

Fields of Specialization

- ▶ Environmental Remediation Engineering
- ▶ Innovative Remedial Technologies
- ▶ Intrinsic Bioremediation
- ▶ DNAPL Remediation
- ▶ Hydrogeology
- ▶ Environmental Assessments
- ▶ Oilfield Assessment and Audits
- ▶ RCRA Facility Investigations
- ▶ Feasibility Studies
- ▶ Regulatory Negotiations
- ▶ Project Management

Credentials/Registrations

- ▶ B.S., Petroleum Engineering, Louisiana State University, 1985

Certifications and Training

- ▶ Hazardous Waste Health and Safety Training, 1989
- ▶ Hydrocarbon Services Conference, 1990
- ▶ Underground Storage Tank Seminar, 1994
- ▶ Technology Transfer Training Course, 1995
- ▶ Hazardous Waste Health and Safety Training Refresher Course, 1996
- ▶ Princeton Groundwater Remediation Course, 1996
- ▶ Symposium on Natural Attenuation of Petroleum Hydrocarbons in Groundwater, 1996
- ▶ Symposium on Natural Attenuation of Chlorinated Organics in Groundwater, 1996
- ▶ Conference on Natural Attenuation of Organic Compounds, 1998
- ▶ Conference on Remediation of Chlorinated Organic Compounds and Recalcitrant Compounds, 1998
- ▶ Conference on Remediation of Chlorinated Organic Compounds and Recalcitrant Compounds, 2002
- ▶ Remediation Technologies Development Forum (RTDF), Permeable Reactive Barriers, 2003.

Career Summary

Mr. Manale is the Chief Operations Officer and a Principal Senior Advisor with Toxicological & Environmental Associates, Inc., a professional environmental consulting firm that specializes in risk-based remediation. Since 1988, his primary focus has been the conceptual design, planning, and implementation of risk-based soil and groundwater remediation systems. The remedial systems successfully implemented by Mr. Manale have included traditional as well as innovative remedial technologies such as intrinsic bioremediation and phytoremediation. The technical approach to the engineering design of his remediation systems relies on a sound understanding of the subsurface environment prior to the selection and implementation of the preferred remedial alternative. Mr. Manale also has extensive experience with environmental assessments, hydrologic testing, regulatory agency negotiations, litigation support, project management, report writing and technical review, and underground storage tank services. Mr. Manale has planned and managed over 50 risk-based remediation and/or environmental assessment projects for nationally and internationally recognized environmental consulting firms. Mr. Manale has a good understanding of the human health and ecological risk assessment process and routinely interacts with environmental chemists, environmental toxicologists, and computer modelers to apply risk-based solutions to remedial decision making.

Experience Summary

Engineering/Remediation

- A \$20 MM risk-based remediation project focusing on high concentrations of dissolved-phase chlorinated volatile organic compounds in groundwater is being conducted at a site in Pittsburg, California (1998-present). The remediation incorporates 4,000 linear feet of an engineered in-situ bioremediation system to intercept and treat contaminants migrating in groundwater. The system uses continuous circulation of groundwater with periodic injection of selected organic material in 39 wells to stimulate dehalogenation of site contaminants by intrinsic bacteria. The system also selectively incorporates bioaugmentation and emulsified zero-valent iron to maximize effectiveness. Numerous studies were conducted to design the system, including a site-wide groundwater biogeochemical study, field injection tests, laboratory microcosm studies, conservative tracer testing, pump testing, and others. To date, the system is achieving an average destruction removal efficiency of greater than 72%.
- A risk-based remediation project focusing on high concentrations of dissolved-phase chlorinated volatile organic compounds in groundwater was conducted at a site in Cape Canaveral, Florida (1996-present). Phase I of the remediation incorporated groundwater extraction, an aboveground iron-filings treatment vessel, amendment of treated water with organic material and nutrients, and then re-injection of the amended treated stream through an infiltration gallery. Successful completion of Phase I of the remediation enabled decommissioning of the system in 2002. Possible implementation of Remedial Phase II, engineered in-situ bioremediation of the source area, is currently being designed and negotiated. Design of the multi-phase remediation program was based on the results of a groundwater biogeochemical study, pump testing, laboratory microcosm studies, a site-specific risk assessment, and a feasibility study.
- A risk-based remediation project focusing on high concentrations of dissolved-phase chlorinated aliphatic volatile organic compounds in groundwater was conducted at a large chemical plant in Plaquemine, Louisiana. The remediation project included an on-site groundwater biogeochemical study to identify and evaluate the effects of anaerobic dehalogenation processes in the subsurface environment.
- A risk assessment was conducted at an oil field services facility in Bossier City, Louisiana for chlorinated volatile organic compounds, aromatic hydrocarbons, and arsenic in groundwater. The project included an on-site groundwater biogeochemical study to identify and evaluate the effects of anaerobic dehalogenation processes in the subsurface environment. Closure of the site was attained using the site-specific risk assessment.
- A study focusing on the intrinsic remediation of chlorinated aliphatic volatile organic compounds in groundwater was conducted at a major chemical company plant site in Louisiana. The objectives of the study were to demonstrate that anaerobic dehalogenation processes in the subsurface environment would limit the migration and effectively reduce the concentrations of these compounds dissolved in shallow groundwater beneath the site, thereby inhibiting potential impacts to human and/or ecological receptor populations; and to establish that intrinsic bioremediation was appropriate as the final corrective action alternative. Based on the results of the study, intrinsic remediation was approved as an acceptable corrective action alternative. Continuous recovery of dense nonaqueous phase liquid (DNAPL) and periodic monitoring of groundwater quality are currently being conducted.
- A biogeochemical study focusing on the intrinsic remediation of volatile aromatic hydrocarbons in groundwater was conducted at a former oil refinery in Mississippi. The objectives of the study were to demonstrate that biodegradation processes in the subsurface environment would limit the

migration and effectively reduce the concentrations of volatile aromatic hydrocarbons in shallow groundwater beneath the site, thereby inhibiting potential impacts to human and/or ecological receptor populations; and to establish that intrinsic remediation was appropriate as the final corrective action alternative.

- Remediation of dissolved-phase chlorinated aliphatic compounds in groundwater and petroleum hydrocarbons in soil was performed using an engineered phytoremediation method at a former oil field services location in Lafayette, Louisiana (1995). A total of 92 trees were planted within the area encompassed by the groundwater plume and a landfarm was constructed within the same planted area. Three varieties of grasses were planted to assist with the remediation of the hydrocarbons in the soil. This remedial scenario was approved by the GWPD-LDEQ and was implemented in August of 1995. Soil and groundwater quality monitoring have been conducted since that time. As a result of the phytoremediation effort, the concentrations of volatile organic compounds in this 25-year old groundwater plume have significantly diminished. Closure was requested in April of 1998, only 2.5 years after implementation of the remedial action.
- Dissolved-phase chlorinated aliphatic volatile organic compounds in groundwater were remediated at a chemical plant in Baton Rouge, Louisiana (1996). The remedial technologies employed at this site included vacuum enhanced groundwater recovery and aboveground treatment. Groundwater is continuously recovered using multiple recovery wells and treated using a carbon adsorption system.
- Developed the work plan to remediate dissolved-phase chlorinated volatile organic compounds and petroleum hydrocarbons in groundwater at a former solvent collection facility in Pineville, Louisiana. The remedial technologies planned for this site included groundwater recovery using a subsurface drain, aboveground treatment of the groundwater and injection of the treated groundwater to enhance the biodegradation of the compounds upgradient of the recovery drain.
- Both liquid-phase and dissolved-phase volatile aromatic hydrocarbons in groundwater were remediated at a fuel terminal facility in Franklinton, Louisiana (1995). The remedial technologies being employed at this site include groundwater recovery, groundwater treatment, and soil vapor extraction. Groundwater was continuously recovered using a french drain, thereby causing a significant depression of the water table beneath the site. Soil vapor extraction was then used as the primary carrier to remove volatile organic compounds from the subsurface. Periodic operation and maintenance, and groundwater/air sampling were conducted at the site.
- Both liquid-phase and dissolved-phase volatile aromatic hydrocarbons in groundwater were remediated at a fuel terminal facility in Laurel, Mississippi (1994). The remedial technologies employed at this site included groundwater recovery and groundwater treatment. Groundwater was continuously recovered using multiple recovery wells and treated using an air diffuser system. The MDEQ approved site closure.
- Dissolved-phase chlorinated volatile organic compounds in soil and groundwater were addressed at four oil field services sites in Louisiana using risk assessment (1994). The GWPD-LDEQ has not required further remedial action at the sites.
- Dissolved-phase volatile aromatic hydrocarbons and chlorinated volatile organic compounds in groundwater were remediated at a fuel storage facility in Oakridge, Tennessee (1992). The remedial technologies employed at this site included in-situ air sparging and soil vapor extraction. The recovered soil vapor was treated using carbon adsorption.

- Dissolved-phase volatile aromatic hydrocarbons and chlorinated volatile organic compounds in groundwater were remediated at three fuel storage facilities in Tennessee and Kentucky (1992). The remedial technologies employed at these sites included in-situ air sparging, groundwater recovery, and soil vapor extraction. The recovered soil vapor was treated using carbon adsorption and the recovered groundwater was treated using air strippers.
- Assisted in the development of the work plan and project specifications for groundwater remediation at a wood treating plant in Jackson, Mississippi. The remedial technologies employed at this site included installation of two subsurface drains and a number of injection wells.
- Both liquid-phase and dissolved-phase volatile aromatic hydrocarbons in groundwater were remediated at a former gasoline station in Evergreen, Alabama (1991). The remedial technologies employed at this site included groundwater recovery and groundwater treatment. Groundwater was continuously recovered using multiple recovery wells and treated using an air diffuser system.

Environmental Assessments

- Designed and implemented multiphased assessments of soil and groundwater quality at 7 oil field services sites in Louisiana. Included site inspections, soil gas surveys, advancement of soil borings, soil sampling, installation of groundwater monitoring wells, groundwater sampling, and reporting.
- Performed assessments of soil and groundwater quality and conducted environmental compliance audits at 12 natural gas compressor stations in Louisiana.
- Performed numerous environmental assessments of soil and groundwater quality at various types of facilities in Louisiana, Arkansas, Texas, Mississippi, and Alabama.

Litigation support

- Provided expert testimony at deposition on behalf of defendants (an oilfield services facility in Houston, Texas (2004)). Designed and conducted two phases of environmental assessments to determine the nature and extent of chlorinated organic compounds in soil and groundwater. Developed a conceptual remediation plan and cost estimate for actively remediating the existing groundwater plume.
- Provided expert testimony at deposition on behalf of plaintiffs (landowner) versus a major oil company. Conducted environmental assessment and developed cost estimates to remediate petroleum hydrocarbons and chlorides in soil and groundwater at five former oilfield sites near Lottie, Louisiana.
- Provided expert testimony at deposition on behalf of plaintiffs (landowner) versus a major oil company. Conducted environmental assessment and developed cost estimates to remediate petroleum hydrocarbons in soils and sediment at eight former oilfield sites in Lafourche Parish, Louisiana.

RCRA and CERCLA

- Conducted a RCRA Facility Investigation (RFI) at a chemical plant in Louisiana. Developed the RFI Work Plan, implemented the work plan, and authored the RFI Report. Initiated work on the Corrective Measures Study (CMS).
- Worked as part of a team planning and performing the RFI at two other sites in Louisiana. Wrote the majority of the work plans and reports for both sites.
- Contributed to planning of assessment strategy for a Feasibility Study at a CERCLA site in Florida.

Publications

- Droy B. F., F. Manale, R. Copeland, C. Creber, G. Klecka. 2002. *Evaluating Enhanced In Situ Anaerobic Bioremediation as a Primary Site-Wide Remediation Strategy*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Booth J. G., P. Jin, B. Droy, F. Manale, C. Creber, G. Klecka. 2002. *Conservative Chemical Tracer Evaluation of Large-Scale Circulating In-Situ Bioremediation*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Fam S. A., B. Dynkin, B. Droy, F. Manale, R. Copeland, M. Findlay, S. Fogel, C. Creber, G. Klecka. 2002. *Designing In-Situ Anaerobic Bioremediation As Primary Remediation For A Manufacturing Facility*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Findlay M., S. Fogel, D. Smoler, B. Droy, F. Manale, P. Jin, C. Creber, G. Klecka. 2002. *Optimizing Reductive Dechlorination In A Large-Scale In-Situ Bioremediation System*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Fogel S., M. Findlay, D. Smoler, B. Droy, F. Manale, P. Jin, C. Creber, G. Klecka. 2002. *Microcosm Method To Assess the Microbial Community at Anaerobic Bioremediation Sites*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Liu S., B. Droy, F. Manale, P. Jin, C. Creber, G. Klecka. 2002. *Statistical Analysis Of Groundwater Chemistry Data Of Large-Scale In-Situ Bioremediation*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Killen M. A., B. Droy, F. Manale, C. Creber, G. Klecka. 2002. *Evaluation & Design Of Large-Scale In-Situ Bioremediation Using Computer Modeling*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Killen M. A., B. Droy, F. Manale, R. Copeland, C. Creber, G. Klecka. 2002. *In-Situ Bioremediation Optimization Study – Evaluating Flow Properties With Borehole Flowmeters*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Manale F., B. Droy, R. Copeland, C. Creber, G. Klecka. 2002. *Defining Success for a Full-Scale In Situ Anaerobic Bioremediation System*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Manale F., B. Droy, R. Copeland, C. Creber, G. Klecka. 2002. *Operation & Maintenance Of A Full-Scale In-Situ Anaerobic Bioremediation System*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.

- Jin P., B. Droy, F. Manale, R. Copeland, C. Creber, G. Klecka. 2002. *Groundwater Biogeochemical Study for Evaluating Feasibility Of In-Situ Anaerobic Bioremediation*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.
- Jin P., B. Droy, F. Manale, R. Copeland, C. Creber, G. Klecka. 2002. *Monitoring The Effectiveness Of Large-Scale In-Situ Anaerobic Bioremediation*. Published in the Proceedings for the Third International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Monterrey, California.