

**2013 Water Reuse Conference
May 15 and 16 - Boise, Idaho**

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Session Title: Penn State's Living Filter System: A 52 –Year Perspective

Abstract: Penn State University began to apply 20 percent (0.5 mgpd) of its secondary sewage effluent on cropland and forests during the 1963 growing season as part of its interdisciplinary waste water conservation and reuse (Living Filter) project (1963-76). Weekly rates of 1; 2; and 4-inches were used during subsequent growing seasons. The first winter distribution experiments relied on potable water. The following winter, 4- and 6-inch weekly rates were used before selecting a more suitable 2-inch year around design rate. Sludge also was included with effluent for a period.

Since 1983, 4 mgpd (100 percent) of its effluent has been applied at two sites under a permit from the Pennsylvania Department of Environmental Protection (PADEP).

Early goals included tertiary treatment of all University Park Campus effluent, elimination of all surface discharges to Spring Creek and its cold water tributaries, enhanced groundwater recharge (98-inch average annual v 10-inch natural rate), reuse of reclaimed water and nutrients applied to the land, game propagation together with other multiple beneficial land uses. Extensive research, education and outreach efforts were encouraged and supported.

Emergent issues included increasing nitrate concentrations within onsite fracture-flow dominated carbonate aquifers, modeling flow and nitrate transport together with evaluation of options for its control during various stages in operation and within groundwater. Restoration and maintenance of cropland infiltration rates, selective planting of water-tolerant trees suited for wildlife propagation, control of herbaceous vegetation and deer browse to allow forest re-growth within clear cuts were addressed. Quantification of annual recharge rates, obtaining evidence of nutrient removal during winter months, overland flow and within natural and enhanced wetlands, fate and transport of health care products and pharmaceuticals were included.

A 98-inch average annual spray field recharge rate has been documented approaching a billion gallons of potable water within its footprint. Nutrients are removed during the non-growing season and nitrates are being maintained at or below 8 mg/l within on site monitoring wells of significance to Chesapeake Bay and other initiatives. Carbonate terrains can be suitable for land application especially during the non-growing season under Pennsylvania's northern climate despite their sink-prone nature and zones of enhance chemical weathering within underlying carbonate aquifers. Detention depressions retain effluent, snow and ice melt and prevent off site overland flow. Unique educational, research and outreach opportunities exist, which we are anxious to share given our years of experience.

Questions remain. How much longer can spray fields be used to treat effluent after having receiver nearly 530 feet of water (1963-2013)? Under what hydrogeologic, soils, climatic and weather conditions might other communities be justified in adopting Penn State's Living Filter concept during the non-growing season thereby reducing or eliminating storage costs?

Background:

EDUCATION

Ph.D., 1961, Geology, University of Illinois
M.S., 1960, Geology, University of Illinois
B.A., 1956, Geology, University of Connecticut

PROFESSIONAL EXPERIENCE

1956-61 Research Assist. Ground-Water Geology and Geophysical Exploration Sec., Illinois State Geological Survey
1959-61 Party Chief, Saskatchewan Research Council (Summer 1959-61)
Acting Head, Ground-Water and Pleistocene Geology Mapping Program (Summer 1960)
Assistant Professor of Geology and Geophysics (1961-65);

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Associate Professor (1965-71)
Professor (1971-present); Professor of Geology and Geo-Environmental Engineering, The Pennsylvania State University (1997-present)
1961-69 Staff Geologist, Assistant and Associate Director (1969-85), Mineral Conservation Section, The Pennsylvania State University
1971 Visiting Scholar, Stanford University and Desert Research Institute, Reno NV;
1972-88 Pennsylvania's representative, Pollution From Land Use Activities Reference Group, Canadian-US International Joint Commission
1978 Visiting Scientist, Radiohydrology Branch, U.S. Geol-Survey, Denver;
1985 Visiting Scholar, Changchun College of Geology and Institute of Karst Geology, Guilin, Peoples Republic of China; 1986 Visiting Professor, National Cheng Kung University, Tainan, Taiwan, Republic of China
1990-97 Administrative Law Judge, Atomic Safety and Licensing Board Panel, U.S. Nuclear Regulatory Commission
1995-97 Consultant, U.S. Nuclear Waste Technical Review Board, Appointed Board Member by President Clinton 1997-2000; reappointed by President Clinton, 2001 to Sept. 2004; Chairman of Natural Systems Panel 2003-04; Member Repository Systems Panel 2003-04
2005-09 Consultant, Frontera Resources, Eastern Georgia, design and supervise an inventory of water resources within Frontera's nearly one million acre energy prospect (Block 12).

HONORS AND AWARDS

USEPA Superior Achievement Group Award (1976); Karl M. Mason (1977); Clear-Water Conservancy (1984); Matthew J. and Anne C. Wilson Outstanding Teaching (1986) Awards. Gabriel Narutowicz Medal, Institute of Meteorology and Water Management, Warsaw Poland (1991); National Ground Water Association's M. King Hubert Award (1998); Geological Society of America Distinguished Service in Hydrogeology (1999); American Institute of Hydrology, C.V. Theis Award (2001); Over 40 Years of Influence in Environmental Hydrogeology: In Honor of Dick Parizek, The Geological Society of America Annual Meeting (2004); The Richard R. Parizek Graduate Fellowship in Hydrogeology fully vested summer 2003; A second fellowship, (2005) The Richard R. Parizek endowment for Field Studies in Geosciences, announced, to help defray the cost of class field trips for Department of Geosciences undergraduate and graduate students. Michael T. Halbouty Award and Distinguished Lecture "Coal v Nuclear Energy: Hydrogeologic Perspectives", The Geological Society of America, Annual Meeting and Exposition, Denver, CO, 2004. Wilson Award for Outstanding Service, College of Earth and Mineral Sciences, 2006.

TEACHING

Taught more than 14 advanced undergraduate and graduate classes in hydrogeology, environmental geology, geomorphology, glacial geology, field geology and related subjects. Supervised 101 successful M.S. and Ph.D. degree candidates including many of the nations most distinguished professional and academic hydro-scientists and 18 senior theses. He offered the nation's first environmental geology seminar (1962 to 2005) and largest hydrogeology class offered to more than 4,000 students (1961-2005; 2011-2013).

SYNEGISTIC EFFORTS

His diverse research interests, powers of observation and integration abilities and stimulating talented groups of graduate students have contributed knowledge to diverse fields of national and international significance..

Drs. L.H. Lattman and R.R. Parizek were the first to demonstrate the relationship between fracture traces and lineaments and their predictive association within underlying zones of fracture concentration. This has led to national and international application of the fracture-trace method of prospecting for groundwater, siting recharge, pollutant clean-up and monitoring wells, foundation stability and site characterization investigations.

He was a member of the original Penn State University interdisciplinary Living Filter Research team (1961-76). They demonstrated that sewage effluent could be treated in a northern climate through application to forests and cropland. Penn State adopted the method to treat up to 4 mgpd of its effluent on a year around basis resulting in about 98-inch annual rate of recharge of potable water v a 10-inch natural rate. He continues to serve as an advisor and conduct research on this project (1990-present).

The International Joint Commission (IJC) appointed him as Pennsylvania's representative to the Pollution From Landuse Activities Reference Group (PLUARG) (1972-80). The 1972 U.S. Canada Water Quality Agreement required an assessment of diffuse-source pollutants impacting Great Lakes water quality. This 8-year pioneering investigation served as a model in other more recent national and international efforts concerned with diffuse-source lake-water quality concerns: identification of their sources, adverse influence on Great Lakes water quality, remedial measure options, social and economic costs for their adoption, best management practices, etc.

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Together with more than 25 graduate students, he continues to investigate environmental and hydrological concerns associated with surface and subsurface methods of coal mining. Notable contributions have been made relating pyrite type, abundance and reactivity with depositional environments, premining acid forecasting, acid mine drainage abatement using natural systems, use of alkaline materials to inhibit acid reaction, air circulation driven by exothermic pyrite oxidation reactions, identification of acid hot spots, consequences of longwall mining on water balance, and numerical modeling of flow.

He has had a long standing interest in nuclear energy and the safe isolation of its wastes. He served as a member of a safety assessment team to provide oversight of AEC's proposed project KETCH (creation of rubble chimneys in which to store natural gas in Pennsylvania) and needs assessment for a low level waste burial ground in Pennsylvania. Later he investigated potential sites for a nuclear fuel reprocessing plant and related high-intermediate-and low level nuclear waste disposal facility within Pennsylvania. He served on the National Research Councils' oversight panel on the Waste Isolation Pilot Plant (WIPP), 1978-84. This led to the successful development of an operating repository for the isolation of transuranic wastes in bedded salt near Carlsbad, New Mexico. He served on the NRC's KBS-II panel to evaluate Sweden's plan for isolating high level nuclear wastes in a granite repository, on a salt modeling task force for DOE, and NRC's Waste Isolation systems Panel (WISP) to review DOE's entire nuclear waste isolation program (1980-82). He served as an Administrative Law Judge (Atomic Safety and Licensing Board Panel for the Nuclear Regulatory Commission (1990-97). He relinquished this appointment to serve on the Nuclear Waste Technical Review Board (NWTRB) created by Congress in 1987 to provide independent oversight of DOE's entire Yucca Mountain Project. President Clinton appointed him to two 4-year terms as a board member (1997 to 2004) following his service as a consultant to the Board.

He served on a US AID-sponsored investigation team to study the consequences of the Chernobyl Power Station accident.

Together with a number of graduate students, he has maintained a long standing interest in karst hydrogeologic and environmental studies. He has identified no fewer than 36 natural and man-made factors that influence porosity and permeability distribution within carbonate, gypsum and salt karst while investigating geotechnical projects: leakage below dams, control of water and flooding of mines and quarries, groundwater investigations, flow and transport models, foundation problems, land planning and nuclear and other waste isolation.

Currently with other Penn State faculty and students, he is investigating the consequences of water and salt in the destruction of Egyptian antiquities located along the Nile Valley, passive and active methods for controlling invasive groundwater and vadose water. Nondestructive methods in site investigation and characterization are being employed. Other investigations include research in Abydos, Egypt, the Republic of Georgia (Frontera Resources, Eastern Georgia-Block 12) and surface and groundwater interactions, methods of investigation within various terranes, and the fate and transport of health care products and pharmaceuticals at Penn State's Living Filter site. He authored or co-authored 300 peer reviewed papers, technical completion and other reports.