375 Morgan Street
Phoenixville, PA 19460
Telephone: (610) 933-1900

Steven P. Sayko, P.G. **Curriculum Vitae**

Areas of Expertise

Hydrogeology and Quantitative Hydrogeologic Data Analysis
Ground Water Flow and Solute Transport Modeling
Design and Evaluation of Ground Water Recovery Systems
Environmental Information Management Systems
Environmental Visualization
Project/Client Management

Professional Experience

Services Environmental, Inc. (Formerly Sayko Environmental Data Analysis), Phoenixville, Pennsylvania, 1998 to Present.

- President/Hydrogeologist

Environmental Resources Management, Inc., Exton, Pennsylvania, 1986 to 1998.

- Associate/Project Director, 1995 to 1998
- Project Manager, 1992 to 1995
- Hydrogeologist, 1986 to 1991

Widener University, Chester, Pennsylvania, Spring 1996.

- Adjunct Assistant Professor

NYS Department of Environmental Conservation, Albany, New York, 1985 to 1986.

- Engineering Geologist

Rensselaer Polytechnic Institute, Troy, New Tork, 1983 to 1985.

- Graduate Teaching Assistant

NCR Corporation, Ithaca, New York, 1979 to 1981.

- Mechanical Engineering Technician

Education

Rensselaer Polytechnic Institute, MS in Geology, 1984
State University of New York at Cortland, BS in Physics, 1983
Broome Community College, A.A.S. in Mechanical Technology, 1978

Professional Affiliation

Association of Groundwater Scientists and Engineers

Pennsylvania Association of Professional Geologists
Registered Professional Geologist - Pennsylvania PG-000659-G

Publications and Presentations

- Methods of Evaluating Short Term Fluctuations in Groundwater Levels: Sayko, S.P., K.L. Ekstrom and R.M. Schuller, 1989, Proceedings of the ASTM Symposium #10-53 Groundwater Vadose Zone Monitoring, 4th qtr. 1989.
- Evapotranspiration as an Important Hydrogeological Consideration for the Management of a Groundwater Contamination Site, Sayko, S.P. and D. Asante-Duah, Ph.D., 1989, Proceedings of the Hydrogeology Days, Colorado State University.
- A Case Model for Assessment of Contaminant Concentration Leaching into an Aquifer, D. Asante-Duah, Ph.D., S.P. Sayko and R. E. Lees, 1989, Proceedings of the Hydrogeology Days, Colorado State University.
- Groundwater Modeling for and NPL Risk Assessment, Schuller, T.A., S.P. Sayko and N.J. DeSalvo, 1992. Environmental Toxicology and Chemistry, Vol. 11, pp. 1355-1362.
- Regional Groundwater Modeling Using the Analytic Element Model, He, H. Y. and S. P. Sayko, 1996. 1996 ERM Excellence Awards.
- Cost-Effective Regional Groundwater Flow Modeling for Aquifer Management, Sayko, S. P. and H. Y. He, 1998. 1998 ERM Excellence Awards.
- Identification of Groundwater Flow Zones with Borehole Geophysics and Flowmeter Profiling, Hyde Park Landfill, Niagara Falls, New York: Sayko, S.P., C.N. Neville, M.A. Kuhl, R.J. Passmore, G.W. Luxbacher, M.G. Mateyk, J.J. Williams, and B.B. Trytten; Presentation at the 2002 NGWA Northeast FOCUS Ground Water Conference - Burlington, Vermont, Oct 3, 2002.
- Refining the Characterization of a Fractured DNAPL Site: Hyde Park Landfill, Niagara Falls, New York: Passmore, R.J. , G.W. Luxbacher, S.P. Sayko; Presentation at the 2002 NGWA Northeast FOCUS Ground Water Conference - Burlington, Vermont, Oct 3, 2002.
- Using Major Ions to Support the Demonstration of Hydraulic Containment in a Fractured Bedrock Aquifer – Steven P. Sayko, P.G. and William F. Daniels, P.G. of Services Environmental, Inc., Richard J. Passmore, P.E. of Glenn Springs Holdings Inc. Presentation and publication for the 2004 USEPA Fractured Rock Conference, Portland, Maine.

Patents

Four U.S. patents on ink-jet printing technology, all assigned the NCR Corporation.

Relevant Experience

- Technical manager for the evaluation of groundwater containment at the Hyde Park Landfill Site in Niagara Falls, NY from 1999 through 2005. Investigations and remediation began in 1983. A bedrock groundwater containment system was required by the USEPA and was installed in 1992. After 7 years of operation, including the installation of additional monitoring and recovery wells and additional pumping, the performance criteria for the containment system (demonstrated hydraulic gradient reversal) had not been fully satisfied.

  In 1999, the client secured an independent assessment of the hydrogeology. S.S. Papadopulos and Associates (SSPA) were hired to develop and 3-dimensional groundwater flow model. SEI (Sayko Environmental Data Analysis at the time) was hired to review the groundwater modeling, and to provide technical review and guidance for the on-going investigation activities performed by a large international consulting firm. The client, primary consultant, SSPA, and SEI formed a working project team to reevaluate the historical site data and to plan future site investigation efforts. The team defined project objectives and all efforts were completed as a cooperative effort by the project team.

  It was determined in 2001 that the existing three-interval Site conceptual model (Upper, Middle, and Lower zones) was not sufficiently precise to satisfy the USEPA's hydraulic performance monitoring requirements. A new conceptual model was developed in 2002 following an extensive borehole geophysical study, groundwater level monitoring, review of geologic cores, and preparation of a report. These studies, completed as a cooperative effort between the project team, resulted in a definition of the site conceptual model (hydrogeologic framework). The new framework included eleven discrete, bedding-parallel flow zones.

  The existing monitoring well network was rebuilt by retrofitting existing long-open interval wells with multiple 1-inch diameter piezometers with 2 feet of screen. Piezometers were installed to monitor eight of eleven flow zones. Additional hydraulic testing was completed to assess the validity of the new hydrogeologic framework. A new flow model was constructed to simulate the eleven flow zones and intervening aquitards.

  The data collected from all testing supported the new conceptual model of eleven flow zones. Hydraulic containment has been demonstrated using multiple lines of evidence, including: water levels, geologic conditions, and major ions data from the new network of piezometers. A final

Comprehensive Remedial Characterization Report summarizing the investigations and evaluating performance of the bedrock remediation was submitted to the USEPA in August 2004. EPA issued a Superfund Remedial Action Report in September 2004 concluding that the remedial actions at the Site were Operational and Functional, i.e., the objective of the five years of study, demonstrating hydraulic containment, had been achieved and approved by the EPA.

SEI subsequently prepared and submitted a Performance Monitoring Program for groundwater monitoring and reporting at the Site. The program was approved by EPA and is ongoing.

EPA began the process of removing the site from the NPL List in May 2007.

Planning and management of a groundwater hydraulic study at a manufacturing site in North Carolina. A release of chromic acid in the early 1970s created chromium plumes in a two-aquifer (Upper and Lower) system. Groundwater recovery was initiated shortly after the release and has been ongoing and expanding since the 1970s. To accurately assess the design of several remedial alternatives (passive treatment barriers and bioremediation injections), groundwater flow conditions under non-pumping conditions had to be precisely determined. The remediation system had never been shut down to assess non-pumping conditions. A four-month long groundwater recovery system shutdown and restart test was designed and implemented to develop an accurate understanding of the groundwater flow conditions. The study results demonstrated that the extent of chromium contamination was limited to a sand layer in the Upper Aquifer and allowed a reduction in the total pumping rate from the recovery system. Alternative remedies are being currently being evaluated.

- Planning and management of a groundwater hydraulic study at a manufacturing site in Niagara Falls, NY. Groundwater levels at this site are greatly influenced by water levels in the adjacent Niagara River and hydraulic power conduits operated by the New York Power Authority. Water level fluctuations in these features cause groundwater levels at the site to fluctuate by approximately 3 feet daily. Due to these fluctuations, a conventional round of water level measurements cannot be used to interpret the effectiveness of the site groundwater containment system. Further, the highly transmissive nature of the aquifer causes very flat hydraulic gradients, making evaluation of groundwater flow more difficult. Following six months of extensive hydraulic monitoring using electronic water level recorders and groundwater flow modeling, a viable method of monitoring hydraulic conditions was developed. The groundwater containment system pumping in the intermediate flow zone at the site was demonstrated to be pumping

more than required for containment by approximately ten-fold. The NYSDEC approved a reduction in pumping from 1,000 gpm to 300 gpm, and a monitoring program based on groundwater pumping rates rather than quarterly water levels. Investigation of a shallow flow zone that is pumping 350 gpm is currently on-going.

- Project Manager for a soil and groundwater investigation project in Georgia. Small releases of chlorinated solvents from an industrial facility, resulted in a large dissolved-phase TCE plume. The plume has migrated in a complex fractured and faulted limestone aquifer. A Compliance Status Report was submitted describing the investigation findings and demonstrating that the TCE plume has been delineated.

- Senior Hydrogeologist for the design of a cometabolic, horizontal well, bio-sparge, remediation system at the DOE STAR facility in Pinellas Park, Florida. Historical releases of VOCs at the site had created a number of discrete dissolved-phase and NAPL plumes. At one location with two dissolved-phase plumes, a dual-phase vapor extraction system (DPVES) had been in operation for approximately 5 years with minimal impact on the concentrations or extents of these plumes. The DPVES had not been able to lower the water table sufficiently to allow treatment of the impacted portions of the aquifer. The plumes addressed with the bio-sparge system contained toluene and TCE, an ideal combination for aerobic co-metabolic bioremediation. However, the groundwater was anaerobic. TCE was degrading very slowly by anaerobic dechlorination. The addition of oxygen via horizontal bio-sparge wells was selected as a replacement for the DPVES. The bio-sparge system was installed and began operation in December 1999. Preliminary results indicate a rapid decline on both the TCE and toluene levels in groundwater.

- Designed and executed a laboratory-scale column studies to evaluate the effectiveness of bio-sparge remediation on carbon tetrachloride and PCE. Soil columns were set up using site soil and groundwater. Using bio-sparge flow rates, remediation rates were compared between sparging with a mixture of air and methane, air alone, and without sparging. The results demonstrated that both carbon tetrachloride and PCE were readily volatilized from the groundwater but any biological degradation that occurred was too small to be resolved.

- Project Manager and Senior Hydrogeologist for a site investigation and evaluation of a soil vapor extraction and air sparging (SVE/AS) system to remediate BTEX contamination. The investigation and subsequent evaluation effort developed target concentrations to determine when remediation could be shut down, identified necessary modifications to the existing system to

improve remedial performance, and quantified the *in-situ* biodegradation capacity of the aquifer. Based on these results, an engineering evaluation of remediation via horizontal versus vertical SVE/AS was prepared to determine the most efficient and cost effective approach to total site remediation.

- Prepared an Expert Report and provided deposition for a diesel fuel release site. The owner of a small equipment storage facility, our client, was accused of contaminating a neighbor's property. Our investigations showed that contamination in the soil beneath the storage facility had actually originated from the neighbor's property. The expert review and report preparation included groundwater modeling, field monitoring of groundwater levels, preparation of a 3-dimensional animation of the site and soil remediation project, and deposition. The case was settled out of court in favor of our client.

- Groundwater transport modeling using BioChlor. The site model had indicated a release of 1,1,1-TCA. Sampling demonstrated that the 1,1,1-TCA was breaking down to 1,1-DCA and 1,1-DCE. The BioChlor model was modified to simulate this breakdown from the parent to two daughters - versus the published version of the model that simulates step-wise degradation of a parent to one daughter and then the daughter to its daughter, i.e. 1,1,1-TCA to 1,1-DCA, and 1,1-DCA to chloroethane. The model was able to accurately simulate the existing conditions. The results were used to locate off-site monitoring wells.
- Senior Hydrogeologist for groundwater flow and transport modeling of a leaking underground storage tank at a site in Belgium. A partially penetrating slurry wall had been proposed for the site. The modeling was performed to evaluate the effectiveness of the wall. The Bioplume II model was used in cross section to quickly evaluate the effectiveness of the proposed barrier. The model demonstrated that the wall would provide no measurable benefit in reducing the flux of contaminants from the site. The model was also used to estimate potential biodegradation. Based on the modeling, biodegradation appeared to be effective at limiting contaminant migration (no field data existed off site to support the model).

- Project Manager and Senior Hydrogeologist for the design and implementation of a 41-well, five million dollar groundwater extraction system in New Jersey. This groundwater extraction system required the development of a network of wells to continuously monitor the hydraulic performance of the extraction system and allow automatic computerized control of the pumping rates in individual extraction wells. The system has been operational since February 1994 and has achieved the hydraulic

containment requirements defined by the New Jersey Department of Environmental Protection (NJDEP).

- Project Manager for the investigation of contamination related to an underground storage tank. A focused Geoprobe® investigation was developed and quantitative performance targets were agreed to with the NJDEP Bureau of Underground Storage Tanks. As a result of negotiations with the NJDEP before fieldwork was performed, the investigation was completed for a very low cost and a "No Further Action" determination obtained.

- Project Manager and Senior Hydrogeologist for the design and installation of a 10 well, two million-dollar groundwater recovery system at a Superfund site in Pennsylvania. Numerical groundwater flow and transport modeling was performed (using the MOC model) to develop a remedial design which would minimize the aquifer restoration time. The system was constructed and began operation in 1993. The system's performance is evaluated annually and has satisfied the US EPA's comprehensive 5-year site review.

- Project Manager for the investigation of a closed, 20-acre landfill in central New Jersey. Twenty-seven groundwater monitoring wells were installed at this NJDEP-lead site to evaluate the groundwater quality and flow conditions. Methane gas migration was also evaluated after the landfill was capped.
- Prepared an Expert Report for the US Postal Service (USPS) being sued for damages to a property that was apparently downgradient of the USPS property. The USPS had experienced a gasoline release and the plaintiff had detected gasoline contamination in the soil and groundwater beneath his property. The Expert Report concluded that there were numerous other potential gasoline sources between the client's and the plaintiff's property, including documented releases, and that contaminants would not have migrated from the client's to the plaintiff's property. The suit was dropped saving the client over a million dollars.

- Senior Hydrogeologist for the development of an analytic element groundwater flow model for the Red Clay Creek Drainage basin in Southeastern Pennsylvania. This model was funded by the non-profit Red Clay Valley Association to provide them with a quantitative decision making tool for watershed management. The model encompassed over 50 square miles.

- Senior Hydrogeologist for the investigation and remedial design for a Superfund site in South Carolina. The aquifer is a highly complex, fluvial,

water-table aquifer. The investigation defined a narrow plume of volatile organic compounds approximately 3,000 feet long. The plume makes a sharp right angle bend about 1,500 feet from the source area. An analytic element groundwater flow model was developed to evaluate potential causes of the right angle bend, and to design a groundwater pump, treat, and reinjection system. The US EPA accepted the model results and the system was installed and began operations in 1996. The model accurately predicted the hydraulic influence of the recovery system.

The investigation defined only a portion of the plume. The remediation system contains only the known portion of the plume. The plume has potentially migrated as much as 4,000 feet beyond the limits of investigation, to a stream that is the natural point of groundwater discharge. The off-site property is uninhabited. Calculation of a worst-case potential impact to the stream demonstrated that, with or without remedial action, the stream would not be adversely impacted. Modeling and experience demonstrates that additional remedial actions beyond the existing containment system would not measurably reduce the cleanup time for the off-site plume. Therefore, a natural attenuation argument has been made for this site.

Annual evaluations of the system performance demonstrates that the hydraulic containment objectives are being met and that the plume concentrations are declining. At the end of 2006, an 85% reduction in the plume mass had been achieved.

- Team coordinator and senior investigator for the evaluation of seasonal and spatial water quality in a large surface water reservoir. The reservoir had been impacted with VOCs from several area dumpsites. Water quality was monitored weekly and all of the water was treated prior to delivery. A technical team was assembled to assess the system dynamics and to develop remedial alternatives. An extensive data collection effort was undertaken to monitor, in 3-dimension, the seasonal variations in the temperature and water quality. The data showed seasonal stratification and turnover, and demonstrated a correlation between the reservoir dynamics and concentrations at the water-supply intake. VOCs were volatilizing from the surface of the reservoir. Alternatives for *in-situ* treatment were evaluated and a remedy implemented.

- Senior Hydrogeologist for the design and development of a regional (600 square mile) 3-dimensional MODFLOW groundwater model for the Milan Army Ammunition Plant in Milan, Tennessee. The model was used to: predict the flow directions; whether groundwater discharged to, or

underflowed, a stream adjacent to the plant; rates of contaminant transport; and evaluate remedial alternatives.

- Senior Hydrogeologist for an assessment to apportion costs for remediation at a manufacturing facility in South Carolina. The client had sold the manufacturing facility in 1973. The new owner performed very similar manufacturing processes. Apportionment of costs was based on contaminant distributions, groundwater velocities, and an evaluation of the degradation products of the organic solvents used in the manufacturing. The analysis demonstrated that the client was liable for less than 10% of the remediation costs - the new owner had been asking for 80% of the costs.

- Senior Hydrogeologist for the evaluation of the impacts to the groundwater quality in Kuwait resulting from the Iraqi invasion of Kuwait and oil fires in 1991. This project involved compiling information on the hydrogeology of Kuwait, meeting with numerous academic personnel and government agencies in Kuwait, and travel throughout Kuwait for data collection. The findings of the study were submitted to the United Nations as part of a claim for war reparations.

- Senior Hydrogeologist for an analysis of groundwater discharge from the bedrock aquifer beneath a Superfund site to a river adjacent to the site. The analysis considered the affects of anisotropy related to geologic deposition. VOCs had impacted that site groundwater and the adjacent river. A public water supply intake downstream of the site had low, but detectable levels of site-related VOCs. A groundwater pump and treat system was designed by expert modelers to stop the discharge to groundwater to the river. The design required 14 wells, extensive drilling, complex access issues, and construction of a large water treatment plant. An estimated 18 months was needed to bring this system on-line. This timeframe was unacceptable to the USEPA, and a 2 million dollar pipeline to relocate the public water supply intake upstream of the site was required by the agency.

  By considering anisotropy along, versus across, the geologic bedding, it was demonstrated that groundwater discharged to the river along only a short portion of the proposed groundwater recovery system. It was also demonstrated that groundwater underflowed the river along most of the proposed recovery system. The immediate concerns related to the river could be addressed by installing and pumping recovery wells in just the area where groundwater was discharging to the river. As a result of this analysis:

  - The USEPA accepted a limited recovery system as an alternative to a two million dollar pipeline.

- A limited recovery system and a temporary treatment plant were immediately installed.
- VOC levels the river fell below detection limits within two weeks of the limited recovery system startup.
- The public surface water supply was able to stop treatment for the site-related VOCs.

- Senior Hydrogeologist for a Superfund investigation of a former chemical disposal lagoon near a municipal groundwater supply well. Using analytical groundwater flow modeling, a recovery system was designed to isolate the area of the lagoon to the supply well. This recovery system and a treatment system were installed in 1988. The impacted soils in the lagoon were excavated and treated on site. By 1994, VOC levels in all but one of the monitoring wells were below MCLs. The recovery system was operated until 1996 when the New York State Department of Environmental Conservation allowed system to be shut down. This project has been identified by the US EPA as one of the few groundwater pump and treat success stories.

- Senior Hydrogeologist on a large chemical manufacturing site in New Jersey. Completed an evaluation of site hydrogeologic conditions and the nature and extent of contaminant migration. Designed and installed a 300 gallon per minute groundwater recovery system. The system has been in operation since 1987 and has achieved 99.9% reduction in VOC levels off-site.
- Engineering Geologist for the development of analytic groundwater flow and transport models for rapid evaluation of groundwater remediation and wellhead protections programs. The flow model was developed at the New York State Department of Environmental Conservation and was used to evaluate numerous groundwater remediation systems. The transport model was designed at ERM to evaluate the arrival of contamination at a municipal supply well. The transport model has also been applied to evaluate the transport of heated water reinjected into an aquifer.

- Engineering Geologist for the development of a regional groundwater flow model for a principal-aquifer in New York State. The model was used to define well-head protection areas.