

Exponent®
Engineering & Scientific Consulting

Tarek Saba, Ph.D.

Office Director and Principal Scientist | Environmental and Earth Sciences
Burlington
+1-978-461-4605 | tsaba@exponent.com

Professional Profile

Tarek Saba, Ph.D., is an office director and principal scientist in Exponent's Environmental & Earth Sciences practice with over two decades of experience in environmental chemical forensics, hydrogeology, and contamination liability analysis. He advises clients on chemical source identification, environmental cost allocation, hydraulic fracturing disputes, and natural gas contamination claims.

Chemical Forensics & Fingerprinting

Dr. Saba performs chemical forensics across a wide range of contaminant classes and industrial settings. His work encompasses per- and polyfluoroalkyl substances (PFAS) and transformations, polychlorinated biphenyls (PCBs), dioxins and furans, polycyclic aromatic hydrocarbons (PAHs), chlorinated solvents (PCE, TCE, and degradation products including 1,4-dioxane), petroleum products (e.g., gasoline, diesel fuels) and additives (e.g., MTBE, BTEX), metals, radioactive compounds such as radium, coal tar and distillation products (creosote, pitch), and pesticides, among other chemicals. He uses compound-specific isotope analysis, congener and homologue profiling, principal component analysis (PCA), positive matrix factorization (PMF), and sediment age dating (among other tools) to link contamination to specific sources, time periods, and responsible parties.

Dr. Saba's forensic analyses are grounded in detailed knowledge of industrial operations, including manufactured gas plants (MGPs), petroleum refineries, chemical manufacturing facilities, airports, landfills, coal ash basins, military sites, and shipyards, enabling him to reconstruct historical releases and evaluate the plausibility of competing contamination narratives. He has authored peer-reviewed publications and book chapters on environmental forensics methods and regularly presents at national and international conferences.

Hydrogeology

Dr. Saba evaluates how contaminants move through groundwater, soil, surface water, and air to determine the extent of environmental impact and the timing of releases. He designs and directs field sampling programs, develops three-dimensional numerical groundwater and solute transport models (MODFLOW, MT3D, MT3DMS), and applies contaminant fate and transport analysis to support both litigation and regulatory proceedings.

His hydrogeologic work spans fractured bedrock, heterogeneous aquifers, non-aqueous phase liquid (NAPL) entrapment and dissolution, DNAPL and LNAPL migration, and soil vapor intrusion analysis. He has modeled pump-and-treat system optimization, hydraulic barrier design, and contaminant plume evolution over time and developed groundwater numerical models for the USGS and the National Science Foundation (NSF).

© 2026 Exponent, Inc. All Rights Reserved

Environmental Response Cost Allocation

Dr. Saba assists clients (such as law firms, insurers, industrial companies, and government agencies) allocate environmental response costs and contamination liability among responsible parties under CERCLA, RCRA, the New Jersey Spill Act, and other regulations. He develops allocation frameworks supported by chemical forensics, historical operational records, waste handling practices, and contaminant transport pathways, and he has applied these methods at major waterway sediment sites, petroleum refineries, manufactured gas plant sites, landfills, and industrial manufacturing facilities, among other setups, across the United States.

Dr. Saba has served as an expert witness in environmental litigation, toxic tort proceedings, and personal injury matters, providing testimony on contamination liability, source identification, and remedial cost allocation.

Natural Gas Investigations

Dr. Saba advises energy companies, law firms, and regulators on natural gas contamination claims, storage field integrity, and gas migration in the subsurface. He uses natural gas composition analysis and stable isotope analysis (carbon and hydrogen isotopes) to differentiate native (biogenic or thermogenic) gas from storage or production gas — a critical tool in disputes involving residential water well contamination, storage field leaks, and pipeline incidents.

He has designed and implemented forensic field programs at gas storage fields in Kansas, Louisiana, Wyoming, Michigan, New York, and Pennsylvania, and he has presented findings to state conservation commissions and the Federal Energy Regulatory Commission (FERC). His natural gas work also encompasses naturally occurring radioactive material (NORM) in produced water, impoundment emissions of hazardous air pollutants, and methanol use in hydraulic fracturing fluids.

Hydraulic Fracturing Disputes

Dr. Saba evaluates scientific claims of groundwater and surface water contamination allegedly caused by hydraulic fracturing (fracking) operations, providing independent technical analysis for energy companies, law firms, and regulatory bodies. His work involves characterizing baseline water quality conditions, sampling groundwater and surface water, analyzing natural gas composition and isotope data to determine gas origins, and evaluating alternative contamination sources such as historical coal mining, land use, and household activities.

He has published peer-reviewed articles and book chapters on hydraulic fracturing and groundwater contamination, presented at major industry and legal conferences in the United States and United Kingdom, and provided expert testimony in depositions and court proceedings on hydraulic fracturing-related contamination claims. His work also addresses PFAS impacts to residential water wells from hydraulic fracturing operations, NORM in produced water, drilling mud releases, and produced water treatment.

Academic Credentials & Professional Honors

Ph.D., Environmental Engineering, University of Colorado, Boulder, 1999

M.S., Water Resources, Cairo University, 1994

B.S., Civil Engineering, Cairo University, 1992

Publications

Book Chapters

Saba, T. 2015. Hydraulic fracturing: Data analysis methods to identify sources of dissolved gas and chemical compounds in drinking water wells. Chapter 14. In: Introduction to Environmental Forensics. Murphy, B.L., and R.D. Morrison (eds), pp. 513–529. ISBN: 9780124046962.

Shields, W.J., T. Saba, P.D. Boehm, and J. Pietari. 2015. Congeners: A forensics analysis. In: Introduction to Environmental Forensics. Murphy, B.L., and R.D. Morrison (eds), pp. 347–393. ISBN: 9780124046962. Congeners addressed included dioxins/furans, PAHs, PCBs, and PFAS congeners.

Peer Reviewed and Other Publications

Saba, T. 2026a. Environmental Forensic Notes – Petroleum Exclusion Under CERCLA. A TSCA Compliance Guide publication.

Saba, T. 2026b. Environmental Forensic Notes – PCB Forensics. A TSCA Compliance Guide publication.

Saba, T. 2023. Using positive matrix factorization to unmix PAH fingerprints in contaminated sediments. Environmental Monitoring Assessment, 195:1003. https://doi.org/10.1007/s10661-023-11615-w.

L. Silver and T. Saba. 2022. What EPA designation of PFAS as hazardous means for companies. Law 360. December 9.

Saba, T., O'Reilly, K., Pitts, B., and K. Robrock. 2022. EPA's proposed hazardous substances designation for PFOA and PFOS. An Exponent Alert. October 20.

Saba, T. 2021. Facing liability for PFAS contamination? An Exponent Thought Leadership article. May 13.

Saba, T. 2019. Forensic analysis of breakthrough curves in fractured bedrock to reconstruct a past contaminant release event— a case study, Environmental Forensics. DOI: 10.1080/15275922.2019.1657518.

Boehm, P.D., J. Pietari, L. Cook, and T. Saba. 2018. Improving rigor in polycyclic aromatic hydrocarbon source fingerprinting, Environmental Forensics, 2018; DOI:10.1080/15275922.2018.1474287.

Saba, T., and P.D. Boehm. 2018. Determination of the applicability of CERCLA's petroleum exclusion at contaminated sites – focus on metals. Environmental Forensics; 19(1):27–38.

Saba, T. 2015. Study finds Marcellus NORM exposure risks low. Oil and Gas Journal; June.

Saba, T. 2013. Evaluating claims of groundwater contamination from hydraulic fracturing. Oil and Gas Journal. July. Available at: http://www.ogj.com/content/ogj/en/articles/print/volume-111/issue-7/drilling-production/evaluating-claims-of-groundwater-contamination.html.

Saba, T., and S. Su. 2013. Tracking polychlorinated biphenyls (PCBs) congener patterns in Newark Bay surface sediment using principal component analysis (PCA) and positive matrix factorization (PMF). Journal of Hazardous Materials; 260:634-643.

Saba, T., and P.D. Boehm. 2012. Use of natural gas compositional tracers to investigate gas migration from a gas storage field. Environmental Geosciences June; 19(2):1-12.

Saba, T., and M. Orzechowski. 2011. Lack of data to support a relationship between methane contamination of drinking water wells and hydraulic fracturing: A response to Osborn et al. Proceedings, National Academy of Science of the United States of America.

Saba, T., and P.D. Boehm. Congener-based analysis of the weathering of PCB Aroclor 1242 in paper mill sludge. Chemosphere 2011; 82:1321-1328.

Saba, T., and P.D. Boehm. 2011. Quantitative polychlorinated biphenyl (PCB) congener and homologue profile comparisons. Environmental Forensics; 12(2):134-142.

Saba, T., and P.D. Boehm. 2011. CERCLA's petroleum exclusion and the use of chemical forensic methods. ABA Superfund and NRD Litigation Committee Newsletter; 6(2).

Saba, T., F. Mohsen, B. Hilbert, M. Garry, and B. Murphy. 2012. White paper: Methanol use in hydraulic fracturing fluids. Submitted to the Methanol Institute, August 2011 (Version 2 issued January).

Saenton, S., T.H. Illangasekare, K. Soga, and T. Saba. 2002. Effects of source zone heterogeneity on surfactant enhanced NAPL dissolution and resulting remediation end-points. Journal of Contaminant Hydrology; 59(1-2):27-44.

Saba, T., T.H. Illangasekare, and J. Ewing. 2001. Effect of flow dimensionality on mass transfer rate coefficient estimations under enhanced conditions. Journal of Contaminant Hydrology; 51(1-2):63-82.

Saba, T., and T.H. Illangasekare. 2000. Effect of groundwater flow dimensionality on mass transfer from entrapped nonaqueous phase liquid contaminants. Water Resources Research; 36(4):971-979.

Conference Proceedings and Presentations

Saba, T. 2022. Separating the Wheat from the Chaff: Understanding background groundwater conditions surrounding coal ash ponds. The World of Coal Ash – Northern Kentucky.

Saba, T. 2022. Modeling compounds leaching from saturated coal ash to evaluate different basin closure scenarios. May 18. The World of Coal Ash – Northern Kentucky.

Drollette, B., T. Saba, L. Cook, and G. Getzinger. 2020. PFAS Environmental Forensics: Unique Approaches to a Unique Contaminant. Presented at the 36th Annual International Conference on Soils, Sediments, Water and Energy. October 20.

Saba, T., and L. Cook. 2020. Considerations for PFAS Fingerprinting. Presented at the 36th Annual International Conference on Soils, Sediments, Water and Energy. October 20.

Saba, T., and L. Cook. 2020. Considerations for PFAS Fingerprinting Presented at the Law Seminar International - PFAS litigation in the Pacific Northwest. Virtual interactive zoom broadcast. September 14-15.

Saba, T. 2019. Simulation of Contaminant Flow Through Fractured Bedrock to Calculate Oil and Gas Impoundment Leakage Date. Presented at the 35th Annual International Conference on Soils, Sediments, Water, & Energy, October 21-24, Amherst, MA.

Saba, T., and L. Cook. 2019. Application and Interpretation Pitfalls of Principal Component Analysis (PCA) for Assessment of Contaminated Sediment Sites. Presented at the 35th Annual International Conference on Soils, Sediments, Water, & Energy, October 21-24, Amherst, MA.

Saba, T. Hydraulic fracturing and the use of chemical fingerprinting methods in claims of natural gas migration and groundwater contamination. Presented at:

• Short course, SETAC North America 36th Annual Meeting, Salt Lake City, UT. November 1-5, 2016.

• Association for Environmental Health and Sciences Conference, Amherst, MA. October 2015.

• Chartered Institution of Water and Environmental Management Annual Conference, University of London, England, July 2015.

• United Kingdom Environmental Law Association. Liverpool, England, July 4, 2015.

• British Water Technical Forum, London, England, November 19, 2014.

• Department of Environmental Earth and Atmospheric Sciences Lecture Series, University of Massachusetts, Lowell, March 5, 2014.

• Association of Engineering Geologists, Woburn, MA, November 21, 2013.

• International Network of Environmental Forensics Conference, Penn State University, University Park, PA, June 10-12, 2013.

• American Nuclear Society Northeast Meeting, Canton, MA, June 5, 2013.

• The Hydraulic Fracking Conference, the Seminar Group, Santa Barbara, CA, February 8, 2013.

• Conference on Research Frontiers in the Science of Unconventional Energy Resources, Yale Climate and Energy Institute, New Haven, CT, March 5, 201

• Future Energy Conference, Seattle, Washington, November 13-14, 2012.

Saba, T. 2013. CERCLA's petroleum exclusion and the use of chemical forensic methods. The 29th Annual International Conference on soils, sediments, water, and energy. University of Massachusetts, Amherst, MA. October 21-24.

Saba, T., and F. Mohsen. 2012. Hydrofracking: Separating the realities from the myths. The American Bar Association 41st Annual Conference on Environmental Law, Salt Lake City, UT, March 22-24.

Garry, M., T. Saba, F. Mohsen, and L. Hilbert. 2012. Health assessment of methanol used in hydraulic fracturing fluids. The 51st Annual Meeting of the Society of Toxicology, San Francisco, CA, March 11-15.

Saba, T., and S. Su. 2011. Tracking sources of polychlorinated biphenyls (PCBs) to Newark Bay sediments using principal component analysis (PCA) and positive matrix factorization (PMF). SETAC North America 32nd Annual Meeting, Boston, MA, November 13-17.

Saba, T., and P.D. Boehm. 2011. Quantitative PCB congener and homologue profile comparisons. Presented at the 6th International Conference on Remediation of Contaminated Sediments. New Orleans, LA, February 7- 11.

Menzie, C., M. Kierski, T. Saba, S. Meyer, E. Kovatch, J. Kahler. R. Fox, and J. Kern. 2011. Multisite ambient investigation for MGPs on the Chicago River. Presented at the 6th International Conference on Remediation of Contaminated Sediments, New Orleans, LA, February 7-11.

Saba, T., P.D. Boehm. 2010. Congener-based analysis of the weathering of PCBs in paper mill sludge. Presented at the 2010 Dioxin Conference, San Antonio, TX.

Saba, T., and P.D. Boehm. 2010. Historical reconstruction of contamination using environmental forensic methods. Boston Bar Association Seminar, Boston, MA, February 11.

Boehm, P., J. Brown, T. Saba, and K. O'Reilly. 2009. The three-part approach to PAH source identification and apportionment in sediments as applied to petroleum, coal tars, and combustion sources. SETAC North America 30th Annual Meeting, New Orleans, LA, November 19-23.

Saba, T. 2009. Environmental weathering of PCBs in sediments. The 26th Annual International Conference on Soils, Sediments, and Water, University of Massachusetts at Amherst, MA, October 18-21.

Boehm, P.D., W. Shields, A. Fairbrother, and T. Saba. 2009. Determination of the chemical background for sediment — Approaches and conundrums. SMWG meeting in Sarasota Springs, NY. September 29.

Saba, T., and P.D. Boehm. 2008. Using chemical forensics and other lines of evidence to distinguish PAH contributions from different pyrogenic sources to the sediments of the Hylebos Waterway Superfund Site — A CERCLA and MTCA cost recovery case. SMWG Spring Sponsor Forum, Kalamazoo, MI, April 29-30.

Saba, T., P.D. Boehm, and L. Benton. 2007. Identification of natural gas sources using geochemical forensic tools. The 23ed Annual International Conference on Soils, Sediments, and Water, University of Massachusetts at Amherst, October 15-18.

Butler, E., and T. Saba. 2006. Use of PCB congener and homolog analysis in source apportionment at a rail yard Superfund site. The Annual International Conference on Soils, Sediments, and Water, University of Massachusetts at Amherst, October 16-19.

Biemer, T., M. Brown, E. Butler, and T. Saba. 2005. Better litigation through chemistry. Presentation to the Boston Bar Association, October 6.

Saxe, J.K., T. Saba, and E.J. Wannamaker. 2003. Do arsenic-containing products influence arsenic concentrations in subsurface drinking water supplies? Society of Environmental Toxicology and Chemistry 24th Annual Meeting, Austin, TX, November 9-13.

Sharma, M., T. Saba, and A. Bittner. 2003. Optimization of groundwater pump and treat systems using numerical modeling and the Monte Carlo approach. 2003 NGWA Midsouth Focus Conference, Philadelphia, PA.

Sharma, M., T. Saba, and A. Bittner. 2003. Optimization of groundwater pump and treat systems using numerical modeling and the Monte Carlo Approach. Presented at the National Ground Water Association Mid-South Focus Conference, Nashville, TN, September 19.

Illangasekare, T.H., S. Saenton, T. Saba, and C.S. Wilson. 2000. Up-scaling of NAPL dissolution from entrapped sources: Implications on end-points for risk assessment. Proceedings, Contaminated Site Remediation Conference, Melbourne, Australia, December 4-8.

Illangasekare, T.H., T. Cort, T. Saba, F. Barranco, and D. Dai. 2000. Pilot-scale laboratory evaluation of subsurface restoration technologies for a diesel contaminated site. Summit of the Geological Society of America, Reno, NV.

Illangasekare, T.H., and T. Saba. 2000. Upscaling of contaminant transport in heterogeneous aquifers: Dissolution of entrapped separate phase organic chemicals. Proceedings, Engineering Jubilee Congress, Engineering of Peradeniya; (2):127-132.

Illangasekare, T.H., and T. Saba. 2000. Intermediate scale physical model testing to investigate upscaling of dissolution of non-aqueous phase liquids in aquifers. Proceedings, Physical Modeling and Testing Environmental Geotechnics, Network of European Centrifuges for Environmental Geotechnic Research (NECER). Garnier J, Thorel, E, and Haze E (eds), pp. 285-292, La Baule, France, May 15-17.

Saba, T., and T.H. Illangasekare. 1999. Surfactant-enhanced dissolution of non-aqueous phase waste chemicals: Effect of flow dimensionality. Conference of Hazardous Waste Research, St. Louis, MO, April.

Saba, T., and T.H. Illangasekare. 1998. Effects of aquifer heterogeneity and groundwater flow dimensionality on upscaling of natural and surfactant enhanced dissolution of non-aqueous phase liquid waste chemicals. Conference on Hazardous Water Research, Snowbird, UT.

Saba, T. and T.H. Illangasekare. 1998. Effect of aqueous phase flow dimensionality on surfactant enhanced dissolution from entrapped non-aqueous phase liquid contaminants at the spill-site scale. American Geophysical Union, San Francisco, CA, December 6.

Illangasekare, T.H., and T. Saba. 1998. Upscaling of mass transfer from zones with entrapped nonaqueous phase chemicals. American Geophysical Union, San Francisco, CA, December 6.

Vestal, E.W., T.H. Illangasekare, A. Ramaswami, A. Bielefeldt, A.M. Riffel, and T. Saba. 1998. Modeling of net interphase mass exchange in NAPL-water systems undergoing biodegradation at the spill-site scale. American Geophysical Union, San Francisco, CA, December 6.

Saba, T., and T.H. Illangasekare. 1998. Natural dissolution of organic chemicals entrapped in a two-dimensional groundwater systems. AGU 18th Annual Hydrology Days, Colorado State University, Fort Collins, CO.

Project Experience

Chemical Forensics & Fingerprinting

Dr. Saba has conducted chemical forensics and chemical fingerprinting investigations at dozens of contaminated sites across the United States, applying advanced analytical methods to identify contaminant sources, reconstruct release histories, and support liability determinations in CERCLA, RCRA, and common law proceedings. The following examples illustrate the breadth and depth of this work.

Forensics: Per- and Polyfluoroalkyl Substances (PFAS)

- For confidential clients at multiple sites: Advised clients on sources and potential liabilities for PFAS contamination in groundwater, soils, and sediments at former military sites, airports, landfills, manufacturing facilities, and sites where previous fires occurred, among others.
- Analyzed PFAS data obtained from the sites required detailed understanding of PFAS manufacturing processes (electrochemical fluorination vs. telomerization), PFAS formulations in different products (e.g., aqueous film-forming foam), changes in PFAS formulations with time, and an understanding of domestic and international manufacturing sources.
- Conducted fate and transport analysis including tracking compound transformations associated with PFAS migration in soil, surface water, groundwater, and air.
- Forensic analysis included evaluation of percent linear versus branched compounds to assist in evaluating PFAS sources, and the effect of transport in different environmental media on PFAS fingerprints. Evaluated background PFAS concentrations and profiles resulting from regional industrial activities.
- Oil and Gas operations: addressed claims of PFAS impacts to residential water wells from hydraulic fracturing operations.

Forensics: Dioxins/Furans

- Southern US: Analyzed dioxin and furan fingerprints in soil using statistical analysis techniques (e.g., Principal Component Analysis – PCA) to determine sources.
- Louisiana site: Evaluated dioxin and furan fingerprinting patterns in the sediment of bayous and marsh areas to determine responsible parties. Combined dioxin/furan data with sediment age dating information to determine with a high degree of certainty the likely sources of contamination.
- The U.S. Virgin Islands: conducted fingerprinting analysis of cistern water samples to evaluate the presence of dioxins/furans and identify sources.
- Transformer service facility, Mississippi: Evaluated dioxin and furan fingerprint patterns in dust and soil samples collected from residential areas around a transformer service facility.
- Major Bay and rivers, eastern and western United States: Analyzed dioxin and furan fingerprints in sediments. Analysis included age dating of sediment core samples, contaminant spatial patterns (e.g., dioxins/furans, PCBs, PAHs, heavy metals), correlation between dioxins (e.g., 2,3,7,8-TCDD) and other contaminants, and evaluation of the impact of historical dredging activities on current contaminant spatial profiles. Assessed dioxin contamination in the sediment in relation to potential upland site sources by reconstructing historical industrial operations at sites located along the bay and river boundaries, evaluating dioxin generation from different industrial processes and contaminant transport pathways

Forensics: Polychlorinated Biphenyls (PCBs)

- Major Bay, northeast United States: Analyzed homologue and congener patterns to identify PCB sources to the sediments. Identified congeners associated with specific sources using EPA numerical models (Positive Matrix Factorization). Conducted principal component analysis (PCA) and analyzed PCB profiles in sediment cores as part of a remedial investigation report for the bay.
- Bayou (CERCLA site) connected to a major channel, southern United States: Investigated fate and transport of PCBs in sediment and the effect of dredging on surface water quality.
- Major bay, Florida: Investigated PCB sources to the surface sediment by analyzing PCB congener data (profile analysis, spatial and concentration distribution analysis, and PCA).
- Midwestern city: Identified historical uses of PCB-containing hydraulic fluids in the die casting industry.
- Major waterways, East and West Coasts: Analyzed PCB congener data to determine PCB sources and entry points to a waterway for allocation of contamination and remedy costs between responsible parties.
- Landfill site, Georgia: Evaluated feasibility of proposed remedial alternative at a PCB- and volatile organic compound (VOC)-contaminated landfill. Recommended modifications to the proposed design to optimize the remediation process.
- Northeast nuclear facility: Characterized the spatial distribution of PCBs and lead in soils; contaminants were present in paints used in the facility and contaminated soils, sediments, and groundwater during decommissioning of the facility. Conducted statistical analysis (e.g., variogram) to calculate the sample spacing needed to characterize the extent of spatial impacts.

Forensics: Petroleum Chemistry, PAHs, BTEX, Coal Tar, Creosote, LNAPL, DNAPL, and Additives (e.g., MTBE)

- Petroleum refinery and terminal in the middle east: Conducted air emission forensic analysis to differentiate between refinery emissions sources (e.g., evaporation ponds, flares), and other sources including an industrial complex, a power plant, and road emissions.
- Southern United States refinery: As part of an insurance claim, evaluated petroleum products, sources, and timing of releases of petroleum compounds and additives (MTBE) to state-owned groundwater. Reconstructed releases by combining refinery unit operational and closure histories before and after the enactment of the Clean Water Act with chemical data collected over 20 years.
- CERCLA sediment site, Brooklyn, New York: Conducted chemical fingerprinting analysis on different chemical classes (i.e., PAHs, PCBs, metals) and identified industrial markers in the sediment to track impacts from a different facility on the sediment site as part of CERCLA remedy design costs allocation.
- Former refinery sites/CERCLA liability, Illinois, Oklahoma: Combined historical waste handling practices, waste handling unit closures, RCRA cleanup actions, and chemical fingerprinting analysis to determine the sources and timing of contamination, with a focus at the sites on the applicability of the petroleum exclusion under CERCLA.
- Texas refinery: Conducted chemical fingerprinting to age-date a petroleum plume beneath the refinery site to determine the responsible party among successive owners.
- Midwestern steel manufacturing site: Evaluated the connection between sediment PAH contamination and surface water sheens using chemical fingerprinting techniques.
- West Virginia salvage yard site: Evaluated the use of benzene/xylene ratio to age-date contamination and allocate cleanup costs between successive owners.
- Petroleum spill, Oregon: Conducted laboratory studies to understand the fate of a diesel spill. Tracked diesel spilled in pilot-scale tanks using gamma ray spectroscopy techniques.
- CERCLA Sediment Sites: Conducted forensic analysis to identify PAH sources in soils and sediment (e.g., creosote, coal tar, pencil pitch, runoff, background). Conducted fate and transport analysis to identify spatial extent of impacts and conducted mixing models to apportion contamination back to sources in some matters, as feasible.

Forensics: Metals

- Former crushed glass disposal site, Pennsylvania: Assessed leach tests conducted on crushed glass and other material to determine the leachability of different metals from disposed material to the site and assessed the extent of impacts to the site soils, groundwater, and a nearby river.
- Bayou sediment, Louisiana: Tracked Bayou sediment metal contamination to multiple responsible parties in support of remedial cost allocation. Data evaluation included identification of marker metals and combination of metals used by different industries located along the creek.
- Metals in paint: Used statistical methods (variogram analysis) to investigate the sufficiency of a soil-sampling program in characterizing a lead contaminated site.
- Former petroleum refinery site, Oklahoma: Investigated the sources of metals in soil and groundwater (petroleum products versus petroleum waste) to determine whether CERCLA’s petroleum exclusion applies to the site.

- Hydraulic fracturing, northeastern United States: Evaluated metals data in residential water wells to determine their sources.

Forensics: Chlorinated Solvents

- Several manufacturing facilities, midwestern, western, and southern United States: Evaluated sources of chlorinated solvents (PCE, TCE, and degradation products and 1-4-dioxane) at or near manufacturing facilities. Utilized different contaminant evaporation models to estimate the approximate start date of PCE releases to the soils, and solvents flow in the unsaturated zone. Combined information from compound-specific isotope analysis, solvent additive concentrations (1,4-dioxane), and historical information to determine sources and contribution from different sources. Evaluated standard of care for solvent handling and disposal.
- Manufacturing facility, Illinois: Conducted isotope analysis for carbon and chlorine and fate and transport analysis to age-date multiple chlorinated solvent plumes (PCE, TCE, and their degradation products). Used multiple lines of evidence including groundwater travel times, daughter/parent compound ratios, and historical construction of contamination to determine the age of the different plumes. Presented findings to the Illinois Environmental Protection Agency.
- Dry cleaning facility, Canada: evaluated carbon isotope data for TCE in groundwater to identify different sources of chlorinated solvent contamination downgradient from the dry cleaner.
- Superfund site, New Hampshire: Optimized injection and extraction well locations and flow rates for faster PCE recovery in a pump and treat system, reducing total remediation time by 25%. Modified MODFLOW and MT3D computer modeling to fit Superfund site-specific characteristics and linked the modified versions to a USGS optimization code. Reduced projected plume recovery time by 25%.
- Dry cleaning facility, Massachusetts: Allocated contamination shares between responsible parties in a chlorinated solvents plume. Evaluated PCE degradation pathway and performed groundwater modeling and soil vapor intrusion analysis.
- Metal electroplating facility, Oklahoma: Conducted analysis, including fate and transport and isotope analysis, to identify sources of chlorinated solvents around the facility. Work included investigating solvent spatial and degradation patterns in groundwater, and assessment of soil vapor intrusion analysis.

Forensics and standard of care: Manufactured Gas Plants

- MGP, Olympia, Washington: Integrated hydrogeology, fate and transport, and chemical fingerprinting analysis of available environmental data to evaluate sources of DNAPL/tar/PAH contamination at a site located two city blocks from a former MGP.
- Bellingham, Washington: Investigated sources of PAH contamination in soils in an area adjacent to former MGP operations. In addition to the former MGP operations, other potential sources included creosoted pilings, historical wood milling operations, and operations related to railroad activities.
- Former MGPs in Florida, Maine, New Hampshire, New York, and Vermont: As part of insurance litigation, evaluated standard of care regarding byproducts handling practices and approximate timing of contamination. Researched historical literature regarding status of environmental knowledge at different times, the different MGP equipment and their construction and operation, historical records such as feedstock changes with time, tar records, spills, leaks, Sanborn

insurance maps, public service commission reports, and aerial photographs, among other sources of information. Integrated historical information with forensic analysis, fate and transport, and hydrogeology to identify the approximate period of historical leaks and spills. Analyzed tar, oil, and NAPL entrapment and migration patterns to identify contamination sources and track the extent of spatial impact to soil, sediment, and groundwater.

- New York former MGPs: As part of site characterization efforts required by the New York State Department of Environmental Conservation, designed environmental sampling programs of soil, sediment, and groundwater to identify potential contamination sources. Conducted chemical fingerprinting analysis on different chemical classes (i.e., PAHs, PCBs, metals) as part of site investigations to track sources of contamination at former MGP sites in Brooklyn, New York. Work is part of site characterization efforts.
- Former MGP Site, Michigan: Evaluated the source of impacts to site's soil and groundwater. Potential sources included an MGP, a landfill, and a wastewater treatment facility, all occupying the same footprint at different time frames. Presented findings to an arbitration committee.
- Former MGP, Rhode Island: Conducted analysis to distinguish between PAHs and metals from different sources (historical filling material, former MGP operations, a former rubber manufacturer, and natural background).

Forensics in Natural Resource Damage Assessment

- New Jersey Bayway and Bayonne refineries (NRDA): Under the New Jersey Spill Act, the New Jersey Department of Environmental Protection (NJDEP) sued the former owner of the Bayway/Bayonne refineries for natural resource damages to soil, sediment, and groundwater. NJDEP experts used the Habitat Equivalency Analysis model to calculate the value of damage to natural resources. Work included forensic analysis of the spatial extent of impact to soil, sediment, and groundwater and evaluation of the start date of contamination for VOCs, PAHs (semi-volatile organic compounds), metals, NAPLs, and pesticides. Reconstructed operations at refinery areas of concern from the early 1900s and identified whether chemical impacts to the environment were attributed to refinery activities or other sources (e.g., background, offsite sources, or other historical activities unrelated to refinery operations). Calculated the extent of groundwater contamination with time in response to remedy actions and whether groundwater use was lost starting from the early 1900s through the future.

Hydrogeology, Fate and Transport Analysis, Numerical Modeling

Dr. Saba has developed and applied groundwater flow and contaminant transport models at Superfund sites, industrial facilities, and energy sector sites across North America, combining numerical modeling with field data to support remedial design, regulatory compliance, and litigation.

- Superfund Site, midwestern United States: Used MODLOW and MT3D to simulate three chlorinated solvent plumes several miles in length and conducted analysis to calculate the percent of solvent mass associated with different source areas for the purpose of allocation.
- Kalamazoo River: Calculated the volume of sediment deposited in different river stretches as a result of the Morrow Dam drawdown.
- Arsenical herbicides, Florida: Evaluated fate and transport of the different arsenic species in soils and their potential for migration to groundwater and surface waters at Florida sites. Authored reports to the Florida Department of Environmental Protection.

- Chlorinated solvents: Conducted analysis of the transport of chlorinated solvents in the vadose zone to groundwater to determine sources of solvents to groundwater from different potential source areas.
- New Hampshire Superfund Site: Developed a 3-D numerical groundwater and solute transport model for chlorinated solvents (MODFLOW and MT3D). Designed a numerical code that automated conducting hundreds of groundwater simulations to optimize the design of a pump and treat system (i.e., optimize groundwater well locations, injection, and extraction rates) to minimize the treatment time of a chlorinated solvent groundwater plume.
- Coal mine, West Virginia: Analyzed groundwater data to investigate the cause of a coal mine flooding.
- Oil and gas impoundment, Pennsylvania: Calculated timing of produced water release by conducting a groundwater flow analysis through fractured bedrock.
- Chemical manufacturing facility, Argentina: Designed and modeled a hydraulic barrier system to mitigate offsite transport of contaminated groundwater. Conducted contaminant transport modeling and optimization of injection/extraction well locations.

Hydrogeology: Coal Ash

- For Duke Energy: Evaluated closure options at six coal ash sites located in the state of North Carolina, by addressing several technical aspects such as analyses of compound (e.g., boron) leaching rates from coal ash to groundwater using different basin closure scenarios (e.g., cap in place, excavation), evaluated contaminant fate and transport models (USGS numerical codes called MODFLOW and MT3DMS) to predict the spatial extent of coal ash-related compounds in groundwater inside and outside ash basin regulatory compliance boundaries, and analysis of seep discharge rates under basin decanting scenarios.
- For Georgia Power: Evaluated claims that coal ash constituents migrated from a coal ash basin through groundwater and surface water pathways to over 30 plaintiff properties. Designed and directed a field sampling program to collect groundwater, surface water, and soil samples from plaintiff properties, coordinated analysis with laboratories, and conducted chemical fingerprinting analysis to track compound sources in different environmental media. Analysis included providing an understanding of ambient background condition at the study area and the piedmont aquifer. Provided expert and rebuttal reports and assisted counsel in depositions preparation.

Hydrogeology: Government Scientific Research

- For the Hazardous Substances Research Center, revised United States Geological Survey (USGS) groundwater numerical codes MODFLOW and MT3D, capable of simulating the fate and transport of dissolved contaminants in groundwater. Revisions extended MODFLOW/MT3D capabilities to simulate the behavior of non-aqueous phase liquids (NAPL) in the subsurface, including NAPL entrapment in subsurface soils and dissolution in groundwater.
- Developed a proprietary model for DNAPL dissolution and transport in groundwater as part of a U.S. Department of Defense contract for a decision support system to evaluate the effectiveness and cost of DNAPL source zone treatment.
- For EPA, investigated novel groundwater remediation technologies on a field scale at the Dover Air Force Base. Supervised and provided technical assistance for research groups to investigate cutting-edge groundwater-remediation technologies (funded by the Strategic Environmental

Research and Development Program; a joint program between the U.S. Department of Defense, U.S. Department of Energy, and EPA). Managed treatment and disposal of hazardous waste generated from remediation experiments. Collected aqueous and soil samples required for regulatory compliance and performance monitoring. Established and maintained electronic data acquisition systems.

- For EPA, served as technical reviewer for BIOCHLOR, a numerical model that simulates biodegradation of chemicals in groundwater.
- For the National Science Foundation, developed groundwater numerical models to predict soil heterogeneity using chemical data (i.e., breakthrough curves) generated from chemical tracers injected into groundwater.

Environmental Response Cost Allocation

Dr. Saba has developed and applied allocation frameworks at some of the most complex multi-party environmental liability matters in the United States, integrating chemical forensics, historical research, and transport modeling to support CERCLA, RCRA, and state law cost recovery proceedings

- Waterway sediment sites, northeastern United States (CERCLA Sites): Developed frameworks to allocate environmental response costs among responsible parties. Allocation frameworks were supported by chemical forensics, historical operational information, and transport pathways from upland sites to the sediment.
- Major waterway sediment sites, northwestern United States (CERCLA): for confidential alternative dispute resolution (ADL) processes, provided several expert reports evaluating 1) upland sites (e.g., historical operations at different manufacturing facilities, contaminants associated with those operations, historical and current transport pathways) and 2) fingerprinting analyses of waterway sediment chemistry data to track contaminant sources. The outcome from the analyses included reconstruction of historical upland operations, contaminant releases, and spatial extents of impacts to the sediment by different potentially responsible parties, and proposals of allocation parameters to be considered by the allocation team.
- Paoli Railyard Site (CERCLA): Identified PCB sources and approximate spill timing as part of a soil remedial cost allocation model. Reviewed historical PCB purchase records and waste handling practices and performed fingerprinting analysis using PCB congener data.
- Major rivers, midwestern Unites States (CERCLA): Designed and directed field sampling programs, conducted fingerprinting analysis, and calculated mass of PCBs discharged as part of contamination liability and remedial cost allocation analysis.
- Petroleum refinery/terminal, midwestern United States: Reviewed and provided comments on an allocation model to allocate cleanup costs between successive refinery owners. Age-dated petroleum products in groundwater, and linked contamination to the evolution of refinery operations with time.
- ·Hylebos Waterway (CERCLA): Evaluated PAH sources to the sediments as part of a dredging cost allocation matter. Determined the relative importance of candidate sources (primarily creosoted pilings, aluminum smelter sludge, and urban runoff) through chemical fingerprinting, sediment age dating, and PAH concentration gradients.
- Industrial site, Kansas: Developed a model to allocate environmental response costs between successive owners/operators at a site. Historical operations included chemical manufacturing, a warehouse, and pipe fabrication. Main chemicals of concern included chlorinated solvents, acetone, and petroleum components (i.e., naphthalene and trimethylbenzene).

- Former munitions site, Massachusetts (CERCLA): Evaluated fate and transport of metals in soil and groundwater resulting from historical munitions and other industrial disposal activities in support of contamination liability analysis.
- Dry cleaning facility, Massachusetts: Reviewed cost recovery documents for municipal water treatment due to alleged contamination from dry cleaning activities. Documented overestimated treatment costs.

Natural Gas Investigations

Dr. Saba has designed and implemented forensic field programs at natural gas storage fields across multiple U.S. states, using gas composition and isotope analysis to differentiate native gas from storage or production gas in support of regulatory proceedings, litigation, and expert testimony

- Gas Storage Fields, Kansas, Louisiana, Michigan, New York, and Wyoming: Designed and implemented forensic field programs to differentiate native gas from storage gas using composition and isotope analysis. Authored reports to state conservation commissions, presented findings to the Federal Energy Regulatory Commission, and testified at the Louisiana Oil and Gas Commission and in courts.
- Gas Storage Fields, northeastern Pennsylvania: Investigated sources of natural gas bubbling in residential water wells and potential connection to nearby natural gas storage fields. Designed field sampling programs and used gas composition and isotope analysis to determine the origin of the gas in the water wells.

Hydraulic Fracturing Disputes

Dr. Saba has evaluated hydraulic fracturing (fracking) contamination claims at multiple sites in Pennsylvania, West Virginia, and Louisiana, providing independent scientific analysis for energy companies and law firms in litigation, regulatory proceedings, and expert testimony.

- Natural gas production, Pennsylvania and West Virginia: Evaluated the scientific merit of claims of groundwater and surface water contamination from hydraulic fracturing operations and produced water. Sampled groundwater, streams, ponds, and natural gases in shallow and deep soils, and characterized potential contamination sources such as land use, household activities, former coal mining, roads, and dust. Reconstructed natural baseline conditions in the study areas, using natural gas composition and stable isotope analysis to track sources of gases in groundwater. Issued expert reports, scientific publications, articles, book chapters, and provided expert testimony in depositions and court.
- For an energy company, Pennsylvania: Evaluated the potential presence of PFOA and PFOS in drilling mud.
- For energy companies, Pennsylvania: Investigated the sources of natural gas that resulted in house explosion incidents. Authored several expert reports.
- For several energy companies, Louisiana: Evaluated claims of groundwater and wetland impacts from former oil and gas operations and the generation of produced water at several sites. Work included design of sampling programs and evaluation of compounds consistent with 29-B parameters, evaluation of background concentrations, and reconstruction of oil and gas operational histories and the use of different compounds.
- For a proppant manufacturer: Directed laboratory testing to leach chemical components from coated proppants and conducted lifecycle analysis of the leached material.

- For an energy company: Developed a conceptual site model for storage gas transport and fate in the subsurface following a catastrophic gas release event from a storage field. Combined information from gas isotope analyses to identify the types of subsurface gases and geology, with a gas well mechanical integrity analysis. Designed and directed field programs to screen soil and water wells for the presence of gases.
- For the Methanol Institute: Evaluated the use of methanol in hydraulic fracturing and modeled hypothetical scenarios of methanol impacting groundwater and surface water. Assessed health impacts of methanol and air emissions from gas operations. Issued a white paper detailing the analysis.
- Drilling mud accidental releases (West Virginia and Pennsylvania): Characterized the extent of impacts and remedy effectiveness.
- Chemical emissions from ponds: Calculated emission rates of methanol from ponds and tanks used to store recycled water (tons per year), as part of a permitting process.
- Naturally occurring radioactive material (NORM) in produced water: Characterized NORM concentration levels with time and space at gas pads to define trends and designed a treatment system to reduce NORM-containing solid waste.
- Produced water treatment facility: Assessed design, chemical reactions, and failure points along the produced water treatment train.
- NORM: Tracked the sources of radioactive compounds in water wells in areas near salt domes in matters related to salt mining operations.