Good evening madam chair members of the board my name is Debbie Krieg and I live here in beautiful Burrillville. The reason I stand before you tonight is to talk about the well contamination more specifically well 3A. As you are aware it was nearly 20 years ago when this town went through a horrific ordeal. You have heard testimony from residents that had to live through that and unfortunately a lot of the residents that went through this have left this town and can't be here to testify before you. Fortunately for me I did not have to deal with it because the Part of town I lived in had an artesian well. but I saw what my neighbors, my friends and my fellow burrillvilians went through at that time. It truly was devastating. The residents of this town came together to try and do whatever we could to help and finally the well was sealed shut and the residents could try to move on with their lives. And now 20 years later while this monster lays sleeping, sealed shut Invenergy wants to open this well but opening up this monster is like pouring salt into an open wound and the residents here are scared to death of what can happen when that monster awakes. Invenergy claims that they can clean up 99.9% of this well so I started looking on the Internet to see any contaminated wells that's been cleaned up it's hard to believe that there are so many contaminated sites throughout the United States it totally blew my mind. As I was reading about different sites throughout the country I came across an article written in 2011 by Dave Fisher/ecoRI news staff. I will not read the whole article to you but there are a couple of bullet points that I would like to bring to your attention. In the article Mike Cote remediation specialist for the state department of environmental management states when dealing with these remediation, the law of diminishing returns applies. it is easy to get out the first 60% 70% Cote said trying to get out the last 30% the Costs go up astronomically and it takes years and years. you start to get to the point that it is either economically or technically infeasible. As I was researching this I found that it does take years and years there has been no site that has been cleaned up in any kind of a timely manner and no site that was ever cleaned up to 99.9% as Invenergy claims they can do. As stated in this article the state department of environmental management continues to monitor the MTBE contaminated aquifer. At one point in time the MTBE levels were as high as 1700 part per billion -- 42 times the EPA limit for drinking water now I'm aware that these numbers have probably come down over time however any amount of MTBE that will be put into our air that we will have to breath daily is unacceptable. Cote goes on to say In a best case scenario for the contamination is reduce to below the 40 pots per million threshold set by the EPA,that's my goal but is that good enough to turn the well back on? that's department of health there are a lot of different standards for what is protective. The Rhode Island Department of Health maintains that even if the MTBE is cleaned up to the EPA standards it will never reopen The village's public well. well 3A will remain closed not because of the current levels of contamination but due to the potential for future contamination at the site. I would respectfully ask that after reading these documents if you are as concerned as I am about the potential for future contamination that you use the resources available to you to look further into this thank you for hearing me tonight.

I ask you to vote against the plant,

Complicated Spill Tough to Clean Up

Editor's note: Ten years ago last month, the water supply in the village of Pascoag, in the town of Burrillville, was contaminated by the now-banned gasoline additive methyl tert-butyl ether (MTBE). MTBE is a petroleum byproduct that replaced lead in gasoline as an oxygenating agent. Many gasoline companies termed it an "anti-knocking agent." The petrochemical has been shown to cause cancer in rodents. As of 2007, it had been banned — partially or fully — in 24 states, including Rhode Island.

By DAVE FISHER/ecoRI News staff

PASCOAG, R.I. — In order to understand the devastating impact of the now-decade-old MTBE contamination on the bedrock aquifer under the village of Pascoag, one must understand how gasoline and its constituent chemicals behave when leaked into soil.

When gasoline is spilled or leaks out of underground storage tanks, it almost immediately begins to break down into the various additives, stabilizers and sub-chemicals that are used to refine petroleum products. MTBE's extremely potent taste and odor mean that, even at very low concentrations, it can render large quantities of groundwater non-potable. The chemical is much more soluble in water than most petroleum byproducts.

This solubility causes it to "dive" into bedrock aquifers and to travel faster and farther than many other components of gasoline when released into aquifers. To make MTBE matters worse, the chemical can be released into groundwater in "pulses" that can cause radical upticks in contamination levels, due in most part to heavy rain events and rising groundwater.

The Environmental Protection Agency (EPA) reports that because MTBE behaves differently in soil, air and water than other petroleum constituents, the choice of remediation technology may be different when MTBE is present. Benzene is most often the contaminant of concern in gasoline because of its relatively high solubility and its known carcinogenicity.

When MTBE is in the soil as the result of a petroleum release, it may separate from the rest of the petroleum, reaching the groundwater first and dissolving rapidly. Once in the groundwater, MTBE travels at nearly the same rate as the groundwater. Benzene and other petroleum constituents tend to biodegrade and adsorb into soil particles.

According to Mike Cote, remediation specialist for the state Department of Environmental Management (DEM), in addition to the natural qualities of MTBE that make cleanups difficult, there were numerous site-specific issues that made the original assessment of the Pascoag spill and subsequent remediation extremely difficult.

"It was found in a weird way," he said. "It was found initially in the public well. We had to make sure of the source, so we had to evaluate several properties around the well to determine the source of the spill."

The problem was so complicated that DEM had to have several managers deal with the spill, and after the source was determined to be the Main Street Mobil station, the responsible parties were charged, and not long after that, they disappeared — leaving DEM the sole responsibility of cleaning up the mess.

"The spill was a big problem not only in size, but in depth," Cote said. "On top of that, the entire town's water supply was being affected because they had no other source."

The problems just snowballed after the initial spill. Gasoline and benzene vapors caused the evacuation of some homes and an assisted-living facility. DEM responded by quickly installing a carbon filter on the wellhead so the people could use the water, at least for bathing, while the assessment was ongoing.

The emergency remediation plan consisted of separating the affected area into five zones that were prioritized by the level of contamination, and the areas with the highest levels of MTBE were addressed first. The geological features of the area, namely the extremely shallow bedrock, allowed the spill to move quickly toward the village's wellheads, which, at the time, had only been online for a few months. The hybrid design of the wellhead itself made the problem worse. The new well was a hybrid that extracted water from the bedrock as well as from the soil.

"After the well was shut off, the contamination stabilized, but at a very high level," Cote said. "Normally, gasoline spills of this type never leave the initial site, but in this case we had several testing wells that had standing gasoline in them. Anytime you find contamination to that degree, you're talking anywhere from a quarter-million to a half-million dollars per site to clean up. It was almost like six or seven problems instead of just one."

The filters that were deployed by DEM can only handle about a half-acre of contaminated land at a time. Currently, there are five different remediation systems in place, in addition to a couple of mobile filtration systems, to deal with contamination wherever it may pop up.

Large production wells like those in Pascoag actually pull contamination toward the well, so the natural movement of contaminants and biodegradation processes are accelerated and hindered, respectively. Then, when the well was shut off in early 2002, instead of the contamination seeping back to whence it came, it moved toward the nearest water source, a stream that empties into the Pascoag Reservoir — a frustrating development for the DEM because, as Cote said, "It made for a very weird shaped plume."

When dealing with these remediations, the law of diminishing returns applies. "It's easy to get out the first 60 percent, 70 percent," Cote said. "Trying to get out the last 30 percent, the costs go up astronomically and it takes years and years. You start to get to the point that it's either economically or technically infeasible. What we'd like to do — and I'm not saying that that's what's going to happen — is to clean up the worst of it and let Mother Nature, through processes like dilution or bacteria that eat it, take care of the rest."

Oddly, the water isn't the problem; it's the soil. Soil acts like a sponge for contaminants. "Think of a soapy sponge," Cote said, "you can rinse and rinse that sponge and never get all of the soap out of it."

Pumping water out of the ground is really just a measure to control the movement of the contamination. Lowering the levels of contamination in soil takes soil vapor extraction (SVE). SVE is basically using giant vacuums that suck vapors out of the soil.

"That (SVE) is very effective and cost-effective," Cote said. "The vapor extraction performed here removed most of the contamination from the soil."

Unfortunately, soil venting only works on unsaturated material. If the contamination is deep under the water, SVE is ineffective.

DEM currently has about 120 monitoring wells in Pascoag, a small set of which are sampled every three months. Once a year, DEM samples all of the monitoring wells. Cote said that while the contamination was really transient initially, it has become much more predictable over time.

In a best-case scenario, the contamination is reduced to below the 40 parts per million threshold set by the EPA. "That's my goal," Cote said, "but is that good enough to turn the well back on? That's Department of Health. There are a lot of different standards for what is protective."

In January 2002, local residents asked the Rhode Island judiciary to close the well, which they did, and the well remains closed to this day.

The Rhode Island Department of Health (DOH) maintains that, even if the MTBE is cleaned up to EPA standards, it will never reopen the village's public well. DOH claims that this is due not to the existing contamination, but the potential for future contamination.

ecoRI News has asked the DOH why — given that there has been almost no major development in the area since 2001, and in fact, a potential major source of contamination was eliminated when the leaking gas tanks were removed from the Main Street Mobil location — that determination wasn't made prior to the Pascoag Utility District spending big money to drill the well in the first place? A response has yet to be received.

Judge Again Defers Pascoag's MTBE Settlement

By DAVE FISHER/ecoRI News staff

PASCOAG, R.I. — Rhode Island Superior Court Judge Judith Colenback Savage last week again deferred the $7 million settlement in the case regarding the now-decade-old methyl tertiary butyl-ether (MTBE) spill in the village of Pascoag.

MTBE is a gasoline additive that has since been banned in many states, including Rhode Island. The spill contaminated the town's water supply, and forced the Pascoag Utility District (PUD) into an agreement with the neighboring village of Harrisville to buy drinking water at nearly double the rate that most Rhode Islanders pay for their public water. Many then and current residents of the village believe the contamination led to a rash of what one resident called "oddball cancers" and multiple sclerosis.

In Savage's initial decision — recorded in July 2011 — she declined reimbursement of just more than $900,000 in attorney expenses by Exxon/Mobil, indicating that the breakdown of expenses was far too vague to satisfy the court, but would reconsider reimbursement if more accurate records were submitted. Those records were submitted to the court, but the judge deemed them still too vague and disorganized to warrant reimbursement. Michael Kirkwood, current head of the PUD, said Savage seemed "really aggravated" that attorneys involved in the case delivered several boxes of unreferenced and unorganized expense reports to the court.

Savage has since appointed Bruce Kogan, a law professor from Roger Williams University, to wade through the boxes of expense reports and determine which were legitimate expenses eligible for reimbursement and which were not. Kogan's report is due March 9. The judge is expected to render her final decision March 30, which should put the wheels of the settlement payment in motion.

The settlement will be divided into a $5 million portion for the Pascoag Utility District to remediate the bedrock aquifer that was contaminated and improve the quality of drinking water in the village. A $2 million portion will be distributed amongst the some 2,000 claimants in the case. Legal fees in the case amounted to

$2.3 million, two-thirds of which will be paid out of the PUD settlement and the remaining $666,667 paid from the claimants' payout.

Potential site for new well

In other news regarding the water supply in Pascoag, Kirkwood said the PUD has determined a potential site where a new public well could be drilled. The area in the northern part of the same wellfield that was contaminated back in 2001 seems to draw water from the aquifer of a nearby stream that empties into the Pascoag reservoir rather than from the contaminated aquifer.

The site actually had a functioning well in the past, but was closed by the state Department of Health about 30 years ago because of high levels of iron and manganese in the groundwater.

"Thirty years ago the technology didn't exist to effectively reduce the level of metals coming out of the well," Kirkwood said. "But today's filtering technology can easily reduce those metals to within a consumable range."

Kirkwood remains cautiously optimistic about the new well site and insists that the PUD is taking a "slow and very studied approach to any new well sites." Any major exploration or drilling of new wells would have to wait until the PUD receives its $5 miillion settlement agreement.

The state Department of Environmental Management (DEM) continues to monitor the MTBE-contaminated aquifer, and the latest round of testing showed that MTBE levels have dropped slighty from a high of 1,700 part per billion — 42 times the EPA limit for drinking water. But [the Department of Health maintains that well 3A will remain closed] not because of the current levels of contamination, but due to the potential for future contamination at the site.

MTBE Drinking Water Contamination in Pascoag, RI: A Tracer Test for Investigating the Fate and Transport of Contaminants in a Fractured Rock Aquifer

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Summary

Ever since 2001, when Pascoag's only public drinking water well was shut down because of MTBE contamination, the people of Pascoag are without a drinking water source of their own. The MTBE problem at Pascoag is one of the largest in the country and probably the largest in New England. While Pascoag is large, it has almost all common MTBE problems in the New England region: drinking water, bedrock, and river contamination. The Rhode Island Department of Environmental Management, RI-DEM, has agreed opening the Pascoag site to scientists and students from the University of Rhode Island. The overarching objective was to work towards a systematic investigation of MTBE bedrock contamination and a prognosis for remediation alternatives. In this report we describe the results of a pump test that was designed to investigate the fate and transport of MTBE. A conservative tracer test was also carried out, but it had to be terminated before tracer breakthrough at the pumping well occurred. The data generated during this pump test was amended with data from groundwater monitoring wells up-gradient from the production well and a statistical evaluation of fracture analysis data. The principal finding was that the MTBE concentration in the production well can be controlled by the pump rate. That is, the MTBE concentration increases beyond the limit (40 μg/L) set by the RI Department of Health when pumping the production well at 240 gpm, but remains below that limit when pumping at a lower rate (150 gpm). It may therefore be possible by carefully adjusting the pumping regime and continuously monitoring the hydraulic and chemical conditions at the site to produce at least some amount of water from the aquifer. Because the pump test was comparably short (approximately 6 weeks), it is recommended to follow up with a step-up pumping rate test and, more importantly, longer (e.g., 6 months) pump test to ensure that the MTBE concentration remain at low levels over extended periods of time.

Introduction

The Pascoag Water District serves about 5,000 people in the Town of Pascoag, RI. Their drinking water was pumped from *one* 16" well, drawing 350 GPM from both the bedrock and overburden aquifers. On August 30, 2001, a resident of Pascoag noticed an odor in his water. A chemical analysis confirmed that the drinking water was contaminated with MTBE.

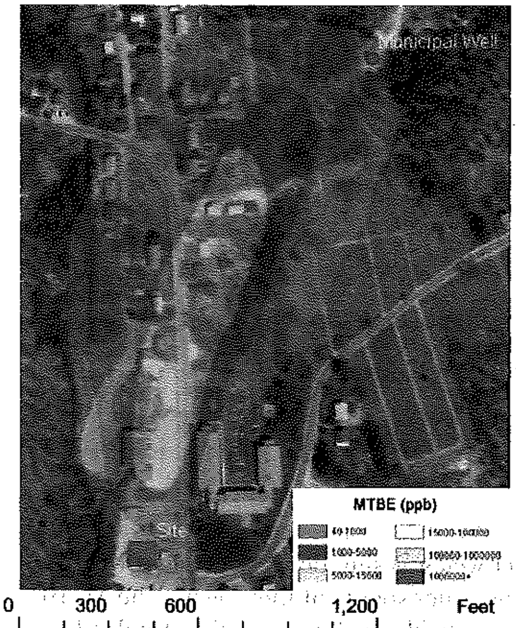

Figure 1: Currently known extend of the Pascoag MTBE plume in the bedrock aquifer.

The acronym MTBE is short for a synthetic organic compound chemically known as methyl tertiary-butyl ether. MTBE is a volatile, flammable, colorless liquid at room temperature and has a terpentine-like odor. MTBE is informally known as a fuel oxygenate because it provides extra oxygen for the internal combustion process ("anti-knocking agent"). MTBE has been used in U.S. gasoline at low levels since 1979, replacing lead-organic compounds as octane enhancer. Since 1992, MTBE has been used at higher concentrations (approx. 10%) in some gasoline to fulfill the oxygenate requirements set by Congress in the 1990 Clean Air Act Amendments. MTBE is now recognized as a very serious threat to groundwater. MTBE contamination is very difficult and expensive to cleanup and is becoming the most common drinking water problem faced by state agencies today.

Following the detection of MTBE in the drinking water, Pascoag residents were immediately notified that they should not drink the town water and minimize skin contact. Nonetheless, residents complained about massive headaches, vomiting, wheezing, and blisters on their lips. Ever since 2001, when the drinking water well was shut down, the people of Pascoag have been without a drinking water source of their own.

Responding to Pascoag's drinking water emergency, the Burrillville School District opened up the hockey rink for residents to take showers and fill water jugs. In the following months, the RI Department of Environmental Management (RI-DEM) supplied the Pascoag residents with about a quarter million dollars worth of bottled water. Currently, Pascoag is receiving water from village/district of Harrisville (both within the Town of Burrillville) at a cost of more than $1,000,000/year. Pascoag cannot sustain this financial burden and may soon become insolvent. Because no other drinking water resources are available, there is strong political pressure building to reactivate the Pascoag well.

RI-DEM identified a nearby gas station as the source of the MTBE. After the owner of the gas station declared bankruptcy, RI-DEM took over all assessment and remediation activities (Project Manager Mike Cote (401) 222-2797, ext. 7118). During the emergency site investigation over 6" of free gasoline was found in some wells. Intrusion of toxic vapors demanded the temporary evacuation of 200 senior citizens from a nearby home for the elderly. By now the MTBE contamination plume is approximately 20 acres in size and up to 100 feet deep. This makes the MTBE problem at Pascoag one of the largest in the country and probably the largest in New England.

The contamination resides in both the overburden and fractured bedrock aquifers and has been consistently detected in a nearby river, too. Bedrock contamination is very complex and expensive to cleanup. It is a common problem in New England as its bedrock aquifers are susceptible to this contamination, due to their being relatively shallow. Currently MTBE in the bedrock aquifer reaches to a maximum of 15,000 µg/L. For comparison, the RI drinking water limit for MTBE is 40 µg/L.

To date, over 50 shallow and deep overburden wells and 16 bedrock wells were installed by RI-DEM. Over 3 million gallons of contaminated water and over 3,000 gallons of gasoline were pumped so far. Funding for the site investigation and water treatment has been provided by the U.S. EPA. EPA's assistance prevented the Rhode Island Leaking Underground Storage Tank (LUST) program from immediate collapse. RI-DEM has now reached a critical decision point – either focusing the remaining funds on constructing a water treatment plant and reactivation of the public well to allow some degree of normalcy to return to the area. Or, concentrate on remediation of the bedrock contamination problem, which – if remained untreated – may again jeopardize the water quality in the future - even after a treatment system has been installed.

The main objective of this pilot-scale field project was to development a conceptual model of MTBE fate and transport within the drinking water aquifer at the Pascoag site. The principle means of generating these data were a tracer test and water quality analysis. Also, the study of this MTBE site served students as an experiential learning opportunity as they were working next to environmental professionals and regulators. Ultimately, the results of this study are expected to produce hydraulic and chemical data in support of RI-DEM and the Town of Pascoag in attempt to reopen the well field.

Methods, Procedures, and Facilities

In cooperation with RI-DEM, more than 60 wells were installed at the site, including many nested wells (i.e. closely spaced wells penetrating different depths of the aquifer). The depth of the wells ranges from 10 ft (overburden) to over one hundred feet into the fractured bedrock. The actual production well (PW3A) is 64 ft deep and penetrates the fractured bedrock aquifer approximately 10 ft.

Starting March 14, 2005, a pump test was conducted at PW3A. The flow rate was recorded at the well head and water level elevations were measured using a vented InSitu data logger. Additional wells were monitored manually and by loggers installed in wells MW18D, MW20S, MW20D, MW28BR, where S and D stand for shallow and deep overburden wells, respectively, while BR is a bedrock well. Precipitation data was recorded at a NOAA weather station located 13 miles south in South Foster, Rhode Island.. Bedrock well LE2 and overburden well MW14D were used as tracer injection wells.

From March 14 through April 19, 2005, the pump rate was 240 gpm. For the last day of the test, April 20, 2005, the pump rate was decreased to 150 gpm. Water samples for MTBE and tertiary amyl methyl ether (TAME), another gasoline oxygenate, were collected on a daily basis starting the day before the beginning of the pump test. All samples were collected in 40 mL VOA vials and preserved with 6N hydrochloric acid with zero headspace. All these samples were analyzed by EPA method 8260B (Low QL) for volatile organic compounds (VOC) and oxygenates by Premier Laboratory (Dayville CT). Samples collected between 04/03/05 and 04/08/05 were collected but not analyzed.

A conservative tracer (fluorescein) was released in well LE2 A total of 50 g fluorescein was pre-dissolved in 1000 ml of deionized (DI)and injected into LE2 at once. The tracer was released one day after the pumping rate was decreased from 240 to 150 gpm. About 100 ml tracer samples were collected on hourly basis. Fluorescein was analyzed by UV-Vis spectrometry (Shimadzu) at a wavelength of 491 nm.

A fracture analysis at bedrock outcrops on and near the site was carried out and statistically evaluated for dominant fracture orientation. Measurements of lineation, foliation, and fracture orientations were collected using a *Silva Compass*. Fracture strikes were plotted on rose diagrams using the *Rockworks* software for plotting individual locations and groups of measurements.

Results

The locations of those wells utilized in this study are shown in Figure 2. Figure 3 shows the water table elevation under non-pumping conditions, while Figure 4 shows the water table under pumping conditions (240 gpm).

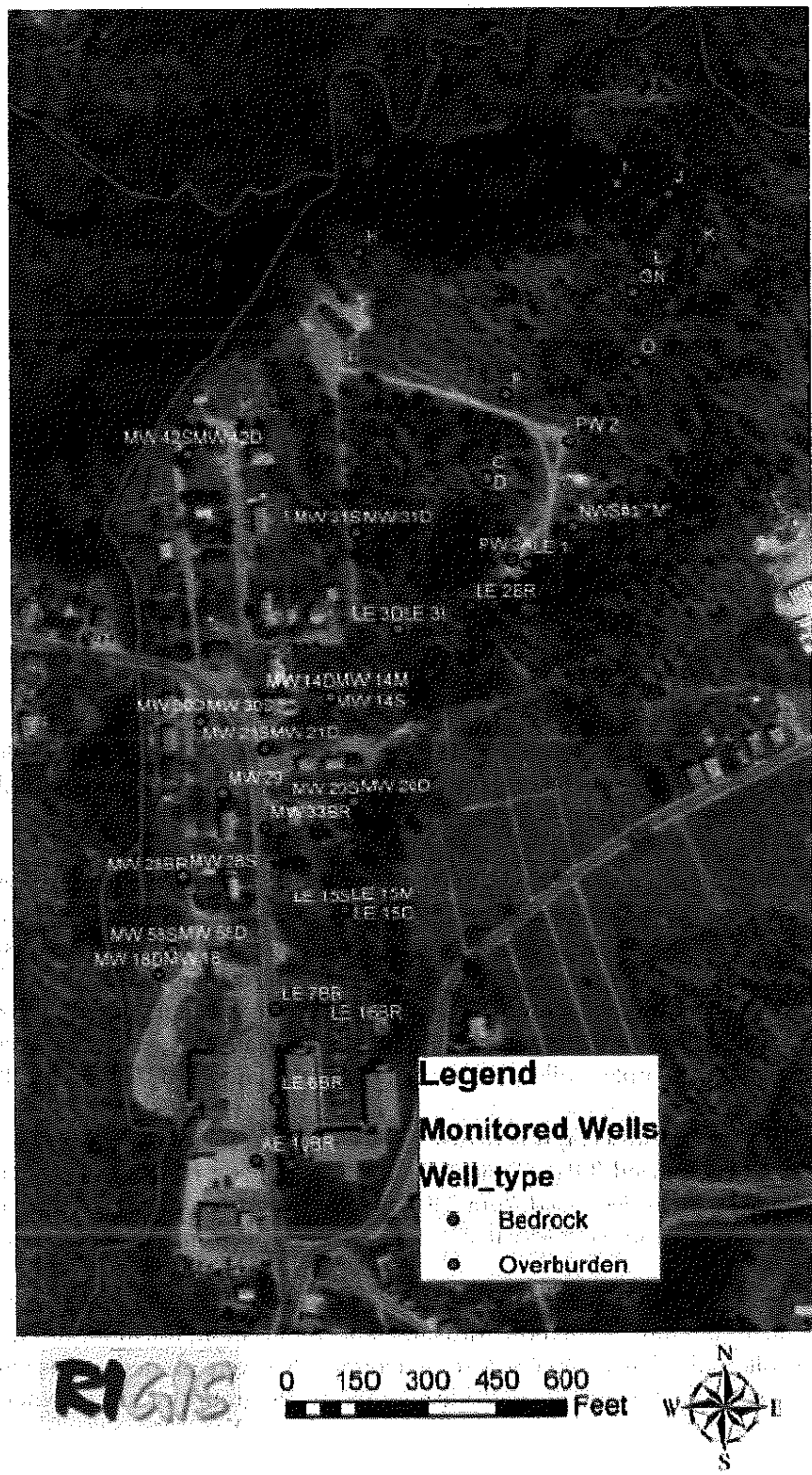

Figure 2: Location of monitoring well utilized in this study.

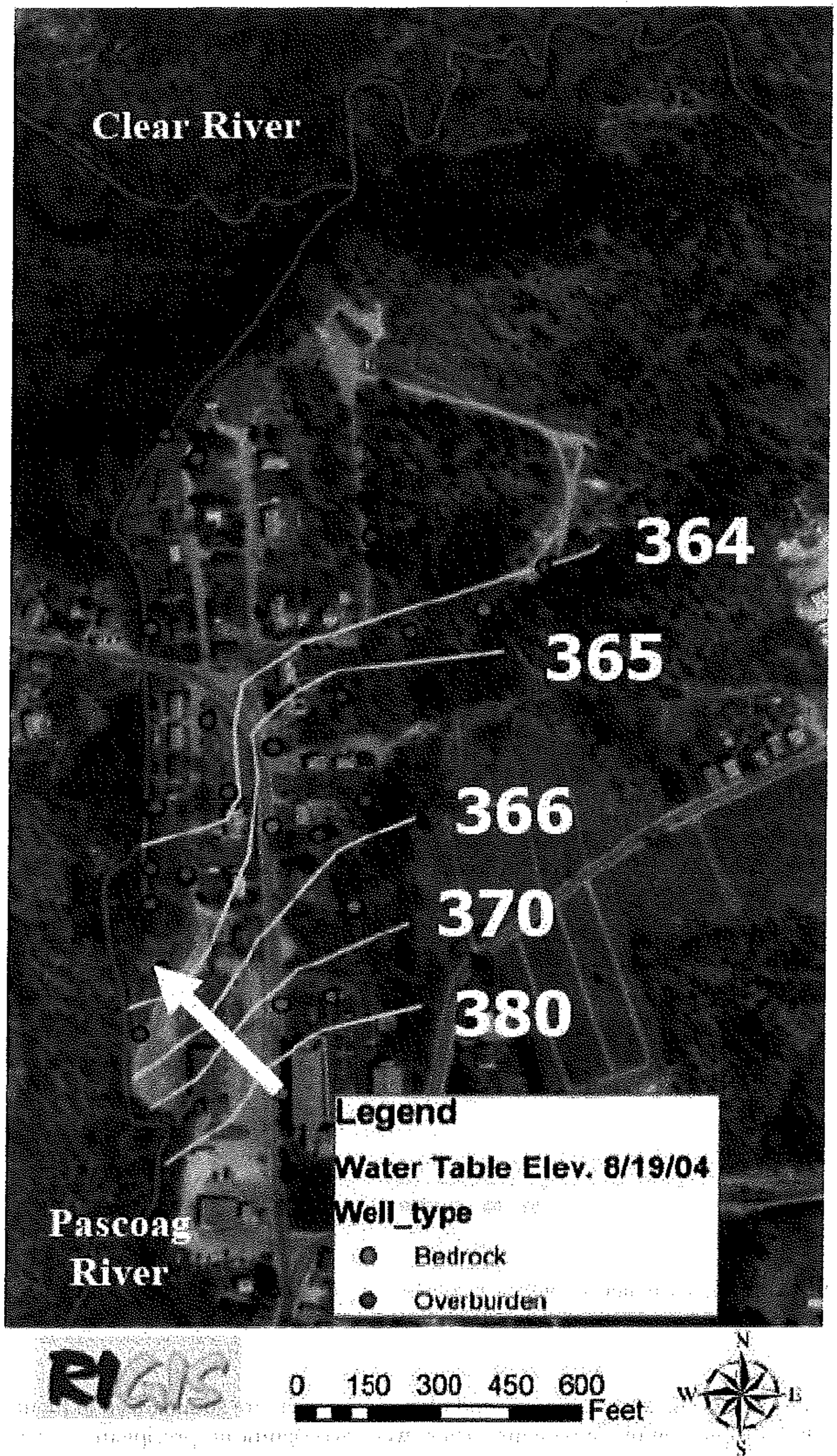

Figure 3. Water table of site under non-pumping conditions. Table drawn using combined bedrock and overburden wells. Uneven contour interval

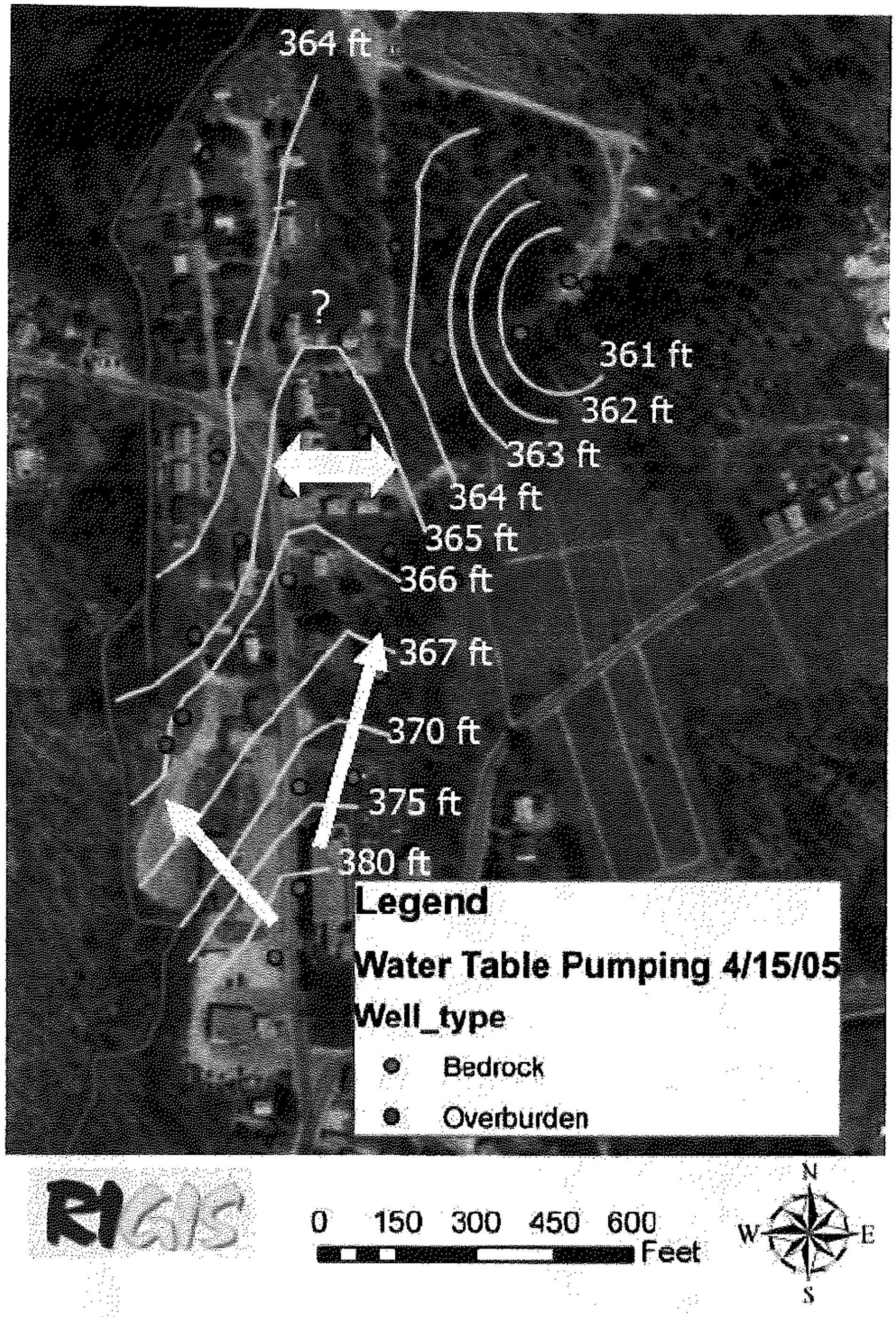

Figure 4. Water table gradient under pumping conditions of 240 GPM. Notice plume separation and the flow divide in middle of the site. Uneven contours

The water table elevations in the pumping and observation wells are summarized in Figure 5. Also shown are the precipitation measurements. There were two significant precipitation events during the aquifer test. These events occurred on March 28 and April 2, with amounts of 2.8 and 2.5 inches respectively.

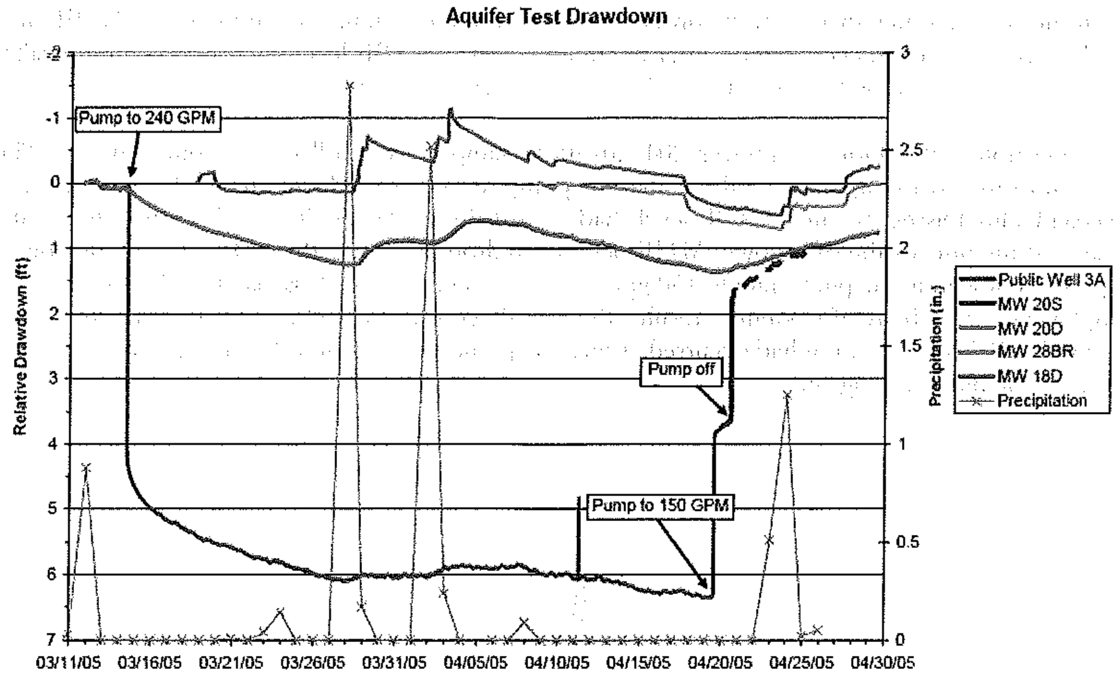

Figure 5: Drawdown curves obtained from pressure transducers. Precipitation is also plotted. The origin of the anomalous point in Public Well #3A on 4/10/05 is unknown. It may have been related to a very short pump disruption.

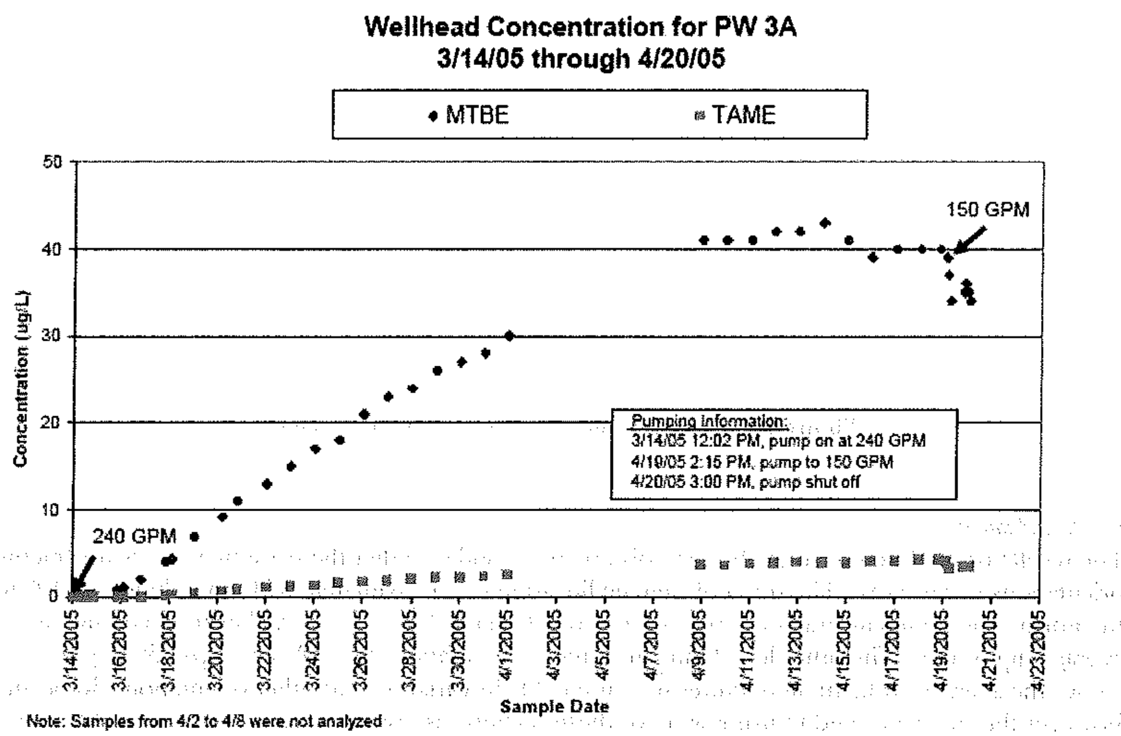

Figure 6: Concentrations of MTBE and TAME at the wellhead from the start of the aquifer test through the end. Notice the apparent steady state at 43 µg/L for MTBE and the drop when pump rate changed.

Water Quality Data
The results of the water analysis at the production well head are summarized in Figure 6. MTBE and TAME were detected in every sample after the first few days. MTBE levels increased asymptotically and peaked at 44 μg/L on 04/14/2005. TAME levels never exceeded 5 μg/L.

After injection of the fluorescein tracers (04/20/2005), samples were collected for only 4 hours. The reason for this short sampling period was that the pump test was shut down on 04/20/2005 by the Pascoag Utility District because MTBE levels had exceeded the 40 μg/L limit. This was unfortunate because at the time of the shut-down, MTBE levels had dropped to less than 40 μg/L, presumably in response to lowering the pump rate to 150 gpm. Because there was a 14-day lag time between sampling and availability of laboratory results, the shut down was ordered without knowing that a drop in MTBE concentration had occurred. Once the pump test was shut down, it was not possible to restart the pump test again.

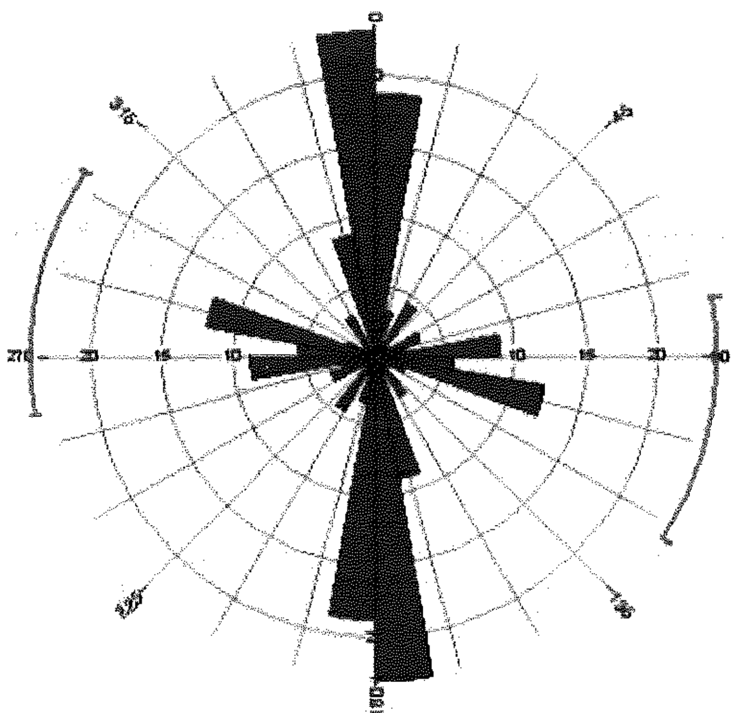

Figure 7: Average fracture strike for all field measurements

Fracture Analysis
The results of the fracture study (91 total observations) indicate that there are two dominant fracture orientations in this area. The trend of mineral lineation is approximately N2E and plunges at 10° to the north. The dominant fracture orientation is nearly parallel to the mineral lineation and has an average dip of 65E. The other less dominant fracture orientation is N75W and dips 75S. Figure 7 shows the average strike of all fractures measured. Slight variation and other orientations do occur, however the frequency and transmissivity of these fractures is less significant. Orthogonal fractures that trend along the same dominant strike but dip much more shallowly also occur. The frequency of the N75W trending fractures appear to be concentrated in localized fracture zones. Between these zones the rock units are massive. The N2E fractures are more regular and their frequency is more consistent.

Discussion

The results of the water table elevation measurements before and during the pump test clearly indicate that the production well – even when pumped at a lower rate than during pre-contamination production (300 gpm) – strongly influences the groundwater gradient and pulls MTBE from the source zone towards the well head. Under no-pumping conditions the MTBE appears to migrate away from the well field and towards the river in an approximately north-north-easterly direction. The natural direction of the groundwater movement seems to be controlled by fractures running in approximately south-to-north direction and by the presence of the river. Also, the response of the water table elevation to precipitation is almost instantaneous suggesting that there is a good hydraulic connection between the surface and the aquifer.

The shape of the MTBE concentrations graph indicates that a quasi-equilibrium concentration level between 40 and 50 μg/L MTBE is being approached when the pumping rate is at 240 gpm for about 4 weeks. Once the pumping rate was lowered to 150 gpm, MTBE concentrations dropped below the regulatory threshold limit of 40 μg/L. This suggests that by carefully controlling the pumping rate, water of drinking water quality can be pumped from the aquifer. Because the aquifer test ended prematurely, the injected conservative tracers had not arrived at the pumping well.

The analysis of the test data has led to a better understanding of the ground water flow, contaminant transport, and ground water/surface water interactions. The goal was to determine how and where contaminants are moving and if it is possible to eventually reactivate the well. Major new advancements regarding water table gradients, plume stabilities, contaminant transport pathways, and the aquifer/surface water interactions have now been made. Based on these findings it is suggested to design a stepped pumping test and monitor the water quality in the production well as well as in up-gradient wells for at least 6 months duration. Ideally, this stepped pumping test should give evidence for, potentially, a threshold pumping rate at which the MTBE concentrations will remain below the drinking water limit.

Acknowledgements

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