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Engineering & Scientific Consulting

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Professional Profile

Mr. Shock has over 25 years of experience in assessment and management of environmental and product risks and liabilities for a variety of industry sectors, including resource extraction, manufacturing, utilities, and insurance. His focus areas include assessment and quantification of environmental liabilities, chemical transport and fate analysis, and evaluation of remedial response actions and costs in due diligence, cost recovery, and insurance claims matters. He employs a variety of cost-benefit, economic, and uncertainty analysis methods to help clients make more informed and defensible environmental risk and liability management decisions.

Mr. Shock is experienced with chemical fate and transport and environmental forensics analyses, risk assessment and risk management, and transactional due diligence involving a variety of contaminant types, including metals, petroleum hydrocarbons, perfluorinated compounds (PFCs), PAHs, PCBs, and VOCs including chlorinated solvents. He has assessed environmental impacts and exposure risks at a wide variety of sites including mines and mills, manufactured gas plants (MGPs), coal ash sites, industrial and brownfields sites, and environmental media including soil, groundwater, surface water, sediment, air, and biota. He has evaluated the timing and impact of operational emissions as well as sudden and accidental releases. He has applied this experience to develop proactive and preventive risk management strategies to minimize the environmental impacts over the life of mining, resource production, and industrial operations. Mr. Shock is experienced in communication, facilitation, and engagement with stakeholders on environmentally complex matters.

Mr. Shock's contaminated site remediation experience includes design, costing, installation, startup, monitoring, optimization, and closure of remediation systems, as well as assessment and mitigation of vapor intrusion. Mr. Shock has evaluated ongoing remedial actions to improve operational performance, assessed the appropriateness of past and prospective future remedial actions and costs, and conducted NCP evaluations in support of litigation and cost allocation negotiations.

Mr. Shock has conducted cost analysis for formal feasibility studies under CERCLA and RCRA, and for cost recovery and insurance disputes, and cost allocation. He employs decision analysis methods such as cost-benefit and economic analysis, Monte Carlo uncertainty analysis, sensitivity analysis, uncertainty reduction, and net environmental benefits analysis to facilitate rigorous and defensible remediation and liability management decision-making.

Academic Credentials & Professional Honors

M.S., Civil/Environmental Engineering, University of Washington, 1994

B.S., Civil Engineering, University of Washington, 1992

Licenses and Certifications

Professional Engineer, Washington, #37417

OSHA Hazardous Waste Operations and Emergency Response 40-hour certification

Professional Affiliations

ASTM International; served on committees to develop ASTM E3123 - Standard Guide for Recognition and Derecognition of Environmental Liabilities and ASTM E3228 - Standard Guide for Environmental Knowledge Management and to review and update ASTM E2137 - Standard Guide for Estimating Monetary Costs and Liabilities for Environmental Matters, and ASTM E2173 - Standard Guide for Disclosure of Environmental Liabilities

Society of Environmental Toxicology and Chemistry

National Ground Water Association — Association of Ground Water Scientists and Engineers (member)

American Society of Civil Engineers (member)

American Bar Association (member; participation in Environmental Disclosure, Environmental Litigation and Toxic Torts, and Mining and Mineral Extraction Committees)

Toastmasters International (Advanced Communicator Bronze)

Publications

EPRI. 2019. Chemical constituents in coal combustion products: cobalt. 3002016497. Electric Power Research Institute, Palo Alto, CA.

EPRI. 2018. Chemical constituents in coal combustion products: lithium. 3002012311. Electric Power Research Institute, Palo Alto, CA.

EPRI. 2015. Framework for sensor-based long-term groundwater monitoring at manufactured gas plant and coal ash sites. 3002006343. Electric Power Research Institute, Palo Alto, CA.

EPRI. 2014. Site management plan guidebook. 3002003461. Electric Power Research Institute, Palo Alto, CA.

EPRI. 2012. Relative risk model for transmission and distribution electric infrastructure (General RRM) Version 1.0. 1023751. Electric Power Research Institute, Palo Alto, CA.

Garry MR, Shock SS, Salatas J, Dau J. Application of a weight of evidence approach to evaluating risks associated with subsistence caribou consumption near a lead/zinc mine. *Science of the Total Environment* 2017; <https://doi.org/10.1016/j.scitotenv.2017.11.149>.

Yost LJ, Shock SS, Holm SE, Lowney YW, Noggle JJ. Lack of complete exposure pathways for metals in natural and FGD gypsum. *Hum Ecol Risk Assess* 2010; 16: 2:317-339.

Menzie CA, Ziccardi LM, Lowney YW, Fairbrother A, Shock SS, Tsuji JS, Hamai D, Proctor D, Henry E, Su SH, Kierski MW, McArdle ME, Yost LJ. Importance of considering the framework principles in risk assessment for metals. *Environ Sci Technol* 2009; 43(22):8478-8482. DOI: 10.1021/es9006405.

Shock SS, Noggle JJ, Bloom N, Yost LJ. Evaluation of potential for mercury volatilization from natural and FGD gypsum products using flux-chamber tests. *Environ Sci Technol* 2009; 43(7):2282-2287. DOI:

10.1021/es802872n.

Shock SS, Bessinger BA, Lowney YW, Clark JL. Assessment of the solubility and bioaccessibility of barium and aluminum in soils affected by mine dust deposition. *Environ Sci Technol* 2007; 41(13):4813-4820; (Article) DOI: 10.1021/es0703574.

Yost LJ, Shock S, Garry M, Garson YN, Sugino AK, Shields WJ. Health risk evaluation of PCBs from joint compound measured on surfaces and in air. *Organohalogen Compd* 2003; 63: 413-416.

Massmann J, Shock S, Johannesen L. Uncertainties in cleanup times for soil vapor extraction. *Water Resour Res* 2000; 36(3):679-692.

Articles

Shock S, Rosengard J. New tools to identify and resolve environmental liabilities. American Bar Association, November 2018.

https://www.americanbar.org/groups/environment_energy_resources/publications/snrld/20181030-snrld-NEW-TOOLS/

Shock S, Rosengard J. Hazards of Relying on Superseded Accounting References for Environmental Liabilities: Implications in Negotiations, Budgeting, and Disclosure Related to Superfund Sites. American Bar Association, August 2017.

https://www.americanbar.org/content/dam/aba/publications/nr_newsletters/snrld/201708_snrld.pdf.

Shock S, Pojasek R. Achieving sustainable mine operations: integrating sustainability and risk management. American Bar Association, December 2013.

https://www.americanbar.org/content/dam/aba/publications/nr_newsletters/mn/201312_ml.pdf

Presentations

Garry, MR, Shock, SS, and Salatas, JH. Application of a weight of evidence approach to evaluating risks associated with subsistence caribou consumption near a lead/zinc mine. Society of Toxicology 55th Annual Meeting. New Orleans, LA. March 2016.

Shock S, Hager R. Environmental and social risk management tools for mining projects — Red Dog Alaska Case Study. SETAC 33rd Annual Meeting, Long Beach, CA, November 2012.

Yost LJ, Shock SS, Noggle JJ. Lack of complete exposure pathways for metals in natural and FGD gypsum. SETAC 28th Annual Meeting, Milwaukee, WI, November 2007.

Noggle JJ, Shock SS, Bloom N, Yost LJ. Evaluation of potential for mercury volatilization from gypsum products using flux chamber tests. SETAC 28th Annual Meeting, Milwaukee, WI, November 2007.

Mesard PM, Shock S. Assessing remedial investigations and remedial actions at DNAPL sites: The case for internally consistent conceptual site models. Groundwater Resources Association of California — Symposium DNAPL Source Zone Characterization and Remediation, San Francisco, CA, December 2005.

Shock S, Nielsen D, Bryant MA. A method for evaluating cost versus environmental benefit using semiquantitative valuation of beneficial uses. SETAC 26th Annual Meeting in North America, Baltimore, MD, November 2005.

Maier EA, Reeder DR, Edwards MR, Gard NW, Shock SS. Assessment of plant communities exposed to

fugitive dust along a mine transportation corridor in Alaska. SETAC 26th Annual Meeting in North America, Baltimore, MD, November 2005.

Gard NW, Maier EA, Shock SS. Assessment of risk to wildlife from fugitive dust releases along a mine transportation corridor in Alaska. SETAC 26th Annual Meeting in North America, Baltimore, MD, November 2005.

Garry MR, Shock SS, Yost LJ, Kulas J, Shields WJ. Assessment of metals concentrations in salmonberries and sourdock collected near a mining transport road in northwest Alaska. Society for Toxicology 44th Annual Meeting, New Orleans, LA, March 2005.

Garry MR, Yost LJ, Shock SS, Shields WJ. Assessment of metals exposure associated with subsistence use of caribou collected near a mining transport road in northwest Alaska. Society for Toxicology 43rd Annual Meeting, Baltimore, MD, March 2004.

Project Experience

Chemical Fate and Transport Analyses / Environmental Forensics

Conducted environmental forensics analyses to assess prospective historical and recent sources of oil that may have impacted plaintiff's property. Prepared an expert report assessing potential sources and transport and fate mechanisms, including the possible transport of a recent oil spill through a fractured bedrock aquifer, as compared with release and transport of a residual oil that may have been in a tank decommissioned over 30 years earlier. Prepared rebuttal points regarding the opposing expert's overly simplistic conceptual site model. Reviewed and evaluated cost estimates on past and potential future remediation to address the spill.

Evaluated PFOS and PFOA occurrence in soil, groundwater, and surface water associated with historical use of aqueous film-forming foam (AFFF) for fire training and fire-fighting at an airport facility. Conducted soil leaching and groundwater transport modeling to evaluate relative significance of various sources and transport pathways. Assessed appropriateness of remedial response actions and costs. Provided litigation consulting support with expert report preparation, rebuttal, and trial preparation.

Analyzed PFOS and PFOA occurrence in soil and groundwater at a manufacturing facility. Assessed groundwater hydrogeology and guided the development of a groundwater model to evaluate contaminant transport under various remedial options. Evaluated remedial options and costs prepared by another consultant, and identified additional more cost-effective remedies based on the results of the modeling analyses.

Conducted an evaluation of fate and transport and possible impacts from releases from a prospective petroleum hydrocarbon pipeline. The work included assessment of potential for surface and subsurface transport and extent of environmental impacts under various hypothetical spill scenarios in different environments along the proposed pipeline corridor.

Evaluated natural attenuation of chlorinated solvents at a Superfund site in Washington, where groundwater extraction had been controlling the plume for 11 years. The project involved development of an approach to evaluate natural attenuation in a pumped plume, and presentation of the results to the regulatory agencies (EPA and Washington State Department of Ecology). Monitored natural attenuation was accepted as the long-term remedy, and groundwater extraction was shut down.

Evaluated natural attenuation, enhanced bioremediation, and the use of zero-valent iron permeable reactive barriers for the treatment of chlorinated solvents and hexavalent chromium at two sites in southern California. Both sites are about 200 acres and were being prepared for redevelopment on a short time horizon.

Investigated and defined the extent of PCE contamination in soil and groundwater associated with a leaking underground storage tank for a dry cleaning shop in Seattle, Washington. Planned and implemented a field-directed exploration program. Successfully defined the extent of the plume in one day, thereby minimizing visibility of the work to neighbors and customers of the business.

Conducted part of a fast-track field sampling program to characterize the nature and extent of petroleum hydrocarbon contamination in soils within the town of St. Paul, and at several outlying sites on the remote island of St. Paul, Alaska.

Managed an inspection, maintenance, and monitoring program to evaluate the effectiveness of a protective soil cap over several cement kiln dust (CKD) fill areas at a park in Seattle, Washington. Coordinated water quality monitoring for several seeps that emerge from the fill zone, and in the nearby creek to which the seepage discharges. Designed and planned a hydrogeologic assessment of water sources and flow conditions within the CKD fill zone.

Developed a Monte Carlo model to evaluate chemical isolation and attenuation of dissolved metals as a result of sediment capping at Lockheed Shipyard in Seattle, Washington. Assessed potential for water quality impacts and cap recontamination using the model, which simulated mixing caused by tidal fluctuations.

Evaluated transport of and changes in mercury concentrations in Bellingham Bay (Bellingham, Washington) sediment over time using a Water Quality Analysis and Simulation Program (WASP) model.

Modeled the effects of landfill capping, groundwater cut-off, and tidal mixing on the contaminant concentrations in leachate discharging from the landfill to Clam Bay at the Manchester Superfund Site in Washington. Evaluated the effects of various cover and armoring designs on concentrations discharging to the intertidal zone.

At a landfill located in an estuarine environment, developed an attenuation model to estimate contaminant concentrations in leachate at the point of discharge to the estuarine slough surrounding the landfill. The model included simulation of mixing due to tidal fluctuations. Evaluated the effects of different proposed landfill capping schemes on the discharge concentrations to the slough.

Revised and calibrated a MODFLOW hydraulic model and an MT3D contaminant transport model of an aquifer system in which a groundwater pump-and-treat system extracts dissolved ordnance constituents TNT and RDX. Assessed the performance of the existing Interim Remedial Action (IRA) pump-and-treat containment system using the calibrated model. Evaluated design options to determine optimal well placements and pumping rates to remediate the ordnance plume, to facilitate selection of the most cost-effective design alternative. Conducted a similar effort for a second dissolved ordnance plume at the facility.

Revised and calibrated a MODFLOW hydraulic model of an aquifer system as part of a Feasibility Study for an industrial facility that has several petroleum product plumes in groundwater. Used the model to evaluate design options (locations and flow rates) for groundwater extraction and injection wells.

Toxic Tort / Exposure Assessment and Dose Reconstruction / Risk Assessment

At an ethanol manufacturing facility, provided consulting litigation support to evaluate claims made by a plaintiff class of homeowners who were alleging loss of use and enjoyment result from air emissions from the facility. Evaluated other sources of dust and particulates and prepared content for the expert report.

At a former copper chromium arsenate (CCA) wood treating facility in California, evaluated claims of injury associated with allegations of historical plaintiff exposures to hexavalent chromium in air, soil, and water. Evaluated background concentrations, coordinated work with air modelers and risk assessors, assisted with preparation and review of expert reports regarding exposure and risk, and prepared

demonstratives for trial.

Planned and implemented a sampling strategy involving wipe sampling and air sampling for a human health risk assessment for PCBs in concrete joint compound and on concrete surfaces in the 550,000-square-foot flightline area of a major aircraft manufacturing and maintenance facility. Researched current regulatory status for managing non-liquid PCBs. The risk assessment results showed that it was sufficiently protective to temporarily leave the joint compound in place until its scheduled removal during the four-year joint compound removal and replacement remediation schedule. Several years after the joint compound replacement was completed, residual PCBs were discovered to have wicked into the new replacement joint compound. Exponent provided additional sampling and updated the assessment to evaluate the risk of leaving the more recent joint compound in place until removal and replacement is implemented over the course of a normal maintenance schedule.

Feasibility Studies / Cost Analysis / Remediation / Optimization

At the Horseshoe Road CERCLA site in New Jersey, conducted a feasibility study to address contaminated sediments in a marsh and an adjacent section of the Raritan River downgradient from two neighboring Superfund sites. The primary contaminants of concern were arsenic, mercury, and PCBs. The feasibility study was prepared in accordance with EPA guidance, including Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA; Presumptive Remedy for Metals-in-Soil Sites; Contaminated Sediment Remediation Guidance for Hazardous Waste Sites; and A Guide to Developing and Documenting Cost Estimates During Feasibility Study. An aspect of the analysis was consideration of technologies to amend marsh soils to reduce exposure risk with minimal impact to existing habitat. An analysis of flood flow velocities was performed to evaluate erosion potential, and a 1-D geochemical transport-and-fate model was developed to evaluate the long-term potential for arsenic movement under highly variable saturated/unsaturated flow conditions caused by frequent tidal flooding.

Reviewed and evaluated the completeness of technology screening that was conducted as part of a feasibility study for remediation of soil, groundwater, and petroleum product in the subsurface at a petroleum storage facility where product releases had been transported through a fractured bedrock system under homes and businesses.

On behalf of an insurer, analyzed the validity and accuracy of claims for remediation costs associated with multiple oil spills along pipelines operated by a Latin American oil producer.

In support of insurance settlement negotiations for a former tannery site in Oregon, evaluated appropriateness of past remedial actions to address hexavalent chromium and other contaminants associated with historic land disposal of wastes, and estimated remaining remedial costs to achieve closure.

At a former PTFE recycling facility in Southern California, analyzed site data to assist in allocation of responsibility for a perchlorate plume in groundwater extending offsite from the site. Evaluated hydrogeologic information and performance of the existing remediation system, reviewed feasibility study alternatives and remedial cost estimates, and independently evaluated opposing expert's estimate of nearly \$50 Million to achieve site closure. Prepared an independent review and cost estimate for use by counsel in mediation between past and current site owners.

At a former steel mill site in the Eastern U.S., evaluated past and ongoing site characterization and remediation activities addressing groundwater plumes of benzene and naphthalene and landfill sites in uplands areas. Reviewed contaminant transport and fate, and potential risks to human and ecological receptors in the offshore environment surrounding the facility in support of litigation regarding compliance with the site Consent Decree.

Conducted remediation technology screening, feasibility evaluation and cost analysis for a coal-fired power plant in the Western U.S. where operations had resulted in large volumes of soil and groundwater

that are potential sources of metals and total dissolved solids (TDS) to a sensitive riparian habitat and adjacent tribal lands.

As part of CERCLA Section 107 and Section 113 cost recovery actions, evaluated the lateral and vertical extent of TCE and other halogenated VOCs at a site in Orange County, California. Used largely historical sampling results to assess potential sources and timing of releases. Bracketed the most likely dates of the release(s), and concluded that they were due to illicit dumping subsequent to client having vacated the Site. Reviewed and evaluated pilot tests and corrective actions by subsequent owner and plaintiff. Showed that costs associated with excavation and ex-situ soil venting were neither reasonable nor necessary, by demonstrating via mass-balance calculations (based all on measurements and data collected by plaintiff) that the excavated soils contained no free product (DNAPL) and therefore, should not have been excavated. Concluded that the remedy originally selected in the feasibility study, in situ chemical oxidation by potassium permanganate injection, would have been a more cost-effective alternative. This conclusion was supported by the subsequent successful application of that technology to treat areas with residual contamination surrounding the excavation.

Conducted a feasibility study for sediment remediation in San Diego Bay at the NASSCO and Southwest Marine shipyard facilities. The feasibility study incorporated a net environmental benefits analysis (NEBA) approach to assessment of impacts on beneficial uses, technical feasibility, and economic feasibility, such as effects on the shipyards, the local economy, and national security. Exponent worked closely with the shipyards' facilities staff and remedial design consultant to develop realistic remedial alternatives that accurately reflected site-specific physical and logistical constraints. Remedial alternatives were evaluated by balancing incremental improvements to beneficial uses with the incremental costs of successively larger cleanup areas. The positive and negative effects of the remedial alternatives were combined with assessments of current biological conditions at the shipyards to derive quantitative estimates of beneficial use improvements/impairments for each remedial alternative. Semi-quantitative valuations of aquatic wildlife, aquatic-dependent wildlife, and human health beneficial uses were developed to evaluate beneficial-use outcomes under alternative remedial scenarios. The analysis of beneficial-use outcomes, when combined with remedial costs, was used to facilitate cost/benefit analysis for the remedial alternatives. The analysis demonstrated that beneficial-use outcomes were not significantly better for alternatives using active remedial measures than for a monitored natural attenuation remedy. The feasibility study showed that the most appropriate remedial alternative for the shipyards was monitored natural attenuation.

Conducted a focused feasibility study for the head of the Thea Foss Waterway, a Superfund site contaminated with MGP wastes including coal tar and creosote within and beneath sediment. Screened technologies to identify those applicable to the site. Developed, prepared cost estimates for, and evaluated remedial alternatives.

Conducted an assessment of bioventing (including pilot testing and analysis) for ExxonMobil at a Superfund site in Seattle, Washington, that had petroleum products in soil and floating product in a tidally influenced aquifer. Provided technical support for the floating-product recovery effort, including oversight of work conducted by the consultant for the other liable party at the site. Technical work included computer simulation of tidal fluctuations of the groundwater table and floating product in the shallow aquifer, with and without the product recovery system operating, to facilitate remediation optimization.

Performed a remedial investigation of DNAPL and petroleum hydrocarbon contamination at the Quendall Terminals former creosote manufacturing and bulk fuel storage site located next to Lake Washington where MGP wastes from operations on Lake Union had historically been processed. Evaluated soil, groundwater, and sediment data to define the extent of areas of concern, evaluated exposure pathways, and developed a model to evaluate effects of groundwater contamination on Lake Washington. Used the model to conduct a cost-benefit analysis for proposed remedial alternatives to control petroleum and creosote constituents migrating with groundwater into Lake Washington.

Worked closely with a large project team at Manchester Superfund Site, a former Navy landfill site next to

Clam Bay in Washington. Characterized groundwater, soil, and sediment contaminated with PCBs, dioxins, and metals through close involvement in the field investigation, data analysis, and interpretation. Assisted in the development of remedial design alternatives for the feasibility study, including landfill capping and armoring, and intertidal habitat mitigation. Modeled the effects of landfill capping and the installation of an upgradient hydraulic cutoff on contaminant concentrations in leachate moving from the landfill to the bay.

Coordinated and conducted pilot testing of a combined soil vapor extraction/air sparging system to remediate dry-cleaning solvent in soil and groundwater at a commercial laundry facility located near several public water supply wells in Tacoma, Washington. Evaluated pilot-test results to facilitate design of a full-scale soil vapor extraction/air sparging system. Assisted in design, installation, and testing of the full-scale system. Monitored and optimized the system to accelerate completion of the site cleanup. Completed the remediation and obtained a No-Further-Action determination from Washington State Department of Ecology.

Designed and installed a soil vapor extraction/air sparging system to remediate PCE and xylenes in unsaturated-zone soils at a plastics manufacturing facility in Tacoma, Washington. Monitored and optimized the system to complete site cleanup in a relatively short time. Worked with both responsible parties and their counsel to put together the closure report and obtain a No-Further-Action letter from the Department of Ecology.

Managed a groundwater monitoring program to track the performance of a groundwater pump-and-treat system using air stripping to remediate chlorinated solvent contamination at a chemical warehousing and distributing facility in Kent, Washington. Worked with the client and regulatory agencies to reduce operation, maintenance, and monitoring costs and reporting requirements. Assisted the client in evaluating whether to pursue a tax rebate for additional remediation (contaminant source removal) when remodeling the loading dock at the facility.

Assisted in the startup and testing of a soil vapor extraction/air sparging system with catalytic oxidation of extracted vapors to remediate mineral spirits in soil and groundwater at a paint manufacturing facility in Tacoma, Washington. Managed the collection and evaluation of groundwater and vapor monitoring data to assess performance of the system and progress of remediation.

Brownfields Assessment and Redevelopment / MGPs / PAHs / VOCs / Vapor Intrusion

On behalf of EPRI, developed a template and user guide for a "site management plan" to improve consistency and cost-effectiveness in management of former manufactured gas plant (MGP) sites that have contaminants remaining in-place after remediation or closure. The plan is designed to ensure continued efficacy of engineering controls and/or institutional controls, and to provide instructions on how to operate, maintain, monitor, and terminate these controls, where appropriate. Published for EPRI members in Fall 2014.

Conducted NAPL mobility analyses for sediments at multiple sites along the Chicago River affected by MGP contaminants. Evaluated mobility using multiple lines of evidence involving site-specific contaminant mobility calculations, and laboratory-based mobility testing.

In support of a pending property transfer, conducted a vapor intrusion evaluation at a brownfields site. Approximately 180 residential units were planned for development upon completion of remediation at this large site. Extensive remediation had been conducted over two decades. However, residual chlorinated solvents including PCE, TCE, DCE, and vinyl chloride remained in fill materials and groundwater. Provided data management, GIS, and risk assessment support to evaluate potential for soil vapor intrusion exposure risks for current conditions based on a soil gas survey. Worked with counsel, other consultants, and agency reviewers to clarify and finalize in-progress reports, and obtain approval for project documents, which facilitated the ultimate sale of the property.

Provided site characterization, remedial design, and construction coordination in support of redevelopment of a former waterfront mill site in Tacoma, Washington. Worked closely with the City of Tacoma to facilitate redevelopment of the site into a public park with a demonstration wetland.

Provided comprehensive support for redevelopment of a number of sites owned by the City of Tacoma along approximately one mile of the Thea Foss Waterway in Tacoma, Washington. The sites were subsequently developed into the Chihuly Glass Museum, several residential and mixed-use projects, and a public esplanade along the waterway. Developed work plans, managed field programs for soil and groundwater sampling, prepared remedial investigation and feasibility study analyses and reports, developed site-specific cleanup action plans, assisted with preparation of remedial design documents, and provided oversight during site remediation and redevelopment.

Conducted a technology screening study and demonstration project for an example brownfield site with hydrogeology and contaminants typical of other sites in the Duwamish Industrial Area of Seattle (focused on chlorinated solvents and petroleum hydrocarbons). The study was conducted as part of a brownfields redevelopment showcase program funded by the U.S. Army Corps of Engineers and the U.S. EPA, in cooperation with King County, the City of Seattle, and the Environmental Coalition of South Seattle. The goal of the work was to provide a resource to help expedite technology selection and remediation at similar sites in the area. Completed the following work as part of the study: 1) identified relevant federal, state, and local regulatory cleanup criteria to be considered during groundwater remediation at the example site and at similarly contaminated properties within the Duwamish Industrial Area; 2) identified, evaluated, and screened technologies to develop a short list of four recommended treatment technologies that could potentially be used by the property owner to remediate groundwater contamination at the example site; 3) estimated present-value costs for the four technologies at the example site; and 4) provided a menu of potentially effective technologies for similarly contaminated properties within the Duwamish Industrial Area.

Provided comprehensive support for redevelopment of a former dry-cleaning site in Seattle, Washington, involving installation of an active remediation and vapor intrusion mitigation system during construction of a new retail building. Work included investigation of the PCE contamination in soil and groundwater; pilot testing of an air sparging/soil vapor extraction system; and design, installation, and optimization of a full-scale system with 30 sparging wells and six horizontal vapor extraction lines. Worked with the project team to develop and implement a monitoring program for the system, which was computer operated and can be controlled remotely by phone or modem. The remediation system was designed so that it could be installed at the same time that a new retail drugstore was being built on the site. Coordinated activities with the design and construction teams, sequencing the work so that the treatment system could be installed beneath the building and environmental safeguards could be incorporated into the building's foundation.

Metals and Mining

Investigated transport and fate of contaminants in surface water and sediment from a release of impounded water from a former gold mine in the southwestern United States. Evaluated potential impacts to human health, biota, businesses and agricultural users.

At a former alumina smelter in St. Croix, U.S. Virgin Islands, provided comprehensive litigation support in response to a CERCLA NRD claim for damages to terrestrial, groundwater, and marine resources, primarily from metals and radionuclides. Directed the collection of additional field data, reviewed and integrated existing and new data using a GIS database, and prepared expert reports regarding soil and groundwater contaminant sources, transport, and fate. Coordinated with a team of experts and counsel to ensure all had access to the GIS and document databases throughout the course of the work.

Conducted a multidisciplinary assessment of the effects of fugitive dust at the largest zinc mine in the world, Red Dog, which is located in a tundra environment 50 miles north of the Arctic Circle. Detection of metals in sensitive tundra habitats raised community concerns about risks from subsistence foods and

adverse effects on the environment. Evaluated transport and fate, and conducted human health and ecological risk assessments for lead, zinc, cadmium, and other metals from dust transport in the areas surrounding the mine and road, and the port facilities on the Chukchi Sea. Provided ongoing support with community relations and risk communication through interaction with multiple regulatory agencies, village residents, Alaskan native corporations, and non-governmental organizations. Local village residents' reliance on subsistence hunting and harvesting in the area of the mine, road, and port made the project highly sensitive, resulting in significant media attention and public exposure. Because of the public concern about potential exposure to metals, and the short field season in northern Alaska, the project was fast-paced and demanding, making careful coordination, communication, and planning key components of the effort. Organized and implemented a stakeholder workshop to establish priorities and objectives for fugitive dust risk management, and established a stakeholder technical workgroup for review of plans and reports. Developed a multifaceted risk management plan to minimize the potential for dust to affect human health and the environment over the life of the mine.

Developed a site characterization and risk assessment work plan to evaluate residential, occupational, and recreational exposure scenarios at a former copper mine and smelter site in Arizona. Guided the development, implementation, and reporting of an innovative sampling and analysis program using EPA Triad methodology, including XRF-based field sampling, to reduce overall characterization costs. Metals of potential concern include arsenic, beryllium, cadmium, copper, chromium, lead, manganese, and zinc.

Environmental Liabilities Assessment / Risk Management

Evaluated environmental risks and liabilities associated with a portfolio of sites subject to cost-sharing under a past transactional agreement. Reviewed and evaluated past spending of reserve funds, and opposing expert's forecast of liabilities, including projected spending for ongoing environmental remediation obligations and for contingent liabilities for the sites in the portfolio. Developed an independent fair value measurement estimate of liabilities (based on ASTM standards E3123, E2137 and E2173) for use in negotiation between parties.

In support of the prospective sale of a former manufacturing facility for planned brownfields redevelopment, prepared and presented a fair value measurement based forecast of environmental liabilities (per methods in ASTM E2137 and E2173) for remediation of sediments in the river next to the former facility. The forecast was used to support negotiation regarding the establishment of a remediation trust to fund future cleanup of river sediments, and to manage and minimize risks associated with the transaction. Also provided an environmental reserve estimate for reporting during the course of the work preparing for the transaction.

Assessed projected value of closure and post-closure environmental liabilities for a coal-fired power plant in support of allocation and prospective divestment of one owner from the power plant. As part of scenario analysis for this matter, prospective remedial actions and costs were developed, and potential regulatory outcomes and possible natural resource mitigation options were evaluated. Uncertainties were assessed, and the value of additional data collection for uncertainty reduction was considered in support of strategic planning of path forward toward exit negotiations.

Developed estimates of remedial costs and liabilities associated with the use of aqueous film-forming foam (AFFF) at a broad variety of facilities worldwide where the chemicals are anticipated to occur in the environment. AFFF contains environmentally persistent poly- and perfluoroalkyl substances (PFAS), also referred to as perfluorinated compounds (PFCs). The analysis also included assessment of the impact of prospective changes in regulatory threshold levels for some PFCs on estimated liabilities resulting from increased groundwater remediation costs.

To facilitate environmental risk management for aging utility infrastructure, developed and prepared documentation for a model to estimate costs for environmental response and remediation of oil released from high pressure fluid-filled electrical transmission lines under a variety of land and water release scenarios. The model software and documentation was published by EPRI in November 2012 as Relative

Risk Model for Transmission and Distribution Electric Infrastructure (General RRM) Version 1.0 (Product ID #1023751).

Developed a multi-tiered approach to evaluate and rank enterprise environmental risk for a large U.S. based multinational manufacturing firm at over 100 facilities located outside of the U.S. Liabilities related to current and historical onsite and offsite disposal practices were evaluated and ranked. A scoring method was developed that incorporated factors such as facility activities and manufacturing processes, chemicals used, disposal practices, potential for chemical transport and exposure related to onsite and offsite disposal facilities, and regulatory requirements related to offsite landfills where wastes had been disposed of (by country). The scores were used to prioritize facilities where resources should be focused to address greater potential liabilities, and additional site-specific assessment was performed for these locations.

Developed a risk management framework to monitor and minimize impacts associated with fugitive metals dust releases from mining operations. Designed a stakeholder workshop and technical workgroup approach to identify additional priorities and objectives for integration into the fugitive dust risk management framework. Implemented the framework at Red Dog Mine in northern Alaska.

Product Liability / Product Stewardship / Supply Chain / Regulatory Compliance

Assisted large retailer with developing a risk management strategy to prevent prohibited products from being sold through their sales platform. Developed an automated approach to maintaining current lists for screening.

Provided technical support regarding leachability concerns for a steel slag product being used for fills and road subgrade applications. Support included assessing the applicability and appropriate use of EPA's Leaching Environmental Assessment Framework (LEAF) leach testing methods with respect to this material and its applications.

Provided technical support to the gypsum wallboard industry association regarding healthy building products initiatives, and provided recommendations and guidance on design and implementation of studies.

On behalf of U.S. Gypsum Association, prepared comments on the EPA Notice of Data Availability (NODA) as part of EPA's coal combustion residuals rulemaking process. This included evaluating the proposed Leaching Environmental Assessment Framework (LEAF) that was included in the NODA, and identifying and commenting on technical, conceptual, and cost issues with the framework, and implications for industry.

Evaluated the content of trace metals in natural and synthetic gypsum (fly ash) sources used to manufacture wallboard products in support of an assessment of human exposure potential. Following implementation of clean-air regulations, an increase in mercury content of synthetic gypsum was anticipated. Therefore, as part of the assessment, conducted flux-chamber studies to evaluate the potential for any mercury to volatilize from synthetic gypsum wallboard. Results indicated that the concentrations of metals in natural and synthetic gypsum do not exceed most health-based screening criteria, and that emissions of mercury from synthetic gypsum do not result in air concentrations above ambient levels.

Provided guidance on supply chain risk management strategies for radioactive contaminants.

Provided regulatory oversight and support at a former Naval Air Facility in Adak, Alaska during preparation for closure and transition to an Alaskan native corporation. Work included construction and remediation oversight, and compliance oversight pertaining to drinking water, wastewater, stormwater, air permits, spill response, regulated waste (RCRA, TSCA, and CERCLA), used oil, and solid waste. Oversight of remediation work included projects with petroleum in soils and sediments, and tank and

pipeline closures.

NPDES / Clean Water Act

At a major shipyard in Southern California, investigated the relative contribution of various metal sources to surface water quality during drydock ship launches. Designed and implemented a field program to sample total and particulate concentrations of copper, zinc, and nickel within the drydock. Developed a mass balance model to simulate water concentrations during drydock flooding and launch events, and to evaluate the potential effectiveness of additional source control options, such as hull and drydock washing and possible surface coatings, for limiting metals releases and meeting discharge requirements during ship launches.

As part of an NPDES discharge permitting effort for a zinc mine in Alaska, conducted analyses to evaluate potential for effects to existing aquatic uses (including industrial, recreation, aquatic life and wildlife) resulting from implementation of a selenium mixing zone.

Hydrology, Hydrogeology, and Water Resources Evaluations

Evaluated claims regarding overcharges for water in the matter of City of Cerritos, et al., v. Water Replenishment District of Southern California, Case No. BS128136, in the Superior Court of the State of California, County of Los Angeles. Work included an assessment of groundwater hydrology and hydrogeology, groundwater modeling of two groundwater basins divided by a fault zone, and review of the hydrogeologic basis for an allocation of water rates between the two basins.

Coordinated collection of water-level and hydraulic conductivity data, evaluated geology and groundwater flow patterns, and assessed impacts of the construction of the Sea-Tac Third Runway in Sea-Tac, Washington, on groundwater and surface water flow conditions.

Analyzed hydrologic and meteorological data to differentiate aquifer impacts caused by gravel mining from the effects of seasonal or multi-year meteorologic trends, at a mine in Snohomish County, Washington. This technical analysis facilitated the pursuit of additional permitting for expansion of the gravel mine.

Conducted a flooding evaluation for an industrially zoned property owned by the Port of Tacoma, in Tacoma, Washington. Collected field data, researched regional hydrogeologic conditions and changes to surface water drainage resulting from recent development, and analyzed time-series precipitation data to assess the factors causing flooding in the area and to estimate how often the flooding is likely to occur.

Assessed the contribution to a flood event from overflow at a sewage treatment plant in Edmonds, Washington, by obtaining data about the flood event, researching local surface water drainage conditions, and analyzing time-series precipitation and tidal data. This enabled the client to determine whether to pursue a claim against the treatment plant for damages to his building.

Compiled and evaluated regional hydrogeologic information to locate potential aquifers for a proposed development in East King County, Washington. Assisted in drilling oversight for the installation of a deep water supply well. Developed water balance calculations for the pre- and post-development conditions to facilitate obtaining water rights from the Washington State Department of Ecology.

Assessed the availability of groundwater around the Upper Deschutes River in Washington as a source of water for a potential fish hatchery facility. Evaluated well logs, geologic and topographic data, and stream-flow data for the area.

Coordinated and performed pump testing of two City of Kent, Washington, water supply areas to facilitate assessment of pumping rates that can be sustained without affecting nearby stream flows. Assisted in

developing a MODFLOW groundwater flow model for the watershed area as part of the City of Kent wellhead protection program.