Personal, Background, and Future Goals Statement

Attending sewer board meetings over the past 17 years (as an elected official and commissioner for the local wastewater plant at the shore of Richardson Bay in Mill Valley, California), I am uniquely aware that sea level rise (SLR), and groundwater flooding through preferential pathways in the urban area are an impending environmental disaster which few agencies are planning for. As a California certified hydrogeologist, environmental consultant, expert witness, engineering contractor, driller, and sewer board member, I know better, and that is the reason why I am pursuing a PhD in coastal urban hydrogeology – to help my agency and other similar urban coastal communities evaluate reoccurring conditions related to SLR, extreme rain events, remobilization of buried contaminants, lateral migration of volatile organic compounds through leaking sewer pipes, and rising groundwater.

One of my first large environmental projects as a hydrogeologist in 1989 was mapping shallow impacted groundwater flow for the Santa Clara, California Preferential Pathway Study. The study area, a U.S. EPA Superfund site, has a 3.2 km chlorinated solvent plume. The preferential pathway study was based on thousands of well logs, driller's logs, borehole logs, electric logs, regulatory agency files, dry wells, historic maps and interviews. The objective was to identify the dry wells and drains which were the solvent release points and the shallow buried sandy channels which allowed for migration of the trichloroethylene (TCE) plume. This project proposal on groundwater rise and flooding study uses many of the same techniques and research methods used in my successful 3-month preferential pathways study of this EPA Superfund site.

Since 2003, I have been a publicly elected official (Director) of the Tamalpais Community Services District, the local community services agency which provides sewer collection, recycling, garbage pickup, and park and recreation services to about 7,500 residents in Tamalpais Valley, California. I have also served as a commissioner of the Sewerage Agency of Southern Marin (Mill Valley, California). What makes me stand out among the other elected directors at the sewer collection agency and wastewater treatment plant commissioners are my skills and experience, interest in collaboration, and scientific curiosity. I am the only director who is a trained earth scientist, on either board. My technical background is a good match because the board oversees a highly technical treatment operation. I am interested in the sustainability of the operations and optimizing the technical aspects of the wastewater treatment process. I am focused on the cost-benefit of maintaining subsurface pipe systems and on the high costs of treatment for both shallow groundwater and salt water intrusion into leaky sewer pipes. Near the tidally influenced San Francisco Bay shoreline, the sea water currently intrudes into the leaky gravity-fed sewer pipes. SLR will only make the problem worse, providing greater head pressure for pipeline infiltration of high-salinity water for which sustainable recycling options are more challenging.

A memorable event in my career merged my interest in public service as an elected official with my knowledge and experience as a hydrogeologist and engineering contractor. The extreme rainfall events in January 2008 in northern California filled leaky sewers to such a degree that the increasing water pressure in the pipes caused 113 kg manhole lids to raise high enough to release raw sewage and groundwater into the streets in the area. The event caused numerous wastewater treatment plants on San Francisco Bay and on the Pacific Ocean to overflow, as many plants did not have the storage capacity for the excessive storm event. I was vice president of the agency at the time and had to rely on my communication skills as I had several calls from the local press. Since 2008, we have spent over $40 million increasing the water storage capacity and significantly upgrading the wastewater treatment plant.

After the 2008 flooding event, I started collaborating more with the civil engineers who design and maintain the sewer pipes. I needed to understand the technical details of the subsurface hydrogeology processes in urban coastal areas. I was well aware that sewer cracks and pipe separations are ubiquitous in the subsurface, however, I was surprised to learn that sewers are not even designed to be water-tight, with an allowable leakage factor which has been defined by ASTM[1]. Since the January 2008 extreme storm, I have collaboratively worked with the engineers and agency managers to have seen dozens of sewer videos with obvious pipe cracks, tree roots, pipe bellies, pipe separations, and features which create subsurface leakage. My curiosity also took me into the field to observe smoke testing for pipe leaks of low-lying sewer lines. I started researching the hydrogeology of shallow groundwater infiltrating into leaky sewer lines as well as raw sewage and industrial wastes exfiltrating out of the pipes and into the surrounding utility trench

back fill and shallow groundwater. About a year later, U.S. EPA and others were concerned about indoor air quality and vapor intrusion of chlorinated solvents tetrachloroethylene (TCE) and perchloroethylene (PCE). At the time, the science was focused on groundwater plumes of benzene, PCE and TCE underlying residences, and the vapors migrating upward into residential basements and living spaces. At about this time, I was involved with an expert witness case related to suspected illicit drugs released into groundwater through a damaged plumbing-sewer system in northern California. By 2014, I realized that urban hydrogeology and preferential pathways were not well documented. I started researching articles on the subject. In 2014, I found Dr. Kelly Pennell, Assistant Professor of Civil Engineering at the University of Kentucky had done work on PCE vapor intrusion into a residential unit due to a leaky sewer line and a faulty p-trap on a toilet near Boston. We corresponded and collaborated on a training session for the California Department of Toxic Substances Control (DTSC) in Sacramento. She discussed her Boston data, and I discussed the intersection of hydrogeology and leaky sewers providing sewer flow data from the January 2008 extreme storm event. From this work, I was invited as a speaker to present my findings at vapor intrusion conferences hosted by AIPG, AEHS, GRAC, and the California Certified Unified Program Agencies (CUPA). I have performed university-funded and self-funded research with Dr. Pennell relating to volatile organic compounds in the air space in sewer pipes in Mill Valley and Mountain View, California. With Dr. Pennell and others, I co-wrote articles for GRAC's *Hydrovisions*[2] and for *Science of the Total Environment*[3]. These two articles were cited in a May 2020 overview article in *Environmental Science & Technology* by leaders in the field of vapor intrusion investigations and decision-making. We also made three presentations at AEHS and AIPG technical meetings[4,5, and 6]. I delivered three other co-authored technical presentations on urban hydrogeology and the sewer-plumbing connections[7, 8 and 9] presented for AEHS and AIPG.

Intellectual Merit

My major talent is reaching out and collaborating with others outside my area of expertise to problem solve in multidisciplinary areas of research. I have demonstrated an ability to bring others together in successful teams of experts with different education and training to work with me to develop training programs or in the case of my writing, to co-author with me on 5 technical books. The books focus on environmental considerations of industrial chemicals or processes and were co-written between 2001 to 2019. I also co-authored 75 encyclopedia articles. The proposed multidisciplinary project is bringing other experts to collaborate with me on the role of preferential pathways such as leaky sewer pipes and utility trench backfill related to emergent groundwater from SLR in coastal urban areas. This project is a logical extension of the experience I gained from the Santa Clara, California Preferential Pathway study combined with the leaky sewer-vapor intrusion study in Mountain View with Dr. Pennell.

Professional development and continued skill building have been furthered by my active association with professional organizations such as my 26 years with the Groundwater Resources Association of California (GRAC), 31 years with the National Ground Water Association (NGWA), 31 years with American Institute of Professional Geologists (AIPG) and 18 years with the Association for the Environment, Health and Sciences (AEHS), among others. I have served as an elected board member and officer of several of these associations as well as having received a variety of awards for my service to these organizations. I encourage others in the profession as my volunteer activity in these groups has allowed me to mentor students, expand friendships, make business contacts as well as add to my skill set. To encourage geology students, I currently sponsor four AIPG student chapters: University of California Davis as of 2010, Sonoma State University as of 2016, SRTM University (India) as of 2017, and University of California Santa Cruz as of 2020. Since 2005, I have been on the Science Advisory Board of AEHS, reviewing abstracts and judging student presentations. Through AEHS, NGWA, GRAC and AIPG technical conferences and annual meetings that I have made presentations and participated in discussions with others on leaky sewers acting as conduits for infiltrating volatile organic compounds (VOCs) dissolved in groundwater or VOCs entering into sewer air creating possible human exposure through vapor intrusion. Recently, I was invited to join the Technical Advisory Committee for the San Francisco Bay Climate Resilience Challenge (CRC) Groundwater/SLR Study sponsored by the San Francisco Estuary Institute (SFEI).

I propose to collaborate with USGS, northern California county flood control agencies, SFEI and their partners, and others with sources of data, to initiate cooperative discussions to develop ideas for groundwater flooding mitigation strategies. The SLR challenges related to urban coastal preferential pathways relates directly to my unique qualifications in education, training, and experience with leaky sewers and other urban preferential pathways, contaminant hydrogeology, and knowledge as a geologist, driller and engineering contractor. I am highly motivated to use my skills and knowledge to perform original research at the PhD level where I will acquire new or updated skills related to hydrogeological modeling, computer programming, statistical analysis, Bayesian network studies, and cost benefit analysis. I am applying for a coastal urban hydrogeology PhD program to use my qualifications and experience and collaborate with others. My goal is to make a significant original contribution to the scientific literature and public understanding of urban coastal hydrogeology related to SLR and preferential pathways.

Broader Impacts

The project work products will include the development of several nationally transferrable elements: Methodology, a hydrogeology Model, a Bayesian network (Tool), and Mitigation strategies including a cost-benefit analysis for use by coastal communities to address local groundwater flooding due to SLR and extreme rain events. The project work products will be designed to be used with local data, allowing decision makers nationwide to address emergent groundwater problems in their communities. I will collaborate with others in public meetings, technical conferences, and write publications with others to help facilitate an understanding of the subsurface groundwater movement in urban coastal preferential pathways as it relates to SLR.

After completing my university studies, I will communicate the importance of earth science in solving some of the most difficult environmental and resource challenges to technical and non-technical audiences by offering public workshops and courses on urban hydrogeology. I also plan (presuming a post-COVID rebound in the travel industry) to continue cruise lecturing as a guest geologist (started in 2007) on topics ranging from the geology of port locations, WWII and the discovery of plate tectonics, to the geochemistry of historic beers.

I have a long-term goal of applying for a 1-year American Geological Institute (AGI) Congressional Fellowship in Washington, D.C. (AGI Fellowship). This highly competitive award allows a professional with a PhD in geology to provide expertise to members of Congress. If selected as an AGI Fellow, I would be able to serve the public and communicate and answer technical questions about complex science issues for members of Congress. The AGI Fellowship would provide me with an opportunity to collaborate with staff members on important geologic and environmental topics of national interest.

REFERENCES

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