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**Scott S. Shock, P.E.**  
**Managing Engineer**

**Professional Profile**

Mr. Shock is a Managing Engineer in Exponent's Environmental Sciences practice. His diverse project experience includes site investigation and characterization, contaminant transport and fate, human health and ecological risk assessment, soil and groundwater remediation, groundwater modeling, cost analysis, and litigation support. Mr. Shock has planned and implemented numerous field investigations involving a wide variety of contaminants in soil, groundwater, and sediment. He is skilled in data interpretation and evaluation, and development of effective conceptual site models.

One of Mr. Shock's specialties is assessing environmental impacts associated with mining, particularly in sensitive habitats. He is a leader in the development of proactive and preventive risk management strategies designed to minimize the environmental impacts of mining. Mr. Shock is also skilled in risk communication, and in facilitating cooperation among diverse stakeholder groups.

Mr. Shock's cost analysis experience includes feasibility studies under CERCLA and RCRA, and cost allocations associated with cost recovery litigation and insurance coverage. He employs tools such as cost/benefit analysis, Monte Carlo uncertainty analysis, sensitivity analysis, uncertainty reduction (e.g., through targeted supplemental data collection), net environmental benefits analysis, and other decision analysis methods to help clients make more informed and robust remediation and liability management decisions.

Mr. Shock's contaminated-site remediation experience includes evaluating and comparing remedial technologies; costing, planning, and implementing field pilot tests of remediation systems; and designing and supervising the installation, startup, monitoring, and closure of full-scale remediation systems. He has evaluated ongoing remedial actions to improve operational performance, and has assessed the appropriateness of past remedial actions in support of litigation and cost allocation negotiations, particularly with respect to volatile organics in soil and groundwater.

**Academic Credentials and Professional Honors**

M.S., Civil/Environmental Engineering, University of Washington, 1994  
B.S., Civil Engineering, University of Washington, 1992

**Licenses and Certifications**

Professional Engineer in Washington State, License No. 37417  
OSHA Hazardous Waste Operations and Emergency Response 40-hour certification

## **Publications**

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](https://doi.org/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](https://doi.org/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](https://doi.org/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.

## **Presentations**

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

Shock S, Nielsen D, Bryant MA. A method for evaluating cost versus environmental benefit using semiquantitative valuation of beneficial uses. Poster presentation at the 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. Poster presented at the 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. Poster presented at the 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. Poster presented at the Society for Toxicology's 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. Poster presented at the Society for Toxicology's 43rd Annual Meeting, Baltimore, MD, March 2004.

## **Project Experience**

The largest zinc mine in the world, Red Dog, is located in a pristine tundra habitat 50 miles north of the Arctic Circle. On behalf of the operator, Teck Cominco, Exponent conducted a multidisciplinary assessment of the effects of fugitive dust. 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 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. The nature of the local village residents' reliance on subsistence hunting and harvesting in the area of the mine, road, and port makes the project highly sensitive, resulting in significant media attention and public exposure. Because of the public concern about the metals, and the short field season in northern Alaska, the project has frequently been fast-paced and demanding, making careful coordination, communication, and planning key components of the effort. Exponent is currently developing a risk management plan to minimize the potential for dust to affect human health and the environment over the life of the mine. The risk management effort included facilitation of a stakeholder workshop to establish priorities and objectives for this plan, and establishment of a stakeholder technical workgroup for review of plans and reports.

Assisted with development of a site characterization and risk assessment work plan at the former Old Dominion 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. The risk assessment will evaluate residential, occupational, and recreational exposure scenarios.

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, the mercury content of synthetic gypsum increased. Therefore, as part of the assessment, we also 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. This information was used to assess potential

liabilities associated with distribution of synthetic gypsum products, and in assessing appropriate feedstock for manufacturing processes.

Evaluated the lateral and vertical extent of TCE and other HVOCs at a site in southern California (Orange County) as part of CERCLA §107 and §113 actions. 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 included an 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.

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 it is removed and replaced over the course of a normal maintenance schedule.

Managed an assessment of bioventing (including pilot testing and analysis) for ExxonMobil at a Superfund site in Seattle, Washington, that has 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.

Provided technical assistance on a project to evaluate 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.

Provided technical support for the evaluation of 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.

Conducted a technology screening study for an example site with hydrogeology and contaminants typical of other sites in the Duwamish Industrial Area (i.e., chlorinated solvents and petroleum hydrocarbons). The study was conducted as part of a 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. 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 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. Sites included 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, wrote remedial investigation (RI) reports, developed site-specific cleanup action plans, assisted with preparation of remedial design documents, and provided oversight during site remediation and redevelopment.

Conducted a focused feasibility study for the head of the Thea Foss Waterway, a Superfund site contaminated with coal tar and creosote wastes within and beneath sediment. Screened technologies to identify those applicable to the site. Developed, ranked, and developed cost estimates for remedial alternatives. Utilized new remedial technologies databases to help complete this work in a relatively short time frame.

Performed a remedial investigation of DNAPL and TPH contamination at Quendall Terminals, a former tar manufacturing and bulk fuel storage site located next to Lake Washington, now a Superfund site. Reviewed historical information to focus sampling efforts on areas of concern and potential exposure pathways. Collected air emissions samples from soil using a flux chamber, soil samples from test pits and borings, groundwater samples, and surface water and sediment samples from Lake Washington. Measured groundwater elevations to assess seasonal groundwater flow patterns as influenced by the elevation of Lake Washington, which is controlled by the U.S. Army Corps of Engineers at the Ballard Locks. 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 evaluate the relative cost effectiveness of proposed remedial alternatives to control petroleum and creosote constituents migrating with groundwater into Lake Washington. Identified the most cost-effective remedial alternative through a graphical analysis of diminishing return on investment.

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.

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 program and collected samples to characterize the nature and extent of soil contamination 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.

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 speed 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 attorneys to put together the closure report and obtain a No-Further-Action letter from the Department of Ecology.

Provided regulatory oversight and support at a former Naval Air Facility in Adak, Alaska. 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.

Provided comprehensive support for redevelopment of a former dry-cleaning site in Seattle, Washington, involving installation of an active remediation 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 troubleshooting 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 is 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.

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 they remodel 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.

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. 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.

Coordinated collection of water-level and hydraulic conductivity data, evaluated geology and groundwater flow patterns, and participated in assessing 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 technically analyzed time-series precipitation data to assess the factors causing regional 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 remuneration from the treatment facility 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.

### **Professional Affiliations**

- Society of Environmental Toxicology and Chemistry
- National Ground Water Association—Association of Ground Water Scientists and Engineers (member)
- American Society of Civil Engineers (member)
- Toastmasters International (Advanced Communicator Bronze)