

Tetra Tech in the News

1998 was a great year for Tetra Tech. *Engineering News-Record* ranked Tetra Tech among the top environmental firms on the following lists:

- Top 10 in Site Assessment and Compliance: No. 1
- Top 25 in Telecommunications: No. 3
- Top 10 in Nuclear Waste: No. 4
- Top 25 in Hazardous Waste: No. 5

Tetra Tech was also recognized by *Forbes Magazine* as one of the 200 Best Small Companies for 1998 and by *Investor's Business Daily* under their "Companies in the News" as **Number One** on the Industry Group Focus: Pollution Control-Service list.

For more information on these rankings see the following:

ENR, The Top 500 Design Firms Sourcebook, Sept. 1998; *Forbes Magazine*, Nov. 2, 1998; *Investor's Business Daily*, Oct. 20, 1998, p. B20.

WOBURN TOXIC TRIAL—12 YEARS LATER

In January 1999 a movie version of the book *A Civil Action* is being released in theaters nationwide. The book recounts events surrounding what is referred to as the "Woburn Toxic Trial." GeoTrans (now HSI GeoTrans) staff provided technical analyses and expert witness testimony on behalf of W.R. Grace & Co. - Conn. (Grace), one of the defendants in that trial. A previous GeoTrans newsletter (July 1987) described hydrogeologic issues that were relevant to Grace. An independent summary of environmental and legal aspects of the trial can be found at the following website: http://www2.shore.net/~dkennedy/woburn_trial.html. The summary was written by Dan Kennedy, a reporter who covered the trial for the *Woburn Daily Times Chronicle*. For those interested in the Grace perspective on the trial and its aftermath, see: civil-action.com.

Woburn public water supply wells G and H were located in the northeastern portion of the city (Figure 1). The wells are located on the edge of a wetland and pump from an unconfined sand and gravel valley fill aquifer in the center of the Aberjona River valley. The trial resulted from a May 1982 lawsuit filed on behalf of eight Woburn families. The lawsuit alleged that family members had suffered serious health effects, including leukemia, as a result of exposure to contaminated water from public supply wells G and H. The May 1982 lawsuit and a subsequent lawsuit alleged that the Grace property, a small manufacturing plant located about one-half mile from the wells, was one of three sources of contamination to the wells. The other two named sources were Beatrice Foods, which owned the John J. Riley tannery, and the UniFirst Corporation, an industrial dry cleaner (Figure 1).

It has been more than 12 years since the trial ended, and there have been numerous additional investigations and evaluations in the area of the two former public supply wells that were a central issue of the trial. This article provides a current summary of the technical issues that were relevant for Grace during the trial, based on data and information contained in publicly available reports prepared since the trial ended. Several relevant reports, which are part of the Administrative Record for the wells G and H superfund site, are listed at the end of this summary and are available for public review.

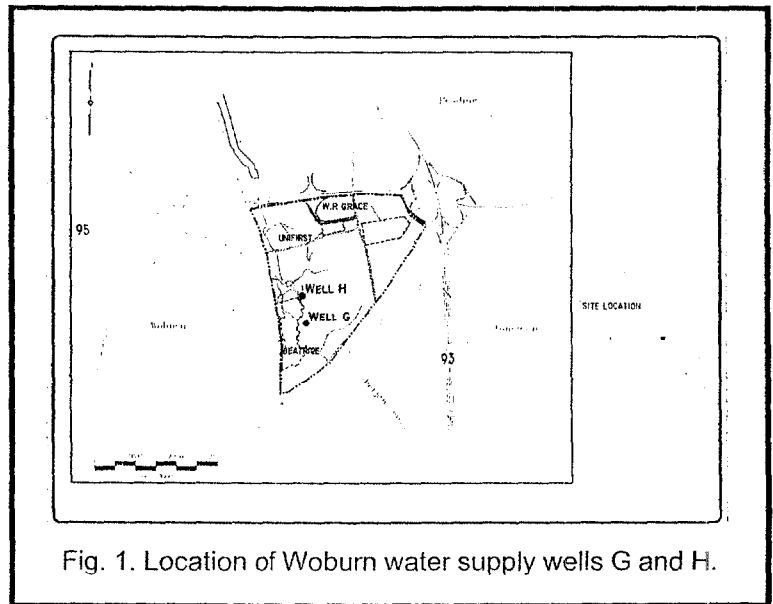


Fig. 1. Location of Woburn water supply wells G and H.

Case Background

The City of Woburn, Massachusetts is located approximately 10 miles north of Boston;

Five chemicals were named as contaminants in the lawsuits: trichloroethylene, 1,1,1 trichloroethane, tetrachloroethylene, 1,2 trans-dichloroethylene, and chloroform. Prior to the trial, the plaintiffs and the UniFirst Corporation reached a settlement; therefore, two defendants remained for the trial. Due to the complexity of the

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case, the trial was divided into four phases. The first phase would determine whether either of the two remaining defendants was responsible for the chemicals found in the public supply wells, the second phase would determine whether any of the chemicals could have caused leukemia, the third phase would address other health claims, and the fourth phase would decide punitive damages. The remaining two defendants were located in opposite directions from the wellfield and in different hydrogeologic settings; therefore, the technical issues were not identical for the two defendants. With respect to Grace the major hydrogeologic issues were:

- *Time of travel* - whether chemicals could have traveled from the Grace property and reached wells G and H by May 1979, the date the Massachusetts DEQE (now DEP) ordered the City of Woburn to cease pumping from wells G and H;
- *Zone of contribution to wells G and H* - identifying the geographic area that contributed water to the wells, and the hydraulic connection between the Aberjona River and the aquifer that supplied water to the wells; and
- *Other potential sources of contamination* - the presence of other VOC source areas and the presence of contaminants other than VOCs within the zone of contribution to wells G and H.

The Trial

Trial testimony lasted four months, and in July 1986 the jury began its deliberations. Differences between the testimony of the two expert hydrogeologists testifying on behalf of the plaintiffs and Grace could not have been more extreme. The plaintiffs' expert had testified, on the basis of a one-dimensional analytical transport model that assumed a uniform hydraulic conductivity between the Grace property and the wells, that VOCs from the Grace property reached the wellfield at concentrations ranging from tens to hundreds of parts per billion in less than three years, and that VOCs from the Grace property were present at the wellfield before the first day of pumping in 1964. The plaintiffs' expert also testified that the Beatrice and Grace properties were the only possible sources of VOC contamination to the wells, that an insubstantial amount of water

pumped by the wells was derived from induced infiltration of Aberjona River surface water, and that infiltrating surface water, if any, would take 10 to 20 years to reach the wells that were located adjacent to the Aberjona River. The opinion of the GeoTrans hydrogeologist testifying on behalf of Grace was that chemicals from the Grace property did not reach the wellfield by May 1979. He also offered the opinions that about half of the water pumped from the wells was derived from induced infiltration of surface water from the Aberjona River; that surface water from the Aberjona River would reach the wells within one to two months; that the zone of contribution to the wells included the upstream portions of the Aberjona River watershed; and that there were several other potential sources of VOC contamination, as well as other contaminants, to the wells.

The Judge's Ruling

After eight days of deliberation the jury reached a verdict. With respect to Beatrice Foods, the jury found that the plaintiffs had failed to establish that any chemicals from the Beatrice property had reached the wells prior to their closure in May 1979. With respect to Grace, the judge had already stricken, or indicated his intention to strike, from the case against Grace the chemicals 1,1,1 trichloroethane, chloroform, and tetrachloroethylene. Of the two remaining chemicals, trichloroethylene and 1,2 trans-dichloroethylene, the jury found that the plaintiffs had failed to establish that Grace was responsible for contaminating the wells with 1,2, trans-dichloroethylene prior to well closure. The jury verdict concerning trichloroethylene was unclear and contradictory. As a result of this ambiguity, Judge Skinner, on September 17, 1986, ordered a new trial. On September 22, 1986, the plaintiff families and Grace announced that a settlement had been reached.

Technical Issues Update

Time of travel

The former Grace plant, a machine shop that produced stainless steel machinery, began operation in June 1960. The plant was built on land that had previously been used for a dairy. The maximum time between the opening of the Grace plant and the closure of the public supply

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wells in May 1979 was 19 years. One of the technical evaluations made to determine whether the chemicals could have reached the wells within 19 years was the construction and use of three-dimensional numerical groundwater flow and chemical transport models. The groundwater flow model was calibrated under steady-state flow conditions using water level data from 119 observation wells. Groundwater level and streamflow change measurements collected during a 30-day pumping test of wells G and H were used to identify the zones of influence and capture of the two wells and to calibrate the groundwater flow model under transient flow conditions. To be conservative in the chemical transport analyses, it was assumed that chemicals entered the groundwater beneath the Grace plant at a constant rate from the first day the plant opened in June 1960. This simplifying assumption overstated the potential for chemicals to reach wells G and H by May 1979. More than 20 alternative transport simulations were made to evaluate the sensitivity of model results to factors such as retardation, dispersivity, effective porosity, degradation, recharge, and pumping. The model analyses supported the opinion that the low permeability of the ground moraine deposits and bedrock beneath the plant significantly limited the rate of groundwater and contaminant migration from the Grace property toward wells G and H, and that chemicals from the Grace property could not have reached the wells by May 1979.

At the time of the trial there were 65 monitoring wells on the Grace property. The wells, which had been installed in the

moraine deposits as well as the underlying bedrock, provided hydrogeologic information indicating that only a small volume of groundwater flowed beneath the Grace property, and that the rate of groundwater flow beneath the plant was slow. Since the end of the trial, an additional 35 wells, including 22 extraction wells, have been installed on the Grace property. The extraction wells, which were installed as part of the groundwater remedy for the Grace property, are screened in both the ground moraine

...the rate of groundwater flow and contaminant migration beneath the Grace property is very limited...

deposits and the bedrock. They have been operational since 1992. The average total pumping rate from all 22 wells is about 7 gallons per minute, or less than 1/2 gallon per minute per well. For 15 wells the average pumping rate is less than 1/4 gallon per minute. The extremely low yield of the extraction wells, as well as other hydrogeologic data collected at the Grace property since the end of the trial, confirms the testimony our expert hydrogeologist offered at the trial. Namely, the ground moraine deposits and bedrock beneath the Grace property have a very low hydraulic conductivity that is much lower than was assumed by the

plaintiffs' expert. These data also indicate that the rate of groundwater flow and contaminant migration beneath the Grace property is very limited and less than the plaintiffs' expert calculated.

Zone of contribution to wells G and H

Shortly before the trial began the U.S. Geological Survey (USGS) conducted a 30-day pumping test of wells G and H on behalf of the U.S. EPA. Data collected during that test were available for the trial, and there was disagreement between the testifying experts regarding the interpretation of those data. The plaintiffs' expert testified that induced infiltration of Aberjona River surface water was irrelevant with respect to understanding the potential sources of contamination to the wells. Our hydrogeologic expert testified that the data confirmed that wells G and H obtained a substantial portion of their water as induced infiltration from the Aberjona River, and that contaminants could have been transported from the upstream reaches of the watershed to the wells.

Available historical water quality information from wells G and H indicated that the wells had a long-standing history of water quality problems that appeared to be related to

industrial discharges in the upstream reaches of the Aberjona River. During the late 1960s and through the 1970s, there were numerous complaints regarding the poor quality of the water in the Aberjona River that resulted from industrial discharges in the upstream portions of the watershed. A graph of sodium, chloride, and nitrate concentrations in well G (Figure 2) shows frequent exceedance of water quality criteria for these inorganic

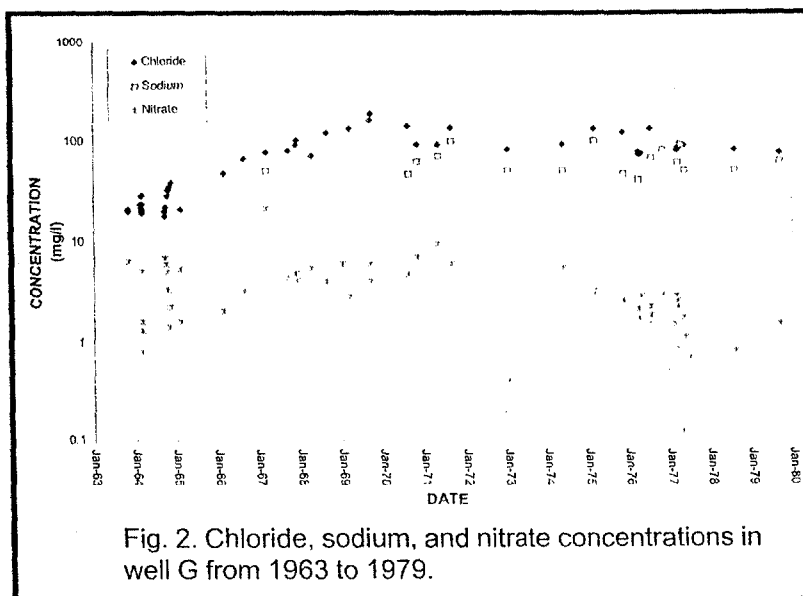


Fig. 2. Chloride, sodium, and nitrate concentrations in well G from 1963 to 1979.

parameters during the time period of public concern regarding the quality of the Aberjona River. The historic water quality data were used to support the testimony our expert offered at trial, namely that induced infiltration of Aberjona River surface water was a potential source of contamination to the wells.

In 1987 the USGS released a report regarding the area of influence and zone of contribution to the two wells. The USGS report was based on the results of their 30-day pumping test. The USGS concluded that more than 40 percent of the water pumped from wells G and H was derived from induced infiltration of Aberjona River surface water, and that the zone of contribution to wells G and H included the approximately 7 mi² drainage basin located upstream of the two public supply wells (Figure 3). The report highlighted the complexity of

indicate widespread groundwater contamination by a variety of contaminants from multiple contaminant sources. Contaminants detected in groundwater in the vicinity of former wells G and H include inorganic compounds, such as arsenic, chromium, lead, sodium, chloride, nitrate, and sulfate; as well as chlorinated

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solvents, benzene, and PAHs. Whether all of these compounds were present in the water pumped from wells G and H during their operational life will never be known because

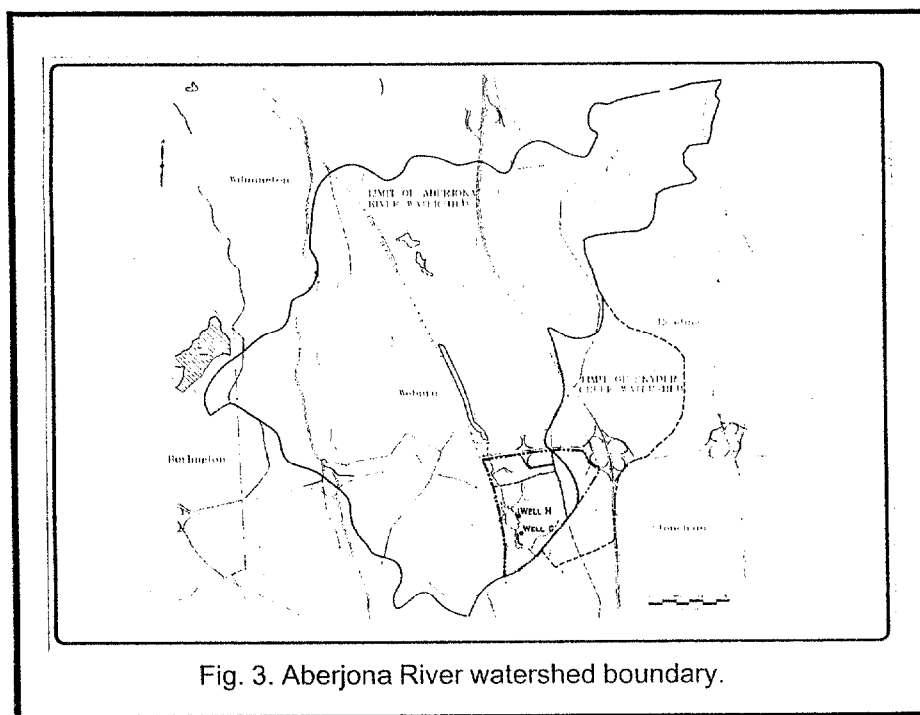


Fig. 3. Aberjona River watershed boundary.

Contaminants detected in groundwater... include...arsenic, chromium, lead... benzene, and PAHs.

understanding potential sources of contamination to the wells, and confirmed the testimony of our expert regarding site hydrogeology and the zone of contribution to wells G and H.

Other potential sources of contamination

Investigations within and near wells G and H continue, and the results of those investigations

water samples from the wells were not analyzed for many of these compounds then. The industrial history of the Aberjona River watershed and the factual, as well as anecdotal, information regarding the surface water and groundwater quality within the watershed indicate that the issues regarding past contamination of the wells are quite complex and not likely to ever be fully known or understood.

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PUBLICATIONS
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PRESENTATIONS

- Andersen, P.F., G.W. Council, R.T. Hagemeyer, and S.V. Donohue, 1998.** Numerical Simulation of the Effect on Groundwater and Surface Water of the Proposed Crandon Mine, The 22nd Annual Meeting of the Wisconsin Section of the American Water Resources Association, Green Lake, WS.
- Andersen, P.F. and G.W. Council, 1998.** Design of a Transport Model for the Tailings Management Area, Crandon Project, Poster presentation, The 22nd Annual Meeting of the Wisconsin Section of the American Water Resources Association, Green Lake, WS.
- Benegar, J.J. and D.C. Skipp, 1998.** Effect of Vertical Discretization and Dispersivity on Predicted Migration of Injected Treated Wastewater Using MODFLOWT, MODFLOW '98 International Conference, Golden, CO (October 4-8).
- Burnell, D.K., J.J. Benegar, J.W. Mercer, and A.L. Grasso, 1998.** Application of Transport Module MODFLOWT for Design of Pulsed Pumping Groundwater Remediation System at a Site in New York, MODFLOW '98 International Conference, Golden, CO (October 4-8).
- Council, G.W., 1997.** Simulating Lake-Groundwater Interaction with MODFLOW, *Proceedings of the 1997 Georgia Water Resources Conference*, The University of Georgia (Kathryn J. Hatcher, Ed) (March 20-22).
- Donohue, S.V., P.F. Andersen, and G.W. Council, 1998.** Project Overview of Groundwater Studies for the Proposed Crandon Mine, Poster presentation, The 22nd Annual Meeting of the Wisconsin Section of the American Water Resources Association, Green Lake, WS.
- Guswa, J.H., 1998.** Groundwater/Surface Water Interactions Can Preclude Aquifer Restoration, American Institute of Hydrology/International Association of Hydrogeologists Joint Conference on Physical, Chemical and Biological Aspects of Aquifer-Stream Relations, Las Vegas, NV (September 27-October 2).
- Merkhofer, L., K. Rehfeldt, and B. Bangerter, 1998.** A Bayesian Analysis of Optimal Site Characterization Strategies for the Nevada Test Site, American Nuclear Society Conference on Risk-Based Performance Assessment and Decision Making, Pasco, WA (April 5-8).
- Peng, W-S., D.R. Hampton, J.J. Benegar, K.K.R. Kambham, and L.F. Konikow, 1998.** Can MODFLOW-Based Contaminant Transport Models Predict Breakthrough? MODFLOW '98 International Conference, Golden, CO (October 4-8).

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Summary

The numerous investigations and evaluations of hydrogeologic conditions and contamination within the Aberjona River watershed that have been made by many investigators during the 12 years since the trial ended have provided an information base that supports the testimony our expert offered on behalf of Grace. The site conditions and history are much more complex than portrayed by plaintiffs' counsel and experts during the trial, and it is unlikely that the real history regarding the contamination of wells G and H will ever be known.

Relevant Reports

- de Lima, V. and Olimpio, J.C., 1989. Hydrogeology and Simulation of Ground-Water Flow at Superfund-Site Wells G and H, Woburn, Massachusetts, U.S. Geological Survey Water-Resources Investigations Report 89-4059.
- GeoTrans, Inc. and RETEC, 1994. Wells G & H Site Central Area Remedial Investigation Phase 1A Report, technical report prepared on behalf of Beatrice Corporation, UniFirst Corporation, and Grace and submitted to the U.S. EPA, Boston, MA.
- GeoTrans, Inc., 1987. Review of EPA Report, Wells G & H Site Remedial Investigation Report Part 1 Woburn, Massachusetts, technical report prepared on behalf of Grace and submitted to the U. S. EPA, Boston, MA.
- Myette, C.F. et al., 1987. Area of Influence and Zone of Contribution to Superfund-Site Wells G and H, Woburn, MA, U.S. Geological Survey Water-Resources Investigation Report 87-4100.
- U.S. EPA, 1989. Wells G & H Site Record of Decision.

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