Professional Statement in Support of the Goliad County Groundwater Conservation District Request to the Texas Commission on Environmental Quality to Deny the Renewal of UEC's ISR Permit (UR03075)

April 2, 2024

Professional Qualifications

My name is Richard J. Abitz. I have a Doctor of Philosophy in geology (emphasis in geochemistry) from the University of New Mexico and over 35 years of experience as an environmental consultant dealing with problems associated with the solubility and mobility of hazardous and radioactive elements in the sediment/water environment of major aquifers.

I presently serve as the director of the Environmental Restoration (ER) Group for the Idaho Closure Project contract at the Department of Energy's (DOE) Idaho National Laboratory Site. The ER Group is an organization of 20 scientists, engineers, and technicians who are responsible for executing groundwater and soil remedial actions to protect human health and the environment, as established in the Record of Decisions under the Comprehensive Environmental Response, Compensation, and Liability Act (42 USC § 9601 et. seq.). The primary actions are to 1) remediate and monitor groundwater contaminated by hazardous solvents and radioactive isotopes, 2) inspect and maintain established environmental controls at legacy sites were remedial actions removed contamination, and 3) prepare annual reports on the progress of remedial actions.

My experience also includes decades of work with uranium contamination in the surface environment and groundwater at the DOE Portsmouth and Fernald Sites. At the Portsmouth Site, which produced low enriched uranium for commercial power plants and highly enriched uranium for weapon components and Navy ship reactors, I served as the senior scientist responsible for dose calculations to assess the risk to human health associated with exposure to uranium and other radionuclide isotopes under present conditions and a future condition where all contamination was buried in an on-site disposal facility. At the Fernald Site, which processed uranium ores and yellow cake for over 30 years (1952 to 1985) to produce uranium metal for plutonium production reactors at the Hanford and Savannah River Sites, I managed the Environmental Services Division for the Fernald Closure Project. Our division was responsible for 1) installation and development of monitoring, extraction, and injection wells, 2) air, water and soil sampling activities, 3) analytical facilities for the measurement of radionuclides, metals, and organic compounds in soil and water samples, 4) *in situ* measurements of ^{226}Ra, ^{232}Th, and ^{238}U activities in soil using sodium-iodide and high-purity germanium detectors, 5) data verification, validation, and reporting, and 6) data analysis, modeling, and reporting.

In addition to my work at DOE sites, I have served as a subcontractor to the Environmental Protection Agency (EPA) in support of groundwater remediation at the Homestake uranium tailings site north of Milan, NM. For the Navajo Nation (New Mexico), Sioux Nation (Nebraska), Goliad County Groundwater Conservation District (Texas), and National Resources Defense Council, I served as a technical expert and witness to evaluate the impact of proposed *in situ* uranium leach mining on community groundwater supplies. I have also provided technical input to the Wyoming Powder River Basin Resource Council's comment responses to EPA's proposed Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192).

Based on my geology education and environmental work experience, I have extensive theoretical, laboratory, and field knowledge on 1) the solid forms of uranium in aquifer sediments; 2) the chemical reactions that are responsible for the mobilization and/or adsorption/precipitation of uranium from groundwater systems; and 3) well fields and ion-exchange operations associated with recovering groundwater that is contaminated with uranium. Therefore, I am qualified to provide scientific arguments in support of GCGCD's request to TCEQ to deny the renewal of UEC's Permit (UR03075) for in situ recovery (ISR) of uranium at the proposed Goliad ISR site.

Stratigraphy and Faulting in the South Texas Coastal Plain

The uranium deposits of South Texas occur in sediments deposited in complex fluvial-shallow marine depositional environments, which differ from the stratigraphically simpler classic roll-front deposits observed in Wyoming and other western uranium districts (Adams & Smith 1980). In addition to the complex lateral and vertical variation in the fluvial stratigraphy, hundreds of growth faults cutting the Pleistocene and Holocene sediments exposed in the coastal plain have been mapped (Verbeek 1979, Yeager et al 2019). The growth faults juxtapose older stratigraphic formations against the younger units, such as the Goliad sandstone units identified by UEC for ISR uranium mining. Researchers have also established that uranium deposits in the permeable fluvial sandstone beds are commonly associated with disseminated pyrite that formed from the upward transport of hydrogen sulfide (from deeper evaporite beds) along the growth faults (Adams & Smith 1980, and references therein).

A combination of fluvial stratigraphy cut by growth faults creates a complex three-dimensional subsurface where downgradient flow pathways along or across fault boundaries and through tilted and fractured lithologic units become impossible to predict over the area of the proposed Goliad ISR mining operation. Complex subsurface flow models developed for the Edwards aquifer, located in a geological environment in south-central Texas similar with the proposed Goliad mining site, required extensive data from drill holes and rock core, mapped faults and other geologic structures, aerial photography, and seismic and electromagnetic surveys; and the resultant model was marginally successful at predicting groundwater flow paths (Pantea et al 2008). UEC groundwater flow models are far simpler than the complex model developed by Pantea and others (2008), and there should be no confidence placed in the UEC model projections of contaminant transport beyond the injection/recovery well clusters.

In summary, the complex subsurface geology at the proposed Goliad ISR mining site precludes *in situ* leaching operations at this location because the lixiviant injected into the ore zone cannot be isolated within the monitor well ring. The migration of mining fluids outside the monitor well ring (i.e., excursions) is a common occurrence at ISR sites with simple subsurface geology (Staub et al 1986). If the UEC permit is renewed by TCEQ, excursions at the proposed Goliad site will occur and impact private wells, as has been observed for other Texas ISR operations at Rosita and Kingsville Dome.

Groundwater Quality at the Proposed Goliad ISR Mining Site

Uranium and radon concentrations in groundwater will be the focus of this discussion because they are the most mobile contaminants released by ISR mining. Uranium because the ISR process is designed to mobilize uranium for recovery as uranyl carbonate ions [$UO_2(CO_3)_2^{-2}$ and $UO_2(CO_3)_3^{-4}$] and radon because it is an inert gas (i.e., no chemical interactions with the solids in the aquifer) that migrates at the same or greater rate than the groundwater.

Figure 1 shows the location of nine private wells, two UEC injection wells, and the proposed UEC permit boundary. Except for the Abrameit and Mooreland wells, seven of the wells are located 500 to 1,700 feet from the permit boundary. The Abrameit well is within the proposed permit area and the Mooreland well is about 1.5 miles to the southeast of the permit boundary.

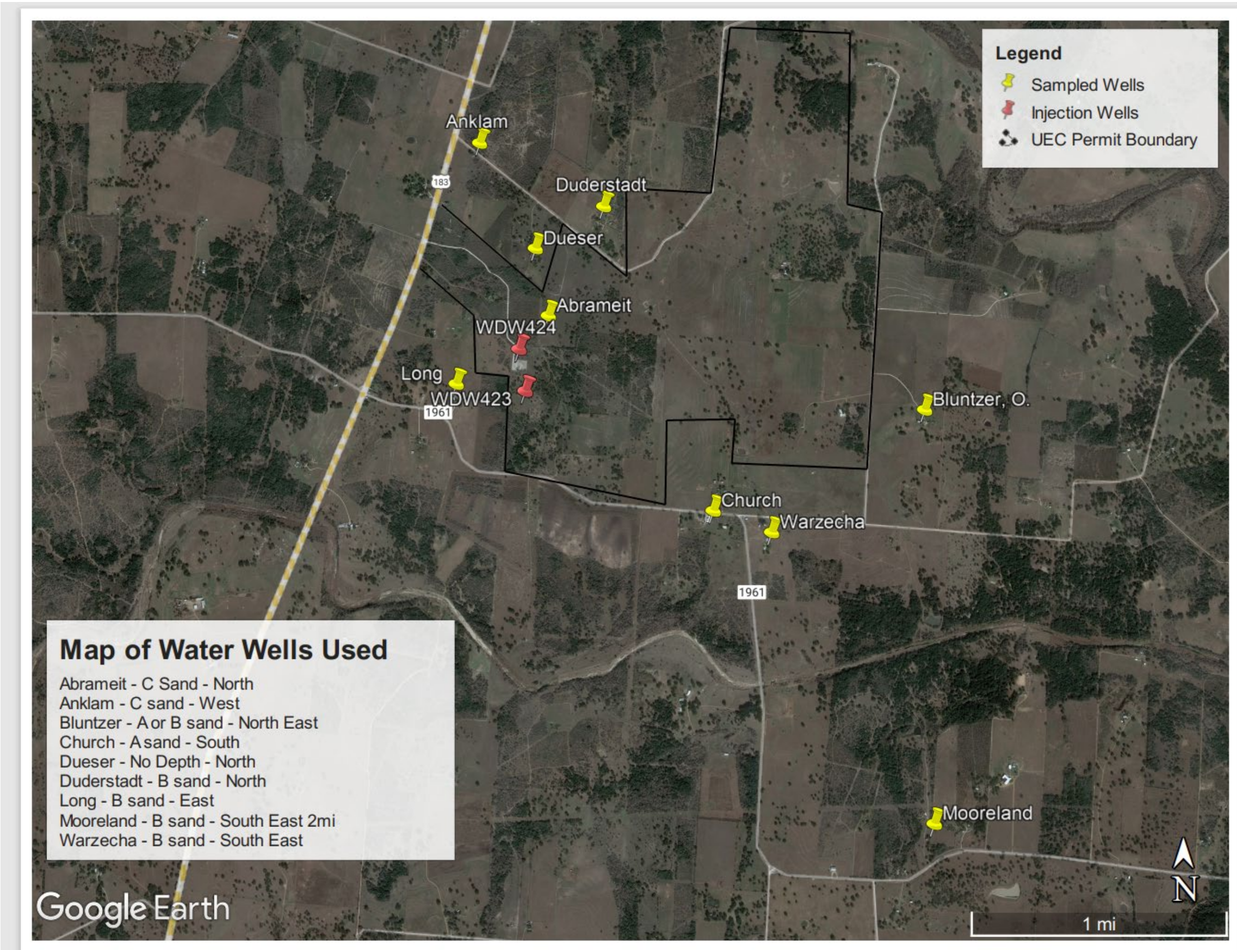

FIGURE 1. Private wells adjacent to the proposed UEC ISR permit boundary.

Figure 2 plots the trends for uranium concentrations for private wells adjacent to the proposed UEC permit area and UEC uranium results for production zone wells (not shown on Figure 1). Many of the private wells have been collecting groundwater quality data for over 16 years, which provides an excellent temporal record for the variation in uranium concentrations for groundwater undisturbed by ISR mining operations. Results for the private wells show very little temporal variation in uranium concentrations (Figure 2), that is there is very little change in the measured concentration of uranium over the past 16-plus years.

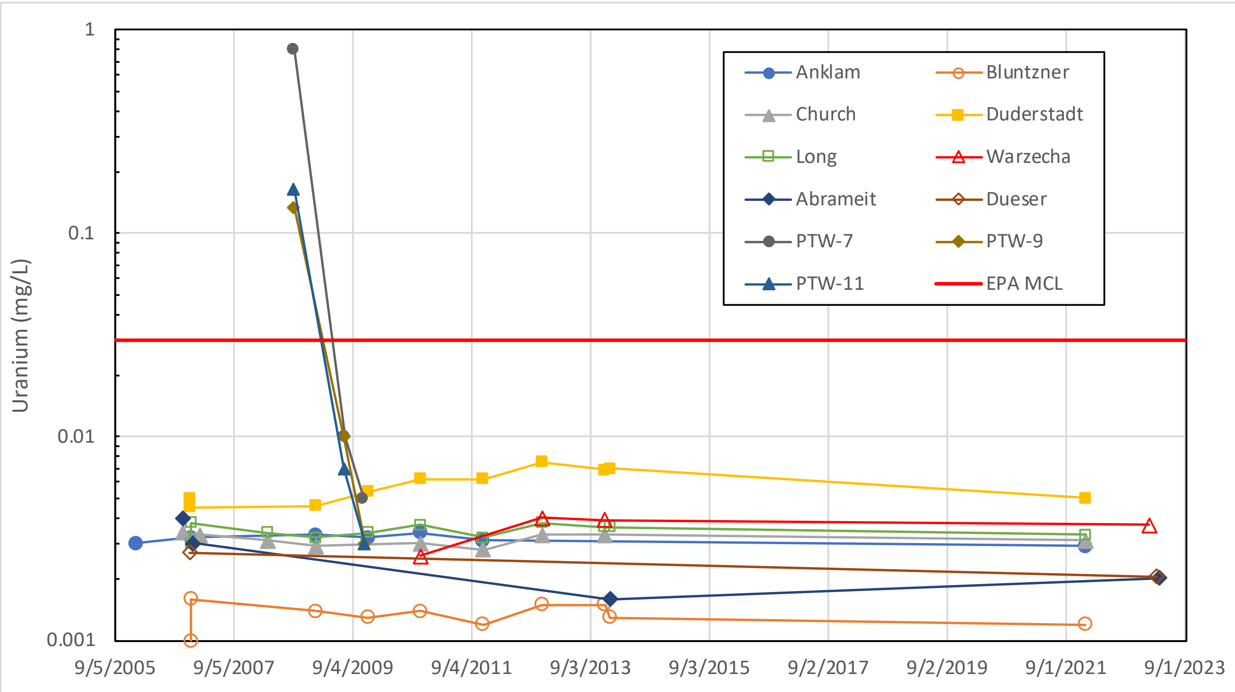

FIGURE 2. Temporal variation of uranium in private wells and ore-zone wells.

In contrast to the private wells, the sample dates for each ore-zone well (PTW-7, PTW-9, PTW-11) show large differences in uranium concentrations (Figure 2), due to the initial samples being collected after drilling the wells in 2008. Well drilling uses water that contains higher levels of oxygen, relative to the reduced aquifer water, and drilling also grinds the ore into finer particles that have a higher surface area for oxidation reactions. The result is oxidation of the uranium ore particles and higher uranium concentrations. Because the drilling is a transient process, the low levels of oxygen introduced into the aquifer are consumed and, without injection of oxidizing lixiviant (i.e., active mining), reducing conditions return and uranium concentrations drop back to baseline levels. Note that the baseline levels for uranium in the reduced ore zone (2009 dates) are nearly identical to those in the private wells. That is, they all are about an order of magnitude lower than the EPA established maximum contaminant level (MCL) for uranium (0.03 mg/L). It is also noteworthy to point out that UEC, and the ISR industry, are allowed to use the higher values induced by drilling (2008 values from ore-zone wells) as 'baseline' for the ore zone, which biases restoration values to high concentrations far above the true baseline for uranium. Additionally, when submitting their request to TCEQ for renewal of their permit, UEC made no effort to revise their biased 'baseline' submitted with the original permit with the 2009 values. Figure 2 clearly illustrates that the true baseline values for uranium in the ore zone (2009 results) and private wells are well below the EPA MCL for uranium.

Radon values for the private wells (Figure 3) show a large range of measured concentrations over the 16-plus years of monitoring. The Long and Blutzner wells show a sharp increase in radon values around 2011, a peak concentration in 2012, and a sharp decline thereafter. Although not as evident, this trend is also observed in the Anklam and Warzecha wells. All wells, except Abrameit, show a decline in radon values after 2013. The high values for the Abrameit well probably reflect its location within the proposed permit area (Figure 1) and proximity to ore deposits in the subsurface.

UEC drilled over 700 boreholes/wells in the proposed permit area between May 2006 and September 2008 to establish ore locations and a 'baseline' groundwater quality in the ore zone and surrounding aquifer. As noted above for uranium results, true baseline values for the groundwater were not established by UEC. It is highly probable that the observed radon peak concentrations in 2012 reflect the transport of radon from the large disturbance in the ore zone during the drilling of over 700 boreholes/wells. As radon moves with the groundwater along fault zones, fractured sandstone, and permeable channel sandstones, the peak radon concentrations indicate groundwater flow paths connect the ore zone to the private wells. The initial indication of a significant increase in radon values occurred in 2011, which implies high levels of radon can reach private wells within three to five years of disturbing the ore zone (borehole drilling began in 2006 and well drilling ended in 2008).

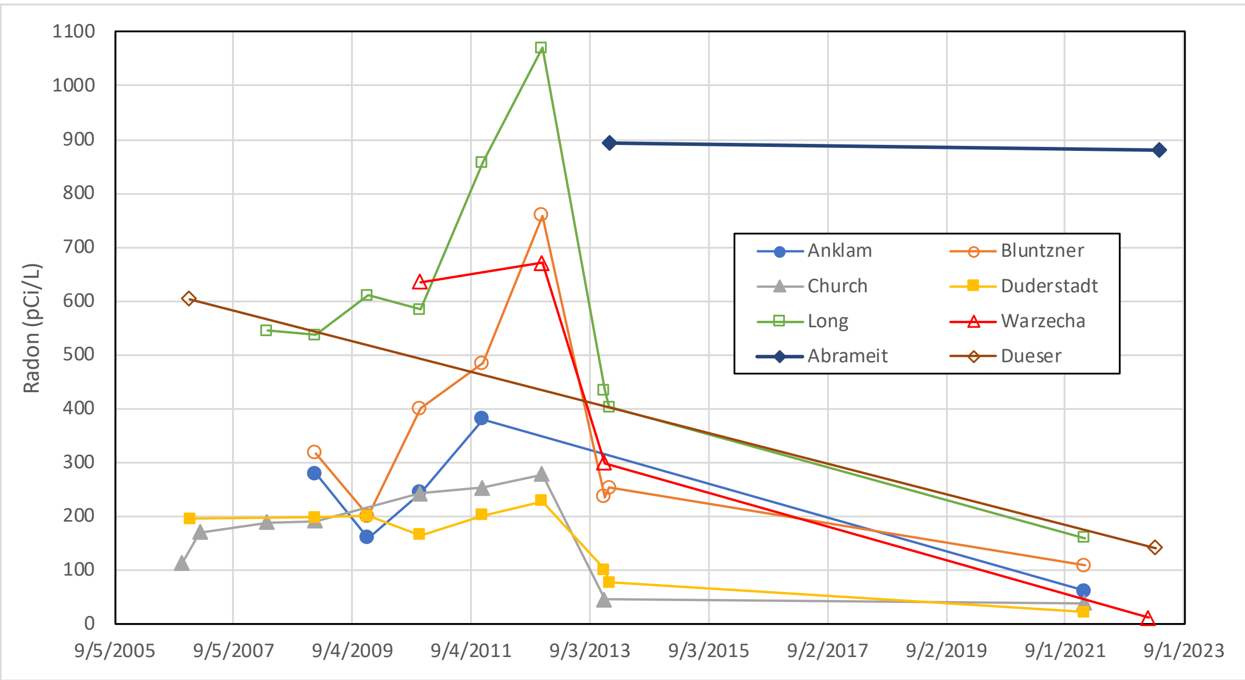

FIGURE 3. Temporal variation of radon in private wells.

Although EPA does not regulate radon levels in groundwater, they are proposing to regulate state water systems to achieve less than 4,000 pCi/L in groundwater provided by community water systems. Radon in the water is released as radon gas when used in the home, and this limit for domestic water systems is estimated to generate a radon air concentration in the home of no greater than 0.4 pCi/L (this is one-tenth of the EPA recommended level of less than 4 pCi/L for radon in indoor air). The proposed value of 4,000 pCi/L for radon in domestic water systems would be lowered to 300 pCi/L if the state does not have an EPA-approved program for enhancing lower indoor radon levels. As shown on Figure 3, all private wells (except Abrameit) have radon concentrations that are presently below the proposed EPA limit of 300 pCi/L.

Depletion of Groundwater Resources

The National Research Council (NAS 2002) indicated that future development of uranium mining and other oil and mineral extraction activities should consider the tradeoffs between extracting oil and mineral deposits and the need to preserve the diminishing western groundwater resources for domestic, livestock, and agriculture use. ISR operations are especially egregious with respect to the consumption of groundwater resources due to consumption of the groundwater during mining and restoration and the large volume of contaminated groundwater that remains in the aquifer after mining. Gallegos and others (2022) report that the Texas Department of Health estimated that 12 ISR companies operating in 1980 were using about two billion gallons per company per year, or a total annual volume of 24 billion gallons of uranium-mining fluids in the injection and recovery process. As present ISR groundwater operations are similar with those 40 years ago, allowing UEC to renew their permit for ISR operations will result in the loss of billions of gallons of groundwater that could have been used for domestic, livestock, and agriculture needs.

Water consumption during ISR operations occurs during mining and restoration, with consumption during restoration generally higher. For five Texas ISR operations in the Goliad Formation, an estimated 500 gallons of groundwater is consumed per pound of mined U3O8 (Gallegos et al 2002). The five Texas ISR operations recovered between 2 and 4 million pounds of U3O8 (Gallegos et al 2002), which equates to the consumption of 1 to 2 billion gallons removed from the aquifer. However, the greatest volume of groundwater that is lost due to ISR operations is the contaminated pore volume that remains after restoration is deemed complete. Pore volumes for the five Texas ISR operations varied from around 10 to 300 billion gallons (Gallegos et al 2002).

For the Goliad Formation sands at the UEC Goliad site, the exempted aquifer pore volume is estimated to be about 32 billion gallons (as noted in previously adjudicated issues during the initial UEC permit hearing). Most of the pore volume in the exempted aquifer volume is lost to contamination because it is well documented that no ISR operation in Wyoming, New Mexico, and Texas has ever restored groundwater to initial pre-mining values (Deutsch, 1984; Staub, 1986; Hall, 2009). Therefore, the renewal of the UEC permit for ISR operations at the Goliad site should be denied by TCEQ to avoid the loss of over 30 billion gallons of groundwater that should be conserved for domestic, livestock, and agriculture use.

Furthermore, the groundwater resource in Goliad County is far more valuable to the people and the State because the extracted uranium from the Goliad Formation is a vanishingly small fraction of the world uranium production. The United States produces less than 0.15% of the worlds uranium (about 75 tons per year relative to a total global production of 49,355 tons per year Uranium Production | Uranium Output - World Nuclear Association (world-nuclear.org)), and the production from the Goliad site would be a tiny fraction of the 0.15% the United States produces annually. Clearly, there is no demand for the uranium that is presently immobile in the aquifer sands at the proposed Goliad site.

Summary

Extraction of the uranium from the aquifer sands at the proposed Goliad site would result in the loss of over 30 billion gallons of groundwater and contaminate private wells that are adjacent to the proposed permit boundary. Based on radon measurements in groundwater samples collected from private wells, there is compelling evidence that groundwater flow paths exist between the ore bodies and the private wells. The ore bodies are not a threat to the water quality of the private wells while natural reducing conditions are present in the aquifer. If ISR operations are permitted, the oxidation of the uranium ore zones would contaminate the aquifer and radon and uranium would be transported along complex flow paths to the private wells. Monitoring well rings cannot ensure the detection of contamination, especially in the complex subsurface geology at the Goliad site. Therefore, the TCEQ should protect human health and the environment and honor the request of the GCGCD to deny the renewal of UEC permit UR03075.

References

Adams, S.S. & Smith, R.B., 1981. National Uranium Resource Evaluation: Geology and Recognition Criteria for Sandstone Uranium Deposits in Mixed Fluvial-Shallow Marine Sedimentary Sequences, South Texas, Samuel S. Adams & Associates, Boulder, Colorado, R. B. Smith & Associates, Austin, Texas, prepared for U.S. DOE Grand Junction Office, Colorado.

Deutsch, W.J., N.E. Bell, B.W. Mercer, R.J. Serne, J.W. Shade, and D.R. Tweeton, 1984. *Aquifer Restoration Techniques for In Situ Leach Uranium Mines,* NUREA/CR-3104, PNL-4538, Pacific Northwest Laboratory, prepared for the U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington DC.

Gallegos, T.J., Scott, A.M., Stengel, V.G., Teeple, A.P., 2022. A Methodology to Assess the Historical Environmental Footprint of In-Situ Recovery (ISR) of Uranium: A Demonstration in the Goliad Sand in the Texas Coastal Plain, USA. Minerals, v.12, p.369.

Hall, S., 2009. Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain. U.S. Geological Survey Open-File Report 2009–1143.

National Academy of Science, 2002. Evolutionary and Revolutionary Technologies for Mining; National Academy Press: Washington, DC.

Pantea, M.P., Cole, J.C., Smith, B.D., Faith, J.R., Blome, C.D., Smith, D.V., 2008. Three-Dimensional Geologic Model of Complex Fault Structures in the Upper Seco Creek Area, Medina and Uvalde Counties, South-Central Texas, Scientific Investigations Report 2008–5131, U.S. Department of the Interior, U.S. Geological Survey.

Staub, W.P., N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness, 1986. *An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas*, NUREG/CR-3967, ORNL/TM-9956, Oak Ridge National Laboratory, prepared for the U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington DC.

Verbeek, E.R., 1979. Surface Faults in the Gulf Coastal Plain Between Victoria and Beaumont, Texas, Tectonophysics, v.52, p.373.

Yeager, K.M., Wolfe, P.C., Feagin, R.A., Brunner, C.A., Schindler, K.J., 2019. Active near-surface growth faulting and late Holocene history of motion: Matagorda peninsula, Texas, Geomorphology, no.327, p.159.