

TECHNICAL SPECIALTIES

Mechanical Engineering; soil and groundwater remediation; design and implementation of enhanced in-situ bioremediation, in-situ chemical reduction, in-situ chemical oxidation, permeable reactive walls, and ex-situ soil and groundwater treatment remedies; management and engineering associated with RI/FS programs including remedial alternatives evaluation and costing; design of production, monitoring, observation, and recovery wells; design and construction of public water treatment and distribution systems, industrial wastewater treatment systems, and soil/groundwater remediation systems; design of vertical turbine, submersible, centrifugal, and positive displacement pumping systems; evaluation and design of constructed treatment wetlands systems for industrial wastewater treatment and management; regulatory compliance audits, permitting and contingency planning; air emissions permitting, reporting and control device design; spill prevention and stormwater management planning and design; construction and project management; cost estimating.

EXPERIENCE SUMMARY

Twenty-eight years' experience: Principal Engineer at Roux Associates, Inc.; Senior Project Manager at A.C. Schultes, Inc. (NJ and MD). Management and engineering responsibilities have included cost estimation to contract closeout of projects involving: emissions control design & optimization; regulatory compliance; well design and installation; potable water, industrial wastewater and remedial treatment system plant design and installation; in-situ and ex-situ soil and groundwater remediation; pump design and installation; mechanical systems design and installation; construction management of building construction, water and fuel oil storage and distribution systems; electrical, instrumentation and controls, mechanical, and chemical feed systems; regulatory compliance management and engineering responsibilities have included preparation of SPCC, SWPPP and other comprehensive compliance plans; wastewater, stormwater & air emissions permitting and management plans; Health & Safety management and industrial hygiene testing and evaluation; design of storage tank systems, containment systems and air emissions controls.

CREDENTIALS

B.S. Mechanical Engineering, University of Bridgeport,
Bridgeport, Connecticut

OSHA 40-Hour Health and Safety Training

Licensed Professional Engineer:

Commonwealth of Pennsylvania (#PE055628)

State of New Jersey (#24GE04939100)

State of South Carolina (#27649)

State of Colorado (#PE.0049341)

State of Oklahoma (#28399)

Completed the First NGWA Regional Environmental Drilling and Field Investigations Course, 1992, University of South Florida, Tampa, Florida.

Presenter at the Battelle International Conference for the Remediation of Chlorinated and Recalcitrant Compounds: May 2006, May 2012, May 2014, May 2016, and April 2018.

PROFESSIONAL AFFILIATIONS

National Society of Professional Engineers.

KEY PROJECTS**Remedial Investigation, Feasibility Study, & Remedial Action**

- Professional Engineer-in-Charge and project manager for the management and remedial optimization of a Superfund Site in southern New Jersey. The project involved the overall management and development of a revised remedial approach for a former wastewater processing Superfund Site in the New Jersey Pinelands with a pump and treat remedial program that started in 1995 and had a predicted remaining remedial timeframe of at least 30 years from 2008. The compounds of concern at this site included various chlorinated solvents (e.g., CVOCs such as PCE, TCE, 1,1,1-TCA, 1,1,2,2-PCA), metals (e.g., beryllium, chromium) and hydrocarbon volatile organic compounds (e.g., ethylbenzene) that were mainly in groundwater but still adsorbed to soils in source areas. The optimized approach to site remediation involved optimizing the existing pump and treat system so that it would effectively provide groundwater capture, operate efficiently and meet effluent limits while other supplemental remedies such as phytoremediation and in-situ chemical reduction (ISCR) could be defined, negotiated with the USEPA, and implemented. This approach helped to establish a better working relationship with the USEPA, who had initially indicated that the existing operation of the pump and treat remedy was inadequate to achieve remedial goals and be protective of a downgradient river. The pump and treat system was optimized through: jar testing; reconfiguring chemical feed points and revising chemical dosing procedures; optimizing the water balance through the system; cost-effectively rehabilitating recovery wells, a clarifier, an air stripper, multi-media filters, conveyance piping and groundwater reinjection features; and developing a comprehensive operations, maintenance and monitoring (OM&M) plan to ensure that the system remained optimized until it could be supplanted by alternate remedial technologies. A pilot-scale phytoremediation plot involving the planting of 1,700 hybrid poplar trees (3 different species) in the source area and area of groundwater reinjection was completed to improve hydraulic control in the source areas. Successful bench-and pilot-scale testing of ISCR using carbon-impregnated zero-valent iron and micronutrients, pH buffering substrate, and microbial inoculum were completed to evaluate the treatment of site-specific CVOCs and metals. Because of successful

bench-and pilot-scale testing, ISCR activities have been expanded to address source areas and hot spots, and a significant change to the ROD is being addressed through an Explanation of Significant Differences. The revised remedial approach for this site is expected to save the PRP Group as much as \$12-million on the remaining remediation and site monitoring.

- Professional Engineer-in-Charge for the development and implementation of a remedial action plan to address TCE contamination in soil, bedrock matrices and groundwater at a steel tube plant in northeastern Pennsylvania. The on-site remedial plan was paired with a public water main installation to address source area contamination and downgradient impact to private water supply wells. An original remedial plan was developed to address the full area of source contamination to a full depth of over 100 feet below ground surface. To reduce remedial costing from \$7-Million to approximately \$4-Million a reduced source area remedy was negotiated to achieve credit for existing capping due to buildings and asphalt and focused the overall remedy on a specific TCE mass removal goal instead of remediating the full affected area to a cleanup standard. To facilitate this plan, the source area was split into two main areas of concern and remedial investigation, including bedrock matrix testing, was used to determine the zones of highest mass concentration in each of the two areas. In one area, the majority of the TCE mass resided in the overburden soils (due to surface spills) while in the other area, a majority of the TCE mass resided in the bedrock matrices and groundwater (due to releases from a subsurface facility feature). It was determined that the best remedy for the area with mostly soils impact would be excavation to bedrock (approximately 23 feet below ground surface) in areas of TCE concentration that equaled 100 mg/kg or more (a site-specific cleanup standard that was approved by PADEP). Because the excavation area was adjacent to critical tube plant buildings and the client desired to expand the tube plant in the remediation area, Roux Associates needed to incorporate geotechnical testing and building design factors into the remedial plan. In the area where a majority of the TCE mass resided in bedrock matrices and groundwater to approximately 110 feet below ground surface, it was determined that electrical resistance heating (ERH) would be the best remedy. ERH was implemented directly adjacent to the active tube plant and included installing 17 electrodes to the full 110-foot depth of contamination and operating and monitoring the system for a period of three months to achieve the targeted TCE mass removal. This focused, mass removal based remedial approach was approved by PADEP through a Remedial Action Plan approval and an Administrative Order on Consent. The TCE mass removed by the two remedial approaches totaled 4,460 pounds and was accepted by PADEP as a successful source removal effort, which along with public water supply connections, facilitated

a monitored natural attenuation approach for remaining groundwater impact.

- Professional Engineer-in-Charge for various activities at the Bridgeport Rental and Oil Services (BROS) Superfund Site in Bridgeport, New Jersey. Supported FS activities through: remedial alternatives evaluation and costing; design and construction management of over four miles of potable water main, including a major interstate highway crossing, and residential service connections; design and management of a 72-hour aquifer pumping test including well and pump design, water storage and tanker transfer system design for disposing of water, and management of various field personnel and subcontractors during the test, plus interpretation of results to support contaminated groundwater and product recovery design; and the design of a lagoon closure cap including stormwater drainage and phytotechnology designs to manage the Site water budget.
- Professional Engineer-in-Charge and project manager for the design and installation of a public water main to eliminate the risk of private potable water well impact from a significant TCE release to overburden and bedrock groundwater in Limerick, Pennsylvania. The water main was approximately 2-miles in length and its design and construction included: private and public meetings with local residents and municipal representatives; negotiations and permitting for water utility and PennDOT approvals; eight residential service connections; a stream crossing; crossing a 36-inch water main that provides cooling tower water to a nearby nuclear power plant; complete restoration including hydroseeding and repaving of state and local roads. At project conclusion, the water main was successfully transferred to the local water utility.
- Preparation of a feasibility study (FS) addendum for the remediation of soil and groundwater at a Superfund Site in Maywood, New Jersey. The FS addendum was prepared because successful bioremediation and phytoremediation pilot studies were completed and a USEPA ROD amendment to include these technologies was desired. The FS addendum included a new remedial alternative involving a three-phased approach to remediate soil and groundwater contaminated with volatile organic compounds. The three-phased remedial approach included in-situ soil bio-augmentation using facultative anaerobes and nutrients to degrade source area contamination, enhanced natural degradation of groundwater contamination through ORC injection, and downgradient hydraulic control through phytoremediation that included the planting of approximately 380 hybrid poplar trees to supplement the 610 poplar trees planted as part of the pilot study. The remedial selection was also influenced by elemental phosphorus and radioactive contamination at the site. The FS addendum provided the client with a USEPA-approved remedial alternative at a minimum net present worth cost savings of approximately 1.7 million dollars.

- Lead design engineer for the design and layout of three area-specific separate-phase product recovery systems at a railyard in Kearny, New Jersey. Design included system design calculations and layout; coordination with railyard renovation engineers to ensure system compatibility with civil, structural, electrical and plumbing features; equipment selection; and preparation of bid specifications in CSI-Masterformat. The project also included construction management, system startup and system operation.
- Project manager and lead design engineer for the remedial evaluation and design of a High Vacuum Dual Phase Extraction (HVDPE) system for a specialty paint manufacturing facility in Jersey City, NJ. The remedial design was completed to address ethylbenzene, toluene and xylene (ETX) contamination in soil, groundwater and separate-phase product. The HVDPE system consisted of a series of extraction wells, interconnecting piping through existing subsurface conduits, a liquid ring pump, a moisture separator, miscellaneous liquid transfer pumps, an oil/water separator, iron filtration, liquid-phase carbon filters, a catalytic oxidizer for vapor-phase treatment and associated electrical, plumbing and control systems (including telemetry). Due to plant operations and the need to install the HVDPE equipment inside of a plant building, all HVDPE equipment, electrical and controls were rated for a Class 1, Division 1 location (explosion-proof and/or intrinsically safe). The HVDPE system was managed, operated and maintained under Mr. Patterson's supervision by Roux Associates, Inc. During HVDPE system operation, total xylenes concentrations in groundwater were reduced from as high as 68,000 parts per billion (ppb) to non-detect in the extraction well area.
- Designed, coordinated, and performed soil vapor extraction (SVE)/air sparge (AS) pilot testing, prepared a remedial action work plan (RAWP), and, based on New Jersey Department of Environmental Protection (NJDEP) approval of the RAWP, designed and constructed a full scale SVE/AS system to remediate BTEX-contaminated soil and groundwater at an active gasoline service station site as part of a voluntary underground storage tank (UST) remediation project. The SVE/AS system design and construction included the installation of (4) SVE and (4) AS wells, subsurface SVE/AS piping, a 10 horsepower (hp) regenerative SVE blower, a 2 hp rotary vane AS blower, a moisture separator, a 300 standard cubic feet per minute (SCFM) catalytic oxidizer, a telemetry system for remote monitoring, and all electrical, mechanical and control equipment necessary to provide a complete system. The construction of the system also required the design of an SVE/AS equipment room in an existing storage shed to accept some of the SVE/AS system components while still providing safe storage for the facility. During the first two months of system operation it was found that 11.27 pounds of BTEX mass was being removed from soil and groundwater through system operation each day. The system continued to operate for 3 years until de minimis BTEX concentrations and Monitored Natural Attenuation conditions were achieved.
- Preparation of a Remedial Action Selection Report (RASR)/Remedial Action Work Plan (RAWP) Addendum and soil vapor extraction (SVE) system design for a public transportation garage facility in Camden, New Jersey. Contamination at the site included VOCs (namely BTEX) in groundwater and chlorinated VOCs (mainly TCE) in both soil and groundwater. The RASR/RAWP Addendum proposed SVE for TCE-contaminated soil and monitored natural attenuation for all groundwater contamination based on pilot study work that was completed by Roux Associates, Inc. The NJDEP approved the RASR/RAWP Addendum, the SVE system was constructed and site closure was obtained within one year of system operation.
- Project management of the operation, maintenance, and regulatory compliance of a groundwater remediation system for a chemical manufacturer in Dayton, New Jersey. The system is operated under a NJPDES permit and consists of three (3) groundwater extraction wells, a 2000 gpm capacity carbon adsorption system, three (3) injection wells, two (2) 75 hp effluent injection centrifugal pumps, and a PLC system with telemetry for the removal of various pesticide contaminants from groundwater.
- Project management of the operation, maintenance, and regulatory compliance of a groundwater remediation system for a PVC manufacturer in Delaware City, Delaware. The system is operated as part of a CERCLA Superfund remedial effort and consists of five (5) operational groundwater extraction wells, a 450 gpm capacity packed tower air stripper system, two (2) 15 hp effluent centrifugal pumps that discharge to surface water via sewer lines, and a PLC system with telemetry for the removal of various chlorinated contaminants from groundwater.
- Lead Design Engineer and Project Manager for the design and construction of a new groundwater remediation system (GWRS) at a pharmaceutical manufacturing facility in Piscataway, New Jersey to replace an antiquated GWRS for the remediation of groundwater impacted with acetone, methyl iso-butyl ketone and di-isopropyl ether in excess of the NJ GWQC. The GWRS design included the use of a patented heated air stripping technology paired with iron pretreatment and catalytic oxidation off-gas treatment to treat the extracted groundwater for discharge to the Middlesex County Utilities Authority (MCUA) sanitary sewer. The project also included the design and implementation of two new bedrock groundwater extraction wells and the management of redevelopment activities for thirteen existing groundwater extraction wells. Roux Associates' scope of work included preparing an options analysis, Basis of Design (BOD) and full contract design drawings and contract specifications for the construction of the

new GWRS. Roux Associates also managed and evaluated contractor bids, provided construction management and oversight services, coordinated state and local treatment works permitting, negotiated the elimination of a Township of Piscataway sewer connection fee and prepared GWRS startup procedures. The GWRS continued to operate under Roux Associates supervision so that the site could be redeveloped as a data center facility, and GWRS shut down and case closure was achieved in 2017.

- Provided construction management and engineering design for a Fortune 500 industrial client in Lodi, NJ involving the drilling and installation of multiple groundwater extraction wells, submersible pumping units with well vaults, double wall containment piping and controls, retrofitting and piping of wells for a groundwater depression/soil vapor extraction (SVE) system, and construction of a remedial treatment plant and an ex-situ SVE stockpile pad to support excavation activities at the site.
- Provided construction management and engineering support at Helen Kramer Landfill in NJ which consisted of the drilling and installation of over 40 groundwater monitoring wells, over 90 vapor extraction wells, a potable water supply well and numerous slurry wall test borings. Also included, the sealing and abandonment of over 25 existing groundwater monitoring wells.
- Provided project management and engineering support at Gloucester Environmental Management Services (GEMS) Landfill in NJ which consisted of drilling and installation of 92 methane gas vent wells, abandonment of over 20 groundwater monitoring wells, modification of 15 groundwater monitoring wells to account for landfill cap, and the design and installation of 92 soil vapor extraction header systems including enclosures, valves and piping.
- Provided project management and engineering support for the New York City Department of Sanitation at Freshkill Landfill in Staten Island, New York. Project consisted of the drilling and installation of over 45 single, double, and triple-cased groundwater monitoring/extraction wells and aquifer pump testing for the design of a groundwater extraction and remediation system.
- Provided project management and engineering support for the Chester County Solid Waste Authority (PA) at the Honeybrook Landfill which consisted of the drilling and installation of leachate extraction wells, design and installation of submersible pumps, and the installation of leachate transfer piping. Also included under separate contract was the drilling and installation of 29 groundwater monitoring wells and soil vapor extraction wells including installation of SVE headers and piping.
- Project Engineer for the design and implementation of groundwater remediation project involving in-situ chemical oxidation (ISCO) for a specialty metal forming facility in Levittown, Pennsylvania. The

project involved introducing potassium permanganate solution into the saturated overburden and bedrock regions of the site to destroy dissolved and sorbed-phase TCE. The end result of the ISCO implementation included the reduction of TCE concentrations from greater than 40,000 ug/l to non-detect.

- Provided project management at Aberdeen Proving Grounds for the Michaelsville Landfill, Western Boundary, and Phillips Landfill Remedial Investigations consisting of the drilling and installation of over 150 single and double-cased groundwater monitoring wells including the use of UXO Clearance Drilling Procedures.
- Design and implementation of an enhanced bioremediation and phytoremediation pilot study program for a chemical manufacturer Superfund Site in Maywood, New Jersey. Tasks included calculation of contaminant mass in groundwater and soil, calculation of Oxygen Release Compound (ORC) mass required for effective groundwater bioremediation, design of optimum ORC slurry boring locations and injection depths, preparation of a site specific health and safety plan as well as a monitoring protocol involving volatile organics, metals, pyrophoric waste, and radioactive wastes, and project management support for the application of biomass and nutrients to contaminated soil. Tasks also included project management support with respect to the installation of trees and nutrients required as part of the phytoremediation pilot study.

Regulatory Compliance & Infrastructure Engineering

- Engineering design and project management for the removal of four (4) 20,000-gallon #6 oil underground storage tanks (USTs) and the construction of a new #2 fuel oil off-loading station and transfer system used in the operation of a process steam boiler at a paper manufacturing facility in Spotswood, New Jersey. The removal of the existing USTs involved sheeting, shoring, dewatering and protective barrier installation to allow UST and impacted soil removal as well as to protect the integrity of the adjacent boiler house, main electrical transformer area and fire water above ground storage tank (AST). Two (2) double-walled ASTs totaling 40,000-gallons of fuel storage (with automated fuel port, overfill protection and level sensors) were incorporated into the design to replace the antiquated #6 oil USTs. In addition to the ASTs, the design also included a tanker offloading station with spill containment, valves, concrete AST containment structure, mechanical systems (including three new fuel oil transfer pumps) to transfer #2 oil from the ASTs to the plant boiler system and all necessary electrical and control equipment. Roux Associates, Inc. also provided support to plant personnel for boiler set-up modifications and air permitting to switch boiler operations from #6 oil to #2 oil. The project included the preparation of a complete set of bid specifications (in CSI format) and plans as well as the procurement and evaluation of

contractor bids to construct the system and abandon the existing USTs. The entire project was completed in an expedited manner to avoid a plant shutdown due to natural gas curtailment issues.

- Audit team leader for five paper mill facilities in the US and Canada. Assessed facilities' compliance with federal, state and local environmental, health and safety regulations. For Canadian facilities, assisted in determining compliance with relevant Canadian environmental, health and safety regulations and directives. Audits included on-site post-audit review meetings and the preparation of comprehensive audit findings reports as well as follow-up of action items with the client to ensure compliance was achieved.
- Audit team leader for a major flooring manufacturing facility in Salem, New Jersey. Assessed facilities' compliance with federal, state and local environmental, health and safety regulations. Audits included on-site post-audit review meetings and the preparation of comprehensive audit findings reports as well as follow-up of action items with the client to ensure compliance was achieved.
- Audit team leader for an evaluation of environmental concerns that existed at truck maintenance facilities for a major national truck leasing company. The evaluation included an assessment of the environmental risks and impacts of current or potential liabilities and an evaluation of the actions that have been planned in the future to address these liabilities. The scope of work included: reviewing existing file information, conducting site visits and evaluating the appropriateness of the current environmental controls to prevent environmental liabilities. The project also involved the preparation of SPCC Plans where required.
- Site inspection, evaluation and preparation of an SPCC Plan for a large freight management facility in Harrisburg, PA. Tasks conducted include site inspections, interviewing of site personnel, review of facility files, and report preparation. The SPCC Plan was prepared in accordance with the Federal Oil Pollution Prevention Regulation, Title 40 Code of Federal Regulations (40 CFR 112).
- Modification and update certification of a DPCC Plan and air permits for a specialty chemical manufacturing facility in Maple Shade, NJ. Tasks conducted include site inspection, interviewing of site personnel, review of facility files, modification of site operations plan to incorporate new storage tanks, update and modification of site drainage and land use mapping, DPCC report preparation and air emissions permit modifications. The DPCC Plan was prepared in accordance with the Federal Oil Pollution Prevention Regulation, Title 40 Code of Federal Regulations (40 CFR 112) and New Jersey state discharge prevention regulations.
- Professional Engineer-in-Charge for various projects involving the preparation of SPCC plans, SWPP plans, air emissions permitting and reporting, and

Hazardous Chemical Inventory reports as required under the Emergency Planning and Community Right-To-Know Act (EPCRA)/Title III of the Superfund Amendments and Reauthorization Act (SARA) and each states' equivalent to the Hazardous Materials Emergency Response and Community Right-to-Know Act. Tasks conducted include site inspections, interviewing of site personnel, review of facility files, review of state stormwater and air emissions regulations, and report/permit preparation. As the Engineer-in-Charge responsibilities also included professional engineering certification of plans and permits as well as the identification and design of corrective measures to provide compliant site features and systems.

- Professional Engineer-in-Charge for major source (Title V) and non-major source air quality permitting and renewals for facilities located in GA, PA, NJ, NC, MD, NY, ID, TX and OH; selection, permitting and compliance testing of emission control equipment including RTO's, catalytic oxidizers, SCRs and zeolite absorbers; Title V permitting; emissions reporting; arbitration with agencies on behalf of numerous clients and industries.
- Permitting of boiler firing landfill gas at a state facility in NJ; strategize Title V modification to avoid triggering PSD with sulfur oxide emissions; interact with Compliance & Enforcement on behalf of client concerning repeat stack testing and COM system; work with designers in proposed blending of landfill gas with methane to reduce potential sulfur oxide and particulate emissions; assist in permitting strategy for related cogeneration system firing landfill gas.
- Forensic engineering to assist Fortune 100 NJ manufacturer in troubleshooting emissions from the operation of a natural gas-fired cogeneration reciprocating engine with selective catalytic reduction (SCR) and oxidation catalyst emission controls. Work included coordinating ambient air and stack testing; sampling and analysis of vanadium-based SCR catalyst and dust/ash collected from the associated ductwork; compliance plan changes and permit revisions; and negotiation with NJDEP on behalf of the client.
- Engineering evaluation of heating, ventilation and air conditioning (HVAC) and electrical equipment for pharmaceutical packaging operations in West Caldwell, New Jersey and Conshohocken, Pennsylvania. A pharmaceutical packaging company was evaluating the acceptance of new packaging operations involving the packaging of Thalidomide and Acetone/Methyl Alcohol at their facilities. A review of the existing HVAC and electrical equipment for the packaging rooms was completed with respect to applicable codes and standards (health based and construction-related) to determine the required extent of room modifications to accept the new packaging processes. A complete report citing specific codes, standards and design guidelines was prepared to recommend the modifications necessary to accommodate the proposed packaging processes. The

report evaluated ventilation and electrical components from a general and worker safety point of view and included preliminary design recommendations to meet safety requirements. The client is currently evaluating this report to decide if the new packaging processes will be lucrative and Roux Associates, Inc. is slated to complete the design of HVAC, electrical and waste handling modifications as deemed necessary to accommodate the potential packaging processes.

- Engineering evaluation of the heating, ventilation and air conditioning (HVAC) system for a pharmaceutical manufacturing facility in Basking Ridge, New Jersey with respect to condensate production. The HVAC evaluation consisted of completing a psychrometric analysis of all air handling units (AHU's) and dehumidification equipment for the purpose of obtaining approval for the discharge of condensate to the local publicly owned treatment works (POTW). The psychrometric analysis was completed using a combination of psychrometric software, published air quality data and engineering calculations after a detailed evaluation of the AHU's and dehumidifiers was completed. A report was generated for use at public meetings and for submission with a permit application to the local POTW.

- Project manager and engineering manager for the completion of a wastewater emissions study and preliminary emissions control design for an asphalt plant in Paulsboro, New Jersey. Roux Associates' scope of work consisted of emissions testing, preliminary bio-bed cover designs for two bio-beds, emissions control design, cost analysis for emissions control options evaluation and health and safety analysis of the bio-bed conditions and proposed emissions controls. Roux Associates supported the client with regard to upper level management cost justification and with regard to value engineering.
- Project manager and engineering manager for numerous boiler and co-generation facility air emissions testing and permitting projects for clients ranging from government facilities to manufacturing facilities to laboratories throughout the Northeastern United States.