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ATTACHMENT B

Resumes

SDMS DocID 25912

PROJECT MANAGER

William Steinhauer **Battelle Duxbury**

Program Manager

Education:

M.S. Chemistry, Northwestern University, 1970
B.S. Chemistry, Lake Forest College, 1968

Qualifications:

Mr. Steinhauer has over 20 years experience in environmental chemistry and coastal marine monitoring, including 17 years with Battelle. During this period, he has conducted and supervised research projects involving the transport, fate, effects, and bioaccumulation of contaminants and is a recognized expert in the fate and effects of organic contaminants in the environment. Mr. Steinhauer's laboratory and management experience includes methods development and analysis of trace levels of petroleum- and combustion-related hydrocarbon contaminants in the environment. He is the author of many environmental reports and scientific papers, including those relating to oil spill assessment, assessment of the fates and effects of sludge dumped at the 106-Mile Deepwater Municipal Dumpsite, methods papers, contaminant residence time studies for NOAA, and marine-related environmental impact *statements*. For the past 3 years, he has been the manager of marine sector programs in Alghero, Italy.

Relevant Experience:

Coastal Monitoring

Program Manager for the California Outer Continental Shelf Phase II Monitoring Program (Assessment of Long-Term changes in Biological Communities in the Santa Maria Basin, sponsor MMS) responsible for the technical execution of the program at Battelle and with Battelle subcontractors and consultants, preparation of reports, and coordination with Federal and State agencies.

Through his role as *Manager of Marine Sector Programs*, Mr. Steinhauer was directly involved in the planning and execution of the monitoring and assessment of the municipal outfall in the Baia di Porto Conte, Alghero Italy. Aspects of the monitoring included discharge bacterial, nutrient and BOD measurements, near-discharge transport and fate monitoring using Battelle Ocean Sampling system and other tools, and diver-assisted near-discharge assessments of the impact of the discharge on the *Posidonia oceanica* seagrass community.

Principal Investigator (1989 to 1994) and task leader (1985 to 1988) of the organic chemistry component in the NOAA Mussel Watch Project responsible for analytical measurements, quality assurance, data review, and report preparation. Goal of the project is to detect status and trends of trace contaminants in sentinel organisms. Organic contaminants include PAH, PCB (individual congener), and selected halogenated pesticides.

Task Leader for EPA/Office of Water work assignment involving analysis of sediment-trap samples for chemical and microbiological sludge tracers, stable isotopes (^{13}C, ^{15}N, and ^{34}S), and physical characteristics. Eight trace elements (Cd, Zn, Ag, Ni, Mn, Cu, Pb, and Cr) plus Fe and Al are being measured. Organic contaminant analyses include PAH, LAB, hopanes, fecal and total sterols, and lignin phenols. Data will be used to determine farfield fate of sludge dumped at the 106-Mile Deepwater Municipal Sludge Site (106-Mile Site).

Work Assignment Leader for two EPA Office of Water work assignments involving water quality monitoring studies at the 106-Mile Deepwater Municipal Sludge Site (106-Mile Site) during summer and winter conditions. The projects involved developing and implementing strategies for sludge-plume tracking and monitoring water quality and oceanic conditions at the site.

Pollution Control and Mitigation

Project Manager for Revision of the Ocean Discharge Criteria. Mr. Steinhauer serves as work assignment leader supporting EPA's revision to implementing regulations for CWA §403(c). He researched and analyzed national data to identify all permitted discharges to marine waters and characterize their impact on the environment. Mr. Steinhauer identified quantities, composition, and bioaccumulation of pollutants, potential transport and fate, and vulnerability of exposed ecosystems. He prepared assessments of impacts of discharged pollutants or pollutant categories on sensitive marine communities and conducted environmental assessments of special ocean sites (marine protected areas) that will be established under the rule.

Through his role as *Manager of Marine Sector Programs*, Mr. Steinhauer was directly involved in several engineered wetlands and wastewater depuration projects in the Region of Sardinia. Activities included (1) design and construction of a pilot scale (2 M^3/day) horizontal flow wetland for depuration of sewage effluent, (2) assembly and ramp-up of a pilot-scale Living Machine™ for sewage treatment (18 M^3/day), and design of several projects for storm water and ephemeral stream clean-up. All of these projects used the most recent alternative treatment thinking from Europe or U.S. in design modified for the Mediterranean climate of Sardinia.

Mr. Steinhauer was *Project Manager* of the contaminated sediment project conducted for the Ministero del Bilancio of which the bench-scale Venice lagoon bioremediation experiment was one task. Sediments from the three areas within the Venice lagoon were subjected to pulsed aerobic/anaerobic to force the degradation of PCBs using the resident sediment bacterial population. In addition to PCB, sediments gases, nutrients, and bacterial populations were measured.

Contaminated Sediment Assessment

Project Manager, Remediation of Contaminated Sediments. Responsible for the technical direction and performance of a 2-year project related to the investigation of physical and mechanical treatment processes for resource recovery of sand and other materials from contaminated harbor sediments in Sardinia. A full range of physical separation and washing procedures are being investigated, supported by trace metal and organic contaminant toxicology, and supporting analyses.

Project Manager of USACE-sponsored analytical project in support of the dredging of Oakland Harbor, California. Analysis of sediment and tissue for polycyclic aromatic hydrocarbons and pesticides/PCBs. Interpretation of data.

Project Manager for the New Bedford Harbor/Buzzards Bay System RI/FS Analytical Study to analyze water (particulate and dissolved), sediments, and tissue samples for PCB level of chlorination using GC/MS (EPA Method 680.1) in support of modeling studies to determine short- and long-term solutions to the contamination problems in New Bedford Harbor. *Expert witness* for the Federal government in New Bedford Harbor Superfund pre-trial hearings (1989, 1990). Provided depositions entered into evidence for the trial and testimony at pre-trial courtroom hearings.

Environmental, Ecological, and Health Risk Assessments

Mr. Steinhauer has been directly involved in the assessment of the impact of point and non-point discharges in Baia di Porto Conte and Rada di Alghero, Alghero Italy for the Ministero del Bilancio, Rome Italy, and co-authored the final report titled State of the Bay. This report contained a "consensus risk assessment" of the environmental impact of point and non-point sources on coastal waters. The Battelle *SYSTEM EIGHT* heuristics software was used extensively to aid and promote the decision-making and demonstrate the outcomes of various impact assessments and risk analyses.

Petroleum Hydrocarbon Analysis

Principal Investigator of the hydrocarbon analytical task for an environmental assessment of Floreffe oil spill, Pittsburgh, Pennsylvania (industrial client). Development of monitoring strategy and analysis of samples to determine the persistence of Floreffe oil in the above river system. Use of petroleum hydrocarbon "fingerprinting" to determine amounts of specific petroleum contamination vis-à-vis chronic inputs of other hydrocarbon pollutants.

Co-author and signatory of EV89 (Rev 0) protocols for preparation and analysis of water, sediment, biological tissue samples for trace levels of total petroleum hydrocarbons and polycyclic aromatic hydrocarbons in support of Exxon-sponsored NRDA studies related to the *Exxon Valdez* oil spill. The protocols which were used with minor revisions throughout 1989–1991 and were also supported by the Alaska Department of Environmental Conservation (ADEC) for ADEC-sponsored environmental studies. *Participant in Exxon Analytical Workgroup* formed to advise Exxon regarding sampling and chemical procedures used to support NRDA Type-B environmental assessments associated with the *Exxon Valdez* oil spill.

Task Manager for the sediment and tissue hydrocarbon analytical task for all 3 years of the Beaufort Sea Monitoring Program (Mineral Management Service). Mr. Steinhauer's involvement included validation of methods, quality assurance, and review of all data packages before submission to data processing. He also prepared the BSMP field manual and participated in field surveys, years 1 and 2.

Task Manager for the hydrocarbon analytical component of the MMS U.S. North Atlantic, Mid-Atlantic, and South Atlantic Slope and Rise Studies. Mr. Steinhauer was responsible for the implementation of the hydrocarbon analytical program, and the quality assurance and reporting of hydrocarbon data. Interpretation of data and contributor to final report.

Task Manager of the hydrocarbon analytical task for the Baffin Island Oil Spill project. Supervision of chemists performing analysis of sediment, tissue, floc, and water samples for petroleum hydrocarbons. Quality assurance of data, data compilation, and initial reporting.

Technical and Public Outreach Activities

Through his role as *Manager of Marine Sector Programs*, Mr. Steinhauer was directly involved in the planning of several public outreach and public education programs in northern Sardinia. These included: (1) Living Machine™ alternative wastewater treatment plant technology demonstration prepared for the Integrated Coastal Zone Management conference (Alghero), (2) a high-school-level curriculum demonstrating the principles of wastewater treatment using the Living Machine™ and pilot-scale wetlands as demonstrations, and (3) preparation of several concept papers for an environmental science center for the national park of the Island of Asinara.

Professional Affiliations:

- American Chemical Society
- Water Environment Federation

Publications:

Steinhauer, W.G., C.D. Hunt, C.S. Peven, M. Moore, J. Stegeman, and D. Redford. 1996. Contaminants in Bottom Fish Collected Near the 106-Mile Site. *J. Marine Envir. Eng.* 3, 173-188.

Peven, C.S., A.D. Uhler, R.H. Hillman, W.G. Steinhauer. 1996. Organic contaminants in Mytilus edulis from the Hudson-Raritan Estuary and Long Island Sound. *Science of the Total Environment.* 179:135-147.

Uhler, A.D., G.S. Durell, W.G. Steinhauer and A.M. Spellacy. 1993. Tributyltin Levels in Bivalve Mollusks from the East and West Coasts of the United States: Results from the 1988-1990 National Status and Trends Mussel Watch Project. *Environmental Toxicology and Chemistry.* 1993. **12:** 139-153.

Douglas, G.S., K.J. McCarthy, D.T. Dahlen, J.A. Seavey, W.G. Steinhauer, R.C. Prince, and D.L. Elmendorf. 1992. The Use of Hydrocarbon Analysis for Environmental Assessment and Remediation. *J. Soil Contamination.* 1(2): 197-216; Also in *Contaminated Soils.* (Calabrese, E.J. and Kostecki, P.T., Eds.) Chelsea, MI, Lewis Publishers, Chapter 1. pp.1-21.

Steinhauer, W.G., E. Imamura, J.R. Barminski, and J.M. Neff. 1992. California study compares natural/drilling discharge contaminants offshore. *Oil Gas Journal*, May 4, 1992: 74-94.

Steinhauer, M., E. Crecelius, and W. Steinhauer. 1992. Temporal and Spatial Changes in the Concentration of Hydrocarbons and Trace Metals in the Vicinity of an Offshore Oil Production Platform. *Marine Environmental Research.* 1991 (submitted).

Prince, R.C., J.R. Clark, J.E. Lindstrom, E.L. Butler, E.J. Brown, G. Winter, M.J. Grossman, P.R.Parrish, E. Bare, W.G. Steinhauer, G.S. Douglas, J.M. Kennedy, and P.J. Barter. 1991. Bioremediation of the *Exxon Valdez* Oil Spill, monitoring its safety and efficacy in 1990. *Environmental Science and Technology.* 1991 (submitted).

Butler, E.L., R.C. Prince, G.S. Douglas, T. Axcel, C.S. Hsu, M.T. Bronson, J.R. Clark, J.E. Lindstrom, and W.G. Steinhauer. 1991. Hopane: A new chemical tool for the measurement of oil biodegradation. Pp. 515-521 in Hinchee, R.E., and R.F. Olfenbuttel (Eds), On-Site Bioreclamation. Butterworth-Heinemann (Pub.), Boston, MA.

Uhler, A.D., G.S. Durell, and W.G. Steinhauer. 1990. Findings of Tributyltin in East and West Coast Bivalves: 1988-1989. *J. Shellfish Research.* 1990. **8:** 453.

Peven, C.S., W.G. Steinhauer, L.M. Altshul, D.T. Dahlen, J.A. Seavey. 1990. Polycyclic Aromatic Hydrocarbons in Shellfish, Overview of the 1989 Mussel Watch Field Season (Abstract). *J. Shellfish Research.* 1990 8:487.

Uhler, A.D., T.H. Coogan, K.S. Davis, G.S. Durell, W.G. Steinhauer, S.Y. Freitas, P.D. Boehm. 1989. Findings of Tributyltin, Dibutyltin, and Monobutyltin in Bivalves from Selected U.S. Coastal Waters. *Environmental Toxicology and Chemistry.* 1989. **8:** 971-979.

Harvey, G.R. and W.G. Steinhauer. 1976. Transport pathways of polychlorinated biphenyls in Atlantic water. *J. Marine Research* 34:127-136.

Harvey, G.R. and W.G. Steinhauer. 1976. Biogeochemistry of PCB and DDT in the North Atlantic. In: *Environmental Biogeochemistry* (J.O. Nriagu, ed.), Ann Arbor Science Publishers, Inc., Ann Arbor, MI. pp. 203-221.

Harvey, G.R., W.G. Steinhauer and H.P. Miklas. 1974. Decline of PCB concentrations in North Atlantic surface water. *Nature* 252:387-388.

Harvey, G.R., H.P. Miklas, V.T. Bowen, and W.G. Steinhauer. 1974. Observations on the distribution of chlorinated hydrocarbons in Atlantic Ocean organisms. *J. Marine Research* 32:103-118.

Harvey, G.R. and W.G. Steinhauer. 1974. Atmospheric transport of polychlorinated biphenyls to the North Atlantic. *Atmospheric Environment* 9:777-782.

Harvey, G.R., W.G. Steinhauer, and J.M. Teal. 1973. Polychlorinated biphenyls in North Atlantic ocean water. *Science* 180:643-644.

Symposium Volumes and Presentations:

Libby P.S., Degioannis N., Pau E. and Steinhauer W. 1999. Coastal Water Quality in Northwestern Sardinia. 2nd EuroGOOS International Conference - Operational Oceanography, Extending the Limits of Predictability, Rome, 10-13 March 1999. In Press

Pau E., Maddau, V., Viola M., Ostazeski S., and W. Steinhauer. 1998. Alternative Technologies for Wastewater Treatment — Sardinia. Water in the Mediterranean Area, conference on Quality and Quantity of Mediterranean Water Resources. Chia Laguna, Cagliari Italy, 11-18 October 1998

Steinhauer W. 1998. Ricerca applicata e trasferimento tecnologico nel settore ambientale. Scenari internazionali nella ricerca e nel trasferimento tecnologico. Porto Conte Richerche, Alghero Italy, 8-9 October 1998

Steinhauer W. 1998. Attivitá petrolifere in mare e conservazione delle risorse marine. IX Rassegna del Mare, Economia ed Ambiente nella Gestione della fascia costiera e delle risorse del mare: dall'analisi alle proposte. Dorgale Italy, 27-29 March, 1998

Steinhauer W. and Gazale V. 1997. La valutazione di salute di Posidonia nella Baia di Conte di Porto — Gli impatti fisici e gli impatti di qualitá dell'acqua. 2nd Forum on Coastal & Marine Biodiversity in the Mediterranean. Alghero Italy, 26-28 November, 1997.

Peven, C.S., A.D. Uhler, R.E. Hillman, and W.G. Steinhauer. 1992. Organic contaminants in *Mytilus edulis* from the Hudson-Raritan Estuary and Long Island Sound. American Geophysical Union 1992 Annual Meeting, Montreal, Canada.

Hillman, R.E., R.A. Lordo, R.G. Menton, C.S. Peven, A.D. Uhler, E. Crecelius, and W.G. Steinhauer. 1992. Relationship of environmental contaminants to occurence of neoplasia in mussels (*Mytilus edulis*) from East and West coast Mussel Watch sites. Marine Technology Society Fall Meeting.

Douglas, G.S., W. Steinhauer, and S. McDowell. 1992. Real-time water column hydrocarbon mapping using the Battelle Ocean Sampling System to identify chronic and spilled oil input to the Coastal Marine Environment. Oceans 92. Newport, Rhode Island.

Durell, G.S., W.G. Steinhauer. 1991. Environmental Assessment of Clay Targets from a Gun Club as Possible Source of PAH Contamination in an Estuary. SETAC 12th Annual Meeting. November 1991, Seattle, WA.

Steinhauer, W.G., G.S. Douglas, G.S. Durell, and S.E. McDowell. 1991. Spatial Distribution in Hydrocarbon Levels in the New York-New Jersey Harbor Estuary. SETAC 12th Annual Meeting. November 1991, Seattle, WA.

Douglas, G.S., K.P. McCarthy, D.T. Dahlen, J.A. Seavey, W.G. Steinhauer, R.C. Prince, and D.L. Elmendorf. 1991. Hydrocarbon Fingerprinting Analyses. In: proceedings of the conference on Hydrocarbon Contaminated Soils: Analysis, Fate, Environmental and Public Health Effects, University of Massachusetts, Amherst. September 1991.

Steinhauer, W.G. 1990. Evolution of PCB Analyses NOAA Mussel Watch Project and Overview of PCB Levels from 1989 Mussel Watch Field Season. 1990 Annual Meeting of the National Shellfisheries Association, Williamsburg, Virginia.

Steinhauer, W.G., C.S. Peven, L.M. Altshul, D.T. Dahlen, and J.A. Seavey. 1990. Polynuclear Aromatic Hydrocarbon Levels in Shellfish, Overview of the 1989 Mussel Watch Field Season. 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, DC.

Hunt, C.D., D. Shea, W.G. Steinhauer, S.E. McDowell, and D. Redford. 1990. Transport and Fate of Sewage Sludge at the 106-Mile Deepwater Sewage Sludge Disposal Site. 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, DC.

Peven, C.S. and W.G. Steinhauer. 1990. Polynuclear Aromatic Hydrocarbon Levels in Shellfish, Overview of the 1989 Mussel Watch Field Season. 1990 Annual Meeting of the National Shellfisheries Association, Williamsburg, Virginia.

Peven, C.S., L.M. Altshul, B. Koczwara, and W.G. Steinhauer. 1990. Polychlorinated Biphenyl, Chlorinated Pesticide, and Butyltin Levels in shellfish, Overview of the 1989 Mussel Watch Field Season. 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, DC.

Durell, G.S., A.D. Uhler, W.G. Steinhauer. 1990. Findings of Tributyltin in East and West Coast Bivalves: 1988-1989. 1990 Annual Meeting of the National Shellfisheries Association. April 1990, Williamsburg, VA.

Peven C.S. and William G. Steinhauer. 1989. Correlation Between Concentrations of Specific PCB isomers and Total PCB Levels in Environmental Samples. 1989 Eastern Analytical Symposium, New York, New York.

Hyland, J., J. Kennedy, J. Campbell, S. Williams, P. Boehm, A. Uhler, and W. Steinhauer. 1989. Initial Environmental Effects of the *Pac Baroness* Oil and Copper Spill. Results of Hydrocarbon and Macrofaunal Analyses. 1989. In: Proceedings, 1989 Oil Spill Conference, American Petroleum Institute, Washington, DC.

Peven, C.S. and W.G. Steinhauer. Correlation between concentrations of specific PCB isomers and total PCB levels in environmental samples. Eastern Analytical Symposium, October 1988

Boehm, P., W. Steinhauer, D. Cobb, S. Duffy, and J. Brown. 1985. Comparative fate of chemically dispersed and untreated oil from experiment oil spills in Arctic nearshore environments. The Baffin Island Oil Spill Studies 1980-1983. In: 1985 Oil Spill Conference Proceedings, American Petroleum Institute, Washington, DC.

Reports:

Hillman, R., C. Peven, W. Steinhauer, A. Uhler, E. Baptiste. 1995. Year 9 Final Report on National Status and Trends Mussel Watch Program; Final Report submitted to U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Battelle Ocean Sciences, Duxbury, MA.

Hillman, R., C. Peven, W. Steinhauer, A. Uhler, E. Baptiste. 1994. Year 8 Final Report on National Status and Trends Mussel Watch Program; Final Report submitted to U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Battelle Ocean Sciences, Duxbury, MA.

Hillman, R., C. Peven, W. Steinhauer, A. Uhler, E. Baptiste. 1993. Year 7 Final Report on National Status and Trends Mussel Watch Program; Final Report submitted to U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Battelle Ocean Sciences, Duxbury, MA.

Hunt, C.D, Dragos, P., Peven, C., Uhler, A., and Steinhauer, W. 1993. Synthesis of 106-Mile Site Sediment Trap Chemistry, Physical Oceanographic Measurements, and Modeling Results. Final Report to Environmental Protection Agency Oceans and Coastal Protection Division, Washington, DC.

Hillman, R., C. Peven, W. Steinhauer, A. Uhler, G. Durell, E. Baptiste, L. Ginsburg, and K. Monahan. 1992. Phase 6 Final Report on National Status and Trends Mussel Watch Program; Final Report submitted to U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Rockville, MD. Battelle Ocean Sciences, Duxbury, MA.

Hillman, R., C. Peven, W. Steinhauer, A. Uhler, G. Durell, E. Baptiste, W. Boudreau, D. Mack, L. Ginsburg, P. McCarthy, and K. Monahan. 1991. Phase 5 Final Report on National Status and Trends Mussel Watch Program; Final Report submitted to U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Rockville, MD. Battelle Ocean Sciences, Duxbury, MA.

Hillman, R., C. Peven, W. Steinhauer, A. Uhler, G. Durell, H. Trulli, T. Gulbransen, E. Baptiste, T. Nitroy, K. Foster, N. Young, E. Warren, E. Crecelius, S. Keisser, B. Buxton, R. Menton, D. Raichart, S. Rust, J. Winter, J. Clayton, A. Lissner, and R. Sims. 1990. Phase 4 Final Report on National Status and Trends Mussel Watch Program; Final Report submitted to U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Rockville, MD. Battelle Ocean Sciences, Duxbury, MA.

Steinhauer, M. and W. Steinhauer. 1990. Chemical Analysis of Hydrocarbons in Sediments, Pore Water, and Animal Tissues in: California OCS Phase II Monitoring Program Year-Tree Annual Report. Minerals Management Service, Pacific OCS Region, Camarillo, CA.

Prince, R.C., J.R. Clark, J.E. Lindstrom, E.L. Butler, E.J. Brown, G. Winter, M.J. Grossman, P.R. Parrish, R.E. Bare, J.F. Braddock, W.G. Steinhauer, G.S. Douglas, J.M. Kennedy, and P.J. Barter. 1991. Bioremediation of the *Exxon Valdez* Oil Spill. Monitoring Safety and Efficacy in 1990.

Shea, D., D.T. Dahlen, and W.G. Steinhauer. 1990. Small Scale Screening Test for Shoreline Cleaners. Exxon Study 52. Prepared for Exxon Research and Engineering Co.

Shea, D., C.D. Hunt, N.S. Young, and W.G. Steinhauer. 1989. Contaminant body burdens in mesopelagic fish (Myctophid) collected near the 106-Mile Site. Report to the Environmental Protection Agency, Washington, DC.

Steinhauer, W.G. and L. Ginsburg. 1988. Analysis of Beaufort Sea Sediment Samples for Detailed Hydrocarbon Distributions. Prepared for Northern Technical Services, Anchorage, AK.

Steinhauer, W., S. McDowell, C. Hunt, C. Albro, P. Boehm, and C. Werme. 1988. Nearfield Monitoring of Sludge Plumes at the 106-Mile Site. Report to EPA/Office of Water. Battelle, Duxbury, MA. 70p.

Uhler, A., and W. Steinhauer. 1988. Measurement of butyltin species in water by n-pentyl derivatization with gas chromatography/flame photometric detection and gas chromatography/mass spectrometry. Battelle Contract No. N0519-6100. Industrial Client.

Werme, C., R. Shokes, W. Steinhauer, S. McDowell, P.Debrule, P. Hamilton, and P. Boehm. 1988. Implementation Plan for the 106-Mile Deepwater Municipal Sludge Site Monitoring Program. Report submitted by Battelle to the Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, DC.

Steinhauer, W., S. McDowell, C. Hunt, C. Albro, W. Trulli, P.Boehm, and C. Werme. 1988. Nearfield fate monitoring at the 106-Mile Municipal Sludge Site: Winter 1988 Oceanographic Survey, March 1-March 5, 1988. Report to EPA/OMEP, Battelle, Duxbury, MA. 83p.

Trulli, W., W. Steinhauer, C. Willauer, C. Hunt, C. Albro, S. McDowell, P. Boehm, and C. Werme. 1988. Nearfield Fate Monitoring at the 106-Mile Deepwater Municipal Sludge Site: Winter 1988 Oceanographic Survey, March 1-5, 1988. Report submitted by Battelle to the Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, DC.

Boehm, P.D., S.Y. Freitas, J. Trefry, E. Crecelius, R. Hillman, H. Costa, R.C. Tuckfield, C.S. Peven, J.S. Brown, W.G. Steinhauer, N. Young, L. Altshul, J. Payne, G. Farmer, D. McNabb, A. Lissner, R. Simms, J. Clayton, T. Fogg, R. Shokes. 1987. Phase 2 final report on National Status and Trends Mussel Watch Program; Final report submitted to U.S. Department of Commerce National Oceanic and Atmospheric Administration. Battelle Ocean Sciences, Duxbury, MA.

Steinhauer, W., S. McDowell, C. Hunt, C. Albro, P. Boehm, and C. Werme. 1987. Site Condition Report for Plume Tracking Survey for the 106-Mile Deepwater Municipal Sludge Site in Support of the EPA 106-Mile Site Monitoring Program. Report submitted by Battelle to the Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, DC.

Maciolek, N.J., J.F. Grassle, B. Hecker, P.D. Boehm, B. Brown, B. Dade, W.G. Steinhauer, E. Baptiste, R.E. Ruff, and R. Petrecca. 1987. Study of biological processes on the .S. Mid-Atlantic slope and rise. Volumes I and 2. Prepared for the U.S. Department of the Interior, Minerals Management Service.

Boehm, P.D., E. Crecelius, W. Steinhauer, and M. Steinhauer. 1986. Beaufort Sea Monitoring Program: Analysis of Trace Metals and Hydrocarbons from Outer Continental Shelf (OCS) Activities. Final Annual Report to Minerals Management Service, Alaska OCS Region, Contract No. 14-12-0001-30163. 238 p.

Boehm, P., W. Steinhauer, E. Crecelius, and J. Neff. 1985. Contaminant residence times and ecosystem recovery rates for shelf and estuarine ecosystems. Final Report, Contract No. 83-ABC-00368. National Oceanic and Atmospheric Administration, Ocean Assessments Division, Rockville, MD.

Boehm, P.D., E. Crecelius, W. Steinhauer, M. Steinhauer, S. Rust, and J. Neff. 1985. Beaufort Sea Monitoring Program: Analysis of Trace Metals and Hydrocarbons from Outer Continental Shelf (OCS) Activities--Year-1 Results. First Annual Report to Minerals Management Service, Alaska OCS Region, Contract No. 14-12-0001-30163. 162 p.

Boehm, P.D., W.G. Steinhauer, and J. Brown. 1984. Final report on organic pollutant biogeochemistry studies, Northeast U.S. marine environment. NOAA National Marine Fisheries Service, Northeast Monitoring Program, Sandy Hook Laboratory, Highlands, NJ.

Steinhauer, W.G. 1981. Environmental Impact Statement, San Juan Dredged Material Disposal Site Designation. Prepared under Contract No. 68-01-4610. U.S. EPA Criteria and Standards Division, Washington, DC.

Steinhauer, W.G. 1981. Environmental Impact Statement, Vieques Dredged Material Disposal Site Designation. Prepared under Contract No. 68-01-4610. U.S. EPA Criteria and Standards Division, Washington, DC.

Steinhauer, W.G., M.F. Scott, and P.D. Boehm. 1977. Investigation of sediment and organism samples from Buzzards Bay for contamination of number 2 fuel oil. P.O. 5091, URS Co. Inc., San Mateo, CA.

Charles W. Apts **Battelle MSL**

Technical Specialist

Education:

B.A. Central Washington University, Biology, 1969

Relevant Experience:

Mr. Apts joined the Aquatic Ecology section of Battelle Northwest in 1969. He has been involved in studies dealing with the impact of thermal discharges on the freshwater environment, particularly the Columbia River ecosystem. His duties included field collection and conducting of thermal tolerance and thermal predation studies on various salmonid species. He also participated in the initiation of nitrogen supersaturation studies on the Columbia River and assisted in tritium research aimed at determining the uptake and incorporation of tritium in the embryo of rainbow trout.

In September 1970, he was assigned to the Battelle Northwest Marine Sciences Laboratory (MSL) at Sequim, Washington, and was instrumental in the establishment of a working facility at the site. At Sequim, Mr. Apts has been a principal investigator on several studies including the development of bioassay procedures for oil and oil dispersant chemicals, the determination of effects of pulp mill effluents on the marine biota of Oakland Bay, Washington, and a baseline study to determine the effects of oil refinery discharge and potential oil spillage on the Cherry Point environs of Georgia Strait. He was also involved in research dealing with the effects of thermal discharge from nuclear power plants on the marine environment, and has accumulated a catalog of thermal tolerance levels for local marine organisms. He has also conducted a bacteria monitoring program in Sequim Bay which is now in the 11th year. Through these studies, he has gained valuable knowledge and experience in marine toxicology and in the development and use of bioassay techniques for the determination of effects of pollutants.

Since 1975 he has been heavily involved in trace metal research at MSL. He was a major contributor to studies aimed at determining the bioavailability of trace metals in the marine ecosystem, with particular emphasis on the effect of copper on coon-stripe shrimp and littleneck clams. He has also done extensive research on the fate and effects of trace metals in the sea-surface microlayer and is responsible for the development of many of the techniques used for microlayer collection and analysis at the laboratory.

In 1984, he was given responsibility for the maintenance and operation of the inorganic chemistry laboratory and in this capacity has worked on numerous projects requiring metals analysis. A few such projects include a baseline study to determine metal concentrations in sediment and tissue samples from the Beaufort Sea prior to oil-well drilling, a study in which metal concentrations in mussels collected at various locations along the east and west coast are used as an indicator of pollution, a study in which metal concentrations in sediment and tissue samples help to determine what effects dredging in and around Oakland Harbor, California would have on resident organisms, and a study to determine the speciation of arsenic in water, tissue, and particulate samples collected from lakes used for cooling water in coal fired power plants. Through such studies, he has gained valuable knowledge and experience in marine geochemistry with particular emphasis on trace metal analysis. Mr. Apts is competent in the use of a number of analytical techniques, including flame, furnace, and hydride and cold vapor atomic

absorption spectrophotometry, as well as beta, gamma, and alpha counting techniques used in metals analysis. He also has had considerable experience in field sampling techniques, particularly those used for the collection of samples for trace metals.

Publications:

Apts, C. W. and E. A. Crecelius. 1993. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1992. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1992. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1991. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1991. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1990. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1990. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1989. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1989. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1988. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1988. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1987. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1987. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1986. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1986. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1985. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and E. A. Crecelius. 1985. Concentration and Speciation of Arsenic in Flatfish and Crabs Collected from Commencement Bay. Prepared for Tacoma-Pierce County Health Department under Contract 23112-06362, by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and R. A. Elston. 1985. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1984. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and R. A. Elston. 1983. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1983. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and R. A. Elston. 1982. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1982. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and R. A. Elston. 1981. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1981. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and R. A. Elston. 1981. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1980. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. 1980. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca staminea, in Sequim Bay. Annual Report for 1979. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. 1979. A Study of the Effects of Boat Traffic on the Levels of Coliforms in Littleneck Clams, Protothaca stamina, in Sequim Bay. Annual Report for 1978. Prepared for Port of Port Angeles by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Apts, C. W. and C. I. Gibson. 1976. Gas Bubble Disease in the Marine Environment. In Part 2 Pacific Northwest Laboratory Annual Report for 1975. BNWL-2000. Battelle, Pacific Northwest Laboratories, Richland, Washington.

Crecelius, E., C. Apts, L. Bingler, O. Cotter, S. Kiesser, and R. Sanders. 1993. "Analysis of Marine Sediment and Bivalve Tissue by X-ray Fluorescence, Atomic Absorption, and Inductively Coupled Plasma Mass Spectrometry." In Sampling and Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Project, 1984-1992, Volume III, Comprehensive Descriptions of Elemental Analytical Methods. NOAA Technical Memorandum NOS ORCA 71. National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

Crecelius, E. A., C. W. Apts, and O. A. Cotter. 1985. Evaluation of the Movement of Arsenic, Cadmium, and Lead in Tacoma Soil Profiles. Prepared for Tacoma-Pierce County Health Department under Contract 23112-06362, by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Gibson, C. I., C. W. Apts, J. R. Vanderhorst, P. Wilkinson and S. L. Kiesser. 1976. The Effects of Continuous Exposure to Elevated Temperatures on Pacific Northwest Intertidal Attached Communities. In Pacific Northwest Laboratory Annual Report for 1975. BNWL-2000. Battelle, Pacific Northwest Laboratories, Richland, Washington.

Gibson, C. I. and C. W. Apts. 1975. Thermal Effects of Effluent Discharge from Nuclear Power Plants to Coastal Waters. In Part 2 Pacific Northwest Laboratory Annual Report for 1974. BNWL-1950. Battelle, Pacific Northwest Laboratories, Richland, Washington.

Hardy, J. T., E. A. Crecelius, S. P. Joyce, C. W. Apts, M. F. Sullivan, B. M. Miller, R.L. Buschbom, and J. C. Simpson. 1981. Determination of the Biological Availability/Absorption of Cadmium - Final Report. Prepared for National Oceanic and Atmospheric Administration by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Roberston, D. E., D. S. Sklarew, K. B. Olsen, N. S. Bloom, E. A. Crecelius and C. W. Apts. 1986. Measurement of Bioavailable Mercury (Hg) Species in Fresh Water and Sediments. Final Report. Prepared for Electric Power Research Institute, Energy Analysis and Environment Division, Palo Alto, California.

Strand, J. A., J. A. Lichatowich and C. W. Apts. 1972. Development of Bioassay Procedures for Oil and Oil-Dispersant Chemicals. Prepared for the American Petroleum Institute, Committee for Air and Water Conservation by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Strand, J. A., J. A. Lichatowich and C. W. Apts. 1972. Research on the Effect of Insulation Board Plant (IBP) Effluent on the Marine Biota of Oakland Bay, Washington. Prepared for Simpson Timber Company by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Strand, J. A., W. L. Templeton, J. A. Lichatowich and C. W. Apts. 1971. Development of Bioassay Procedures for Oil and Oil Dispersant Chemicals. Prepared for the American Petroleum Institute, Committee for Air and Water Conservation by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Vanderhorst, J. R., P. Wilkinson, C. W. Apts and S. L. Kiesser. 1974. Field and Laboratory Studies to Obtain a Comparative Baseline for Assessing the Impact pf Refinery Discharge and Potential Oil Spillage on the Cherry Point Environs. Vol. II. Refinery Impact Evaluation. Final report. Prepared for Atlantic Richfield Company by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Vanderhorst, J. R., P. Wilkinson, C. W. Apts and S. L. Kiesser. 1974. Field and Laboratory Studies to Obtain a Comparative Baseline for Assessing the Impact of Refinery Discharge and Potential Oil Spillage on the Cherry Point Environs. Vol. III. Refinery Impact Evaluation. Final report. Prepared for Atlantic Richfield Company by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Word, J. Q., J. A. Ward, C. A. Apts, D. L. Woodruff, M. E. Barrows, V. I. Cullinan, J. Hyland, J. F. Campbell, J. S. Anderson, V. L. Broadhurst, and J. A. Coley. 1988. Results of Confirmatory Sediment Analyses and Solid and Suspended-Particulate Phase Bioassay Testing on Selected Sediment from Oakland Inner Harbor, San Francisco, California. Prepared for the U.S. Army Corps of Engineers, San Francisco District.

Young, J. S. and C. W. Apts. 1977. Thermal Shock Tolerances of Six Fishes and One Invertebrate From the Pacific Northwest. BNWL-2289, Battelle, Pacific Northwest Laboratories, Richland, Washington.

Journal Articles:

Crecelius, E. A., J. T. Hardy, C. I. Gibson, R. L. Schmidt, C. W. Apts, J. M. Gurtisen, and S. P. Joyce. 1982. "Copper Bioavailability to Marine Bivalves and Shrimp: Relationship to Cupric Ion Activity." Mar. Environ. Res. 6:13-26.

Crecelius, E. A., C. W. Apts, J. M. Gurtisen, C. I. Gibson, S. P. Joyce, R. L. Schmidt and J. E. Rogers. 1980. "Physical and Chemical Factors Affecting Bioavailability of Metals to the Littleneck Clam, Protothaca staminea." Abstract. Thalassia Jugoslavica 16(2-4):377-380.

Hardy, J. T., E. A. Crecelius, L. D. Antrim, V. L. Broadhurst, C. W. Apts, J. M. Gurtisen and T. J. Gurtisen. 1987. "The Sea-Surface Microlayer of Puget Sound: Part II. Concentration of Contaminants and Relation to Toxicity." Mar. Env. Res. 23:251-272.

Hardy, J. T., and C. W. Apts. "Photosynthetic Carbon Reduction: High Rates in the Sea-Surface Microlayer." Global Biogeochemical Cycles. (Submitted)

Hardy, J. T., C. W. Apts, E. A. Crecelius and G. W. Fellingham. 1985. "The Sea Surface Microlayer: Fate and Residence Times of Atmospheric Metals." Limnol. Oceanogr. 30(1):93-101.

Hardy, J. T., C. W. Apts, E. A. Crecelius and N. S. Bloom. 1985. "Sea-surface Microlayer Metals Enrichments in an Urban and Rural Bay." Estuarine Coastal Mar. Sci. 20:299-312.

Hardy, J. T., and C. W. Apts. 1984. "The Sea Surface Microlayer: Phytoneuston Productivity and Effects of Atmospheric Particulate Matter." Mar. Biol. 82:293-300.

Hardy, J. T., M. F. Sullivan, E. A. Crecelius, and C. W. Apts. 1984. "Transfer of Cadmium in a Phytoplankton-Oyster-Mouse Food Chain." Arch. Environ. Contam. Toxicol. 13:419-425.

Hardy, J. T., R. L. Schmidt, and C. W. Apts. 1981. "Marine Sediment and Interstitial Water: Effects on Bioavailability of Cadmium to Gills of the Clam Protothaca staminea." Bull. Environ. Contam. Toxicol.27:798-805.

Phelps, H. L., J. T. Hardy, W. H. Pearson, and C. W. Apts. 1983. "Clam Burrowing Behavior: Inhibition by Copper-enriched Sediment." Mar. Pollut. Bull. (14)12:452-455.

Young, J. S., J. M. Gurtisen, C. W. Apts and E. A. Crecelius. 1978. "The Relationship Between the Copper Complexing Capacity of Sea Water and Copper Toxicity in Shrimp Zoeae." Mar. Environ. Res. 2(4):265-273.

Chapter Publication:

Hardy, J. T., C. W. Apts, J. M. Gurtisen and R. L. Schmidt. 1986. "Bioavailability of Energy-Effluent Materials in Coastal Ecosystems." Submitted to Physiological Responses of Marine Organisms to Environmental Stressors. Lawrence Livermore National Lab, University of California, Livermore, California.

Blythe Barbo **Battelle MSL**

Marketing Information Specialist

Education:

B.A. Foreign Languages and Literatures, Washington State University, 1974
EMBA Executive Masters in Business Administration, Kennedy-Western University, Thousand Oaks, CA, anticipated 2001

Qualifications:

Ms. Blythe Barbo, who has worked at Battelle since 1991, has nearly 20 years of administrative experience with an emphasis in marketing, technical communications, editing, working with the public, and legal proceedings. Her current responsibilities involve coordinating proposal efforts, compiling technical information for clients, technical editing, public outreach, and maintaining various information database and tracking systems related to marketing and proposal activities. Her position as Marketing Information Specialist is unique within the Battelle system and involves extensive collaborations among various Battelle offices for marketing and proposal efforts. Ms. Barbo specializes in technical communications, including technical editing of large reports for private clients and state and federal agencies, as well as editing of peer-reviewed journal articles and various presentation materials. She was instrumental in the editing and formatting of the *Suggested Methods Manual for Environmental Sampling and Analysis in San Francisco Bay,* a comprehensive three-volume compilation of suggested methods for conducting all aspects of environmental investigations under the Long Term Management Strategy (LTMS) for San Francisco Bay. She was also a key support in the editing, formatting, and compilation of two important EPA documents: *Method for Assessing the Chronic Toxicity of Sediment-associated Contaminants with Leptocheirus plumulosus,* and *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates.*

In addition, Ms. Barbo serves on the editorial review board and frequently writes and edits articles for *Environmental Updates,* a publication produced by Battelle offices in Massachusetts, New York, Louisiana, Ohio, Washington, and Geneva, Switzerland. Ms. Barbo routinely composes statements of capabilities, marketing flyers, technical correspondence, and articles for media release in support of staff program and marketing efforts. Other activities include literature searches, market research, and participation in business strategy development. Ms. Barbo frequently hosts visitors at the Marine Sciences Laboratory, which includes giving site tours and coordinating meetings and workshops. Ms. Barbo was awarded the first 1999-2000 CREM Oscar Award, an internal award recognizing contributions to the development and success of the Coastal Resources and Ecosystem Management business model.

Daniel P. Bardon **Battelle Duxbury**

Researcher

Education:

B.S. Zoology, University of Massachusetts, Amherst, 1988
Minor in Chemistry

Qualifications:

Mr. Bardon has 8 plus years of experience in the field of environmental chemistry at Battelle. He is currently a member of the Gas Chromatography/Mass Spectroscopy (GC/MS) group where he is responsible for sample analysis by GC/MS, analytical and calibration standard preparation, and instrument maintenance and troubleshooting. During his four and a half plus years as a GC/MS analyst, he has gained experience dealing with a variety of sample matrices including marine waters and sediments, animal and plant tissues, and petroleum products and sludges. He is familiar with analyses dealing with various alkyllated polyaromatic hydrocarbons, linear alkyl benzenes, and petroleum biomarkers. Other duties include spreadsheet and data package preparation and sample monitoring.

Previously, Mr. Bardon spent three and a half years working in Battelle's Organic Chemistry Lab. There, he consistently demonstrated great care and skill in performing tissue and sediment extraction. He also assumed a leadership role and proved to be highly skilled in operating high performance liquid chromatography machinery. Additionally, he has experience as a Hazardous Waste handler and as laboratory Sample Custodian.

Relevant Experience:

Researcher: Analyzed sediments, waters, tissues, sludges, and/or oil samples for a variety of compounds including PAHs, linear alkyl benzenes, alkylated PAHs, and/or petroleum biomarkers for the following projects:

- NOAA National Status and Trends Mussel Watch Program
- United States Army Corps of Engineers (New England and New York Divisions)
- Several EPA Work Assignments
- MWRA Sediments
- MWRA Waters
- MWRA Tissues
- Agip Trecate 24 Blowout Project
- Agip Trecate Greenhouse Project
- SISAS

Researcher: NOAA National Status and Trends Mussel Watch Program. As a field technician on this project, collected mussel and oyster samples from various intertidal and underwater locations, prepped samples for transportation to the laboratory, filled out appropriate paperwork (site logs and custody transfer forms), and assisted boat captain in launching and retrieving Sisus type boat. Familiar with charting site locations using field glasses, navigational charts, and hand held GPS. Some experience driving and towing a Boston Whaler.

Researcher: Mussel Watch Caged Mussel Study. As a field technician for this project, assisted with the tending and retrieval of cages containing mussels and lipid bags deployed in Duxbury and Dorchester Bays. Duties included launching, retrieving, and securing a Boston Whaler used for sampling, and preparation of samples for transportation back to the laboratory.

Researcher: Massachusetts Water Resources Authority Harbor Monitoring Program. As a field technician for this project, accompanied lobstermen during the collection of live lobsters in both Boston harbor and Cape Cod Bay, transported lobsters to the laboratory, determined and recorded various external data (carapace length, weight, sex, and unusual shell characteristics), and removed hepatopancreas and tissue for further processing and analysis.

Researcher: EPA Work Assignments 109 and 353. As a field technician for this project, participated in the collection of sediment and tissue samples, field processing, and shipment of the samples to different laboratories for a variety of analyses (including benthic infauna, dioxin, polynuclear aromatic hydrocarbon, pesticide, polychlorinated biphenyl, total organic carbon, and grain size analyses).

Researcher: USACE-NED Providence River Project. Served as Chief Scientist during collection of water and sediment samples during re-sampling of Providence River sites. Acted as sole Battelle representative during sampling activities and was responsible for sample transport to Battelle.

Researcher: Massachusetts Water Resources Authority Harbor Monitoring Program. As a field technician for this project, participated in water sample collection and processing. Duties included winch operation, Battelle BOSS data system operation, and sample filtration.

Linda S. Bingler **Battelle MSL**

Senior Research Scientist

Education:

B.S. University of Nevada, Biology, 1981
M.S. University of South Florida, Marine Chemistry, 1989

Qualifications:

Ms. Bingler has experience in shipboard measurements of TCO_2 in seawater using the SOMMA/ coulometric system. In addition, she has a working knowledge of the analysis of other carbon parameters, such as pH and alkalinity, and is familiar with pCO_2 methodologies. She has participated as a CO_2 chemist on four WOCE cruises as part of the WHP global measurement program. She has been trained and worked with Dr. Andrew Dickson of Scripps Institution of Oceanography and Mr. Kenneth Johnson of Brookhaven National Laboratory. She is competent with the use and operation of a CTD, Niskin and Nansen bottles, and associated water sampling equipment. She is familiar with sediment sampling techniques in marine and estuarine environments.

Ms. Bingler has managed many water monitoring projects and is familiar with metals in freshwater, effluent, stormwater, and seawater. She has managed projects designed to examine the effective removal of contaminants (organic and metal) from river sediments by thermal and hydrocyclone processing for the Great Lakes National Program Office and the U.S. Army Corps of Engineers. She has managed Battelle's portion of a 60-day cruise from Dutch Harbor to New Caledonia, designed to collect CTD and high-accuracy measurements of a suite of anthropogenic and natural tracers as part of the WHP global measurement program.

Relevant Experience:

Managed the metals chemistry portion of the St. John's River Water Management Program for the past year. She is familiar with the program and client needs and is capable of directing the work to provide high quality data.

Ms. Bingler has experience in the areas of rare earth element nutrient complexation in seawater, determination of formation constants for metal-nutrient complexation and phytoplankton uptake of rare earth elements over time. As a graduate student in the Chemistry Department of Oceanography at the University of South Florida, she studied the complexation of gadolinium and phosphate in seawater. As part of her thesis research, she determined formation constants for $GdH_2PO_4^{2+}$, $GdHPO_4^{+}$ and Gd $(HPO_4)_2^{-}$

Ms. Bingler has participated in the SEAMAP program at the Department of Natural Resources for the State of Florida. This program is designed to assess the larval plankton compliment of the Gulf of Mexico. Also at the Department of Natural Resources, she took part in the organization of the ichthyoplankton curatorial museum. She has participated in over a dozen scientific cruises as a nutrient and chlorophyll chemist.

Ms. Bingler is experienced in conducting seawater, freshwater, and soil analyses for total and dissolved metals, inorganic nutrients, trace metals, gamma-emitting particles and various other chemical, biological, and physical parameters. She has assisted in many phases of field sampling for fisheries statistics including age and growth curves, fecundity and population standing stock assessment for several species of fish. She is familiar with EPA (SW846; CLP) and USATHAMA methods for chemical analyses of solid and liquid matrices.

She is an experienced operator of the following scientific equipment: Technicon II Autoanalyzer, IR Spectrophotometer, UV-VIS Spectrophotometer, DMS-90 computer-interfaced spectrophotometer, Tracor-Northern and Canberra Series 90 Multichannel Analyzer, SOMMA CO_2 Extraction System, UIC Coulometer, various electrodes, meters and other equipment useful to the analyses of the above constituents.

She is familiar with IBM-PC, MacIntosh and other PC computers, DBase, Lotus, Cricketgraph, Wordperfect, and Excel. Capable of some programming and statistical manipulation of data, such as: regression analyses (linear, multiple, least squares, and non-linear least squares).

She has supervised the water quality division of a large environmental corporation.

She jointly presented TCO_2 data collected on a WOCE Cruise in 1993 at a Somma Workshop and Science Team Meeting.

She presented data relative to the use of acid baths for cleaning containers for ultra-trace metal samples.

Publications:

Bingler, L. S. and R. H. Byrne. 1989. "Phosphate Complexation of Gadolinium-(III) in Aqueous Solution." *Polyhedron* 8(10):1315-1320.

Bingler, L. S. and R. H. Byrne. 1989. "Rare Earth Element Uptake by the Marine Diatom Skeletonema costatum." *Chemical Speciation and Bioavailability* 1(3):103-110.

Byrne, R. H., J . H. Lee, and L. S. Bingler. 1992. "Rare Earth Element Complexation by PO^{3-} Ions in Aqueous Solution." *Geochimica et Cosmochimica Acta*. 55:2729-2735.

Byrne, R. H. and L. S. Bingler. 1989. Comment on "Cerium: A chemical tracer for paleo-oceanic redox conditions" by Y. B. Liu, M. R. U. Miah, and R. A. Schmitt. *Geochimica et Cosmochimica Acta*. 53:1475-1476.

Campbell, D., Roche, M., Olivella, S., Purkerson, D.G., Bingler, L., and Millero, F.J. (1996) Carbon Dioxide Measurements in the South Pacific along P14N. University of Miami Technical Report 96(006).

Crecelius, E.A., C. Apts, L. Bingler, J. Brandenberger, M. Deuth, S. Kiesser, and R. Sanders. (1998) Analysis of Marine Sediment and Bivalve Tissue by X-Ray Fluorescence, Atomic Absorption and Inductively Coupled Mass Spectrometry, in: Sampling and Analytical Methods of the National Status and Trends Program, Mussel Watch Project: 1993-1996 Update, NOAA Technical Memorandum NOS ORCA 130: 74-92.

Crecelius, E. A., C. W. Apts, L. S. Bingler, and O. A. Cotter. 1993. "The Cycling of Arsenic Species in Coal-Fired Power Plant Cooling Reservoirs." In *Arsenic in the Environment*. John Wiley & Sons, Inc. (In press.)

Ríos, A.F., F.F. Pérez, L.S. Bingler, J. Aristegui, L. Mémery. (in press) Carbon Dioxide Along WOCE Line A14: internal consistency, water mass characterization and anthropogenic entry. *Journal of Geophys. Res.*

WHP Ref. No. P14C, 1996 A. Cruise Narrative A.1 Highlights.

Reports:

Arhan, M., H. Mercier, X.A. Salgado, L. Mémery, J. Dutay, O. Marti, L. Bingler, A.F. Ríos. (1995) Campagne Cither-2 N/O Maurice Ewing (4 janvier-21 mars 1994): Recueil de données Volume 2: CTD-O_2.

Arhan, M., H. Mercier, X.A. Salgado, L. Mémery, J. Dutay, O. Marti, L. Bingler, A.F. Ríos. (1995) Campagne Cither-2 N/O Maurice Ewing (4 janvier-21 mars 1994): Recueil de données Volume 3: Traceurs Géochimiques.

Bingler, L. S. and L. Arlen. 1997. Recueil de donnees, Vol. 3: Traceurs Geochemiques 1--Total Inorganic Carbon Measurements.

Bingler, L.S., (1995) Measurements of CO_2 in Sea Water on WOCE Hydrographic Line A-13 and A-14, IN: Global Change Research: Summaries of Research in FY 1995. Prepared for United States Department of Energy.

Bingler, L.S., (1994) Measurements of CO_2 in Sea Water on WOCE Hydrographic Line A-17, IN: Global Change Research: Summaries of Research in FY 1994. Prepared for United States Department of Energy.

Bingler, L.S., (1993) Measurements of CO_2 in Sea Water on WOCE Hydrographic Line P-17, IN: Global Change Research: Summaries of Research in FY 1993. Prepared for United States Department of Energy.

Bingler, L.S. and Crecelius, (1992) Measurements of CO_2 in Sea Water on WOCE Hydrographic Lines P-13 and P-14C, IN: Global Change Research: Summaries of Research in FY 1992. Prepared for United States Department of Energy.

Bingler, L.S. (1992) Total Inorganic Carbon along WOCE line P14N (1991). Prepared for Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Rios, A. F., L. S. Bingler, G. Roson, and L. Arlen. 1997. Recueil de donnees, Vol. 3: Traceurs Geochemiques 3--Internal Consistency Carbonate System Measurements.

Thom, R. M., L. S. Bingler, E. A. Crecelius, and K. Steenwerth. *Puget Sound Delta Accretion Rates*. PNWD-2373. Prepared for the University of Washington by the Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle Memorial Institute, Pacific Northwest Division, Richland, Washington.

SENIOR TOXICOLOGIST

Susan Blanton **Battelle MSL**

Research Scientist

Education:

B.S. Zoology, Miami University, 1992

Qualifications:

Ms. Blanton is a Research Scientist at the Battelle Marine Sciences Laboratory in Sequim, Washington. Since joining the Sequim operation in 1999, she has conducted bioassays to evaluate open-water dredge disposal sites in Puget Sound, evaluated chronic and acute toxicity test methods for *Leptocheirus plumulosus,* and conducted whole effluent toxicity (WET) bioassays. Ms. Blanton is also a research diver for the laboratory, performing habitat and population estimates and assessments, underwater photography and videography. She provides support to diverse projects through technical writing, field sampling, and data processing and analysis. Ms. Blanton joined Battelle in 1994, working out of the Pacific Northwest National Laboratory in Richland, Washington. While in Richland her research focused on diverse salmonid issues in the Columbia and Snake River Basins.

Relevant Experience:

Ecotoxicological Bioassays – Ms. Blanton conducts freshwater and marine toxicological bioassays. Her experience includes testing dredged disposal sediments in Puget Sound under the Puget Sound Dredged Disposal Analysis (PSDDA) program, evaluating bioassay methodologies, and testing treated effluent. Animals tested include fish, amphipods, echinoderms, mussels, and polychaete worms.

Fish Culture – Ms. Blanton provided daily care for fish at the Pacific Northwest Laboratory's aquatic testing facility. This aquatic laboratory is used to conduct in vitro tests to answer questions difficult to resolve in the field. The Ecology Group maintains a population of rainbow trout year-round, as well as a variety of cold- and warm-water fishes and invertebrate organisms.

Gas Bubble Research – Ms. Blanton evaluated the use of ultrasound as a tool to observe gas bubbles in fish. Excess spillage at dams can result in gas supersaturation. As a result, bubbles can form in fish tissues and body fluids causing a condition termed gas bubble trauma (GBT). Bubbles forming in the heart and in arteries leading to the gills can result in asphyxiation. Real-time ultrasonic imaging equipment was modified to determine if the technology could be used to detect bubbles in the internal organs and fins of juvenile salmonids.

Publications:

Geist, D.R., C.S. Abernethy, S.L. Blanton, and V.I. Cullinan. 1999. The use of electromyogram telemetry to estimate energy expenditure of adult fall chinook salmon. *Transactions of the American Fisheries Society*, 129:126-135.

Blanton SL and JA Ward. 2000. 45-Day Bioaccumulation Test with *Macoma nasuta* and *Nephtys caecoides:* Hylebos Wood Debris Group PSDDA. PNWD-3052. Prepared for Pentec Environmental, Edmonds, Washington.

Neitzel, D., T.J. Carlson, R. Mueller, W. Mavros, and S. Blanton. 1997. Avoidance Response of Juvenile Hatchery and Wild Chinook Salmon and Rainbow Trout. Prepared for the Bonneville Power Administration, Portland, Oregon.

Pinza, MR, SL Blanton, LM Johnson. 2000. *Comparison of the Sensitivities of Acute and Chronic Marine Sediment Toxicity Tests with Leptocheirus Plumulosus Using Sediment Quality Advisory Levels*. PNNL-13216. Prepared for the U.S. Environmental Protection Agency by Pacific Northwest National Laboratory, Richland, Washington; Battelle Marine Sciences Laboratory, Sequim, Washington.

Poston, T.M., R.A. Pappas, S.L. Blanton, A.A. Diaz, and K.J. Lessor. 1997. Using Ultrasound to Detect Gas Bubbles in Rainbow Trout *(Oncorhynchus mykiss).* PNNL-15545, Pacific Northwest National Laboratory, Richland, Washington.

Ward, JA and SL Blanton. 2000. Amphipod Bioassay Results: Hylebos Wood Debris Group PSDDA. PNWD-3048. Prepared for Pentec Environmental, Edmonds, Washington.

Kimberly L. Blodnikar **Chesapeake Biological Laboratory**

DOC & TOC – Sample Preparation/Analyst

Education:

B.S. Miami University, Oxford, OH, Botany (emphasis in Environmental Science), 1995.

Relevant Experience:

For Chesapeake Biological Laboratory: Analyzed samples for Total Dissolved Nitrogen and Phosphorus. Sub-sampled and prepared samples for analysis. Analyzed for Dissolved Organic Carbon on a Shimadzu TOC 5000. Prepared and Analyzed for Particulate Phosphorus AAII. Coordinated the MDE Total Maximum Daily Load Project. Entered QA/QC data for the Patuxent River.

For Environmental Data Resources: Produced Phase I Site Assessments under ASTM Standards using city directories and maps. Coordinated review of Phase II reports in MD and VA to determine groundwater flow and depth. Hired, trained, and oversaw temporary employees for groundwater project. Researched potential new products and other library collections. Assisted in the development of new company operating procedures.

For McDonnell Douglas Aerospace: Analyzed and applied satellite data in environmental studies. Produced excel charts from incoming satellite data. Worked on computer projects and web page development.

For U.S. Department of Agriculture Research Center: Performed electrophoresis experiments on soybean seeds. Conducted large scale plasmid preparations. Evaluated data, results, and processes.

Roxanne Brackett **Battelle Duxbury**

Research Technician
Environmental Chemistry Section

Education:

G.E.D. Massachusetts, 1990

Qualifications:

Ms. Brackett joined Battelle as a member of the marine trace metal group in 1990. She has become adept at preparing field samples using ultra-clean procedures and is currently responsible for preparing sediment, tissue, and aqueous field samples. Her attention to detail has allowed successful completion of large sample loads accurately with very little contamination. Ms. Brackett is an Alternate Sample Custodian. She is currently being cross-trained in Organic Chemistry Techniques.

Relevant Experience:

Research Technician – EPA Norfolk Disposal Site Monitoring Program. Analyst responsible for sediment sample preparation and processing for analysis of Cd, Cu, Fe, and Zn.

Research Technician – EPA NY/NJ Harbor Waste Load Allocation Study. Analyst responsible for seawater sample processing for carbon measurements and total recoverable, acid soluble, dissolved, and particulate processing for trace metal measurements.

Research Technician – EPA Philadelphia Dump Site Recovery Study. Analyst responsible for scallop and sediment sample preparation and processing for analysis of metals.

Research Technician – Industrial client riverine site assessment. Performed porewater extractions.

Research Technician – New York Harbor Site-specific Copper Criterion Study. Supervised sample prep staff as they filtered and prepared surface water samples for total and dissolved Cu analysis.

Research Technician – New York Bight Monitoring Project. Prepared samples and conducted nutrient analyses for NH_4, PO4, NO2, NO3, and SiO3.

Research Technician – Collected wastewater treatment plant effluent samples using clean techniques. Prepared and analyzed samples for copper.

Research Technician – US Army Corps of Engineers New York District. Prepared and analyzed water, sediment, and tissue samples for trace metals analysis.

Research Technician – Industrial client site assessment. Prepared and analyzed worms, rodents, and fish for a suite of trace metals.

Research Technician – Team member of a Tributyltin long term monitoring project which is conducted under the Good Laboratory Practices (GLP) standard.

Research Technician – Ceimic 1996: prepared ultra-trace sampling equipment for a large trace metals project for US EPA. Prepared and analyzed the samples for specific metals (Cd, Hg, Cu, Ni, Zn).

QUALITY ASSURANCE OFFICER

Rosanna L. Buhl **Battelle Duxbury**

Quality Systems Manager

Education:

ASQ Certified Quality Auditor, 1996
Occupational and Environmental Radiation Protection, Harvard School of Public Health, 1993
Quality Assurance for the Analytical Chemistry Laboratory, 1991
Good Laboratory Practice Standards, Center for Professional Advancement, 1989
Quality Assurance Basic Training course, Society of Quality Assurance, 1989
Bridgewater State College (also Philadelphia College of Bible and Bob Jones University)

Qualifications:

Ms. Buhl joined Battelle in 1973 and brings a broad background of technical experience to her present position as Quality Systems Manager. With 10 years' experience in the biology/biochemistry laboratories she was appointed study director for aquatic toxicology tests conducted according to Good Laboratory Practice (GLP) standards and served in that capacity for five years. In 1989, Ms. Buhl joined the Quality Assurance Unit and was the site Quality Assurance Coordinator for six years until her appointment to the position of Quality Systems Manager in 1998. She has received formal QA instruction through the Center for Professional Advancement, the Society of Quality Assurance, and American Society for Quality (ASQ).

As Quality Systems Manager for Battelle, Ms. Buhl is responsible for overseeing all site quality assurance activities, verifying that technical activities are conducted in compliance with the site Quality Management Plan (QMP), and managing the technical activities of the Battelle Duxbury Operations' Quality Assurance Office.

Ms. Buhl develops and implements the quality management system at Battelle, and is responsible for preparation of the site QMP, for preparing and reviewing standard operating procedures, identifying and implementing staff training, conducting laboratory inspections of both Battelle and subcontractor activities, and verifying reported data through data audits. Ms. Buhl coordinates, supervises, and participates in all QA activities associated with the collection of environmental data. She has extensive knowledge of state and Federal QA programs, and has written Quality Management Plans for client and regulatory approval.

Professional Positions:

Quality Systems Manager, Quality Assurance Unit, Battelle. 1998 - present. Oversees the implementation of the Quality Assurance Program at Battelle and in particular oversees the activities of the Quality Assurance Unit, report production, and information services.

Quality Assurance Coordinator, Quality Assurance Unit, Battelle. 1992 - 1998. Responsible for management of the Quality Assurance Unit activities.

Quality Assurance Specialist, Quality Assurance Unit, Battelle. 1989 - 1992. Responsible for performing data audits, laboratory inspections, and administration of standard operating procedures.

Researcher, Environmental Toxicology, Battelle. 1984 - 1989. Study director for toxicology testing under GLPs and related analyses, including analytical HPLC.

Technician/Research Technician, Biology, Battelle. 1973 - 1983. Various assignments: benthic ecology technician and polychaete taxonomist; biochemistry lab technician for analytical HPLC and specialized instrumentation.

Relevant Experience:

As *Quality Systems Manager* Ms. Buhl prepares the site Quality Management Plan, the Quality Assurance Manual that describes the analytical laboratory's procedures and quality control requirements, and she is responsible for maintaining the laboratory's State certifications.

As *Program QA Officer* for the EPA Oceans and Coastal Protection Division contract Ms Buhl prepared the original Program Quality Management Plan and is responsible for the annual review and revision of this document. She has also prepared Quality Assurance Program Plans for a large multidisciplinary field and laboratory study conducted for the Massachusetts Water Resources Authority (MWRA).

Program QA Officer: Ms. Buhl is responsible for scheduling and conducting quarterly laboratory inspections at Battelle, and of field and subcontractor laboratories activities as necessary to assess compliance with QA Program Plans, SOPs, and regulatory requirements, and for preparing written reports to management. Ms. Buhl conducts routine inspections of analytical activities conducted in the Chemistry laboratory for GLP studies.

Program QA Officer: Ms. Buhl has a wide variety of experience in support of extrinsic inspections conducted at Battelle by EPA, State agencies, clients, third-party auditors, and the Nuclear Regulatory Agency. She coordinates preparation, accompanies inspectors during the inspection, assists laboratory personnel in corrective action to audit findings, and prepares written reports of findings to management and written responses to inspection reports. Recent inspections have included two client inspections related to Battelle's analysis of samples for Superfund site. Battelle was audited twice by Exxon Corporation during the analysis of samples collected after the *Exxon Valdez* oil spill. Ms. Buhl coordinated all laboratory activities associated with the inspections.

Program QA Officer: In addition to the planning and inspection phases of each project, a major role of the QA Office at Battelle is the verification that all reported data are accurate, traceable, and collected according to the project QA plan and associated SOPs. Ms. Buhl coordinates and participates in this essential activity. Her expertise ranges from the audit of analytical chemistry and biology data, to verification of data contained in database systems. She functions as the QA Officer for all projects and is the lead auditor for many. She participated in CLP-level data validation of environmental monitoring data collected at the Pantex Plant in Amarillo, TX. Because Battelle offers the capability to conduct large, multidisciplinary studies, like the EPA Office of Water investigations at the 106-mile dump site, Ms Buhl is skilled in verifying large and complex data sets, including sediment trap, settling rate,

microlayer, productivity, and *in situ* electronically-captured oceanographic data. In support of GIS development for the Resource Conservation Recover Act (RCRA) Facility Investigation (RFI) for three divisions of United Technologies, Ms. Buhl conducts audits of database contents prior to inclusion in the client database.

Program QA Officer for Battelle's task order technical services contract with the EPA's Oceans and Coastal Protection Division (OCPD). In this role Ms. Buhl reviews all work assignment QAPjPs for adequacy, evaluates the QA programs of subcontractors, supervises audits of all reported data, and reviews technical deliverables.

Program QA Officer for Battelle Columbus' EPA NRMRL contract. She is responsible for the QA review of QAPPs produced in compliance with the requirements of EPA's Risk Reduction Engineering Laboratory.

Task Leader responsible for preparing the Quality Management Plan for the Gulf of Mexico Program Office. This effort involved interviewing numerous State and Federal agencies to identify common ground for establishing a program-wide quality assurance program.

Program QA Officer for the Harbor and Outfall Monitoring program conducted by Battelle for the Massachusetts Water Resources Authority. Seven separate Quality Assurance Program Plans for the 7 monitoring tasks are being prepared for this program, which included extensive field activities, *in situ* water quality measurements, sample collection for laboratory analyses, extensive analytical chemistry and nutrient analyses, and the development of a client-compatible database. This assignment includes the oversight of several offsite subcontractors to ensure that their QA/QC procedures meet the program requirements.

Program QA Officer for Newtown Creek Facilities Upgrade program conducted by Battelle for the City of New York. Five separate Quality Assurance Program Plans for the 5 monitoring tasks were prepared for this program which was conducted in support of NPDES permit revision. Certification by the New York Department of Health Environmental Laboratory Approval Program was required. The program consisted of a rigorous field program of 100 stations visited 10 times during a one-year period. Nutrient, water quality measurements, productivity, and discharge monitoring data were entered into a modeling database.

Project QA Officer for the Ecological and Human Health Assessment for the Trecate 24 Oil Spill in Northern Italy study conducted for a major European oil company. Chemical analysis of sediments, soils, oils, plant, and animal tissues are being conducted and entered into a client-compatible database. The damage assessments are being performed according to U.S. Natural Resource Damage Assessment Guidelines.

Project QA Officer for the Broadkill Beach Interim Feasibility Study conducted for the U.S. Army Corps of Engineers, Philadelphia District. Battelle evaluated the physical characteristics and benthic biological resources at potential fill borrow sources, analyzing benthic infauna samples and associated data. These data were used to identify the abundance and distribution of rare and commercial species that may be impacted by sediment removal activities.

Program QA Officer for the program Monitoring the Fate and Effects of the *Exxon Valdez* Oil Spill in Prince William Sound, Alaska conducted for Exxon Corporation. This project involved long-term natural resource damage assessment (NRDA) studies and assistance with shoreline treatment operations.

Battelle provided program design and management, field support, analytical support, data interpretation, and database management for more than 20 studies associated with the *Exxon Valdez* oil spill.

Program QA Officer for Battelle's contract with NOAA for the Period 2 Status and Trends Mussel Watch Program, a program involving the collection of bivalve molluscs and surficial sediment at estuarine/coastal sites on the each and west coasts of the United Sates, and the analyses of these samples for selected organic and inorganic analytes.

QA Auditor for Analytical Chemistry Services in Support of Remedial Investigation Projects at U.S. Navy Sites in Hawaii and Guam conducted for the U.S. Navy Pacific Division/Ogden Environmental Inc. Sediment and tissue samples collected in support of the Navy CLEAN program were processed and analyzed for PAH, PCB, chlorinated pesticides, petroleum hydrocarbons, trace elements, and butyltins. Performance on this contract required NEESA certification. The certification process included review and approval of a laboratory quality assurance plan and all SOPs used on the project, successful analysis of several laboratory performance evaluation samples, and successful completion of a site audit by Navy inspectors.

Researcher/Research Technician. Ms. Buhl has extensive experience in conducting aquatic toxicity tests according to the stringent requirements of both TSCA (40 CFR Part 720) and FIFRA (40 CFR Part 160). She has been the GLP study director for over 15 studies with overall responsibility for the technical conduct of each study, as well as data interpretation, analysis, documentation, and reporting. Due to her success in conducting several tests for a Fortune 500 Chemical Company, and no findings during related EPA inspections, she was requested specifically to oversee all testing for this client. Ms. Buhl served as polychaete taxonomist and as the laboratory technician for a nationally recognized research team, assisting in the development of innovative applications of biochemical and physiological techniques as indicators of sublethal stress in marine organisms.

Professional Affiliations:

- National Environmental Laboratory Accreditation Conference; On-Site Assessment Committee
- ASQ Training
- Society for Quality Assurance
- New England Regional Chapter Society for Quality Assurance

Additional Training and Licenses:

- ASQ Training
- Society for Professional Advancement Training
- Society for Quality Assurance Training

Publications:

Breteler, R.J., J.W. Williams, and R.L. Buhl. 1982. Measurements of chronic toxicity using the opossum shrimp Mysidopsis bahia. Hydrobiolgia 93:189-194.

Carr, R.S., J.W. Williams, F.I. Saksa, R.L. Buhl, and J.M. Neff. 1985. Bioenergetic alterations correlated with growth, fecundity, and body burden of cadmium for mysids (Mysidopsis bahia). Envir. Toxicol. Chem. 4:181-188.

Neff, J.M., R.E. Hillman, R.S. Carr, R.L. Buhl, and J.I. Lahey. 1987. Histopathologic and biochemical responses in arctic marine bivalve molluscs exposed to experimentally spilled oil. Arctic 40 (Suppl. 1): 220-229.

Breteler, R.J., Buhl, R.L., and Maki, A.W. The effects of dissolved H_2S and CO_2 on short-term photosynthesis of Skeletonema costatum, a marine diatom. Plants for Toxicity Assessment: Second Volume, ASTM STP 1115, J.W. Gorsuch, W.R. Lower, W. Wang, and M.A.Lewis, Eds., American Society for Testing and Materials, Philadelphia, 1991. pp 118-125.

Cheryl Ann Clark **Chesapeake Biological Laboratories**

TSS – Sample Preparation/Analyst

Education:

B.A. St. Mary's College of Maryland, Natural Science (Chemistry/Biology concentration), 1990.

Relevant Experience:

- Gravimetric determination of total suspended solids and total volatile solids.
- Fluorometric determination of chlorophyll a and phaeopigments.
- Persulfate digestion of total dissolved nitrogen and phosphorous samples.
- Analysis of water samples for dissolved organic carbon.
- QA/QC data entry for Maryland Department of Environment samples and Department of Natural Resources Potomac River samples.
- Oversee handling of paperwork and samples for Department of Natural Resources Targeted Watershed Project.
- Train new employees on subsampling techniques.
- Analyze air and rain samples for polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).
- Cleaned and prepared sample matrices – glass fiber filters, Amberlite XAD-2 resin, and polyurethane foam plugs.
- Maintained sampling equipment and sample station.
- Coordinated sampling supplies and data collection between research groups from University of MD. College Park , Virginia Institute of Marine Science, and University of Delaware Institute of Marine Science during CBADS project.
- Preservation of trace metal samples by acidification.
- Prepared sample extracts using soxhlet extraction, separatory funnel extraction and Florisil column clean-up.
- Prepared standard solutions and surrogate solutions.
- Instrument maintenance and troubleshooting.
- Order laboratory supplies.
- Train new employees and students in sample collection, extractions, analysis, instrument use and maintenance, and software.
- Responsible for organizing and compiling data into tables and graphs.
- Assisted with General Chemistry and Organic Chemistry laboratory classes at St. Mary's College of Maryland.
- Maintain laboratory and stockroom areas.
  - Hewlett-Packard 5890 Gas Chromatograph w/Electron Capture Detector
  - Hewlett Packard 5972 Gas Chromatograph w/Mass Spectrometer

- Hewlett-Packard 5989A Gas Chromatograph w/Mass Spectrometer
- Hewlett-Packard 5970 Gas Chromatograph w/Mass Spectrometer
- Turner Fluorometer TD-700
- Shimadzu Total Organic Carbon Analyzer 5000

Publications:

Baker, J.E., D.L. Poster, C.A. Clark, T.M. Church, J.R. Scudlark, J.M. Ondov, R.M. Dickhut and G. Cutter. 1997. Loadings of Atmospheric Trace Elements and Organic Contaminants to the Chesapeake Bay, 1990-1992. In: Atmospheric Deposition of Contaminants to the Great Lakes and Coastal Waters, J.E. Baker (Ed.), 171-194.

Baker, J.E. and C.A. Clark. 1995. Chesapeake Bay Atmospheric Deposition Study, 1990-1993.

QUALITY ASSURANCE OFFICER

Deborah Coffey **Battelle MSL**

Senior Quality Engineer

Education:

M.S. Resource Ecology, School of Natural Resources, University of Michigan, 1983
B.S. Biology, University of Michigan-Flint, 1977

Qualifications:

Ms. Coffey brings to Battelle over 16 years of quality assurance (QA) experience. Her current responsibilities include serving as the primary contact for client QA staff and providing Quality Engineering (QE) assistance for implementing QA Program requirements at the Marine Sciences Laboratory in Sequim, Washington. She assures implementation of QA Program requirements by assisting project personnel in developing QA Project and QA Program Plans, reviewing procurement documents and technical procedures, assisting in the resolution of QA system problems, promoting continuous improvement practices, managing the controlled documents guiding analyses and overall QA Program implementation, planning and performing QA training, performing quality verification activities such as internal and supplier assessments and audits, and reviewing final data and reports. Ms. Coffey has five years experience as an NQA-1 certified lead auditor. She has participated in well over 175 audits.

Prior to Battelle, Ms. Coffey served four years as Deputy QA Manager for the Waste Isolation Pilot Plant (WIPP) project managed by Sandia National Laboratories, Albuquerque, New Mexico. She also provided nearly ten years of QA support for a wide variety of research projects conducted by the EPA's Environmental Research Laboratory, Corvallis, Oregon. These projects included assessing the regional health of streams, lakes, soils and forest; assessing the effect of pollutants on plants, animals, forests and the global climate; and assessing the affects of the introduction of genetically engineered organisms. As an Associate Chemist at Tetra Tech, Bellevue, Washington, Ms. Coffey contributed to data collection and analysis for EPA Superfund projects and NPDES permitting. She has also served as Director of an analytical laboratory managed jointly by the USDA Forest Service and Oregon State University in Corvallis, Oregon, which focused on the analysis of low-level surface water samples. In this position, Ms. Coffey conducted field sampling at Spirit Lake, Washington, following the eruption of Mount Saint Helens and analyzed samples from Crater Lake in support of U.S. Army Corps of Engineers research and the Long Term Ecological Monitoring (LTER) project site in the H.J. Andrews Experimental Forest, near Blue River, Oregon.

During her career, Ms. Coffey has designed and implemented QA programs for projects meeting CERCLA, RCRA, NQA-1, EPA and GLP requirements. Working with scientists, Deborah Coffey has implemented QA requirements in a variety of projects including disposal of ocean dredged material, site characterization and feasibility studies, biological studies associated with oil spills, and environmental characterizations, including field sampling, biological toxicity testing and analytical chemistry. In many of these projects, her participation began with project design and extended to the end of the project and into the publication phase of the work.

Relevant Experience:

Lead Role in obtaining and maintaining State accreditations for the following states: Washington, New Jersey, South Carolina, Florida, and Wisconsin. Part of this role includes assisting in the Laboratory's participation in Performance Evaluation Sample programs.

Implementation and Periodic Review And Revision of the Marine Sciences Laboratory (MSL) Quality Assurance Management Plan. Responsible for the annual review and revision of the over 100 MSL operating procedures and maintenance of the controlled document system.

QA Representative on Superfund, site characterization, and environmental risk assessment projects.

Developed a Good Laboratory Practice Program for studies evaluating effects of pollutants on wildlife. Served as the Quality Assurance Unit and was responsible for monitoring each study to assure management that the facilities, equipment, personnel, methods, practices, records, and controls were in conformance with regulations.

Worked on Numerous Programs/Projects dealing with the following nationally recognized QA programs:

- Department of Energy Order 5700.6C, Quality Assurance
- QAMS-005/80, Guidelines and Specifications for Preparing EPA Quality Assurance Project Plans
- EPA (40 CFR Part 160, 40 CFR Part 792) and FDA (21 CFR Part 58) Good Laboratory Practices regulations
- ASME NQA-1, Quality Assurance Program Requirements in Nuclear Facilities
- 10CFR, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants
- IEEE 730-1984, Software Quality Assurance.

Publications:

Erickson, H.E., and D.S. Coffey. 1991. "The Watershed Manipulation Project: Case Study of an Interlaboratory Program." *Accountability in Research*, 1:195-206.

Lee, J., R. Church, D. Lammers, L. Liegel, M. Johnson, D. Coffey, R. Holdren, D. Stevens, R. Turner, L. Blume. 1989. "Watershed Surveys to Support an Assessment of the Regional Effects of Acidic Deposition on Surface Water Chemistry." *Environmental Management*, 13(1):95-108.

Coffey, D.S., J.C. Sprenger, D.T. Tingey, G.E. Neely, and J.C. McCarty. 1988. "National Crop Loss Assessment Network: Quality Assurance Program." *Environmental Pollution*, 53:89-98.

SENIOR BIOLOGICAL STATISTICIAN

Valerie Cullinan **Battelle MSL**

Research Scientist

Education:

B.S. Zoology, The Ohio State University, 1980
M.S. Biometry, Cornell University, 1984
Ph.D. Biometry, Cornell University, 1988

Qualifications:

Dr. Cullinan, statistician for the Battelle Marine Sciences Laboratory, has over 15 years of experience in the statistical design, analysis, and interpretation of results from multidisciplinary experimental research. This research has focused on marine and freshwater environmental issues, particularly relative to dredged material disposal, environmental assessments, shellfish and fisheries studies, toxicity testing programs, and protocol development, as well as issues pertaining to wildlife management, agricultural systems, and terrestrial ecosystems. Dr. Cullinan has 10 years experience in the recently emerged field of landscape ecology. Her specialty is the development of statistically efficient sampling designs to detect ecological change at landscape levels of spatial heterogeneity. Such designs have related to data collected from ground-based field sampling, aerial photography, and satellite imagery. She has critically reviewed quantitative methodology in landscape ecology and has been an invited participant in workshops identifying issues and developing techniques in the analysis of landscape data over a wide range of scales. Dr. Cullinan is a reviewer for the journal *Landscape Ecology*.

Relevant Experience:

Monitoring of East Sha Chau Contaminated Mud Disposal for EIA, Hong Kong: Dr. Cullinan has overall responsibility for the development of statistical methods, analysis, and interpretation of the monitoring data during the disposal of contaminated sediment in the East Sha Chau, Hong Kong, marine borrow pit. The objectives of this environmental monitoring program are to determine changes and trends in the sediment quality, fisheries resources, and the water quality that can be associated with the disposal activities.

Dredged Materials Toxicity Testing: From 1989 to the present, Dr. Cullinan provided statistical design, analysis, and interpretation of results on numerous studies conducted to evaluate toxicity of dredged materials. These programs include the Oakland Harbor program (USACE San Francisco), one of the largest dredged material evaluation studies ever conducted on the west coast, several current studies for the New England Division of the Corps of Engineers, as well as programs for the Seattle, Portland, and New York Corps districts. She has also assisted with toxicity testing programs for the U.S. Environmental Protection Agency, Washington Department of Natural Resources, and the National Oceanic and Atmospheric Administration (NOAA).

Standard Chronic Sediment Toxicity Protocol with the Estuarine Amphipod, Leptocheirus plumulosus: Dr. Cullinan coauthored the standard protocol for this chronic sediment toxicity test method that

evaluates sediment associated chemical contaminants using *L. plumulosus*. This protocol is being presented to the Office of Water, Office of Science and Technology of the U.S. Environmental Protection Agency to be developed as a standard test method. Dr. Cullinan conducted data analysis, which included a cost-benefit analysis to determine the number of replicates required per treatment (*i.e.*, an analysis of both the improvement in statistical power of the test and the additional costs of adding more replicates), an evaluation of the effects of total organic carbon to the chronic results, and the determination of which endpoints should be measured to evaluate growth and reproduction. In conjunction with this protocol development program, additional population studies were conducted to understand the interaction of natural processes and anthropogenic stressors in estuarine ecosystems, and to link individual- and population-level stressor-response relationships in benthic organisms. These tests provide a new method of assessing the lethal and sublethal effects of chemical contaminants in marine and estuarine sediments and an approach for estimating the ecological risk contaminated sediments pose to populations of estuarine and marine benthic species.

Suggested Methods Manual for Environmental Sampling and Analysis in San Francisco Bay: This comprehensive document consists of three volumes of suggested methods for all aspects of planning and conducting environmental investigations, and is being used as a reference for programs conducted under the authority of the U.S. Army Corps of Engineers, the Environmental Protection Agency, and various state and local agencies participating in the Long Term Management Strategy (LTMS) for San Francisco Bay. Dr. Cullinan wrote the chapter on statistical design and analysis, which included sections on determining sample size, randomization, methods for the analysis of analytical chemistry, toxicological, and bioaccumulation data, statistical reference tables, and a FORTRAN program for the trimmed Spearman-Karber.

EPA Survey of Mud Dump Site and Environs: Dr. Cullinan conducted the data analysis and coauthored the report of this 4-year project involving chemical and toxicological analysis of sediment, benthic community analysis, and an assessment of bioaccumulation potential of the New York Bight Mud Dump Site and environs. This analysis involved the collection and interpretation of historical data in order to establish background contaminant levels for the New York Bight.

NY District USACE Programs: Dr. Cullinan developed spreadsheet software to automate the process of data presentation and statistical analysis for the NY District USACE programs. This software was also applicable to toxicological data for several other program.

Status and Trends Program: Collection of Bivalve Molluscs and Surficial Sediments and Performance of Analyses for Organic Chemicals and Toxic Trace Elements: Dr. Cullinan conducted statistical analysis on data spanning approximately 8 years to determine trends in the NOAA Mussel Watch program. This program measured environmental quality conditions throughout coastal and estuarine areas of the west coast of the United States by analyzing the body burden of contaminants in tissues of bivalves. Mussels or oysters and sediment samples were sampled annually at approximately 120 sites along the coastline of the United States, including Alaska and Hawaii, and analyzed for metals, pesticides, organotins, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons. In addition, tissues were examined histopathologically for indications of abnormal cells or cancer.

Historical Trends in the Accumulation of Chemicals in Puget Sound: Dr. Cullinan conducted the data analysis and coauthored the report for the US Dept of Commerce, National Oceanic and Atmospheric Administration. This project involved the evaluating chemical trends from six age-dated sediment cores collected from the main basin of Puget Sound. Sedimentation rates and deposition rates were estimated using a steady-state ^{210}Pb dating technique. Recovery of contaminants was also evaluated.

Selected Publications:

Crecelius, EA, and VI Cullinan. 2000. "Development of a Metals Data Analysis Method for District-wide Assessment of Sediment Contamination." PNWD-3067. Prepared for the St John's River Water Management District, Florida, by Battelle Marine Sciences Laboratory, Sequim, Washington.

Geist DR, CS Abernethy, SL Blanton, and VI Cullinan. 2000. "The use of electromyogram telemetry to estimate energy expenditure of adult fall chinook salmon." *Transactions of the American Fisheries Society*. 129(1):126-135.

Cullinan, V.I., L.F. Lefkovitz, and E.A. Crecelius. (In process). "The Impact of Environmental Regulation on Contamination in Puget Sound." *Environmental Science and Technology*.

USEPA (U.S. Environmental Protection Agency). 1998. *Method for Assessing the Chronic Toxicity of Sediment-Associated Contaminants with Leptocheirus plumulosus. First Edition, Draft.* PNNL-26566. EPA 600/XXX/XXX. Prepared for U.S. Environmental Protection Agency, Office of Research and Development, Duluth, Minnesota, by Pacific Northwest National Laboratory, Richland, Washington; Battelle Marine Sciences Laboratory, Sequim, Washington. Contributing authors LD Antrim, VI Cullinan, MR Pinza, BD Gruendell, LA Niewolny.

DeWitt, T.H., M.R. Pinza, and L.A. Niewolny, V.I. Cullinan, and B.D. Gruendell. 1997. *Development and Evaluation of a Standard Marine/Estuarine Chronic Sediment Toxicity Test Method Using Leptocheirus plumulosus*. PNNL-11768. Prepared for the U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, D. C., by Battelle Marine Sciences Laboratory, Sequim, Washington; Pacific Northwest National Laboratory, Richland, Washington.

Niewolny, L.A., V.I. Cullinan, and J.A. Ward. 1997. *Evaluation of Dredged Material Proposed for Ocean Disposal from Kennebunk River, Maine.* PNWD-2388. Prepared for the U.S. Army Corps of Engineers, New England Division, by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; and Battelle Ocean Sciences Laboratory, Duxbury, Massachusetts.

Ward, J.A., L.A. Niewolny, and V.I. Cullinan. 1997. *Ecological Evaluation of Proposed Dredged Material from the Charleston Harbor Entrance Channel, Charleston, South Carolina.* PNWD-2389. May, 1997. Prepared for Gulf Engineers & Consultants by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington.

Ward, J.A., L.A. Niewolny, and V.I. Cullinan. 1997. *Evaluation of Dredged Material Proposed for Ocean Disposal from Union River, Maine.* PNWD-2403. Prepared for the U.S. Army Corps of Engineers, New England Division, by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; and Battelle Ocean Sciences Laboratory, Duxbury, Massachusetts.

SAMPLE ANALYSIS TASK LEADER

Deirdre Dahlen **Battelle Duxbury**

Research Scientist

Education:

B.S. Bates College, 1987

Qualifications:

Ms. Dahlen has over 13 years of professional experience in the field of environmental chemistry and specializes in the analysis of environmental samples for trace organic contaminants. Since joining Battelle, Ms. Dahlen has managed a variety of monitoring studies involving both terrestrial and aquatic environments. She also has extensive experience with development and implementation of quality control programs for laboratory studies and oversight of methods development studies. Currently Ms. Dahlen is managing chemistry tasks related to Battelle's contract with the U.S. Army Corps of Engineers/New England District. She has also acts as a project manager/analytical task leader for a variety of government (EPA, Navy) and industrial monitoring programs. In this role, Ms. Dahlen coordinates field efforts, oversees conduct of chemical analyses, monitors data quality, interprets sample results, oversees subcontractor activities and prepares final reports.

Professional Positions:

Chemistry Laboratory Manager, 1995. While at Battelle, Ms. Dahlen completed a one-year assignment as manager of the chemistry laboratory. She scheduled all analytical work, directly oversaw 17 technical staff, and was ultimately responsible for the quality of data generated in the chemistry facility.

Chemistry Laboratory Supervisor, 1992-1995. Prior to managing the chemistry laboratory, Ms. Dahlen served as the supervisor of the chemistry sample preparation laboratory. She was responsible for scheduling all analytical work in the sample preparation laboratory and directly oversaw 8 technical staff. Ms Dahlen was also responsible for development and implementation of quality control and technical training programs.

GC/MS Analyst, 1988-1992. Ms. Dahlen was responsible the analysis of marine tissues, sediments, soils, dredged material, ocean water, wastewater and sludges for a variety of environmental contaminants including polynuclear aromatic hydrocarbons, linear alkyl benzenes and petroleum biomarkers.

Chemistry Laboratory Technician, 1987-1988. Ms. Dahlen was responsible for the preparation (extraction, cleanup) of environmental samples for trace organic analysis.

Relevant Experience:

Project Manager, for U.S. Army Corps of Engineers/New England District Delivery Order #41, Cochato River Sampling and Analysis. Sediment and fish samples were collected at five locations along the Cochato River in Holbrook, MA and near the former superfund site of Baird & McGuire. The objectives of this study were to 1) collect and analyze sediment and fish tissue samples for chemical analyses, 2) evaluate the spatial distribution of contaminants in the study area, 3) evaluate the correspondence within bulk sediment properties and against contaminants, 4) evaluate the temporal response of contaminants in sediment and fish, and 5) evaluate the temporal response of physiological conditions in fish. Prior to sampling activities, a project quality assurance project plan (QAPP) was prepared following Region 1, EPA-New England Compendium of Quality Assurance Project Plan Guidelines. Sediment samples were analyzed for grain size, TOC, metals, VOAs, chlorinated pesticides and PAH. Fish samples (whole body, fillet, offal) were analyzed for pesticides and PAH. Reconstructed whole body concentrations of organic contaminants were also determined from fillet and offal results. Data and interpretive reports were prepared to address the study objectives listed above.

Project Manager, for WA 2-51. Shellfish samples collected from Raritan Bay, NJ were analyzed for organic and metals contaminants in support of a human health assessment study. Shellfish samples were prepared in the laboratory and analyzed for 107 PCB congeners, PAH and metals. PCB data were evaluated to determine the distribution of PCB congeners by chlorination level. PCB distribution patterns were also examined to determine resemblance to known Aroclor patterns. The distribution of PAHs was examined to identify dominant PAHs detected in the shellfish samples. Analytical data were used by EPA and NJ DEP to determine whether a human health threat still exists from consumption of shellfish in the Rartan and Sandy Hook Bay areas.

Task Leader, Analytical Chemistry, for WA 133. Sediment and resident polychaete species were collected within the New York Bight Dredged Material Disposal Site, or Mud Dump Site (MDS) and historic disposal areas adjacent to the MDS. Sediment and tissue samples were prepared in the laboratory and analyzed for chemical, physical, and biological parameters. Chemical parameters included PAH, Pesticides/PCBs, organotins, major and trace elements, AVS/SEM, and dioxin/furan analyses. Physical parameters included TOC and sediment grain-size analyses. Biological parameters included performance of acute toxicity tests on sediments using the amphipod *Ampelisca abdita* and benthic infauna abundance and composition.

The objectives of this study were to 1) characterize the sediments within the MDS and in the 16-square-mile area surrounding the site, 2) determine the areal extent of each sediment characteristic, 3) determine which sediments were degraded, nondegraded, or marginal, 4) review published literature and other historic studies of the MDS and environs and compare chemical and physical parameters where applicable, and 5) define background contaminant concentrations (body burden) in polychaete tissues and identify the relationship between contaminant concentrations in bulk sediment and concentrations in polyuchaete tissues at the Study Area.

Project Manager for OOC. The bioaccumulaton potential in marine organisms (fish, crustaceans, and bivalves) of selected inorganic and organic compounds associated with discharges of produced water in the marine environment were addressed in a long-term monitoring study within the Gulf of Mexico. Tissue and water samples were collected in three sampling events over a two-year period. After each sampling event, samples were shipped to the laboratory for tissue processing and sample analyses.

Tissue processing activities included sectioning, compositing, and aliquoting all tissue samples for analysis of selected volatile organic compounds (VOC), semivolatile organic compounds (SVOC), metals, and radiochemical compounds by Battelle and other laboratories. Sample analysis activities included the preparation of water and tissue samples for target VOCs and SVOCs.

Standard EPA methodologies were not available for the analysis of VOCs in tissue by purge and trap GC/MS. A literature search was performed and method validation studies carried out to develop and optimize the purge and trap GC/MS method. Standard EPA methodologies were not available for the extraction, cleanup, and analysis of target SVOCs (phenol and bis(2-ethylhexylphthalate) in tissue. As was the case with the VOC method, Battelle performed literature searches and devised method validation studies to optimize sample extraction and cleanup methods for this study.

Task Leader, Analytical Chemistry, for environmental assessment for the *Exxon Valdez* oil spill. Working for Exxon USA, was a team member of the first group to immediately study the spill. Responsible for laboratory analysis of sediment, water, and tarball samples for petroleum product identification. Used sensitive analytical techniques, including triterpane and sterane biomarker measurement, to determine the distinct signature in samples and representative petroleum products including North Slope Crude Oil.

Task Manager, Analytical Chemistry, for the U.S. Army Corps of Engineers dredge material disposal study in San Francisco Bay; New York Harbor; Wilmington Bay, NC; Charleston Harbor, SC; and Panama City, FL. Working with Battelle team to implement USEPA/USACE "Green Book" dredge material testing, has been responsible for analysis of over 1000 water, sediment and marine tissue samples for polynuclear aromatic hydrocarbons, pesticides/PCBs and TBT compounds. Directed chemical analyses, quality control, and electronic reporting.

Additional Training and Licenses:

- Hewlett-Packard Training: 1) Fundamentals of Gas Chromatography, 2) RTE-A GC/MS Operation, 3) Advanced RTE-A Operation, 4) RTE-A Procedural Files (macro writing)
- Environmental Applications of GC/MS, Indiana University

Publications:

Douglas, G.S., K.J. McCarthy, D.T. Dahlen, J.A. Seavey, W.G. Steinhauer, R.C. Prince, and D.L. Elmendorf. 1992. The Use of Hydrocarbon Analysis for Environmental Assessment and Remediation. *J. Soil Contamination.* 1(2): 197-216. Also in *Contaminated Soils.* (Calabrese, E.J. and Kostecki, P.T., Eds.) Chelsea, MI, Lewis Publishers, Chapter 1. pp. 1-21.

Douglas, G.S., K.J. McCarthy, D.T. Dahlen, J.A. Seavey, W.G. Steinhauer, R.C. Prince, and D.L. Elmendorf. 1991. "Hydrocarbon Fingerprinting Analysis – Fact or Fiction." In: Proceedings of the Conference on Hydrocarbon Contaminated Soils: Analysis, Fate, Environmental and Public Health Effects, University of Massachusetts, Amherst. September 1991.

Douglas, G.S., K.J. McCarthy, D.T. Dahlen, J.A. Seavey, and E.L. Butler. 1991. "Fingerprinting Petroleum Hydrocarbons in Water." Invited paper presented at the 14th Annual EPA Conference on Analysis of Pollutants in the Environment, Norfolk, VA. May 1991.

Superfund Records Center
SITE:
BREAK:
OTHER:

Peven, C.S., W.G. Steinhauer, L.M. Altshul, D.T. Dahlen, J.A. Seavey. 1990. Polycyclic Aromatic Hydrocarbons in Shellfish, Overview of the 1989 Mussel Watch Field Season (Abstract). *J. Shellfish.* 8:487.

Wenzel, T.J., L.M. Collette, D.T. Dahlen, S.M. Hendrickson, and L.W. Yarmaloff. 1988. "Liquid Chromatographic and Flow Injection Analysis of Tetracycline Using Sensitized Europium (III) Luminescence Detection." *J. Chromat.* 433:149-158.

Presentations:

Society of Environmental Toxicology and Chemistry (SETAC). 1995. *Petroleum-Specific Analytical and Interpretive Techniques for Product Identification and Source Allocation*

SETAC. 1994. *Ultratrace Analysis of Organic Contaminants in Sediments, Water, and Tissues from Marine Superfund Site*

Dahlen, D., Lefkovitz, L, Hunt, C. 2000. *Sediment Contaminant Monitoring in Massachusetts and Cape Cod Bays*. In Trulli, H.R., Coniaris, C., Carroll, S.R. (Eds.). Outfall Monitoring Science Advisory Panel Technical Workshop 1999 [compact disc]. Boston: Massachusetts Water Resources Authority. Report ENQUAD ms-57.

QC MANAGER

Charles Davis **Applied Marine Sciences, Inc.**

Senior Geotechnical Engineer/Quality Assurance Manager

Education:

B.S.Civil Engineering, Texas A&M University, 1984

Relevant Experience:

Senior Geotechnical Engineer/Quality Assurance Manager, providing technical guidance for geotechnical services. Responsibilities include quality control management and monitoring, business development, project management, and marketing.

Chief Engineer responsible for all phases of railroad and highway bridge projects ranging from $25,000 to over $10 million. Personally managed over 30 successful projects and provided engineering input for over 70 additional projects. Annual gross profits of projects personally responsible for has been approximately $3 million.

Mainspan Project Engineer. Supervised quality assurance inspections during construction of the Houston Ship Channel Bridge. Responsibilities included supervision and direction of five field engineers, daily liaison with bridge design consultant, resolution of daily construction problems, and coordination of stay cable qualification testing program.

Field Construction Engineer Responsibilities include quality assurance inspection of cable-stayed mainspan unit. Specific duties included pylon construction, large segment casting, post-tension tendon installation and mainspan stay cable installation and grouting.

Professional Affiliations:

Registered Professional Engineer in the states of Texas, Alabama, and South Carolina.

GRAIN SIZE AND TOC TASK LEADER

Kenneth S. Davis **Applied Sciences, Inc.**

President/Project Manager

Education:

M.S. Oceanography, Texas A&M University, 1992
B.S. Marine Sciences, Texas A&M University, 1987

Qualifications:

Mr. Davis has over 12 years experience throughout the United States and abroad on studies and projects related to dredged material characterization, natural resource damage assessments, environmental monitoring, environmental assessments, geotechnical investigations, and contaminant transport. Mr. Davis is experienced in collecting environmental samples and field data, and the proper handling and testing of marine, estuarine and terrestrial samples for geotechnical parameters.

Mr. Davis is responsible for the direct technical and financial performance of Applied Marine Sciences, Inc. His management responsibilities include developing business plans and budgets, staffing, preparing proposals, evaluating staff performance, reviewing reports, and providing direction and assistance on technical assignments.

Mr. Davis is a member of the Western Dredging Association and the Society of Environmental Toxicology and Chemistry. Mr. Davis has authored or co-authored over 16 publications on marine geotechnical, geophysical and geochemical-related topics.

Relevant Experience:

Dredged Material Testing
Project Manager, U.S. Army Corps of Engineers, New England District contract to Battelle Ocean Sciences. Conducted several laboratory investigations to evaluate the geotechnical characteristics of sediments from numerous sites within the District. Samples were evaluated following the 1991 USEPA/USACE guidance manual "Evaluation of Dredged Material Proposed for Ocean Disposal-Testing Manual" and the 1989 USACE New England District guidance manual "Guidance for Performing Tests on Dredged Material to be Disposed of in Open Waters".

Project Manager, U.S. Army Corps of Engineers, Waterways Experiment Station contract to SAIC.. Conducted laboratory investigation to evaluate the geotechnical characteristics of maintenance dredge material for placement in confined aquatic disposal (CAD) cells.

Project Manager, New York Federal Dredging Projects, *U. S. Army Corps of Engineers, New York District contract to Battelle Ocean Sciences.* Conducted several laboratory investigations to evaluate the geotechnical characteristics of sediments from numerous harbors within the District. Samples were evaluated following the 1991 USEPA/USACE guidance manual "Evaluation of Dredged Material

Proposed for Ocean Disposal-Testing Manual" and the 1992 USEPA Region II/CENAN Regional Implementation Manual.

Project Manager, Dredged Material Management Plan Phase 2 Stage 1, *Massachusetts Office of Coastal Zone Management contract to Maguire Group, Inc.* Provided physical characterization of sediment samples from Salem, Gloucester, Fall River, and New Bedford Harbors in support of Environmental Impact Reports for the siting of disposal sites which will contain contaminated dredged material from each harbor.

Natural Resource Damage Assessments
Project Manager Duwamish River Sediment Study, NOAA Damage Assessment Center Northwest contract to Industrial Economics, Inc. Provided physical characterization of sediment samples in support of a project designed to identify the extent of PCB contamination in sediments of the Duwamish River, WA.

Project Manager, Southern California Damage Assessment Program. NOAA Damage Assessment Center contract to Industrial Economics, Inc. and Arthur D. Little, Inc. Provided physical characterization of sediment samples in support of a project designed to identify the extent of DDT and PCB contamination in continental shelf sediments near a sewer outfall located offshore Los Angeles, CA.

Project Manager, North Cape Barge Oil Spill, Rhode Island. NOAA Office of Resource Conservation and Assessment. Provided physical characterization of sediment samples in support of a damage assessment of a fuel oil spill on the beaches and salt ponds of southern Rhode Island.

Environmental Monitoring
Project Manager, Harbor and Outfall Monitoring Program, Boston Harbor, MA. Massachusetts Water Resource Authority contract to Battelle Ocean Sciences. Provide geochemical testing of sediment samples from sites within Boston Harbor and Massachusetts Bay.

Project Manager, Assessing Point-Source Discharges, Sakhalin Islands, Russia. Consortium of Major Oil Companies contract to Arthur D. Little, Inc. Provided physical characterization of sediment samples in support of a study designed to identify and characterize point-source effluent discharges from petroleum platforms off the Sakhalin Islands, Russia.

Environmental Assessments
Environmental Scientist Release Delineations, Houston, Texas. Exxon Company contract to Applied Earth Sciences, Inc. Conducted field investigations at 40 UST sites to determine if hydrocarbons were present in the subsurface soil. Supervised the drilling of ca. 200 soil borings. Collected ca. 600 soil samples for chemical and geotechnical analysis.

Environmental Scientist, Risk-Based Assessments, Houston, Texas. Exxon Company contract to Applied Earth Sciences, Inc. Conducted field investigations at contaminated UST sites to delineate the vertical and horizontal extent of petroleum contamination in the soil and to delineate the extent of dissolved hydrocarbons and/or free product in the ground water. Supervised the drilling of ca. 200 soil borings and the installation of ca. 75 ground water monitoring wells, resulting in the collection of over 825 soil, water, and free product samples.

Graduate Research Assistant. Mississippi-Alabama Marine Ecosystem Study. Minerals Management Service contract to Texas A&M University. Participated in a multi-disciplinary characterization of the Mississippi-Alabama outer continental shelf. Interpreted and mapped high-resolution geophysical data, provided geotechnical and acoustical analysis of sediment cores, integrated geophysical and geological data to develop conceptual model for deltaic sedimentation on the Mississippi-Alabama outer continental shelf.

Marine Geotechnical Investigations
Research Associate., Coastal Benthic Boundary Layer Program, Baltic Sea. Naval Research Laboratory contract to Texas A&M University. Conducted sediment coring, grab sampling, and diving operations of the seafloor in Eckernfoerde Bay, Baltic Sea, Germany. Provided acoustic and geotechnical measurements of sediment cores.

Research Associate, Coastal Benthic Boundary Layer Program, Florida Keys. Naval Research Laboratory contract to Texas A&M University. Conducted sediment coring, grab sampling, and diving operations of the seafloor in the Dry Tortugas Region, Florida. Provided acoustic and geotechnical measurements of sediment cores.

Research Associate, Coastal Benthic Boundary Layer Program, Panama City, Florida. Naval Research Laboratory contract to Texas A&M University. Conducted sediment coring, grab sampling, diving operations, sub bottom profiling of the seafloor near Panama City, Florida. Provided acoustic and geotechnical measurements of sediment cores, analysis and interpretation of geotechnical and geophysical data.

Shipboard Geologist, Chesapeake Bay Bridge-Tunnel Survey, Norfolk, Virginia. Alpine Ocean Seismic Surveys, Inc. Conducted side-scan sonar and high-resolution sub bottom profiling along the proposed corridor for the new bridge-tunnel across the mouth of Chesapeake Bay. Collected 20-foot vibracores from potential borrow sites for geotechnical analysis.

Contaminant Transport
Project Manager, Drilling Mud Assessment, U.S. Virgin Islands. Major Telecommunications Company contract to Arthur D. Little, Inc. Provided physical characterization services in support of a study designed to determine the potential impact of a drilling mud and hydraulic oil release in an aquatic setting.

Project Manager, Remington Gun Club, Connecticut. Dupont Remediation Services contract to Battelle Ocean Sciences. Provided physical characterization to identify the horizontal and vertical extent of lead shot in a saltwater marsh to support the design a remedial action plan.

Professional Affiliations:

- Society of Environmental Toxicology and Chemistry (SETAC)
- Western Dredging Association (WEDA)

Publications:

Sager, W.W., Schroeder, W.W., Davis, K.S., and Rezak, R., 1999. A Tale of Two Deltas: Seismic Mapping of Near Surface Sediments on the Mississippi-Alabama Outer Shelf and Implications for Recent Sea Level Fluctuations. Marine Geology, v. 160, p. 119-136.

Davis, K.S., Slowey, N.C., Stender, I.H., Fiedler, H., Bryant, W.R., and Fiechner, G., 1996. Correlating Acoustic Backscatter with Sediment Textural Properties of Inner Shelf Sands, Northeastern Gulf of Mexico. Geo-Marine Letters, v. 16.

Bryant, W.R., Orsi, T.H., Slowey, N.C., and Davis, K.S., 1996. Processes of Macroscale Volume Inhomogeneity in the Benthic Boundary Layer, Eckernfoerde Bay, Western Baltic Sea. Geo-Marine Letters, v. 16.

Sager, W.W., Schroeder, W.W., Laswell, J.S., Davis, K.S., Rezak, R., and Gittings, S.R., 1992. Mississippi-Alabama Outer Continental Shelf Topographic Features Formed During the Late Pleistocene-Holocene Transgression. Geo-Marine Letters, v. 12, p. 41-48.

Laswell, J.S., Sager, W.W., Schroeder, W.W., Davis, K.S., and Rezak, R., 1991. High-Resolution Geophysical Mapping of the Mississippi-Alabama Outer Continental Shelf. CRC Handbook of Geophysical Exploration at Sea, v.2. R. Geyer (editor).

Laswell, J.S., Sager, W.W., Schroeder, W.W., Rezak, R., Davis, K.S., and Garrison, E.R., 1990. Mississippi-Alabama Marine Ecosystem Study: Atlas of High-Resolution Geophysical Data. MMS/OCS 90-0045. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA, 42 pp.

Uhler, A.D., Coogan, T.H., Davis, K.S., Durell, G.S., Steinhauer, W.G., Freitas, S.Y., and Boehm, P.D., 1989. Findings of Tributyltin, Dibutyltin, and Monobutyltin in Bivalves From Selected U.S. Coastal Waters. Environmental Toxicology and Chemistry, v. 8, p. 971-979.

Abstracts:

Slowey, N.C., Bryant, W.R., Davis, K.S., Lambert, D., and Walters, D., 1995. Geoacoustic Stratigraphy of the Marquesas Keys. Society of Sedimentary Petrology, St. Petersburg, Florida.

Orsi, T.H., Anderson, A.L., Bryant, W.R., Davis, K.S., Rezak, R., Fischer, K.M., and Brunner, C., 1995. Computed Tomography of Macroscale Heterogeneity of Carbonate Muds, Marquesas Keys and Dry Tortugas, South Florida. Society of Sedimentary Petrology, St. Petersburg, Florida.

Davis, K.S., Bryant, W.R., Slowey, N.C., and Lambert, D., 1994. Reflections on the Geoacoustic and Geotechnical Characteristics of Eckernfoerde Bay Sediments. Forschungsanstalt der Bundeswehr fur Wasserschall und Geophysik (FWG), Gassy Mud Workshop, Abstract Volume, Kiel, Germany.

Sager, W.W., Schroeder, W.W., Laswell, J.S., and Davis, K.S., 1991. Topographic and Sedimentary Features of the Mississippi-Alabama Outer Continental Shelf and Their Implications for Sea Level Fluctuations During the Late Pleistocene-Holocene Transgression. Geodynamics Research Institute Symposium, Texas A&M University, Abstract Volume p. 42.

Technical Reports:

Orsi, T.H., Anderson, A.L., Fischer, K.M., Davis, K.S., and Bryant, W.R., 1995. Computed Tomography and Geoacoustic Property Measurements of Carbonate Muds from Marquesas Keys and Dry Tortugas, South Florida. Naval Research Laboratory Technical Report.

Stender, I.H., Fiedler, H.M., Davis, K.S., and Fechner, G., 1995. Surveying a Sandy Seafloor off Panama City, Florida, Gulf of Mexico, with Bottom Samples and Side Scan Sonar. Forschungsanstalt der Bundeswehr fur Wasserschall und Geophysik (FWG), FWG-Report 20, Kiel, Germany.

Rezak, R., Davis, K.S., and Schroeder, W.W., 1991. Sediment Analyses, in J.M. Brooks, ed., Mississippi-Alabama Marine Ecosystem Study: Data Summary and Synthesis. Volume II: Technical Narrative. OCS Study MMS 91-0063. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Regional Office, New Orleans, LA, 862 pp.

Rezak, R., Davis, K.S., and Schroeder, W.W., 1990. Sediment Analyses, in J.M. Brooks and C.P.Giammona, eds., Mississippi-Alabama Marine Ecosystem Study, Year 3. Volume II: Technical Narrative. OCS Study MMS 90-0095. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Regional Office, New Orleans, LA

Rezak, R., Davis, K.S., and Schroeder, W.W., 1989. Sediment Analyses, in J.M. Brooks and C.P. Giammona, eds., Mississippi-Alabama Marine Ecosystem Study, Year 2. Volume II: Technical Narrative. OCS Study MMS 89-0095. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Regional Office, New Orleans, LA, 348 pp.

FACILITIES ENGINEER

Gary Dennis **Battelle MSL**

Science and Engineering Associate III

Education:

Washington State University, 1990-1992
AA Columbia Basin College, Pasco, WA. 1989
Olympic College, Bremerton, WA. 1978
University of Guam, Agana, 1975-1976

Qualifications:

Mr. Gary Dennis has been employed with Battelle since 1980 and has served as a Science and Engineering Associate III, Technical Support Specialist II, and Laboratory Equipment Specialist. He has worked primarily in the departments of Atmospheric Sciences and Property Management and Accounting. Mr. Dennis currently serves as the Manager of the Marine Sciences Laboratory (MSL) Wet Laboratory small job center, which supports a variety of freshwater and marine ecotoxicological studies. During his more than 20 years with Battelle, Mr. Dennis has been involved in all phases of laboratory management, including logistical planning, cost accounting, system design, program coordination and test scheduling, supervisory management, and public outreach. He has also had full responsibilities of facility operations, including property oversight, equipment procurement, chemical and supply inventory, hazardous waste disposal, computer control and data acquisition systems, and equipment calibration. Project management duties have involved development of instrumentation and operating procedures, conduct of experiments, data collection and analysis, and report writing. Mr. Dennis recently remodeled and modernized the MSL toxicology wet laboratory. Mr. Dennis comes to Battelle with a strong background in electrical and mechanical applications and served over 8 years with the U.S. Navy where, as leading Petty Officer, he supervised 20 personnel at the time of discharge. Mr. Dennis is pursuing continued education and is near completion of a degree in Business through Washington State University.

Relevant Experience:

Knowledge of the Marine Sciences Laboratory Wet Laboratory System – Mr. Dennis completely redesigned and installed delivery systems for raw seawater, heated seawater, and filtered sea water. The former head tank system allowed support of 12 toxicity test tables; by installing new head tanks and temperature control systems and by reconfiguring the design setup, he increased this capability to 16 tables, which could feasibly increase testing capabilities of up to 30% running at full capacity. In addition, the redesign provides four temperature ranges, versus two with the old system. The new temperature controller, which has the capabilities to be networked to a central computer system, replaces an inefficient system based on controlling heated seawater. Mr. Dennis designed the new temperature system to control the cold water, both raw and filtered, depending on need. This new system has already shown over a 3-month period an operating efficiency of the boiler system seven times greater than the previous method. Although figures for resulting propane cost savings have not yet been determined, Mr. Dennis hopes costs will be reduced by 30% to 50% of the current $8 K expenditure, pending results of

similar upgrades planned for other sections of the wet laboratory later this year. By far, the greatest impact of this new system lies in increased reliability and safety and a decrease in required maintenance. Mr. Dennis immediately identified several potential safety issues with the old system. Old piping that crossed over light fixtures was replaced with heavier grade piping that was routed away from any light or electrical fixtures. The heated seawater piping, which was of incorrect grade, was replaced with the correct grade to match the F&O system. In addition, the old system had no way of flushing raw seawater lines; this has been corrected and lines are now being flushed monthly at the tank. In addition, Mr. Dennis upgraded the air line system to comply with OSHA standards.

Facility Management /Equipment Oversight – Mr. Dennis has experience in all aspects of facility management through his managerial roles in both the Aerosol Wind Tunnel and Laboratory Equipment Pool small job centers. Duties have included equipment procurement, cost accounting, staff supervision, project scheduling, equipment calibration and maintenance, and keeping accurate records of supply inventories, maintenance, quality assurance, and calibration. He also has had experience of researching and purchasing supplies for maintenance shops and other related facilities while with the U.S. Navy.

Environmental Safety & Health – Mr. Dennis has directly addressed ES&H issues at the toxicity testing wet laboratory at the MSL. His modifications to the existing system significantly reduced potential hazards as well as costs. Attention to safety and health issues was an important aspect of Mr. Dennis' role in managing the Aerosol Wind Tunnel small job center in Richland, Washington. He gained experience for these responsibilities while serving as Lab Monitor for this facility, at which time he was responsible for chemical inventory, disposal of hazardous waste, sealed source custodian, and ES&H compliance. Mr. Dennis also served 4 years as Atmospheric Sciences Department Custodian for nuclear materials, hazardous chemicals, property, vehicles, and light equipment. His responsibilities involved tracking, disposal, cost accounting, and ensuring equipment was in safe, operational condition.

Mary Ann Deuth **Battelle MSL**

Science and Engineering Associate

Education:

B.S. Colorado State University, Applied Chemistry, 1969
M.A. University of Northern Colorado, Elementary Education, 1977

Relevant Experience:

As a technical specialist, Ms. Deuth is responsible for ongoing analyses for trace amounts of mercury in tissue, sediment, and water. She is proficient with the TSP mercury analyzer, EPA method 245, and has learned to repair the system since there is no maintenance support. She has seven years of experience with cold vapor atomic fluorescence and atomic absorption analysis, specifically in EPA methods 1631 and 1630.

Experienced with computers and software including; word processing, data base management, and spreadsheet software, PC Tools, Norton Commander and DOS. Experienced in troubleshooting PCs, teaching software to new users, and solving software problems.

Senior research technician for metabolic and soils laboratories at Colorado State University. Responsible for animal care, sampling, and the calculation of results after chemical analysis using the Kjeldahl apparatus, bomb calorimeter, spectrometers, and analytic balance. Headed a research project on cat nutrition for General Foods. Other responsibilities involved teaching graduate students chemical procedures and assisting them with their research projects. In the soils lab, Ms. Deuth maintained routine soils analysis under deadlines using atomic absorption, UV spectrometry and, titration analysis.

Supervisory skill in managing a laboratory, preparing chemicals, recording data, scheduling workers, ordering supplies and keeping equipment in working order.

Laboratory technician in Sanatorium Taubertal, a hospital in Bad Mergentheim, West Germany, doing routine medical procedures in blood chemistry, urinalysis, electrophoresis and spectrometry.

ELS PROJECT MANAGER

Heida Diefenderfer **Battelle MSL**

Research Scientist

Education:

M.A. Western Washington University, English, 1999.
B.A. The Evergreen State College, Liberal Arts, 1997.
B.A. Reed College, Biology (minor: Cognitive Science), 1991.

Qualifications:

Ms. Diefenderfer is a project manager with the Ecotoxicology and Risk Assessment technical group at the Battelle Marine Sciences Laboratory (MSL). Since joining Battelle in 2000, she has also become an MSL certified research diver. She has worked on programs involving landscape and ecosystem analysis, ecotoxicology and risk assessment, water quality monitoring, habitat characterization and mapping, and threatened and endangered species. She has contributed to bioassays of undersea drilling fluids and the evaluation of bioaccumulation data on Navy installations. Projects have included collecting data on regional fisheries, stream habitats, bioaccumulation tests, and forest ecosystems including field collection and cataloguing of numerous species. Ms. Diefenderfer has created maps of Pacific Northwest watersheds; served as an editor, writer and speaker on various topics in ecology; and taught English and marine biology at the college level. She has received additional training through the National Park Service, Washington Department of Fish and Wildlife, USDA Forestry Sciences Laboratory, Andrews Ecosystem Research Group, and other organizations.

Relevant Experience:

Soil, sediment, and surface water sampling and analysis. Ms. Diefenderfer is currently developing a sampling and analysis plan for soil, sediment and surface water on 420 acres of diked agricultural land near the mouth of the Willapa River that is proposed for restoration to a tidal wetland. Her report on the results of analyses for nutrients, coliform bacteria and pesticides will identify areas of concern and target areas for remediation if necessary.

Modeling the effects of acid deposition on New York State water bodies. As project manager, Ms. Diefenderfer coordinated the development and delivery of the work plan, all interim deliverables, and the final CD report. She received the Pacific Northwest National Laboratory Environmental Technology Division Outstanding Performance Award. The EPA Office of Wetlands, Oceans, and Watersheds, Oceans and Coastal Protection Division contract coordinator asked that the work plan be used as a model for other future work plans under the contract. The CD brought together selected datasets, modeling systems, and literature, and demonstrated the application of a set of models with data-linked libraries to categorize waterbodies in the Adirondacks by susceptibility to acidification.

"The Links of Isolated Waters and Wetlands to Interstate or Foreign Commerce and to the Objectives of the Clean Water Act." Ms. Diefenderfer researched and wrote two parts of this report, prepared by Battelle for the EPA: "Ecosystem Functions: Biodiversity", and "Fish and Wildlife Functions:

Amphibian and Reptile Habitat". She addressed EPA comments throughout the draft. The report was used in a case before the U.S. Supreme Court.

Risk & uncertainty analysis. Ms. Diefenderfer researched and wrote the scope of work for development of a framework for U.S. Army Corps of Engineers (USACE) planners to analyze risk and uncertainty in environmental investments. Currently, she is developing the framework in the form of a report for the USACE Institute for Water Resources.

Biogeochemistry of forest soils. Ms. Diefenderfer investigated variation in properties of forest soil in relation to vegetational cover on transects she established on the H.J. Andrews Experimental Forest. She collected and analyzed soil cores and samples of evolved gases, the latter using a gas chromatograph; another researcher conducted understory mapping.

Water quality monitoring. At the Padilla Bay National Estuarine Research Reserve, Ms. Diefenderfer converted baseline water quality data from YSI datalogger instruments for transmission with metadata to a NOAA database, set up water quality monitoring station hardware and software, and conducted weekly water quality sampling in the field and lab.

Quality assurance program implementation and U.S. Navy accreditation support. Ms. Diefenderfer provides back up for the quality assurance officer in the areas of data review, report review, and the review and development of standard operating procedures, and serves as the QA officer delegate. She supported the QA office during the Navy accreditation process, and has conducted QA assessments of activities in the analytical chemistry laboratories and in Good Laboratory Practices toxicological studies for pesticide registration.

Oregon state forest mapping. Ms. Diefenderfer designed a method to convert the Oregon Department of Forestry timber inventory into maps distinguishing forest age/size classes, critical habitat for the marbled murrelet, and habitat features required by the northern spotted owl, salmonids, and other T&E species. She analyzed the database and produced 5 color maps of state forests and a technical report. The maps were used by the Forest Conservation Council, Oregon Department of Fish & Wildlife and USDI Fish & Wildlife Service.

Landscape ecological assessment. Ms. Diefenderfer assessed the forest cover, habitat qualities, and landscape context of a 4800-acre park using aerial photos. Her report analyzed changes in landscape context and plant/wildlife communities, and concluded with policy recommendations. It reviewed literature in ecosystem theory, landscape and restoration ecology, and the biological function of corridors between habitat patches. It was utilized by the City of Portland Bureau of Planning and several non-governmental organizations.

Stewardship planning. Ms. Diefenderfer assisted with biological and cultural research (field, literature, interview) and writing in development of a land-management plan for 820 acres of rangeland in ponderosa pine/juniper zones. She worked with the landowner to meet Oregon Department of Forestry stewardship regulations for water, timber, and other resources.

Watershed mapping. Researched, designed, and drafted 36-foot color map of Pacific coastal watersheds and temperate rainforest ecosystems from Yakutat Bay, AK to San Francisco Bay, CA, and wrote accompanying texts. Compiled data on temperate rainforest ecosystems (library research, interviews). *The Serpentine Lattice* installation toured internationally.

Field coordination. In support of the National Audubon Society Forest Ecosystem Reserve project, Ms. Diefenderfer coordinated the collection of data in western Oregon from non-governmental organizations, environmental impact statements and environmental assessments, and site visits in which she identified plant associations and other features. She wrote and illustrated 22 reports describing hydrologic, silvicultural, geologic, landscape, biological, and cultural features of stands from 320-29,600 acres in 6 National Forests.

Publications:

Borde AB, RM Thom, HL Diefenderfer, and SL Blanton. 2000. The links of isolated waters and wetlands to interstate or foreign commerce and to the objectives of the Clean Water Act - Section I Ecological Functions. Prepared for the US Environmental Protection Agency, Washington, DC.

Diefenderfer, HL. 1995. Oregon state forest mapping project: Summary materials. Forest Conservation Council, Portland, OR. 18pp.

Diefenderfer HL. 1992. Protecting a vanishing ecosystem: The ancient forests of the Pacific Northwest. Audubon Society of Portland, National Wildlife Federation, The Wilderness Society, and Oregon Natural Resources Council, Portland, OR. 1,095pp.

Diefenderfer HL. 1991. Isolation and connection in ecological theory and the design of nature reserves: A case study of Forest Park, Portland, OR. Thesis, Reed College Division of Mathematics and Natural Sciences, Portland, OR. 122pp.

Vail LW, EA Jenne, HL Diefenderfer, WR Barchet and LF Hibler. 2001. Assessment of pH-Impaired Lakes for TMDL Development in New York State. PNWD-SA-5234. CD report prepared for the US Environmental Protection Agency, Washington, DC.

---. 1992. Oregon Department of Forestry stewardship plan. Special Trees, Corvallis, Ore.

---. 1992. National Audubon Society adopt-a-forest project briefing book on ancient forests, western and central Oregon region: Willamette national forest. National Audubon Society/Forest Conservation Council, Eugene, OR.

---. 1992. Briefing book, protecting the ancient forests, section III: Necessary amendments to the scientific panel's options. National Audubon Society/Forest Conservation Council, Eugene, OR.

Timothy J. Fortman **Battelle MSL**

Technical Specialist

Education:

B.A. Southern Illinois University, Carbondale, IL, 1976

Qualifications:

Mr. Fortman has been at Battelle Marine Sciences Laboratory for 14 years and has participated in a variety of environmental pollution monitoring projects such as NOAA's status and trends, mussel watch projects, Exxon Oil Spill Herring study, EPA's Great Lakes assessment program, a variety of dredging programs for COE and many more. He has been involved in sampling on several projects. He also spent about a year and a half performing all aspects of trace metals analysis including sample preparation and operation of a Graphite furnace AA. Most of his time has been spent in the analysis of trace organic contaminants. The analyses performed are organotins by GC-FPD with confirmation by GC-MS, PAH's (including alkylated homologs) by GC-MS, saturates by GC-FID and GC-MS, chlorinated hydrocarbons (pesticides and PCB's) By GC-ECD using wither a dual column or GC-MS for confirmation; helped staff scientist develop method for separation of slightly toxic coplanar PCBs using HPLC with column; set up automated gel permeation chromatography system used as an advanced cleanup of organic environmental analyses, plus many more. He has attended various training courses including Capillary GC Operation (HP), GC-MS operation (HP), Interpretation of mass spectra (University of Indiana). He has trained and supervises several technicians.

Relevant Experience:

- Trace metal analysis of microlayer collected from the Puget Sound.
- Trace metal analysis for NOAA's Mussel Watch Project, with some sample collection.
- PAH analysis including alkylated homologs for Exxon.
- PAH and PCB by Congener analysis for EPA Great Lakes.
- TBT, PAH, PCB's and Pesticides for COE Dredging programs.

Publications:

Crecelius, E. A., T. J. Fortman, S. L. Kiesser, C. W. Apts, and O. A. Cotter. 1990. "Contaminant Loading to Puget Sound from Two Marinas." Puget Sound Notes, Winter 1990.

Crecelius, E. A., T. J. Fortman, S. L. Kiesser, C. W. Apts, and O. A. Cotter. 1990. Survey of Contaminants in Two Puget Sound Marinas. Prepared for U.S. Environmental Protection Agency, Region 10 Seattle, Washington. EPA 910/9-89-014.

Fortman, T. J., and E. A. Crecelius. 1989. "Tributyltin Concentrations in Sediments of Puget Sound Urban Bays, Non-Urban Bays, and Marinas." Presented at Oceans '89, Seattle, Washington, September 1989.

Strand, J. A., V. I. Cullinan, E. A. Crecelius, T. J. Fortman, R. J. Citterman, and M. L. Fleischmann. 1990. Monitoring of Olympic National Park Beaches to Determine Fate and Effects of Spilled Bunker C Fuel Oil. Prepared for U.S. Department of the Interior, Minerals Management Service. MMS 90-0061.

Mark Guilmain **Battelle Duxbury**

Quality Assurance Coordinator

Education:

Aquaculture Technology, Salem State College, 1998
Introduction to Business Management, University of Massachusetts, 1997
Marine Toxicology, University of Massachusetts Graduate Program, 1997
Biological Oceanic Processes, University of Massachusetts Graduate Program, 1996
Pollution Prevention, Tufts University Graduate Program, 1995
Site Remediation Technology, Tufts University Graduate Program, 1994
University of Massachusetts, BS Zoology, 1992

Qualifications:

Mr. Guilmain joined Battelle in May 2000 and brings a broad background of technical experience to his present position as Quality Assurance Coordinator. With 7 years' experience as an environmental chemist he was appointed Quality Assurance Officer for the Massachusetts Department of Environmental Protection, Division of Watershed Management. Mr. Guilmain joined Battelle's Quality Assurance Unit as the analytical laboratory Quality Assurance Coordinator.

As Quality Assurance Coordinator for Battelle, Mr. Guilmain is responsible for management of the Quality Assurance Unit analytical activities. Mr. Guilmain ensures implementation of the site Quality Management Plan at Battelle, and is responsible for maintaining state certifications for Battelle's analytical laboratory, for preparing and reviewing standard operating procedures, identifying and mitigating staff training, conducting laboratory inspections of both Battelle and subcontractor activities, and verifying reported data through data audits.

Mr. Guilmain coordinates, supervises, and participates in all QA activities associated with the collection of environmental data. He implements Battelle's requirement that all environmental data be audited by the Quality Assurance Unit and; therefore, has extensive experience in auditing analytical chemistry. He is cognizant of state and federal QA programs related to the collection and analysis of environmental data.

Professional Positions:

Quality Assurance Coordinator, Quality Assurance Unit, Battelle. 2000–present. Responsible for the management of the Quality Assurance Unit activities for the analytical chemistry laboratory, performing data audits, laboratory inspections, and review of analytical standard operating procedures.

Quality Assurance Officer, Massachusetts Department of Environmental Protection (DEP), Division of Watershed Protection. 1999–2000. Responsible for the development of the Quality Assurance Program at the DEP including environmental monitoring data validation, writing and reviewing field and laboratory standard operating procedures and providing technical support and review for the preparation of Quality Assurance Project Plans.

Environmental Chemist, Massachusetts Water Resource Authority. 1996–1999. Responsible for final validation and review of organic laboratory environmental data reports, for performing GC/MS low level method development, for tracking trends in environmental data and implementing strategies to correct deviations, for writing and reviewing laboratory standard operating procedures and statistical spreadsheets, and for training staff on data reporting and GC/MS maintenance/analysis procedures.

Environmental Analyst ,Camp Dresser & McKee Engineering. 1992–1996. Analysis and method development of drinking water and wastewater by GC/MS using EPA Methods 625, 8270 and 500 series. Compiling and entering environmental laboratory data into LIMS database for review. Training staff on data reporting and GC/MS maintenance/analysis procedures.

Relevant Experience:

As *Quality Assurance Coordinator* Mr. Guilmain maintains the Quality Assurance Manual that describes the analytical laboratory's procedures and quality control requirements, and he is responsible for maintaining the laboratory's State certifications.

Project QA Officer – In addition to the planning and inspection phases of each project, a major role of the QA Office at Battelle is the verification that all reported data are accurate, traceable, and collected according to the project QA plan and associated SOPs. Mr. Guilmain coordinates and participates in this essential activity. His expertise ranges from the audit of analytical chemistry data, to verification of data contained in database systems. He functions as the QA Officer for several projects and is the lead auditor for many.

Project QA Officer – Mr. Guilmain has experience in support of extrinsic inspections conducted at Battelle. He coordinates preparation, assists laboratory personnel in corrective actions to audit findings, and prepares written reports of findings to management. Recent field sampling and analytical laboratory inspections include an EPA Oceans and Coastal Protection Division *Enterococcus* beach monitoring study.

Project QA Officer for the EPA National Fish Study – Mr. Guilmain is responsible for managing and coordinating all project QA activities. Specific responsibilities include: reviewing and approving the Quality Assurance Project Plan (QAPP) and updating it as needed, verifying that project activities are conducted according to the QAPP and administering a laboratory training program for both QA and technical staff to ensure the QAPP requirements are understood and implemented. In addition, he is responsible for ensuring project audits and inspections are conducted, participating in or coordinating client on-site inspections and audits and preparing periodic status reports of QA activities and audit results for the Battelle Operations Manager.

Jonathan Wayne Haupt **Severn Trent Laboratories**

Organic Extractions Group Leader

Education:

Goucher College, Baltimore, Maryland
B.A. Chemistry, 1998

Qualifications:

Mr. Haupt is currently the Group Leader for our Organic Extractions section with two years of environmental chemistry experience. His duties include management of all SW-846 and CLP organic extraction operations including scheduling daily assignments and oversight of training for eight laboratory technicians. In addition, Mr. Haupt has extensive experience with the Laboratory Information Management System (LIMS) along with the operation and maintenance of two Gel Permiation Chromatographs (GPC) and Gas Chromatograph (GC-ECD). Furthermore, Mr. Haupt prepares organic standards in guidance with Quality Control / Quality Assurance specifications.

Relevant Experience:

Laboratory – Currently responsible for the daily operations of the Organic Extractions section. Prior experience includes organic extraction preparation involving clean-up procedures for organic contaminants from soil, sludge, liquid, oil, and tissue in accordance with AFCEE, USACE and RMA protocols.

Field – Prepared professional documents and tables for publication of a hydrogeologic water and sediment study for a freshwater tidal wetland in Aberdeen, Maryland. Assisted in stream gauging, water quality sampling, low-flow water quality analysis, field parameter determinations (pH, specific gravity and alkalinity) and fish sampling.

Computer – Tested and prepared documentation of Ingress databases. Developed user database test plans for NASA, used UNIX programs and created HTML documents. Highly skilled with PC and MAC platforms.

SENIOR TOXICOLOGIST

Rhonda Karls **Battelle MSL**

Science and Engineering Associate III

Education:

A.A.S. Fisheries Technology Program, Peninsula College, 1991
Forest Harvesting & Rehab. Program, Edmonds Community College, 1979

Qualifications:

Ms. Karls has been with Battelle since 1990. She is the Laboratory Lead for a variety of ecotoxicological bioassays. Ms. Karls oversees bioaccumulation, chronic, and acute toxicity tests using a variety of marine and freshwater animals and intermittent, static, static renewal, and flow-through systems. Her responsibilities include preparation of the laboratory for testing, animal care and maintenance of test organisms, testing, maintaining water quality instruments, ordering supplies, collecting marine animals in the field, and compositing sample sediments for chemical evaluation.

Relevant Experience:

USACE New York/New Jersey: Participated in field sampling efforts, core processing, laboratory setup, test initiation, monitoring, reference toxicant testing, and termination of sediment toxicity tests using the amphipod *Ampelisca abdita,* the juvenile silver-side fish *Menidia beryllina*, the mysid *Mysidopsis bahia*, and the bivalve larvae of *Mytilus galloprovincialus*.

EPA Heckathorn Superfund Project: The potential contamination levels of sediment cores taken from the Heckathorn field site, Richmond, CA, required use of respirators, protective Tyvek suits, and strict adherence to safety procedures. Participated in laboratory setup, initiation, monitoring, and termination of tests using *Mytilus edulis* larvae, *Macoma nasuta*, *Mysidopsis bahia*, *Rhepoxynius abronius*, and other test organisms.

McCormick Baxter/Stockton, CA Superfund project: Assisted with sediment characterization, sediment composting, and chain-of-custody tracking of samples in this complex project involving ecological risk assessment through site characterization, sediment core analysis, and chemical evaluation.

San Rafael Ammonia: Spiked sediment with ammonia to evaluate the effect of ammonia as a confounding factor in toxicity tests. Conducted water quality measurements, instrument calibrations, laboratory preparation, test initiation, monitoring, and termination.

Port of Oakland Maintenance: Several phases of this project required *Ampelisca* 10-day tests, reference toxicant tests, and bivalve larval test. Performed laboratory preparation, initiation, monitoring, termination, and lab supervisory work in this extensive monitoring program for the Port of Oakland.

Alyeska: Support to scientists in all phases of effluent and sediment toxicity testing, co-author on two reports, bivalve larvae counts. Provided care for pink salmon smolts prior to use in toxicity test. Test supervisor: Salmon Acute Test.

Publications:

Gruendell, B.D., N.P. Kohn, K.D. Pohlod, R.K. Karls. 1995. *1993 Ecological Evaluation of Mare Island Strait Ship Channel and San Rafael Channel Maintenance Dredging Sediments.* PNL-10783. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest National Laboratory, Richland, Washington.

Pinza, M.R., M.E. Barrows, R.K. Karls, H.L. Mayhew, J.Q. Word. 1995. "Survival of *N. caecoides* in Hard-Packed Sediments with Low Total Organic Carbon Content." Presented at the Second SETAC World Congress, Sponsored by the Society of Environmental Toxicology and Chemistry, November 5-9, 1995, Vancouver, British Columbia. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Laboratories, Richland, Washington.

Karle, L.M., H.L. Mayhew, M.E. Barrows, R.K. Karls. 1994. "Establishing Relative Sensitivities of Various Toxicity Testing Organisms to Ammonia." PNL-SA-24309 A. Presented at the Society of Environmental Toxicology and Chemistry (SETAC) conference October 30 - November 3, 1994, Denver, Colorado. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Laboratories, Richland, Washington.

Kohn, N.P., W.W. Gardiner, R.K. Karls, P.J. White, J.A. Ward. 1994. *Evaluation of Proposed Deepening Dredged Material from Oakland Harbor Berth 23, Berth 24, and Berths 60-63.* PNWD-2270. Prepared for the Port of Oakland under Contract 19471 by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Laboratories, Richland, Washington.

Kohn, N.P., W.W. Gardiner, R.K. Karls, P.J. White, J.A. Ward. 1994. *Evaluation of 1994 Proposed Maintenance Dredged Material from Oakland Harbor Berth 20, Berth 21, Berth 23, Berth 24, Berth 25, Berths 60-63, and Berths 67-68.* Prepared for the Port of Oakland under Contract 19471 by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Laboratories, Richland, Washington.

Kohn, N.P., R.K. Karls, M.E. Barrows. 1994. "Measurement and Reduction of Porewater Ammonia in 10-Day Sediment Toxicity Tests with Marine Amphipods." PNL-SA-24312 A. Presented at the Society of Environmental Toxicology and Chemistry (SETAC) conference October 30 - November 3, 1994, Denver, Colorado. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Laboratories, Richland, Washington.

Ward, J.A., M.R. Pinza, M.E. Barrows, R.K. Karls, J.Q. Word. 1994. *Toxicological Evaluation of Sediment Samples from Burns Harbor, Porter County, Indiana.* PNL-9452. Prepared for the U.S. Army Corps of Engineers, Chicago District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Ward, J.A., M.E. Barrows, R.K. Karls, and J.Q. Word. 1993. *Toxicological Evaluation of Sediment Samples from Port Valdez, Alaska. 1992 Sediment Study.* Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, under Contract TAPS 4875, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., M.R. Pinza, M.E. Barrows, R.K. Karls, J.Q. Word. 1993. *Toxicological Evaluation of Sediment Samples from Burns Harbor, Michigan.* Draft report prepared for the U.S. Army Corps of Engineers, Chicago District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. To be published by Pacific Northwest Laboratory, Richland, Washington.

Antrim, L.D., R.K. Karls. 1992. *Partial Results of Effluent Toxicity Testing Conducted in December 1991 for Unocal Chemicals Division.* PNL-1944. Prepared for Unocal Chemicals Division, Kenai, Alaska, April 1992, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Nancy Latham Kaumeyer **Chesapeake Biological Laboratory**

DOC & TOC – Sample Preparation/Analyst

Education:

B.S. University of North Carolina at Wilmington, Marine Biology, 1977.
B.A. University of North Carolina at Wilmington, Chemistry, 1977.

Relevant Experience:

- Analysis of dissolved organic carbon in fresh, estuarine, and coastal ocean waters.
- Analysis of chlorophyll α in fresh, estuarine, and coastal ocean waters, using fluorometry.
- Processing and analyzing particulate carbon and nitrogen samples collected from Chesapeake Bay.
- Analyzing motor fuels and heating fuels for conformation to Maryland state requirements using ASTM methods.
- Analyzing alcoholic beverages for proof, color, and higher alcohols for Maryland State Alcohol Tax Agency.
- Expert witness for Maryland Motor Vehicle Fuels Agency and State Alcohol Tax Agency.
- Collecting, processing, and analyzing water and submerged aquatic vegetation samples for presence of herbicides.
- Monitoring nuclear power plant intake and discharge waters for invertebrate mortality rates.
- Collecting, processing, and analyzing fish for feeding habits.
- Collecting, processing, and analyzing benthic sediments for community structures.

Instrumentation used in the above analyses:

- Shimadzu TOC 5000 and 5000A Total Organic Carbon Analyzers
- Turner Designs Model TD700 fluorometer
- Sequoia Turner Model 112 fluorometer
- OI Model 700 TOC analyzer
- OI Model 524C TOC analyzer
- Control Equipment 240-XA CHN analyzer
- Perkin Elmer 240B CHN analyzer
- Precision Scientific Automatic Distillation Apparatus
- Perkin Elmer Model 4000 Atomic Absorption with 3600 data station
- Fisher 475 sulfur analyzer
- Perkin Elmer 600 Series Infrared Spectrophotometer
- Coleman 124 UV-VIS Spectrophotometer
- Perkin Elmer Sigma I Gas Chromatograph

- Perkin Elmer 990 Gas Chromatograph
- Water Associates HPLC

Publications:

D'Elia, C.F., R.E. Magnien, C.F. Zimmermann, P.A. Vaas, N.L. Kaumeyer, C.W. Keefe, D.V. Shaw, and K.V. Wood. 1987. Nitrogen and phosphorus determinations in estuarine waters: A comparison of methods used in Chesapeake Bay monitoring. UMCEES-CBL Ref. 87-19.

D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K.V. Wood, C. F. Zimmermann. 1997, Nutrient Analytical Services Laboratory Standard Operating Procedures. UMCES-CBL 158-97.

Jones, T.W., J.C. Means, J.C. Stephenson, W.M. Kemp, N. Kaumeyer, and J. Metz. 1982. Chapter 8. Degradation of atrazine in estuarine water/sediment systems and selected soils. In: Kemp, W.M., W.R. Boynton, R.R. Twilley, J.C. Stephenson, and J.C. Means (eds.), Submerged aquatic vegetation in Upper Chesapeake Bay. Final Report, UMCEES Ref. No. HPEL 82-193, Cambridge, MD.

Twilley, R., M. Metteyer, N. Kaumeyer, J. Means, W. Boynton, K. Kaumeyer, K. Staver, and A. Herman. 1982. Chapter 3. Nutrients, sediments, and herbicides in agricultural runoff and the distribution of these water quality variables in the middle and upper reaches of Chesapeake Bay. In: Kemp, W.M., W.R. Boynton, R.R. Twilley, J.C. Stephenson, and J.C. Means (eds.), Submerged aquatic vegetation in Upper Chesapeake Bay. Final Report, UMCEES Ref. No. HPEL 82-193, Cambridge MD.

Wood, K.V., W.R. Boynton, N.L. Kaumeyer, C.W. Keefe, C.F. Zimmermann, D.T. Roxey. 1998. Solomons Harbor Study, Water Quality Monitoring and Long Term Analysis, Summer, 1997. UMCES-CBL Ref. 98-063.

Carolyn W. Keefe **Chesapeake Biological Laboratory**

Nitrite + Nitrate – Sample Preparation/Analysis

Education:

B.S. Juniata College, cum laude, 1967

Qualifications:

Primary production and nutrient dynamics in marshes and estuaries, including associated analytical techniques.

Publications:

Biggs, R.B. and C.D. Wetzel Keefe. 1968. Concentration of particulate carbohydrate at the halocline in Chesapeake Bay. Limnol. Oceanogr. 13:169-171.

Boynton, W.R., K.V. Wood, C.W. Keefe, L. Lubbers and J.E. Boynton. 1985. Nutrient, oxygen and productivity survey of the Bush River estuary. Final Report. UMCEES Ref. No. 85-6.

Boynton, W.R., L. Lubbers, K.V. Wood and C.W. Keefe. 1984. Seston dynamics in the lower Susquehanna River. Final Report. UMCEES Ref. No. 84-81.

Boynton, W.R., C.A. Hall, P.G. Falkowski, C.W. Keefe and W.M. Kemp. 1983. Phytoplankton productivity in aquatic ecosystems. pages 305-327 in O.L. Lange, P.S. Nobel, C.B. Osmond and H. Ziegler (eds.), Encyclopedia of Plant Physiology 12D, Physiological Plant Ecology IV. Springer-Verlag, Berlin.

Boynton, W.R., W.M. Kemp and C.W. Keefe. 1982. A comparative analysis of nutrients and other factors influencing estuarine phytoplankton production. pages 69-90 in V.S. Kennedy (ed.), Estuarine Comparisons. Academic Press, New York.

Boynton, W.R., W.M. Kemp, K.V. Wood, C.W. Keefe and C.F. D'Elia. 1982. Final Report, "Estuarine community dynamics in relation to power plant operations. Benthic process program." UMCEES Ref. No. 82-78 CBL.

D'Elia, C.F., E.E. Connor, N.L. Kaumeyer, C.W. Keefe, K.V. Wood and C.F. Zimmermann. 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures.

D'Elia, C.F., R.E. Magnien, C.F. Zimmermann, P.A. Vaas, N.L. Kaumeyer, C.W. Keefe, D.V. Shaw and K.V. Wood. 1987. Nitrogen and phosphorus determinations in estuarine water: A comparison of methods used in Chesapeake Bay monitoring. Ref. No. UMCEES 87-19 CBL.

D'Elia, C.F., W.R. Boynton, W.M. Kemp, K.V. Wood and C.W. Keefe. 1981. Benthic nutrient studies on the lower Patuxent River. UMCEES Ref. No. 81-169 CBL.

Flemer, D.A., D.R. Heinle, C.W. Keefe and D.H. Hamilton. 1978. Standing crops of marsh vegetation of two tributaries of Chesapeake Bay. Estuaries 1:157-163.

Flemer, D.A., D.H. Hamilton, C.W. Keefe and J.A. Mihursky. 1970. The effects of thermal loading and water quality on estuarine primary production. Final technical report to the Office of Water Resources Research, U.S. Dept. Interior. NRI Ref. No. 71-6 CBL.

Hamilton, D.H. Jr., D.A. Flemer, C.W. Keefe and J. A. Mihursky. 1970. Power plants: effects of chlorination on estuarine primary production. Science 169:197-198.

Keefe, C.W. 1994. The contribution of inorganic compounds to the particulate carbon, nitrogen, and phosphorus in suspended matter and surface sediments of Chesapeake Bay. Estuaries 17:122-130.

Keefe, C.W. 1982. An assessment of environmental data in the Patapsco and Back Rivers of Maryland. Final Report to USEPA Chesapeake Bay Program. UMCEES Ref. No. 82-48 CBL.

Keefe, C.W. and K.V. Wood. 1982. Assessment of the environmental impacts of construction and operation of the Hart and Miller Islands containment facility. Project III. Water column nutrients and productivity. Interpretive Report. UMCEES Ref. No. 82-149 CBL.

Keefe, C.W., W.R. Boynton and W.M. Kemp. 1981. A review of phytoplankton process in estuarine environments. UMCEES Ref. No. 81-193 CBL

Keefe, C.W., D.A. Flemer and D.H. Hamilton. 1976. Seston distribution in the Patuxent River Estuary. Chesapeake Sci. 17:56-59.

Keefe, C.W. and W.R. Boynton. 1973. Standing crop of salt marshes surrounding Chincoteague Bay, Maryland-Virginia. Chesapeake Sci. 14:117-123.

Keefe, C.W. 1972. Marsh production: a summary of the literature. Contrib. Mar. Sci.16:163-181.

Keefe, C.W., D.H. Hamilton and D.A.. Flemer. 1972. Acetone contamination of water samples during quick-freezing. Chesapeake Sci. 13:226-229.

Wood, K.V., W.R. Boynton, N.L. Kaumeyer, C.W. Keefe, C.F. Zimmermann, D.T. Roxey. 1998. Solomons Harbor Study: Water quality monitoring and long term analysis, summer, 1997 Ref. No. UMCEES 98-063 CBL.

Wood, K.V., C.W. Keefe, D.A. Jasinski and W.R. Boynton. 1997. Solomons Harbor Study: Water quality monitoring and long term analysis, summer, 1996 Ref. No. UMCEES 97-028 CBL.

Zimmermann, C.F. and C.W. Keefe. 2000. Chesapeake Bay program blind audit nutrient results January and June 1998.

Zimmermann, C.F. and C.W. Keefe. 1998. Chesapeake Bay program blind audit nutrient results January and June 1998.

DIOXIN QUALITY ASSURANCE OFFICER

Charles D. Lawrie **Battelle Columbus**

Quality Assurance Manager

Education:

M.S., Marine, Estuarine, and Environmental Sciences, University of Maryland, 1990
B.S., Biological Science, University of Illinois at Chicago, 1987

Qualifications:

Mr. Lawrie currently serves as Quality Assurance (QA) Coordinator in Battelle's Environmental Protection Division and AgriFood Division. In this capacity, he provides QA guidance to a variety of environmental research programs and is also responsible for coordinating all internal and external QA audits and inspections. Mr. Lawrie has over 10 years experience administrating Good Laboratory Practices (40 CFR Part 160) both as a GLP study director and as a Quality Assurance Manager. Since arriving at Battelle two years ago he has established a Quality Assurance Program within the Atmospheric Sciences and Applied Technology department as specified in EPA Order 5360.1. He routinely administers QA and QC programs required in environmental monitoring, environmental surveys, and analytical laboratory systems. He also reviews standard operating procedures (SOPs) and conducts performance and data audits to ensure compliance of facilities and operations with Quality Management Plans (QMPs) and Quality Assurance Project Plans (QAPPs). An environmental chemist with 10 years' experience, Mr. Lawrie holds a Master's degree in Marine, Estuarine, and Environmental Science, specializing in Environmental Chemistry. He has experience conducting audits, providing technical leadership during environmental laboratory certifications, and providing training to technical staff in the use of quality and improvement tools. His areas of expertise include analytical chemistry, environmental toxicology, and experimental design.

Relevant Experience:

Human and Ecological Exposure Monitoring Research (HEEMR) Projects: Mr. Lawrie is the Battelle Quality Manager on all the Task Orders pertaining to the EPA HEEMR project. These studies target a wide variety of chemical agents and study designs concerning human exposure studies. As the Quality Manager Mr. Lawrie's administrates all quality aspects of this project including Quality Assurance Project Plan (QAPP) review and technical system and data audits to ensure that staff follow QAPPs, Standard Operating Procedures (SOPs), and pertinent regulations and methods.

AgriFood Projects: Mr. Lawrie administers the quality assurance program of a large agricultural research department specializing in agrochemical product development under the EPA Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). This department is compliant with the Good Laboratory Practices and all pertinent regulations of FIFRA. Mr. Lawrie administrates all the Battelle

quality aspects of this department including protocol reviews, technical system and data audits to ensure that staff adhere to the GLPs, protocols, SOPs, and pertinent regulations and methods.

Environmental Technology Verification (ETV) Program: Mr. Lawrie is the Battelle Quality Manager for the EPA's ETV program for the Advanced Monitoring System pilot. This program provides independent facility testing of new and existing environmental technologies to enhance their commercial appeal. The nature of this program requires an extremely high level of quality assurance activities. Mr. Lawrie's administrates all the Battelle quality aspects of this pilot program including Battelle Quality Management Plan (QMP) preparation, QAPP review, and technical system and data audits to ensure that staff adheres to the QMP, QAPPs, SOPs, and pertinent regulations and methods.

Dioxin Projects: Battelle operates an advanced dioxin laboratory specializing in high-resolution mass spectrometry. Clients are typically federal and state agencies requiring dioxin analysis according to established EPA methods, which often requires certification under the respective state's guidelines. Mr. Lawrie's administrates all the Battelle quality aspects of this project including Battelle QMP preparation, QAPP review and technical system and data audits to ensure that staff adheres to the QMP, QAPPs, SOPs, and pertinent regulations and methods.

ORGANICS LABORATORY MANAGER

Robert Lizotte **Battelle Duxbury**

Research Scientist

Education:

B.S. Biology, Allegheny College, 1987

Qualifications:

Mr. Lizotte joined Battelle in 1990 and has a total of 11 years of experience in the field of environmental chemistry. His responsibilities include lab oversight and scheduling. He also ensures proper procedural techniques are employees throughout the lab. His analytical responsibilities are preparation and analysis with various detectors in gas chromatography of environmental samples in various matrices. These detectors include GC/FID, PID, FPD, and ECD. Analytes include petroleum hydrocarbons, polynuclear aromatic compounds, sterols, pesticides, butyltins, and polychlorinated biphenyls. Further duties include sample preparation, analytical standard preparation, interpretation of GC/FPD, GC/FID and GC/ECD chromatograms, instrumentation troubleshooting and maintenance, and final preparation of data packages. He also acts a project manager, involving client contact, preparation of reports, and preparation of workplans. Mr. Lizotte is Lab Manager of the organics laboratory at Battelle.

Professional Positions:

Supervisor of the Hydrocarbon Laboratory, Enseco Incorporated, Cambridge, Massachusetts. Duties included client contact, instrument scheduling and maintenance, and assigning work to technicians.

Relevant Experience:

Ecological and Human Exposure Measurement and Monitoring
Research Scientist – Performed project management tasks and analysis for a study in China Bay (Hong Kong) examining possible butyltin contamination.

Research Scientist – Performed project management tasks and analysis for the Consortium of Tributyltin Manufacturers for the Long Term Tributyltin Monitoring Project.

Research Scientist – Conducted butyltin analysis and prepared data report for a study conducted for EPA's Oceans and Coastland Protection Division at the 106-mile dumpsite.

Research Scientist – Performed PCB congener and pesticide analysis in support of the NOAA NRDA study at a Superfund site in San Francisco Bay (excess of 200 tissue and sediment samples).

Research Scientist – Performed PCB congener and pesticide analysis for US Army Corps of Engineers Oakland Harbor Navigation project, Richmond Harbor improvement, and J.F. Baldwin channel. An excess of 200 tissue samples were analyzed in these projects.

Research Scientist – Performed PCB congener and pesticide analysis for a U.S. Navy Superfund site. Analyzed samples and reported data for over 250 samples.

Research Scientist – Performed PCB congener and pesticide analysis for the NOAA Mussel Watch projects (1990 to 1994). Analyzed samples and reported data for over 500 tissue samples.

Research Scientist – Performed Massachusetts Water Pollution Performance Evaluation study for PCB and pesticides in 1992 through 1994.

Research Scientist – Analyzed and reported petroleum hydrocarbon data in many Exxon studies including two intercalibration exercises.

Research Scientist: Analyzed and reported data petroleum hydrocarbon data for an industrial oil and gas research program.

Trained two people from Thailand on the extraction, instrumentation, and calculation of the EPA Method 418.1 IR analysis.

Charles H. Lyman **Harding ESE**

Project Environmental Scientist

Education:

B.S. University of Rhode Island, Soil and Water Resources, 1993
A.S. New England Institute of Technology, Mechanical Drafting Technology, 1984

Qualifications:

Mr. Lyman has more than nine years of experience in the environmental field and engineering design and drafting industry. This experience includes regulatory ecological risk assessment, wetland assessment and delineation, compliance work, environmental chemistry, hydrogeologic investigation and field work, water conservation management, and mechanical design and drafting. He has worked with several municipalities to facilitate compliance with various state and federal regulations and held various positions with federal and state agencies such as the Environmental Protection Agency, Natural Resource Conservation Service, and the University of Rhode Island.

Relevant Experience:

Currently providing support on various projects to the Ecological Risk Group. The projects include the Massachusetts Military Reservation, Loring Air Force Base OU-13, and the Naval Air Stations Key West and Jacksonville. Support ranges from field work, such as wetland delineations, and plant, animal, and sediment sampling to data analysis and report writing.

Wetland Delineation and Permitting, USCG LORAN Station, Nantucket Massachusetts. Conducted a wetland delineation at the Coast Guard LORAN Station in Nantucket. The delineation was conducted to provide information on the presence or absence of wetlands under the LORAN C tower, which is maintained as a mowed grass habitat, by the Coast Guard. The site was delineated using the methods described in the Massachusetts Wetlands Protection Act (Delineating Bordering Vegetated Wetlands). This information was used in support of a Request for Determination, to the conservation commission of the Town of Nantucket.

Upland and Wetland Remediation, Rol-Flo Engineering, South Kingstown, Rhode Island. Provided construction oversight, during all phases of remedial activities conducted at the Rol-Flo facility. Remedial activities included excavation and off-site removal of highly contaminated surface soil, collection of confirmatory soil samples, removal of contaminated wetland sediment, placement of contaminated sediment in the upland, and installation of a permeable cap in the upland area. The remedial activities conducted in the wetland included, removal of contaminated sediment and subsequent placement in the upland excavations, replacement of sediment with clean fill material (a mixture of peat and loam was used as the backfill sediment), and restoration of wetland plants.

Soil Removal Action, Area of Concern 57, U.S. Army Environmental Center, Fort Devens, Ayer, Massachusetts. Provided construction oversight during all phases of the soil removal action at AOC 57. The removal action included excavation and offsite disposal of approximately 1,300 cubic yards of

contaminated soil. This task included directing the excavation based on field screening of soils, and the collection of confirmatory samples and characterization samples.

Wetland Delineation and Permitting, Textron Inc., Everett Massachusetts. Conducted a wetland delineation at the site as a part of a landfill capping project. The site was delineated using the methods described in the Massachusetts Wetlands Protection Act (Delineating Bordering Vegetated Wetlands). Also prepared and submitted a Notice of Intent to the conservation commission of the City of Everett.

Wetland Delineation and Permitting, Vibration Mountings and Controls, Inc., Bloomingdale New Jersey. Delineated the wetlands at this site using the methods described by the State of New Jersey, Department of Environmental Protection and Energy. Also helped in preparing the Freshwater Wetlands Permit Application which included a Transition Area Waiver, which was required in addition to the wetlands permit for work which will be conducted within one hundred feet of a wetland.

Wetland Permitting, Private Client, Cambridge Massachusetts. Prepared and presented a Request for Determination of Applicability for the Cambridge Conservation Commission, for the removal of an underground storage tank.

Ecological Risk Assessment, U.S. Navy, CLEAN Program, NAS Cecil Field, Jacksonville, Florida. Updated the quantitative ERA for OU5, Site 14 (Blue 5 Ordnance Disposal Area) and Site 15 (Blue 10 Ordnance Disposal Area). Terrestrial, semi-aquatic, and aquatic organism exposures to chemicals (including metals and organics) in surface soil, sediment, surface water, and groundwater were evaluated. In addition to the ecological risk assessment work, was responsible for updating the General Information Report (GIR) and Basewide Ecological Assessment Report (BEAR) at NAS Cecil Field. The GIR update included revising the ecological risk assessment methodology. The BEAR update included summarizing and updating all ecological site investigations and assessments conducted to date at the facility.

Preliminary Ecological Risk Evaluations, U.S. Navy, CLEAN Program, NAS Cecil Field, Jacksonville, Florida. Conducted Preliminary Ecological Risk Evaluations at the following Potential Sources of Contamination at NAS Cecil Field: historic grease pits (PSC 4); Lake Fretwell rubble disposal area (PSC 6); public works disposal area (PSC 12); ammunition disposal area (PSC 18); and Rowell Creek disposal area (PSC 19). The PEREs were conducted to determine the need for further evaluation, based on comparisons of detected chemical concentrations to ecologically based screening criteria.

Hazardous Waste Remedial Actions Program (HAZWRAP), Massachusetts Military Reservation, Lockheed Martin Energy Systems, Inc., Cape Cod, Massachusetts. Revised preliminary risk evaluations (PREs) for surface water, surface soil and groundwater at a number of study areas (SD-2, SD-3, Leading Edge, and SERGOU) using HAZWRAP guidance. The tasks involved estimating ecological receptor exposure to environmental contaminants of potential concern in the study area habitats, and characterizing risk to receptors using site analytical data and established criteria in food web models.

Ecological Risk Assessment and Field Sampling, U.S. Army Environmental Center, Fort Devens, Ayer, Massachusetts. Participated in the field collection of surface water, sediment and biological samples at Ft. Devens at Group 1a, SA 57 and 69. In addition, assisted with various ecological risk assessment tasks, including an ecological habitat evaluation and wetland delineation, toxicity data presentation and evaluation, and report writing, performed for the 1a sites.

Hazardous Waste Remedial Actions Program (HAZWRAP), Loring Air Force Base Operable Unit 13, Lockheed Maring Energy Systems, Inc., Limestone, Maine. Worked on the ecological risk assessment for

the surface soil, surface water, and sediment at Operable Unit 13, which also included incorporating site specific biological data as well as published data for the completion of the ecological risk assessment. Additionally, developed PRGs (preliminary remediation goals) in support of a feasibility study conducted at the base.

Ecological Risk Assessment, U.S. Navy, CLEAN Program, NWS Charleston, Charleston, South Carolina. Participating in the ecological risk assessment of surface soils, sediment, surface water and groundwater at SWMUs 3, 4, 5, and 6. Risk to terrestrial and semi-aquatic receptors from exposure to site related contaminants of potential concern was estimated by the use of food chain models and by comparison to criteria and guidelines.

Arsenic Investigation, U.S. Army Environmental Center, Sudbury Annex, Massachusetts. Participated in the collection of plant and sediment samples to support a basewide arsenic investigation being conducted at the Annex . Arsenical herbicides were historically used at the base to provide a clear line of sight between the patrol road and the perimeter fence. Supported senior staff in the preparation of the ecological components of the work plan for the basewide arsenic investigation, and has been responsible for implementing the biological tissue sampling and sampling for toxicity tests. The results of this assessment will be instrumental in determining future remedial activities associated with arsenic contamination at the base.

Ecological Risk Assessment, Confidential PRP Group, Rhode Island. Provided technical support for an ecological risk assessment conducted at mercury-contaminated site in Rhode Island. Conducted plant and sediment sampling at the site. These data were used along with other site-specific and literature data to support an ecological risk assessment.

Ecological Risk Assessment Re-evaluation, CHPPM, Badger Army Ammunition Plant, U.S. Army Environmental Center, Baraboo, Wisconsin. Participated in an effort to re-evaluate the assumptions made in an ecological risk assessment that were driving clean-up at several sites at this facility. This included re-evaluating the exposure assumptions, evaluating how selected toxicity values relate to the assessment endpoints, and performing a sensitivity analysis. The primary contaminants of concern at two Rocket Paste Areas and four Settling Ponds included analytes used in the manufacture of explosives (*i.e.*, nitrocellulose, dinitrotoluenes, and diphenylamines), lead, mercury, and several other heavy metals. As part of this re-evaluation, Mr. Lyman and other ecologists conducted a small mammal survey whereby live traps (*i.e.*, Havahart, Sherman, and pitfall traps) and snap traps were installed at the sites and two reference areas to survey the composition of the small rodent population at the facility. All site activities were performed at Level C to minimize exposures to airborne pathogens.

Biological Sampling, New York State Department of Environmental Conservation, North Lawrence Oil Dump Site, Lawrence, New York. Provided technical support conducting a biological sampling program to document baseline (pre-remediation) biological tissue concentrations at the site and at a reference site. Data collected during the biological sampling program will be compared to post-remediation tissue concentrations as part of the long-term biomonitoring program, to evaluate the effectiveness of the chosen remedy.

Wetlands Delineations, Massachusetts Highway Department, Taunton and Dartmouth, Massachusetts. Conducted wetland delineations at two Massachusetts Highway Department facilities. The sites were delineated using the methods described in the Massachusetts Wetlands Protection Act (Delineating Bordering Vegetated Wetlands). This work included a site visit and a submission of a request for determination to the conservation commissions of the respective towns.

Method 3, Stage II Environmental Risk Characterization, Confidential Client, Wilmington, Massachusetts. Providing technical support for a Method 3, Stage II Environmental Risk Characterization (ERC) being conducted in accordance with the Massachusetts Contingency Plan (MCP) at a former manufacturing facility to evaluate ecological risks associated with the historical release of contaminants to several on- and off-site ditches that have been contaminated as a result of direct discharge from former settling lagoons, overland surface runoff, and discharge of shallow groundwater. Primary contaminants include chromium, bis(2-ethylhexyl)phthalate, and several other SVOCs as well as several pesticides and ammonia. Participated in surface soil, surface water, and sediment sampling conducted to evaluate background concentrations, and conducted biological sampling at the site in support of the ERC. Procured subcontract laboratories to conduct frog-embryo-toxicity (FETAX) tests, earthworm toxicity and bioaccumulation tests for the Stage II ERC. Which will also utilize, population modeling, and site-specific biological tissue data to evaluate population-level effects for ecological receptors at the site.

Sediment Sampling for the Army Corps of Engineers. Prepared sampling plans and conducted sampling in several ponds in Rhode Island and Massachusetts. The work was conducted on an expedited schedule, and required coordination with sub-contractors to conduct sediment sampling and analytical laboratories. This work was performed under a teaming agreement with Battelle.

Soil Sampling and Hazardous Waste Manifest preparation for Amtrak, Boston Massachusetts, and Providence Rhode Island. Prepared sampling plans and conducted sampling at several Amtrak facilities. Which included coordination and collection of soil samples to characterize samples for disposal and reuse as land fill cover.

Emergency Spill Response for Amtrak, New England. Responded to several fuel oil spills related to train activities, that required oversite of spill cleanup and confirmatory sampling.

Representative Projects While With Town of North Smithfield, Rhode Island, 1994-1995
Wellhead Protection Program for the Town of North Smithfield. As a consultant to the town, performed various tasks with regard to the town's compliance with the Rhode Island Department of Environmental Management Wellhead Protection Program. Organized and compiled data concerning existing and potential threats to groundwater quality and developed a fact sheet for public education regarding wellhead protection.

Representative Projects While With Town of Westerly, Rhode Island, 1994
Wellhead Protection in Southern Rhode Island. As a research assistant to the town, inventoried wellhead protection areas with in five towns in Southern Rhode Island, thus fulfilling the requirements of the Rhode Island Department of Environmental Management (RIDEM) Wellhead Protection Program. Responsibilities included developing wellhead protection area inventories; promoting public education through informational forums and meetings with the towns boards and commissions; and the production of a final report, which was distributed to each town, RIDEM, and the US Environmental Protection Agency.

Representative Projects While With University of Rhode Island, Kingston, Rhode Island, 1993
Irrigation Water Management Program, Kingston, Rhode Island. As an irrigation scheduling technician, worked for the URI cooperative extension and the USDA Soil Conservation Commission to provide agricultural producers with a method to determine timing and quantity of irrigation to relieve crop water stress. Performed comparative analysis of soil moisture measuring techniques including gypsum blocks, tensiometers, roof gage, neutron probe and an irrigation scheduling computer program (*Scheduler*).

Fieldwork included the installation and daily maintenance of sampling equipment and data collection. Groundwater Laboratory/Field Technician, Kingston, Rhode Island. As a technician for the Department of Geology, collected and performed various chemical analyses on groundwater samples from the U.S. Geological Survey wells in the Usquepaug-Queen aquifer. Chemical analyses included temperature, dissolved oxygen, pH, conductivity, alkalinity, and water table elevations.

Representative Projects While With U.S. Environmental Protection Agency, Narragansett, Rhode Island, 1991-1993
As a physical science aide, worked on a variety of projects with the Exposure Branch/Chemistry Group at the USEPA Environmental Research Laboratory in Narragansett, Rhode Island. Those projects included a bioaccumulation study, an acid volatile sulfide study, and a chemical markers study. During the bioaccumulation study, assisted in the set up, daily maintenance and break down of the laboratory experiment to determine the pathway and rate of the accumulation of PCBs and dioxin congeners in the American lobster. The acid volatile sulfides study involved acid extractions and analysis of sulfides from sediments collected in local estuaries, whereas the chemical markers study involved extractions of organic compounds from sediments and benthic organisms.

Representative Projects While With E.R. Smith Associates, Westerly, Rhode Island, 1984-1987
As a Mechanical Designer/Drafter, engineered, designed and drafted printing presses and related machinery. Responsibilities included travel to customer facilities, preliminary project assessment, design and engineering, supervision of machining and assembly, and final job site installation and inspection.

Tara E. Martz **Severn Trent Laboratories**

Laboratory Project Manager

Education:

M.S. Miami University; Botany; Oxford, OH; expected 2001
B.S. Susquehanna University; Biology; Selinsgrove, PA; 1996

Qualifications:

Ms. Martz has over two years experience in the environmental analytical field. Her current position as laboratory project manager requires handling client projects from implementation through reporting and invoicing. Ms. Martz has also worked as sample management officer, lead extractions chemist, and as an Inorganic Chemist.

Relevant Experience:

Laboratory Project Manager, Severn-Trent Laboratories, Inc, 2001 – Present
Responsibilities include ensuring all client expectations are met by maintaining complete knowledge of the project from the initial contact and throughout the duration of the project including coordination with lab personnel. Requires building price quotes, developing method list, communicating with clients and operations staff on a regular basis, and invoicing at project completion. Maintains all records and documentation for the duration of each project.

Lead Extractions Chemist/Project Manager, Envirosystems, Inc , 1999 –2001
Responsibilities included receiving samples from clients while ensuring proper sample custody protocols are met, delegating samples to proper operations groups, creating chain of custody and associated forms, shipment of bottle orders to clients, client cooler return, disposal of environmental samples, and implementation of new sample custody and tracking policies. Was responsible extraction of samples for various organic analyses, supervision of 2-5 full and part-time employees, ordering laboratory supplies, and project management.

Research/Teaching Assistant, Miami University, August 1996–1998
Was responsible for the instruction of the General Botany course lab and a wetlands graduate course lab. Was awarded a research fellowship through the National Oceanic and Atmospheric Administration (NOAA) to conduct primary productivity research of a Lake Erie estuary at the Old Woman Creek National Estuarine Research Reserve. Attended and conducted presentations at several regional and national conferences.

Dennis J. McCauley **Great Lakes Environmental Center**

Traverse City Operations Manager
Principal Research Scientist

Education:

B.S. Biology, 1979, University of Wisconsin-Superior
M.E.-P.D. Fishery Biology, 1983, University of Wisconsin-LaCrosse

Qualifications:

Mr. McCauley has extensive experience in managing, planning, and conducting in-situ field and laboratory studies that: assess the effect on hydropower projects on aquatic life and river systems; assess the abundance of fishes in various habitats; assess the impact of effluents, single chemicals, and storm water on receiving waters; characterize and identify effluent toxicity, and assess fish ventilatory response to wastewater; assess the effect of low level contaminant burden on fish ova fertilization, development, and survival; assess the impact of water and sediment quality on various freshwater organisms; and assess the relationship between bioconcentration and bioaccumulation using single chemical, whole sediment, and complex effluent toxicity assays. His experience as a project manager and principal investigator has ranged from participation in interlaboratory validation of specific test protocols to large complex field studies that assess the fishery and water and sediment quality on various life stages of fish and aquatic invertebrates. Mr. McCauley has also coordinated regulatory whole effluent toxicity testing, toxicity identification/reduction evaluation (TI/RE) studies, and communicated with industrial groups and specific permittees for state wastewater NPDES permits and has coordinated large complex field evaluations that involved stream flow modeling, fish entrainment, fish escapement, fish diversion, shoreline erosion, and water quality assessment. He also interacts with state and federal agencies on the behalf of clients to design and negotiate realistic study plans and interpret study results.

Relevant Experience:

Environmental Research and Water Quality Assessments. At GLEC, Mr. McCauley is the Deputy Program Manager for the EPA/HECD contract and Work Assignment Leader for several Work Assignments under that contract with EPA. He also collaborates with professional and technical staff to plan and conduct field and laboratory studies that assess the impact of complex effluents, sediments, storm water, and single chemicals on aquatic biota, water and sediment quality and assess the effectiveness of created wetlands for wastewater treatment. He manages, coordinates, and oversees laboratory and field activities as well as participates as a principal investigator and/or technical advisor in toxicity identification/reduction evaluations (TI/RE), integrated sediment quality assessments, fish biouptake studies, and environmental assessments of impacted areas. Coordinates off-site laboratory studies that employ Automated Biomonitoring Systems (ABS) that assess the ventilatory response of fish to industrial effluents and bioconcentration studies.

Environmental Assessment and Study of Hydroelectric Projects. Manage Federal Energy Regulatory Commission (FERC) Exhibit E preparations, license applications, and additional studies. Manage impoundment studies that assess forage fish abundance, spawning success, and the seasonal distribution of fish as a result of water level fluctuations. Coordinate and conduct tailrace netting studies that assess

fish entrainment, turbine mortality, fish escapement and net efficiency at hydroelectric dams. Design and perform fish protection studies that assess behavioral and mechanical fish diversion and exclusion, and mitigation techniques to minimize fish losses due to entrainment and escapement. In addition, Mr. McCauley is responsible for studies that assess aquatic habitat, water quality, shoreline erosion, flow modeling, fisheries, and fishery enhancement above and below the impoundments and for the hydrographic mapping of the reservoirs.

Laboratory Studies. Manages the technical and logistical planning that will organize and ready laboratories for various studies of complex effluents, contaminated sediments, and single chemicals as they apply to NPDES permits, TI/RE studies, registration of new products, and environmental assessment.

Bioconcentration Studies. Coordinate and conduct field investigations that are responsible for collecting water, sediment and tissue for bioconcentration studies in ambient lake and river waters' sediment and in municipal and industrial effluents. Performs laboratory investigations to assess the bioconcentration of various pollutants in aquatic life and the sub-lethal effect on development and survival in fish and invertebrates.

Biomonitoring Specialist. While with the Wisconsin Department of Natural Resources he was responsible for the evaluation of whole effluent testing data for toxic substances submitted by industrial dischargers and for assessing the relationship of that effluent test data to receiving water impacts. Coordinated the implementation of the biomonitoring program in Wisconsin NPDES permits. Provided assistance to staff in developing sampling strategies and in identifying laboratories with adequate bioassay capabilities. Developed approaches to Toxicity Identification Evaluations (TIE). Communicated with industrial groups and specific permittees as necessary to aid in implementing Wisconsin DNR biomonitoring programs. Prepared NPDES discharge permits and evaluated relevant data and correspondence to protect aquatic life, wildlife and human health.

Research Scientist. While with the Center for Lake Superior Environmental Studies, University of Wisconsin-Superior he was Project Manager and Principal Investigator of a cooperative agreement entitled "Water Resources of the Apostle Islands National Lakeshore." The objective of the study was to monitor water quality and forage fish abundance within visitor use areas in the Park. Supervised and conducted research that assessed water quality by bacteriological and physical/chemical techniques. Supervised and conducted research that estimated the seasonal and spatial abundance of forage fishes within the Apostle Islands National Lakeshore. Forage fish abundance was estimated by outboard trawling, seining and gill netting. Operated and maintained two nearshore research vessels and operated and maintained the numerous sampling devices and equipment for open lake and nearshore sampling. Designed and constructed experimental apparatus for use in ecological field experiments. He was also Project Manager and Principal Investigator as a participant in the Interlaboratory Validation of the Seven-Day *Ceriodaphnia* Survival and Reproduction Test" and the "Seven-Day Fathead Minnow Survival and Growth Test". Mr. McCauley was Co-Principal Investigator for a U.S. EPA cooperative agreement that developed protocols and specific methodology for assessing the toxicity of bacteria used as pesticides. Developed methods and wrote protocols for acute and chronic toxicity assays using *Ceriodaphnia, Daphnia magna*, and a copepod as the test organisms. He was also Co-Principal Investigator for a U. S. EPA cooperative agreement entitled "Ecological Assessment of Factors Affecting Walleye Ova Survival in the Lower Fox River Wisconsin" where he incubated walleye ova in artificial incubators in the Fox River to assess the impact of water and sediment quality on survival and development. Was responsible for data collection, data tabulation and analysis, and report writing.

Biological Technician (Fisheries). While with the National Fishery Research Laboratory, U.S. Fish and Wildlife Service he conducted toxicity tests exposing various life stages of fish and aquatic invertebrates to selected chemicals. There he evaluated chemicals for their effectiveness in controlling fish populations; the effects of water temperature, pH, and hardness on the activity of chemicals; the potential for synergistic action when chemicals are applied jointly, and the persistence of chemicals in water. Assessed the impact of dredge spoils on aquatic organisms and the release of contaminants from sediments during dredging using solid phase and elutriate phased toxicity tests. Estimated the abundance and distribution of larval fishes by spatial and temporal sampling with metered plankton nets.

Natural Resources Assistant. While with the Wisconsin Department of Natural Resources he assisted in fykenetting, seining and electrofishing to gather information on walleye/centrarchid communities concerning growth, survival, population structure and reproduction. Netted adult muskellunge for tagging to determine after spawning dispersal in two study lakes. Conducted a creel census to estimate angler harvest of muskellunge. Mapped vegetation and substrate type on study lakes to estimate the percentage of various habitat types and to determine their relationship to fish communities.

Laboratory/Field Assistant. While with the Center for Lake Superior Environmental Studies, University of Wisconsin-Superior he identified aquatic invertebrates from stream benthos for the calculation of diversity and habitat quality indices. Conducted experiments that determined the effects of turbidity and siltation on aquatic insects and various life stages of fish. Exposed fish ova to various levels of suspended sediments to determine the effect of sedimentation on embryo and fry survival. Netted and electrofished fish populations to monitor abundance, distribution and dispersal. Drift netted larval fish in lacustrine habitats to determine spatial and diel variations in abundance and distribution.

Professional Recognition and Affiliations

- Member, American Fisheries Society (AFS)
- Member, American Society of Testing and Materials (ASTM), Subcommittee on Sediment Toxicity Testing
- Member, Society of Environmental Toxicology and Chemistry (SETAC)
- Member, North American Lake Management Society (NALMS)

Publications and Reports:

Balcer, M.D., D.J. McCauley, G.J. Niemi and L.T. Brooke. 1986. Ecological Assessment of Factors Affecting Walleye Ova Survival in the Lower Fox River. Final Report to the U.S.EPA, Environmental Research Laboratory - Duluth. Cooperative Agreement CR-811723-02-0.

McCauley, D.J. 1983. Feeding and Distribution of Larval Freshwater Drum (*Aplodinotus grunniens*) in Pool 7 of the Upper Mississippi River. Masters Thesis. University of Wisconsin-LaCrosse. Presented at the 8th Annual Larval Fish Conference, University of British Columbia, Vancouver, B.C.

McCauley, D.J. and M.D. Balcer. 1987. Water Resources of the Apostle Island National Lakeshore. Final Progress Report to the National Park Service, Apostle Island National Lakeshore. Cooperative Agreement, CX6000-5-0065.

McCauley, D.J., M.D. Balcer, D. Will, and M. Hage. 1989. Abundance and distribution of Forage Fishes in the Apostle Islands National Lakeshore. Final report to the National Park Service, Apostle Island National Lakeshore.

McCauley, D.J., L.T. Brooke, D.J. Call and C.A. Lindberg. 1986. Acute and Chronic Toxicity of Aluminum to *Ceriodaphnia dubia* at Various pH's. University of Wisconsin-Superior, Superior, WI.

Mount, D.I. and D.J. McCauley. 1986. Validity of Effluent and Ambient Toxicity Tests for Predicting Biological Impact, Naugatuck River, Waterbury, Connecticut; *in* On Site Tests for Toxicity of Effluents and Receiving Water. D.I. Mount, T. Norberg-King and S.E. Steen, eds. EPA Research Series.

Vaishnav, D.D., L.T. Brooke, S.H. Poirier, D.J. McCauley and E.T. Korthals. 1988. Acute and Chronic Protocols for Bacteria. Center for Lake Superior Environmental Studies. University of Wisconsin-Superior, Superior, WI.

DeGraeve, G.M., D.O. McIntyre, D.J. McCauley, W.H. Clement, M.A. Lewis, and N.G. Reichenbach. 1990. A Field and Laboratory Site-Specific Evaluation of Cadmium, Copper, and Zinc for the Cuyahoga River in the Vicinity of the Northeast Ohio Sewer Districts Southerly Effluent Discharge. Final Report to: Northeast Ohio Regional Sewer District.

McCauley, D.J., G.M. DeGraeve, and W.H. Clement. 1990. Toxicity Identification/Reduction Evaluation (TI/RE) at Tinker Air Force Base. Final Report to INEL/EG&G, Idaho Falls, Idaho.

Navarro, J.E., D.J. McCauley, and T.A. Forgette. 1993. Fish Escapement from Two Low-Head Hydropower Reservoirs in Michigan. Rivers, Volume 4, No. 1.

Navarro, J.E., D.J. McCauley, and A.R. Blystra. 1994. Instream Flow Incremental Methodology (IFIM) for modelling Fish Habitat; *in* Current Practices in Modelling the Management of Stormwater Impacts. W. James ed. Lewis Publishers.

Burkhard, L.P., B. Sheedy, and D. McCauley. 1994. A Comparison of Measured and Predicted Bioaccumulation Factors for Biphenyl, Phenanthrene, Anthracene, Flouranthrene, and Pyrene. Archives of Environmental contamination and Toxicology (In-Press)

Burkhard, L.P., B. Sheedy, and D. McCauley. 1994. Prediction of Chemical Residues in Aquatic Organisms For a Field Discharge Situation Chemosphere 1 Vol. 29, No. 1. pp. 141-153

Blystra, A.R., D.J. McCauley, and J. Navarro. 1994. Fish Entrainment and Strategies for Diversion. Symposium on Fundamentals and Advancements in Hydraulic Measurements and Experimentation. National Conference on Hydraulic Engineering.

Navarro, J., D.J. McCauley, and A.R. Blystra. 1994. Shared Management of Fish Resources on Developed Rivers: A Balance of Needs and Resources (Manuscript in Review). Symposium on Reservoir Fisheries Management, American Fisheries Society.

McCauley, D.J., J. Navarro, and A. Blystra. 1996. Turbine Passage at Four Low-Head Hydroelectric Facilities in Northeast Michigan. North American Journal of Fisheries Management, 16:182-191.

McCauley, D.J., L. Montuori, J. Navarro, and A.R. Blystra. 1995. Using Strobe Lights, Air Bubble Curtains for Cost-effective Fish Diversion. Hydroreview, Vol. 15, No. 2.

McCauley, D.J., J. Navarro, and T. Forgette. 1996. A Rapid and Cost-effective Method for Field/Laboratory Extraction of Porewater from Whole Lake Sediment using Vacuum Extraction. American Society for Testing Materials, special symposium. (In Press).

Burkhard, L., B. Sheedy, D. McCauley, and G. M. DeGraeve. 1996. Bioaccumulation factors for Chlorinated Benzenes, Chlorinated Butadienes, and Hexachloroethane. Environmental Toxicology and Chemistry. (Manuscript Review).

McIntyre, D.O., D.J. McCauley, P. McCool, N. Winkler and G.M. DeGraeve. 1998. Effect of Sulfate Concentration on Acute Toxicity of Selenite and Selenate to Invertebrates and Fish. Great Lakes Environmental Center, Columbus, Ohio. EPRI, Palo Alto, CA: 1998. TR-111878.

McCauley, D.J., G.M. DeGraeve, and T.K. Linton. 2000. Sediment Quality Guidelines and Assessment: Overview and Research Needs. Env. Sci and Policy. 3(2000) 5122-5144.

Presentations:

McCauley, D.J. 1983. Feeding and Distribution of Larval Freshwater Drum (*Aplodinotus grunniens*) in Pool 7 of the Upper Mississippi River. Masters Thesis. University of Wisconsin-LaCrosse. Presented at the 8th Annual Larval Fish Conference, University of British Columbia, Vancouver, B.C.

McCauley, D.J., D.J. Call and S.H. Poirier. 1985. Comparison of Subchronic Toxicities Using Two Laboratory Fathead Minnow (*Pimephales promelas*) Assays with Identical Compounds and Exposures. Presented at the Society of Environmental Toxicology and Chemistry, Sixth Annual Meeting, St. Louis, MO.

McCauley, D.J. and M.D. Balcer. 1987. Ecological Assessment of Factors Affecting Walleye Ova Survival. American Fisheries Society, Winston Salem, North Carolina.

McCauley, D.J. 1989. Abundance and Distribution of Nearshore Forage Fishes in the Apostle Islands National Lakeshore. Eleventh Research Conference, November 01/02, 1989, Bayfield, Wisconsin.

McCauley, D.J., D.O. McIntyre, and G.M. DeGraeve. 1991. A Field and Laboratory Site-Specific Evaluation of Cadmium, Copper, and Zinc. Presented at the ASTM Aquatic Toxicology Symposium. Atlantic City, New Jersey.

McCauley, D.J., P. Lea, and P. Hoch. 1992. Whole Sediment and Sediment Pore-water Toxicity to Hyalella and Chironomus in 10-day Survival and Growth Toxicity Tests. Society of Environmental Toxicology and Chemistry. Cincinnati, Ohio.

McCauley, D.J., J. Navarro, and T. Forgette. 1992. Comparison of Fish Entrainment Studies and Tailwater Net Efficiency at Four Low-Head Hydropower Dams in Michigan. Presented at the North American Lake Management Society, 12th Annual Meeting, Cincinnati, Ohio.

Navarro, J.E., D.J. McCauley, and A.R. Blystra. 1993. Instream Flow Incremental Methodology (IFIM) for Modeling Fish Habitat. Storm water and Water Quality Conference, February 25, 1993, Toronto, Canada.

McCauley, D.J., J.E. Navarro, and T.A. Forgette. 1993. A Rapid and Cost Effective Method for Field/Laboratory Extraction of Pore-Water from Whole-Lake Sediment using Vacuum Extraction. First International Specialized Conference on Contaminated Sediments: Historical Records, Environmental Impact, and Remediation. June 14-16, 1993, Milwaukee, Wisconsin.

Blystra, A.R., D.J. McCauley, and J. Navarro. 1994. Fish Entrainment and Strategies for Diversion. Symposium on Fundamentals and Advancements in Hydraulic Measurements and Experimentation. National Conference on Hydraulic Engineering. August 1994. Buffalo, New York.

McCauley, D.J., G. Phillips, and M. Stewart. 1994. Bluegill Stress Response and the Correlation with Whole Effluent Toxicity Testing. Society of Environmental Toxicology and Chemistry. Denver, Colorado.

McCauley, D.J., J. Navarro, and A.R. Blystra. 1995. Shared Management of Fish Resources on Developed Rivers: A Balance of Needs and Resources. Reservoir Fisheries Management Symposium. American Fisheries Society. June 1995. Chattanooga, Tennessee.

McCauley, D.J., J. Navarro, and A.R. Blystra. 1995. The Effectiveness of Strobe Lighting and Air Curtains as Fish Deterrents. Midwest Hydropower User Group, Wausau, Wisconsin, August 1995; and Midwest Fish and Wildlife Conference, Detroit, Michigan, 1996.

McCauley, D.J. 1999. Fish Entainment and Turbine Survival at the Wissota Hydroelectric Facility – Chippewa River. Chippewa River Settlement Committee/NSP. Northern States Power Company, Eau Claire, WI.

McCauley, D.J. 1998. Sediment Quality Guidelines and Assessment EPRI/EPA Workshop on Sediment Quality Guidelines. Palo Alto, CA. and at the EPRI Electric Power Generation Symposia. Atlanta, GA.

McCauley, D.J., G.M. De Graeve, and J. Stricko, 2000. Ammonia Toxicity Testing Against *Hyalella azteca* at six Test Temperatures. Poster Presentation. Society of Environmental Toxicology and Chemistry, Nashville, TN.

McCauley, D.J. B. Fessell and T. Callison, 2000. Rapid Bio-Assessment Protocols for Wadeable Streams in the 1836 Ceded Territories. Midwest Fish and Wildlife Conference, December 2000 Minneapolis, MN.

Donald L. McNew **Great Lakes Environmental Center**

Environmental Technician

Education:

B.S. University of Michigan School of Natural Resources

Qualifications:

Mr. McNew has a broad background in the biological sciences. Technical experience includes employment as a laboratory and a field technician relating to water resources, as well as many laboratory and field courses at the university level. While employed as a park naturalist for many years, he gained considerable knowledge of the biology and taxonomy of the Great Lakes region's fauna and flora. He is especially skilled in the identification of plants, birds, and benthic macroinvertebrates. This has enabled him to function as a key staff person in conducting ecological inventories. Experience as a writer and editor has enhanced his communication skills in areas such as writing, organization, and computer literacy.

Relevant Experience:

Benthic Taxonomy. For the past six years at Great Lakes Environmental Center, Mr. McNew has identified macroinvertebrates in over 1000 benthic samples as part of various water quality projects. Clients include the U.S. Environmental Protection Agency, the U.S. Department of Defense, and various industrial clients. In addition, Mr. McNew is responsible for coordinating all aspects of processing benthic samples including sorting, data management, and quality control.

Ecological Surveys. Mr. McNew has participated in a number of ecological surveys in which he has observed and cataloged birds, mammals, reptiles, amphibians, and plants. At Great Lakes Environmental Center, projects include surveying waterfowl and breeding birds at hydroelectric reservoirs in Wisconsin and Michigan and conducting ecological inventories for land conservancies in Michigan. Mr. McNew also participated in ecological surveys while employed at Sleeping Bear Dunes National Lakeshore, Empire, Michigan. He recorded observations of significant species for park files and updated the Lakeshore's official bird checklist.

Resource Management Plans. For a northern Michigan land conservancy, Mr. McNew co-authored management plans for several conservancy properties. Following detailed ecological inventories, the plans were developed to balance the conservancy's goals regarding use by the public and the preservation of significant resources.

Environmental Assessments. At Great Lakes Environmental Center, Mr. McNew co-authored an environmental assessment of a proposed communications tower. The major concern addressed in the assessment was the potential impact of the proposed tower on migrating birds. Mr. McNew conducted a literature search and investigated bird mortality at an existing tower. For another assessment relating to the relicensing of hydroelectric facilities, Mr. McNew wrote a management plan for bald eagles.

Aquatic Toxicology. At Great Lakes Environmental Center, Mr. McNew has been involved in a variety of laboratory and field-based water quality tasks. He has cultured test organisms, conducted aquatic toxicity tests with those organisms, and performed effluent manipulations for industrial and municipal toxicity identification evaluations (TIEs). He also is a key member of field teams, sampling a variety of chemical, physical, and biological parameters.

Atmospheric Deposition Monitoring. At Sleeping Bear Dunes National Lakeshore, Mr. McNew assisted with acid precipitation monitoring. He was involved in the collection of samples, preliminary analyses, lab reporting, and shipment of samples to the EPA. As a volunteer in another acid precipitation study at the Lakeshore, Mr. McNew collected weekly stream samples. He performed preliminary analyses before shipping samples to Michigan Technological University where the primary research was being conducted.

Groundwater Monitoring. While employed at Otwell Consultants, Traverse City, Michigan, Mr. McNew performed sampling for a variety of groundwater remediation projects. He charted data via computer and wrote technical reports summarizing results.

Natural History Interpretation. While at Sleeping Bear Dunes National Lakeshore, Mr. McNew researched and presented programs to the public which interpreted the biological, geological, and historical resources of the park.

Writer/Editor. While employed at the *Ad-Visor Community Weekly* in Beulah, Michigan, Mr. McNew conceived and produced the front page each week, including writing original feature articles, photography, and layout. Also edited news releases and other inside copy.

Angela Millard **Great Lakes Environmental Center**

Environmental Technician

Education:

B.S. Applied Ecology & Environmental Science, Michigan Technological University.2000
Additional Science related classes: Wetlands, Forest Biometrics, Remote Sensing I & II, Watershed Management, Forest Wildlife Ecology, Plant Toxonomy, Limnology, Zoology and Natural Resource Policy, 1996-2000

Qualifications:

Ms. Millard has experience in collecting, identifying, and examining scientific data. She is also skilled in conducting laboratory analysis that monitors the impact of effluents and chemicals on water quality and aquatic communities. She has conducted acute and chronic bioassays with wastewater and sediment and, sediment/effluent manipulations for toxicity identification/reduction evaluations with industrial and municipal wastewater treatment plant effluents. She also has mass cultured and reared *Daphnia magna*, *Ceriodaphnia dubia*, fathead minnows *Hyalella,* and mysid shrimp for use in aquatic bioassays.

Ms. Millard has additional experience in conducting laboratory and field research, focused on microbiological and toxicological aspects of environmental pollution. She has extensive experience in general laboratory techniques and operations.

Relevant Experience:

Culturing and Toxicity Testing. Maintained cultures of *Daphnia magna, Daphnia pulex, Ceriodaphnia dubia, Mysidopsis bahia, Hyallela azteca, Chironomus tentans, Pimephales promelas* (fathead minnows), and *Selenastrum capricornutum* (algae).

Aquatic Laboratory Studies. Conducts routine water chemistry and nutrient analysis.

Toxicity Identification and Reduction Analysis. Conducts effluent characterizations to identify and reduce toxicity of industrial and municipal effluents.

Laboratory Technologist. Experience in maintaining and preparation of sterile laboratory techniques for laboratory and sampling equipment.

Scientific and Technical Writing. Served as Publications (Journalist). Experienced in Scientific and Technical writing (including reports, memos, proposals).

Ecosystem Impacts. Worked to improve park ecosystem (Michigan Department of Natural Resources - Parks and Recreation) by educating the public of the impacts on their environment.

SAMPLE CUSTODIAN/SAMPLE PREPARATION CHEMIST

Mark Misita **Battelle Columbus**

Research Technician

Education:

A.A.S., Hazardous Materials Technology, Ohio University, 1996

Qualifications:

Mr. Misita is currently responsible for overseeing the daily activities in Battelle's dedicated PCDD/PCDF sample preparation laboratory. His duties include maintaining supply inventories, scheduling standard and reagent preparation and extract cleanup activities to coordinate with project schedules, and calibration and maintenance of all equipment used in sample preparation activities. Mr. Misita has demonstrated success in PCDD/PCDF sample preparation using EPA Methods 1613, 8290, 23, and TO9. Mr. Misita has also participated in an internal research and development project to evaluate draft Method 1668 for toxic PCBs and has also developed preparation procedures for the determination of PCBs in sewage sludge, incinerator scrubber water, and emission samples from sewage incinerator stationary sources. He is also experienced in sample preparation for PAH and metals analysis and has extensive hazardous materials training.

Relevant Experience:

PCDD/PCDF Analyses to Determine Coastal Environment Quality. Prepared over 1200 sediment and tissue samples from multiple sites along the East Coast for PCDD/PCDF analysis according to Method 8290 and 1613. The analyses were conducted to determine environment quality and the quality of dredged material proposed for ocean disposal. Samples prepared for these programs have consistently met or exceeded data quality objectives.

PCBs in Sewage Sludge, Incinerator Emissions, and Scrubber Water. Mr. Misita led method development for the extraction of toxic PCBs by a modification of Method 1668. This method was then applied to the analysis of sewage sludge, emissions, and scrubber water from a sewage sludge incineration facility.

PCDD/PCDF in Wastewater Treatment Plant Sludges. Prepared wastewater treatment plant sludge samples from various municipalities in Ohio for PCDD/PCDF analysis according to modified Method 8290 procedures. Preparation involved additional cleanup columns for especially filthy samples.

PCDD/PCDF in Drinking Water. Drinking water samples were extracted and analyzed for a government agency. Detection limits were in the part-per-quadrillion range (less than 10 pg/Liter)

Evaluation of Influent and Effluent Water for a Water Treatment Facility. Pre-discharge water samples from a water treatment facility were extracted and analyzed for PCDD/PCDF using Method 8290 with modifications from Method 1613.

PCDD/PCDF in Air Samples. Air samples, sampled with PUF cartridges, were extracted and analyzed for a government agency using Method TO9.

PCDD/PCDF and Coplanar PCBs in Cage Wash Rinses. Prepared water samples from animal cage wash rinses for the simultaneous determination of PCDD/PCDF and coplanar PCBs. Results of these analyses were used to clear the rinse water for disposal.

Evaluation of Method 1668 for Toxic PCBs (Oct. 1995 Draft). Prepared samples for an internal research and development project to evaluate Draft Method 1668. An initial precision and recovery sample set using the tissue reference matrix (corn oil) was prepared.

PAH Studies. Participated in the development of a sample preparation method to determine PAH in resin samples. Also prepared XAD traps for collecting air samples used in PAH analysis programs. Method development of PAH in food samples using accelerated extraction and clean-up techniques such as accelerated solvent extraction (ASE), super critical fluid extraction (SFE), solid phase extraction (SPE) and immunoassay techniques. PUF and XAD clean up and trap packing

Inorganic Sample Preparation. Prepared soil samples for determination of metals following procedures in Method 3050.

Additional Training and Licenses:

- General Health and Safety Procedures
- Hazardous Communications
- Good Laboratory Practice Regulations (Mid-January 1998)
- OSHA 8-Hour Refresher Training
- OSHA 40-Hour HAZWOPER Training
- First Responder Awareness
- First Responder Operations Level
- Industrial Safety
- CPR/First Aid

SAMPLE PREPARATION

Hein (Henry) Pham **Battelle Columbus**

Technician

Education:

B.A. Chemistry, Ohio State University, 1999

Qualifications:

Mr. Pham is currently responsible for performing the daily activities in Battelle's dedicated PCDD/PCDF sample preparation laboratory. His duties include ordering supplies, reagent preparation, and performing sample extraction and extract cleanup activities to coordinate with project schedules. Mr. Pham has demonstrated success in PCDD/PCDF sample preparation using EPA Methods 1613, 8290, 23, and TO9. Mr. Pham has also participated in the setup and demonstration of EPA Method 1668A for PCB in water samples and the development of a modified Method 1668 for the determination of PCBs in sewage sludge.

Relevant Experience:

PCDD/PCDF Analyses to Determine Coastal Environment Quality. Prepared over 200 sediment and tissue samples from multiple sites along the East Coast for PCDD/PCDF analysis according to Method 8290 and 1613. The analyses were conducted to determine environment quality and the quality of dredged material proposed for ocean disposal. Samples prepared for these programs have consistently met or exceeded data quality objectives.

PCBs in Sewage Sludge, Incinerator Emissions, and Scrubber Water. Mr. Pham participated in method development for the extraction of toxic PCBs by a modification of Method 1668. This method was then applied to the analysis of sewage sludge, emissions, and scrubber water from a sewage sludge incineration facility.

PCDD/PCDF in Drinking Water. Drinking water samples were extracted and analyzed for a government agency. Detection limits were in the part-per-quadrillion range (less than 10 pg/Liter)

Evaluation of Influent and Effluent Water for a Water Treatment Facility. Pre-discharge water samples from a water treatment facility were extracted and analyzed for PCDD/PCDF using Method 8290 with modifications from Method 1613.
PCDD/PCDF in Air Samples. Air samples, sampled with PUF cartridges, were extracted and analyzed for a government agency using Method TO9.

Additional Training and Licenses:

- General Health and Safety Procedures
- Hazardous Communications

Norman A. Richardson **Harding ESE**

Associate Environmental Scientist

Education:

M.S. Science Education, University of Pennsylvania, 1987
M.S. Entomology, University of California, 1983
B.A. Biology, Dartmouth College, 1977

Qualifications:

Mr. Richardson's areas of technical expertise include ecological modeling and habitat characterization/impact assessment. He is currently responsible for managing and providing technical oversight for a variety of risk characterization and bioassessment studies and has developed and utilized various biostatistical and modeling techniques to quantify potential environmental impacts. He has also conducted over 100 ecological risk assessments including several long-term multiple source investigations. Mr. Richardson is active in various conservation groups, serves as a municipal Conservation Commissioner, and is a director of a local open space conservation group. He has also served as a volunteer for the Charles River Watershed Association for several years where he has assisted in water quality and point source identification studies. He has served on the adjunct faculty for Tufts University and as a guest lecturer at Northeastern University, where he developed and presented several graduate level courses on ecological impact assessment techniques. Specialized skill areas include:

- Ecological Risk Assessment
- Biostatistical Analyses
- Bioassay/Aquatic Toxicology
- Ecological Modeling and Analysis
- Wetlands Assessment
- Natural Resource Damage Assessment.

Relevant Experience:

Ecological Programs, Loring Air Force Base, Limestone, Maine. Task lead for ecological assessment activities at this base in northern Maine. Participated in the planning and design of a stream bioassessment work plan that was applied to the entire surface water drainage associated with the base. Key components of the assessment include a study of aquatic macroinvertebrate community structure using the EPA Rapid Bioassessment Protocol, multiple species sediment bioassays, and a habitat suitability analysis for the Atlantic Salmon. In addition, he has managed the production of ecological risk assessments at over 20 sites on the base and conducted basewide faunal surveys and habitat characterizations. Following consultation with nationally recognized nuclear radioecological experts, modeled radiological doses to ecological receptors at a former warhead storage area.

Ecological Risk Assessment, Confidential Client, Lawrence, MA. Providing ecological risk assessment and risk management support for a former manufactured gas plant site. Focused ecological investigations

on defining background conditions in this heavily industrialized (and historically polluted) reach of the river and characterizing the overall ecological value of the available habitat. Conducted a river characterization to identify available habitat features (*e.g.*, fish spawning areas, presence of submerged aquatic vegetation) with respect to significant biological resources known to occur in the river (*e.g.*, Atlantic salmon, Short-nose Sturgeon). Conducted a survey of the macroinvertebrate community and concluded that no qualitative differences in faunal diversity and biomass exist between study area and upriver reference locations. With exception of an isolated hot spot area, which will be remediated, concluded that river resources were not adversely affected by site.

Ecological Assessments, Massachusetts Military Reservation, Cape Cod, MA. Conducted a predictive ecological analysis of potential impacts to several salt ponds where contaminated groundwater will discharge. Assigned, managed, and provided technical oversight on ecological assessments for numerous sites, presented findings at public meetings, and provided input on a variety of ecological issues associated with investigation and remediation effects at the facility.

Environmental Impact Assessment, Towns of Richmond and Pownal, ME. Conducted a detailed technical review of two route alternatives of a proposed Maritimes and Northern natural gas pipeline through Maine. Led a project team that reviewed existing aerial photographs, topographic and National Wetland Inventory maps to evaluate the overall environmental impacts associated with each alternative. Potential impacts were categorized and ranked to provide a summary score. Prepared a report that summarized the assessment methodology and supported HLA's recommendation regarding the preferred alternative. In particular to the Town of Pownal, considered three resource categories in the analysis including water quality, wetlands, and upland habitat, with particular emphasis given to minimizing impacts to the Chandler Brook Watershed. Collected field data and reviewed available information to conduct the analysis.

Wetland Design/Creation, ASTEC Industries, Chattanooga, TN. Delineated wetland boundaries and conducted a qualitative wetland functional value assessment in conjunction with initial planning for a parking lot expansion project. Current plans entail the destruction of approximately one acre of emergent marsh habitat. Provided wetland permitting expertise and developed a wetland creation/mitigation plan that will focus on habitat enhancement features.

Streambank Stabilization/Restoration, Confidential Client, Baltimore, MD. Conducted a wetlands delineation and assisted in the preparation of permit applications and a restoration plan for a tidally-influenced stream. Restoration plan focused on stabilizing and revegetating a quarter mile of eroding bank that posed a potential threat to shellfish and fish resources in the Chesapeake Bay.

Ecological Assessments, New Jersey Department of Environmental Protection. As the ecological task lead for a specialty oil formulation facility, assisted in an assessment of ecological risks associated the offsite migration of lead and PCBs. Subsequently developed, and helped implement, a biological field investigation which included Microtox sediment screening, macroinvertebrate community studies, and laboratory bioassays. These data were used to provide a more detailed evaluation of potential ecological impacts and assist in developing remedial objectives at the site.

Ecological Risk Assessment, Confidential Client, Saltville, VA. Developed several aquatic and terrestrial food web models for predicting potential dietary exposure levels to organisms at different trophic levels. These models have been used in conjunction with toxicological data to evaluate ecological impacts at a variety of hazardous waste sites. At a mercury-contaminated river in Virginia, these models were used to evaluate the potential for and magnitude of site-related impacts to various aquatic organisms as well as to

terrestrial species feeding on these resources. These models were critical to the impact assessment process because a significant proportion of fish species known to occur in the affected stretch of river are threatened or endangered and required special attention during the evaluation process.

Aquatic Stream Bioassessment, Confidential Client, Lewiston, ME. Designed a bioassessment program to evaluate potential impact to natural communities associated with the discharge of contaminated groundwater into a nearby stream. Management activities included coordination with state regulatory staff regarding project design, evaluation/selection of a subcontractor, and oversight of all biological assessment activities. Interpreted results and incorporated these into an ecological risk assessment.

Biomonitoring Program, Naval Ordnance Station, Indian Head, MD. Developed a biomonitoring work plan in support of planned remedial activities in a mercury-contaminated tidal pond at the Indian Head NOS adjacent to the Mattawoman Creek in Maryland. The sampling program will include laboratory sediment bioassays, in situ toxicity studies, and macroinvertebrate community studies. Field sampling and laboratory studies conducted prior to, during, and for a period of years following the stream dredging activities. These results will be used to evaluate preexisting conditions within the tidal pond as well as the ecological response to remediation. In addition, biomonitoring results from this study will be compared with similar data collected by the United States Fish and Wildlife Service as part of a multiple year sampling program in the Mattawoman Creek itself.

Wetland Delineations, Various Clients, ME, MA, NH, ME, and West VA. Performed numerous wetland boundary delineations and assisted in preparation of permit applications. Met with regulatory agencies and the local conservation commissions to describe and develop project designs in accordance with all applicable wetlands regulations.

Ecological Risk Strategy Development, Hercules, Brunswick, GA. Provided corporate-level risk management assistance for a newly listed NPL site on a coastal estuary in southern Georgia. Conducted a thorough ecotoxicological assessment of the potential impacts of the primary contaminant of concern, toxaphene, on marine resources and assisted in the development of strategic options for the client in negotiation with federal and state regulators.

Site-specific Water Criteria Development, Confidential Client, Ashtabula, PA. Evaluated available approaches to developing a site-specific water criteria for hexavalent chromium at a chemical processing plant in western Pennsylvania. Confirmed the critical role of water hardness in affecting the toxicity of this chemical to aquatic receptors following a review of the toxicological data compiled by USEPA to develop the national criteria. Concluded that existing permit requirements were overly protective for the hard water conditions of the receiving water body and determined that a site-specific approach would likely provide regulatory relief to the client. Recommended that a combination of a resident species approach and metals translator procedure be employed to address discharge requirements. Assisted in the development of a project work plan, which is currently being implemented.

Memberships:

- Conservation Commissioner for City of Newton, Massachusetts
- Massachusetts Association of Conservation Commissions
- Newton Conservators, Board of Directors
- Charles River Watershed Association
- Society of Environmental Toxicology and Chemistry
- Society for Risk Analysis

Publications and Presentations:

1998. "Strategic Sampling Approach to Support Risk Assessment at the U.S. Army Sudbury Annex, MA"; The 14th Annual Conference on Contaminated Soils; Amherst, MA; October 18-21, 1998 (with T. Eschner, J. Peterman, A. Fogg, and T. Strunk).

1997. "Ecological Risk Assessment Under the Recent NJ Technical Requirements"; Environmental Regulations in New Jersey seminar; Morristown, NJ; April 16-17, 1997.

1996. "Refinements to an Ecological Risk Assessment: Multiple Lines of Evidence and Risk Uncertainties"; Ecological Risk Assessment and Military Related Compounds: Current Research Needs Conference, Denver, CO; July 31 – August 2 1996 (with N. Roka and J. Pickett).

1995. "Uncertainty Analysis of Bioaccumulation Factors Used in Terrestrial Food Chain Models for Ecological Assessments"; The 16th Annual Meeting for the Society of Environmental Toxicology and Chemistry (SETAC), Vancouver, B.C., Canada; November 1 - November 4 (with C. Welsh and J. Duncan).

1995. "Ecological Risk Assessment for the Practitioner"; 4-week course given at Tufts University, Center for Environmental Management, Medford, MA; June 1994 and June 1995.

1995. "Ecological Risk Evaluation of Contaminated Sediments"; continuing education workshop given at Tufts University, Center for Environmental Management, Medford, MA; December 8.

1995. "Regional Ecological Risk Evaluation of Surface Water/Sediment Contamination at a Large Military Installation"; The 15th Annual Meeting for the Society of Environmental Toxicology and Chemistry (SETAC), Denver, CO; October 30 - November 2 (with M. Murphy and J. Bleiler).

1995. "Balancing the Risk of Habitat Alteration and Environmental Contamination in a Contaminated Forested Wetland"; The 15th Annual Meeting for the Society of Environmental Toxicology and Chemistry (SETAC), Denver, CO; October 30 - November 2 (with J. Bleiler and G. Daukus).

1994. "Uncertainty Analysis of Bioaccumulation Factors Used in Terrestrial Food Chain Models for Ecological Assessments"; The Ninth Annual Conference on Contaminated Soils, Amherst, MA; October 17-20, 1994 (with C. Welsh).

1993. "Introduction to Ecological Risk Assessment"; 4-week course given at Tufts University, Center for Environmental Management, Medford, MA; June 7-30.

1993. "Ecological Assessment of Mercury Contamination in the North Fork Holston River"; Presented at the Water Environment Federation Specialty Conference Series (Developing Cleanup Standards for Contaminated Soil, Sediment, & Groundwater - How Clean is Clean?) in Washington, D.C.; January 10-13 (with K. Roberts and T. Pride).

1989. "Assessment of Site Specific Sediment Toxicity by Theory and Bioassessment: The Integration of Sediment Quality Assessment Methods for Ecological Risk Assessment at a Superfund Site"; Poster presentation at the 10th Annual Society of Environmental Toxicology and Chemistry Conference in Toronto, Ontario; November (with J.A. Burris and T.S. Eschner).

1989. "The Application of Joint Probability Analysis for Assessing Aquatic Ecological Risk"; Presented at Oceans '89 Conference in Seattle, WA; September 18-21 (with J.S. Volosin and R.A. McGrath).

1989. "Hazardous Assessment in ACL Demonstration"; Presented at the 6th Annual HWHM Conference in New Orleans, LA; April 12-14, 1989 (with M.J. Donato and A.H. Baldwin).

1989. "Sediment Bioassay for Target Cleanup Determination"; Presented at the 6th Annual HWHM Conference in New Orleans, LA; April 12-14 (with M.J. Donato and A.H. Baldwin).

Craig S. Schenning **Severn Trent Laboratories**

Section Chief, Organic Volatiles Department

Education:

Catonsville Community College; 1991
University of Maryland; 1985
Salisbury State University; 1982

Qualifications:

Mr. Schenning is the Section Chief of our Organic Volatiles and HPLC Departments with more than 10 years' experience in environmental chemistry, including organic extractions and GC and GC/MS analysis. He has previously been responsible for organic data review, organic analysis of volatile compounds by GC and GC/MS, as well as organic extractions of soil and water samples, and the preparation of laboratory data. Mr. Schenning is knowledgeable in EPA-CLP methodology as well as SW846, 40CFR, USATHAMA, and USEPA drinking water methods.

Relevant Experience:

Management – Currently serves as VOA/HPLC Section Chief for STL. Duties include supervising of organic analysis of volatile compounds by GC, GCMS and HPLC, reduction of data, and processing of reports. He also is responsible for scheduling of employees and assignments. Knowledgeable in EPA-CLP methodology as well as SW846, 40CFR, USATHAMA, and USEPA drinking water methods. He is also capable of project summary and data review of these methods.

Sample Custodian– Was responsible for the log-in and tracking of both incoming and outgoing samples from the laboratory. Also managed the distribution of samples for proper analyses physically within the lab and also within the LIMS computer system. Additional responsibilities included the disposal of non-hazardous wastes and notification of proper agencies to dispose of hazardous waste.

Organic Extractionist – Was responsible for the extraction and preparation of water, soil, and oil samples for the analysis of pesticide, PCB, semivolatile, and herbicide compounds. Also was responsible for the clean-up of samples using florisil, alumina, acid, sulfur, and gel permeation chromatography. Extraction methods included soxhlet, sonication, sept-funnel, and continuous liquid-liquid.

Organic Extractions Supervisor – Responsible for the supervision of 2-8 employees in the extraction, preparation, and clean-up of samples for the analysis of pesticide, PCB, semivolatile, and herbicide compounds.

Data Coordinator – Responsible for the preparation and generation of hardcopy and electronic deliverables of organic data for client evaluation. Additional responsibilities included the downloading of data from instrumentation into appropriate software packages for data completion.

Data Coordination Specialist – Responsible for the generation of both hardcopy and electronic data deliverables, as well as the management and archival of database files used in the generation of data deliverables.

DIOXIN LABORATORY MANAGER

Mary E. Schrock **Battelle Columbus**

Principle Research Scientist

Education:

B.S., (Summa Cum Laude) Chemistry, Kent State University, 1986

Qualifications:

Ms. Schrock's primary responsibility is managing large PCDD/PCDF analysis programs for various government and industrial clients. Ms. Schrock has overseen the analysis of several thousand PCDD/PCDF samples and has consistently provided clients with data packages that meet or exceed quality assurance requirements and are on time and within budget. Ms. Schrock has more than 13 years of experience creating and optimizing analytical methods for separating, identifying, and quantifying trace levels of organic compounds in environmental samples and consumer products, including over 8 years in the analysis of PCDD/PCDF compounds by GC/HRMS. Ms. Schrock has provided data packages meeting the quality control criteria of EPA Methods 8290, 1613, 23, and TO9. In addition, Ms. Schrock led the development of procedures to simultaneously determine PCDD/PCDF and coplanar PCBs, and also led an internal evaluation of Draft Method 1668 for toxic PCBs.

Relevant Experience:

PCDD/PCDF Analyses to Determine Coastal Environment Quality. Managed programs from multiple sites along the east coast to evaluate more than 1,000 sediment and tissue samples from bioaccumulation studies to determine environment quality and the quality of dredged material proposed for ocean disposal. These data packages have consistently met or exceeded data quality objectives and have been performed within time and budget constraints.

Toxic PCBs in Sewage Sludge Incinerator Emissions. Assisted in the development of HRMS methods for determining toxic PCBs in raw sewage sludge, sewage sludge incinerator emissions, and incinerator scrubber water. These methods were then applied to the analysis of samples from a sewage sludge incinerator facility to assist in source characterization.

Support for the Dioxin Workgroup of the Canada-U.S Binational Toxics Strategy (BNS). Researched the current literature and worked with contacts at EPA to develop several reports presenting an overview of dioxin sources and providing direct answers to stakeholder questions concerning dioxin inventories with respect to their quality, remaining uncertainties, and points of contention. The reports were well received by both EPA and the multi-stakeholder dioxin workgroup.

Simultaneous Determination of PCDD/PCDF and Coplanar PCBs. Led the development of sample preparation and GC/HRMS analysis procedures to simultaneously determine PCDD/PCDF and coplanar PCBs. This single procedure has allowed clients to evaluate not only PCDD/PCDF, but also the dioxin like coplanar PCBs in their environmental samples at little additional cost.

Evaluation of Method 1668 for Toxic PCBs (Oct. 1995 Draft). Led an internal research and development project to evaluate Draft Method 1668. Coordinated preparation and analysis efforts to evaluate procedures for tissues using corn oil as the reference matrix.

Remedial Investigation and Ecological Assessment for Surface Water and Sediments at the McCormick and Baxter Superfund Site. Managed the PCDD/PCDF analysis task of this program, which included analyzing 100 tissue and sediment samples for PCDD/PCDF and coplanar PCBs. EPA Method 8290 was adapted for simultaneous determination of PCDD/PCDF and coplanar PCBs. Tissue types included a variety of fish, crayfish, and worms from bioaccumulation test studies. TCDD detection limits less than 1 pg/g were obtained. Battelle received an overall "excellent" rating from EPA Region IX for work supporting this Superfund program.

Draft Guidance Document on Evaluation of Dredged Material Contaminated with PCDD/PCDF. Provided technical expertise on the analysis of PCDD/PCDF and the use of EPA approved PCDD/PCDF analytical methods for this draft guidance document, which is being prepared to assist regulators involved with dredged material testing.

Technical Support to the Exploratory Statistical Analysis of Dioxin Data in Meat and Poultry. Provided dioxin analysis expertise to support an exploratory statistical analysis of beef, pork, and poultry data generated as part of the U.S. EPA Dioxin Exposure Initiative.

Dioxin/Furan Analysis of Lobster and Fish Tissues. As Project Manager, oversaw the analysis of lobster muscle and hepatopancreas tissues and tissues from fish collected in the New York Bight Apex and nearby areas for chlorinated dioxins and furans. Study requirements included achieving a 1 pg/g MDL under EPA Method 8290 and analyzing extensive quality control samples to ensure precision and accuracy of the data. Several hundred samples were analyzed under these projects. The lobster and fish data were used by NOAA to develop information on potential contamination of organisms captured by recreational and commercial fishermen in the area.

Study of Toxic Emissions from Coal-Fired Power Plants. Coordinated and participated in the PCDD/PCDF analysis of emission from coal-fired power plants to help characterize toxic emissions for the U.S. Department of Energy.

PCDD/PCDF in Kuwait Air Samples. Organized and participated in the analysis of ambient air samples from Kuwait for the U.S. Army Environmental Hygiene Agency. This study provided key data in determining air quality in the vicinity of oil fires.

PBDD/PBDF Characterization of Commercial Products. Modified and optimized GC/HRMS methods for determining polybrominated dibenzo-p-dioxins and dibenzofurans in flame retardants in support of product registration.

PCB Analysis of Air Samples from a PCB Fire. Provided GC/ECD determination of polychlorinated biphenyls (PCB) in ambient air samples collected during a PCB fire.

Additional Training and Licenses:

- Opusquan Training Course; Fisons Instruments, 1994

- Basic Operation of the VG Autospec Mass Spectrometer - Fisons Instruments, 1994
- ACS Course - Mass Spectrometry: Principles and Practice; Michigan State University, 1991
- Fundamentals of Chromatographic Analysis; Kent State University, 1988
- Basic Capillary GC; Northeastern University; Chrompak, 1987

Professional Affiliations:

Ms. Schrock is a member of the American Chemical Society, Phi Beta Kappa, and Iota Sigma Pi. She was the recipient of a Lubrizol Foundation Scholarship in 1984 and an Honors College Scholarship during the period 1982-86. She received an Undergraduate Award in Analytical Chemistry and was recognized as Outstanding Junior Class Chemistry Major in 1985.

Pertinent Publications:

Schrock, M.E.; Barrows, E.S.; Rosman, L.B.; "Biota-to-Sediment Accumulation Factors for TCDD and TCDF in Worms from 28-Day Bioaccumulation Tests," Chemosphere, Vol. 34, Nos 5-7, pp. 1333-1339, 1997.

Schrock, M.E.; Armbruster, M.J.; Riggs, K.B.; Tabor, J.E.; Doherty, A.K.; Lorber, M. "Simultaneous Determination of PCDD/PCDF and Dioxin-Like PCBs in Edible Vegetable Oils," Dioxin '96 - 16th International Meeting, Amsterdam, The Netherlands, August 1996.

Riggs, K.B.; Roth, A., Kelly, T.J.; Schrock, M.E.; "Ambient PCDD/PCDF Levels In Montgomery County, Ohio: Comparison to Previous Data and Source Attribution," Dioxin '96 - 16th International Meeting, Amsterdam, The Netherlands, August 1996.

Schrock, M.E.; Barrows, E.S.; Rosman, L.B.; "TCDD/TCDF Levels in Bioaccumulation Test Tissues and their Corresponding Sediments," Second SETAC World Congress, Vancouver, British Columbia, Canada, November 1995.

Schrock, M.E.; Barrows, E.S.; Rosman, L.B.; "TCDD/TCDF Levels in Bioaccumulation Test Tissues and their Corresponding Sediments," Dioxin '95 - 15th International Meeting, Edmonton, Alberta, Canada, August 1995.

Riggs, K.B.; Brown, T.D.; Schrock, M.E.; "PCDD/PCDF Emissions from Coal-Fired Power Plants," Dioxin '95 - 15th International Meeting, Edmonton, Alberta, Canada, August 1995.

Tsai, C.; Maxwell (Schrock), M.; *et al.* "Co-crystallization of Interferon-Inducing Drug Ethidium Bromide with Nucleic Acids," The Ohio Journal of Science, 80, 38, 1984.

SENIOR ECOLOGIST

Irvin Schultz **Battelle MSL**

Senior Research Scientist

Education:

Ph.D. Pharmacology/Toxicology, Washington State University, 1990
B.S. Fisheries Biology, Oregon State University, 1986

Qualifications:

Mr. Schultz has been a researcher at Battelle since 1996. His interests lie in developing PK-PD models for Vitellogenin formation and ethynylestradiol exposure in trout, molecular mechanisms by which ethynylestradiol reduces fertilization rate in trout, haloacetate metabolism and in-vitro – in vivo correlation of metabolic clearance, and in developing PBPK models for prediction of human exposures to haloacetate mixtures.

Relevant Experience:

- "Mechanisms Involved in Trichloroethylene Induced Liver Cancer: Importance to Environmental Cleanup" Awarded by U.S. Department of Energy, Environmental Management Science Program
- "Determination of Estrogenic Effects of Environmental Contaminants." Awarded by U.S. Department of Energy's laboratory directed research and development program.
- "Physiologically Based Pharmacokinetic Modeling of Haloacid Mixtures in Rodents and Humans." Awarded by U.S. Environmental Protection Agency STAR grants program.
- "Haloacid Kinetics in Humans". Approved for funding by U.S. Environmental Protection Agency's STAR grants program.

Publications:

Abbas, R., I.R. Schultz, S. Doddapaneni, and W.L. Hayton. (1996). Toxicokinetics of Parathion and Paraoxon in Rainbow Trout After Intravascular Administration and Water Exposure. *Toxicol. Appl. Pharmacol.* 136: 194-199.

Barron, M.G., Schultz, I.R. and Newman, M.C. (1999). Pharmacokinetics of Intravascularly Administered Zinc-65 in Channel Catfish. *Ecotoxicology and Environmental Safety.* 45(3):304-309.

Barron, M.G., I.R. Schultz and W.L. Hayton. (1989). Presystemic Branchial Metabolism Limits Di-2-ethylhexyl Phthlate Accumulation in Fish. *Toxicol. Appl. Pharmacol.* 98: 49-57.

Barton, H.A., Bull, R.J., Schultz, I.R. and Andersen, M.E. (1999). Dichloroacetate (DCA) Dosimetry: Interpreting DCA-Induced Liver Cancer Dose Response and the Potential for DCA to Contribute to Trichloroethylene-Induced Liver Cancer. *Toxicology Letters.* 106(1):9-21.

Gonzalez-Leon, A., Merdink, J.L., Bull, R. J., Schultz, I. R. (1999). Effect of Pretreatment with Dichloroacetic or Trichloroacetic Acid in Drinking Water on the Pharmacokinetics of a Subsequent Challenge Dose in B6C3F1 Mice. *Chemico-Biological Interact.* 123:239-253.

Gonzalez-Leon, A., Schultz, I. R., Xu, G., Bull, R. J. (1997). Pharmacokinetics and metabolism of dichloroacetate in the F344 rat after prior administration drinking water. *Toxicol. Appl. Pharmacol.* 146, 189-195.

Hayton, W.L. and I.R. Schultz. (1991). Scaling Bioconcentration and Pharmacokinetic Parameters for Body Size and Environmental Variables in Fish, in Aquatic Toxicology and Risk Assessment: Fourteenth Volume, ASTM STP 1124, M.A. Mays and M.G. Barron, Eds., American Society for Testing and Materials, Philadelphia, pp. 149-165.

McCloskey, J.T., Schultz, I.R and M.C. Newman. (1998). Estimating the oral bioavailability of methyl mercury to channel catfish (*Ictalurus punctatus*). *Environmental Toxicology and Chemistry* 17(8):1524-1529.

Merdink, J.L., Bull, R.J. and I.R. Schultz. (1999). Hepatic Metabolism of Bromodichloroacetate by B6C3F1 Mice. Submitted to *Chemical Research & Toxicology.*

Merdink, J.L., Bull, R.J. and I.R. Schultz. (1999). Toxicokinetics of Bromo-dichloroacetate (BDCA) in B6C3F1 mice. In Press *Journal of Applied Toxicology*

Merdink, J.L., Bull, R.J. and I.R. Schultz. (1999). Trapping and Identification of the Dichloroacetate Radical from the Reductive Dehalogenation of Trichloroacetate by Mouse and Rat Liver Microsomes. In Press *Journal of Free Radicals in Biology and Medicine.*

Merdink, J.L., Gonzalez-Leon, A.G., Bull, R.J. and I.R. Schultz (1998). Dichloroacetic acid formation in B6C3F1 mice following administration of trichloroethylene or its metabolites. *Toxicolgical Sciences* 45(1):33-41.

Peters, E.L., I.R. Schultz and M.C. Newman. (1999). Rubidium and Cesium Kinetics and Tissue Distributions in Channel Catfish (Ictalurus punctatus). *Ecotoxicology* 8(4):287-300.

Schultz, I.R., Orner, G.A., Merdink, J.L and Drum, A.S. Dose-Response Relationships and Pharmacokinetics of Vitellogenin in Rainbow Trout after Intravascular Administration of 17α-ethynylestradiol. In Press *Aquatic Toxicology.*

Schultz, I.R. and W.L. Hayton. (1999). Interspecies Scaling of the Bioaccumulation of Lipophilic Xenobiotics in Fish: An Example Using Trifluralin. *Environmental Toxicology and Chemistry* 18(7): 1440-1449.

Schultz, I.R. and W.L. Hayton. (1999). Predicting the Toxicokinetics of Trifluralin in Rainbow Trout Using Clearance Volume Pharmacokinetic Models. In (D. Smith and W. Gingerich eds.) Xenobiotic Metabolism in Aquatic Species. American Chemical Society Press, pp 150.

Schultz, I.R., Merdink, J.L., Gonzalez-Leon, A.G. and R.J. Bull. (1999). Comparative Toxicokinetics of Chlorinated and Brominated Haloacids in F344 rats. *Toxicology and Applied Pharmacology.* 158: 103-114.

Schultz, I.R., Barron, M.G., Newman, M.C. and Vick, A. (1999). Blood Flow Distribution and Tissue Allometry in Channel Catfish (*Ictalurus punctatus*). *Journal of Fish Biology.* 54:1275-1286.

Schultz, I. R. and W. L. Hayton. (1997). Influence of Body Fat on Trifluralin Toxicokinetics in Rainbow Trout (*Oncorhynchus mykiss*) . *Environmental Toxicology and Chemistry.* 16(5):997-1001.

Schultz, I.R and M.C. Newman. (1997). Interspecies Differences in the Toxicokinetics of Methyl Mercury in Fish. *Environmental Toxicology and Chemistry* 16(5):990-996.

Schultz, I.R., E.L. Peters and M.C. Newman. (1996). Toxicokinetics and Disposition of Inorganic Mercury and Cadmium in Channel Catfish After Intravascular Administration. *Toxicol. Appl. Pharmacol.* 140: 39-50.

Schultz, I.R., W.L. Hayton and B.H. Kemmenoe.(1995). Disposition and Toxicokinetics of Diquat in Channel Catfish. *Aquat. Toxicol.* 33: 297-310

Schultz, I.R. and W.L. Hayton. (1994). Body Size and the Toxicokinetics of Trifluralin in Rainbow Trout. *Toxicol. Appl. Pharmacol.* 129: 138-145.

Schultz, I. R. and W.L. Hayton. (1994). Toxicokinetics of Trifluralin in Rainbow Trout. *Aquat. Toxicol.* 26: 287-306.

Schultz, I.R. and W.L. Hayton. (1991). Experimental Design for Pharmacokinetic Data Analysis Using Compartmental Pharmacokinetic Models, in Aquatic Toxicology and Risk Assessment: Fourteenth Volume, ASTM STP 1124, M.A. Mays and M.G. Barron, Eds., American Society for Testing and Materials, Philadelphia, pp. 139-148.

Szoke, A., Hayton, W.L. and I.R. Schultz. (1997). Quantification of Benzocaine and its Metabolites in Channel Catfish Tissues and Fluids. *Journal of Pharmaceutical and Biomedical Analysis.* 16, 69-75.

Michael P. Sekel **Severn Trent Laboratories**

Laboratory Director

Education:

B.S., B.A University of Washington
Numerous in-depth seminars and workshops related to management, TQM and customer service.

Qualifications:

Responsible for all aspects of the Baltimore operation of STL. Full Profit and Loss responsibility for all functions of an 18,000 square foot facility with 60 associates and a $6 million annual operating budget.

Relevant Experience:

QuantIMS Implementation Director, Severn Trent Laboratories, (1979–Present)
Leading the implementation team to standardize all facilities nationwide on a common Information Management System. Requires coordinating hardware, software, software development and testing, training and post cutover support from resources around the country.

Regional IT Operations Director (1994– 1996)
Managed the activities of information services. Installed AS/400 based information management system at four facilities. Developed regional budget and achieved cost savings goals. Created a team capable of providing 24-hour hardware/software support. Coordinated software development. Planned and coordinated NT based data communication networks. Supervised personnel responsible for systems support at six regional locations. Directed, coordinated, installed and refined computer based tools to automate data collection and data processing.

Operations Manager, Enseco (1992– 1994)
Selected to build an operational team to return a facility to profitability and making customer service everyone's goal. Shared full P&L responsibility for all functions of a 40,000 square foot facility with 165 associates and a $9 million annual operating budget. Developed Basic Concepts of Leadership, a leadership-training course for all associates. Introduced and implemented Total Quality Management. Improved on time delivery from 30% to 80%. Presented at Corning's annual Quality Day. Handled personnel decisions in operations. Produced corporate training video. Coordinated the design of a pilot hardware/software system which standardized processes across two facilities, increasing productivity and quality while reducing operating expenses.

Business Development Manager, Enseco (1990–1992)
Analyzed other analytical services opportunities to diversify company. Managed health science (industrial hygiene) division. Developed new market directives. Responsible for budget development and profitable operation. Active in sales and marketing activities. Conducted market studies for possible expansion into pharmaceutical industry.

Vice President/Lab Manager, Wadsworth/ALERT Laboratories (1985–1990)
Started fixed laboratory operation through acquisition and expansion of existing bankrupt operation. Responsible for P&L. Negotiated supplier/vendor agreements. Increased annual revenues from $60,000 to over $1 million. Responsible for all facets of the new operation including sales, customer service, operations and information systems. Developed data management process specifications. Member of the Board of Directors.

Senior Chemist, Wadsworth/ALERT Laboratories (1979-1985)
Researched, developed, and implemented analytical methods. Developed and maintained quality programs. Key member of the team which developed and implemented the infrastructure and support systems required to be awarded a USEPA contract generating $300,000 annually and improving the reputation and recognition of the company resulting in increased annual revenues to over $18 million.

Mike A. Seymour **Applied Marine Sciences, Inc.**

Grain Size and TOC Analyst

Education:

B.S. Chemistry, University of Houston, 2002

Qualifications:

Mr. Seymour has over six years experience in the field and laboratory as a research technician. He has demonstrated expertise in sample collection and preservation techniques, and geotechnical and chemical testing.

Mr. Seymour has worked on hundreds of geotechnical and geochemical projects providing index properties testing, particle size analysis following sieve/pipette and sieve/hydrometer protocols, rigid and flexible wall permeability for coarse and fine-grained soils, Atterberg limits, volume change tests (consolidation and swell), total inorganic and organic carbon analyses for soil and water samples using a CO_2 coulometer, field and laboratory chemical probe analyses, chemical sample preparation and analysis for organic and inorganic chemicals using wet chemistry, GC/MS, IC, HPLC, and UV-Visible spectrum instrumentation.

Relevant Experience:

Project Analyst: Palos Verdes Pilot Capping Project and Supplemental Survey. Confidential Client. Lead Analyst for soil classification, grain size, bulk density, specific gravity, Atterberg limits, and moisture content analyses.

Project Analyst: U.S. Army Corps of Engineers, New England Division, Weymouth Fore River. Provided soil classification, moisture content, and grain size technical support.

Project Analyst: Dabob Bay. Performed total organic carbon analysis on sediments.

Project Analyst: Harbor and Outfall Monitoring Program, Boston Harbor, MA. Provided total organic carbon testing of sediment samples from sites within Boston Harbor and Massachusetts Bay.

Project Analyst, Drilling Mud Assessment, U.S. Virgin Islands. Provided physical characterization services in support of a study designed to determine the potential impact of a drilling mud and hydraulic oil release in an aquatic setting. As analyst he performed moisture content, grain size, and total inorganic and organic carbon analyses.

Research Technician, Laboratory for Environmental and Oceanographic Research, Texas A&M University. Performed analysis of water samples for ^{129}Iodine vs. ^{127}Iodine ratios as a current/time tracer. Assisted with development of a wet chemistry and high performance liquid chromatography process, ending with atomic mass spectrometer analysis at Lawrence Livermore National Laboratory.

Research Technician, Bio-aquatic Research Facility, Department of Biology, Texas A&M University. Assisted with laboratory analysis of tissue and serum samples for corticoid bio-molecules (from marine turtles, red drum, catfish, and goldfish) using gel electrophoresis and high performance liquid chromatography.

Professional Affiliations:

- American Chemical Society (ACS)

Sarah S. P. Shah **Harding ESE**

Senior Environmental Specialist

Education:

B.A. Physics, University of Chicago, Illinois, 1986

Qualifications:

Ms. Shah has developed a broad base of environmental consulting experience over the past 11 years, encompassing Brownfield Redevelopment, regulatory agency interaction and reporting, Phase I and II environmental site assessment, risk-based site closure, remediation evaluation and implementation, and environmental construction oversight. Ms. Shah currently provides environmental consulting services focused primarily on Brownfields, and industrial and commercial projects in the United States.

Relevant Experience:

Site Assessment and remediation, Starwood Hotels and Resorts Worldwide Inc., Houston, Texas. Ms. Shah managed the assessment and remediation of soil impacted with dry-cleaning solvents beneath the basement of a 25-story hotel to achieve site closure under the Texas Voluntary Cleanup Program prior to sale of the site. Assessment and remediation activities were performed at night to minimize impact to hotel operations and guest services during the busy holiday season. The project included asbestos abatement, assessment of soil beneath the hotel, installation of a soil vapor extraction system, and technical report preparation. Ms. Shah directed HLA's field team and more than 10 subcontractor; provided oversight of health and safety procedures; coordinated between the client, property owner, hotel personnel, and legal counsel; and negotiated with regulators.

Site Investigation for Privatization, Ethylene Manufacturing Plant, Veracruz, Mexico. Responsibilities included coordinating and managing the field effort associated with a Site Investigation of a 150-acre ethylene manufacturing facility. The field effort consisted of a subsurface investigation of soil and groundwater in active and historic waste disposal areas, an evaluation of air emission sources and sampling of boiler and furnace stacks, and an evaluation of the facility wastewater treatment systems. Functioned as the point of contact for facility personnel, supervisor for the HLA field team and subcontractors, as well as the soil/groundwater investigation team leader. Other responsibilities included oral presentations of project results to corporate and facility personnel and preparation of technical reports, project work plans, and site-specific health and safety plans.

Risk-Based Site Closure, Mercedes-Benz of North America, Laredo, Texas. Managing the oversight of closure activities of a 2,000-acre vehicle proving ground. Assessment and remediation of 16 areas of concern was performed by the property owner under the Texas Voluntary Cleanup Program to facilitate a pending real estate transaction. Responsibilities include management of HLA's field oversight team, oral presentations of project progress to representatives of Mercedes-Benz and Daimler-Benz, review of assessment and remediation work plans, coordination with regulators and property owners to identify appropriate cleanup standards, and review of Response Action Completion Report.

Petroleum Storage Tank Program, City of Houston, Texas. Managed the construction phase of a petroleum storage tank compliance project for the City of Houston. This phase of the project represented over $500,000 in consulting fees and approximately $2,500,000 in contractor fees. During this program, more than 100 petroleum storage tanks at over 50 city facilities were removed, replaced, or retrofitted within a four-month period. Responsibilities included supervising and coordinating 20 field engineers and technicians as well as six construction contracting firms; negotiating with regulatory agencies on behalf of the City; reviewing contractors' work, scheduling and invoicing; supervising environmental sampling and compliance; along with budget tracking and invoicing.

Brownfield Pilot Program, City of Houston, Houston, Texas. HLA has been contracted to provide environmental services to support the City of Houston's Brownfield Assessment Demonstration Pilot Grant from the USEPA. Responsible for managing the environmental projects performed under this grant program. Responsibilities include developing scopes of work and managing environmental consulting services provided at various Brownfield Pilot sites, oral presentations of project progress to the City's Land Redevelopment Committee, coordinating with Brownfield stakeholders to facilitate communication, and preparing weekly progress reports, budget tracking, and invoicing. MS. Shah worked hand in hand with the City of Houston as they grew from a brand new Pilot program in 1997 to one of the most successful programs in the country.

Phase I and II ESA, Solar Turbines Inc., Channelview, Texas. Ms. Shah managed and performed a Phase I and II ESA of an oilfield pipe refurbishing facility as part of the due diligence activities associated with purchase of the property. Responsibilities included oversight of the field sampling team, evaluation of the site data, development of remedial strategies and associated costs, interaction with the regulatory agency, and oral presentations of the project findings to the property owners and buyers. The project documents were used to obtain site closure under the Texas Voluntary Cleanup Program.

Petroleum Storage Tank Services, Texas Department of Transportation, Houston, Texas. Managed and monitored UST removals and closures for the Texas Department of Transportation from 1992 to 1993. These projects represented approximately $200,000 in consulting fees and $1,100,000 in contractor fees. Responsibilities included negotiating with regulatory agencies on behalf of the of the client, supervising field personnel and UST removal contractors, reviewing contractor invoices, project budget tracking, environmental sampling and report preparation. Negotiated contaminant remediation goals with the Texas Natural Resource Conservation Commission (TNRCC), which saved the Texas Department of Transportation over $150,000.

Tenant Impact Evaluation, Confidential Commercial Developer, Houston, Texas. Managed and performed environmental site assessment activities to determine the environmental impact of an oil blending and packaging facility on the lessor's property. Responsibilities included project management, coordination of eight field personnel, management and performance of field work, data analysis, report preparation and interaction with regulatory agencies, tenants, and client's legal counsel. Activities included identification of potential environmental concerns, monitoring and sampling during excavation of contaminated soils along a 400-foot railroad spur, delineating contaminated soils beneath a concrete slab in a 7,000-square-foot tank farm and sampling soils adjacent to onsite sumps.

UST Assessment, Ryder Truck Rental, Inc., Amarillo, Texas. Evaluated soils to determine the vertical and horizontal extent of contamination resulting from releases from fuel delivery lines. Identified an additional fuel release which extended to a depth of 160 feet at the facility during the investigation of a small release. Activities included coordination of field activities, advancing thirteen borings to depths

ranging from 20 to 180 feet, soil classification and sampling, field and laboratory data analysis, report preparation and interaction with the TNRCC.

Sludge Characterization, Confidential Oil Company, Upton County, Texas. Performed field evaluation of sludge disposal ponds ranging from one-quarter acre to seven acres in size at an former oil refinery. Activities included coordination of field activities, sludge sampling, pond volume estimating, laboratory data analysis, and report preparation. Level C safety equipment and procedures were used during the field activities.

Gas Pipeline Assessment, Confidential Client, Southeastern New Mexico. Performed a surface and subsurface assessment associated with a real estate transaction of approximately 24 remote compressor stations and dehydration facilities along a natural gas pipeline. The scope of work included collecting surficial soil samples at each facility to identify petroleum and arsenic releases. A subsurface assessment was performed of the impacted areas identified with elevated petroleum and arsenic concentrations in the first phase of field sampling. Other activities included data evaluation, report preparation, evaluation of regulations and risk assessment techniques to identify applicable remediation guidelines, and negotiation with facility owners to establish remedial guidelines for the transaction.

Petroleum Pipeline Assessment, Confidential Client, Central and Eastern Texas. Performed a subsurface assessment associated with a real estate transaction at seven compressor stations along a petroleum pipeline. The pipeline was scheduled to be converted from transportation of crude oil to natural gas. The scope of work included collecting shallow subsurface soil samples near underground sumps and aboveground storage tanks to assess whether releases had occurred from the tanks. Activities included field sampling, laboratory analytical data interpretation, and report preparation

Industrial Assessment, Metropolitan Insurance Company, Denver, Colorado. Evaluation of soils at a metals reclaiming facility to determine the vertical and horizontal extent of metals and organic chemicals release through a corroded sanitary sewer line. Activities included safety plan development, coordination of field activities, soil sampling beneath the building foundation slab, monitoring and documenting third party sample collection, field and laboratory data analysis, and report preparation. Level B safety equipment and procedures were use during the field activities.

Remediation Evaluation, Confidential Chemical Manufacturing Plant, Bay City, Texas. Evaluated alternative remedial methods appropriate for the clean-up of diesel fuel contaminated soil in the fire training ground of a chemical manufacturing plant. Methods evaluated include land farming, thermal desorption, soil washing, bioremediation and landfilling. Activities included estimating quantity of impacted soil, evaluating the effectiveness and remediation time frame of each method, estimating method costs, and presenting recommendations to the client.

Spill Prevention, Control, and Countermeasures and Storm Water Pollution Prevention Plan Preparation, Confidential Industrial Gas Manufacturing Plant, LaPorte, Texas. Developed and prepared an SPCC and SWPP Plan for an industrial gas manufacturing facility and its associated cogeneration plant. The plan was adopted as the standard document for facilities company wide.

Phase I and II Environmental Site Assessment, Manufacturing Company, Houston, Texas. Conducted an assessment of an undeveloped site. Activities included a review of historical site use, regulatory records review, and identification of potential onsite and offsite sources of soil and groundwater contamination. A subsurface assessment including installation of soil borings and groundwater monitoring wells, collection of soil and groundwater samples, and evaluation of data and applicable regulations.

Real Estate Transaction Assessment, Major Insurance Company, Woodbridge, Virginia. Performance of a Phase I environmental site assessment and asbestos survey of a shopping center. Activities included a review of historical site use, regulatory records review, and identification of potential asbestos-containing materials. Also managed a follow-up subsurface assessment to evaluate the concerns identified during the Phase I assessment.

Registration and Certification:

Certified Hazardous Materials Manager, Master Level, 1997

Additional Training:

OSHA's Health and Safety Training for Hazardous Waste Operations (29 CFR 1910.120): Completed May 1990, updated May 1991, April 1992, May 1993, June 1994, August 1995, April 10, 1996, March 1997, January 1998, January 1999, and June 2000.

Air Transportation of Dangerous Goods Seminar: A 16-hour course sponsored by Federal Express to provide a basic understanding on the dangers associated with transporting environmental samples, equipment, and supplies by air. The course addressed proper packaging, labeling, shipping, and disclosure procedures for national and international shipment of dangerous goods. Completed March 1995.

Robin A. Silva-Wilkinson **Great Lakes Environmental Center**

Principal Research Scientist

Education

B.S. Biology and Chemistry, Marietta College, 1978
Graduate Studies, Immunology, University of Pittsburgh

Qualifications:

Ms. Silva-Wilkinson is an environmental chemist whose career has focused on the assessment of water quality and the development of solutions to water quality problems. She has extensive and diverse experience coordinating, designing, managing and conducting tasks associated with water quality assessment programs. She coordinates all aspects of environmental/analytical chemistry activities at GLEC, including analysis for organic contaminants in all types of matrices, nutrient monitoring and metals analyses. She is experienced and adept at evaluating the quality of data, due to her expertise in numerous instrumental analysis techniques and her role performing quality assurance/quality control evaluations. She has a strong complimentary background in the evaluation, refinement and application of new methodologies. Over the past ten years, she has worked to compile and review available methodologies; determine which methods are appropriate for particular applications; test, refine, laboratory validate and field validate those methods; and apply the methods to collect data. In Ms. Silva-Wilkinson's multi-disciplinary approach to research, she has incorporated her background in chemistry, biochemistry, microbiology, immunology and toxicology.

Relevant Experience:

Environmental Chemistry Coordination. Coordinates all aspects of the chemistry portions of multi-disciplinary programs. Responsibilities include: project management; coordination and training of chemistry staff; coordination of field sampling and laboratory activities; analytical methods development, data summary, and interpretation; report preparation; quality assurance review; client interaction; and budget management.

EPA Bioconcentratable Contaminant Assessment (BCA) Project. Key contributor to the development, refinement, and validation of the EPA's methods for assessing bioconcentratable contaminants in water, tissues, and sediments. In the initial stages of this project, she was responsible for refining the demanding, low-level analytical procedures and performing the analyses. She was also significantly involved in planning and conducting an inter-and intralaboratory variability study of the methods. This round-robin study began with a training course during which she instructed participants (representing 15 laboratories) on how to perform the methods. She was involved in designing the study; coordinating the sample collection, shipment, and analysis; and providing technical support to the participants. After receiving the data from the participants, she was responsible for coordinating the statistical analysis and interpretation; presenting the results; and preparing manuscripts for publication. Since the round robin study results demonstrated that revisions to the analytical procedures were necessary before the methods could be finalized, an EPA work assignment was conducted to identify alternative procedures for the steps requiring revision, to evaluate the alternative procedures in the laboratory, and to incorporate the agreed upon revisions into the methods; She was the Work Assignment Leader for the project.

EPA Guidance Document Preparation. Responsible for coordinating the preparation of a document for publication by the U.S. EPA to provide guidance for the derivation of waterbody-specific bioaccumulation factors (BAFs) and biota sediment accumulation factors (BSAFs) for organic chemicals based upon data generated from field collected samples. The document described how an effective field sampling program should be structured, including recommendations and considerations regarding field procedures, laboratory methods, statistical analyses, uncertainty estimates, and data quality requirements for the generation of scientifically defensible BAFs and BSAFs.

Derivation of Baseline Bioaccumulation Factors (BAFs) from Field-Measured BAFs for Benzo[a]pyrene. Designed and coordinated a field study for the derivation of water body-specific and baseline bioaccumulation factors (BAFs) for benzo[a]pyrene (B[a]P) to be used by the State of Indiana in the calculation of human health criteria. Evaluated the representativeness of the samples being collected over a six month period, by examining the temporal and spatial variability associated with the concentration of B[a]P in the water body and in the fish being consumed by humans from the water body. Adapted methods for the collection and extraction of large volume (100 liters) water samples. Coordinated the analyses to determine the concentration of B[a]P, dissolved organic carbon, and particulate organic carbon in large volume water samples; and the B[a]P concentration and percent lipid in composite fish tissue samples. Implemented extensive QA/QC measures to provide information on the quality of the data. Calculated site-specific BAFs and baseline BAFs for B[a]P in various trophic levels using the results. Prepared a report of the study findings.

Product Environmental Risk Evaluation. Project manager of a study performed to assess the impact of an industrial product on the toxicity and bioconcentration potential of municipal wastewater. She coordinated this multi-disciplinary effort between engineers (who designed, built, and operated a bench-scale municipal wastewater treatment system), aquatic toxicologists (who performed the toxicity evaluations on the wastewater), and organic chemists (who performed the EPA's newly developed BCA procedures on the wastewater).

Assessment of Bioconcentratable Contaminants in Select Lake Michigan Tributaries. Project manager for a study to determine the following: assess and compare contaminant loads in resident and caged fish, prioritize Lake Michigan tributaries for future monitoring, determine the utility of the BCA methods for future monitoring efforts, and provide data for the Lake Michigan Loading study and Lakewide Management Plan. This study resulted in the identification of several sites as being contaminated by polynuclear aromatic hydrocarbons (PAHs), chemicals which were not traditionally monitored as part of the Lake Michigan Loading Study. These findings led the Michigan DNR to fund a PAH confirmation study, which she also managed. In the confirmation study, newly collected tissue and sediment samples, as well as previously collected samples, were prepared and analyzed using target analysis for PAHs by GC/MS with Single Ion Monitoring. For both studies, she was responsible for coordinating field sampling and sample analysis, interactions with Michigan DNR, data analysis and interpretation, and report preparation.

Bioconcentratable Contaminant Studies. Project manager of several projects which apply the EPA's BCA protocols to solve real-world environmental problems for industrial clients and government agencies. For instance, she was the manager for a project designed to conduct a BCA study for a large municipal wastewater treatment plant receiving discharge from multiple and varied industries. The results of the project demonstrated that the plant was effectively removing bioconcentratable contaminants, which led to a follow-up pilot plant study designed to optimize the efficiency of the treatment. She was responsible for managing the bioconcentratable contaminant testing component of the pilot plant study and of a study designed to identify the source of contamination by analyzing

15 effluent samples from industries which discharge to the facility. Current efforts aim to confirm the source of three organic compounds of concern using chemical-specific analytical methods.

Development of Improved Monitoring Strategies for Recreational Water Indicators. Work Assignment Leader for this project designed to assess the sources of variability in the concentration of enteric pathogens present in recreational waters. She coordinated all tasks associated with: 1) the selection of six sampling sites representing varying conditions throughout the U.S.; 2) field sampling for a week at a time at each site; 3) shipment, processing and analysis of samples; 4) statistical analysis to test for an association between hydrological, meteorological, physical and/or chemical data with organism counts; 5) preparing recommendations for improved monitoring strategies; and 6) report preparation.

Development of a Rapid Method for the Detection of Non-enteric Pathogens. Work Assignment Leader for this EPA project. She coordinated and conducted efforts to: 1) determine, through a literature search, which non-enteric pathogens are the most prevalent in the ambient waters of the United States, 2) determine what methods exist for assessing the level of contamination from those pathogens, 3) estimate the feasibility of developing a rapid method for the detection of the most prevalent non-enteric pathogens, 4) develop the method, and 5) field test the developed method.

Investigation of Trace Metals in the New Jersey Portion of the New York/New Jersey (NY/NJ) Harbor. Quality Assurance Officer for project designed to collect metals data using "clean metals techniques" as Part I of the program to establish discharge limits for the NY/NJ Harbor system based upon total maximum daily loads (TMDLs) and waste load allocations (WLAs). Coordinated the development of the Work Plan and the Quality Assurance Project Plan. Summarized the draft Comprehensive Conservation and Management Plan (CCMP), developed by USEPA, for presentation to a consortium of clients in the NY/NJ Harbor system.

Natural Resource Damage Assessment at a DDT Contaminated Site. Responsible for the coordination of laboratory activities associated with the preparation and analysis of large numbers of fish samples collected from a DDT contaminated site and a control site. Analysis was performed for DDT and its metabolites (including metabolites not routinely monitored), chlorinated pesticides, and Aroclors.

Performance Criteria Testing for Water Distribution Devices. Developed a procedure (adapted from the National Sanitation Foundation 61 Protocol) for assessing the leach rate and relative concentrations of extractable metals from potable water distribution devices and their components. Managed a study to perform the evaluation testing for an industrial client who develops new metal alloys to be used in the manufacture of faucets.

Prediction of Effluent Water Quality and Permit Limits for an NPDES Permit Review. In response to a mining company's efforts to comply with upcoming revised permit limits, she was responsible for mathematically/chemically predicting the effects that various operating scenarios would have on effluent water quality. The effects associated with changing multiple parameters was taken into consideration, including various complexation processes.

Options for Addressing Permit Limits. Presented chemistry-related options for addressing water-quality based limits in effluent discharge permits during a series of three workshops sponsored by an industry trade group. The workshop presented background and a strategy for the group members to investigate means of achieving compliance without treatment.

Nutrient Monitoring. Developed and implemented analytical chemistry procedures for monitoring low-level nutrients in surface waters as part of ongoing watershed management programs in and around the Great Lakes, including the Grand Traverse Bay Initiative and the Mitchell Creek Watershed Non-Point Pollution Study.

Environmental Study for FERC License Application. Coordinated sampling, analysis and report preparation for water quality determinations above and below impoundments at hydroelectric dams. She was the Quality Assurance Officer for this project.

Toxicity Identification and Reduction Evaluations. Responsible for laboratory coordination of characterizations on municipal and industrial effluents to identify toxicants.

Research Assistant. While with the Ohio Agricultural Research and Development Center she was involved in the management of research to study the fermentation of silage. She was the laboratory manager responsible for coordinating and conducting extensive chemical analyses and microbial studies of silage, and digestibility trials on cows. She developed the laboratory's analytical capabilities, refining methods for HPLC analysis, atomic absorption spectroscopy, and nutrients. She developed new methods of analysis for carbohydrates.

Research Associate. While with the Northeastern Ohio Universities College of Medicine she was involved in the coordination of tumor suppression studies, radioimmunoassay, and protein characterization research. She was responsible for making refinements to several biochemical techniques which led to new directions for the research group. She presented seminars on new methodologies and was responsible for demonstrating procedures to graduate students.

Laboratory Assistant. As a research assistant at Montefiore Hospital, Clinical Immunology Laboratory she was responsible for the coordination of immunological experiments to study the effects of Prostaglandin E_1 on Systemic Lupus Erythematosus.

Publications and Reports:

Winkelstein, A., V. E. Kelley and R. A. Silva. 1979. Effects of Prostaglandin E_1 (PGE_1) on Murine Lymphocytes - The Molecular Basis of Immune Cell Function, Proceedings of the 13th International Leucocyte Conference, May 22-25, 1979, Ottawa, Canada.

Winkelstein, A., V. E. Kelley and R. A. Silva-Wilkinson. 1980. The Effects of Prostaglandin E_1 (PGE_1) on Lymphoid Cellularity in Murine Models of Systemic Lupus Erythematosus (SLE). Proceedings of the International Congress of Hematology, August, 1980, Montreal, Canada.

Ong, Say Kee, G. M. DeGraeve, R. A. Silva-Wilkinson, Jim McCabe, and William L. Smith. 1996. Toxicity and Bioconcentration Potential of Adsorbable Organic Halides from Bleached Laundering in Municipal Wastewater. Environmental Toxicology and Chemistry, Vol. 15, No. 2, 1996.

Silva-Wilkinson, R. A., L. P. Burkhard, B. R. Sheedy, and G. M. DeGraeve. A Simple Comparison of Mass Spectral Search Results and Implications for Environmental Screening Analyses. Archives of Environmental Contamination and Toxicology, Vol. 36, No. 2, 1999.

Silva-Wilkinson, R.A., G.M. DeGraeve, L.P. Burkhard, D.W. Tholen and B.R. Sheedy. Results of an Interlaboratory Evaluation of an Analytical Screening Method for Assessing Persistent Bioaccumulative Toxic Chemicals in Sediment Samples. Environmental Toxicology and Chemistry, Vol. 19, No. 9, 2000.

Selected Presentations:

Silva-Wilkinson, R. A. Current Status of EPA's Developing Program for Controlling Bioconcentratable Contaminants in Surface Water. Twelfth Annual Meeting of the Society of Environmental Toxicology and Chemistry, November 4-7, 1991, Seattle, Washington.

Shuey, J. A., G. M. DeGraeve, C. A. Harris, R. A. Silva-Wilkinson, and C. R. Koch. Development of a Grand Traverse Bay, Lake Michigan, Long-Term Management Plan. 12th Annual Meeting of the Society of Environmental Toxicology and Chemistry, November 4-7, 1991, Seattle, Washington.

DeGraeve, G. M., W. H. Clement, and R. A. Silva-Wilkinson. Novel Applications of EPA's Analytical Bioconcentration Procedures. Presented at the 13th Annual Meeting of the Society of Environmental Toxicology and Chemistry, November 8-13, 1992, Cincinnati, Ohio.

Silva-Wilkinson, R. A., G. M. DeGraeve, L. Burkhard, and B. Sheedy. Preliminary Findings from the Inter- and Intralaboratory Study of EPA's Bioconcentration Procedures. Presented at the 13th Annual Meeting of the Society of Environmental Toxicology and Chemistry, November 8-13, 1992, Cincinnati, Ohio.

Silva-Wilkinson, R. A. An Overview of EPA's Bioconcentratable Contaminant Screening Program. NCASI Central-Lake States Regional Meeting, September 14-16, 1993, Grand Rapids, Michigan.

Burkhard, L. P., R. A. Silva-Wilkinson, G. M. DeGraeve, and B. Sheedy. Status of EPA's Draft Guidance Document, Assessment and Control of Bioconcentratable Chemicals in Surface Water. Presented at the 14th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 14-18, 1993, Houston, Texas.

Silva-Wilkinson, R. A., G. M. DeGraeve, B. Scott, G. Saalfeld and C. Waggoner. Assessing Bioconcentratable Contaminants in Select Lake Michigan Tributaries. Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 14-18, 1993, Houston, Texas.

DeGraeve, G. M., D. Sabock, D. O. McIntyre, and R. A. Silva-Wilkinson. A Workshop on Utility Industry Options for Addressing Water Quality Based Chemical Limits in Effluent Discharge Permits. Presented in Washington, D.C., May 23, 1996; Chicago, IL, July 16, 1996; and Columbus, OH, January 22 & 23, 1997.

Silva-Wilkinson, R. A., G. M. DeGraeve, and B. Scott. The Effectiveness of EPA's Bioconcentratable Contaminant Assessment procedure in Screening Tissue Sample for PAHs. Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 17-21, 1996, Washington, D.C.

McIntyre, D. O., R. A. Silva-Wilkinson, W. H. Clement, and R. W. Brocksen. Options for Addressing Water Quality Based Limits in Effluent Discharge Permits. Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 17-21, 1996, Washington, D.C.

SENIOR ICHTHYOLOGIST

Ann Drum-Skillman **Battelle MSL**

Senior Research Associate

Education:

B.S. The Evergreen State College, Environmental Science, 1999

Qualifications:

Ms. Skillman has been with the Battelle Marine Sciences Laboratory for nearly 25 years. During that time, her research has focused on biological mechanisms of marine invertebrate and fish infectious diseases and cancer; environmental pathology and toxicology; parasitology; and aquatic animal health management, disease diagnosis and prevention. Health management of salmon and invertebrates, and the relationship of animal health to resource management, are Ms. Skillman's areas of specialization.

Relevant Experience:

Environmental pathology.

- Endocrine disruption model development
- Pathological characterization of marine invertebrate and fish infectious diseases
- Marine animal cancer, genotoxicity, and toxicology

Marine Microbiology. Virology, bacteriology and parasitology, prokaryotic and eukaryotic molecular taxonomy

Fisheries Management. Endangered stock health management, sustained utilization of resources, forensic pathology and introduced species evaluations

Aquaculture Development. Drug registrations, animal health management, feasibility studies and development of aquaculture techniques

Marine Public Health. Marine toxin characterization including risk assessment related to edible shellfish, worldwide occurrence of marine toxins and production, and introduced toxic phytoplankton.

Marine Biological Environmental Impact Studies. Characterization of physical, chemical, and biological oceanographic processes, and preliminary risk assessment to fisheries resulting from ocean munitions disposal.

Determination of Endocrine-Disrupting Contaminants in the Environment. Under this program, Ms. Skillman participated in studies that exposed trout to estrogen and estrogen-like compounds, studied effects of these compounds on egg fertilization rate, sperm motility, spermatocrtit, GSI/LSI, and circulating plasma levels of important reproductive hormones, including the maturational steroid 17α, 20β--dihydroxyprogesterone (17, 20-DHP). Ms. Skillman monitored the induction and breakdown of

vitellogenin in the blood of trout; data from this study was used to develop a model to establish a dose-response relationship and allow inter-species comparison based on the internal dose of specific chemicals.

Endangered Salmon Survival, Growth, and Immunocompetence. The objective of this program is to determine the impact of contaminated waterways used for migration and early development by salmon listed under the Endangered Species Act. Studies examined whether dietary exposure to PCBs impacted the survival, growth and immunocompetence of juvenile Chinook salmon. The ability of juvenile Chinook to respond to controlled laboratory challenges of the bacterial pathogen *Listonella* (*Vibrio*) *anguillarum* were used to determine the effects of fish size on the immunocompetence of juvenile chinook salmon. Results of the studies will be used to assess the risk associated with contaminated waterways and declining populations of salmonids.

Salmon Farm Health Management. The objective of this program was to determine the impact of specific diseases in salmon net-pen culture in Puget Sound and to execute a training program for pre- and post-graduate veterinarians in fish-health management in conjunction with Washington State University, Oregon State University, and Texas A&M University. A priority list of the most important diseases of fishes was developed along with quantitative data on the impact of each disease. Naturally occurring toxic algal blooms are the most significant environmental disease of marine farmed salmon while furunculosis, a naturally occurring disease of Pacific salmon, is the most important infectious disease in net pen culture. Results of the study have enhanced farm management of diseases and reduced their impacts.

Exxon Valdez Oil Spill Studies. After the Exxon Valdez oil spill in Prince William Sound, Ms. Skillman participated in histopathological studies on herring eggs to determine immunotoxicity and genotoxicity of crude and diesel oil to fish, with emphasis on Pacific Herring and Pacific Salmon. In a later study, Ms. Skillman examined the condition and disease status of herring from Prince William Sound to determine the mechanisms underlying the substantial 1993 decline in herring spawning biomass. High levels of viral hemorrhagic septicemia virus (VHSV) were confirmed in herring in 1993 but not 1994. Histopathological and chemical analyses indicated that the decline was unrelated to the Exxon Valdez oil spill, but rather most likely due to mass mortality following a disease outbreak.

Publications:

Elston. R. A., A. S. Drum and W. H. Pearson. 1997. Health and Condition of Pacific Herring, *Clupea pallisi*, from Prince William Sound, Alaska, 1994. Diseases of Aquatic Organisms 31: 109-126

Elston, R. A., A. S. Drum and P. R. Bunnell. 1995. Efficacy of orally administered difloxacin for the treatment of furunculosis in Atlantic salmon held in seawater. Journal of Aquatic Animal Health 7:16-21.

Elston, R. A., A. S. Drum and P. R. Bunnell. 1995. Furunculosis injection model in Atlantic salmon, *Salmo salar*, for drug efficacy testing. Journal of Aquatic Animal Health 7:16-21.

Elston, R. A., A. S. Drum, M. G. Schweitzer, and P. R. Bunnell. 1994. Comparative uptake of orally administered difloxacin in Atlantic salmon, *Salmo salar*, in freshwater and seawater. Journal of Aquatic Animal Health 6:341-348.

Elston, R. A., A. S. Drum and P. R. Bunnell. 1994. Efficacy of orally administered difloxacin for the treatment of furunculosis in Atlantic salmon, *Salmo salar*, held in seawater. Journal of Aquatic Animal Health. 6:341-348.

Kerk, D., A. Gee, M. Standish, P. O. Wainwright, M. Sogin, A. S. Drum and R.A. Elston. 1995. The rosette agent of chinook salmon (*Oncorhynchus tshawytscha*) is closely related to choanoflagellates, as determined by the sequence of DNA encoding the small ribosomal subunit RNA. Marine Biology 122:187-192.

Pearson WH, Elston RA, Bienert RW, Drum AS and Antrim LD. 1999. "Why did the Prince William Sound, Alaska, Pacific herring (Clupea pallasi) fisheries collapse in 1993 and 1994? Review of hypotheses.". Can. J. Fish. Aquat. Sci.. 56(4):711-737.

Pamela F. Smith **Great Lakes Environmental Center**

Research Technician

Education

B.S. Environmental Biology (Botany), Ohio University, 1983

Qualifications:

Ms. Smith has experience in laboratory toxicity testing on research projects for industrial, municipal, and government clients. Ms. Smith also has experience in biomonitoring and specimen (fish and invertebrates) culturing processes for National Pollution discharge Elimination System (NPDES) related projects. Also, Ms. Smith has a strong background in the biological sciences with a major emphasis in botany. Her experience as a naturalist, botany research assistant and field technician has included collection, taxonomy and study of various plant communities. Since Ms. Smith has been with GLEC, she has been one of our principal wetland delineators. She has also conducted aquatic and terrestrial vegetation studies including threatened and endangered plant surveys, plant inventories, vegetation mapping and nuisance plant studies. Ms. Smith has conducted public education programs and workshops pertaining to the flora of northern Michigan. She also provides plant identification services for GLEC clients. In addition Ms. Smith serves as a laboratory coordinator that conducts and oversees laboratory analyses that monitor the impact of effluents and chemicals on water quality and fresh water communities.

Relevant Experience:

Water Quality Studies. Maintained cultures of *Daphnia magna, Ceriodaphnia dubia, Mysidopsis bahia, Hyallela azteca, Chironomus tentans, Pimephales promelas* (fathead minnows) and *Selenastrum capricornutum* (algae) and conducted toxicity tests using these organisms. Also conducted a workshop on culturing and toxicity testing for an industrial client. Conducts routine water chemistry and nutrient analysis including chlorophyll analysis. Also conducts effluent characterizations to identify and reduce toxicity of industrial and municipal effluents. In the field measured depth and stream flows to define possible sources of non-point source pollution.

Sediment Bioassays. Conducts whole sediment and sediment elutriate acute and chronic bioassays.

Wetland Identification and Delineation. Conducts wetland identification and delineations for private construction companies and developers. Field experience in the identification and delineation of a variety of wetland types, including: depressional, riparian, urban/diked, seasonally flooded, and disturbed (agriculture/developed).

Vegetation Studies. Conducts vegetation studies in aquatic and terrestrial habitats including vegetation mapping and inventories for ecological baseline studies. Also conducted endangered and threatened plant surveys in Michigan, Ohio, North Carolina, and Arkansas. Served as an expert on nuisance plants such as purple loosetrife and Eurasian milfoil for hydroelectric producers and local lake associations. Also cultivated plants for research purposes at GLEC.

Environmental Impact Study of Hydroelectric Facility as Part of Procedures for Obtaining New FERC Licenses. Conducted tailrace netting studies to assess entrainment mortality of fish at two hydroelectric dams.

Relevant Experience:

Park Naturalist. While with the National Park Service recorded observations of park flora and fauna, determined locations of threatened or endangered species, collected plant specimens to be used in park service displays, put together interpretive brochures and presented programs to the public about park flora and natural history.

Research Assistant. As a research assistant for the Ohio University Botany Department assisted various professors in life cycle studies of plants.

Soil Studies. While with the Athens Soil and Water Conservation District she was responsible for air photo interpretation and erosion studies

Presentations:

Workshop on Culturing and Toxicity Testing. Conducted a workshop on organism culturing and toxicity testing for an industrial client.

Threatened and Endangered Species of South Fox Island, Michigan for the Sierra Club Membership Meeting.

Additional Courses:

- *Wetland Plant Identification Course* - University of Michigan, June 19-22, 2000
- *SETAC Short Course*: The Use of *Ceriodaphnia dubia* in Toxicity Testing. October, 1994
- *Hazardous Materials Trainin:*. Received emergency response training. July 1992.

Professional Affiliations:

- Michigan Botanical Club
- Wildflower Association of Michigan

James P. Stricko **Great Lakes Environmental Center**

Technician IV

Education:

B.S. Natural Resources, The Ohio State University, 1990
Graduate Studies, Environmental Science, The Ohio State University

Qualifications:

Mr. Stricko has experience in laboratory toxicity testing on research projects for industrial, municipal, and government clients including the U.S. Environmental Protection Agency (EPA) and U.S. Department of Defense. Mr. Stricko also has experience in biomonitoring and specimen (fish and invertebrates) culturing processes for National Pollution Discharge Elimination System (NPDES) related projects. Mr. Stricko has conducted field investigations to determine wastewater discharge effects on instream fish and macroinvertebrate communities. He has also done stream habitat assessment as part of the field investigations. His principal area of expertise is in field methodology for aquatic community monitoring.

Relevant Experience:

Aquatic Field Studies. Coordinates and conducts fish and macroinvertebrate sampling to determine the impact of an industrial effluent. Collects fish tissue data to determine wildlife and human risk assessment for metals. Evaluates ecological community data using community metrics analyses such the Index of Biotic Integrity and the Invertebrate Community Index. Assesses lentic and lotic habitat types using rapid bioassessment techniques and quantitative physical habitat proticols. Water quality field measurements and water sample collection.

Biomonitoring. Currently performs individual bioassays on effluent samples provided by the client to assist in NPDES certification. Tests include static acute and chronic renewal procedures using various fish and invertebrate species. Conducts routine water chemistry analysis on effluent samples and monitors for chlorine, ammonia, and nitrate levels. Also assists in report generation.

Site-Specific Water Quality Testing. Coordinates and conducts laboratory testing to determine site-specific water quality criteria. Tests include static acute fish and invertebrate procedures for determination of water effect ratio (WER).

Fish and Invertebrates Culturing. Currently responsible for *Pimephales*, *Daphnia*, and *Ceriodaphnia* culture maintenance. The specimens are reared and maintained for use in TI/RE and other water quality testing. Also responsible for providing preparation and support activities for the culture operations.

Sediment Bioassays. Extracted pore water from sediments to assess chronic toxicity to *Ceriodaphnia*.

Soil Toxicity Testing. Currently performs individual tests on soil samples from hazardous waste sites. Tests include acute procedures using earthworm species.

Wetland Construction. Constructed a pilot scale waste water treatment wetland to remove organic dyes. Performed maintenance and instructed technicians in operational procedure.

Technology Application, Inc. Conducted biological field surveys throughout the Appalachian Mountain ecoregions as part of the USEPA's Ecological Monitoring and Assessment Program (EMAP). Collected instream chemistry and flow data. Also assessed stream habitat using rapid bioassessment protocol and physical habitat assessment.

The Ohio Environmental Protection Agency. Assisted in conducting biological field surveys of Ohio lakes, rivers, and streams. Surveys were done in accordance with NPDES permit renewal. Collected, identified, and processed biological data to evaluate industrial and municipal wastewater treatment plants. He also assessed stream habitat in surveyed areas.

The Ohio State University. Updated and maintained a computer networking system. Supervised Lab employees, gave assistance to computer users. Developed instruction guides for lab users.

Professional Recognition and Affiliations:

- Member, Society of Environmental Toxicology and Chemistry
- Member, American Fisheries Society
- Member, Ohio Chapter, American Fisheries Society Rivers and Streams Committee
- Member, Ohio Academy of Science

Presentations:

Sanders, R.E. and J.P. Stricko. 1992. Darters (Percidae) of the Ohio River: Ohio's shoreline assemblages from mile 66.2 to 487.2. 101st. Annual Meeting of the Ohio Academy of Science, May 2, Akron, Ohio.

McIntyre, D.O., J.P. Stricko, and R.J. Reash. 1995. Development of a site-specific water quality criterion for hexavalent chromium. Annual meeting of the Society of Environmental Toxicology and Chemistry, November 5-9, Vancouver, British Columbia, Canada.

Stricko, J.P. and C.E. Boucher. 1997. Determination of Acute Ammonia Toxicity to fishes of the genus *Moxostoma*. Annual meeting of the Society of Environmental Toxicology and Chemistry, November 16-20, San Francisco, CA.

Additional Courses:

- American Fisheries Society, 1993, Bioassessments and Biological Criteria Development for Warmwater Streams and Rivers
- Ohio Valley SETAC, 1995, Environmental Resources on the Internet

SAMPLE CUSTODIAN/DATA MANAGER

Carolynn R. Suslick **Battelle MSL**

Technician III: Marine Chemistry

Education:

A.A.S. Associate of Applied Sciences, Engineering, Peninsula College, 1995
Pursuing an Environmental Science BA degree, Western Washington University, 1997-present

Relevant Experience:

Ms. Suslick has a thorough understanding of the requirements of the sample preparation laboratory at the Marine Sciences Laboratory. She designed and presently manages the sample log-in system, and is responsible for monitoring incoming sample conditions, proper storage, and chain-of-custody accuracy. Ms. Suslick is also responsible for preparation of environmental samples for chemical analyses. This includes filtering, pH measurement, pH adjustment, salinity measurement, acid cleaning, packaging, and shipping.

Ms. Suslick is the Chemistry Data Manager for the Marine Chemistry Group at Battelle Marine Sciences Laboratory. This includes the processing of both Organic and Inorganic data as requested by Project Managers, electronic download of ICP-MS raw data, evaluation and determination of ICP-MS data for mass selection and quality control, and maintenance of the Chemistry Group Technical Files. Ms. Suslick is experienced in data reduction, manipulation, graphing, storage, and writing macros for complex data manipulation. She gives direction to staff in the preparation of data reports or data packages, assists in the development of presentation materials, and maintains control charts for the Chemistry Group. Ms. Suslick has a thorough working knowledge of the spreadsheet and database programs necessary to comply with client requirements and she is proficient with various types of electronic data transfer protocol, often interacting with clients to facilitate the transfer of data. Ms. Suslick is presently developing a modified laboratory information management system (LIMS) tailored to the special needs of the Marine Chemistry Group. She is also coordinating an effort for the connection of the Sequim facility and the Duxbury facility to share joint laboratory information

As an intern in the Clallam County Water Quality Department, Ms. Suslick designed and prepared a Visual Reference for the Long Range Planning Team depicting the Septic History of the Dungeness Bay Study Project. Her research included cross referencing the historical physical files with the computer database management system currently in use, interacting with various County agencies and special interest groups, and on site exploration of the Study area.

While attending Peninsula College, Carolynn assisted the Buccaneer Newspaper in setting up a computer accounting system. During her seven years as an Administrative Secretary/Office Manager with Cape Flattery School District, Ms. Suslick was responsible for monitoring the Clallam Bay school budget, reviewing purchases, hiring substitutes and preparing monthly payroll and employee files.

Joseph E. Tabor **Battelle Columbus**

Master Research Technician

Education:

Chemistry: Miami University, Ohio

Qualifications:

Mr. Tabor has over 15 years experience in the operation and maintenance of high resolution double focusing magnetic sector mass spectrometers and is currently responsible for the upkeep and maintenance of Battelle's high resolution mass spectrometers dedicated to dioxin and related compound research. In addition, Mr. Tabor has provided GC/HRMS method development and analysis support to a variety of projects requiring determination of PCDD/PCDF and coplanar PCBs. Projects for which Mr. Tabor has led HRMS analysis efforts include the analysis of tissues and sediments to evaluate dredged material for ocean disposal, air samples to characterize stack emissions and ambient air, and chemical products to aid in product registration. Mr. Tabor has provided quality analytical data to meet the requirements of EPA Methods 8290, 1613, 23, 1668, and TO-9. Matrices include tissue (fish, lobster, clams, worms), air, water, soil, sediment, sludge, and wipes from PCB fires and building contamination.

Mr. Tabor has instituted several innovative analytical techniques to assure high quality GC/HRMS data including instrumental procedures to minimize contamination potential and background PCDD/PCDF levels and has also prepared automated data reduction routines to increase efficiency in sample data reporting. Additionally, Mr. Tabor has worked with the Dioxin Sample Preparation Laboratory to build and modify equipment to prepare extracts for cleanup procedures. He is currently involved in an internal research project to evaluate supercritical fluid extraction (SFE) and accelerated solvent extraction (ASE) of PCDD/PCDF from a variety of matrices as an alternative to the conventional Soxhlet extraction method.

Relevant Experience:

PCBs in Sewage Sludge, Incinerator Emissions, and Scrubber Water. Mr. Tabor led method development for the HRGC/HRMS analysis of toxic PCBs by a modification of Method 1668. This method was then applied to the analysis of sewage sludge, emissions, and scrubber water from a sewage sludge incineration facility.

PCDD/PCDF in Drinking Water. Drinking water samples were analyzed for a government agency. Detection limits were in the part-per-quadrillion range (less than 10 pg/Liter)

Evaluation of Influent and Effluent Water for a Water Treatment Facility. Pre-discharge water samples from a water treatment facility were analyzed for PCDD/PCDF using Method 8290 with modifications from Method 1613.

Method 23 Modification. Mr. Tabor modified Method 23 for the analysis of air samples to screen for mono-, di-, and tri-chlorinated dioxins and furans in addition to the usual tetra- octa- chlorinated compounds.

PCDD/PCDF Analyses to Determine Coastal Environment Quality. Mr. Tabor has analyzed thousands of sediments and tissues from bioaccumulation studies for PCDD/PCDF to determine environment quality and the quality of dredged material proposed for ocean disposal.

Dioxin/Furan Analysis of Lobster and Fish Tissues. Mr. Tabor led analytical efforts for the analysis of several hundred lobster muscle and hepatopancreas tissues and tissues from recreationally important fish collected in the New York Bight Apex and nearby areas for chlorinated dioxins and furans. Study requirements included achieving a 1 pg/g MDL under EPA Method 8290 and analyzing extensive quality control samples to ensure precision and accuracy of the data The lobster and fish data were used by NOAA to develop information on potential contamination of organisms captured by recreational and commercial fishermen in the area.

Remedial Investigation and Ecological Assessment for Surface Water and Sediments at the McCormick and Baxter Superfund Site. Mr. Tabor provided HRMS analysis of 100 tissue and sediment samples for PCDD/PCDF and coplanar PCBs. Tissue types included a variety of fish, crayfish, and worms from bioaccumulation test studies. TCDD detection limits less than 1 pg/g were obtained. Battelle received an overall "excellent" rating from EPA Region IX for work supporting this Superfund program.

Study of Toxic Emissions from Coal-Fired Power Plants. Provided PCDD/PCDF analyses of emissions from coal-fired power plants to help characterize toxic emissions for the U.S. Department of Energy.

PCDD/PCDF in Kuwait Air Samples. Provided HRMS PCDD/PCDF analyses of ambient air samples from Kuwait for the U.S. Army Environmental Hygiene Agency. This study provided key data in determining air quality in the vicinity of oil fires.

PBDD/PBDF Characterization of Commercial Products. In support of product registration, Mr. Tabor has modified and optimized GC/HRMS methods for determining polybrominated dibenzo-p-dioxins and dibenzofurans in flame retardants.

Prior to joining Battelle, Mr. Tabor was responsible for Chemical Samples' Co., Columbus, Ohio, qualitative analytical capability for 12 years. He handled all equipment purchases, supplies, and maintenance, as well as method development and day to day operations. His expertise involved packed and capillary column systems, as well as modification and adaptation of instrumentation.

Additional Training and Licenses:

- Opusquan Training Course – Fisons Instruments, 1994
- Basic Operation of the VG Autospec Mass Spectrometer – Fisons Instruments, 1994
- High Resolution Mass Spectrometry Training – VG Instruments, 1990
- Interpretation of Mass Spectra – ACS Audio Course

Publications:

Schrock, M.E.; Armbruster, M.J.; Riggs, K.B.; Tabor, J.E.; Doherty, A.K.; Lorber, M. "Simultaneous Determination of PCDD/PCDF and Dioxin-Like PCBs in Edible Vegetable Oils", Dioxin '96 - 16th International Meeting, Amsterdam, The Netherlands, August 1996.

Shafer, K. H., A. Bjorseth, J. Tabor, and R. J. Jakobsen, "Advancing the Chromatography of GC/FT-IR to WCOT Capillary Columns", HRC and CC, Vol. 3 (2/1980) 87-88.

Shafer, K. H., T. L. Hayes, and J. Tabor, "The Use of a Small FT-IR System for GC/FT-IR/MS Analysis", SPIE, Vol. 289, p. 160 (1981).

TASK LEADER – DIOXIN/FURAN/HCX/TCX AND PCB CONGENERS

Karen L. Tracy **Battelle Columbus**

Research Scientist

Education:

B.S. Biology, Valparaiso University, Valparaiso, Indiana
M.B.A. Business, Indiana University Northwest, Gary, Indiana

Qualifications:

Ms. Tracy currently serves as supervisor for the polyhalogenated dibenzo-p-dioxin and dibenzofuran (PCDD/PCDF) analysis programs. Ms. Lesniak has over 10 years experience in the environmental field. Ms. Lesniak has provided data packages meeting the quality control criteria of SW846 Method 8290, and EPA Methods 1613 and TO9 along with coordinating the analysis of sediment, tissue, and water samples using 8290/1613 and air samples for Method TO9 for both industrial and government clients. Instrumental techniques with which Ms. Tracy is familiar include low resolution GC/MS for both volatile and base-neutral organic compounds. Ms. Tracy has over eight years experience conducting analysis for volatile organic compounds by GC/MS using SW846 Methods 8240, 8260, and 624, Drinking Water Method 524, and US EPA SOW90 for the Contract Laboratory Program. She also has conducted analysis for semi-volatile organic compounds by GC/MS using SW846 Method 8270. Ms. Tracy also has reviewed data for polychlorinated biphenyls, gasoline range organics, diesel range organics, herbicide, pesticide, and glycol analyses.

Relevant Experience:

Dioxin/Furan Analysis of Waters and Sediments from a Waste-Waster Discharge Plant. As project manager, Ms. Lesniak oversaw the analysis of influent, effluent, and sea water, and sediment samples from a waste water treatment plant for chlorinated dioxins and furans.

PCDD/PCDF Analyses of Niagara River Sediments. Coordinated the PCDD/PCDF analysis of sediments from several locations of the Niagara River for the U.S. EPA.

Sewage Sludge Incinerator Study. As Laboratory Coordinator for this project Ms. Lesniak coordinated in-house analysis for PCBs and PCDD/PCDF as well as the subcontracted analyses for Proximate/Ultimate and Poly Aromatic Hydrocarbons by HRMS for stack emission, scrubber water, and sludge samples.

PCDD/PCDF Analyses to Determine Coastal Environmental Quality. Reviewed data packages for sediment and marine tissue samples from bioaccumulation studies to determine the quality of dredged material proposed for ocean disposal.

Prior to joining Battelle, Ms. Tracy was responsible for the operations of the Organic Department for DLZ Laboratories, Incorporated in Columbus, Ohio. She was responsible for GC/MS, GC/FID, and GC/ECD groups for both volatile and semi-volatile analyses as well as the organic preparation laboratory. These responsibilities included scheduling both staff and equipment, review of all data generated, meeting turn around times, and providing answers to client concerns.

Additional Training and Licenses:

Project Management Seminar; Battelle – 1999

Jonathan R. Thorn **Battelle Duxbury**

Researcher
Environmental Chemistry Section

Education:

B.S. Chemistry, Bridgewater State College, May 1996, Concentration in Biochemistry

Qualifications:

Mr. Thorn joined Battelle in 1995 and has approximately four years of experience in the field of environmental chemistry. During that time he has assumed a variety of roles and trained in various laboratory extraction and cleanup procedures. Mr. Thorn has worked in both the trace metals and organic laboratories.

Relevant Experience:

Research Technician – *Task leader on organophosphorus pesticide project that expanded Battelle's capabilities to include new analytes and analytical methods.*

Research Technician – *Task leader on several pesticide/PCB analytical projects by ECD.*

Research Technician – *Task leader on several Butyltin analytical projects by FPD.*

Technician – *Prep task leader on several major pesticide/PCB/PAH projects for various matrices.*

Technician – *Prep task leader on major tributyltin monitoring project for both waters and tissues.*

Technician Trainee – Team member of a Tributyltin long term monitoring project which is conducted under the Good Laboratory Practices (GLP) standards.

Technician Trainee – Ceimic: Organized the ordering, cleaning and shipping of sample equipment for a large metals project along with the help of Ms. Brackett. Was in direct contact with the client on a daily basis to ensure all client needs for this sampling event were met.

Technician Trainee – Hampton Roads Sanitation District: Prep task leader of small project for the determination of butyltin species in water samples.

Mary M. Uhlfelder **Severn Trent Laboratories**

Quality Services Manager

Education:

M.A. The Johns Hopkins University; Chemical Oceanography; Baltimore, Maryland; 1971
B.A. College of Notre Dame of Maryland; Chemistry; Baltimore, Maryland; 1967

Qualifications:

Ms. Uhlfelder is the Quality Services Manager for STL's Baltimore facility with responsibility for the Quality Assurance and Safety programs. Ms. Uhlfelder directs the development and evaluation of QA/QC policy and procedures to comply with the laboratory certification and approval programs for the DOE (HAZWRAP), DOD, and 42 states. A chemist with over 30 years experience in environmental analytical chemistry, her management experience includes laboratory operations, client service, health and safety, and quality assurance. Ms. Uhlfelder also functions as the Quality Assurance principal for laboratory projects. She has participated as a team member throughout the planning, execution and report writing phases of DOD and private sector projects under CERCLA, MPRSA, RCRA and other federal regulations. Ms. Uhlfelder has extensive experience with DOD QA programs including AFCEE, NFESC, PMRMA, USAEC, USACE, and Dredged Materials. She works with clients and EA's offices nationally in the development of Data Quality Objectives, prepares Quality Assurance Project Plans, and provides technical assistance on the choice of appropriate and cost effective analytical support. Ms. Uhlfelder also serves as the contractor Laboratory Quality Assurance Coordinator (QAC) for U.S. Army Environmental Center (USAEC) and Rocky Mountain Arsenal (RMA) contracts.

Ms Uhlfelder is responsible for QA oversight for STL's analytical support subcontractors to ensure suppliers are qualified and meet performance expectations. In that effort, she has developed and currently manages the subcontractor evaluation program.

Relevant Experience:

Quality Assurance—Responsible for the development, oversight, and evaluation of QA/QC policy and procedures for routine and project-specific analytical work. Wrote the STL's Quality Assurance Management Plan. Coordinated internal and external systems and data audit activities. Reviewed and approved laboratory SOPs. Responsible for the validation of laboratory quality control procedures. Directed development of document control procedures for all laboratory manuals. Managed laboratory certification and approval activities for U.S. EPA, DOD and all 50 states. Managed quality assurance oversight of analytical work in support of numerous RI/FS projects performed under a variety of federal QA programs including USATHAMA, NEESA, USAF, USACE, and state programs including NJDEP, CADHS, NYDOH, NYDEC-CLP ASP.

Attended meetings with clients and regulatory agencies as laboratory Quality Assurance Manager. Participated in development of Data Quality Objectives, and in preparation of QA project plans for government and private clients. Ensured that sample handling, analysis, and data reporting were consistent with project requirements. Provided staff and client training on quality control activities and

QA program and project requirements. Responsible for the development and implementation of analytical service subcontractor approval program.

Laboratory Health and Safety—Manages STL's Health and Safety program. Responsible for development, oversight and evaluation of the policies and procedures specified in the laboratory Chemical Hygiene Plan is compliance with all OSHA requirements.

Laboratory Project Management—Managed STL's Project Management program which serves as client liaison function between clients, regulators, and laboratory staff for all analytical work. Was responsible for oversight on all analytical projects from proposal/costing submissions, through analysis, to final report delivery, invoicing, and account receivables. Responsible for coordination of efforts of laboratory staff to deliver technically valid, legally defensible, and cost effective analytical services. Provided effective communication between STL and clients to ensure delivery of required scope of services completed as specified, in the required time frame, and according to client requirements.

Data Management—Established and supervised laboratory documentation group for the preparation of all final reports. Responsible for release of 1,200 laboratory data reports annually. Ensured that presentation of analytical data met deliverables requirements for government and private clients. Trained staff and developed SOPs.

Laboratory Operations Management—Directed performance of inorganic and organic analysis and trained analytical technicians. Responsible for scheduling personnel and equipment, logging samples and results, and maintenance of reagents and equipment. Participated in development of analytical price list and prepared cost evaluations for general analyses. Conducted literature searches and developed laboratory Standard Operating Procedures to conform to EPA methodology. Reviewed analytical data and prepared client reports. Assisted in development of laboratory QA/QC program.

Environmental Chemistry—Directed organic and inorganic analysis of industrial effluents for local monitoring requirements. Developed field kit for dissolved oxygen determination based on Winkler titration, prepared the SOP, and conducted the field study. Responsible for maintenance and calibration of field water quality analyzers.

Analytical Experience—Performed determination of general inorganics and organics in surface and ground water, sediments, elutriates, soils, and biological materials. Specialized in analysis of metals by atomic absorption spectrometry. Validated methods and prepared SOPs for all general analyses.

Professional Affiliations:

- American Chemical Society
- American Society Quality Control
- American Association for Laboratory Accreditation, Accreditation Council
- National Environmental Laboratory Accreditation Conference, Performance Based Measurement Systems Subcommittee

Certifications:

- Seminar on Environmental Law (Piper & Marbury), May 1990
- Orientation to Quality Assurance Management (U.S. EPA QAMS), October 1990
- Data Quality Objectives Workshop (U.S. EPA QAMS), October 1990
- Good Customer Service (Dun & Bradstreet), December 1990
- EA Project Manager Training, January 1991
- EA Expert Witness Training, April 1991
- Environmental Regulations Course, November 1993
- EA Managers and Supervisors Training, June 1994
- Data Quality Objectives/Data Quality Assessment Workshop (Navy Northern Division), October 1996

Publications:

Uhlfelder, M.M. and J.H. Carpenter. 1973. Magnesium to chlorinity ratio in seawater. *J. Geophysical Research 78:3621-3626.*

Cypher, R.L., M.M. Uhlfelder, and M.M. Robison.1994 Mastering the Laboratory Inspection. *Water Environment Laboratory Solutions*

Uhlfelder, M.M. 1997. Determination of TPH in Tissue for Application in Risk Assessments. Presented at the Cold Regions Remediation Conference. Anchorage, Alaska, 3 - 5 April 1997.

Jeffrey A. Ward **Battelle MSL**

Senior Research Scientist
Technical Group Leader, Ecotoxicology

Education:

Ph.D. Environmental Engineering, Kennedy Western University, Thousand Oaks, CA (in progress)
B.A. Zoology, University of Washington, 1980

Qualifications:

Mr. Jeff Ward, Technical Group Leader for the Ecotoxicology group, joined Battelle in 1986. He has nearly 20 years experience in numerous programs involving the collection and biological/chemical analysis of dredged material proposed for unconfined open-water disposal, as well as baseline studies of intertidal and subtidal environments, pilot monitoring studies, field sampling efforts, environmental impact assessments, analysis of benthic community structure in Puget Sound, and a number of computer assisted analyses involving oceanographic and biological data. Recent work has concentrated on biological and chemical evaluations of sediment proposed for dredging and the development of ambient monitoring programs for industrial clients. As the Technical Group Leader for Ecotoxicology, Mr. Ward is responsible for all toxicological testing conducted at the Marine Sciences Laboratory, and the development of innovative solutions to complex environmental problems. To this end, Mr. Ward is currently involved in the evaluation and development of innovative techniques and technologies to decontaminate sediments associated with ports and harbors in the United States and the world. Potential decontamination technologies include the use of passive dewatering, oxidation/reduction, mineralization/fixation, mycoremediation, and other techniques to remediate highly contaminated sediments, resulting in a variety of beneficial end-use products. Mr. Ward is responsible for allocating the MSL's Wet Laboratory resources in support of these programs as well as innovative methods for conducting toxicity tests.

Relevant Experience:

Innovative Capabilities
While at Battelle, Mr. Ward has gained a reputation for successfully conducting challenging programs that involve coordinating of agencies, staff, and information; dealing with cutting-edge issues; and helping to interpret complex environmental and regulatory issues with both agencies and the general public. Some of these programs include

U.S. Navy, Engineering Facility West BRAC Program. Mr. Ward is working with a multidisciplinary team of scientists and engineers to assess the environmental conditions at Navy facilities in San Francisco Bay, California prior to their release to the general public. This multi-year program involves evaluation of historical data, field sampling and analysis, assessment of environmental cleanup alternatives using innovative technology, and the assessment of environmental risk associated with the closure of Navy bases and subsequent release to the public.

Re-licensing SEIS for Calvert Cliffs Nuclear Power Plant, Maryland. The Calvert Cliffs Nuclear Power Plant in Solomons, Maryland, was the first facility in the United States to request an extension to its operating license. In support of this request, Mr. Ward participated in a multidisciplinary team of scientists, engineers, environmental planners, sociologists, and economists to develop the draft and final supplementary environmental impact statement (SEIS) to extend the plant's operation on the shores of Chesapeake Bay. Mr. Ward was responsible for addressing all potential effects of the plant on the marine communities in Chesapeake Bay near the plant, the development of the SEIS, participation at public meetings, and the formal response to questions associated with the study. The final SEIS was submitted to the EPA by NRC in early 1999. Re-licensing is pending.

US*ACE Waterways Experiment Station (WES) Environmental Residue Database (ERED).* The objective of this program was to collect information on sublethal effects on sensitive marine organisms that are directly related to measured body burdens of contaminants of concern. Study objectives also included the inclusions of physical/chemical characteristics of contaminants, the life-stage and history of the test organisms, the target tissues analyzed, and the laboratory methods used. This research resulted in the development of a searchable database that is currently available through the WES Internet home page.

Criteria for Disposal in Confined Disposal Facilities (CDFs). Project Manager. A modeling program was developed to better understand the transport of leachate (porewater/ionterstital water) movement of contaminants of concern out of Confined Disposal Facilities (CDFs) into groundwater or other sources, such as rivers and streams. By identifying and predicting the availability of contaminants of concern and the pathways in which they travel, the modeling program can be used to evaluate the effectiveness of possible management courses of action before actual expenses are incurred. For example, courses of action to which responses can be predicted would be modifications of the CDF or the material enter it or other means of reducing the mobility or availability of contaminants. Project in progress.

Suggested Methods Manual for Environmental Sampling and Analysis in San Francisco Bay: Project Manager. This comprehensive document consists of three volumes of suggested methodologies for quality assurance/quality control, statistical analyses, field sampling, analytical chemistry measurements, and toxicological testing. It will be used as a reference for environmental investigations conducted under the authority of the U.S. Army Corps of Engineers, the Environmental Protection Agency, and various state and local agencies participating in the Long Term Management Strategy (LTMS) for San Francisco Bay. This manual is designed to assist agencies in program planning, to provide standard methods for evaluating selected environmental parameters, and to create standard datasets which can be compared. This facilitates decision-making processes, resulting in a cost-effective, efficient, and scientifically defensible program.

Water*ways Experiment Station (WES) QA/QC Workshop: Project Manager*. This workshop was held in Seattle, Washington on May 27-27, 1993, and was concerned with establishing guidelines for laboratory dredged material bioassays. Mr. Ward coordinated all aspects of the workshop and developed a list of topics including Data Quality Objectives; Biological Procedures; Sample Handling, Storage, and Shipment; Data Recording, Reduction, Validation, and Reporting; Internal Quality Control Checks, and Corrective Action. At the end of the workshop, Mr. Ward worked closely with WES to develop a comprehensive guidance document, QA/QC Guidance for Laboratory Dredged Material Bioassays. This document was later published by WES.

USACE Chicago Burns Harbor Environmental Program: Project Manager. This freshwater project involved the physical/chemical and toxicological testing of sediments proposed for dredging from Lake Michigan. Sediments were evaluated through standard analytical chemistry procedures and fresh-water

toxicological tests including solid-phase evaluations using *Chironomus tentans* and *Hyalella azteca*, and elutriate testing using *Pimephales promelas* and *Daphnia magna*. Mr. Ward coordinated the sediment sampling, managed all aspects of the toxicological testing and physical/chemical analysis, and represented the client during conversations with EPA.

Toxicological Testing and Benthic Assessment Program

Mr. Ward has been Project Manager, Chief Scientist, and Task Leader on numerous toxicological testing and benthic analyses programs, some of which include the following:

USACE Wilmington, North Carolina, and USACE Charleston, South Carolina, programs: Project Manager. These projects involved the collection of sediment samples from selected areas in Wilmington Harbor and the Military Ocean Terminal Sunny Point, North Carolina, and from Winyah Bay, South Carolina, using vibracore and van Veen grab samplers. A series of physical/chemical and toxicological tests have been conducted on these samples in accordance with the *Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual*, also referred to as the *Implementation Manual* (EPA/USACE 1991). Chemical analyses included sediment and tissue chemistry for PAHs, pesticides, metals, organotins, and dioxins. Toxicity tests and bioaccumulation exposure analyses involved suspended-particulate-phase (SPP) tests using *M. beryllina, M. bahia,* and *L. pictus* larvae, and solid-phase tests using *N. virens*, *R. abronius*, and *A. abdita* (10-day acute), and *N. virens* and *M. nasuta* (28-day bioaccumulation). This data will be used in the determination of the suitability of dredged material from these waterways for unconfined open-water disposal.

USACE Jacksonville, Florida, Dioxin Study: Project Manager. During this study, a series of sediment and tissue samples were evaluated for the presence of dioxin/furans. Mr. Ward coordinated the analyses of these samples, evaluated the quality of analytical measurements, and worked with the client to interpret the results.

US*ACE Panama City, Florida, Study: Program Manager*. This study involved the physical/chemical and toxicological evaluation of sediment proposed for dredging from St. Andrew Bay, Florida. Physical/chemical analyses included sediment conventionals as well as PAHs, PCB/Pesticides, phenols, phthalates, dioxins, and butyltins. Toxicological tests included solid-phase evaluations using *Ampelisca abdita*, *Rhepoxynius abronius*, and *Nereis virens*, and elutriate-phase evaluations using *Mysidopsis bahia*, *Menidia beryllina*, and the larvae form of *Mytilus edulis*. The results of this study enabled USACE to make decisions concerning the suitability of the dredged material for open-water disposal. As program Manager, Mr. Ward provided mentorship to other scientists, participated in planning sessions, and worked closely with the client during the performance of the program.

Alyeska Sediment Pilot Program: Project Manager. This program, sponsored by the Alyeska Pipeline Service Company, has been concerned with developing a monitoring program to evaluate environmental changes in Port Valdez, Alaska as a part of Alyeska NPDES permit. During the study, candidate monitoring organisms have been evaluated through the innovative use of solid-phase toxicological tests, analysis of chemicals of concern in sediment samples, and the use of spiked sediment tests to evaluate test organism sensitivity. Throughout this study, Battelle has worked in close association with Alyeska and regulatory agencies in planning and evaluating the success of this Pilot Study and future permit-related work.

Good Laboratory Practices (GLP) Studies

Participated in the planning, management, and conduct of Good Laboratory Practices (GLP) studies for a variety of private clients. These studies follow stringent quality control procedures utilizing sensitive

marine and estuarine organisms under flow-through and static testing conditions.
USACE Grays Harbor Dioxin Program: Deputy Project Manager. Chief Scientist on field collections of samples suspected of containing dioxins. Laboratory manager of toxicological testing to evaluate solid-phase sediment toxicity.

ADEC Toxicity Testing Program: Project Manager. This program, sponsored by the Alaska Department of Environmental Conservation (ADEC), included a suite of toxicological tests to evaluate the effect of the *Exxon Valdez* accident on Prince William Sound in 1989. Battelle provided support in testing and interpretation of environmental perturbations caused by the oil spill to assess spill cleanup and remediation actions.

USACE San Francisco WES/Uplands Program: Project Manager. This program was concerned with the collection and transportation of large volumes of sediment from areas of Oakland Harbor and upland disposal sites to USACE's Waterways Experiment Station (WES) in Vicksburg, Mississippi. During this program, a 12 in. diameter by 40 ft long split-core sampler was constructed and deployed in the Harbor. A total of 1815 gal of material (6870 L) was collected over a period of four days, and transported to WES in a refrigerated truck within three days after field sampling concluded.

USACE San Francisco Oakland Harbor Programs (Phases I, II, and III): Deputy Project Manager. Duties included the planning of the study, program costing, field sampling, management of all bioassay activities conducted during the program, and co-authorship of the draft and final reports to USACE.

USACE San Francisco Oakland Harbor 38-Foot Program: Chief Scientist for field collections and Bioassay Task Leader. Field collection activities included collecting sediment samples from Oakland Harbor with a gravity coring device and obtaining clean sediments from an offshore site with a pipe-dredge. Collected material was shipped on a daily basis to the Battelle MSL for biological and chemical processing. Bioassay Task leadership activities included conducting the bivalve larvae bioassay tests and participating in five other tests.

Olympia Harbor Program: Task Leader for bioassay testing of sediments. Under contract to USACE Seattle, bioassay tests performed under this program included bivalve larval tests, sea urchin sperm cell and development tests, static and flow through tests with amphipods, and protocol development for bioassay tests utilizing juvenile geoduck clams.

ARCO Anchorage Oil Spill: Participation in Battelle's evaluation of the extent and effects of the 1985 ARCO Anchorage oil spill in Port Angeles, Washington. His contributions included compiling and analyzing the field data, and verifying laboratory results.

EPA Studies
Participation in various studies for EPA to determine the toxicity of various organic pesticides to marine invertebrates such as *Rhepoxynius abronius*, by exposing the animals to various pesticide concentrations under controlled conditions.

Grays Harbor, Washington, Program: Chief Scientist for field collection of samples and Task Leader of bioassay tests in a study for the U.S. Army Corps of Engineers, concerning the toxicity of material destined to be dredged from the Chehalis River in Grays Harbor, Washington.

Eagle Harbor, Washington, Program: Participation in the experimental design, field studies, and analysis of an intertidal baseline study.

Benthic Resource Assessment Techniques (BRAT): Conducted field collections, managed the sorting, identification, and biomass procedures, and provided the Corps of Engineers with computer databases summarizing the laboratory results.

Budd Inlet, Washington, Program: Assisted in the development of a three-dimensional computer model designed to assess effects of secondarily treated effluent discharge.

Puget Sound Sewage Discharge Studies: Participation in studies at the University of Washington to assess the effects of primarily and secondarily treated sewage discharge on marine benthic communities in Puget Sound.

Publications:

Pinza, MR, JQ Word, JA Ward, and RK Kropp. 2000. *Ecotoxicological Testing to Address Confounding Factors for Hong Kong Contaminated Sediments.* PNWD-3020. Prepared for ERM-Hong Kong, Ltd., by Battelle Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., J.Q. Word, and L.F. Hibler. *Criteria for Disposal of Dredged Material in Confined Disposal Facilities (CDFs).* Prepared for the U.S. Army Corps of Engineers, Savannah District, by Battelle Marine Sciences Laboratory, Sequim, Washington; Pacific Northwest National Laboratory, Richland, Washington. (Draft)

Niewolny, L.A., V.I. Cullinan, and J.A. Ward. 1997. *Evaluation of Dredged Material Proposed for Ocean Disposal from Kennebunk River, Maine.* PNWD-2388. Prepared for the U.S. Army Corps of Engineers, New England Division, by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; and Battelle Ocean Sciences Laboratory, Duxbury, Massachusetts.

Ward, J.A., and L.F. Hibler. 1997. Criteria for Disposal of Dredged Material in Confined Disposal Facilities (CDFs). PNNL-SA-28851. Presented at the 18th Annual meeting of Society of Environmental Toxicology and Chemistry (SETAC): Bridging the Global Environment: Technology, Communication, and Education, November 16-20, 1997, San Francisco, California.

Ward, J.A., L.A. Niewolny, and V.I. Cullinan. 1997. *Ecological Evaluation of Proposed Dredged Material from the Charleston Harbor Entrance Channel, Charleston, South Carolina.* PNWD-2389. May, 1997. Prepared for Gulf Engineers & Consultants by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington.

Ward, J.A., L.A. Niewolny, and V.I. Cullinan. 1997. *Evaluation of Dredged Material Proposed for Ocean Disposal from Union River, Maine.* PNWD-2403. Prepared for the U.S. Army Corps of Engineers, New England Division, by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; and Battelle Ocean Sciences Laboratory, Duxbury, Massachusetts.

Pinza, M.R., B.D. Gruendell, J.A. Ward, A.D. Uhler, and A.B. Borde. 1996. *Evaluation of Dredged Material Proposed for Ocean Disposal from Portland Harbor Project Area, Maine.* PNWD-2347. Prepared for the U.S. Army Corps of Engineers, New England Division, by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; and Battelle Ocean Sciences Laboratory, Duxbury, Massachusetts.

Ward, J.A. 1996. *Ecological Evaluation of Proposed Dredged Material from Charleston Harbor, South Carolina.* PNNL-11390. Prepared for the U.S. Army Corps of Engineers, Charleston District, by Battelle Marine Sciences Laboratory, Sequim, Washington; Pacific Northwest National Laboratory, Richland, Washington.

Ward, J.A., V.I. Cullinan, and L.A. Niewolny. 1996. *Evaluation of Dredged Material Proposed for Ocean Disposal from 5-Mile River, Connecticut.* PNWD-2379. Prepared for the U.S. Army Corps of Engineers, New England Division, by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; and Battelle Ocean Sciences Laboratory, Duxbury, Massachusetts.

Ward, J.A., M.R. Pinza, A.B. Borde, V.I. Cullinan. 1996. *Ocean Disposal Site Bioaccumulation Testing.* PNWD-2364. Prepared for the U.S. Environmental Protection Agency, Wetlands and Sediment Management Section (W-3-3) and Region 9, San Francisco, California, under EPA Contract Number 68-C2-0134, Work Assignment 234. Prepared by Battelle Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; Battelle Ocean Sciences, Duxbury, Massachusetts.

Antrim, L.D., J.A. Ward, W.G. Steinhauer. 1995. *Tier I Evaluation of the Proposed Marine Pipeline Route in the Weymouth Fore River Estuary.* PNWD-2301. Prepared for the Massachusetts Water Resources Authority under Contract 23097 by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington; and Battelle Ocean Sciences Division, Duxbury, Massachusetts.

Ward, J.A., and J.Q. Word. 1995. *Option/Alternative Analysis for Requiring Selected Species in Suspended-Particulate-Phase and Solid-Phase Toxicological Tests.* Subtask 1D, Contract 22190, PNWD-SA-4225. Prepared for the Environmental Protection Agency, Oceans and Coastal Protection Division, Washington, D.C., by Battelle Ocean Sciences and Battelle/Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., J.Q. Word, A.D. Uhler, E.S. Barrows, V.I. Cullinan, R. Cuello, D.K. Niyogi. 1995. *Suggested Methods for Environmental Sampling and Analysis in San Francisco Bay.* Volumes 1-3. PNL-10565. Prepared for the U.S. Army Corps of Engineers, San Francisco District, in support of the Long-Term Management Strategy Program for San Francisco Bay, by Battelle/Marine Sciences Laboratory, Sequim, Washington; Pacific Northwest Laboratory, Richland, Washington.

Gardiner, W., J.A. Ward, and J.Q. Word. 1994. *Ecological Evaluation of Proposed Dredged Material from the Point Frazier Bend Reach, Winyah Bay, South Carolina.* Letter report prepared for the U.S. Army Corps of Engineers, Charleston District, by Battelle/Marine Sciences Laboratory, Sequim, Washington; Pacific Northwest National Laboratory, Richland, Washington.

Karle, L.M., J.A. Ward, and J.Q. Word. 1994. *Toxicological Evaluation of Sediment Samples from Port Valdez, Alaska. 1993 Sediment Study*. Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington. In press.

Kohn, N.P., W.W. Gardiner, R.K. Karls, P.J. White, J.A. Ward. 1994. *Evaluation of Proposed Deepening Dredged Material from Oakland Harbor Berth 23, Berth 24, and Berths 60-63*. Prepared for the Port of Oakland under Contract 19471 by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington. In press.

Kohn, N.P., W.W. Gardiner, R.K. Karls, P.J. White, J.A. Ward. 1994. *Evaluation of 1994 Proposed Maintenance Dredged Material from Oakland Harbor Berth 20, Berth 21, Berth 23, Berth 24, Berth 25, Berths 60-63, and Berths 67-68*. Prepared for the Port of Oakland under Contract 19471 by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington.

Tang, C., C.B. Boatman, J.A. Ward, B. Titus. 1985. *Southern Puget Sound Water Quality Assessment Study, Part II Report: Circulation/Dissolved Oxygen Model for Budd Inlet, Washington*. For Washington State Department of Ecology. URS Corporation, Seattle, Washington.

Ward, J.A., M.R. Pinza, M.E. Barrows, R.K. Karls, J.Q. Word. 1994. *Toxicological Evaluation of Sediment Samples from Burns Harbor, Porter County, Indiana*. PNL-9452. Prepared for the U.S. Army Corps of Engineers, Chicago District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Ward, J.A., and J.Q. Word. 1994. "The Effect of Sediment Equilibration and Disturbance on Acute Toxicity to the Amphipod, *Rhepoxynius abronius*." PNL-SA-23245 A. Presented at the Regulatory and Scientific Issues Associated with Sediment Contamination, American Chemical Society, March 13-18, 1994, San Diego, California. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Division, Richland, Washington.

Mayhew, H.L., J.Q. Word, N.P. Kohn, M.R. Pinza, L.M. Karle, J.A. Ward. 1993. *Ecological Evaluation of Proposed Dredged Material from St. Andrew Bay, Florida*. PNL-8894. Prepared for the U.S. Army Corps of Engineers, Mobile District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Moore, D.W., T. Dillon, J.Q. Word, J.A. Ward. 1993. *QA/QC Guidance for Laboratory Dredged Material Bioassays*. Results of QA/QC Workshop Held May 26-27, 1993, in Seattle, Washington. Prepared for the U.S. Army Corps of Engineers, Waterways Experiment Station (USACE/WES), by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by USACE/WES, Vicksburg, Mississippi.

Ward, J.A., M.E. Barrows, R.K. Karls, and J.Q. Word. 1993. *Toxicological Evaluation of Sediment Samples from Port Valdez, Alaska. 1992 Sediment Study*. Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, under Contract TAPS 4875, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., W.W. Gardiner, M.R. Pinza, J.Q. Word. 1993. *Ecological Evaluation of Proposed Dredged Material from Winyah Bay, South Carolina.* PNL-8893. Prepared for the U.S. Army Corps of Engineers, Charleston District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Ward, J.A., M.R. Pinza, M.E. Barrows, J.Q. Word. 1993. *Ecological Evaluation of Proposed Dredged Material from Wilmington Harbor and Military Ocean Terminal, Sunny Point, North Carolina.* PNL-8766. Prepared for the U.S. Army Corps of Engineers, Wilmington District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Ward, J.A., J.Q. Word. 1993. "The Effect of Sediment Equilibration and Disturbance on Acute Toxicity to the Amphipod *Rhepoxynius abronius*." Accepted for presentation at the Regulatory and Scientific Issues Associated with Sediment Contamination, Sponsored by the American Chemical Society, March 13-18, 1994, San Diego, California.

Word, J.Q., H.L. Mayhew, M.R. Pinza, J.A. Ward. 1993. "Metals Bioaccumulation by *Macoma nasuta* and *Nephtys caecoides* after 28-Day Exposure to Dredged Sediment." 1993. Presented at the 14th Annual Society for Environmental Toxicology and Chemistry (SETAC) meeting in Houston, Texas, November 15-18, 1993. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Word, J.Q., J.A. Ward. 1993. "Contamination of the Sea Surface." Presented at the Pacific Northwest Pollution Control Association (PNWPCA) Conference, November 8-10, 1993, Seatac, Washington.

Kohn, N.P., H.L. Mayhew, J.A. Ward, N.A. Cadoret, J.Q. Word. 1992. *Ecological Evaluation of Proposed Dredged Material from Oakland Harbor Berthing Areas.* Prepared for the Port of Oakland, Contract BNW 18157, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Kohn, N.P., J.A. Ward, H.L. Mayhew, J.Q. Word, E.S. Barrows, S.M. Goodwin, L.F. Lefkovitz. 1992. *Ecological Evaluation of Proposed Discharge of Dredged Material from Oakland Harbor into Ocean Waters (Phase III B of -42-Foot Project).* PNL-8174. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Mayhew, H.L., N.P. Kohn, M.R. Pinza, J.Q. Word, J.A. Ward, R.M. Thom. 1992. *A Summary of Chemical and Biological Testing of Sediment from Oakland Harbor Navigation Channel and Berthing Areas Relative to Potential Disposal at Bay Farm Borrow Area.* Prepared for the U.S. Army Corps of Engineers and the Port of Oakland under Contract 14511 by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Mayhew, H.L., N.P. Kohn, J.A. Ward, J.Q. Word, M.R. Pinza. 1992. *Ecological Evaluation of Oakland Harbor Phase III -38-Foot Composites Relative to the Alcatraz Island Disposal Site (R-AC).* Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Mayhew, H.L., N.P. Kohn, J.A. Ward, J.Q. Word, M.R. Pinza. 1992. *Ecological Evaluation of Oakland Harbor Phase III -38-Foot Composites Relative to the Alcatraz Island Environs (R-AM).* PNL-7963. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Pinza, M.R., J.A. Ward, H.L. Mayhew, J.Q. Word, D.K. Niyogi, N.P. Kohn. 1992. *Ecological Evaluation of Proposed Dredged Material from Richmond Harbor.* PNL-8389. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Pinza, M.R., J.A. Ward, J.Q. Word, A.M. Christian. 1992. "Endrin Porewater Partitioning: Toxicity (*Rhepoxynius abronius*) and Equilibration." Presented at the SETAC 13th Annual Meeting, November, 1992, Cincinnati, Ohio. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., M.E. Barrows, R.K. Karls, J.Q. Word. 1992. *Toxicological Evaluation of Sediment Samples from Port Valdez, Alaska: 1991. Alyeska Sediment Study, Phase 3.* Prepared for Alyeska Pipleine Service Company, Anchorage, Alaska, under contract number TAPS 4875, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., J.Q. Word, M.R. Pinza, H.L. Mayhew, M.S. Barrows, N.P. Kohn, L.K. Lefkovitz. 1992. *Ecological Evaluation of Proposed Discharge of Dredged Material from Oakland Harbor into Ocean Waters (Phase III, -38-Foot Project).* PNL-7890. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Ward, J.A., J.Q. Word, M.R. Pinza, H.L. Mayhew, E.S. Barrows, L.F. Lefkovitz. 1992. *Ecological Evaluation of Proposed Discharge of Dredged Material from Oakland Harbor into Ocean Waters (Phase III A of -42-Foot Project).* PNL-8302. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Ward, J.A., J.Q. Word. 1991. *The Sensitivity of Two Species of Amphipods to Sediments Spiked with Alaska North Slope Crude Oil - Alyeska Sediment Study, Phase 2.* PNWD-1780. Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., J.Q. Word. 1991. *Toxicological Evaluation of Sediment Samples from Port Valdez, Alaska, Using the Amphipod Rhepoxynius abronius - Alyeska Sediment Study, Phase 2.* PNWD-1779. Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Ward, J.A., J.Q. Word, L.D. Antrim. 1991. *Toxicological Evaluation of Sediment Samples from Port Valdez, Alaska, Using Three Species of Marine Amphipods - Alyeska Sediment Pilot Study.* Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, under Contract TAPS 4875, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Word, J.Q., B.W. Claiborne, J.A. Ward, and C. Chapin. 1991. "The Effect of Test Sediment Stabilization and Distrubance on Acute Toxicity to the Amphipod *Rhepoxynius abronius*." In *Puget Sound Research '91 Proceedings*, Vol.2, pp.441-448. January 4-5, 1991, Washington State Convention and Trade Center, Seattle, WA. Puget Sound Water Quality Authority, Olympia, WA.

Word, J.Q., J.A. Ward, B. Brown, B.E. Walls, S. Lemlich. 1991. *Relative Sensitivity and Cost of Amphipod Bioassays*. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Antrim, L.D., J.M. Kelly, J.Q. Word, and J.A. Ward. 1990. *Results of Effluent Toxicity Tests Conducted in July 1990 for Alyeska Pipeline Service Company*. PNL-1669. Final Report to Alyeska Pipeline Service Company, Anchorage, Alaska. November 1990. Prepared by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Antrim, L.D., J.A. Ward, N.P. Kohn, and J.Q. Word. 1990. *Results of Effluent Toxicity Tests Conducted for Alyeska Pipeline Service Company, March 1990*. PNL-1549. Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, April 1990, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Antrim, L.D., J.Q. Word, and J.A. Ward. 1990. *Results of Effluent Toxicity Tests Conducted in October 1990 for Alyeska Pipeline Service Company*. PNL-1688. Prepared for Alyeska Pipeline Service Company, Anchorage, Alaska, November 1990, by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Brown, B., N.P. Kohn, E.A. Crecelius, J.A. Ward, B.N. Bjornstad. 1990. *Environmental Evaluations for Deepening of Richmond Harbor and Santa Fe Channels*. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Word, J.Q, J.A. Ward, L.D. Antrim. 1990. *The Toxicity of Corexit 9580 M-2 and Mixtures of Corexit and Weathered Crude Oil to Four Species of Marine Organisms*. Prepared for Exxon Company USA by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Word, J.Q., J.A. Ward, A.L. Squires. 1990. *Results of Chemical, Toxicological, and Bioaccumulation Evaluations of Dioxins, Furans, and Guaicol/Organic Acids in Sediments from Grays Harbor/Chehalis River Area*. PNL-7480. Prepared for the U.S. Department of Energy by Pacific Northwest Laboratory, Richland, Washington.

Word, J.Q., J.A. Ward, J.A. Strand, V.I. Cullinan, E.A. Crecelius, W. Steinhauer, J.L. Hyland. 1990. *Ecological Evaluation of Proposed Discharge of Dredged Material from Oakland Harbor into Ocean Waters (Phase I of -42-Foot Project)*. PNL-7484. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Word, J.Q., J.A. Ward, J.A. Strand, N.P. Kohn, A.L. Squires. 1990. *Ecological Evaluation of Proposed Discharge of Dredged Material from Oakland Harbor into Ocean Waters (Phase II of -42-Foot Project)*. PNL-7483. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Word, J.Q., J.A. Ward, D.L. Woodruff. 1990. *Results of Bulk Sediment Analysis and Bioassay Testing on Selected Sediments from Oakland Inner Harbor and Alcatraz Disposal Site, San Francisco, California*. PNL-7686. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Kohn, N.P., and J.A. Ward. 1989. *Hylebos Waterway, Segment 5 Sediment Sampling: Cruise Report.* Prepared for Conestoga-Rovers & Associates, Niagara Falls, NY. 18pp.

Kohn, N.P., M.R. McLean, and J.A. Ward. 1989. *Results of Microtox Testing Performed on Sediment Samples from Prince William Sound, Alaska. Test 7: September, 1989.* Final Report to the Alaska Department of Environmental Conservation.

Ward, J.A., J.C. Coley, L.D. Antrim. 1989. *Ecological Evaluation of Proposed Discharge of Dredged Material from Oakland Harbor into Ocean Waters: WES/Uplands Program.* Cruise Report prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Ward, J.A., N.P. Kohn, L.D. Antrim, and J.Q. Word. 1989. *Results of Toxicological Testing Performed on Sediment Samples from Prince William Sound, Alaska.* Six Technical Reports submitted to the Alaska Department of Environmental Conservation: May - September 1989.

Ward, J.A., J.Q. Word, L.D. Antrim. 1989. *Biological Testing of Sediment for the Olympia Harbor Navigation Improvement Project, 1988 - Geoduck, Amphipod, and Echinoderm Bioassays.* PNL-6883. Prepared for the U.S. Army Corps of Engineers, Seattle District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Strand, J.A., J.Q. Word, V.I. Cullinan, N.P. Kohn, J.A. Ward, and J.S. Young. 1988. "Chemical and Biological Assessment of Treated Wastewater." Letter Report to Alyeska Pipeline Service Company, 46 pp., by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Word, J.Q., C.C. Ebbesmeyer, J.A. Ward. 1988. "Shoreline Stranding of Floatable Materials in Seahurst Bay." In *Proceedings, First Annual Meeting on Puget Sound Research*, Vol.2, pp. 409-420. March 18-22, 1988, The Seattle Center, Seattle, Washington. Puget Sound Water Quality Authority, Seattle, Washington.

Word, J.Q., J.A. Ward, C.W. Apts, D.L. Woodruff, M.E. Burrows, V.I. Cullinan, J.L. Hyland, J.F. Campbell. 1988. *Confirmatory Sediment Analyses and Solid and Suspended Particulate Phase Bioassay Tests on Sediment from Oakland Inner Harbor, San Francisco, California.* PNL-6794. Prepared for the U.S. Army Corps of Engineers, San Francisco District, by Battelle/Marine Sciences Laboratory, Sequim, Washington. Published by Pacific Northwest Laboratory, Richland, Washington.

Skalski, J.R., M.A. Simmons, J.M. Thomas, J.A. Ward. 1987. *Evaluation of Group Testing Methodology for Streamlining the Urine Analysis of 90SR.* Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Laboratories, Richland, Washington.

Word, J.Q., J.R. Skalski, W.H. Pearson, J.A. Strand, R.B. Lucke, J.A. Ward. 1987. *Effectiveness of Cleaning Oiled Beach Sediments at Ediz Hook Following the ARCO ANCHORAGE Oil Spill.* Prepared for ARCO Marine, Inc. by Battelle/Marine Sciences Laboratory, Sequim, Washington.

Word, J.Q., J.A. Ward, L.M. Franklin, V.I. Cullinan, S.L. Kiesser. 1987. *Evaluation of the Equilibrium Partitioning Theory for Estimating the Toxicity of the Nonpolar Organic Compound DDT to the Sediment Dwelling Amphipod Rhepoxynius abronius).* Prepared for the Criteria and Standards Division of the U.S. Environmental Protection Agency, Washington, D.C., by Battelle, Pacific Northwest Laboratories, Richland, Washington, submitted by Battelle, Washington Environmental Program Office, Washington, D.C.

Word, J.Q., J.L. Skalski, J.A. Ward, P. Wilkinson. 1986. *Reconnaissance Survey of Intertidal Property Owned by Wyckoff Company in Eagle Harbor, Washington.* Battelle/Marine Sciences Laboratory, Sequim, Washington; Battelle, Pacific Northwest Laboratories, Richland, Washington.

Word, J.Q., P.L. Striplin, K. Keeley, J. Ward, P. Sparks-McConkey, L. Bentler, S. Hulsman, K. Li, J. Schroeder, K. Chew. 1984. "Subtidal Benthic Ecology," Vol. V, Section 6, of *Renton Sewage Treatment Plant Project: Seahurst Baseline Study.* Principal investigators Q.J. Stober, K.K. Chew. Final Report for the period April 1, 1982 to December 31, 1984, pp. 1-461. For the Municipality of Metropolitan Seattle, Seattle, Washington.

Word, J.Q., P. Striplin, J. Ward, K. Keeley and K. Chew. 1984. *Subtidal Benthic Ecology, in Renton Sewage Treatment Plant Project: Duwamish Head.* pp. 140-196.

Word, J.Q., P.L. Striplin, K. Keeley, J. Ward, J. Sassano, S. Hulsman, K. Li, P. Sparks, J. Schroeder, T. LaValle, K. Chew. 1982. *Subtidal Ecology-Annual Report: Renton Sewage Treatment Plant Project; Seahurst Baseline Study.* pp 280-442. For the Municipality of Metropolitan Seattle, Seattle, Washington.

Pamela Anne Wasel **Harding ESE**

Project Environmental Scientist

Education:

MEM Water Resources and Resource Ecology, Duke University, 1996
B.S. Natural Resource Management, Cornell University, 1992

Qualifications:

Ms. Wasel has more than seven years experience in the environmental field with experience in human health and ecological risk assessment, regulatory development, community relations, biological investigations, and field work. During the past three and a half years, Ms. Wasel has provided technical support and assumed the role of task lead for human health and ecological risk assessments, primarily for sites regulated under the Massachusetts Contingency Plan (MCP). Ms. Wasel has provided technical assistance to EPA on oil pollution prevention regulations and provided technical interpretation of those proposed rules to the regulated community. She has assisted in field investigations to remediate hazardous waste sites. During graduate school, Ms. Wasel participated in a long-term project for Westvaco Company to monitor the distribution and diversity of breeding birds on timberlands and to study the potential effects of prescribed burning regimes on bird communities. Specialized skill areas include:

- Human Health Risk Assessments
- Ecological Risk Assessments
- SPCC Plans
- Regulatory Development
- Technical Writing

Relevant Experience:

MCP Human Health Risk Assessment Addendum, Confidential Client, Wilmington, Massachusetts. Task lead for conducting the Method 3 human health risk assessment addendum for this chemical manufacturing facility. The focus of this risk assessment addendum was to determine the nature of potential risks associated with the anticipated redevelopment for the site in accordance with MCP requirements. Risks to on-site workers, construction workers, and neighborhood residents associated with potential exposures to soil (via direct contact, inhalation of particulates, and inhalation of VOCs) and groundwater (via direct contact and inhalation of VOCs) were evaluated.

MCP Method 3 Risk Characterization,Confidential Client, Webster, Massachusetts. Task lead for conducting the Method 3 human health risk characterization for this former manufactured gas plant (MGP). This information will be used to determine if additional response actions are required to achieve or maintain a condition of no significant risk. The majority of chemicals detected at the site were related to residuals associated with the former MGP operations. These chemicals included primarily PAHs, VOCs (including BTEX and styrene), and cyanide.

MCP Method 3 Risk Characterization, Confidential Client Group, Arlington, Massachusetts. Assisted with the Method 3 human health risk characterization for site that is located on five separate properties, including active recreational playing fields. Responsible for managing and maintaining the database used for all risk assessment calculations. Chemicals of concern at the site included hexavalent chromium and trivalent chromium, PAHs, cyanide, and lead associated with a former chromium works, a manufactured gas plant, and historical filling.

MCP Human Health Risk Assessment, Courier Corporation, Lowell, Massachusetts. Performed a Method 1 risk assessment for Courier per the MCP. The primary goal of this risk characterization was to determine if site closure could be achieved under the MCP without Activity and Use Limitations (AULs). The extent of contamination at this site included industrial and sanitary wastes including volatile and semi-volatile organics and some inorganics.

MCP Human Health and Ecological Risk Assessment, Confidential Client, Attleboro, Massachusetts. Task lead for conducting the Method 3 human health and ecological risk assessment for this former manufactured gas plant in Attleboro, Massachusetts. Manufactured gas plant residuals, primarily PAHs, lead, and cyanide, were the primary constituents of potential concern at this site. Results of this risk assessment will be used to achieve a Class A-3 Response Action Outcome (RAO) for the site.

MCP Human Health and Ecological Risk Assessment, Goodyear Tire and Rubber Company, New Bedford, Massachusetts. Conducted human health and Stage 1 environmental risk characterization for this former manufacturing facility. Constituents of concern at the site were VOCs, PAHs, lead, and TPH associated with petroleum releases.

MCP Human Health and Ecological Risk Assessment, National Railroad Amtrak, Dorchester, Massachusetts. Conducted Method 1 risk characterization at a diesel fuel spill site located on railroad property. Extractable petroleum hydrocarbons in soil were the focus of the risk characterization. Results of the risk assessment were used to evaluate the need for remedial action at the site.

MCP Imminent Hazard Evaluation, Confidential Client, Wilmington, Massachusetts. Conducted an Imminent Hazard Evaluation (IHE) in accordance with the MCP for flocculent and groundwater samples collected in the ditch system at the facility. Conducted the IHE to further evaluate whether or not flocculent and groundwater conditions in the ditch system required expedited response actions in the form of an Immediate Response Action (IRA). Chromium detected in the flocculent was the primary focus of the IHE.

MCP Human Health and Ecological Risk Assessment, Textron Systems Division, Everett, Massachusetts. Conducted Method 3 risk assessment in accordance with the MCP for the western parcel of the Textron facility. Assessed the potential for impacts to human health, safety, public welfare, and the environment. Petroleum and lead were the primary contaminants of concern evaluated at this site.

MCP Imminent Hazard Evaluation, Boston Edison Company, South Boston, Massachusetts. Conducted an Imminent Hazard Evaluation for surface soil at the Boston Edison site per the requirements of the MCP. Evaluated exposures via inhalation of particulates from soils that may have migrated from the site to surrounding area and downwind properties. Estimated downwind ambient concentrations resulting from wind erosion using an air dispersion model. Characterized health risks to workers in the surrounding properties and to downwind residents, and also characterized risks to safety and the environment.

MCP Human Health and Environmental Risk Assessment, Confidential Client, Lawrence, Massachusetts. Served as task lead for the human health and environmental risk assessments for this manufactured gas plant in Lawrence, Massachusetts. Conducted the Method 3 human health risk assessment in accordance with the MCP to characterize the potential health risks at the site. Manufactured gas plant residuals, primarily PAHs, lead, and cyanide, were the primary constituents of potential concern at this site. Conducted a Method 3 Stage I environmental screening for the site per the MCP. Potential exposure to aquatic receptors was of primary concern at the site. Assisted in conducting an evaluation of local conditions in accordance with MADEP guidance. Conducted an effects-based screening for PAHs of potential concern detected in groundwater and surface water samples. As part of the effects-based screening, derived equilibrium partitioning-based sediment benchmarks for several PAHs. Results of the human health risk assessment and environmental screening were used to evaluate the need for remedial action at the site.

MCP Human Health Risk Assessment, Textron Systems Division, Everett, Massachusetts. Conducted Method 3 risk assessment in accordance with the MCP for the eastern parcel of the Textron facility. Assessed the potential for impacts to human health, safety, public welfare, and the environment. Petroleum and lead were the primary contaminants of concern evaluated at this site. Used an adult lead model to evaluate lead exposures to excavation workers. Results of this risk assessment were used to achieve a partial Class A-3 Response Action Outcome (RAO) for the eastern portion of the site.

MCP Human Health Risk Assessment, McCord Winn Textron, Winchester, Massachusetts. Conducted Method 1/Method 2 risk assessment per the MCP for the former McCord Winn manufacturing facility in Winchester, Massachusetts. Results of this risk assessment were used to evaluate the need for remedial action at the site.

MCP Human Health Risk Assessment, Watertown Formerly Used Defense Site, Watertown, Massachusetts. Conducted Method 1/Method 2 risk assessment per the MCP for Arsenal Park at the Watertown site. Results of this risk assessment were used to evaluate the need for remedial action at the site. Developed groundwater Method 2 standards for carbazole, dibenzofuran, 2-methylphenol, and 4-methylphenol. Developed soil Method 2 standards for carbazole and dibenzofuran.

MCP Human Health and Environmental Risk Assessment, Confidential Client, Wilmington, Massachusetts. Assisted in the preparation of a Method 3 public health risk assessment for this chemical manufacturing facility. The focus of this risk assessment was to determine the nature of potential risks associated with the anticipated future land use of the facility per the MCP requirements, including risk to on- and off-site workers and neighborhood residents associated with potential exposures to hot spot areas of chemical contamination in drainage ditches, groundwater, and soil. Project activities include the evaluation of analytical data and conducting of a focused risk assessment to identify defined areas of elevated risk.

Human Health Risk Assessment, CE Windsor Site, Windsor, Connecticut. Conducted a human health evaluation for this industrial facility consistent with Connecticut Department of Environmental Protection Remediation Standards Regulations and USEPA Region I risk assessment requirements. Twenty-seven Areas of Concern where historical practices may have impacted environmental conditions were evaluated. Chemicals detected include solvents, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), fuel oils, and inorganic analytes. The purpose of the risk assessment was to assess the risk of harm to human health for current and potential land uses and to determine if the Site meets the criteria for stabilization or if response actions might be required to permit future unrestricted land use.

Human Health Risk Assessment, Textron-Gorham Manufacturing Site, Providence, Rhode Island. Conducted a human health and ecological risk evaluation for this former manufacturing facility consistent with the Rhode Island Department of Environmental Management (RIDEM) Remediation Regulations. Contamination at the site was predominantly TPH, PAHs, copper, and lead in soils and primarily chlorinated VOCs in groundwater. The primary goal of this risk evaluation was to provide quantitative and qualitative information necessary to assess the need for remedial action at the site.

Human Health Risk Assessment, UFF and NWSA sites, Kazakstan. Conducted a human health risk assessment to determine if SVOCs, petroleum hydrocarbons, and inorganics detected in soils at the UFF and NWSA sites in Kazakstan posed a potential risk to excavation workers involved in site restoration. The risk assessment was performed by developing risk-based screening levels protective for site worker exposures to soil, and comparing those screening levels to analytical soil data collected at these sites. The risk assessment was performed using USEPA risk assessment guidance.

Human Health and Ecological Risk Evaluation, ABB Service, Inc., St. Gabriel, Louisiana. Prepared a human health and ecological risk evaluation consistent with the Louisiana Department of Environmental Quality Risk Evaluation/Corrective Action Program (RECAP). Constituents of concern at the site were primarily volatile organic compounds. Calculated soil and groundwater remediation standards for comparison to site concentrations. Demonstrated that site-specific conditions were conducive to natural attenuation.

Development of Risk-Based Concentrations, Zeneca-Stauffer Site, Tampa, Florida. Developed risk-based concentrations (RBCs) for pesticides in treated soils to be used as landfill daily cover. Developed RBCs for a variety of worker scenarios. Calculated RBCs associated with cancer and noncancer effects.

Human Health and Environmental Risk Assessment, McCord Winn Textron, Cookeville, Tennessee. Conducted a baseline human health and ecological risk assessment of the McCord Winn Textron property in Cookeville, Tennessee per the Tennessee Voluntary Cleanup, Oversight, and Assistance Program under RCRA. Assessed risk of harm to human health and the environment posed by contaminants detected in groundwater at the site as the result of past manufacturing practices for use in remedial decision-making. Completed focused risk assessment screening for evaluation of contaminated soils at the Textron facility. Evaluated potential ecological exposures to site-related contaminants.

Ecological Preliminary Risk Evaluation, United States Geologic Survey, Raleigh, North Carolina. Conducted preliminary risk evaluation for Solid Waste Management Units (SWMUs) at Fort Bragg site in North Carolina. Conducted an ecological PRE for surface soil, groundwater, surface water, and sediment at the site. Characterized the site and performed an effects-based screening for terrestrial vertebrates, invertebrates, and plants.

Interior Building Contamination - Cleanup Level Development, Rol-Flo Engineering Site, South Kingstown, Rhode Island. Developed a target cleanup level for mercury compounds on building interior surfaces for the Rol-Flo site. Calculated daily intakes for the ingestion, dermal, and inhalation exposure routes. Back-calculated the target cleanup level for surface decontamination in the building onsite.

Public Health and Ecological Preliminary Risk Evaluations, U.S. Army Corps of Engineers, New England Division, Fort Devens Sudbury Training Annex, Sudbury, Massachusetts. As Scientist, responsible for conducting public health and ecological preliminary risk evaluations based on site investigations and data from laboratory analysis. Project focuses are to direct remedial investigation

decision-making through risk-based evaluations of hazards in soil, subsurface soil, groundwater, sediment, and surface water.

Ecological Risk Assessment, Army Environmental Center, Fort Devens, Massachusetts. As Scientist, prepared an ecological risk assessment to evaluate potential risks to terrestrial and semi-terrestrial receptors from exposure to site-related contaminants in surface soil, sediment, and groundwater. Project activities included the evaluation of analytical and toxicological data to identify areas of elevated risk.

Ecological Risk Assessment, Comprehensive Long-term Environmental Actions Navy (CLEAN) Program, U.S. Navy, NAS Jacksonville Operable Unit 2, Jacksonville, Florida. As Scientist, assisted in performing an ecological risk assessment for Operable Unit 2. This assessment estimated risks to terrestrial and semi-terrestrial receptors from exposure to site-related contaminants in surface soil and sediment.

Oil Pollution Prevention Program, USEPA, Crystal City, Virginia. As Associate Scientist, drafted regulatory language for use in EPA's Oil Pollution Prevention regulations. Task Manager and technical expert for EPA's Oil Spill Prevention, Control, and Countermeasures (SPCC) Information Line, providing technical interpretation of the proposed rules to over 100 members of the regulated community per week. Task Manager for meetings and workshops, providing technical support at EPA Workgroup meetings. Prepared responses to public comments on the Oil Pollution Prevention proposed rules. Prepared biweekly and monthly technical reports summarizing the work performed on the Oil Project.

Community Relations, U.S. Department of the Navy, Florida. As Associate Scientist, developed fact sheets for the community relations program to ensure that the citizens understood the issues associated with the Superfund cleanup program and were aware of the planned environmental investigations and remedial actions at specific Superfund sites.

CLEAN Program, U.S. Navy, Coastal Systems Station, Panama City, Florida. As Associate Scientist, assisted in field investigations to remediate sites contaminated with hazardous wastes. Collected surface soil samples at Solid Waste Management Units at CSS Panama City for data analysis. Assisted in the preparation of Health and Safety Plans. Assisted in conducting geophysical surveys.

Field Investigations, Lockheed Martin Energy Systems, Inc., Loring Air Force Base, Limestone, Maine. As Associate Scientist, assisted in field investigations to remediate sites contaminated with hazardous wastes. Collected surface soil and sediment samples for data analysis.

Representative Projects while with Westvaco Timber Company, Ridgeville, South Carolina, 1995
As Wildlife Technician, participated in a long-term study monitoring distribution and diversity of breeding birds within specific habitats on Westvaco study areas. Collected demographic data on birds through nest searches and mist netting. Compiled data on the stand structures and vegetative characteristics of the sites.

Representative Projects While With Research Triangle Institute, RTP, North Carolina, 1994-1996
Soil Screening Guidance, USEPA, RTP, North Carolina. As Temporary Associate Scientist, provided technical assistance on the Soil Screening Guidance.

Remediation Technologies Assessment, Confidential Client, RTP, North Carolina. As Temporary Associate Scientist, researched and summarized information on remediation technologies. Communicated with vendors to discuss the status of their technologies.
Additional Training:

- OSHA Certification
- Beyond TPH: Understanding and Using The New VPH/EPH Approach; MADEP training seminar
- Advances in Ecological Risk Assessment; short course at Duke University
- GIS Key: Basic Training

Publications and Presentations:

1996. The Effect of Prescribed Burning Regimes on Avifauna Communities on Intensively Managed Timber Lands. Presented at the Nicholas School of the Environment Master's Project Symposium, Duke University, March.

1993. *Identifying Environmentally Sensitive Areas Under the Oil Pollution Act.* Presented at the Society of Environmental Toxicology and Chemistry Conference, Houston, Texas, November (with Lively-Diebold, B., Davis, S.M., Pease, A.L.).

1992. *Handling Oil Contaminated Media from Oil Spills.* Accepted for presentation at the 1993 International Oil Spill Conference, Tampa, Florida, March (with McEaddy, M.C., Buckley, S.E., Pease, A.L.).

Susan Winnard **Battelle Columbus**

Technician

Education:

A.S. Medical Laboratory Technology, Columbus State University, 1995

Qualifications:

Ms. Winnard is currently responsible for performing daily activities in Battelle's dedicated PCDD/PCDF sample preparation laboratory. Her duties include ordering supplies, preparing reagents, and performing sample extraction and extract cleanup activities to coordinate with project schedules. Ms. Winnard has demonstrated success in PCDD/PCDF sample preparation using EPA Methods 1613 and 8290. Ms. Winnard worked in the microbiology department at Laboratory Corporation of America, Dublin, Ohio. Her responsibilities included: identification and susceptibility of organisms from human, animal, and environmental sources using manual and automated methods; logging-in and processing specimens according to source; training personnel for bench-work; ordering and maintaining stock of antibiotic disks; daily and monthly QC of media and instrumentation; customer service; and entry of results.

Relevant Experience:

PCDD/PCDF Analyses to Determine Coastal Environment Quality. Prepared tissue samples from multiple sites along the U.S. East Coast for PCDD/PCDF analysis according to Method 8290 and 1613. The analyses were conducted to determine environment quality and the quality of dredged material proposed for ocean disposal. Samples prepared have consistently met or exceeded data quality objectives.

PCDD in Drinking Water. Extracted drinking water samples which were then analyzed on an effort for a government agency. Detection limits in the part-per-quadrillion range (less than 10 pg/Liter) were obtained.

Jordana Regan Wood **Battelle MSL**

Science and Engineering Associate III

Education:

M.S. Arizona State University, Chemistry, 1991
B.A. Hiram College, Chemistry, 1988

Qualifications:

Ms. Wood has over ten years experience as an inorganic analytical chemist, including sample preparation and trace metals analysis using a variety of recognized analytical methods and related instrumentation. Ms. Wood's analytical expertise is complemented by a background in inorganic data review and report preparation.

Relevant Experience:

Scientist, Trace Metals Supervisor. LAS Laboratory, Southern Petroleum Laboratories, Las Vegas, Nevada, 1997 to 1998.

Associate Scientist. Lockheed Environmental Systems & Technologies Co., Lockheed Analytical Services Division, 1994 to 1996.

Ms. Wood's responsibilities included instrumental analysis of environmental samples using procedures found in the USEPA CLP and SW-846, as well as other recognized methods manuals. She is proficient in trace metal analysis using graphite furnace, flame, and cold vapor atomic absorption spectroscopy, as well as inductively coupled plasma atomic emission spectroscopy. Ms. Wood was also responsible for the interpretation and review of inorganic data. She also prepares in-house and client QC Control Charts.

Analytical Chemist. ICF Kaiser Engineers,1991 – 1994.

Ms. Wood was responsible for CLP inorganic sample preparation, trace metal analysis by GFAA, microwave sample preparation, and organic extraction methods. She performed standard operating procedure reviews to meet current technologies, produced and analyzed performance evaluation standards and inorganic ICV solutions, and maintained sample inventory.

Teaching Assistant. Ms. Wood was a Teaching Assistant at Arizona State University and Hiram College.
Research Assistant. Ms Wood was a research Assistant at Arizona State University (X-Ray Fluorescence analysis of rock samples) and Kent State University (Solubility of organic compounds in binary solvent mixtures).

Kathryn V. Wood **Chesapeake Biological Laboratory**

Ammonium and Nitrite – Sample Preparation/Analyst

Education:

B.S. Purdue University, 1972

Qualifications:

Collection, processing, and analyzing samples associated with nutrient dynamics of the Chesapeake Bay and other water bodies. Collection and identification of Chesapeake Bay ichthyoplankton.

Relevant Experience:

1971. Summer student assistant, University of Maryland, Center for Environmental Science, Chesapeake Biological Laboratory, Solomons

1773-78. Faculty Research Assistant, University of Maryland, Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, Maryland

1978-Present. Senior Faculty Research Assistant, University of Maryland, Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, Maryland.

Awards and Special Recognition:

- State of Maryland, Governor's Salute to Excellence, April 24, 1992.
- State of Maryland, Department of the Environment, Environmental Excellence Award, 1992

Memberships in Professional Societies:

- Atlantic Estuarine Research Society
- Estuarine Research Federation

Publications:

D. A. Neumann, J. M. O'Connor, J. A. Sherk, Jr., and K. V. Wood. Respiratory and hematological responses of oyster toadfish (*Opsanus tau*) to suspended solids. Trans. Amer. Fish. Soc. 104(4): 775-781.

E. M. Setzler, W. R. Boynton, T. T. Polgar, J. A. Mihursky, and K. V. Wood. Spatial and temporal distribution patterns of striped bas ichthyoplankton and juveniles in the Potomac Estuary. Trans. Am. Fish, Soc. 110:121-136.

J. A. Mihursky, W. R. Boynton, E. M. Setzler-Hamilton, K. V. Wood, and T. T. Polgar. Freshwater influences on striped bass population dynamics. Proceedings of the National Symposium on Freshwater Inflow to Estuaries, Vol. I. U. S. Dept. of Interior, Fish and Wildlife Service.

J. A. Mihursky, E. M. Setzler-Hamilton, F. D. Martin, and K. V. Wood. 1982. Spatial and temporal patterns of springtime utilization of the Potomac Estuary by fish larvae. Pages 20-27 in C. F. Bryon, J. V. Conner and F. M. Truesdale (eds.). Fifth Annual Larval Fish conference Proceedings. Louisiana State Univ., Baton Rouge, LA. March 2-3, 1981.

D. A. Neumann, J. M. O'Connor, J. A. Sherk, Jr. and K. V. Wood. Respiratory responses of striped bass (*Morone saxatilis*) to suspended solids. Estuaries 8:28-39.

Technical Reports:

Sherk, J. A., J. M. O'Connor, D. A. Neumann, R. D. Prince, and K. V. Wood. Effects of suspended and deposited sediments on estuarine organisms, Phase II. Final Report to U. S. Army Corps of Engineers Coastal Engineering Center. N. R. I. Ref. No. 74-20.

Boynton, W. R., E. M. Setzler, K. V. Wood, H. H. Zion and M. Homer. Final Report on Potomac River Fisheries Study: Ichthyoplankton and Juvenile Investigations, 1976. Univ. of MD CEES Ref. No. 77-169 CBL.

Wood, K. V., L. Lubbers, W. R. Boynton and J. A Mihursky. Final Report on Calvert Cliffs Nuclear Facility Monitoring Program; Troika Studies, 1976. Univ. of MD CEES Ref. No. 78-5a CBL.

Setzler, E. M. and K. V. Wood. Chalk Point Steam Electric Station Studies: Ichthyoplankton Population Studies. Univ. of MD CEES Ref. No. 79-20 CBL.

Wood, K. V., L. Lubbers, and J. A. Mihursky. Calvert Cliffs Nuclear Facility Monitoring Program; Ichthyoplankton Program; Troika Studies 1977. Univ. of MD CEES Ref. No. 79-66 CBL.

Setzler, E. M., W. R. Boynton, K. V. Wood, L. Lubbers, N. K. Mountford, P. Frere, L Tucker, and J. A. Mihursky. Synopsis of biological data on striped bass, *Morone saxatilis* (Walbaum). Dept. Commerce, NOAA Tech. Rept., NMFS Cir. 433, 69p.

Setzler-Hamilton, E. M., J. A. Mihursky, W. R. Boynton, K. V. Wood, and T. T. Polgar. Pages 89-100 in F. E. Carlton (chairman) Marine Recreational Fisheries V., Sport Fishing Institute, Washington, D. C.

D'Elia, C. F., W. R. Boynton, J. H. Tuttle, K. V. Wood, C. W. Keefe. and W. M. Kemp. Benthic nutrient studies on the lower Patuxent River. Final Report. UMCEES Ref. No. 81-190 CBL.

Boynton, W. R., W. M. Kemp, K. V. Wood, C. W. Keefe and C. F. D'Elia. Final Report, Chesapeake Bay Nutrient and Plankton Dynamics. Direct measurement of sediment-water exchanges along the estuarine gradient. UMCEES Ref. No. 82-84 CBL.

Lubbers III, L., K. V. Wood, C. W. Keefe, W. R. Boynton. Summary data report for seston dynamics in the lower Susquehanna River. UMCEES Ref. No. 83-85 CBL.

Wood, K. V., C. W. Keefe and W. R. Boynton. Assessment of the Environmental Impacts of Construction and Operation of the Hart and Miller Islands Containment Facility. Project III. Water Column Nutrients and Productivity. 1982-1983 Data Report. UMCEES Ref. No. 83-67 CBL.

Keefe, C. W., K. V. Wood and W. R. Boynton. Assessment of the Environmental Impacts of Construction and Operation of the Hart and Miller Islands Containment Facility. Project III. Water Column Nutrients and Productivity. 1982-1983 Interpretive Report. UMCEES Ref. No. 83-85 CBL

Boynton, W. R., L. Lubbers, K. V. Wood and C. W. Keefe. Seston dynamics in the lower Susquehanna River. Final Data Report. UMCEES Ref. No. 84-81.

Boynton, W. R., W. M. Kemp, L. Lubbers, K. V. Wood and C. W. Keefe. Maryland Chesapeake Bay Water Quality Monitoring Program. Ecosystem Processes Component. Data Report. UMCEES[CBL] Ref. No.84-109.

D'Elia, C. F., R. E. Magnien, C. F. Zimmermann, P. A. Vaas, N. L. Kaumeyer, C. W. Keefe, D. V. Shaw and K. V. Wood. Nitrogen and phosphorus determinations in estuarine waters: A comparison of methods used in Chesapeake Bay monitoring. UMCEES[CBL] Ref. No. 87-19.

Wood, K. V., C. W. Keefe, D. A. Jasinski and W. R. Boynton. Solomons Harbor Study Water Quality Monitoring and Long Term Analysis Summer1996. UMCEES [CBL] Ref. No 97-028.

D'Elia, C. F., E. E. Connor, N. L. Kaumeyer, C. W. Keefe, K. V. Wood and C. F. Zimmermann. Nutrient Analytical Services Laboratory Standard Operating Procedures. UMCES[CBL] Tech. Rept. Ser. No. 158-97.

Wood, K. V., W. R. Boynton, N. L. Kaumeyer C. W. Keefe, C. F. Zimmermann and D. T. Roxey. Solomons Harbor Study Water Quality Monitoring and Long Term Analysis Summer1997. UMCES [CBL] Ref. No. 98-063.

Frank, J. M., K. V., Wood, R. M. Stankelis, J. D. Hagy and W. R. Boynton. Solomons Harbor Study Water Quality Monitoring and Long Term Analysis Summer1998. UMCES [CBL] Ref. No. 99-0071.

Frank, J. M., R. M. Stankelis, K. V., Wood, J. D. Hagy and W. R. Boynton. Solomons Harbor Study Water Quality Monitoring and Long Term Analysis Summer1999. UMCES [CBL] Ref. No. 00-0032.

Seminars and Presentations:

The Distribution of Ichthyoplankton Associated with Striped Bass in the Potomac Estuary. Atlantic Estuarine Research Society: May 1976, Rehobeth Beach, Delaware.

Mailee D. Woods **Great Lakes Environmental Center**

Environmental Technician

Education:

B.S. Science, Alma College, 1998
Additional Science related classes: Northwestern Michigan College, 1994-1995

Qualifications:

Ms. Woods has experience conducting laboratory analysis that monitors the impact of effluents and chemicals on water quality and aquatic communities. She has conducted chronic bioassays and effluent manipulations for toxicity identification/reduction evaluations with industrial and municipal wastewater treatment plant effluents. She also has mass cultured and reared *Daphnia magna, Ceriodaphnia dubia,* fathead minnows, and *mysid* shrimp for use in aquatic bioassays.

Ms.Woods has additional experience in conducting laboratory and field research, focused on microbiological and toxicological aspects of environmental pollution. She has extensive experience in general laboratory techniques and operations.

Relevant Experience:

Culturing and Toxicity Testing. Maintained cultures of *Daphnia magna, Daphnia pulex, Ceriodaphnia dubia, Mysidopsis bahia, Hyallela azteca, Chironomus tentans, Pimephales promelas* (fathead minnows), and *Selenastrum capricornutum* (algae).

Aquatic Laboratory Studies. Conducted routine water chemistry and nutrient analysis.

Toxicity Identification and Reduction Analysis. Conducts effluent characterizations to identify and reduce toxicity of industrial and municipal effluents.

Microbiology Lab Operations. Responsibility for maintenance and operation of a microbiology lab; field sample collection, sample processing and analysis of surface water samples for *E. Coli* and *Enterococci*; data entry and data reduction; assisted in toxicological analysis of industrial effluent.

Laboratory Technologist. Research of physiological, morphological, and ecological aspects of fungal symbionts associated with *Xyleborus ferrugineus* beetle. Experience in maintaining and preparation of sterile laboratory techniques for laboratory and sampling equipment.

Phlebotomist. Trained to draw, receive, send out and spin down blood.

Research Presentation. Presented research to Michigan Academy on the fungal symbionts associated with *Xyleborus ferrugineus* beetle. Alma college honors day presented research to the faculty and students.

Carl F. Zimmermann **Chesapeake Biological Laboratory**

Senior Faculty Research Assistant

Education:

B.S. Wagner College, New York (Bacteriology), 1969
M.S. Long Island University, New York (Marine Science), 1973

Qualifications:

- Research Assistant/Lab Chief, Harbor Branch Foundation
- Research Technician, University of Alaska, Institute of Marine Science
- Research Assistant, New York Ocean Science Laboratory
- Junior Bacteriologist, New York City Health Dept.

Relevant Experience:

Nutrient Dynamics of Aquatic Systems, Wetland Processes, Groundwater Flow to Near-shore Areas

Professional Societies:

- American Society of Agronomy
- Estuarine Research Federation

Publications:

Zimmermann, C.F., M.T. Price and J.R. Montgomery.1978. A comparison of ceramic and teflon *in situ* samplers for nutrient porewater determinations. Estuar. Coast. Mar. Sci. 7:93-97.

Montgomery, J.R., C.F. Zimmermann and M.T. Price. 1979. The collection, analysis and variation of nutrients in estuarine porewater. Estuar. Coast. Mar. Sci. 9:203-214.

Zimmermann, C.F., T.D. French and J.R. Montgomery. 1981. Transplanting and survival of the seagreaa Halodule wrightii under controlled conditions. N.E. Gulf Science 4(2):131-136.

Montgomery, J.R., M.T. Price, J. Holt, and C. Zimmermann. 1981. A close-interval sampler for collection of sediment pore waters for nutrient analyses. Estuaries 4(1):75-77.

Zimmermann, C.F. and J.R. Montgomery. 1984. Effects of a decomposing drift algal mat on porewater nutrient concentrations in a Florida seagrass bed. Mar. Ecol. Prog. Ser. 19:299-302.

Short, F.T., M.W. Davis, R.A. Gibson and C.F. Zimmermann. 1985. Evidence for phosphorus limitation in carbonate sediments of the seagrass Syringodium filiforme. Estuar. Coast. Shelf Sce. 20:419-430.

Zimmermann, C.F., J.R. Montgomery and P. Carlson. 1985. Variability of dissolved reactive phosphorus flux rates in nearshore estuarine sediments: effects of groundwater flow. Estuaries 8(2):228-236.

Technical Reports:

D'Elia, C.F., R.E. Magnien, C.F. Zimmermann, P.A. Vaas, N.L. Kaumeyer, C.W. Keefe, D.V. Shaw and K.V. Wood. 1987. Nitrogen and Phosphorus Determinations in Estuarine Waters: A Comparison of Methods Used in Chesapeake Bay Monitoring. Reference Number UMCEES 87-19 CBL.

Staff. 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures Manual. Tech. Rpt. 158-97; 77pp. Chesapeake Biological Laboratory, University of Maryland, Center for Environmental Science, Solomons, MD 20688-0038

Zimmermann, C. and C. Keefe. 1998. Chesapeake Bay Program Blind Audit Nutrient Results January and June 1998.

Zimmermann, C. and C. Keefe. 2000. Chesapeake Bay Program Blind Audit Nutrient Results January and June 1999.

ATTACHMENT C

Definition of Raw Data

Raw Data Elements – Battelle Duxbury

Data Package Elements	PCB Aroclor/Pesticide	SVOCs (PAHs)
Inventory Sheet	✓	✓
QA/QC Narratives	✓	✓
Sample Custody/Receipt Data		
Airbills	✓	✓
Custody forms	✓	✓
Sample tags (if available)	Will provide if not adhered to sample bottles	
Sample receipt/log-in sheets	✓	✓
Miscellaneous shipping/receiving records	✓	✓
Internal lab sample transfer/tracking records	✓	✓
Sample Data		
Final data tables (summary data; field and QC)	✓	✓
Tentatively identified compounds summary form		✓
Total ion chromatograms		✓
Raw spectra of target compound and background subtracted spectrum of target compound for each sample		
Mass spectra of all reported TICs/three best library matches for each sample		
Chromatograms (both columns, if applicable)	✓	
GC integration reports	✓	✓
Pesticide identification summary form [1]	✓	
For Pest/PCBs confirmed by GC/MS, copies of raw spectra	Not applicable	
GPC sample chromatograms	✓	✓
Manual worksheets	✓	✓
Sample preparation records ***(includes lipid and moisture content results)***	✓	✓
Sample acquisition logsheets [2]	✓	✓
ICP/MS raw data		
Furnace AA raw data		
Mercury raw data		
Cyanide raw data		
Other analytical raw data		
Standards Data		
MDL study final tables	✓	✓
Initial calibration reports	✓	✓
Continuing calibration reports (including pesticide degradation checks)	✓	✓
Chromatograms and quant reports for all GC/MS standards		✓
Pesticide analyte resolution summary form	Not applicable (*)	
Pesticide calibration verification summary form [3]	✓	
Pesticide analytical sequence summary form [4]	✓	
GC chromatograms and data system print outs for all GC standards	✓	
For pesticides/Aroclors confirmed by GC/MS	Not applicable	
GPC standard chromatograms	✓	✓
Florisil cartridge check summary form		
Instrument detection limits summary data		
ICP Interelement correction factors summary form		
ICP linear ranges summary form		
CRDL standards for AA and ICP summary form		
Standards preparation forms	✓	✓

Raw Data Elements – Battelle Duxbury (continued)

Data Package Elements	PCB Aroclor/Pesticide	SVOCs (PAHs)
QC Data		
Tune reports		✓
SIS recovery data	✓	✓
MS/MSD recovery data	✓	✓
Method blank data	✓	✓
Internal standard areas/RTs (quant reports, above)	✓	✓
QC raw data (RICs, chromatograms, quant reports)	✓	✓
ICP interference check sample summary form		
Spike sample recovery summary form	✓	✓
Post digest spike sample recovery data		
Sample duplicate precision data	✓	✓
LCS recovery data	✓	✓
Standard addition results		
ICP serial dilutions summary form		
QC raw data – ICP, Furnace, mercury		
QC sample preparation records	✓	✓
Miscellaneous Data		
Copies of preparation/analysis logbooks	✓	✓
Screening records		
All instrument output from screening activities		
Preparation logs raw data	✓	✓
Percent solids data	✓	✓
Other records (QAPP, project memorandums)	✓	✓

[1] Battelle assumes this is a summary data table of target pesticides detected in project samples.
[2] Battelle assumes that acquisition logsheets are records of GC oven conditions under which samples are analyzed.
[3] Battelle assumes that the pesticide calibration verification summary form is the continuing calibration check report.
[4] Battelle assumes that the analytical sequence summary form is the hardcopy listing of samples acquired in the analytical sequence.
* Battelle SOP 5-128 does not require analyte resolution check.

Raw Data Elements – Battelle Columbus

Data Package Elements	PCB Congeners	Dioxin/Furan/HCX/TCX
Inventory Sheet	✓	✓
QA/QC Narratives	✓	✓
Sample Custody/Receipt Data		
Airbills	✓	✓
Custody forms	✓	✓
Sample tags (if available)	Will provide if not adhered to sample bottles	
Sample receipt/log-in sheets	✓	✓
Miscellaneous shipping/receiving records	✓	✓
Internal lab sample transfer/tracking records	✓	✓
Sample Data		
Final data tables (summary data; field and QC)	✓	✓
Tentatively identified compounds summary form		
Total ion chromatograms	✓	✓
Raw spectra of target compound and background subtracted spectrum of target compound for each sample		
Mass spectra of all reported TICs/three best library matches for each sample		
Chromatograms (both columns, if applicable)	✓	✓
GC integration reports	✓	✓
Pesticide identification summary form		
For Pest/PCBs confirmed by GC/MS, copies of raw spectra		
GPC sample chromatograms	✓	
Manual worksheets	✓	✓
Sample preparation records	✓	✓
Sample acquisition logsheets [1]	✓	✓
ICP/MS raw data		
Furnace AA raw data		
Mercury raw data		
Cyanide raw data		
Other analytical raw data		
Standards Data		
MDL study final tables	✓	✓
Initial calibration reports	✓	✓
Continuing calibration reports (including pesticide degradation checks)	✓	✓
Chromatograms and quant reports for all GC/MS standards	✓	✓
Pesticide analyte resolution summary form		
Pesticide calibration verification summary form		
Pesticide analytical sequence summary form		
GC chromatograms and data system print outs for all GC standards		
For pesticides/Aroclors confirmed by GC/MS		
GPC standard chromatograms	✓	
Florisil cartridge check summary form		
Instrument detection limits summary data		
ICP Interelement correction factors summary form		
ICP linear ranges summary form		
CRDL standards for AA and ICP summary form		
Standards preparation forms	✓	✓

Raw Data Elements – Battelle Columbus (continued)

Data Package Elements	PCB Congeners	Dioxin/Furan/HCX/TCX
QC Data		
Tune reports	✓	✓
SIS recovery data	✓	✓
MS/MSD recovery data	✓	✓
Method blank data	✓	✓
Internal standard areas/RTs (quant reports, above)	✓	✓
QC raw data (RICs, chromatograms, quant reports)	✓	✓
ICP interference check sample summary form		
Spike sample recovery summary form [2]	✓	✓
Post digest spike sample recovery data		
Sample duplicate precision data	✓	✓
LCS recovery data	✓	✓
Standard addition results		
ICP serial dilutions summary form		
QC raw data – ICP, Furnace, mercury		
QC sample preparation records	✓	✓
Miscellaneous Data		
Copies of preparation/analysis logbooks	✓	✓
Screening records		
All instrument output from screening activities		
Preparation logs raw data	✓	✓
Percent solids data	✓	✓
Other records (QAPP, project memorandums)	✓	✓

[1] Battelle assumes that acquisition logsheets are records of GC oven conditions under which samples are analyzed.
[2] Battelle assumes that Spike Sample Recovery Summary Forms are summary report tables with recovery results

Raw Data Elements – Battelle MSL Chemistry

Data Package Elements	Metals / MeHg / AVS/SEM	Hardness
Inventory Sheet	✓	✓
QA/QC Narratives	✓	✓
Sample Custody/Receipt Data		
Airbills	✓	✓
Custody forms	✓	✓
Sample tags (if available)	Will provide if not adhered to sample bottles	
Sample receipt/log-in sheets	✓	✓
Miscellaneous shipping/receiving records	✓	✓
Internal lab sample transfer/tracking records	✓	✓
Sample Data		
Final data tables (summary data; field and QC)	✓	✓
Tentatively identified compounds summary form		
Total ion chromatograms		
Raw spectra of target compound and background subtracted spectrum of target compound for each sample		
Mass spectra of all reported TICs/three best library matches for each sample		
Chromatograms (both columns, if applicable)		
GC integration reports		
Pesticide identification summary form		
For Pest/PCBs confirmed by GC/MS, copies of raw spectra		
GPC sample chromatograms		
Manual worksheets	✓	✓
Sample preparation records	✓	✓
Sample acquisition logsheets		
ICP/MS raw data	✓	
Furnace AA raw data	✓	
Mercury raw data	✓	
Cyanide raw data		
Other analytical raw data		✓
Standards Data		
MDL study final tables		
Initial calibration reports	✓	✓
Continuing calibration reports (including pesticide degradation checks)	✓	✓
Chromatograms and quant reports for all GC/MS standards		
Pesticide analyte resolution summary form		
Pesticide calibration verification summary form		
Pesticide analytical sequence summary form		
GC chromatograms and data system print outs for all GC standards		
For pesticides/Aroclors confirmed by GC/MS		
GPC standard chromatograms		
Florisil cartridge check summary form		
Instrument detection limits summary data	✓	✓
ICP Interelement correction factors summary form		
ICP linear ranges summary form		
CRDL standards for AA and ICP summary form		
Standards preparation forms	✓	✓

Raw Data Elements – Battelle MSL Chemistry (continued)

Data Package Elements	Metals / MeHg / AVS/SEM	Hardness
QC Data		
Tune reports		
SIS recovery data		
MS/MSD recovery data	✓	
Method blank data	✓	✓
Internal standard areas/RTs (quant reports, above)		
QC raw data (RICs, chromatograms, quant reports)	✓	✓
ICP interference check sample summary form	✓	
Spike sample recovery summary form [1]	✓	
Post digest spike sample recovery data		
Sample duplicate precision data	✓	✓
LCS recovery data	✓	
Standard addition results		
ICP serial dilutions summary form		
QC raw data – ICP, Furnace, mercury	✓	
QC sample preparation records	✓	✓
Miscellaneous Data		
Copies of preparation/analysis logbooks	✓	✓
Screening records		
All instrument output from screening activities		
Preparation logs raw data	✓	
Percent solids data	✓	
Other records (QAPP, project memorandums)	✓	✓

[1] Battelle assumes that Spike Sample Recovery Summary Forms are summary report tables with recovery results

Raw Data Elements – Battelle MSL ELS Study

Data Package Elements	Catfish ELS
Inventory Sheet	
QA/QC Narratives	✓
Sample Custody/Receipt Data	
Airbills	✓
Custody forms	✓
Sample tags (if available)	Will provide if not adhered to sample bottles
Sample receipt/log-in sheets	✓
Miscellaneous shipping/receiving records	✓
Internal lab sample transfer/tracking records	✓
Sample Data	
Final data tables (summary data; field and QC)	✓
Tentatively identified compounds summary form	
Total ion chromatograms	
Raw spectra of target compound and background subtracted spectrum of target compound for each sample	
Mass spectra of all reported TICs/three best library matches for each sample	
Chromatograms (both columns, if applicable)	
GC integration reports	
Pesticide identification summary form	
For Pest/PCBs confirmed by GC/MS, copies of raw spectra	
GPC sample chromatograms	
Manual worksheets	
Sample preparation records	✓
Sample acquisition logsheets	
ICP/MS raw data	
Furnace AA raw data	
Mercury raw data	
Cyanide raw data	
Other analytical raw data	
Standards Data	
MDL study final tables	
Initial calibration reports	✓
Continuing calibration reports (including pesticide degradation checks)	✓
Chromatograms and quant reports for all GC/MS standards	
Pesticide analyte resolution summary form	
Pesticide calibration verification summary form	
Pesticide analytical sequence summary form	
GC chromatograms and data system print outs for all GC standards	
For pesticides/Aroclors confirmed by GC/MS	
GPC standard chromatograms	
Florisil cartridge check summary form	
Instrument detection limits summary data	✓
ICP Interelement correction factors summary form	
ICP linear ranges summary form	
CRDL standards for AA and ICP summary form	
Standards preparation forms	

Raw Data Elements – Battelle MSL ELS Study (continued)

Data Package Elements	Catfish ELS
QC Data	
Tune reports	
SIS recovery data	
MS/MSD recovery data	
Method blank data	
Internal standard areas/RTs (quant reports, above)	
QC raw data (RICs, chromatograms, quant reports)	
ICP interference check sample summary form	
Spike sample recovery summary form	
Post digest spike sample recovery data	
Sample duplicate precision data	
LCS recovery data	
Standard addition results	
ICP serial dilutions summary form	
QC raw data – ICP, Furnace, mercury	
QC sample preparation records	
Miscellaneous Data (a)	
Copies of preparation/analysis logbooks	✓
Screening records	
All instrument output from screening activities	
Preparation logs raw data	
Percent solids data	
Other records (QAPP, project memorandums)	✓

(a) **Additional Miscellaneous Data – Wet Laboratory Data:**

Water Quality Data Sheets	✓
Daily Observation Sheets	✓
Water Renewals	✓
Feeding Record	✓
Weight and Length Data Sheets	✓
Test Termination Data Sheets	✓
Randomization Code Sheet	✓
Percent Dry Weight and Percent Wet Weight	✓

Raw Data Elements – Applied Marine Sciences

Data Package Elements	Grain Size	TOC
Inventory Sheet	✓	✓
QA/QC Narratives	✓	✓
Sample Custody/Receipt Data		
Airbills	✓	✓
Custody forms	✓	✓
Sample tags (if available)	Will provide if not adhered to sample bottles	
Sample receipt/log-in sheets	✓	✓
Miscellaneous shipping/receiving records	✓	✓
Internal lab sample transfer/tracking records	✓	✓
Sample Data		
Final data tables (summary data; field and QC)	✓	✓
Tentatively identified compounds summary form		
Total ion chromatograms		
Raw spectra of target compound and background subtracted spectrum of target compound for each sample		
Mass spectra of all reported TICs/three best library matches for each sample		
Chromatograms (both columns, if applicable)		
GC integration reports		
Pesticide identification summary form		
For Pest/PCBs confirmed by GC/MS, copies of raw spectra		
GPC sample chromatograms		
Manual worksheets	✓	✓
Sample preparation records	✓	✓
Sample acquisition logsheets		
ICP/MS raw data		
Furnace AA raw data		
Mercury raw data		
Cyanide raw data		
Other analytical raw data		
Standards Data		
MDL study final tables		✓
Initial calibration reports		✓
Continuing calibration reports (including pesticide degradation checks)		✓
Chromatograms and quant reports for all GC/MS standards		
Pesticide analyte resolution summary form		
Pesticide calibration verification summary form		
Pesticide analytical sequence summary form		
GC chromatograms and data system print outs for all GC standards		
For pesticides/Aroclors confirmed by GC/MS		
GPC standard chromatograms		
Florisil cartridge check summary form		
Instrument detection limits summary data		
ICP Interelement correction factors summary form		
ICP linear ranges summary form		
CRDL standards for AA and ICP summary form		
Standards preparation forms		

Raw Data Elements – Applied Marine Sciences (continued)

Data Package Elements	Grain Size	TOC
QC Data		
Tune reports		
SIS recovery data		
MS/MSD recovery data		
Method blank data		✓
Internal standard areas/RTs (quant reports, above)		
QC raw data (RICs, chromatograms, quant reports)	✓	✓
ICP interference check sample summary form		
Spike sample recovery summary form		
Post digest spike sample recovery data		
Sample duplicate precision data	✓	✓
LCS recovery data		
Standard addition results		
ICP serial dilutions summary form		
QC raw data – ICP, Furnace, mercury		
QC sample preparation records	✓	✓
Miscellaneous Data		
Copies of preparation/analysis logbooks	✓	✓
Screening records		
All instrument output from screening activities		
Preparation logs raw data	✓	✓
Percent solids data		
Other records (QAPP, project memorandums)	✓	✓

Raw Data Elements – STL Baltimore

Data Package Elements	SVOC (phenol & phthalates), Dalapon	BOD
Inventory Sheet	✓	✓
QA/QC Narratives	✓	✓
Sample Custody/Receipt Data		
Airbills	✓	✓
Custody forms	✓	✓
Sample tags (if available)	Will provide if not adhered to sample bottles	
Sample receipt/log-in sheets	✓	✓
Miscellaneous shipping/receiving records	✓	✓
Internal lab sample transfer/tracking records		
Sample Data		
Final data tables (summary data; field and QC)	✓	✓
Tentatively identified compounds summary form		
Total ion chromatograms	✓	✓
Raw spectra of target compound and background subtracted spectrum of target compound for each sample		
Mass spectra of all reported TICs/three best library matches for each sample		
Chromatograms (both columns, if applicable)	✓	✓
GC integration reports	✓	✓
Pesticide identification summary form		
For Pest/PCBs confirmed by GC/MS, copies of raw spectra		
GPC sample chromatograms	✓	
Manual worksheets	✓	✓
Sample preparation records	✓	✓
Sample acquisition logsheets [1]	✓	✓
ICP/MS raw data		
Furnace AA raw data		
Mercury raw data		
Cyanide raw data		
Other analytical raw data		
Standards Data		
MDL study final tables		
Initial calibration reports	✓	✓
Continuing calibration reports (including pesticide degradation checks)	✓	✓
Chromatograms and quant reports for all GC/MS standards	✓	✓
Pesticide analyte resolution summary form		
Pesticide calibration verification summary form		
Pesticide analytical sequence summary form		
GC chromatograms and data system print outs for all GC standards		
For pesticides/Aroclors confirmed by GC/MS		
GPC standard chromatograms	✓	
Florisil cartridge check summary form		
Instrument detection limits summary data		
ICP Interelement correction factors summary form		
ICP linear ranges summary form		
CRDL standards for AA and ICP summary form		
Standards preparation forms	✓	✓

Raw Data Elements – STL Baltimore (continued)

Data Package Elements	SVOC (phenol & phthalates), Dalapon	BOD
QC Data		
Tune reports	✓	✓
SIS recovery data	✓	✓
MS/MSD recovery data	✓	✓
Method blank data	✓	✓
Internal standard areas/RTs (quant reports, above)	✓	✓
QC raw data (RICs, chromatograms, quant reports)	✓	✓
ICP interference check sample summary form		
Spike sample recovery summary form [2]	✓	✓
Post digest spike sample recovery data		
Sample duplicate precision data	✓	✓
LCS recovery data	✓	✓
Standard addition results		
ICP serial dilutions summary form		
QC raw data – ICP, Furnace, mercury		
QC sample preparation records	✓	✓
Miscellaneous Data		
Copies of preparation/analysis logbooks	✓	✓
Screening records		
All instrument output from screening activities		
Preparation logs raw data	✓	✓
Percent solids data	✓	✓
Other records (QAPP, project memorandums)	✓	✓

[1] Assume that acquisition logsheets are records of GC oven conditions under which samples are analyzed.
[2] Assume that Spike Sample Recovery Summary Forms are summary report tables with recovery results.

Raw Data Elements – Chesapeake Biological Laboratory

Data Package Elements	Nutrients and TSS
Inventory Sheet	✓
QA/QC Narratives	✓
Sample Custody/Receipt Data	
Airbills	✓
Custody forms	✓
Sample tags (if available)	Will provide if not adhered to sample bottles
Sample receipt/log-in sheets	✓
Miscellaneous shipping/receiving records	✓
Internal lab sample transfer/tracking records	
Sample Data	
Final data tables (summary data; field and QC)	✓
Tentatively identified compounds summary form	
Total ion chromatograms	
Raw spectra of target compound and background subtracted spectrum of target compound for each sample	
Mass spectra of all reported TICs/three best library matches for each sample	
Chromatograms (both columns, if applicable)	
GC integration reports	✓
Pesticide identification summary form	
For Pest/PCBs confirmed by GC/MS, copies of raw spectra	
GPC sample chromatograms	
Manual worksheets	✓
Sample preparation records	✓
Sample acquisition logsheets	
ICP/MS raw data	
Furnace AA raw data	
Mercury raw data	
Cyanide raw data	
Other analytical raw data	✓
Standards Data	
MDL study final tables	✓
Initial calibration reports	✓
Continuing calibration reports	✓
Chromatograms and quant reports for all GC/MS standards	
Pesticide analyte resolution summary form	
Pesticide calibration verification summary form	
Pesticide analytical sequence summary form	
GC chromatograms and data system print outs for all GC standards	
For pesticides/Aroclors confirmed by GC/MS	
GPC standard chromatograms	
Florisil cartridge check summary form	
Instrument detection limits summary data	
ICP Interelement correction factors summary form	
ICP linear ranges summary form	
CRDL standards for AA and ICP summary form	
Standards preparation forms	✓

Raw Data Elements – Chesapeake Biological Laboratory (continued)

Data Package Elements	Nutrients and TSS
QC Data	
Tune reports	
SIS recovery data	
MS/MSD recovery data	✓ (MS only)
Method blank data	✓
Internal standard areas/RTs (quant reports, above)	
QC raw data (RICs, chromatograms, quant reports)	✓
ICP interference check sample summary form	
Spike sample recovery summary form [1]	✓
Post digest spike sample recovery data	
Sample duplicate precision data	✓
LCS recovery data	
Standard addition results	
ICP serial dilutions summary form	
QC raw data – ICP, Furnace, mercury	
QC sample preparation records	✓
Miscellaneous Data	
Copies of preparation/analysis logbooks	✓
Screening records	
All instrument output from screening activities	
Preparation logs raw data	✓
Percent solids data	
Other records (QAPP, project memorandums)	✓

[1] Assume that Spike Sample Recovery Summary Forms are summary report tables with recovery results.

Raw Data Elements – Great Lakes Environmental Center

Data Package Elements	Bioassay Testing	Water Quality Measurements
Inventory Sheet		
QA/QC Narratives		
Sample Custody/Receipt Data		
Airbills	✓	
Custody forms	✓	
Sample tags (if available)	✓	
Sample receipt/log-in sheets	✓	
Miscellaneous shipping/receiving records		
Internal lab sample transfer/tracking records		
Sample Data		
Final data tables	✓	✓
Tentatively identified compounds summary form		
Total ion chromatograms		
Raw spectra of target compound and background subtracted spectrum of target compound for each sample		
Mass spectra of all reported TICs/three best library matches for each sample		
Chromatograms (both columns, if applicable)		
GC integration reports		
Pesticide identification summary form		
For Pest/PCBs confirmed by GC/MS, copies of raw spectra		
GPC sample chromatograms		
Manual worksheets		
Sample preparation records	✓	
Sample acquisition logsheets		
ICP/MS raw data		
Furnace AA raw data		
Mercury raw data		
Cyanide raw data		
Other analytical raw data	✓ (a)	
Standards Data		
MDL study final tables		
Initial calibration reports		
Continuing calibration reports (including pesticide degradation checks)		
Chromatograms and quant reports for all GC/MS standards		
Pesticide analyte resolution summary form		
Pesticide calibration verification summary form		
Pesticide analytical sequence summary form		
GC chromatograms and data system print outs for all GC standards		
For pesticides/Aroclors confirmed by GC/MS		
GPC standard chromatograms		
Florisil cartridge check summary form		
Instrument detection limits summary data		
ICP Interelement correction factors summary form		
ICP linear ranges summary form		
CRDL standards for AA and ICP summary form		
Standards preparation forms		

Raw Data Elements – Battelle MSL ELS Study (continued)

Data Package Elements	Bioassay Testing	Water Quality Measurements
QC Data	✓ (a)	
Tune reports		
SIS recovery data		
MS/MSD recovery data		
Method blank data		
Internal standard areas/RTs (quant reports, above)		
QC raw data (RICs, chromatograms, quant reports)		
ICP interference check sample summary form		
Spike sample recovery summary form		
Post digest spike sample recovery data		
Sample duplicate precision data		
LCS recovery data		
Standard addition results		
ICP serial dilutions summary form		
QC raw data – ICP, Furnace, mercury		
QC sample preparation records		
Miscellaneous Data		✓ (a)
Copies of preparation/analysis logbooks		
Screening records		
All instrument output from screening activities		
Preparation logs raw data		
Percent solids data		
Other records (QAPP, project memorandums)		

(a) Additional Miscellaneous Data – Wet Laboratory Data:

Organism Source ✓
Raw Bioassay Data ✓
Summary Data Tables ✓
Water Quality Data ✓
Other Miscellaneous Data ✓
Audit Report ✓
Corrective Actions ✓

ATTACHMENT D

Examples of Validation Check Lists

Data Validation Checklist for Data Packages – Battelle Duxbury

Calibrations

- [ ] Spot check the response factors for the initial calibration (1/column and 1 mean) and verify that the standard concentrations are correct and that the calibration meets the SOP or work plan criteria.
- [ ] Check that mid-check standards bracket all reported samples, and that results meet the SOP or work plan criteria (frequency and acceptance level).
- [ ] Verify that the correct method file is used to quantify each sample
- [ ] Check that Q-deletes have been deleted correctly.

Data Tables

- [ ] Check transcription of weight data onto the report tables.
- [ ] Check any standard amounts and dilutions entered on the quant reports.
- [ ] Verify the report table reporting units and header information.
- [ ] Check that reported analytes are those called for by the work plan.
- [ ] Spot-check at least one data point for each sample. Recalculate from scratch using all calibration and prep factors.
- [ ] Check qualifiers and MDLs vs. work plan.
- [ ] Spot-check surrogate recoveries, focusing on samples with differing dilutions, etc. and check vs. work plan criteria.
- [ ] If required, verify that reported pesticides and PCBs have been confirmed.
- [ ] Calculate QC data (LCS, MS, SRM, etc.) and check qualifiers vs. work plan.

Documentation

- [ ] Flag questions, document ambiguities and errors in the data package.
- [ ] Review the work plan to ensure that all work plan specifications have been met.

I certify that the validation procedures checked above have been completed:

Validated By:	**Date:**

Data Review Checklist for Data Packages – Battelle Columbus

for
Samples Analyzed on:
OPUS Filename:

Initials/Date	Activity
	Check transcription of extract no., sample ID, and sample weight from prep LRB into OPUS forms for each sample.
	Check to see that all 2,3,7,8-isomers are accounted for: concentration reported, flagged for reason not used, or obviously not present in each sample.
	Double check that there are no ethers contributing to furans in each sample.
	Review lock mass checks for any variations, which could affect reported results.
	Flag any recoveries outside 40-135%/25-150% on OPUS form. Tag flagged forms with post-its for ease in highlighting final forms and report.
	Return data to analyst for corrections.
	Analyst makes corrections, updates, reprints and resaves OPUS data.
	Corrected OPUS data saved as ASCII text file. **ASCII text file Filename:**
	ASCII file pulled over to PC
	ASCII file imported to Quattro Pro or Excel **QPRO or Excel Filename:**
	Format spreadsheet data
	Flag in spreadsheet file any recoveries outside 40-135%/25-150% as on OPUS forms.
	Add and flag second column confirmation results in spreadsheet file.
	Check calculations for EMPCs.
	Review all LRBs used for project, check for completeness of information, ensure that the proper correction techniques have been used, sign the bottom of the page, and make a copy of the pages needed for the study file.
	Verify that the original COC and the miniaturized copy of the COC in the sample log-in LRB are identical.
	Spot-check the calculations of concentrations.
	Verify that the daily calibrations, the window set mixture, and the percent valley are within the QC ranges allowed by the method.
	Print 2 copies of each finalized QPRO sample sheet. Place one in the OPUS printouts for each sample. Collect the others for the final report.
	Check to see if the QC check sample records have been updated within the last quarter. Add any new QC sample results from this project.

ATTACHMENT E

Early Life Stage Testing Methods

EPA/USACE CENTREDALE MANOR PROPOSED EXPERIMENTAL DESIGN FOR FISH EARLY-LIFE STAGE TEST: CATFISH EGG EXPOSURES

1.0 OVERVIEW

In order to evaluate the lethal and sublethal effects of dioxin/furan, polychlorinated biphenyls (PCB), and hydrocarbon compounds (HCX) associated with sediments from Allendale Pond in the vicinity of Centredale Manor in Providence, RI, a fish early-life stage (ELS) test is proposed. This test will expose fertilized eggs to a dilution series of a manufactured cocktail of contaminants that were detected in whole-body analyses of fish frequenting or residing in the pond. This will provide a reasonable equivalent of maternal transfer from exposed adult to egg, and allow us to better understand the lethal, sublethal, and no-effect levels associated with this complex mixture under controlled laboratory conditions. It is assumed that based on these experimental observations and known biota-sediment accumulation factors, we can provide EPA with valuable information as they attempt to develop protective cleanup levels for mobile and bioavailable chemicals during site remediation. The proposed experimental design will include range-finding and definitive tests, and reference toxicant exposures to assess egg sensitivity. In addition, a pretest will be performed to optimize our test system and ensure that there are no confounding effects associated with the laboratory procedures.

The proposed experimental design evaluates the effects of contaminants of concern that were present as whole-body residues in fish frequenting or residing in the pond. Since it is expected that most of the residue compounds will be nonpolar organics, the manufactured extract will exhibit lipophilic tendencies in the exposure. Because the test design maximizes the exposure of the contaminants to the fertilized egg, the experimental result will express the potential rather than the actual hazard of the contaminants, since lipophilic compounds are relatively insoluble in water and have limited mobility out of sediment via the aqueous pathway. The estimate of risk derived from this experimentation should, therefore, be considered conservative and protective.

2.0 PROPOSED METHODS

2.1 Literature Review of ELS Exposures and Chemical Characteristics

To make informed decisions on test exposures and experimental design, we will perform a review of the literature to:

- determine appropriate experimental design based on ELS literature, standardized protocols and procedures, or adaptations of existing techniques – with review to include the *Standard Guide for Conducting Early Life-Stage Toxicity Tests with Fishes* (ASTM E 1241-92), and *Ecological Effects Test Guidelines: OPPTS 850.1400, Fish Early-Life Stage Toxicity Test* (EPA 712-C-96-121).
- determine appropriate adaptations of fish husbandry techniques for the experimental design.
- make preliminary dosing calculations and determine solubility of contaminants of concern with solvents in water.

2.2 Species Selection and Biological Endpoints

Appropriate test organism selection is crucial to the relevance, success, and interpretation of a test. Selection should be based on environmental relevance and practical concerns (DeWitt *et al.* 1989). Species selection for these tests will be based on similarity to fish species present in the Woonasquatucket River, likelihood of direct contact of fish egg with sediment during ordinary life history, and ease of culture in the laboratory.

Two catfish species have been documented in the Woonasquatucket River system: the brown bullhead *(Ameiurus nebulosos)* and yellow bullhead *(Ameiurus natalis)* (Libby 1995). Survey data indicate that the brown bullhead and yellow bullhead may be locally extirpated from the Woonasquatucket River, with brown bullhead remaining in its tributary creeks. Although no studies have directly addressed catfish extirpation, electrofishing surveys of the Woonasquatucket River watershed showed that while bullhead are present in the watershed they do not tend to inhabit the river itself (Libby 1995). Based on these criteria, we propose using a catfish species for ELS studies: the channel catfish *(Ictalurus punctatus)* is a southern species related to the bullhead, but not native to the Woonasquatucket River.

Features of the ecology and life history of the catfish indicate a potential susceptibility to contaminated sediments. First, the catfish is an omnivorous fish that grazes on the river bottom and is thus prone to ingesting contaminated sediments. Second, the catfish deposits its eggs on the river bottom. The contamination in Woonasquatucket River sediments may make habitat there unsuitable for fish with these life history features. Early life stage testing with exposures to contaminants found in Woonasquatucket River fish will provide information to help determine whether or not this is the case and contribute to restoration planning.

Catfish culture techniques have been improved in the past decade. Fertilized eggs are readily available during spawning in the late spring and summer from Osage Catfisheries, Inc., Osage Beach, MO. Shipping catfish eggs is routine. The life cycle timing is short enough for completion of testing and data analysis according to the desired reporting date of December 2001, and long enough to permit the necessary experimental manipulations and observations.

Biological endpoints that we propose to measure include the following:

Range-finding

- time to hatch
- survival to hatch

Definitive

- time to hatch
- survival to hatch
- body burden – fertilized egg
- survival post-hatch
- abnormalities – behavior, appearance
- growth – length and weight

Reference Toxicant

- 96-hour survival of post-hatch fry

2.3 Dosing Technique

Homogenized whole fish collected from the Woonasquatucket River will be analyzed by chromatography to establish concentrations of the organic chemicals of concern: dioxins, PCBs, and HCXs. The fish species will be a resident as determined by Libby (1995), such as the white sucker. A chemical mixture will be prepared to imitate the levels of chemicals of concern found in the whole fish homogenate. The mixture will contain either all chemicals of concern or dioxin-like compounds only. The mixture will be serially diluted for fertilized egg exposure. Dilutions for the range-finding test will be calculated relative to LC_{50} data for the contaminants of concern found in the literature (such as Elonen *et al.* 1998), and dilutions for the definitive test will be based on the results of the range-finding test.

Dosing will occur under static-renewal conditions. Overlying water in each test chamber will be renewed once daily. Fertilized eggs will be exposed to the chemical mixture continuously for three renewals. Fertilized eggs and newly hatched fish will be placed in clean water for the remainder of the test period.

2.4. Preliminary Test

The exposure of fertilized eggs to a synthetic chemical mixture will require a static-renewal design as opposed to the flow-through conditions standard in catfish husbandry. A preliminary test will ascertain the optimal adaptations of catfish husbandry techniques proposed in this experimental design. For example, the required aeration will be determined and the water renewal method will be fine-tuned.

2.5 Rangefinding Test

The range-finding test will incorporate a large dilution series that brackets the estimated LC_{50}s of the constituents of the chemical mixture. Nine treatments will be tested, including a control, solvent control, and seven test concentrations (Table 1). This will be an abbreviated test, conducted only through hatching. We propose to test three replicates per treatment. Each replicate container will start with 20 fertilized eggs. Nominal extract concentrations will be used and the endpoints assessed will be time to hatch and percent hatch. The test will be terminated at 48 hours after the first control eggs hatch. Information from this test will be used to determine the dilution series and to fine-tune the experimental design of the definitive test.

2.6 Definitive Test

The definitive test will incorporate a dilution series based on the results of the range-finding test. Eight treatments will be tested, including a control, solvent control, and six test concentrations. The proposed experimental design is presented in Table 2. This test will be conducted through Day 32. We propose to test five replicates per treatment. Nine additional replicates will provide material for the purposes of chemical analyses. Each replicate container will start with 20 eggs and be randomly thinned to 10 larvae posthatch. Exposure will be conducted from Day 0 through Day 2. Endpoints assessed will be time to hatch, percent hatch, posthatch survival, observable physical abnormalities, growth, and body burden in eggs just prior to hatching (Day 6). A 96-hour reference toxicant test with post-hatch fry will be conducted, with five replicates of each of five concentrations of a metal known to affect a response, to determine an LC_{50} value.

Table 1. Range-finding Test Experimental Design

Test Organism Species	Channel catfish *(Ictalurus punctatus)*
Age	< 24 hrs, if possible; no more than 48 hrs (*i.e.*, fertilized eggs)
Method	Exposure: Static renewal (change out at least 2/3 of water in the original test container daily & leave eggs inside). Post-Exposure: Flow-through.
Duration	10 day
Test Material	Synthetic chemical mixture, in dilution series
Endpoints	Time to hatch, percent hatch
Number of Treatments	9 (control, solvent control, 7 test concentrations)
Concentration Series	To be determined
Number of Replicates	3
Number or Organisms/ Replicate	20
Test Chamber	1 L beaker
Test Volume	850 mL water
Flow conditions	Static renewal for fertilized eggs
Lighting	16 hr light, 8 hr dark
Temperature	25 °C ± 2°C; measure all test chambers on Day 0, 6, 10, 30; Daily in at least 1 rep/treatment
pH	All on Day 0, 6, 10, 30; Daily in at least 1 rep/treatment
Alkalinity	Beginning/end/weekly in controls and in highest test concentration at least 1x
Dissolved Oxygen	90-100% saturation; measure all test chambers on Day 0, 6, 10, 30; measure daily in at least 1 replicate/treatment
Hardness	< 300 mg/L
Salinity	0 ± 0.5 ppt (conductivity – at beginning/end & weekly in controls)
Aeration	Rate sufficient to provide adequate water exchange and vigorously roll the egg masses and keep them suspended in the water column. As soon as hatching begins, airflow must be decreased to a gentle stream so as not to damage newly hatched larvae.
WQ frequency	Measure daily
Observation frequency	Measure daily. Because an adhesive gelatinous matrix holds the fertilized eggs together, no attempt should be made to remove dead eggs. Time to hatch will be recorded and when hatching is completed, the # of fish hatched will be recorded.
Feeding	Not applicable.
Other Notes	If fungus appears in any treatment, all eggs should be treated with malachite green at a concentration of 60 mg/L for 3 min. once each day until fertilized eggs are eyed
Termination	48 hr post first control hatch
Test Validity Criteria	Control Survival ≥ 65% hatch of fertilized eggs

Table 2. Definitive Test Experimental Design

Test Organism Species	Channel catfish *(Ictalurus punctatus)*
Age	<24 hrs, if possible; no more than 48 hrs (*i.e.*, fertilized eggs)
Method	Exposure: Static renewal (change out at least 2/3 of water in the original test container daily & leave eggs inside). Post-Exposure: Flow-through.
Duration	32 day
Test Material	Synthetic chemical mixture, in dilution series
Endpoints	Time to hatch, percent hatch, survival post hatch, abnormalities, growth, body burden in eggs just prior to hatching (Day 6)
Number of Treatments	8 (control, solvent control, 6 test concentrations)
Concentration Series	To be determined
Number of Replicates	5 test, 9 analysis
Number or Organisms/ Replicate	20 pre-hatch; 10 post-hatch
Test Chamber	1 L beaker
Test Volume	850 mL water
Flow conditions	Static renewal for fertilized eggs; flow through at 100 mL/min post-hatch
Lighting	16 hr light, 8 hr dark
Temperature	25°C ± 2 °C; measure all test chambers on Day 0, 6, 10, 30; measure daily in at least 1 replicate/treatment
pH	Measure all on Day 0, 6, 10, 30; measure daily in at least 1 replicate/treatment
Alkalinity	Beginning/end/weekly in controls and in highest test concentration at least 1x
Dissolved Oxygen	90-100% saturation; measure all on Day 0, 6, 10, 30; measure daily in at least 1 replicate/treatment
Hardness	< 300 mg/L
Salinity	0 ± 0.5 ppt (conductivity – at beginning/end & weekly in controls)
Aeration	Pre-hatch: Rate sufficient to provide adequate water exchange and vigorously roll the egg masses and keep them suspended in the water column. Post-hatch: As soon as hatching begins, airflow must be decreased to a gentle stream so as not to damage newly hatched larvae.
WQ frequency	Measure daily
Observation frequency	Measure daily. Because an adhesive gelatinous matrix holds the fertilized eggs together, no attempt should be made to remove dead eggs. Time to hatch will be recorded and when hatching is completed, the # of fish hatched will be recorded. A written or photographic record of all deformed larvae should be kept throughout the entire post-hatch exposure. Dead fish should be removed & recorded when observed. Only remove abnormal fish when dead.
Feeding	Larvae and fry should be fed commercial catfish food at least 4 times per day at approximately 2% of mean body weight per day.

Table 2, continued. Definitive Test Experimental Design

Other Notes	If fungus appears in any treatment, all eggs should be treated with malachite green at a concentration of 60 mg/L for 3 min once each day until fertilized eggs are eyed
Termination	Fish shouldn't be fed 24 hr prior to termination. Individual fish should be weighed & measured to the nearest 0.5mm fork length (use standard length if there is fin rot or erosion). Dry weight(g) (dry tissue sample at 60 °C for 24 hr) of all surviving fish should be determined.
Test Validity Criteria	Control Survival ≥ 65% hatch of fertilized eggs

2.7 Test Material and Residue Analyses

Required chemical analyses are outlined in Table 3. Six homogenized whole fish collected from the Woonasquatucket River will be analyzed by chromatography to establish concentrations of the organic chemicals of concern: dioxin, PCB, and HCX. The synthetic chemical mixture developed based on the fish analyses will be analyzed to verify the concentrations of organic compounds by chromatography to provide an initial reference point for exposure concentrations. During the definitive test, 30 egg tissue samples from the test jars will be analyzed for organic compounds by chromatography. During the definitive test, additional exposures to the test dilution series will be conducted in order to provide exposed eggs for the measurement of body burden.

Table 3. Required Chemical Analyses

Matrix	Analysis	Total No. Samples
Synthetic chemical	Chromatography for Organics	1
Tissue (fish)	Chromatography for Organics	6
Tissue (egg)	Chromatography for Organics	30 (includes control)

2.8 Data Analyses, Endpoints, and Reporting

All reported data will be validated. Reduced or summarized data from the toxicity tests will be reported to the client. The following is a list of data that is typically reported in association with toxicity testing by the Battelle Marine Sciences Laboratory.

- description of test material (*i.e.*, synthetic mixture based on fish extract); its handling, manipulation, storage, and disposal
- description of test organisms; scientific name, age, size (when applicable), life stage, source, handling, culturing, and acclimation
- toxicity test method used
- date and time test started and terminated
- percent survival for each test treatment
- control treatment survival
- results of water quality measurements (may be reported as mean, range of measurements, number of times criteria limits were exceeded)

- number of organisms used per test chamber
- number of replicate test chambers per treatment
- summary of statistical endpoints (mortality, growth, LC_{50}, no observed effect concentration [NOEC],)
- gender determinations (when appropriate)
- growth (when appropriate)
- reproduction (when appropriate)
- summaries of biological observations
- summaries of reference toxicant evaluations
- summary of any problems encountered and corrective actions
- description of any deviations from prescribed laboratory protocols

The biological endpoints to be measured for the catfish ELS tests are listed under 2.2, above. The required data are detailed in Tables 1 and 2, above. An LC_{50} will be determined for the reference toxicant tests. The definitive tests will result in the determination of ED_{50}, lowest observable effect dose (LOED), and no observable effect dose (NOED). Abnormalities in behavior and appearance, as well as effects on growth and survival, will be discussed with respect to the known effects of contaminants of concern identified in the sediment extract.

2.9 Quality Assessment

Periodic surveillance by the MSL's Quality Assurance Representative is planned to ensure that all aspects of the testing accurately reflect the work that was planned and completed, and that all necessary information, as defined by regulations, SOPs, or program-specific plans, is included. Results of periodic surveillances may become a part of the project files.

2.10 Quality Control

Quality control in toxicity tests consists of establishment of criteria for water quality, test acceptability, reference toxicant tests, replication, control treatments, etc. Each toxicity test has its own quality control criteria that are included as part of the test design established in project planning documents (Tables 1 and 2).

Holding Times and Preservation

Holding times for toxicity tests typically begin the day of sample collection. Holding times of 7 to 28 days will apply to the analysis of whole-body fish samples and catfish eggs.

Water Quality Monitoring

Acceptable criteria for water quality (pH, DO, salinity, temperature, ammonia) measurements are established for each test and are identified in project planning documents (such as a test conditions Tables 1 and 2).

Reference Toxicant Test

Reference toxicant tests (positive controls), are performed to demonstrate that test organisms used are appropriately sensitive and that the laboratory procedures and techniques are appropriate and repeatable. A reference toxicant test is normally performed with each test, or at a minimum, once with each batch of test organisms.

Acceptability of Toxicity Tests

Each test method contains specific test acceptability criteria for controls, reference toxicant results, test conditions, etc. See Table 4 for corrective action when criteria are not met.

An individual test may be conditionally acceptable if temperature, DO, or other specified conditions fall outside specifications, depending on the degree of the departure from the specified conditions and the overall impact on the test. The acceptability of the test will depend on the professional judgment of the laboratory supervisor and project manager. Any deviation from test specifications will be noted when reporting data.

Table 4. Summary of Test Deviations and Suggested Responses

	Suggested Responses	
Deviation	**Retesting Required**	**Retesting May Be Required (1)**
Lack of test array randomization	✓	
Testing was not blind	✓	
Required references or controls were not tested	✓	
Test chambers not identical	✓	
Test container(s) broken or misplaced		✓
Test organism mortality in controls exceeds acceptable limits	✓	
Excessive test organism mortality in a single replicate of a control	✓	
Test organisms were not randomly assigned to test chambers	✓	
Test organisms were not from the same population		✓
Test organisms were not all from the same species (or species complex)	✓	
Test organism holding times were exceeded		✓
Test organism sensitivity out of acceptable control chart range		✓
Water quality parameters consistently out of range	✓	
Brief episodes of out-of-range water quality problems		✓
Test monitoring was not documented	✓	
Test monitoring was incomplete		✓
Sediment/testing water holding times were exceeded	✓ (2)	
Sediment/testing water storage conditions deviated from acceptable ranges		✓(2)

(1) If retest not completed, data may have to be qualified.

(2) Unless evidence is provided to show that sediment quality (geochemistry and contaminant levels) has not been affected.

3.0 SCHEDULE OF MILESTONES AND DELIVERABLES

Table 5. Milestones (M) and Deliverables (D)

Initiate Preliminary Testing (M)	**May 25–June 1 (start of spawning season is ambient temperature dependent)**
Complete Preliminary Testing (M)	Early-June
Initiate Range-finding Test (M)	Mid-June
Complete Range-finding Test (M)	Late-June
Initiate Definitive Test (M)	Early-July
Complete Definitive Test (M)	Early-August
Complete Analysis of Data: Wet Laboratory and Analytical Chemistry (M)	Early-September
Complete Draft Report for Peer Review (D)	Mid-October
Complete Final Report (D)	Mid-November

4.0 ASSUMPTIONS FOR FISH EARLY LIFE STAGE TEST: CATFISH EGG EXPOSURES

4.1 Initial Program Planning Assumptions

- Standard Operating Procedure (SOP) development
- Literature review
- Coordination with field personnel and USEPA on field collection of fish in Allendale Pond
- Coordination with Battelle-Duxbury and Battelle-Columbus on the chemical analysis of the homogenized whole fish and the preparation and shipping of the test solution to Battelle-Sequim
- Coordination with catfish growers on spawning window (seasonally dependent and variable year-to-year) and provision of viable embryos < 36 hours old.
- Pacific Northwest National Laboratory (PNNL) Animal Care Committee application
- PNNL Wastewater Treatment Plan

4.2 Preliminary Testing Assumptions

- Purchase embryos and materials
- Development of laboratory data sheets, notebook, labels, work plan, rands
- Wet laboratory set-up (water tables, test containers, aeration, lighting system, water renewal system, designated equipment (required due to dioxin contamination), etc.)
- Receipt of embryos (chain of custody)
- Animal holding
- Practice egg separation techniques (chemical, physical)
- Determine average weight/egg

- Test initiation
- Comparative testing of aeration techniques and renewal techniques
- Daily monitoring and observations
- Judge catfish egg development under test conditions (time to hatch, etc.)
- QA assessments
- Solve any problems detected in the method developed for the rangefinding and definitive tests, in consultation with USEPA technical advisors
- Test termination
- Test cleanup
- Waste disposal

4.3 Range-finding Test Assumptions *(Requires pre-analysis of fish tissues collected from Allendale Pond, agreement with USEPA on content of chemical mixture, and synthesis and shipping of chemical mixture by Battelle-Columbus.)*

- Purchase embryos and materials
- Development of laboratory data sheets, notebook, labels, work plan, rands
- Wet laboratory set-up
- Receipt and storage of test solution and receipt of embryos (chain of custody)
- Animal holding
- Determine average weight/egg (may change over season)
- Test initiation (weighing, counting, QA) (~10 day test)
- Daily monitoring and observations
- Water quality measurements
- Test termination (weighing, counting, QA)
- Test cleanup
- QA assessments
- Waste disposal

4.4 Definitive Test and Reference Toxicant Test Assumptions

- Purchase embryos and materials
- Development of laboratory data sheets, notebook, labels, work plan
- Wet laboratory set-up
- Receipt of embryos (chain of custody)
- Animal holding
- Determine average weight/egg (may change over season)
- Test initiation (weighing, counting, QA) (32 days)
- Daily monitoring, observations, and feeding (after hatch)

- Water quality measurements
- Transfer from static renewal to flow-through system after exposure period
- Collection and shipment of eggs for chemical analysis (chain of custody)
- Test termination (weighing, counting, QA)
- Abnormality data collection
- Growth measurements
- Test cleanup
- QA assessments
- Reference Toxicant Test: a separate test conducted during the Definitive Test period that includes most of the steps detailed here under "Definitive Test".
- Waste disposal

4.5 Data Analysis and Reporting Assumptions

- Daily laboratory notebook review for rangefinding, definitive and reference toxicant tests
- Final laboratory notebook review
- Summary of preliminary test results
- Summary of rangefinding test results
- Rangefinding data analysis and calculations for definitive test concentration series
- QA review of laboratory notebook and the data transferred to summary tables (review for transposition, calculation, etc.)
- Definitive test data analysis and interpretation
- Incorporation of results of chemical analyses of embryo tissue
- Definitive test report *(Requires receipt of analysis of embryo tissue from Battelle-Columbus.)*
- PNNL clearance of report (Technical review, Editorial review, QA review)

5.0 REFERENCES

ASTM. 1992. Standard guide for conducting early life-stage toxicity tests with fishes. E1241-92, ASTM Committee E-47 on Biological Effects and Environmental Fate, Subcommittee E47.01 on Aquatic Toxicology.

DeWitt, T.H., R.C. Swartz, and J.O. Lamberson. 1989. Measuring the acute toxicity of estuarine sediments. Environ. Toxicol. Chem. 8: 1035-1048.

Elonen, GE, RL Spehar, GW Holcombe, RD Johnson, JD Fernandez, RJ Erickson, JE Tietoe, and PM Cook. 1998. Comparative toxicity of 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin to seven freshwater fish species during early life-stage development. *Environmental Toxicology and Chemistry* 17(3):472-483.

Libby, A.D. 1995. Woonasquatucket River watershed, stream, and pond fisheries survey. Division of Fish and Wildlife, Rhode Island Department of Environmental Management, Federal Aid to Fisheries Project F-20-R Rhode Island.

U.S. EPA. 1996. Ecological effects test guidelines: OPOPTS 850.1400 Fish early-life stage toxicity test. EPA 712-C-96-121.

ATTACHMENT F

Bioassay Testing Methods

PROTOCOL

WHOLE SEDIMENT TOXICITY TESTING AGAINST *Hyalella azteca* (Amphipod) AND *Chironomus tentans* (Diptera) THAT MEASURE THE EFFECTS OF SEDIMENT-ASSOCIATED CONTAMINANTS ON SURVIVAL, GROWTH AND REPRODUCTION

1.0 OBJECTIVES AND SCOPE OF WORK

The objectives of this protocol are to outline the specific methods (including Standard Operating Procedures) to conduct whole sediment toxicity tests of the surficial sediments in field collected samples. In this instance, sediment samples will be collected by EPA in support of the Centredale Manor Restoration Project Ecological Risk Assessment (ERA). Field collected sediment samples will be evaluated to determine if sediment contamination is likely to adversely affect aquatic life in the study area. The sediment toxicity tests will be conducted following the guidance outlined in EPA/600/R-99/064 *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates,* Second Edition; ASTM 1706-95B, *Standard Test Methods for Measuring the Toxicity of Sediment Associated Contaminants with Freshwater Invertebrates* (ASTM 2000), and GLEC Standard Operating Procedures (SOPs). *Hyalella* and *Chironomus* are invertebrates routinely used to assess the toxicity of contaminants in sediment. The sediment toxicity endpoints will be survival, growth and reproduction. For *Hyalella* the endpoints are 10-day survival, 28-day survival and growth (measured as weight gain); 35-day survival and reproduction; 42-day survival, growth, reproduction and number of adult males and females on day 42. The toxicity endpoints for *Chironomus* are; 10-day survival; 20-day survival and growth (measured as weight gain); female and male emergence, adult mortality, the number of egg cases oviposited, and the number of eggs produced.

The toxicity tests will be conducted with an automated water delivery system, which replaces the overlying water at least once every 12 hours. The overlying water must be replaced at least once every 12 hours to prevent wastes and food from accumulating in the test chambers.

2.0 TECHNICAL APPROACH

2.1 Toxicity Testing and Associated Tasks

2.1.1 Scope and Summary

The objective of the aquatic toxicity tests with *Hyalella azteca* (amphipod) and *Chironimus tentans* (midge) is to determine if sediment contamination is likely to adversely affect aquatic life within the study area. The long-term exposure (28 days) to contaminated sediment, can identify marginally contaminated sediments by evaluating potential effects of contaminated sediment on survival, growth and reproduction, and the 10-day survival results will identify sediments that are acutely toxic to the test organisms. The acute lethality estimates will be based on10-day survival data for both test species. The chronic lethality estimations will be based on survival, growth and reproduction.

The automated overlying water delivery system provides a daily minimum of two overlying water renewals to the test organisms, provides minimal disturbance to the test organisms, and helps to guarantee adequate water quality for the survival of the test organisms. The organisms will be fed daily to ensure that there is enough food for their survival.

The sediment toxicity tests with *Hyalella azteca* and *Chironomus tentans* will be conducted at a temperature of 23 ± 1 degree Celcius (C), with a 16L:8D photoperiod at an illuminance of approximately 500-1000 lux (Tables 1 & 3). Test chambers are 300 mL high form beakers placed inside rectangular shaped chambers. Each 300 mL beaker has one or two screened holes which are centered approximately 8 cm from the bottom of the beaker. Consequently, each beaker will contain 100 mL of whole sediment and approximately 175 ml of overlying water. Each replicate test chamber will receive at least two volume additions per day of overlying water. The automated water delivery system will be evaluated before the testing is initiated to ensure that the exposure systems are functioning properly. At any time during any of the tests, the flow rates through any two test chambers should not differ by more than 10 percent, and the hardness, alkalinity, and ammonia concentrations should not vary by more than 50 percent within a treatment. The overlying water source (dechlorinated municipal tap water) has been demonstrated to support survival, growth and reproduction of *Hyalella azteca* and *Chironimus tentans* in culture.

2.1.2 Experimental Design

Two separate toxicity tests will be conducted on each sediment sample, one with *Hyalella*, and one with *Chironomus*. Each sediment toxicity test exposure will include at least one laboratory control sediment and field collected whole sediment samples (a minimum of eight samples) with sixteen replicate treatment chambers for each sediment type.

Sediment into Test Chambers
The day before the sediment test is started (Day –1) each sediment sample will be thoroughly homogenized and approximately 100 mLs of sediment will be added to each test chamber. Sediment will be visually inspected to judge the degree of homogeniety. Excess water on the surface of the sediment can indicate separation of solid and liquid components. Each test chamber will contain 100 mLs of sediment by volume. Overlying water will be added on Day –1, and the automated overlying water renewal system activated.

Temperature Control
The temperature of the overlying water in the headbox (the distribution point to the test chambers) will be controlled to maintain the desired test water temperature (± 1 °C) using immersion heaters and/or chillers. Water temperature will also be controlled in the test chambers by surrounding the test chambers in a temperature controlled water bath in which the test chambers will be maintained. Ambient air within the testing area will also be held near the desired test temperature. Temperature in the sediment toxicity tests will be monitored daily by taking manual readings with a digital hand held thermometer; these readings will be recorded on the test data sheets. Temperature will also be recorded continuously in at least one test chamber throughout the toxicity test.

Dissolved Oxygen Control and Measurement
Dissolved Oxygen will be maintained by the continuous aeration of the overlying water before it is distributed to the test chambers with a minimum of two volume additions of overlying water daily. Following SOP # GLEC-II-013-00 (Use of Dissolved Oxygen Meters), dissolved oxygen will be monitored at test initiation, and at least three times a week in two alternating replicates of each sediment type, and the control. The dissolved oxygen concentration in any test chamber should not drop below 2.5 mg/L of DO. If saturation falls below 2.5 mg/L, the cause of the oxygen reduction will be

investigated and remedied. More frequent renewal of the overlying water will be intitiated if necessary. In addition, daily brushing of the screens on the test chambers will help maintain the exchange of water during renewals. Dissolved oxygen measurements will be recorded on laboratory data forms.

Measurement of Overlying Water-quality Characteristics (pH, alkalinity, hardness, ammonia, and specific conductance)

Overlying water will be sampled just before water renewal from about 1 to 2 cm above the sediment surface using a pipet. It may be necessary to composite water samples from individual replicates so that enough overlying water is available for the analysis. The pipet should be checked to make sure no organisms are removed during sampling of overlying water. Following SOP # GLEC-II-033-01 (Use of a pH Meter), **pH** will be measured at test initiation in all test treatments (2 alternating replicates) at the beginning of the test, and then three times a week until the end of the test.

Following SOP's # GLEC-II-015-00 (Determination of Hardness in a Water Sample), SOP #GLEC-II-007-00 (Determination of Alkalinity in a Water Sample), and SOP # GLEC-II-032-00 (Determination of Ammonia in a sample), **hardness, alkalinity** and **ammonia** will be measured in all treatments at the beginning of the test, on Day 20 in the *Chironimus* test, on Day 28 in the *Hyalella* tests, and at the end of the tests.

Following SOP #GLEC-II-031-00 (Use of Conductivity Meters), **conductivity** will be measured at the beginning of the test, on Day 20 in the *Chironomus* tests, on Day 28 in the *Hyalella* tests, and at the end of the tests and weekly throughout the toxicity tests in two alternating replicate chambers.

Placing Organisms in Test Chambers

Test organisms should be handled as little as possible. To start the test, *Chironomus* larvae (<24-hours old) are collected using a Pasteur pipet from the bottom of the incubation dish with the aid of a dissecting microscope. *Hyalella* (7-8 days old) are collected from hatching chambers with known age young (hatched within the same 24 hours period) are used to initiate the *Hyalella* toxicity tests. *Hyalella* and *Chironomus* are exposed separately in replicate test chambers. Ten test organisms are pipetted directly into overlying water for the *Hyalella* test and 12 organisms are pipetted for the *Chironomus* toxicity tests, and care should be exercised to release the organisms under the surface of the water. A minimum of twenty organisms will also be preserved and weighed to determine initial weights for the *Hyalella* toxicity test.

Test Initiation

At least one day prior to the initiation of the toxicity tests, the automated water delivery system will be checked and adjusted if necessary to achieve the desired flow. The tests will be initiated by impartially distributing the correct number (ten or twelve per replicate chamber) of organisms into each test chamber. This will be accomplished by pooling all of the test organisms into one holding chamber and indiscriminately selecting and transferring the correct number of organisms to randomly selected test chambers, until all of the test chambers hold the desired number of test organisms.

Feeding

For each beaker, 1.0 mL of YCT will be added daily from Day 0 to Day 42 for the *Hyalella* tests, and 1.5 mL of Tetrafin® (4 mg/mL solids) for the *Chironomus* tests will be added daily or as needed. Each test chamber will be observed daily to determine if there is an excess of food build up, or if there is excessive fungal growth at the sediment surface. If an excess of food or fungal growth is detected, feeding will be reduced.

Test Duration
The duration of the toxicity tests will be 42 days for the *Hyalella* toxicity tests and about 50 to 65 days for the *Chironomus* tests. The *Chironomus* tests are ended when no additional adult emergence has been recorded for seven consecutive days. For each test species if there is 50 percent or greater mortality recorded on Day 10 when the acute survival of the organisms is assessed in four of the replicate chambers, the toxicity test with that sediment sample will be terminated for that test species.

2.1.2 Biological Data

Test Monitoring
All test chambers will be checked daily and observations made to assess test organism behavior such as sediment avoidance. Observations will be recorded daily on data sheets. However, monitoring effects on burrowing activity of test organisms may be difficult because the test organisms are often not visible during the exposure. The operation of the exposure system will also be monitored daily.

The measured endpoints for the toxicity tests will be survival, growth and reproduction. Death will be defined as no response to gentle prodding and no apparent gill or appendage movement for both *Hyalella* and *Chironomus*. After the organisms have been exposed to the sediments for 10 days, four replicates from each sediment sample will be sacrificed and used to determine survival for an acute toxicity test endpoint. Percent survival will be estimated from the survival data generated at the 10-day observation.

Chronic toxicity will be assessed from the tests by recording survival on day 20 in the *Chironomus* tests, and on days 28, 35 and 42 in the *Hyalella* tests. Growth (weight gain), as dry weight, will be measured on Days 28 and 42, with *Hyalella*. On day 20 of the *Chironomus* test, four of the initial 16 replicates will be selected and sacrificed for growth and survival measurements. Any immobile larvae will be considered dead, and will not be used for growth measurements. If pupae are recovered, these organisms will be included in survival data but not included in the growth data. The *Chironomus* larvae will be removed from the sediment using a #40 sieve (425-µm mesh), and the survival and growth (ash free dry weight) results will be recorded on the data sheets. In the *Hyalella* tests, on day 28, four of the replicate beakers of sediment will be sieved with a #40-mesh sieve (425-µm mesh) to remove surviving amphipods for growth determinations. Immobile organisms isolated from the sediment surface or from sieved material, will be considered dead. Surviving amphipods from these four replicates can be preserved in vials containing 8% sugar formalin to be measured at a later date. This same procedure is used for the 42 day survival and growth determination. After the amphipods are measured, they can be weighed to determine the average weight.

Average dry weight is used for measuring *Hyalella* growth since the sediment does not comprise a large portion of the overall dry weight as can be the case with *Chironomus*. The ash free dry weight is used to measure *Chironomus* growth to ensure that only the animal tissue weight and not the ingested sediments are weighed.

Monitoring Reproduction
For the *Chironomus* test, between day 23 and the end of the test, emergence of males and females, pupal and adult mortality, and time to death for adults is recorded daily for the reproductive replicates. Reproduction of *Chironomus* is measured by collecting emerging adults, placing them in reproduction/oviposit (R/O) chambers, allowing them to mate and produce egg cases. Each R/O unit is checked daily for dead adults and egg cases. Dead organisms are removed. At about Day 33 to the end of the test, auxiliary males may be needed to support reproduction in females since the males hatch

earlier than the females. To provide auxiliary males, four test chambers for each sediment type will be initiated on Day 10 of the *Chironomus* toxicity test with less than 24-hour old larvae. For each emerged female, at least one male, obtained from the corresponding reproductive replicate, from another replicate of that treatment, or from the auxiliary male beakers, is transferred into the R/O unit. Females generally remain sexually receptive up to 3 days if they have not already mated. A female will usually oviposit within 1 day of fertilization; however, some may require as long as 72 hours to oviposit. A female will lay a single primary egg case, usually in the early morning. A second, generally smaller egg case may be laid; however, these second egg cases are prone to fungus and the viability of embryos is typically poor. These second egg cases do not need to be counted, or recorded, and the numbers of eggs are not included in the egg counts because eggs in second egg cases typically have lower viability. The primary egg cases from the R/O chamber are transferred to a separate and corresponding petri dish to observe and count the eggs. The number of eggs will be estimated in each egg case by using a "ring method" as follows: (1) for each egg case, the mean number of eggs in five rings is determined; (2) these rings are to be selected at about equal distance along the length of the egg case; (3) the number of eggs/ring multiplied by the number of rings in the egg case will provide an estimate of the total number of eggs. Reproductive output in *Chironomus* will be expressed as the number of eggs/female.

On Day 28 of the *Hyalella* sediment test, the remaining 8 beakers are sieved and the surviving amphipods in each sediment beaker are placed in 300-mL water-only beakers containing 275 ml of overlying water and a 5 cm x 5 cm piece of Nitex screen (Nylon boiling cloth). Each water-only beaker receives 1.0 mL of YCT and at least two volume additions of water daily. Reproduction of *Hyalella* is measured on Day 35 and Day 42 in the water-only beakers by removing and counting the adults and young in each beaker. On Day 35, the adults are returned to the same water-only beakers. Adult amphipods surviving on Day 42 are preserved in sugar formalin solution. The number of adult females is determined by counting the adult males and assuming all other adults are females; mature male amphipods will have an enlarged second gnathopod.

Data Analysis
Endpoints measured in the 42-day *Hyalella* test include survival (Day 28, 35 and 42), growth (as length or dry weight on Day 28 and 42), and reproduction (number of young/female produced from Day 28 to 42). Depending on the toxicity of the sediments the data analyses used will follow the guidelines in Sections 14.4.2-14.4.6 in the EPA Guidance document.

Endpoints measured in the *Chironomus* test include survival, growth, emergence and reproduction. Depending on the toxicity of the sediments, the data analyses used will follow the guidelines in Section 16 of the EPA Guidance document.

Hyalella Culture and Collection
Tomasovic *et al.* (1995) described a procedure used by USGS for obtaining known age amphipods. We will use a variation of that procedure to obtain known age *Hyalella* for the sediment toxicity tests. At GLEC, mixed age *Hyalella azteca* are cultured at 23 degrees Celcius at a luminance of approximately 500 lux in 80L glass aquaria, each containing approximately 60 L of water in a flow-through system. Amphipods in the mixed age cultures are fed YCT and algae *ad libitum*. The bottom of each aquarium is lined with artificial substrate (10 x 10 cm sections of artificial substrate and gauze cheesecloth). Known age amphipods will be obtained for the tests by sieving organisms from the mixed age culture through a #25 (710 um mesh) U.S. standard sieve placed under water. Approximately fifty pairs of mature

amphipods remaining in the #25 sieve will be pipetted into a 15 x 15 cm shallow glass pan containing water (~1200 mL). The mature amphipods will be held in the pan overnight to release newborn amphipods. After 7-8 days amphipods will be removed for the tests.

Chironomus Culture and Collection
Known age Chironomus will be acquired by isolating egg cases from an in-house culture or an outside source. Newly laid egg cases (15-25) will be placed in petri dishes 3 days prior to test initiation so that the young will be less that 24 hours on test initiation day.

Temperature Acclimation
Test cultures are reared at 23 degrees Celcius, which is the same as the test temperature; therefore, no acclimation is necessary.

Test Initiation
A test will be initiated by adding the test organisms to the test chambers (Day 0). Sixteen replicate test chambers will be prepared for each sediment type, each test chamber containing ten organisms for the *Hyalella* test and twelve organisms per chamber for the *Chironomus* test.

For the *Hyalella* test, twenty amphipods will be archived in a sugar/formalin solution (Ingersoll and Nelson 1990) at the start of each toxicity test (Day 0) for length and weight measurements. A stock sugar formalin solution will be prepared by adding 120 g sucrose (table sugar) and 80 mL of 37% formalin to 920 mL deionized water. An equal volume of this stock sugar/formalin solution will be added to a vial containing an equal volume of overlying water containing the amphipods to be archived. The *Chironomus* larvae will be too small to accurately weigh or measure at test initiation; therefore, no organisms will be archived at test initiation for the *Chironomus* test. The testing will proceed following the general activity schedules for conducting toxicity tests with *Hyalella azteca* (Table 2) and *Chironumus tentans* (Table 4).

Requirements for control performance are provided in Tables 1 and 3. Laboratory data forms for the toxicity tests are also attached.

Ending the Tests
For the *Hyalella test*, reproduction is measured on Day 35 and Day 42 in the water-only beakers by removing and counting the adults and young in each beaker. On Day 35, the adults are then returned to the same water-only beakers. Adult amphipods surviving on Day 42 are preserved in sugar formalin. The number of adult females is determined by simply counting the adult males (mature male amphipods will have an enlarged second gnathopod) and assuming all other adults are females. The number of females is used to determine number of young/female/beaker from day 28 to Day 42. Growth will be measured by weighing the surviving adult amphipods on Day 42.

For the *Chiromomus* test, the point at which the life-cycle test is ended depends upon the sediments being evaluated. In clean sediments, the test typically requires 40 to 50 days from initial setup to completion. However, test duration will increase in the presence of environmental stressors, which act to reduce growth and delay emergence. Where a strong gradient of sediment contamination exists, emergence patterns between treatments will likely become asynchronous, in which case each treatment needs to be ended separately. For this reason, emergence is used as a guide to decide when to end a test. For sediments in which emergence has occurred, the test is ended when no further emergence is recorded over a period of 7 days. At this time, all beakers of the sediment are sieved through a #40-mesh screen to

recover remaining larvae, pupae, or pupal castes. When no emergence is recorded in a particular sediment at any time during the test, that sediment test can be ended once emergence in the laboratory control sediment has ended using the 7 day criterion.

2.1.3 Data Analysis

Endpoints measured in the 42-day *Hyallela* test include survival (Day 28, 35. and 42), growth (as dry weight on day 28 and 42), and reproduction (number of young/female produced from Day 28-42). Procedures outlined in Sections 14 and 16 of the EPA 2000 manual will be followed, including species specific information needed to interpret results for the *Hyalella* 42-day sediment toxicity tests. Endpoints measured in the *Chironomus* test are survival, growth , emergence and reproduction. The statistical analyses for both test species will be based on species specific information provided in sections 14 and 16 of the EPA 2000 manual, which will be used as guidance to interpret the results of the long-term sediment toxicity tests.

Data Verification and Validation
The data generated for the long-term sediment toxicity tests will be entered in ink in laboratory record books and on specific data sheets. The data and related project records will be reviewed daily by laboratory personnel at the end of each working day to ensure that analytical activities are completely and adequately documented. The Task Leaders will be responsible for reviewing toxicity test results and supporting documentation. All hand-entered or transcribed data will be 100 percent validated. All calculations performed manually will be checked for accuracy. Calculations performed by software will be checked at a frequency sufficient to verify their accuracy. All data will be validated to ensure that the organism performance criteria have been met, and that the data are complete, accurate, and traceable. All data that do not meet the performance criteria will be submitted to the Project Manager for review and assessment of the potential impact of the results. Affected samples may be re-analyzed at the Project Manger's discretion. Data that are accepted outside of these criteria will be noted, and the rationale for accepting the analysis will be thoroughly documented.

5.0 REFERENCES

American Society for Testing and Materials. 2000. Standard test methods for measuring the toxicity of sediment-associated contaminants with freshwater invertebrates. E1706-95b. In Annual Book of Standards. Vol. 11.05. Philadelphia, PA.

Ingersoll, C.G., and M.K. Nelson. 1990. Testing sediment toxicity with *Hyalella azteca* (Amphipoda) and *Chironomus riparius* (Diptera). In Aquatic Toxicology and Risk Assessment: 13th Volume, ASTM STP 1096. W.G. Landis and W.H. van der Schalie (eds). American Society for Testing and Materials. Philadelphia.

Tomasovic, M.J., F.J. Dwyer, I.E. Greer, and C.G. Ingersoll. 1995. Recovery of known age *Hyalella azteca* (Amphipoda) from sediment toxicity tests. Environmental Toxicology and Chemistry 14:1177-1180.

U.S. Environmental Protection Agency. 2000. Methods for measuring the toxicity and bioaccumulation of sediment associated contaminants with freshwater invertebrates. Second Edition EPA 600/R-99/064. Duluth, MN.

ASTM. 1995. Standard guide for conducting acute toxicity tests with fishes, macroinvertebrates, and amphibians. ASTM E 729. Vol. 11.05. Philadelphia, PA.

Table 1. Conditions for Conducting a 42-day Sediment Toxicity Test with *Hyalella azteca* (modified from USEPA 2000 and ASTM 2000).

Parameter	Conditions
1. Test type:	Whole-sediment toxicity test with renewal of overlying water
2. Temperature:	23 ± 1 degree Celsius
3. Light quality:	Wide-spectrum fluorescent lights
4. Illuminance:	Approximately 500 to 1000 lux
5. Photoperiod:	16L:8D
6. Test chamber:	300 mL high form beakers
7. Sediment volume:	100 mL
8. Overlying-Water volume:	175 mL in the sediment exposure from Day 0-28 , and 275 mL on the water-only exposure from Day 28 to Day 42.
9. Volume additions:	Minimum of 2 per day
10. Age of organisms:	7-8 days old at test initiation
11. Organisms per replicate	10
12. Number of replicates	16 at test initiation (4 for 10-Day survival, 4 for 28-Day survival and growth, and 8 for 35-and 42-day survival, growth and reproduction).
13. Feeding:	1.0 mL YCT/d (1800 mg/L stock)
14. Aeration	None (if dissolved oxygen > 2.5 mg/L)
15. Overlying water:	Lake Michigan (Traverse City municipal dechlorinated) water that has been demonstrated to support survival, growth and reproduction of *Hyalella azteca* and *Chironomus tentans* in culture).
16. Chamber cleaning:	Gently brush screens daily
17. Water quality Measurements:	Hardness, alkalinity, conductivity and ammonia at the beginning and end of the sediment exposure (Day 0 and 28). Temperature daily. Conductivity weekly. Dissolved oxygen (DO) and pH three times/week. Concentrations of DO will be measured more often if DO drops more than 1 mg/L since the previous measurement.
18. Test duration:	42 days
19. Endpoints:	10 day survival; 28 day survival and growth; 35 day survival and reproduction; and 42 day survival, growth, reproduction and number of adult males and females on Day 42.
20. Test acceptability:	Minimum mean control survival of 80% on Day 28, and performance based criteria specified in Table 14.3, EPA, 2000).

Table 2. General Activity Schedule for Conducting a 42-d Sediment Toxicity Test with *Hyalella azteca* (modified from USEPA 2000).

Day	Activity
-8	Separate known-age amphipods from the mass cultures and place in holding chambers. Begin preparing food for the test. The <24 hour amphipods are fed 10 mL of YCT (1800 mg/L stock solution) and 10 mL of *Selanastrum capricornutum* (about 3.0 x 107 cells/mL) on the first day of isolation and 5 mL of both YCT and *S. capricornutum* on the 3rd and 5th day after isolation.
-7	Remove adults and isolate <24-hour old amphipods.
-6 to –2	Feed and observe isolated amphipods. Measure water quality (for example, temperature and dissolved oxygen). Acclimation tests organisms to test temperature by incremental adjustments to the holding chambers.
-1	Feed and observe isolated amphipods. Measure water quality. Add sediment into each test chamber, place chambers into exposure system, and start renewing overlying water.
Sediment Test	
0	Measure water quality (pH, temperature, dissolved oxygen, hardness, alkalinity, conductivity, ammonia). Transfer ten 7-8-day old amphipods into each test chamber. Release organisms under the surface of the water. Add 1.0 mL YCT (1800 mg/L stock) and 1mL algae into each test chamber. Archive 20 test organisms for weight and length determination. Observe behavior of test organisms.
10	End the acute survival portion of the study by collecting the amphipods with a #25 sieve. Count survivors for acute toxicity data analysis.
11-27	Add 1.0 mL algae of YCT to each test beaker. Measure temperature daily, conductivity weekly, and dissolved oxygen (DO) and pH at least three times/week. Observe behavior to test organisms daily.
28	Measure temperature, dissolved oxygen, pH, hardness, alkalinity, conductivity and ammonia. End the sediment-exposure portion of the test by collecting the amphipods with a #40-mesh sieve. Use four replicates for growth measurements: count survivors and preserve organisms in sugar formalin for growth measurements. Use eight replicates for reproduction measurements: place survivors in individual replicate water-only beakers and add 1.0 mL of YCT to each test beaker each day and 2 volume additions per day of overlying water.

Reproduction Phase

29-35	Feed daily (1.0 mL of YCT). Measure temperature daily, conductivity weekly, and DO and pH three times a week. Measure hardness and alkalinity weekly. Observe behavior of test organisms.
35	Record the number of surviving adults and remove offspring. Return adults to their original individual beakers and add food.
41	Measure total water quality (pH, temperature, dissolved oxygen, hardness, alkalinity, conductivity, ammonia).
42	Record the number of surviving adults and offspring. Surviving adult amphipods on Day 42 are preserved in sugar formalin solution. The number of adult males in each beaker is determined from this archived sample. This information is used to calculate the number of young produced pre female per replicate from day 28 to 42.

Table 3. Conditions for Conducting a Long-term Sediment Toxicity Test with *Chironomus tentans* (modified from USEPA 2000 and ASTM 2000).

Parameter	Conditions
1. Test type:	Whole-sediment toxicity test with renewal of overlying water
2. Temperature:	23 ± 1 degree Celsius
3. Light quality:	Wide-spectrum fluorescent lights
4. Illuminance:	Approximately 100 to 1000 lux
5. Photoperiod:	16L:8D
6. Test chamber:	Plexi-glass chamber with 16 300 mL high form beakers inside
7. Sediment volume:	100 mL
8. Overlying-Water volume:	175 mL in the sediment exposure from Day 0-28 , and 275 mL on the water-only exposure from Day 28 to Day 42.
9. Volume additions:	Minimum of 2 per day
10. Age of organisms:	<24 hours old at test initiation
11. Organisms per replicate	12
12. Number of replicates	16 at test initiation (4 for 10-day survival, to be replaced with 4 for auxiliary males).
13. Feeding:	Tetrafin® goldfish food, fed 1.5 mL daily to each test chamber starting Day –1 (1.0 mL contains 4.0 mg of dry solids)
14. Aeration	None (if dissolved oxygen > 2.5 mg/L)
15. Overlying water:	Lake Michigan (Traverse City municipal dechlorinated) water that has been demonstrated to support survival, growth and reproduction of *Chironomus tentans* in culture).
16. Chamber cleaning:	Gently brush screens daily
17. Water quality Measurements:	Hardness, alkalinity, conductivity and ammonia at the beginning, on Day 20, and end of the sediment test. Temperature daily (continuously). Conductivity weekly. Dissolved oxygen (DO) and pH three times/week. Concentrations of DO will be measured more often if DO drops more than 1 mg/L since the previous measurement.
18. Test duration:	About 50-65 days; each treatment is ended separately when no additional emergence has been recorded for seven consecutive days. When no emergence is recorded from a treatment, termination of that treatment should be based on the control sediment using this 7-day criterion.
19. Endpoints:	10 day survival; 20 day survival and growth; female and male emergence, adult mortality, the number of egg cases oviposited, and the number of eggs produced.
20. Test acceptability:	Average size of *C. tentans* in the control sediment at 20 days must be at least 0.6 mg/surviving organism as dry weight or 0.48 mg/surviving organism as AFDW. Emergence should be greater than or equal to 50%. The mean number of eggs/egg case should be greater than or equal to 800. The average survival of *Chironomus* in the control sediment should be greater than or equal to 70 % on Day 20 and greater than 65% at the end of the test. In addition, the performance based criteria specified in Table 15.3, EPA, 2000 will be followed.

Table 4. General Activity Schedule for Conducting a Long-term Sediment Toxicity Test with *Chironomus tentans* (modified from USEPA 2000).

Day	Activity
-4	Start reproduction flask with cultured adults (1:3 male:female ratio).
-3	Collect egg cases (6-8) and incubate at 23 degrees Celcius.
-2	Check egg cases for viability and development.
-1	Check egg cases for hatch and development. Add 100 mL of homogenized test sediment to each replicate beaker and place in corresponding treatment holding tank. After sediment has settled for at least 1 hour, add 1.5 mL Tetrafin slurry (4 g/L solution) to each beaker. Overlying water renewal begins at this time.
Sediment Test	
0	Transfer all egg cases to a crystallizing dish containing overlying water. Discard larvae that have already left the egg cases in the incubation dishes. Add 1.5 mL food to each test beaker with sediment before the larvae are added. Add 12 larvae to each replicate baker (beakers are chosen by random block assignment). Let beakers sit (outside the test system) for 1 hour following addition of the larvae. After this period, gently immerse all beakers into their respective treatment holding tanks. Measure water quality (pH, temperature, dissolved oxygen, hardness, alkalinity, conductivity, ammonia).
1-End	On a daily basis, add 1.5 mL food to each beaker. Measure temperature daily. Measure the pH and dissolved oxygen three times a week during the test. Measure conductivity weekly. If the DO has declined more than 1 mg/L since previous reading, increase frequency of DO measurements and aerate if DO continues to be less than 2.5 mg/L. Measure hardness, alkalinity, conductivity, ammonia, temperature, pH and dissolved oxygen at the end of the test.
6	For auxiliary male production, start reproduction flask with cultured adults (*e.g.*, 1:3 male to female ratio).
7-10	Follow set-up schedule for auxiliary male beakers (4 replicates/treatment) described above for Day –3 to Day 0.
10	End the acute survival portion of the study by collecting the midges with a sieve. Count survivors for acute toxicity data analysis.
19	In preparation for weight determinations, ash weigh pans at 550 degrees Celcius for 2 hours.

20 Randomly select four replicates from each treatment and sieve the sediment to recover larvae for growth and survival determinations. Pool all living larvae per replicate and dry the sample to a constant weight (*e.g.*, 60 degrees Celsius for 24 hours). Install emergence traps on each of the remaining reproductive replicate beakers. Measure temperature, pH, hardness, alkalinity, dissolved oxygen, conductivity and ammonia.

21 The sample with dried larvae is brought to room temperature in a dessicator and weighed to the nearest 0.01 mg. The dried larvae in the pan are then ashed at 550 degrees Celsius for 2 hours. The pan with the ashed larvae is then re-weighed and the tissue mass of the larvae determined as the difference between the weight of the dried larvae plus pan and the weight of the ashed larvae plus pan.

Chronic Measurements

23-End On a daily basis, record emergence of males and females, pupal, and adult mortality, and time to death for previously collected adults. Each day, transfer adults from each replicate to a corresponding reproduction/oviposition (R/O) chamber. Transfer each primary egg case from the R/O chamber to a corresponding petri dish to monitor and count. Record each egg case oviposited, and the number of eggs produced (using either the ring or direct count methods).

28 Place emergence traps on auxiliary male replicate beakers.

33-End Transfer males emerging from the auxiliary male replicates to individual inverted petri dishes. The auxiliary males are used for mating with females from corresponding treatments from which most of the males have already emerged or in which no males emerge.

40-End After 7 days of no recorded emergence in a given treatment, end the treatment by sieving the sediment to recover larvae, pupae, or pupal exuviae. When no emergence occurs in a test treatment, that treatment can be ended once emergence in the control sediment has ended using the 7-day criterion.