

Exponent®
Engineering & Scientific Consulting

Michael Garry, Ph.D.

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Professional Profile

Dr. Garry is a toxicologist with more than 25 years of experience analyzing the biological effects of chemicals on humans and other organisms. He has extensive experience analyzing mechanisms of toxicity for both metals and organic chemicals, and has developed science-based toxicity criteria and guidelines and critically reviewed those developed by others.

In the field of regulatory toxicology, Dr. Garry has designed and overseen laboratory-testing programs aimed at understanding the mechanisms of toxicity and developing safe exposure levels for industrial chemicals. Dr. Garry has conducted safety evaluations for a variety of pharmaceuticals, medical devices, and consumer products.

As an environmental toxicologist, he specializes in applying risk-based methods to the design, implementation, and analysis of environmental and remedial investigations. Dr. Garry has worked extensively on projects involving petroleum, pulp and paper, and mining sites developing and applying scientifically-based methods to assess ecological and human exposure and toxicity. These projects have been located in the U.S., Asia, South America, Oceania, and Africa. He has also collaborated with U.S. EPA Region 10 on several projects, including the development of streamlined, risk-based screening software for indirect exposure to incinerator emissions, and compilation of seafood arsenic speciation and toxicity data.

Dr. Garry has conducted molecular and biochemical research at the Fred Hutchinson Cancer Research Center and at the University of Washington. He has used this knowledge and experience to evaluate function and replacement of genetically engineered cells, cell derivatives, and cell products. He is able to translate advances in basic science and technology into the practice of risk assessment and risk communication. Dr. Garry's experience in public health practice includes nutrition and maternal and child health counseling, community education and outreach, program planning and administration, in-class teaching, and clinical counseling. He has assisted in the development, implementation, and management of a national health system with the Ministry of Health in Cameroon, West Africa. Dr. Garry has a doctoral degree in toxicology from the University of Washington, where his research focused on the cellular and molecular mechanisms of metal-induced reproductive, developmental, and inhalation toxicity.

Academic Credentials & Professional Honors

Ph.D., Toxicology, University of Washington, 2006

M.S., Nutritional Biochemistry, University of Washington, 1989

B.S., Zoology, University of California, Davis, 1985

Environmental Pathology and Toxicology Traineeship, National Institute of Environmental Health

Sciences, University of Washington, 1999-2003

Society of Toxicology, Outstanding Presentation Award, Risk Assessment Specialty Section, 2001 Annual Meeting

Student Advisory Committee to Society of Toxicology National Council, 1999-2001

Hazardous Waste Operations and Emergency Response 40-hour training program

OSHA 8 hour Refresher Courses for Health and Safety

Licenses and Certifications

8-Hour HAZWOPER Managers and Supervisor Training (WA)

Academic Appointments

Affiliate Assistant Professor, Department of Environmental and Occupational Health Sciences, University of Washington, January 2017-present

Prior Experience

Research Associate, University of Washington, 1998-2003

Toxicologist, Foster Wheeler Environmental Corporation, 1995-1999

Research Scientist, Fred Hutchinson Cancer Research Center, 1992-1995

Public Health Care Coordinator, Ministry of Health, Republic of Cameroon, 1989-1992

Program Coordinator, Women, Infants, and Children Program (WIC), U.S. Department of Agriculture, 1988-1989

Professional Affiliations

Society of Toxicology

Pacific Northwest Association of Toxicologists

Society for Birth Defects Research and Prevention

Languages

French (France)

Publications

Rice Y, Dolan D, Bandara S, Morgan R, Garry M, Tsuji J. Considerations and derivations of permitted daily exposure limits for impurities from intravitreal pharmaceutical products. Reg Toxicol Pharmacol 2025, 155:105745. DOI: 10.1016/j.yrtph.2024.105745

Garry MR, Shock SS, Salatas J. Human health risk assessment of metals exposure through subsistence foods consumption and subsistence harvest activities near a mining transport road in northwest Alaska.

Hum Ecol Risk Assess. 2020. 27(1):227-257.

Leonhard MJ, Chang ET, Loccisano AE, Garry MR. 2019. A systematic literature review of epidemiologic studies of developmental manganese exposure and neurodevelopmental outcomes. Toxicology. 2019; 420:46-65.

Taylor AA, Tsuji JS, Garry MR, McArdle ME, Goodfellow WL, Adams WJ, Menzie CM. 2020. Critical review of exposure and effects: implications for setting regulatory health criteria for ingested copper. Environ Manage 65: 131 – 159.

Lemberg, J, Guyer, E, Seidel, S, Garry, M, Tsuji, J, Valenty, S. Utilizing a combination of TGA and GC-MS to estimate health-based risks from off-gassed volatile compounds. Journal of Failure Analysis and Prevention 2018; 18(2): 246-249.

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, Volumes 619-620, 1 April 2018, Pages 1340-1348.

Bogen KT, Garry MR. Risks of allergic contact dermatitis elicited by nickel, chromium, and organic sensitizers: quantitative models based on clinical patch test data. Risk Analysis 2017. doi:10.1111/risa.12902.

Judd N, Lowney Y, Anderson P, Baird S, Bay SM, Breidt J, Buonanduci M, Dong Z, Essig D, Garry MR, Jim RC, Kirkwood G, Moore S, Niemi C, O'Rourke R, Ruffle B, Schaider LA, Vidal-Dorsch DE. Fish consumption as a driver of risk-management decisions and human health-based water quality criteria. Environmental Toxicology and Chemistry 2015; 34:2427-2436.

Tsuji JS, Garry MR, Perez V, Chang ET. Low-level arsenic exposure and developmental neurotoxicity in children: A systematic review and risk assessment. Toxicology 2015; 337:91-107.

Garry MG, Santamaria AB, Williams AL, DeSesso JM. In utero arsenic exposure in mice and early life susceptibility to cancer. Regul Toxicol Pharmacol 2015; 73:378-390.

Kimmel CA, Garry MR, DeSesso JM. Relationship between bent long bones, bent scapulae, and wavy ribs: Malformations or variations? Birth Defects Res B Dev Reproductive Toxicology 2014; 101:379-392.

Tsuji JS, Perez V, Garry MR, Alexander, DD. Association of low-level arsenic exposure in drinking water with cardiovascular disease: A systematic review and risk assessment. Toxicology 2014; 323:78-94.

Tsuji JS, Garry MR. Advances in toxicity testing herald improvements and challenges for risk assessment. Risk Analysis 2009; 29(4):490-491.

Garry MR, Kavanagh TJ, Faustman EM, Sidhu JS, Liao R, Ware C, Vliet PA, Deeb SS. Sensitivity of mouse lung fibroblasts heterozygous for GPx4 to oxidative stress. Free Radial Biology and Medicine 2008; 44(6):1075-1087.

Petito Boyce C, Garry MR. Developing risk-based target concentrations for carcinogenic polycyclic aromatic hydrocarbon compounds assuming human consumption of aquatic biota. Journal of Toxicology and Environmental Health, Part B 2003; 6:497-520.

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 Compounds 2003; 63:413-416.

Petito Boyce C, Garry MR. Review of information resources supporting human exposure assessment models. Human and Ecological Risk Assessment 2002; 8(6):1445-1487.

Chew CM, Lorenzana RM, Garry MR. Indirect Exposure Screening Model for Evaluating Contaminant Intake from Air Emissions Via Ingestion of Milk and Beef: Risk-Based Air Concentrations. In: Environmental Toxicology and Risk Assessment: Modeling and Risk Assessment, Sixth Volume. ASTM STP 1317. Dwyer FJ, Doane TR, Hinman ML (eds), American Society for Testing and Materials, 1997.

National Health Care Reorganization Task Force. Methodologie pour la mise au point de grilles de supervision des centres de sante. Ministry of Health, Republic of Cameroon, 1992.

Presentations and Published Abstracts

Tsuji JS, Corey LM, Lin J, Garry MR. Triangulation of evidence in reconstruction of historical exposure and health risks for nuclear workers. Poster presented at Society of Toxicology's 65th Annual Meeting, San Diego, CA. 2026.

Rice YY, Dolan DG, Bandara SB, Morgan RE, Garry, MR, Tsuji JS. Considerations and derivations of permitted daily exposure limits for impurities from intravitreal pharmaceutical products. Poster presented at Society of Toxicology's 64th Annual Meeting, Orlando, Fl, 2025.

Taylor AA, Garry MR, McArdle ME, Goodfellow, Jr. WL, Adams WJ, Tsuji JS, Menzie CA. New copper research provides an opportunity to update current copper regulatory information. Poster presented at Society of Toxicology's 57th Annual Meeting, San Antonio, 2018.

Garry MR, Badding MA. Hazardous air pollutant emissions at MSW landfills: does NMOC monitoring adequately characterize health? Poster presented at Society of Toxicology's 56th Annual Meeting, Baltimore, MD, 2017.

Bogen KT, Garry MR. Risks of Allergic Contact Dermatitis Elicited by Ni, Cr(VI), Cr(III), and Five Organic Sensitizers, and a Proposed Default Non-Cr Risk Model. Poster presented at Society of Toxicology's 56th Annual Meeting, Baltimore, MD, 2017.

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

Garry MR, Santamaria AB, Williams AL, DeSesso JM. Arsenic and transplacental carcinogenesis. Poster presented at Society of Toxicology's 54th Annual Meeting, San Diego, CA, 2015.

Bogen K, Volberg V, Garry MR. Risks of allergic contact dermatitis elicited by nickel, chromium, and (meth)acrylates: modeled comparisons of published patch-test data on ~6,000 sensitive individuals. Poster presented at Society of Toxicology's 54th Annual Meeting, San Diego, CA, 2015.

Garry MR. Dietary survey study design considerations for fish consumption studies used in regulatory decision making. Oral presentation at Society of Environmental Toxicology and Chemistry North America 35th Annual Meeting, Vancouver, BC, Canada, 2014.

Garry MR, Tsuji JS, Perez V, Alexander DD. Evaluation of an arsenic reference dose for potential neurobehavioral effects in children. Oral presentation at Society of Toxicology's 53rd Annual Meeting, Phoenix, AZ, 2014.

Perez V, Tsuji JS, Garry MR, Alexander DD. A systematic review of the epidemiologic evidence on low-level arsenic exposure and cognitive function in children: applicability for risk assessment. Poster presented at Society of Toxicology's 53rd Annual Meeting, Phoenix, AZ, 2014.

Salatas JH, Garry MR, Lowney YW. Assessment of the impacts of changes in regulatory toxicology of polycyclic aromatic hydrocarbons on site assessments. Poster presented at Society of Toxicology's 52nd Annual Meeting, San Antonio, TX, 2013.

Garry MR. Communicating science to the public. Oral presentation at Society of Toxicology's 51st Annual Meeting, San Francisco, CA, 2012.

Garry MR, Saba T, Mohsen F, Hilbert B. Health assessment of methanol used in hydraulic fracturing fluids. Poster presented at Society of Toxicology's 51st Annual Meeting, San Francisco, CA, 2012.

Kimmel CA, Garry MR, DeSesso JM. Relationship between bent long bones, bent scapulae and wavy ribs: Malformations or variations? Birth Defects Research (Part A) 2011; 91:357.

Garry MR. Getting from biomonitoring to risk for perfluoroalkyl acids (PFAAs): Critical data gaps for understanding the meaning of the measures. Oral presentation at the 2nd World Congress on Risk, Society for Risk Analysis, Guadalajara, Mexico, 2010.

Garry MR, Shock SS. Assessment of metals concentrations monitored in caribou collected near a mining transport road in northwest Alaska. Poster presented at the Society of Toxicology's 49th Annual Meeting, Salt Lake City, UT, 2010.

Garry MR, Deeb SS, Kavanagh TJ, Yu X, Vredevoogd MA, Kim E, Faustman EM. Differential modulation of stress signaling pathways by cadmium in cultured mouse lung fibroblasts heterozygous for GPx4. Poster presented at the Society of Toxicology's 46th Annual Meeting, Charlotte, NC, 2007.

Garry MR, Shock SS, Yost LJ, Kulas J, Shields WJ. Human health risk assessment of metals exposure through subsistence foods consumption and subsistence harvest activities near a mining transport road in northwest Alaska. Poster presented at the Society of Toxicology's 45th Annual Meeting, San Diego, CA, 2006.

Shock SS, Lowney YW, Peterson LD, Bessinger BA, Garry MR. Assessment of solubility and bioaccessibility of barite in mine-impacted soils. Poster presented at the Society of Toxicology's 45th Annual Meeting, San Diego, CA, 2006.

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 of Toxicology's 44th Annual Meeting, New Orleans, LA, 2005.

Garry MR, Shock SS, Yost LJ, Kulas J, 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 of Toxicology's 43rd Annual Meeting, Baltimore, MD, 2004.

Garry MR, Sidhu JS, Kavanagh TJ, Faustman EM. Differential modulation of stress and ubiquitination signaling pathways by cadmium, H2O2, and serum withdrawal in cultured mouse fibroblasts. Abstract 311. Oral presentation at the Society of Toxicology's 44th Annual Meeting, Salt Lake City, UT, 2003.

Yost LJ, Shock S, Garry M, Garson YN, Sugino AK. Health risk evaluation of PCBs measured in wipe samples from joint compound. Poster presented at the Society of Toxicology's 44th Annual Meeting, Salt Lake City, UT, 2003.

Garry MR. 2003. Red Dog mine DMTS risk assessment workplan. Oral presentation at the Alaska Forum for the Environment, Anchorage, AK, February 2003.

Garry MR, Kavanagh TJ, and Faustman EM, Sidhu JS, Deeb SS. Differential susceptibility to oxidative stress in mouse lung fibroblasts heterozygous for GPx4. Poster presented at the 9th Annual Meeting of The Society for Free Radical Biology and Medicine, San Antonio, TX, 2002.

Garry MR, Tsuji JS. Evaluating lead exposure at mining sites with heterogeneous soil types and lead bioavailability. Poster presented at the Society of Toxicology's 42nd Annual Meeting, Nashville, TN.

Toxicologist 2002; 66(1-S), 500.

Yost LJ, Schoof RA, Garry MR. Estimation of dietary intake of inorganic arsenic in children. Fifth International Arsenic Meeting, Society of Environmental Geochemistry and Health, San Diego, CA, 2002.

Garry MR, Lowney YW, Tsuji JS. A critical analysis of assumptions used when evaluating intake of metals from homegrown vegetables. Poster presented at the Society of Toxicology's 41st Annual Meeting, San Francisco, CA. Toxicologist 2001; 60(1), Abstract 2007.

Tsuji JS, Garry MR. Metals exposure from homegrown produce at mining and smelting sites. Poster presented at the Society of Toxicology's 41st Annual Meeting, San Francisco, CA. The Toxicologist 2001; 60(1), Abstract 95.

Petito Boyce C, Garry MR. Development of carcinogenic PAH trigger levels for human consumption of aquatic biota based on modifications to the default bioconcentration factor and the use of toxicity equivalency factors. Presented at the Society for Risk Analysis annual meeting, December 4, 2000.

Garry MR, Kavanagh TJ, Faustman EM. Phosphatidylcholine hydroperoxide decreases mitochondrial membrane potential and oxidizes cardiolipin. Poster presented at the Society of Toxicology's 40th Annual Meeting, Philadelphia, PA. Toxicol Sci 2000; 54(1), Abstract 767:163.

Garry MR, Vredevoogd M, Faustman EM. Gene expression as a potential biomarker of inorganic mercury exposure in terrestrial ecosystem. Poster presented at the Society of Toxicology's 39th Annual Meeting, New Orleans, LA, 1999.

Garry MR, Kirchner SC, Schroeder JL, Faustman EM. Amplification and detection of RNA from mature human sperm. Poster presented at Pacific Northwest Association of Toxicology, Regional Chapter of the Society of Toxicology, 1997.

Garry MR. Methylmercury and developmental neurotoxicity: Historical context and current exposure. Co-chair of educational webinar Developmental Neurotoxicity of Methylmercury. Sponsored by the Society for Birth Defects Research and Prevention and the Developmental Neurotoxicology Society. May 4, 2021.

Garry MR, Watson A. Developmental toxicity of the skeletal system: Interpretation of findings in DART studies and implications for risk assessment. Continuing Education course organizer and co-chair with A Watson. Annual Meeting of the Society of Toxicology, Baltimore, MD, March 10, 2019.

Project Experience

Medical Devices, Biotechnology, and Consumer Products

Design and/or consult on design of biocompatibility testing programs for a wide range of medical devices and combination products, including orthopedic, neurological, cardiac, continuous glucose monitoring, auditory, gastrointestinal, wound treatment, and aesthetic devices, as well as drug delivery and container systems, The efforts include conduct of toxicological risk assessments and design/oversight/interpretation of biocompatibility and chemical characterization testing.

Developed a framework for evaluating impurities in intravitreal drug products. The efforts include development of the framework, testing it on case studies, and applying it to develop permitted daily exposure (PDE) values and leaching recommendations for drug substances, drug products, and process train evaluations.

Evaluate exposure and health risks associated with impurities, including benzene and nitrosamines, in over-the-counter drug products and consumer products to support health hazard evaluations, safety recall

decisions, and regulatory submission/responses. The evaluations have included metals, nitrosamines, benzene, and other organic impurities, covering products intended for oral and dermal administration.

Conducted an evaluation of viability and functionality of genetically modified, monoclonal antibody secreting cell lines following deviation from the cryopreservation protocol. The evaluation included: 1) potential for damage to the cell lines as a result of a temporary freezer failure; 2) possible long-term damage to the viability and productivity of the cells; and 3) cost estimates to regenerate the damaged cell lines.

Evaluated the technical and budget aspects of an insurance claim to regenerate genetically modified research cells lines lost in a freezer failure, including cells derived from cross-mating of genetically modified mouse strains and cells derived from direct bioengineering of existing cell lines. The investigation included: 1) evaluation of publications, past grant proposals, and other documentation related to the cell lines; 2) a laboratory/facility site visit and interviews with the principal investigator and research technician; 3) review of cost assumptions and the research protocols necessary to generate new cell lines; and 4) recommended modifications to the research proposal and cost basis.

Assessed exposure and health risks of leaching of metals from alloys used in various implanted medical devices. Projects involved potential for device failures, evaluation of potential exposure and health effects, assessments in support of FDA submissions for device approvals, and recommendations for follow-up studies.

Conducted an evaluation of biocompatibility testing and potential health risks for organic chemicals identified from leaching and volatilization tests of an implantable nerve stimulation device. The evaluation included review of data on hematology, clinical chemistry, and adverse events reported following use of the device, as well as laboratory research conducted on the device in animals and cell lines prior to use in humans. Provided perspective on potential exposures and toxicity given the intended use relative to other known and approved exposures to these chemicals.

Developed detailed safety evaluations on chemicals used in cosmetics and fragrance materials. The resulting monographs, each focused on a specific class of chemicals, include a summary of chemical use in the cosmetic and fragrance industry, metabolism, a review of available toxicology data, and recommendations for future research necessary to more fully characterize the potential toxicity of the chemical class.

Conducted a safety evaluation of volatile organic chemicals off-gassed and leached from the plastic chassis of a home consumer electronics device. The evaluation included evaluation of chemical concentrations leached from the device, modeling of potential air concentrations, estimation of human exposures, and comparison to health-based concentration limits.

Conducted a safety evaluation on an ethylene propylene diene monomer (EPDM) synthetic rubber used in potable water systems for flexible pipe couplings, joints, and gaskets in hot and cold water applications. Evaluated potential for exposure, toxicity, and compliance with American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 for protection of health.

Develop permitted daily exposure values for impurities, reagents, and excipients in pharmaceutical drug substances and drug products. Evaluated available toxicology, pharmacology, exposure and other related data. Derived safe intake levels in accordance with International Conference on Harmonization (ICH) guidelines and standard industry practices.

Regulatory Toxicology

Evaluated potential mechanisms of action (MOAs) for birth defects observed in animal studies associated with exposure to an herbicide. Provided context for species-specific issues related to the MOA and evaluated the relevance to humans at likely exposure levels. Reviewed data from developmental biology

and toxicology studies on other chemicals to evaluate the significance of the specific skeletal anomalies observed.

Conducted an integrated developmental and reproductive toxicology and endocrine modulation assessment of a crop protection compound in the context of proposed revisions to the European Commission Directive 91/414/EEC. The analysis specifically evaluated how proposed new “cut-off” criteria would affect the compound’s future authorization for use in the European Union.

Conducted data review, analysis, and summary for evaluation of functional equivalence of Other Scientifically Relevant Information (OSRI) to EPA’s Tier 1 screening battery for evaluating the potential for estrogen, androgen or thyroid effects. Provided review and verification accuracy, consistency and interpretation of the data relied on and cited in EPA’s response.

Conducted Structural Activity Relationship (SAR) analysis on multiple industrial, agricultural, and pharmaceutical chemicals using DEREK software and provided reports summarizing interpretation and potential biological significance.

Developed technical/scientific guidance for conducting hazard and risk assessment of alloys suitable for meeting emerging international regulatory systems (e.g., GHS, REACH) for chemical risk assessment and classification schemes that are protective of human health. The guidance included: 1) grouping of alloys based on their particular characteristics of relevance for exposure and health risk; 2) read-across for relating similar metal forms, as appropriate based on the scientific evidence, and 3) protocols for bioavailability and bioaccessibility testing.

Provided technical and risk communication support to a Washington State municipality and local industry in support of State-directed sediment and uplands investigations. Worked to coordinate input and direct meetings with Washington State Department of Ecology in efforts to evaluate high-end and general public seafood consumption rates in the context of water and sediment quality standards, and for evaluating input on site-specific assessments.

Conducted a technical review of Arizona’s proposed soil remediation levels (SRLs) and provided comments to the Arizona Department of Environmental Quality. Chemical-specific comments that resulted in modification of the proposed standards addressed the SRLs for barium, beryllium, chromium, iron, manganese, and vanadium. Additional comments addressed issues affecting all SRLs, including soil ingestion rates, and the target risk level assumed for exposure to carcinogenic chemicals.

Directed toxicological investigations on a confidential industrial chemical with the aim of deriving the necessary data to develop a scientifically valid occupational exposure limit. Reviewed existing occupational exposure-limit documentation for the compound. Evaluated available toxicological and chemical research on the compound of interest and related compounds. Developed a detailed research plan designed to address data gaps and uncertainties in the existing toxicological database and provide the requisite data to develop a health-protective occupational exposure limit. Evaluated proposals submitted by contract research laboratories (CRLs) and, based on a specific, defined process, selected a CRL to conduct the laboratory research. Conducted Phase 1 of the research program involving genetic toxicology testing.

Conducted a technical review of Arizona’s proposed Surface Water Quality Standards (SWQS) and provided comments to the Arizona Department of Environmental Quality. Chemical-specific comments addressed the fish-tissue criteria for cadmium and the drinking-water standard for barium. Additional comments addressed assumptions regarding exposure through full and partial body contact with water, and the method by which relative source contribution of a chemical from the water body is calculated.

Metals and Mining

Serving on technical subcommittee of international experts providing input to the committee overseeing a multiyear assessment of legacy impacts to the surrounding communities from an historic copper on Bougainville Island. The legacy impact assessment is the result of an agreement between the mining company and the community residents and their representatives, facilitated by the Australian OECD National Contact Point. The assessment is being carried out by an independent third-party consortium.

Evaluated health claims from potential exposures to metals in effluent discharged into the environment from copper mining operations in Zambia. The evaluation focused on potential exposures to copper, cobalt, and manganese to community members residing in four villages near and/or downstream of the mine facilities.

Provided review and technical advising for a lead smelting facility in Peru undergoing environmental protection upgrades. Served as project manager and provided technical expertise on toxicology, exposure, and risk assessment. Project involved complex air modeling and direct and indirect exposures to metals, particulates, and sulfur dioxide.

Served as project manager and human health risk assessment and toxicology lead for a former elemental phosphorous refinery in Montana. Conducting a multi-pathway human health and ecological risk assessment focusing on chemical and radiological exposures. Chemicals of potential concern include elemental phosphorous, metals, uranium, radon and other radionuclides.

Designed a multi-pathway human health and ecological at a former lead smelter in East Helena, Montana. Served as project manager and human health toxicology and risk assessment leader. The assessment addressed onsite risks from current and future exposures to lead, arsenic, cadmium and other metals.

Conducted an assessment of potential health and environmental impacts of barium, cadmium, chromium, copper, manganese, and vanadium in steel slag recycled as construction fill and railroad or road ballast. The assessment addressed concerns by the New York State Department of Environmental Conservation regarding unrestricted use of the material because of its chromium content. The evaluation considered typical uses of the steel slag and its specific characteristics, such as chromium content, physical and chemical characteristics, and leaching properties.

Served as human health technical lead on multi-discipline team evaluating the effects of lead shot and bullets used in upland game hunting on human health and wildlife. Project focused on a review of the state of knowledge, critical data gaps, and recommendations for future research. The team produced a technical white paper presenting the results of the review.

Directed a site characterization and risk assessment work plan at the former Old Dominion mining and smelter site in Arizona. Provided overall direction of the sampling and analysis design and oversight of development of the sampling and analysis plan. 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.

Provide toxicology and risk assessment consultation and review for a former smelter site in Arizona. Provide technical review of a probabilistic assessment evaluating exposure and risks from arsenic in soil at residential and industrial properties in a community in Arizona that received historical flooding from a tailings impoundment. Provided arsenic toxicology expertise and scientific input on distributions for exposure and arsenic bioavailability.

Provided toxicology, risk assessment, and risk communication expertise for an active zinc mine in northern Alaska. Detection of elevated metals in sensitive tundra habitats raised community concerns about risks from subsistence foods and adverse effects to the environment. The metals evaluated at the

site included arsenic, antimony, barium, cadmium, chromium, lead, mercury, thallium, and zinc. Analyzed risks from potential exposure to metals in subsistence foods and the environment and conducted community meetings in native villages to discuss the analyses and results. Provided community relations support during interactions with village residents, Alaska 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 made the project highly sensitive, resulting in significant media and public exposure.

Conducted and managed human health risk assessment in historical copper mining area in Arizona. Evaluation focused on direct exposure to metals in floodplain soils and stream sediments, and considered residential, occupational, and recreational exposure scenarios. Provide ongoing toxicology and risk communication expertise.

Conducted human health risk assessments for multiple sites in a former mining area in Utah under a voluntary engineering evaluation/cost analysis agreement with EPA. Unique aspects of these assessments included the focus on adult exposures under intermittent recreational use, or short-term occupational use scenarios. The primary site metals of concern are lead and arsenic in soils, and cadmium and zinc in water. The sites are being converted to recreational uses (e.g., mountain biking, hiking, and skiing).

Conducted a human health risk assessment for tailings and naturally mineralized soil at a former mill site in New Mexico as part of a voluntary removal action. The primary site constituents were manganese and zinc in groundwater, and lead, manganese, and arsenic in soil. Lead in soil was evaluated using EPA's adult and child lead models with site-specific assumptions where justified. Detailed site geochemistry studies and simulated gastrointestinal leaching tests indicated very low bioavailability of lead in soil.

As a part of an inter-disciplinary, international team, evaluated the health impacts of tailings discharged into a river system from a copper mine in Southeast Asia. This risk assessment entailed designing dietary, human exposure, and biomarker surveys. The survey collected information from 10 villages on dietary intake of crops grown in tailings, and fish or other animals that are exposed to metals in tailings. The exposure survey documented activities of the various populations and cultural groups that might affect the amount of exposure to tailings. Blood, urine, and hair were also collected from survey participants to assess exposure to various metals in tailings, including arsenic, cadmium, chromium, lead, and zinc. Analyzed potential correlations between biomarker and exposure data. Developed toxicity criteria for novel organic chemicals used in the milling process.

Conducted a human health risk assessment for a metals-affected floodplain for an industrial client in the Midwestern United States. The primary site metal of concern was lead. Technical issues addressed included delineating potentially exposed populations, identifying appropriate data and additional data requirements, and assessing bioavailability.

Provided technical analysis on issues related to residential arsenic and lead exposure in communities near one active smelter and two previously existing smelters. Reviewed and provided detailed comments and recommendations on ATSDR's Public Health Assessment and EPA's Baseline Human Health Risk Assessment. Specific issues addressed include the site approach for assessing intake of homegrown vegetables, health effects from environmental exposure to arsenic in the U.S., and the literature regarding low-dose effects of arsenic.

Provided toxicology and risk assessment support to a mining client evaluating risks from exposure to arsenic in a recreational area of a mining-related NPL site in Montana. Reviewed and commented on an EPA-led human health risk assessment of recreational exposures to arsenic in soil.

Provided toxicological analysis and expertise in a case involving alleged health effects from consumption of an herbal tea purchased from a San Francisco herbalist. Analyzed the potential for the plaintiff's symptoms to be caused or exacerbated by exposure to metals from the herbs or brewing equipment,

exposure to a plant toxin (i.e., podophylotoxin), and pre-existing health conditions. The case was subsequently settled.

Wrote a manuscript evaluating the potential for lead to cause endocrine disruption. Critically evaluated the epidemiological and experimental data regarding lead and potential endocrine-related effects. Limited evidence suggests that lead may affect male reproduction, but at exposure levels far above those that cause neurological effects in children, which is considered the critical effect for the purposes of risk assessment and regulatory policy.

Participated on a team conducting a health risk assessment of tetraethyl lead in sediments at a loading facility. Evaluated the current literature on organic lead toxicity and developed an alternative toxicity criterion to EPA's reference dose using available human occupational biomonitoring data.

Wrote a chapter on state and federal mercury regulations as they apply to petroleum refineries, for a monograph on mercury toxicity and treatability in petroleum-industry effluents.

Developed an alternative lead cleanup level for a Florida industrial site using recent scientific literature to support changes to the default values for critical parameters in EPA's adult lead model for predicting blood lead levels. The modifications supported a lead soil cleanup level as high as 2,600 ppm, compared to a level of 888 ppm calculated in a previous study using only EPA default values.

Wrote sections of a White Paper pertaining to potential exposure to elemental mercury from various sources, including mercury-containing paint and dental amalgams. Identified appropriate biomarker measures for elemental mercury, arsenic, and lead, and characterized reference levels and levels of concern. Reviewed and modified an ATSDR Fact Sheet on elemental mercury exposure. Modifications included clarification of possible toxic effects under low-exposure conditions, and development of a section on reducing mercury exposure to the general population, and in particular to residents of houses that may be built over mercury-contaminated soil.

Solvents

Conducted causation evaluation related to claims of birth defects, including cardiac and neurodevelopmental effects, as a result of exposure to chemicals in the workplace, including in the aerospace, petroleum, and pulp and paper industries. The claims included cases in which the mother worked at the facility under evaluation and cases in which the father worked at the facility (male-mediated). In conjunction with an industrial hygienist who conducted detailed exposure reconstruction, my analyses included exposure modeling for 10 to 20 organic solvents and metals and analysis of the likelihood of that workplace exposures caused the specific birth defect identified in the child of each worker. The chemicals evaluated included trichloroethylene (TCE) and other chlorinated hydrocarbons, petroleum hydrocarbons (including benzene, toluene, ethylbenzene, and xylene) and petroleum-related products, methyl ethyl ketone, methyl isobutyl ketone, glycols and glycol ethers, methacrylates, methylene chloride, lead, chromium, and cadmium.

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Conducted a toxicological and epidemiological literature review to assess chemical toxicity and provide perspective on the potential for occupational exposure to chloroform, carbon tetrachloride, and 1,1,1-trichloroethane to result in development of cancer, with an emphasis on esophageal cancer. The findings were documented in a state-of-the-science report, and resulted in the plaintiffs agreeing to dismiss their complaint.

Provided technical support for a manufacturing facility that detected tetrachloroethylene and trichloroethylene in the well supplying water to a large work force. Provided review and analysis of key toxicological and epidemiological issues regarding trichloroethylene to the client. Identified critical issues in EPA's Trichloroethylene Health Risk Assessment and discussed those issues in a public forum that included leading regulators and scientists in the field.

Provided toxicological expertise in a case involving residential exposure to trichloroethylene and tetrachloroethylene in groundwater. Evaluated the potential for health effects of the two compounds at specific exposure levels relative to requested medical screening exams.

Petroleum Sites

Conducted a health assessment of methanol used in hydraulic fracturing ("fracking") fluids. The evaluation focused on potential exposure to groundwater impacted by methanol-containing fracking fluids, and incidental ingestion of river and stream waters that received treated flowback.

Provided toxicological expertise on dispersants and petroleum chemicals related to the Deepwater Horizon release in the Gulf of Mexico, including both technical analysis and interpretation for non-scientists. Provided input on proposed medical monitoring programs.

In support of a research grant evaluating PAH bioavailability, drafted a White Paper on the regulatory toxicology of Polycyclic Aromatic Hydrocarbons (PAHs), focusing on current regulatory approach to health assessment of PAHs, proposed modifications to the regulatory approach, and the implications of those modifications to environmental assessment of PAHs. Provided expertise on absorption, distribution, metabolism, and excretion of PAHs.

Member of team that provided toxicology and health risk support to a city following an oil spill in a river from a pipeline leak. Assessed air exposures to those living along the river from volatile emissions. Provided recommendations on air sampling.

Conducted a probabilistic analysis to quantitatively evaluate the range of the potential contribution of facility emissions to ambient air concentrations of selected chemicals from an oil refinery in the Middle East. The study characterized variability and uncertainty in predicted facility-related air concentrations.

Wrote a technical paper evaluating carcinogenic PAH bioaccumulation in aquatic species. The evaluation focused on modifications to the water-to-tissue bioconcentration factor used in calculating PAH trigger levels for human consumption of fish and crustaceans. Recommendations included incorporating factors

to account for dissolved organic carbon content in the water column and differential distribution of PAHs in the edible and inedible portions of fish. Manuscript published in a peer-reviewed journal.

Conducted human health and ecological screening-level risk assessment to address marine sediments in the vicinity of an oil company's petroleum storage facility in Washington State. Assessment included sediment and shellfish ingestion pathways and addressed bioassay and specific chemical data. Chemicals of potential concern included metals, SVOCs, petroleum hydrocarbons, and PCBs.

Conducted a data-gap analysis and recommended a sampling plan to be included in a remedial investigation at the property of a former tanker terminal in New York. Performed a human health and ecological risk assessment. Chemicals of concern for the risk assessment included PAHs, chlorobenzene, ethyl ether, lead, asbestos, and PCBs. Ecological receptors were both aquatic and terrestrial, and included muskrats, bald eagles, gulls, herons, crab, and sturgeon.

Developed toxicity reference values (TRVs) for the effects of petroleum hydrocarbons on terrestrial mammals and birds for the Washington State Department of Ecology as part of the Duwamish brownfields program. Methods included mathematical modeling of petroleum constituent toxicity data and resulted in separate TRVs for aliphatic and aromatic constituents.

Conducted human health and ecological risk assessments on multiple petroleum release sites at U.S. Navy bases in Washington State. Applied MTCA interim policy for evaluation of risk from petroleum releases, and the Narcosis model to predict petroleum uptake and toxicity in aquatic receptors. Modeled risk from shellfish ingestion to a subsistence fishing population, used Monte Carlo probabilistic analyses, and conducted temporal and spatial contaminant trend analyses. Chemicals of potential concern included BTEX, PAHs, and petroleum hydrocarbons.

Developed a work plan for a risk-based screening-level assessment for a service station in Alaska undergoing renovation to include a restaurant. Evaluated potential ecological and human health risks associated with exposure to petroleum hydrocarbons and other organic compounds through groundwater ingestion, soil ingestion, and vapor inhalation. Chemicals of potential concern included BTEX, petroleum hydrocarbons, trichloroethylene, and ethylene glycol.

Project manager for ASTM-sanctioned training of state regulators and consultants in risk-based corrective action (RBCA). Provided input to planning of RBCA policy and marketing strategy, and provided technical and editorial support for ASTM-sanctioned training of regulators in multiple states on RBCA at petroleum release sites.

Performed a risk-based screening-level assessment for a former service station in Alaska that was subsequently occupied by a commercial restaurant. Evaluated the potential human health risks associated with exposure to petroleum hydrocarbons through groundwater ingestion, soil ingestion, and vapor inhalation. Modeled groundwater benzene and toluene transport to assess potential offsite risks.

Assisted in developing a guidance document to aid in the application of RBCA legislation at petroleum release sites for the Michigan Department of Natural Resources.

Dioxins, PCBs, and Pesticides

Conducted comprehensive literature review and toxicological assessment of paraquat and Parkinson's disease, including a detailed analysis of high-quality studies by routes of exposure most relevant to human exposures. The analysis identified key toxicological endpoints, along with lowest and no observed adverse effect levels for those endpoints.

Evaluated issues important for characterizing paraquat exposure (e.g., dermal absorption, biological half-life, impact of dosing patterns and exposure route) as applied to assessment of causation of Parkinson's disease in several cases involving paraquat applicators.

Conducted causation evaluation related to claims of birth defects (including bladder exstrophy, hypospadias, urine incontinence, loss of kidney function, bladder spasm issues, and retinoblastoma) as a result of exposure to herbicides, dioxins, and other chemicals associated with sugarcane farming practices.

Conducted a toxicological and epidemiological literature review to assess chemical toxicity and provide perspective on the potential for residual levels of agricultural fumigants (ethylene dibromide, dichlorobromo¬propane, chlorinated propenes and propanes) in groundwater to cause various alleged health effects (miscarriage, birth defects, cancers, asthma, attention deficit hyperactivity disorder, lupus) in a community in Hawaii. Co-author of a state-of-the-science report documenting relationship between the chemicals and health effects of interest.

Provided risk assessment and toxicology support in a comprehensive human health risk assessment evaluating potential worker exposure to PCBs discovered in concrete joint compound in a flightline area for commercial aircraft in Washington. Evaluated risk assessment approach for novel exposure pathways, including contact with surfaces as measured by wipe samples. Researched current regulatory guidance within EPA for non-liquid PCBs and evaluated applicable assessments conducted nationwide. Site characterization suggested limited migration potential for PCBs from joint compound. The risk assessment results supported phased removal of PCB-containing material that was both health-protective and practical.

Provided toxicological expertise in a human health risk assessment to evaluate potential effects of mercury and PCBs in sediments in an urban lake in New York State. Analyzed and reported on the potential toxicity from methyl mercury and PCBs to humans from fish consumption. Highlighted the uncertainties in EPA's approach to risk assessment of methylmercury and PCBs and reported on alternative methods for analyzing their toxicity.

Conducted an analysis of the contribution of effluent from the Tosco refinery in Richmond, California, to the total maximum daily load of dioxins into the San Francisco Bay. Specific issues addressed included total mass loading estimates to the Bay from all sources and contributions from the Tosco refinery, dioxins fingerprinting patterns in the Tosco effluent and Bay waters, and the appropriate use of background comparisons. Based on these analyses, demonstrated that contributions to dioxin loads in effluent from the Tosco oil refinery were minimal. Summarized findings in a technical memorandum submitted to the San Francisco Bay Regional Water Quality Control Board.

Conducted a terrestrial ecological risk assessment as part of a supplemental field study at the U.S. Army Rocky Mountain Arsenal in Colorado. Developed and applied mathematical models to predict chemical bioaccumulation in the food chain. Chemicals of concern included aldrin, dieldrin, endrin, DDT, DDE, and chlordanes. Ecological receptors included bald eagles, kestrels, owls, prairie dogs, deer mice, rabbits, and starlings.

Pulp and Paper

Provided toxicology, risk assessment, and site characterization expertise for the City of Port Angeles, Washington, for review of the remedial investigation (RI) and interim actions conducted at the Rayonier Mill Site. The RI process was conducted as part of a collaborative effort between Rayonier, Washington State Department of Ecology (WDOE), and the Lower Elwha Klallam Tribe, to establish the nature and extent of potential impacts from the historical acid sulfite pulp and paper mill. Reviewed site characterization, remedial action, and remedial investigation data and reports. Provided detailed technical evaluation and critique. Summarized findings in comments submitted to WDOE. Provided specific expertise on subsistence fish consumption, design, and implementation of food consumption surveys, and interpretation of fish consumption data for regulatory decision-making.

Managed and conducted an epidemiological analysis of age-adjusted disease-specific mortality rates in a community near a pulp and paper mill in Washington State. Results indicated that elevated crude

mortality rates noted in Washington State Department of Health Vital Statistics tables were largely due to population age distributions in the community relative to statewide age distributions.

Provided toxicological and risk assessment analysis on odor and health issues for a pulp mill in Camas, Washington, that had a release of hydrogen sulfide and mercaptans that reached a school. The strong odors at the school resulted in children feeling acutely ill, with some being sent to the local hospital. Evaluated the epidemiological and experimental literature on these compounds, particularly with regard to chronic, low-dose exposure, long-term effects, and sensitive subpopulations. Provided input on the nature of the risk and latest scientific information for state and local health agencies to promote better risk communication.

Provided toxicological and risk assessment expertise on a project team assessing ecological and human health risks associated with terrestrial and marine impacts at a non-operational pulp mill in Sitka, Alaska. Task leader for developing toxicity reference values of terrestrial receptors. Evaluated benthic succession and recovery following organic enrichment from wood waste and pulp effluent. Assessment addressed soils, sediments, groundwater, and marine waters. Target aquatic receptors included crabs, flatfish, mussels, and benthic invertebrates. Bioaccumulation and impacts on higher-trophic-level species were addressed through modeling. Chemicals of concern included pesticides, dioxins, metals, PAHs, petroleum hydrocarbons, and PCBs.

Multipathway and Multichemical Analysis

Provided technical expertise in the development of a framework to assess arsenic and chromium exposure and toxicity to children from chromated copper arsenic (CCA)-treated wood. Evaluated the potential exposures to arsenic by children playing on play structures and decks made of CCA-treated wood. Developed approaches for evaluating this novel exposure scenario, and wrote a White Paper regarding issues for risk assessment, which was provided to the U.S. EPA for consideration in developing their assessment for these exposures. Researched and developed a White Paper evaluating occupational exposure to CCA in wood products. The project involved analysis of the available scientific data and identification of critical uncertainties for exposure parameters that would benefit most from additional research. Results of the analyses were presented to ATSDR, EPA, and the Consumer Product Safety Commission.

Provided technical expertise, analysis, development, and review for Demographics and Databases project funded by the Human Health Exposure Assessment (HHEA) Technical Implementation Panel (TIP) of the American Chemistry Council (ACC). Led task to identify, research, document, and characterize databases providing distributions of demographic, consumer product use, and residential building characteristics that are necessary in modeling exposure to chemicals in consumer products. Summarized the results in a report to ACC and a manuscript published in a peer-reviewed journal.

Developed simplified screening model for assessing human health risk from indirect exposure to incinerator emissions for EPA Region 10. Reviewed environmental risk assessments from incinerator sites. Reviewed proposed EPA indirect exposure guidelines and provided comments. Evaluated lead and PCB chemical fate data. Evaluated available seafood arsenic speciation data and potential health risk, and reported findings and recommendations.

Conducted a human health risk assessment as part of a comprehensive sediment investigation at two shipyards in San Diego Bay. The assessment focused on consumption of fish and shellfish from the site. Potential chemicals of concern at the site included chromium, mercury, copper, lead, PCBs, PAHs, and tributyltin. The evaluation considered both recreational and subsistence consumption patterns. The initial screening used an in situ bioassay to measure metals uptake into mussel tissue, followed by screening with human health–based tissue criteria. The second tier of the assessment incorporated both deterministic and probabilistic risk assessment to evaluate potential exposure to metals in native fish and shellfish from the site.

Developed an interim groundwater maximum allowable concentration for formaldehyde based on groundwater ingestion for a paper company in North Carolina. Evaluated potential risks to humans associated with exposure via this pathway.

Conducted a streamlined risk evaluation addressing groundwater impacts and designed to aid in deciding whether to conduct a removal action at a naval submarine base in Washington State. Assessed human exposure to groundwater used as drinking water and for irrigation. Chemicals of concern included benzene, toluene, ethylbenzene, naphthalene, vinyl chloride, 1,1-dichloroethane, 1,2 dichloroethane, carbon tetrachloride, 1,2-trichloroethane, and 1,1,2,2-tetrachloroethane.