

David Porter

From: Balmer, Nan
Sent: Monday, October 16, 2017 6:12 AM
To: David Porter
Subject: Fwd: Proposed Athletic Field at Oxbow Meadows
Attachments: ZBA Letter - Environmental Report.pdf; ATT00001.htm

Correspondence

Nan Balmer
(508) 237-1330

Begin forwarded message:

From: "Friends of Oxbow Meadows" <friendsofoxbowmeadows@gmail.com>
To: "Balmer, Nan" <nbalmer@wayland.ma.us>, "Anderson, Lea" <landerson@wayland.ma.us>, "Karlson, Cherry" <ckarlson@wayland.ma.us>, "Mantes@wayland.ma.com" <Mantes@wayland.ma.com>, "Jurist, Louis" <ljurist@wayland.ma.us>, "Levine, Doug" <dlevine@wayland.ma.us>, "Ellen_grieco@wayland.k12.ma.us" <Ellen_grieco@wayland.k12.ma.us>, "nate_buffum@wayland.k12.ma.us" <nate_buffum@wayland.k12.ma.us>, "jeanne_downs@wayland.k12.ma.us" <jeanne_downs@wayland.k12.ma.us>, "kim_reichelt@wayland.k12.ma.us" <kim_reichelt@wayland.k12.ma.us>, "kathie_steinbeeg@wayland.k12.ma.us" <kathie_steinbeeg@wayland.k12.ma.us>, "Wayland.boardpw@gmail.com" <Wayland.boardpw@gmail.com>, "Millette, Don" <dmillette@wayland.ma.us>, "Doucette, Joe" <jdoucette@wayland.ma.us>, "Junghanns, Julia" <JJunghanns@wayland.ma.us>, "Claypitpto@gmail.com" <Claypitpto@gmail.com>, "Happyhollowpto@gmail.com" <Happyhollowpto@gmail.com>, "Dariaegreeley@gmail.com" <Dariaegreeley@gmail.com>, "Waylandmiddleschoolpto@gmail.com" <Waylandmiddleschoolpto@gmail.com>, "Cpandes@yahoo.com" <Cpandes@yahoo.com>, "Apsses@verizon.net" <Apsses@verizon.net>, "Hansen, Linda" <lhansen@wayland.ma.us>, "Bbenson@wickedlocal.com" <Bbenson@wickedlocal.com>, "Higginst@lincolntown.org" <Higginst@lincolntown.org>, "Asafoster@gmail.com" <Asafoster@gmail.com>, "Frankkrasin@hotmail.com" <Frankkrasin@hotmail.com>, "Heidiseaborg@gmail.com" <Heidiseaborg@gmail.com>, "Aquaticlss@aol.com" <Aquaticlss@aol.com>, "Ggschuler@verizon.net" <Ggschuler@verizon.net>, "Sarkisian, Sarkis" <ssarkisian@wayland.ma.us>
Cc: "charlie.dambrosio@gmail.com" <charlie.dambrosio@gmail.com>
Subject: Proposed Athletic Field at Oxbow Meadows

Dear Town Officials,

It has come to our attention that a conference call has been scheduled for Monday, October 16, 2017 to discuss the risks of proceeding with field construction at Oxbow Meadows. We are surprised that town officials would even consider such action for two reasons. First, there is a pending civil action in the Land Court of Massachusetts. Second, the Zoning Board of Appeals has been provided the attached letter from a significantly-qualified expert recommending that

additional testing be performed at the site of the proposed Oxbow Meadow soccer field adjacent to the former Nike site. It is public record that Hercules nuclear missiles were stored there. Therefore, further testing is required to determine whether the emergent toxic contaminants PFOA and PFOS from the polyfluorinated carbon (PFC) compound class exist in the nearby wells and groundwater. Such testing has not been done because previous studies were undertaken prior to recent scientific and public awareness of the seriousness of the threat.

Issues from PFOA and PFOS have been now identified throughout the country at and near military sites resulting in millions of dollars in remediation costs and lawsuits – and cancer. Here in Massachusetts the town of Westfield is spending \$5 million dollars to make its drinking water safe after significant problems were discovered traceable to a National Guard facility. Last year the town of Barnstable filed a multi-million dollar lawsuit in Massachusetts federal court against 3M for polluting the Hyannis water system through use of the same fire-fighting foam used by the National Guard at Westfield. Such foam was highly likely to have been available and practiced with at the Nike Site in Wayland and Lincoln simply to contain horrific risks if a fire occurred. Simple research by anyone will reveal many more such serious cases from New Hampshire to Colorado, Pennsylvania and New York to Idaho. Additional states, including Maine, Maryland and Minnesota have adopted new guidance in light of this current knowledge. The military itself, which no longer owns this Nike site, is in the process of testing (initially) over 400 sites – an undertaking that will take years with the United States Air Force in the lead and the Army in the planning stages.

It is incumbent upon responsible town leadership to follow this recommendation BEFORE beginning work on the proposed field and potentially wasting substantial taxpayer monies in construction of a field that will have to be removed if remediation is required.

At the April 2017 Town Meeting the lead town representative told participants before their vote that nuclear missiles had never been installed at the Nike facility for use in case of war - please see attached video link. His statement on a key issue was untrue. See the 1986 Law Report at pages 10, 33 and 45. Then, with the vote in hand, the Recreation Commission hurried to conduct a radiation test, which demonstrated both its own hidden fears and its lack of the necessary scientific knowledge of the true risks the site presents – known now **and even more critically, unknown for the future as new contaminants emerge** – regardless of any findings concerning this single new class.

For this reason and many others, nearly **300 residents of Wayland and Lincoln have signed petitions** opposing the construction of a soccer field at the Nike site.

We respectfully suggest that true leadership means far-sighted thinking – for the safety of all.

Friends of Oxbow Meadows

<https://drive.google.com/file/d/0B3bH14jn-Tr8aE9nZml4SjBSNWM/view>



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September 27, 2017

VIA CERTIFIED AND FIRST-CLASS MAIL
Certified Mail Article No. 7017 0660 0001 1356 7983, Return Receipt Requested

Town of Wayland Zoning Board of Appeals
41 Cochituate Road
Wayland, Massachusetts 01778

Re: Supplement to Appeal of Planning Board Decision No. 02-2017 (the "Appeal"):
Oxbow Meadows Parking Lot and Athletic Field (the "Site")

Dear Chairman Sachs and Members of the Board:

This law firm represents several residents of the Towns of Wayland and Lincoln in the above-referenced Appeal. Enclosed in support of the Appeal please find the report of Underground Energy, LLC detailing the serious potential environmental hazards at the Site (the "Report").

The Report concludes that harmful contaminants such as "perfluorinated compounds (PFCs), including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS)" may be present at the Site. Indeed, the Report states that the technology to detect such contaminants did not exist in 2004, when the most recent testing of the site was conducted, and it strongly recommends that a sampling and testing program be implemented prior to field construction to insure that there is no groundwater contamination and human exposure to these substances.

As you know, our clients' Appeal asserts that the Planning Board failed to account for environmental criteria mandated by the Town Bylaws and ignored requests for environmental studies which, as detailed by the Report, are urgently needed before the Site is converted to a youth soccer field.

Thank you for your consideration.

Very truly yours,

A handwritten signature in black ink that reads 'T. N. Schofield'.

Timothy N. Schofield

Cc: Carolyn M. Murray, Esq. (via email)

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26 September 2017

Timothy N. Schofield, Esq.
Schofield Law Group, LLC
29 Commonwealth Avenue, Suite 700
Boston, Massachusetts 02116

**Re: Opinion Letter
Former Nike Missile Site
133 Oxbow Road, Wayland, Massachusetts**

Dear Mr. Schofield:

At your request, I have conducted a data review and prepared this opinion letter regarding potential residual contamination at the former Nike Missile site at 133 Oxbow Road in Wayland, Massachusetts.

Qualifications

My qualifications for this work include over 30 years of professional experience as a hydrogeologist in the environmental consulting field. As a Massachusetts Licensed Site Professional (LSP) from 1993 to 2016, I was the LSP-of-Record at over 60 disposal sites in Massachusetts. My curriculum vitae is attached.

Background

The former Nike site in Wayland was one of more than 200 air-defense facilities constructed near major metropolitan areas and military installations and operated from about the early 1950s until the mid 1970s. The Wayland Nike site was constructed in 1955 on previously undeveloped land near the Sudbury River, and comprised about 14 acres. The US Army operated the Wayland Nike site until 1964, when the Massachusetts Army National Guard assumed operations until 1974, after which it was used by the National Guard as a storage facility and also reportedly as maintenance shop where vehicles were serviced. Like most US Nike sites, the Wayland Nike site stored both nuclear and conventional warheads.

In September 1995 the Massachusetts National Guard conducted an Environmental Site Investigation that identified two areas of surficial soil contamination. A Release Notification Form was submitted to Massachusetts Department of Environmental Protection (DEP) on November 1, 1996, and two Release Tracking Numbers (RTNs) were assigned: RTN 3-14462 for the North Outfall - Missile Magazine Area and RTN 3-14463 for Assembly Test Building L-5. The National Guard performed Response Actions at the site

pursuant to 310 CMR 40.0000, the Massachusetts Contingency Plan (MCP). The response actions included a Release Abatement Measure (RAM) under which 59 tons of soil contaminated with Extractable Petroleum Hydrocarbons (EPH) and Polynuclear Aromatic Hydrocarbons (PAHs) were excavated and disposed off-site under a Bill of Lading. A Class A-2 RAO was submitted to DEP on September 30, 1997 after soil samples from the walls and floors of the final excavation were found to have PAH and EPH concentrations below the MCP S-1 soil cleanup standard. The applicable MCP groundwater category at the site, GW-1, has the most stringent MCP cleanup standards, because the site is underlain by an aquifer and within a mapped Zone II Aquifer Protection District for a Public Water Supply. Three public water supply wells nearest the site are about 2,000 feet to the north in Lincoln, 2,500 feet to the south in Wayland, and 7,000 feet to the northeast in Wayland.

The Town of Wayland's Nike Site Advisory Committee commissioned environmental studies of the site in 2003-2004 to assist the Town in evaluating potential environmental liabilities associated with site, which was being considered at the time by the Town for acquisition and reuse. The Bois Consulting Company, Inc. report (March 2004) concluded that "*there are no significant environmental issues currently present at the Former Nike Missile Site.*" However, Recognized Environmental Conditions (RECs), as defined by ASTM E 1527-00 for environmental site assessment work, were identified including asbestos- and lead-containing materials, potential for contaminated soil from past land uses, potential for metals in groundwater, lead- contaminated standing water in missile silo bunkers, metals in catch basins, and potential for oil to be present in hydraulic lifts in the missile silo bunkers. Demolition of the Nike-related structures was performed in 2008, removing the silo caps and filling in the silos, followed by grading and seeding. On July 1, 2009 the Wayland Department of Public Works assumed jurisdiction for Oxbow Meadows park, a passive recreation area that comprises about 10.7 acres of the former 13.65-acre Nike missile site. The remaining portions of the Nike missile site were developed into 16 units of affordable housing at 89 Oxbow.

Data Reviewed

The following documents were reviewed:

- Law Engineering Testing Company, March 1996, *Final Report – Investigation of Former NIKE Missile Sites for Potential Toxic and Hazardous Waste Contamination* (this report was not site-specific, but provided an overview of environmental issues at former NIKE sites.)
- Bois Consulting Company, Inc. and Lightship Engineering, LLC, March 19, 2004, *Final Limited Environmental Site Assessment Report, NIKE Site #73, 133 Oxbow Road, Wayland, Massachusetts* (this report did not include graphics or appendices)

- New England Environmental Technologies Corporation, September 30, 1997, *Response Action Outcome Statement, Massachusetts Army National Guard Facility, Oxbow Road, Wayland, MA, RTN #3-14462 & RTN #3-14463* (report downloaded from Massachusetts DEP BWSC searchable site list).
- Tetra Tech, July 11, 2017 correspondence to Wayland Town Planner regarding Oxbow Meadows Recreation Fields Site Plan Review.
- Massachusetts DEP, January 2017, Draft Fact Sheet - Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan.
- Massachusetts GIS OLIVER online mapping Tool at http://maps.massgis.state.ma.us/map_ol/oliver.php.
- Massachusetts DEP, Office of Research and Standards, May 26, 2016. Addressing Emerging Contaminants in Massachusetts.
- Online data including MA DEP BWSC files, Google Earth satellite imagery (1995-2017), and information regarding contaminants of potential concern.
- Photographs of site demolition activities and email correspondence.

Opinion and Recommendations

Underground Energy understands that the Town of Wayland plans to convert a portion of the former Nike Site from passive to active recreational land use with the proposed development of an athletic field and parking lot. This activity may involve site excavation, filling and grading that could potentially disturb residual soil contaminants associated with the US Department of Defense's (DoD's) former use of the property as a Nike Missile battery. A Site Plan review performed for the Town of Wayland by Tetra Tech in July 2017 included the statement that "*given the history, scope and quality of investigation and the level of inspection and documentation required during the demolition phase, we do not expect there to be any outstanding environmental risks at the site.*"

It is the opinion of Underground Energy that the environmental studies that preceded the Town's acquisition of the site were performed in accordance with the industry-standard practices of the day. However, because those standard practices have evolved *significantly* since the last environmental studies were performed in 2004, environmental due diligence and the non-degradation clause of the MCP dictate that it is prudent to assess groundwater

and soil at the site for the presence of potential Contaminants of Concern that were not considered in historic investigations.

In particular, environmental cleanup standards are being developed for perfluorinated compounds (PFCs), including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). These compounds, which were in wide-spread industrial and military use during the period of missile operations at the site, are highly stable in the environment and mobile in groundwater. In 2016 the EPA released an extremely low health advisory level of 70 parts per trillion in groundwater for PFCs. Massachusetts DEP defines PFCs as an Emerging Contaminant, and an Emerging Contaminant work group is developing new Reportable Concentrations and Method 1 Cleanup Standards for PFCs. PFCs and their potential health risks were effectively unknown to the regulated community and to the regulators in 2004 when the most recent environmental studies were performed at the site.

PFCs were used in firefighting foams for flammable liquids, and DEP's draft MCP guidance document for PFCs recommends sampling for PFCs at *"former or current DoD sites where the historic use of PFAS in firefighting foams may have resulted in soil and groundwater contamination."* While there is no documentation of PFC use at the former Nike missile site, it is Underground Energy's opinion that firefighting foam was likely stored and used while it was an active missile battery, given the extremely flammable fuels and oxidizers that were routinely handled there, and the high risk of a fire.

An example of environmental impacts and infrastructure upgrade costs that can be associated with PFC contamination can be found in Westfield, Massachusetts where municipal officials are considering a new \$5 million water treatment facility. Public and private drinking water wells were closed due to PFCs contamination, allegedly from firefighting foam used at Barnes Regional Airport and the Air National Guard's 104th Fighter Wing from the 1950s to the 1980s.

Underground Energy strongly recommends that, prior to any redevelopment or earthwork at the former Nike site, a sampling program be developed and implemented to evaluate the potential presence of PFCs or other Emerging Contaminants that were not normally evaluated during the timeframe when previous samples were collected and analyzed. This investigation should begin with an assessment of the location and condition of any wells at the site and in the area, followed by sampling and analysis of groundwater from all on-site monitoring wells and any nearby municipal wells. Analyses should include all constituents for which DEP has promulgated drinking water standards and for the following Emerging Contaminants:

- PFCs including PFOA and PFOS, in accordance with evolving DEP guidance

- Hexavalent chromium. The EPA drinking water standard for total chromium of 100 ug/l is outdated. California has promulgated a standard of 50 ug/l for total chromium and 10 µg/l for hexavalent chromium
- Nitrosamines
- Perchlorates
- 1,4-dioxane

If groundwater contamination is detected, then soil investigation should be performed to identify the source areas and determine most appropriate remediation process to protect groundwater and also control human and environmental exposure via soil contact and incidental ingestion.

Thank you for the opportunity to perform this review and prepare this opinion. Please contact me if you have any questions.

Sincerely,



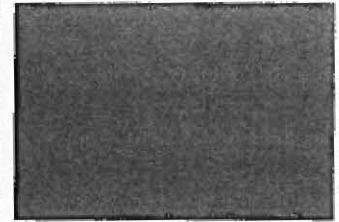
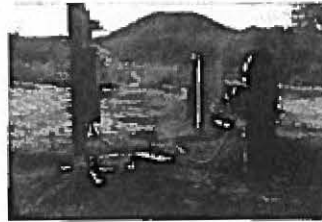
Mark A. Worthington
Principal Hydrogeologist

Attachment: Mark Worthington CV

cc: Thomas M. Hoopes, Esq.

Mark A. Worthington

Principal Hydrogeologist



Mr. Worthington is the founder of Underground Energy, LLC and a Principal Hydrogeologist with 30 years of diverse consulting and management experience. Areas of expertise include evaluation and design of Earth-coupled (geothermal) systems for heating and cooling buildings, underground thermal energy storage, aquifer hydraulic testing and analysis, FEFLOW modeling subsurface flow and heat transport, and subsurface investigations using geophysical, geotechnical, geochemical and hydraulic monitoring methodologies. Since 2008, he has focused on bringing sustainability and value to geothermal heating and cooling projects by using underground thermal energy storage techniques to optimize the design and performance of the Earth couple. As a Massachusetts Licensed Site Professional (LSP), Mr. Worthington was responsible for technical quality, regulatory compliance, risk-based corrective action, and regulatory site closure at over 80 oil and hazardous material disposal sites in Massachusetts.

Areas of Expertise

- Underground Thermal Energy Storage
- Earth-coupled heating and cooling systems
- Hydrogeologic and geophysical investigations
- Aquifer hydraulic testing and numerical modeling
- Geothermal heat exchanger design
- Assessment of oil and hazardous material releases
- Soil, groundwater and sediment remediation
- Geotechnical and seismic hazard investigations
- Environmental permitting, brownfield redevelopment
- Landfill gas control and vapor intrusion evaluation
- Environmental due diligence

Education

- B.S., Geology/Physics, Stephen F. Austin State University, 1983
- M.S., Hydrology and Water Resources, University of Arizona, 1987
- Adjunct Earth Science Faculty, Massachusetts Maritime Academy, 2009

Selected Publications

"Aquifer Thermal Energy Storage Feasibility at the Ford Site, St. Paul, MN," 2015, International District Energy Association 107th Annual Conference and Trade Show, St. Paul, MN, June 2016.

"In-Depth Feasibility Studies of Aquifer Thermal Energy Storage (ATES) at VAMC Medical Centers in Columbus and Chillicothe, OH," 2015, International District Energy Association 106th Annual Conference and Trade Show, Boston, MA, June 2015.

"Exploring Synergies between In-Situ Thermal Remediation and Geothermal Energy Storage," 2012, co-author with Dr. Ralph Baker of Terra Therm, Inc., 27th Annual International Conference of Soils, Sediments, Water and Energy, Amherst, MA, October 2011.

"Aquifer Thermal Energy Storage: An Enabling Green Technology for Campus District Energy Systems," 2011, Presented to the International District Energy Association 24th Annual Campus Energy Conference, Miami, FL, February 2011.

"Dating gasoline releases using ground-water geochemical analyses: case studies," Proceedings of the 1993 Petroleum Hydrocarbons Conference, Houston, Texas, 1993.

"Thermal anomalies and the ground-water flow system south of The Narrows, Upper San Pedro Valley, Arizona", 1987, Master's thesis, Department of Hydrology and Water Resources, University of Arizona.

Registrations & Professional Affiliations

- Certified Geologist - Maine (1991-2016)
- Licensed Site Professional - MA (1993-2016)
- Certified Installer - International Ground-Source Heat Pump Association (2009)
- LEED Accredited Professional (2009)
- New England Geothermal Professional Association (Charter Member, Board Member)
- International District Energy Association (IDEA)
- MIT Enterprise Forum

Underground Thermal Energy Storage Projects

Project Manager and Principal Hydrogeologist for Aquifer Thermal Energy Storage (ATES) feasibility study for the City of St. Paul, MN regarding sustainable redevelopment of the 135-acre Ford site. Developed hydrogeologic conceptual model, sized well system and developed a cost estimate to support conceptual engineering design of a 15MW district energy system at the former Ford Twin Cities Assembly Plant.

Project Manager and Principal Hydrogeologist for evaluation and maintenance of the ATES system at Stockton University in Galloway, NJ. Performed field hydrogeologic and geochemical testing of the 6 ATES wells and coordinated with subcontractor IF Technology, BV in preparation of reports and work plans. Project in progress.

Project Manager and Principal Hydrogeologist for in-depth feasibility studies of ATES for Veterans Administration Medical Centers in Chillicothe and Columbus, Ohio. Used GIS tools to screen VAMC facilities in Ohio for aquifer availability, developed hydrogeologic investigation work plan, evaluated hydrogeologic properties at each site, identified regulatory requirements and financing options, and led an exceptionally qualified team of energy engineers in the preparation of detailed ATES feasibility study reports. ATES conceptual designs were developed including cooling-only with district energy system distribution of chilled water, and heating with cooling using a natural-gas-driven heat pump. The VA is currently evaluating ATES design for the Chillicothe site.

Project Manager and Principal Hydrogeologist for Borehole Thermal Energy Storage (BTES) feasibility study at a remote diamond mine in the Canadian Northwest Territories. The conceptual design diverted waste heat from diesel gensets in summer to charge a large BTES wellfield, which is discharged each winter to preheat ventilation air. This design displaces 20 million litres of diesel fuel annually, with a CAPEX of \$15M CAD for the system and a 7 year simple payback.

Principal Hydrogeologist for regional ATES feasibility screening for the City of Baltimore. Reviewed and modified Maryland Geological Survey GIS maps to prepare

a series of maps depicting Patuxent Aquifer properties in Baltimore, including estimation of ATES well yields.

Principal Hydrogeologist for prefeasibility study of ATES and BTES to expand thermal capacity of Deep Lake Water Cooling system in Toronto.

Principal Hydrogeologist for a feasibility study of ATES for a confidential client in Massachusetts. Evaluated engineering, hydrogeologic, regulatory, and economic feasibility. Developed conceptual design from which a financial analysis was performed.

Principal Hydrogeologist for a feasibility study of Borehole Thermal Energy Storage and redevelopment of a district energy system in Attleboro, Massachusetts. Designed borehole array to accept low-grade heat from a CHP plant and to provide space heating to buildings on the campus.

Earth-Coupled Cooling and Heating Projects

Principal Hydrogeologist for feasibility study and design of a hybrid geothermal/biomass district heating and cooling system for a performing arts facilities in western Massachusetts under Mass Clean Energy Center grant.

Calculated building loads and designed vertical and horizontal ground heat exchangers and associated piping and heat pump systems for various new-construction and retrofit residential geothermal projects in Massachusetts. Worked with an experienced installer on system installations.

Performed forensic geothermal evaluation of poor-performing standing-column well system in Marlborough, MA. Recommendations fixed system.

Evaluated operating performance of standing column well geothermal system at Boston Nature Center at request of Mass Audubon Society Director.

Hydrogeologic Engineering Projects

Expert Hydrogeologist for the successful defense of a remediation construction firm against class-action litigation regarding levee failures in New Orleans during Hurricane Katrina, with potential damages in excess of \$100 billion at stake. In concert with geotechnical experts,

designed and implemented field permeability testing programs involving multiple slug and pumping tests, performed data analysis, and worked with multiple parties to develop standard operating procedures and to coordinate an intensive field program subject to a court-ordered deadline. Assisted geotechnical experts and attorneys with deposition preparation and analysis, and with preparation of expert testimony. Designed, fabricated, tested and demonstrated analog flow simulators as a demonstrative exhibit to that was used to assist the judge in understanding the difference between transient and steady groundwater flow.

Principal Hydrogeologist responsible for hydrogeologic analysis and FEFLOW modeling of groundwater infiltration to tunnels, ore heaps and open-pit mines in South America.

Principal Hydrogeologist responsible for peer review of multi-aquifer pumping test analyses at Eagle Mountain Lake in Tarrant County, Texas. Used AQTESOLV software to model boundary conditions, calculate aquifer properties for seepage analysis and performed sensitivity analyses relating calculated values of hydraulic conductivity to assumed values of aquifer thickness.

Principal Hydrogeologist for analysis of unsaturated flow associated with extraction of copper from crushed ore at a copper mine in Chile. Used HYDRUS-1D model to simulate unsaturated flow through ore heap and provided recommendations for improved operations. Used FEFLOW model to simulate transient 2-D infiltration through ore heap and steady state pore pressure distributions.

Project Hydrogeologist for a wastewater discharge siting study at Otis Air Base on Cape Cod. Hydrogeologic analysis included water table contouring, slug testing, flow net analysis, design, performance and data analysis of a five-day pumping test, an assessment of aquifer tidal response and salt water intrusion.

Senior Hydrogeologist for a dewatering project in Beirut, Lebanon for a deep foundation set in a highly transmissive karst limestone formation. Evaluated construction contractor tenders for dewatering to review applicability of cutoff methods including diaphragm walls, ground freezing and permeation grouting.

Conducted hydrogeologic investigation of a proposed 70,000 gpd subsurface wastewater discharge facility in Lanesborough, Massachusetts. Participation in this project included field collection of seismic refraction data, assessment of hydrogeologic impacts of the discharge facility and writing the EIR draft.

Conducted hydrogeologic investigations for a proposed Superconducting Super Collider (SSC) site in Mississippi. Investigated water-supply and dewatering/tunneling aspects of the state's SSC proposal.

Aquifer Testing and Hydrogeologic Analysis

Designed hydrogeologic, geochemical and geothermal subsurface investigation programs for two VA hospitals in Ohio being considered for Aquifer Thermal Energy Storage (ATES). Work included installation and testing of 17 observation wells, four pumping wells, and four pumping tests. Analyzed all field data and prepared updated feasibility study reports.

Designed and performed 5-day pumping test at Otis Air National Guard Base in Bourne, Massachusetts. Prepared specifications regarding monitoring well and pumping well design, instrumented wells with pressure transducers, sited water discharge location, performed step-drawdown tests, and 5-day pumping test (300 gpm discharge rate), post-test recovery monitoring and data analysis in support of a Class III groundwater discharge permit application.

Performed 8-hour pumping test of 1,500-gpm irrigation well in Benson, Arizona. With minimal resources as a grad student, used kinematics to calculate discharge rate and collected groundwater elevation data using Stevens analog chart recorder. Calculated aquifer hydraulic properties using analytical techniques.

Performed 24-hour pumping test of artesian wells in Benson, Arizona. Designed and constructed mercury U-tube manometer to record artesian pressure head data, and calculated aquifer hydraulic properties using analytical techniques.

Performed step-drawdown tests and 24-hour pumping tests of LNAPL-contaminated aquifers in Mattapoisett and Acton, Massachusetts for a major oil company. Analyzed

data and prepared capture zone analyses for use in groundwater recovery remedial systems.

Performed step-drawdown test and 8-hour pumping tests of residential wells in fractured rock in Westbrook and Tenants Harbor, Maine. Calculated aquifer hydraulic properties using analytical techniques.

Performed slug tests at multiple LNAPL-contaminated sites in Massachusetts, Connecticut and Maine.

Provided peer review services and reviewed slug test and pumping tests at various locations in New England, Texas and South America.

Performed slug tests and evaluated injection tests at a former oil terminal and then-proposed LNG import terminal in Fall River, Massachusetts. Instrumented monitoring wells to record tidally affected groundwater elevations, used analytical techniques to evaluate aquifer tidal response.

Performed flow net analyses of hydrogeologic systems at multiple sites in New England and the Americas to evaluate contaminant transport, remedial strategies, and spatial variability of aquifer hydraulic properties.

Taught short courses and gave presentations on aquifer testing techniques to law firms, major oil company clients, and university students.

Used available boring logs and an understanding of continental glacial depositional processes to prepare hydrogeologic cross sections and conceptual site models at numerous sites in New England.

Performed dye tracing studies to evaluate subsurface conditions at sites in Massachusetts, Maine and Pennsylvania.

Ground-Water Supply Investigations Projects

Principal Hydrogeologist for hydrogeologic studies in support water supply development for two LNG export terminal projects in coastal Louisiana. Performed desktop studies and designed/implemented subsurface testing for production well design and to assess saltwater intrusion.

Project Manager for multi-disciplinary studies to locate high yield water-bearing bedrock fractures in Weston, Massachusetts. Coordinated borehole, crosshole, and surface geophysical methods to trace a fracture system towards Town-owned land.

Expert Hydrogeologist representing the Blackstone River Consortium appeal of a Water Management Act permit issued to Town of Shrewsbury by Massachusetts DEP. Evaluated hydraulic effects of municipal pumping effect on tributary stream and upstream impoundment.

Expert Hydrogeologist for defense in litigation regarding alleged adverse hydraulic impact to private water supply well in Plympton, Massachusetts.

Program Hydrogeologist for the investigation of a potential municipal water supply aquifer in Weston, Massachusetts. Designed and conducted exploration program and pump tests and analyzed data by analytical and computer modeling techniques.

Project Manager of a comprehensive study of the safe yield of all aquifers in the Town of Marshfield, Massachusetts. Developed and quantified water budget equations for drainage basins in the town. Developed five computer models to simulate safe yield aquifer conditions and characterized the potential for salt water intrusion in coastal aquifers using calibrated flow models.

Conducted a ground-water adequacy investigation near Benson, Arizona. Included aquifer tests, two of which were for an artesian aquifer, requiring the design and construction of special hydraulic testing equipment. Other work included mapping piezometric configurations over a 300 mi² area. A computer model was developed, calibrated, and used to simulate future exploitation of ground-water resources.