segment comes from the San Antonio portion to the south. Some of this flow could be underflow that bypasses San Marcos Springs. Other sources of recharge include the Blanco River that crosses the recharge zone of the San Antonio segment northwest of San Marcos.

Discharge of Water
Spring flow from Barton Springs is an important measure of the overall condition of this segment of the Edwards Aquifer. A network of conduits directs water from the recharge areas to the spring outlets. The approximate locations of some of these conduits has been determined with dye-tracer studies. Drought declaration based on timely and accurate spring-flow data triggers pumping restrictions imposed by BSEACD. The USGS-WRD has been measuring spring-flow at Barton Springs since the early 1900s, and by 1978, a stage-discharge relation (or rating curve) was developed for a well near the Main Spring of Barton Springs Pool. Manual measurements below the pool at the confluence with Lady Bird Lake are required to verify the stage-discharge relationship and to make any shifts or corrections to the data. As the 2011 drought conditions worsened, accurate spring flow data became more important as drought trigger values (20 cfs) were approached and eventually reached. Long-term average discharge from Barton Springs is about 60 cfs. Maximum flow rates during periods of extreme rain events are about 160 cfs. The lowest flow ever measured was about 10 cfs during the drought of record of the 1950s. At that time, there was very little pumping from the aquifer.

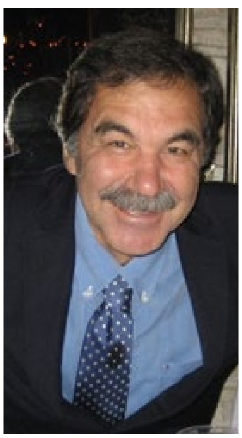
Brian Smith has been the Aquifer Science Team Leader and Principal Hydrogeologist at the Barton Springs/Edwards Aquifer Conservation District since 2001. At the District, he has guided the science program to support policy makers in management of the aquifers within the District. Most of his 35+ years of professional experience have involved the study of karst and aquifers developed in karst. Prior to working at the District, he worked for private consulting companies doing contaminant hydrogeology. In addition, he has provided technical support to a number of litigation projects. Brian Smith has a bachelor's degree from Rice University in Houston and a Ph.D. from the University of Texas at Austin. He is licensed as a Professional Geologist in the state of Texas.

MULTI-GEOPHYSICAL CASE STUDY OF A KARSTIC AQUIFER

Mustafa Saribudak, Ph.D., Environmental Geophysics Associates (EGA)

Barton Springs in Austin, Texas is a major discharge site for the Barton Springs Segment of the Edwards Aquifer. Barton Springs consists of at least four springs. Main Barton Springs discharges into the Barton Springs pool from the Barton Springs fault. Surface geophysical surveys [resistivity imaging, induced polarization (IP), self-potential (SP), seismic refraction, and ground penetrating radar (GPR)] were performed across the Barton Springs fault and Main Barton Springs during the years of 2012 and 2013. The purpose of the surveys was two-fold: 1) locate the precise location of submerged conduits (caves, voids) carrying flow to Main Barton Springs; and 2) characterize the geophysical signatures of the fault.

Geophysical results indicate significant anomalies to the south of the Barton Springs pool. Most of these anomalies indicate a fault-like pattern, in front of the south entrance to the swimming pool. In addition, resistivity and SP results in particular show the presence of a large conduit in the southern part of the Barton Springs pool. The groundwater flow-path to the Main Barton Springs could follow the locations of those resistivity and SP anomalies along the newly discovered fault. Since the geophysical work done, in December 2019, Main Barton Spring started discharging plumes of turbidity flows into the Barton Springs swimming pool (BSSP). Within a couple of days, the source was a geothermal drilling site at a residential neighborhood, which is located about 4,000 ft to the southwest of the pool. During the drilling operation ten closed-loop geothermal wells were drilled into the karstic Edwards Aquifer. A report concluded that a void was encountered at a depth of 240 ft and was likely connected to a karst conduit flowing to the BSSP. The estimated pathway corresponds to the geophysical anomalies to the south of the BSSP.



Mustafa Saribudak is the principal of Environmental Geophysics Associates (EGA), ega@pdq.net. He holds a Master's in geology from the University of Istanbul and a PhD in geophysics from the Istanbul Technical University (ITU) in Turkey. He worked at ITU for a year as assistant professor. He then came to the University of Houston in 1990 as a visiting geoscientist. He founded EGA in 1994 to provide near-surface geophysical services for engineering, environmental, and oil and gas industries, and real estate developers. During the last 26 years he has conducted many geophysical surveys successfully in the U.S., Central and South America, and Canada. He has published numerous papers and short notes in geophysical and environmental journals. He lives in Austin.

Riparian Stream and Native Plant Display Area in Zilker Botanical Gardens, Austin,Texas

David Mahler, Ecologist, Environmental Survey Consulting, dvmahler@envirosurvy.com

In 2017 an existing artificial streambed at the Zilker Botanical Gardens, which was unsightly, leaky, and in need of extensive repair, was replaced with a concrete lined streambed with wetland planting niches designed as a display area for Texas native wetland and riparian plants. This stream and its associated paths connect the Taniguchi Japanese Garden, installed a half century ago, to the Rose Garden pond. The goal was to enhance the beauty, sustainability and educational potential of this underdeveloped area of the gardens. This 125-ft long stream consists of three linked concrete shells enhanced and hidden by large natural stones sourced from limestone quarries located on the Edwards Formation northwest of Georgetown, Texas. These stones were shaped, fitted, and mortared into the shell to create waterfalls, pools, bridges, and stream edges which retain wet soil areas for planting. Typical cross sections and photos of before, during, and after construction will be displayed during the tour to show the currently hidden substructure. After construction the stream and surrounding gardens were planted with a selection of approximately 100 plant species native to Central Texas. These include submergent, floating and emergent wetland species as well as species that might be typically seen in adjacent riparian woodland habitats. A list of useful Texas native wetland and riparian plant species will be provided for tour participants.

David Mahler is the ecologist for Environmental Survey Consulting, a company that specializes in site analysis, seed harvesting, habitat restoration, restoration landscaping, naturalistic rockwork, wetland and pond construction, and park and trail design and construction. He has been a pioneer in site-specific restoration in Central Texas since initiating restoration projects at Wild Basin Preserve in 1982 while he was their first Executive Director. He is a founding board member of the Society for Ecological Restoration International and an Ecologist for Environmental Survey Consulting, Inc.

Project Management for Environmental Sciences

Julia K. Wilson, Ph.D., P.G., Roux Associates, Inc.

Project management is the planning, organizing, and managing of tasks and resources to accomplish a defined objective, typically within specific time and cost constraints. It is the "application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project" (PMI Standards Committee, 1996). Once we understand the basics of what project management is, we will find that it is applicable across disciplines from business to academia. Ultimately, project management is about taking a project from inception to successful completion in a logical, organized way.

To understand how to get to that successful completion, it is important to define, at the outset, what "success" means for a given project. Once the problem or project is defined, project management helps us work through the steps needed to arrive at completion. In academia, perhaps the problem or project is completion of a specific degree program or publishing your research in a specific journal. In business, it is usually delivering the agreed upon work product to the client within the appropriate time and budgetary constraints. In general, "success" means:

- Customer/client requirements are satisfied/exceeded;
- The project is completed within the allotted time frame;
- The project is completed within the allocated budget; and
- The work product is accepted by the customer/client.

Once "success" has been defined, it is important to realize that a project can become somewhat derailed at various points, resulting in project failure. Failures occur primarily due to scope creep/improperly defined scope, poor requirements gathering, unrealistic planning and scheduling, and a lack of resources. The role of the Project Manager is to accomplish the project objectives by balancing the competing demands for quality, scope, time, and cost.

In this presentation, we will discuss the essentials of successful Project Management from project initiation, planning and design, project execution, monitoring and controlling, and completion. We'll also discuss the importance of adapting and overcoming the inevitable complications that can arise during project execution to get the project back on track.

Julia Wilson specializes in management of due diligence Phase I and Phase II Environmental Site Assessments; preparation and management of Remedial Investigation Work Plans, Remedial Investigation Reports, Remedial Action Work Plans, and Final Reports. She has 17 years' experience as principal geologist/office manager, Roux, Inc., Houston, Senior geologist asst. office manager, EarthCon, Houston, and staff geologist/project manager, RETEC/AECOM, Nyack, NY. She has BA in Environmental Geology & History from Colgate University, MA in Geology from Georgia State University, and Ph.D. in Geological Oceanography from Texas A&M University.