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Testing and Application of Diffusion Samplers to Identify Temporal Trends in Volatile-Organic Compounds

By Philip T. Harte, Michael J. Brayton, Wayne Ives, Sharon Perkins, Carroll Brown Jr., and Richard E. Willey

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Volume	
cubic foot (ft^3)	0.02832	cubic meter
gallon (gal)	3.785	liter
	Flow	
cubic feet per second (ft^3/s)	0.02832	cubic meter per second
gallon per minute (gal/min)	0.06308	liter per second
million gallons per day (Mgal/d)	0.04381	cubic meter per second
million gallons per day (Mgal/d)	1.547	cubic feet per second (cfs)
	Hydraulic Conductivity	
foot per day (ft/d)	0.3048	meter per day

Temperature in degrees Fahrenheit (^{o}F) can be converted to degrees Celsius (^{o}C) as follows:
$^{o}C = 5/9\ (^{o}F - 32)$.

Vertical Datum: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

ABBREVIATIONS AND EXPLANATIONS OF TERMS USED IN THIS REPORT:

VOC	volatile organic compound
PCE	tetrachloroethylene
TCE	trichloroethylene
cis-1,2DCE	*cis*-1,2-dichloroethane
ppm	parts per million [In this report, ppm is equivalent to milligrams per liter]
ppb	parts per billion [In this report, ppb is equivalent to micrograms per liter]
yr	year
min	minute
DNAPL'S	dense non-aqueous phase liquids
VC	vinyl chloride
TOC	total organic carbon
PID	photoionization detector
PVC	polyvinyl chloride
CFC	chlorofluorocarbon
ARPD	absolute relative percent difference
RPD	relative percent difference
MTBE	methyl *tert*-butyl ether
QA/QC	quality assurance/quality control
L/min	liters per minute
m	meter
mm	millimeter
mL	milliliter
mg/L	milligrams per liter
cm	centimeter
NTU	neophelometric turbidity units

Well identification

obswell	observation well
airwell	soil vapor extraction well
sparwell	soil sparge well
injwell	recharge well
extrawell	extraction well

The following abbreviations are used in well names:

<u>Suffix</u>

S or A	shallow cluster well
M or B	medium cluster well
D or C	deep cluster well
R	bedrock well

<u>Prefix</u>

SVE	soil vapor extraction well
SP	soil sparge well
IW	interior wall extraction well
EW	exterior wall extraction well
PW or B or MI or MW	observation wells
RW	recharge wells
P	piezometer

Lithology abbreviations

f	fine
m	medium
c	coarse
Wx	weathered

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By Philip T. Harte, Michael J. Brayton, Wayne Ives[1], Sharon Perkins[1], Carroll Brown Jr.[1], *and* Richard E. Willey[2]

Abstract

Methods for ground-water sampling have evolved over time. This evolution has been driven by changing theories on how to obtain representative aquifer water samples. Passive sampling is a fairly recent method that relies on the natural flushing capacity of a well to obtain representative samples. The use of diffusion samplers is one method of passive sampling and works well under certain conditions.

As part of a 2-year study to determine the temporal variability and trends in concentrations of volatile organic compounds (VOC's) in a large plume (0.5 mi^2 area) of contaminated ground water in a glacial-drift aquifer, results of VOC analyses of samples collected with diffusion bag samplers were compared with those of samples collected with other types of samplers. The area of study is the primary source area of the large VOC plume and is located adjacent to a a river that losses flow and recharges the aquifer. The concentrations of VOC's, primarily tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethene (*cis*-1,2DCE), in samples collected with diffusion samplers show a strong positive linear correlation (root-mean square error of 0.94 and above) with concentrations from purged samples following low-flow sampling procedures. A total of 20 coupled diffusion and peristaltic-pump samples were collected from 7 wells completed in high-permeability glacial-drift. The mean concentration of PCE in the diffusion samples was 1,152 parts per billion (ppb) and the mean from the peristaltic-pump samples was 1,119 ppb. The standard deviations also were similar. The mean concentrations of TCE were slightly higher in diffusion samples (89.2 ppb) than peristaltic-pump samples (75.4 ppb). The mean concentration of *cis*-1,2DCE in diffusion samples (95.0 ppb) was virtually identical to the mean in peristaltic-pump samples.

Although VOC concentrations changed dramatically at several wells over the sampled period, trends in VOC's detected using diffusion samplers corresponded with trends in VOC's from other low-flow sampling methods. For example, at two wells where coupled diffusion and peristaltic-pump samples were collected, VOC concentrations varied by a half order of magnitude over a two-month period. Although the diffusion sampler was installed and left in the well for the entire period, VOC concentrations in the diffusion sampler at the time of retrieval generally matched those in the instantaneous samples collected with the peristaltic pump on the same day, suggesting relatively rapid equilibration of the diffusion sampler to VOC concentrations in the well.

The use of diffusion samplers allowed for the understanding of contaminant transport conditions at the study site because it allowed for an increase in the frequency of sampling without an associated increase in labor cost. For example, spatially variable declines in PCE concentrations were identified over the two-year study that are related to spatial variations in sediment lithology and the location of the plume within the ground-water flow system. Wells screened in coarse-grained gravel layers and located

[1] New Hampshire Department of Environmental Services.
[2] U.S. Environmental Protection Agency.

along the northern part of the plume, close to the river boundary, showed the largest decline in concentrations of PCE. At several wells, concentrations of TCE and *cis*-1,2DCE increased, suggesting that small scale biodegradation is occurring. Temporary increases in concentrations of the primary VOC's followed several large recharge events, suggesting that VOC's are being desorbed from the aquifer matrix.

INTRODUCTION

The Savage Well Superfund Site, named after the former Savage municipal water-supply well for the Town of Milford, is underlain by a large (0.5 mi^2) plume of volatile organic compounds (VOC's) (figs. 1 and 2). The area is underlain by a highly transmissive sand and gravel aquifer. A discontinued tool manufacturing facility, has been identified as the primary source of volatile organic compounds (mostly tetrachloroethylene (PCE)) that led to contamination of the Savage well. The State of New Hampshire Department of Environmental Services (NHDES) and the U.S. Environmental Protection Agency (USEPA) have constructed a remedial system for the primary source area (fig. 3). The remedial system includes a barrier wall, which encapsulates the highest concentrations of dissolved PCE and most likely some dense non-aqueous phase liquids (DNAPL's), and various injection and extraction wells (vapor and water) to capture and treat the dissolved contaminant plume. The barrier wall was constructed from July to November 1998. Remedial operations of wells were tested between December 1998 to March 1999 but full operation started in May 1999.

The U.S. Geological Survey (USGS), in cooperation with NHDES, has established a detailed monitoring system for the source area that includes (1) continuous observations of ground-water levels and physical water properties, (2) manual measurements of ground-water levels to complement the continuous network, and (3) a geochemical and water-quality sampling program. Furthermore, a solute-transport model of the glacial-drift aquifer has been constructed and used to simulate the remedial system.

The main purpose of the geochemical and water-quality sampling program is to document the rate of clean-up of the VOC plume. The sampling program began in May 1997, using low-flow sampling procedures (described in a later section of the report). To facilitate the sampling program, passive diffusion sampling began in 1998 to provide high frequency sample collection to coincide with the beginnings of remedial operations. Passive diffusion sampling, using the method delineated in U.S. Patent No. 5,804,743, is an easy and inexpensive approach to sampling.

Passive diffusion sampling offers time-saving advantages over purged sampling following low-flow procedures. During this study, diffusion sampling was done in 1/5th the time of low-flow sampling; therefore, in an equivalent amount of time, five times as many samples were collected with diffusion samplers than with low-flow procedures. Previously, the frequency of VOC data collection in ground water was usually low because of the labor-intensive nature of sampling. Thus, standard guidelines for the collection of ground-water quality samples suggest a quarterly per annum time basis (Wiedemeier and others, 1998, p. 52) partly because of the infeasibility of increased sampling. A quarterly or longer sampling frequency, however, may be insufficient to characterize time trends. For example, seasonal variability of ground-water flow has been demonstrated by the primary author as a mechanism in increasing the transverse dispersion of contaminants in the aquifer and will complicate analysis of long-term trends. Furthermore, anthropogenic factors in the study area, such as construction and operation of the remedial system, also cause short- and long-term changes in VOC concentrations. The use of diffusion samplers allows for more frequent measurements thereby facilitating the identification of short- and long-term trends.

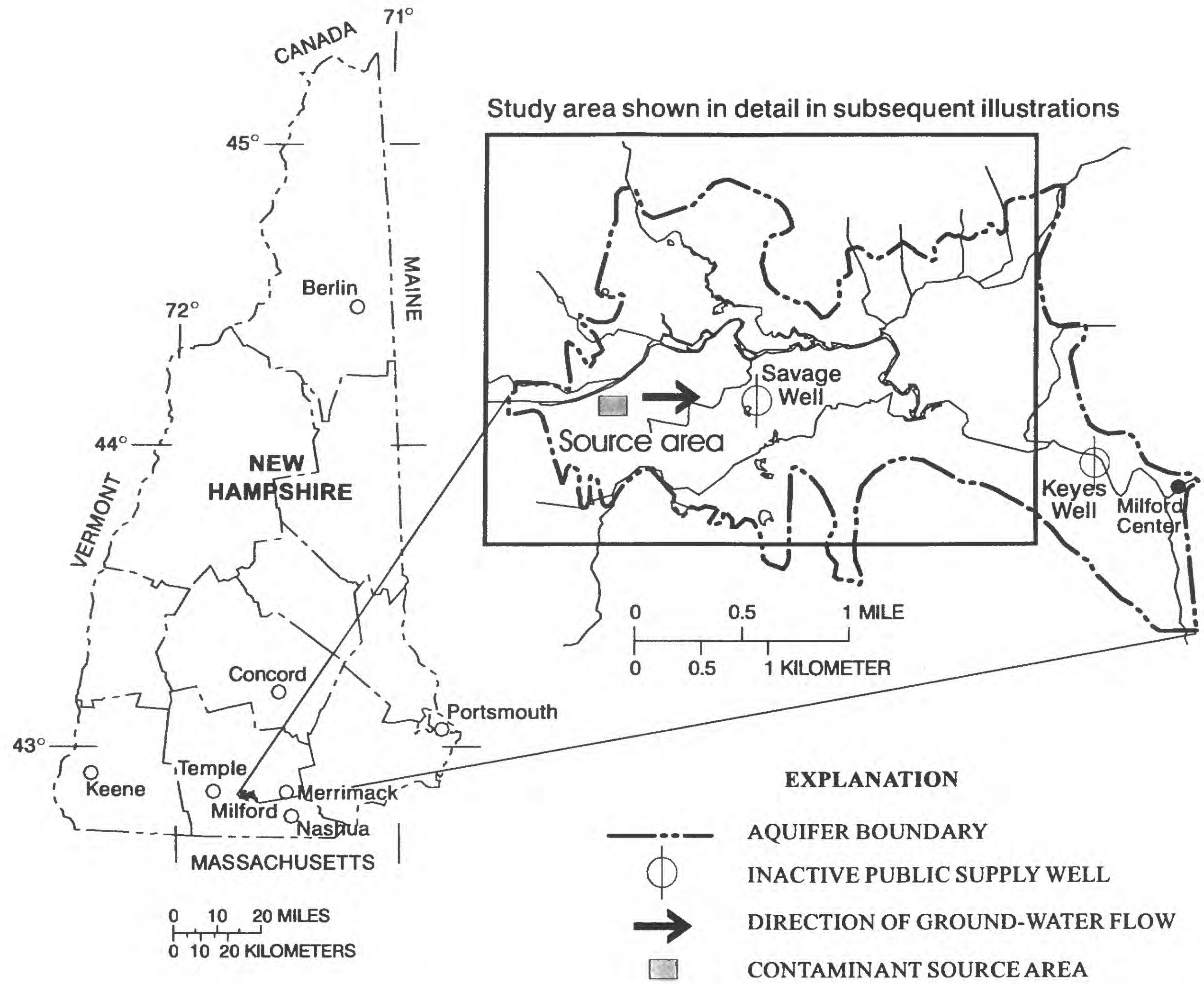
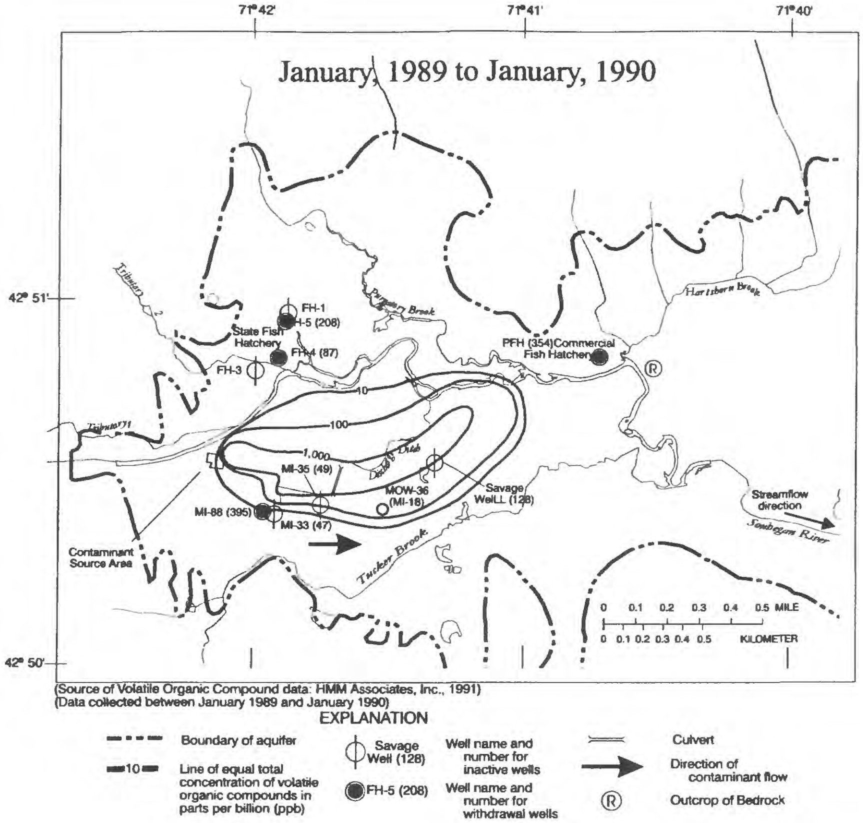


Figure 1. Location of the Milford-Souhegan Glacial-Drift aquifer, Milford, New Hampshire.

(A)



(B)

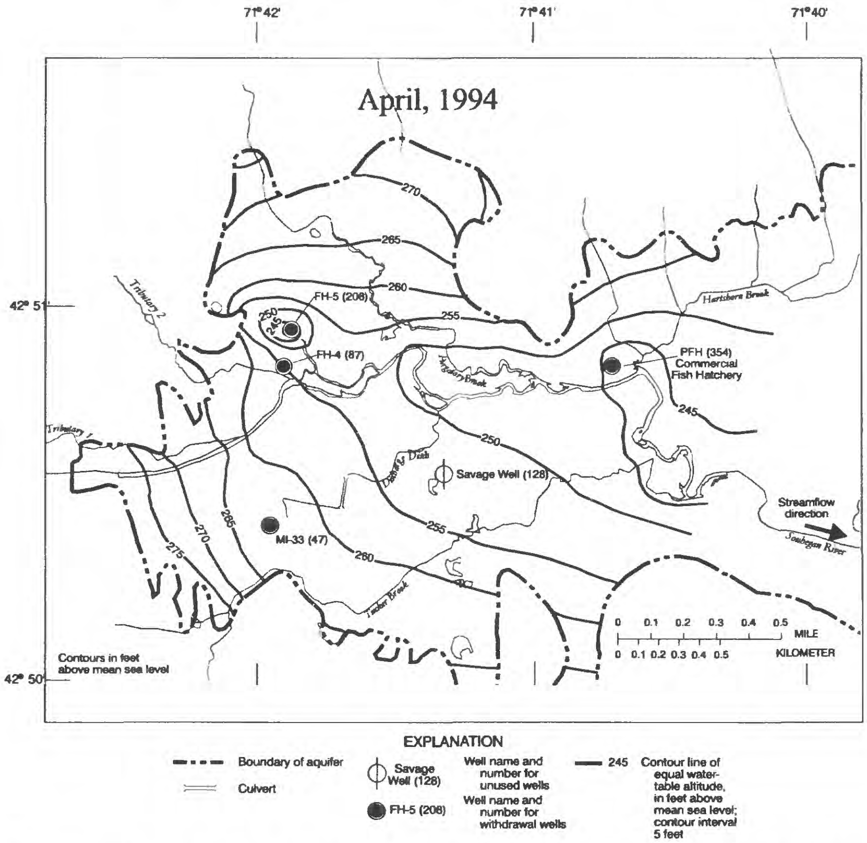


Figure 2. Extent of contaminant plume of total volatile organic compounds (A) and ground-water head contour map (B) in the Milford-Souhegan Glacial-Drift aquifer, Milford, New Hampshire.

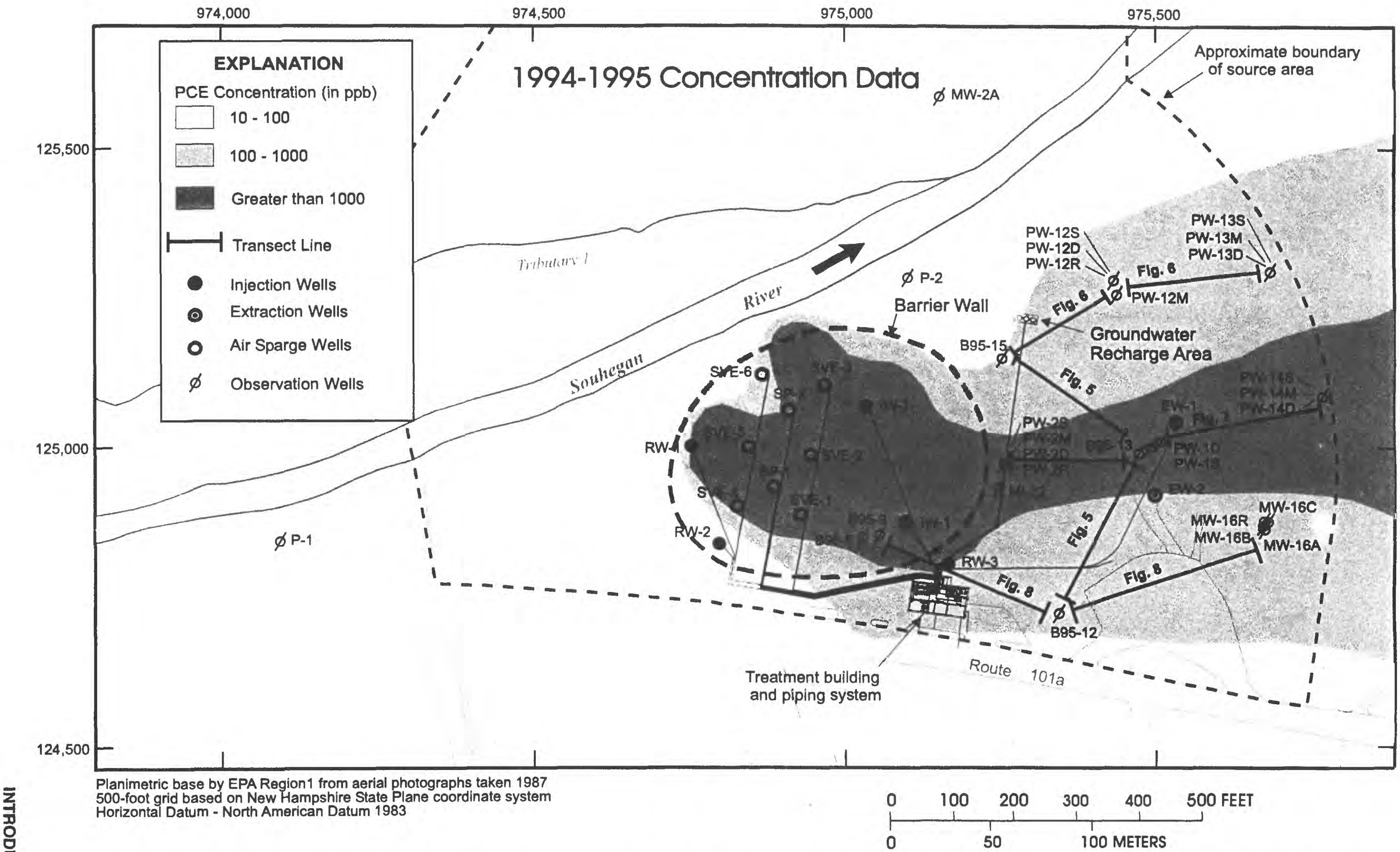


Figure 3. Remedial system, contaminant plume in source area, and monitoring wells at source area of the Savage Superfund Well Site, Milford, New Hampshire. (See table 3 for well construction information; see abbreviations page for well type)

Purpose and Scope

This report summarizes the results of a 2-year data collection effort (1997-99) to understand the temporal variability of VOC's in ground water at an area previously identified as the primary source of a large VOC plume. The report describes general geologic and geochemical characteristics of the source area, compares VOC concentrations in samples obtained by diffusion samplers and by other sampling methods, and presents an analysis of time trends of VOC concentrations.

Comparisons of results of VOC concentration in samples from passive samplers and collected by purged methods are presented for seven wells completed in unconsolidated, glacial drift. At two of the seven wells, testing of diffusion sampling included comparisons with more than one purged water-sampling device on more than one occasion. All purged water samples were collected following USEPA low-flow sampling procedures.

Time trends in concentrations of VOC's from diffusion samplers are presented for 16 wells (14 glacial-drift wells and two bedrock wells). Seven of the sixteen wells had diffusion-sampling results tested by comparing with purged water-sampling results as previously mentioned. At one other well, a bedrock well, diffusion-sampling results from a vertical string of samplers were compared to one purged sample.

The primary VOC's detected in the study area include tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethene (*cis*-1,2DCE). Other VOC's were detected but at levels insufficient for comparison.

Description of Study Area

The study area coincides with the area identified as the primary source area of VOC's to the Savage Well Superfund Site in Milford, New Hampshire (figs. 2 and 3). It is located in the western part of the Savage Well Superfund Site. The source area was the site of a now discontinued tool company where solvents were discharged into the subsurface for many years until the early 1980's. Although discharges have ceased, the underlying contaminant-soaked sediments and immiscible solvents continued to contaminate ground water flowing easterly underneath the site until a barrier wall was constructed. This large plume continues to threaten existing ground-water usage at State and commercial fish hatcheries (fig. 2) and restricts the full beneficial use of this resource.

The barrier wall is constructed of low permeability materials and encapsulates the highest concentrations of contaminants. The barrier wall encircles 0.008 mi^2 area. The wall fully penetrates the unconsolidated glacial drift (both stratified drift and glacial till) and sits atop the bedrock. Various injection and extraction wells (fig. 3 and table 1) were constructed to insure hydraulic isolation and reduce contaminant mass inside the barrier wall and to capture and treat the contaminants outside the barrier wall. PCE is the primary contaminant and it's maximum concentrations range from 100,000 parts per billion (ppb) inside the wall to 10,000 ppb outside the wall. Secondary VOC contaminants (TCE and *cis*-1,2DCE) concentrations are typically 1-2 orders of magnitude less than those of PCE.

The study area is underlain by up to 100 ft of sands and gravels, and a discontinuous till overlying a biotite granite and gneiss bedrock. Ground-water flow is to the east at velocities of up to several feet per day in the unconsolidated sediments. A partially penetrating river, called the Souhegan River, bounds the northwestern part of the source area. Here the river losses flow and recharges the aquifer on average of about 4 ft^3/s.

Previous Investigations of Diffusion Sampling

Methods for ground-water sampling continue to evolve over time. This evolution is driven by advances in understanding of ground-water flow and chemical transport in the aquifer and wells, improvements in equipment, and efforts to reduce sampling costs. Water-quality data collection practices at Superfund sites offer an example of the evolution in ground-water sampling. Retrieval of ground-water samples have utilized decreasingly smaller volumes and lower rates of pumpage since the advent of contaminant sampling. In the early to mid 1980's, samples (for analysis) were commonly collected only after the purging of large volumes of water at high pumping

Table 1. Well screen data and geology for selected wells in the study area

[All data in feet; altitude in feet above mean sea level, NGVD29; Aquifer code: S&G = sand and gravel, f-c= fine to coarse, G&S = gravel and sand, rk=bedrock, --, no data available; site type names explained in abbreviation section of report; all wells shown in figure 3 except PW-3, PW-4, PW-6, PW-8, and PW-10 cluster wells]

Well No.	Well name	Easting	Northing	Site type	Altitude of land surface	Top of opening below land surface	Bottom of opening below land surface	Depth to bed-rock below land surface	Screen material
46	MI-32	975247.2	124933.7	obswell	270.2	30.0	75.0	95	S&G
233	MW-16A	975671.2	124863.1	obswell	267.5	16.9	26.9	--	S&G
310	MW-2A	975148.9	125591.3	obswell	266.6	29.0	39.0	--	S&G
321	MW-16B	975671.0	124868.6	obswell	267.6	39.6	49.6	--	Sand,f-c
335	P-1	974088.3	124847.5	obswell	276.6	13.9	14.9	--	S&G
336	P-2	975100.9	125281.9	obswell	268.6	17.0	18.0	--	S&G
344	MW-16C	975678.1	124877.1	obswell	267.4	73.2	83.2	87.5	S&G
345	MW-16R	975670.8	124875.2	obswell	266.5	88.0	138.0	87.5	rock
404	B95-09	975039.81	124825.60	obswell	270.31	10.0	20.0	--	S&G
407	B95-12	975343.81	124724.70	obswell	269.45	55.0	60.0	76	G&S
408	B95-13	975490.62	125002.0	obswell	267.01	60.0	65.0	90.5	S&G
409	B95-15	975254.0	125149.40	obswell	269.61	85.0	95.0	96.5	G&S
531	PW-1D	975507.1	125010.99	obswell	266.88	84.48	94.48	94	Till/rk
535	PW-2R	975254.74	124973.56	obswell	268.92	113.9	133.93	102	rock
536	PW-3S	975059.0	125239.0	obswell	269.83	19.76	29.76	--	S&G
537	PW-3D	975059.1	125239.1	obswell	269.84	84.85	94.85	94.5	S&G
538	PW-4M	974970.0	124767.0	obswell	271.81	31.87	41.87	--	S&G
539	PW-4D	974970.1	124767.0	obswell	272.01	62.0	72.0	70	S&G/rk
543	PW-6S	975016.0	124942.0	obswell	276.65	23.63	33.63	--	S&G
544	PW-6M	975016.1	124942.1	obswell	276.37	40.39	50.39	--	S&G
545	PW-6D	975016.2	124942.2	obswell	276.98	87.6	97.6	94	S&G/rk
546	PW-6R	975016.3	124942.3	obswell	276.32	101.04	111.04	95	rock
549	PW-8M	974856.2	125140.4	obswell	273.34	31.37	41.37	--	S&G
551	PW-10M	975152.0	125127.0	obswell	273.98	50.15	60.15	--	S&G
552	PW-10D	975152.1	125127.1	obswell	273.80	94.71	104.71	--	S&G
555	PW-12S	975432.0	125281.0	obswell	265.73	18.1	28.1	--	S&G
556	PW-12M	975437.17	125255.65	obswell	265.81	57.8	68.0	--	S&G
557	PW-12D	975432.20	125281.20	obswell	265.69	87.0	97.0	--	Sand
558	PW-12R	975432.30	125281.30	obswell	265.66	113.9	134.0	100	rock
559	PW-13S	975682.00	125294.00	obswell	267.68	20.3	30.3	--	S&G
560	PW-13M	975682.10	125294.10	obswell	267.86	59.8	70.0	--	S&G
561	PW-13D	975682.20	125294.20	obswell	267.55	94.3	104.35	103	Gravel/rk
562	PW-14S	975765.00	125085.00	obswell	266.76	20.03	30.03	--	S&G
563	PW-14M	975765.10	125085.10	obswell	266.76	60.0	70.0	--	Sand,c-f
564	PW-14D	975765.20	125085.20	obswell	266.77	102.71	112.71	111.5	Sand,c-f/rk
565	EW-1	975535.23	125046.05	extrawell	266.88	63.55	93.55	--	S&G
566	EW-2	975492.89	124936.25	extrawell	267.05	51.22	81.22	81.5	S&G
567	IW-1	975105.37	124871.14	extrawell	272.4	78.32	108.32	108.3	Sand
568	IW-2	975037.83	125068.37	extrawell	277.03	78.32	108.32	--	S&G
569	RW-1	974751.80	125000.52	injwell	273.67	31.65	41.65	--	Gravel
570	RW-2	974799.44	124838.74	injwell	273.38	22.04	32.04	--	S&G
571	RW-3	975168.45	124805.82	injwell	269.96	18.450	28.450	--	Gravel
572	SP-1	974885.08	124935.83	Sparwell	274.45	60.66	65.66	66.8	Sand
573	SP-2	974910.85	125063.90	Sparwell	275.34	59.71	64.71	--	Sand
574	SVE-1	974927.14	124888.11	airwell	274.99	8.37	23.36	--	--
575	SVE-2	974946.49	124988.03	airwell	276.25	9.41	24.41	--	--
576	SVE-3	974966.91	125106.60	airwell	273.38	12.34	27.34	--	--
577	SVE-4	974828.74	124901.85	airwell	274.02	12.66	27.66	--	--
578	SVE-5	974846.81	125001.08	airwell	274.76	7.870	23.87	--	--
579	SVE-6	974870.28	125128.88	airwell	273.7	12.39	27.39	--	--

rates. Typically, a minimum of three casing volumes of water were extracted from the well prior to sampling as an attempt to obtain representative water samples. High turbidity in the water samples, a common effect of large volume pumping, was reduced by filtering. Continuing research in contaminant transport found that high rates and volumes of pumping resulted in a number of undesirable effects—such as problems in disposing of contaminated water, and mobilization of particulates surrounding the well as witnessed by high turbidity. The presence of large particulates in sampled water could elevate concentrations of contaminants even if filtration is used and potentially overexaggerate the magnitude of contaminant transport because these particles are mobilized only locally around a pumped well.

With the advent of low-flow and low-volume sampling methods (Pohlmann and others, 1994; McFarlane, 1996), less turbulent approaches have been developed that seek to minimize the entrainment of large locally mobile particulates suspended in the water sample. An extension of this low-flow, less turbulent trend is the passive (no purge) sampling approach and specifically, diffusion sampling (Vroblesky and Hyde, 1997). Diffusion sampling and(or) samplers, as the name implies, work on the principle of diffusion: the movement of chemical compounds as a consequence of concentration gradients. Water-diffusion samplers consist of deionized, contaminant-free water enclosed in polyethylene bags (fig. 4), which are suspended in wells in a mesh sleeve or section of slotted pvc pipe. Contaminants in the well water such as chlorinated VOC's and aromatic VOC's are able to diffuse through the polyethylene bag into the previously contaminant-free water until the concentrations in the bag water and well water equilibrate.

Two types of passive-diffusion samplers have been used in previous studies—a water-vapor sampler and a water-water sampler (like that used for this study). The water-vapor sampler consists of a 40 mL glass vial enclosed in a water-free sealable polyethylene bag. Concentrations of VOC's in the vapor phase can range from 0.27 to 27.3 times higher than in the water phase (Mullaney and others, 1999). Therefore, it is difficult to infer a correlation between concentrations in water-vapor samplers and water-water samplers. For this reason, water-vapor diffusion method should not be used to infer ground-water concentrations.

Water-vapor samplers were used by Vroblesky and Robertson (1996) to collect time-series VOC data and to monitor changes in VOC concentrations of ground water discharging to surface-water bodies. Previous studies using water-water samplers include work at several Air Force Bases [Hanscom Air Force Base in Massachusetts (Forest Lyford, U.S. Geological Survey, oral commun., 1999); and McClellan Air Force Base in California (Parsons Engineering Science, Inc., 1999)]. In both those studies, VOC concentrations from diffusion samplers compared favorably to VOC concentrations from purged water samples collected in accordance with low-flow procedures (also used in this study). Vroblesky and Hyde (1997) found that the concentrations of VOC's (primarily PCE, TCE, *cis*-1,2DCE, *trans*-1,2-dichloroethene (*trans*-1,2DCE), 151-DCA, and vinyl chloride (VC)) in water-diffusion samples retrieved at five wells during one-round of sampling were within 10 percent of concentrations in samples retrieved by submersible and bladder pumps and bailers.

Diffusion sampling may not be an effective sampling method for all VOC's. VOC's with low vapor pressures and(or) extremely high solubilities may not reach equilibrium between the water column and the contents of the sampler within a reasonable time frame (Paul Hare, General Electric Company, written commun., 1999). For example, acetone was observed not to reach equilibrium after 10 days, while most of the chlorinated solvents quickly reached equilibrium within several days.

Acknowledgments

This study, which is part of a larger remedial effort of the Savage Well Superfund Site, is a collaborative effort between Federal, State, and local governments, and private companies and individuals. The authors wish to express thanks to Richard Goehlert, remedial project manager of the Savage Well Superfund Site of the U.S. Environmental Protection Agency, Region 1; Thomas Andrews of the New Hampshire Department of Environmental Services; and Joseph Newton of Camp, Dresser, and McKee, Inc., for their cooperation and support. Methane data were analyzed by Cindy Mosedale and Dean Moosavai of the University of New Hampshire. Total organic carbon data were analyzed by Dr. William McDowell also of the University of New Hampshire. The

(A)

(B)

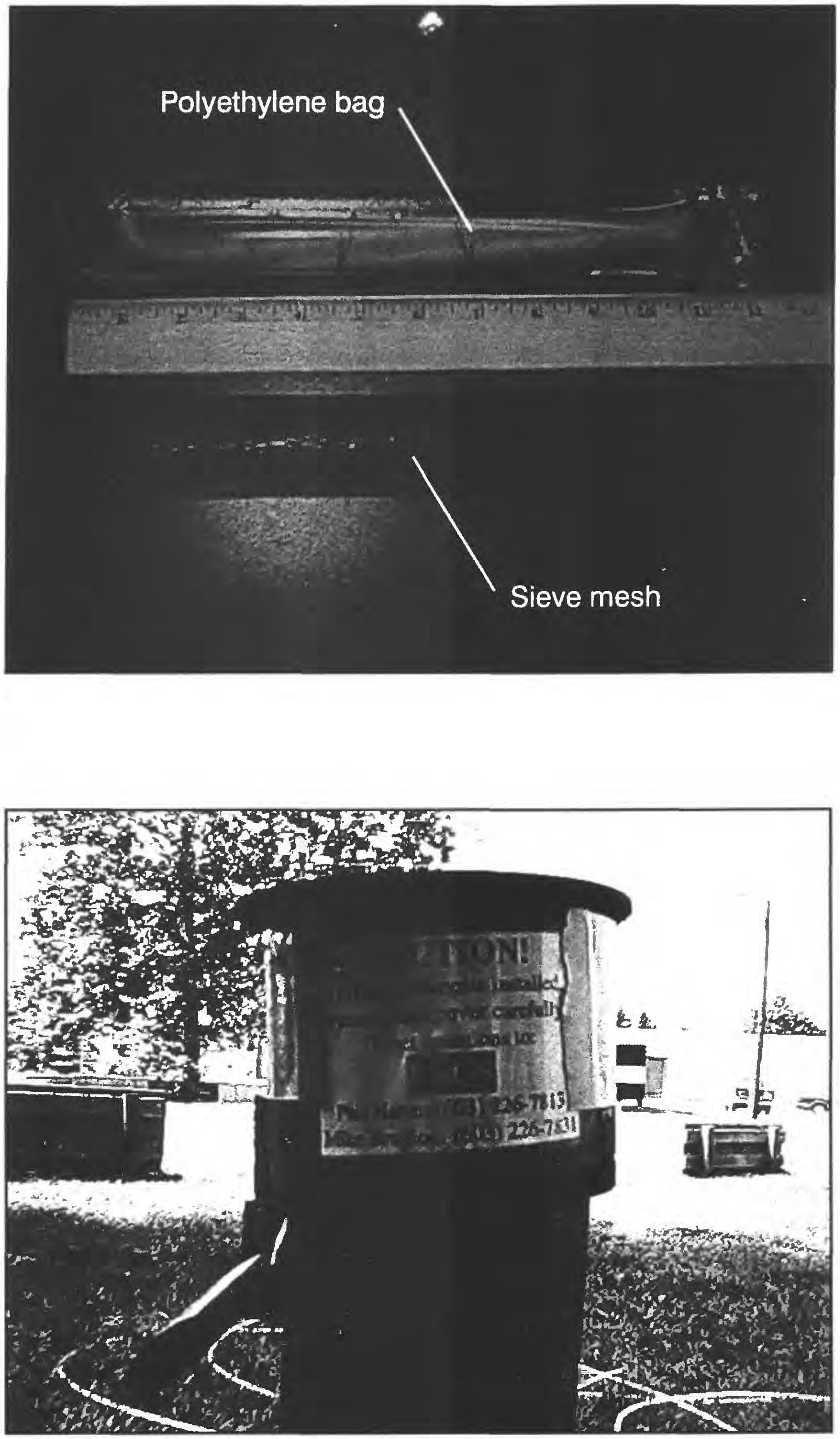


Figure 4. Diffusion sampler (A) and well identifier (B) used to label wells.

majority of the VOC analyses and geochemical analyses were done by the New Hampshire Department of Environmental Services Laboratory. Scott Clifford of the U.S. Environmental Protection Agency, Region 1, also performed additional VOC analyses with the U.S. Environmental Protection Agency, Region 1 Mobile Laboratory.

HYDROGEOLOGIC SETTING

The unconsolidated sediments beneath the study site consist of up to 100-ft thick deposits of predominantly sand and gravel. Borehole geophysical logs (natural gamma and electromagnetic conductivity) and lithologic logs from wells along a north to south transect of the site (fig. 5) and west to east transect (figs. 6-8) show the sand and gravel sequences are interspersed with discontinuous finer grained sands at depths of 40 ft and 70 ft. Coarse-grained deposits (cobbles and gravels) occur at the uppermost layer near the water table (at a depth of 6-14 ft), at around 60 ft, and at the base of the unconsolidated sediments at 90 ft. Till, which discontinuously mantles the bedrock, is thickest to the west (not shown on figures) and thins to the east.

The stratigraphy appears to suggest a sequence of multiple glacial advances. The deep, coarse-grained deposits at 85-90 ft below land surface (figs. 5-8) suggest that subglacial meltwater may have contributed to deep erosion into the bedrock from the glacier. The remaining deposits suggest meltwater deposition in the form of deltas, outwash, and lastly a glacial outburst deposit as witnessed by the coarse cobble zone near the uppermost sequence.

Ground water flows easterly through the study area and receives recharge from the Souhegan River, which loses an average of approximately 4 ft^3/s to the aquifer. Water-table maps from pre- and post-wall construction indicate that construction of the low-permeability barrier wall has not impeded recharge from the Souhegan River (fig. 9). The direction and magnitude of maximum ground-water gradients computed from a three-point planar solution (Johnston and Harte, 1998) for the downgradient side of the site shows that completion of the barrier wall in November 1998, coupled with operation of extraction wells (EW1 and EW2, fig. 3) since mid-May 1999, have moderated variations in direction of gradients (fig. 10a) and increased the maximum gradients (fig. 10b).

GEOCHEMISTRY OF WATERS

The geochemistry of ground water is an important factor in assessing the potential for biodegradation of chlorinated aliphatic compounds like PCE and will therefore affect analysis of time trends. Processes such as reductive dechlorination occur when electron donors are available and competing electron acceptors are eliminated (Wiedemeier and others, 1998). The principal electron donor in the absence of anthropogenic sources is organic carbon in the aquifer. Electron acceptors include oxygen, nitrate, iron, and sulfate.

The sampled waters at the site are characterized by low total organic carbon (TOC) (less than 2 mg/L). A listing of median concentrations of key geochemical parameters, grouped by uncontaminated and contaminated wells and by depth of well (shallow, medium, and deep) is given in table 2. TOC ranges from 0.83 to 1.67 mg/L. Dissolved oxygen decreases with depth and is lower in contaminated wells than in uncontaminated wells. Whereas oxygen levels appear to be reduced in the contaminated parts of the aquifer, other electron acceptors show no appreciable difference between uncontaminated and contaminated wells. Chloride concentrations are affected at the site by road-salting along the southern part of the plume, which skews comparisons between background and contaminated areas. In general, the geochemical data suggest that ground waters underneath the site are not conducive to widespread biological degradation of PCE at rapid rates (such as with degradation half lives of 1 year or less) over a large part of the source area.

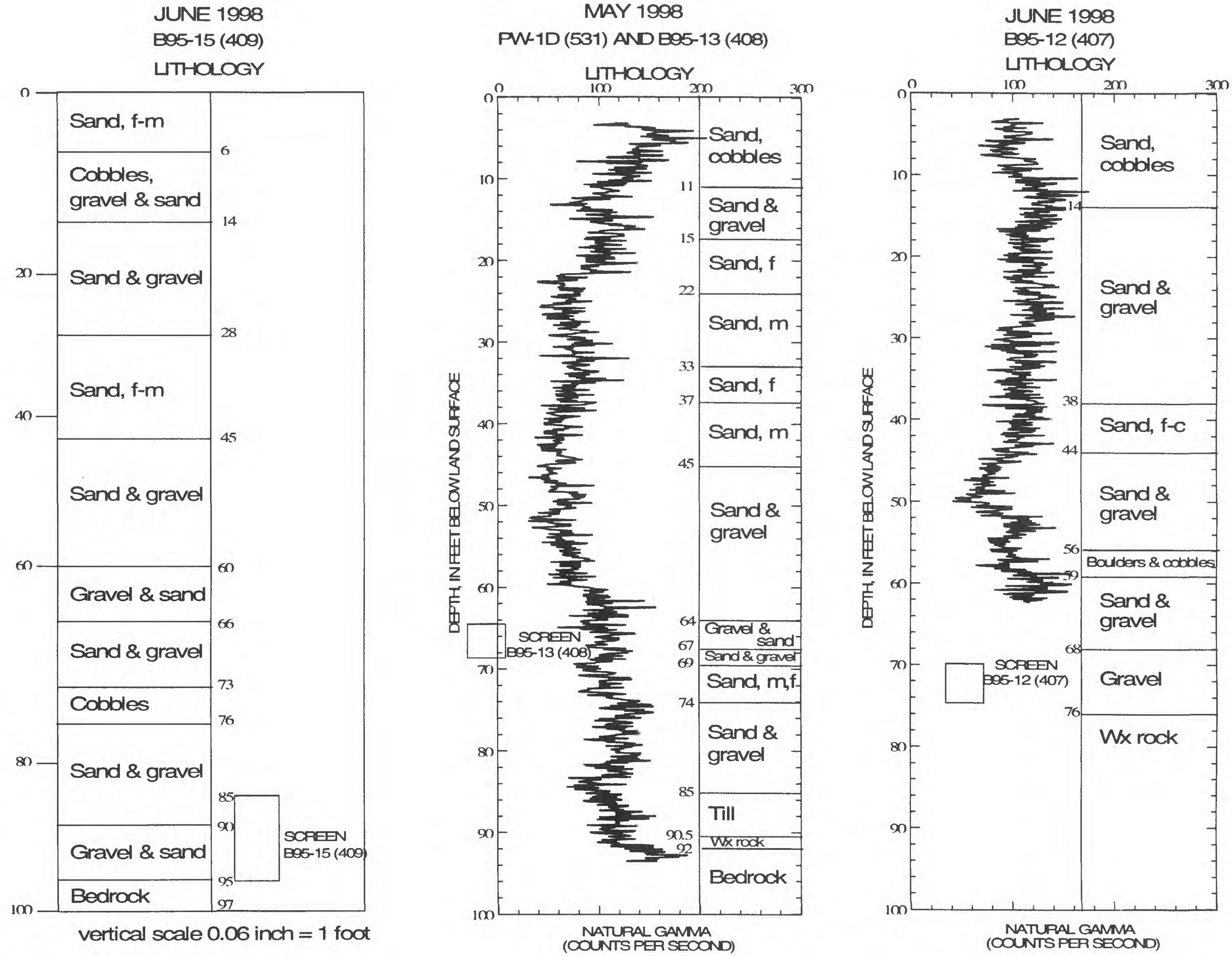


Figure 5. Lithologic and borehole logs for wells in the source area along a north to south transect, including wells B95-15, B95-13, and B95-12. (See abbreviations page)

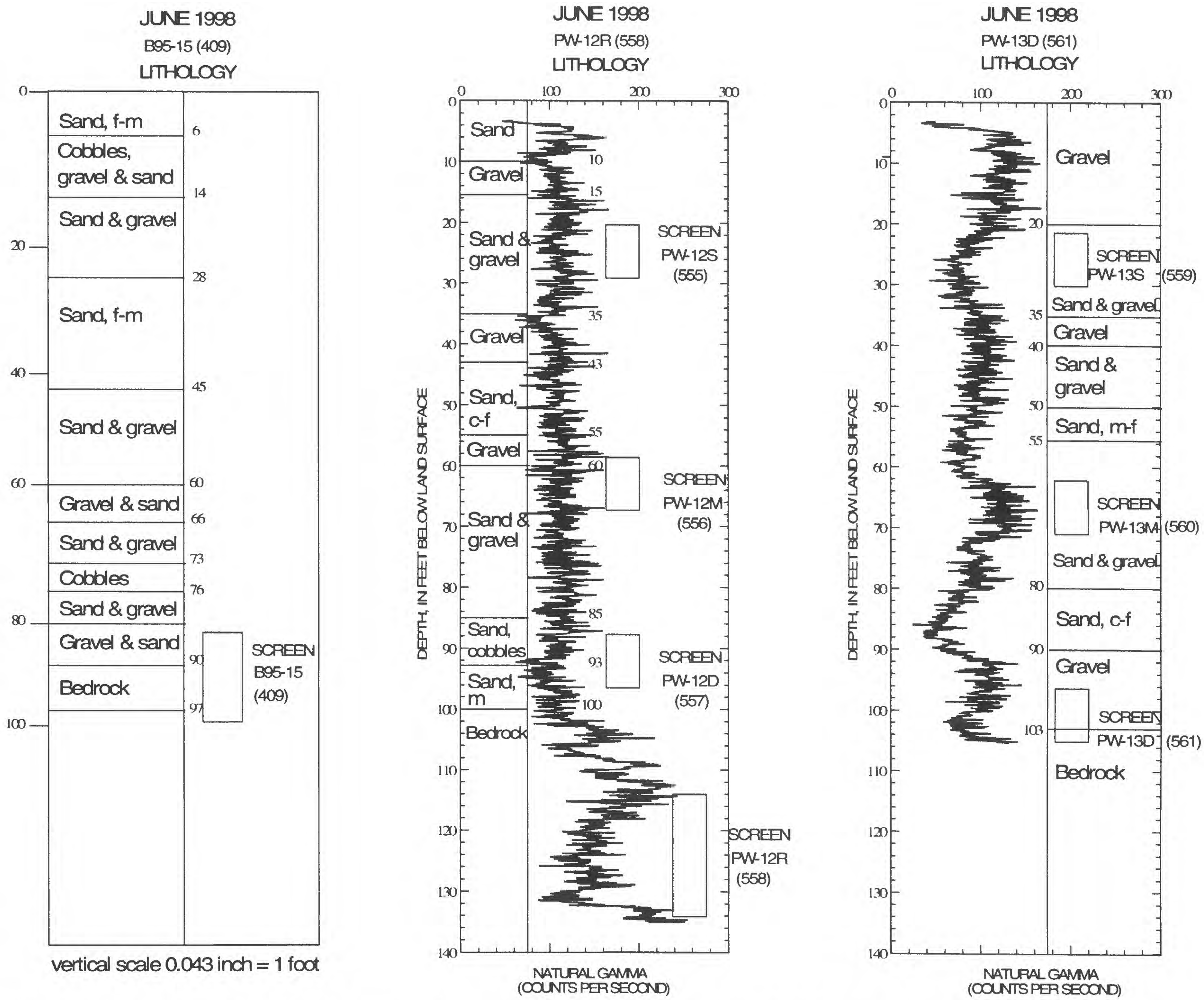


Figure 6. Lithologic and borehole logs for wells in the source area along a west to east transect, including wells B95-15, PW-12R, and PW-13D. (See abbreviations page)

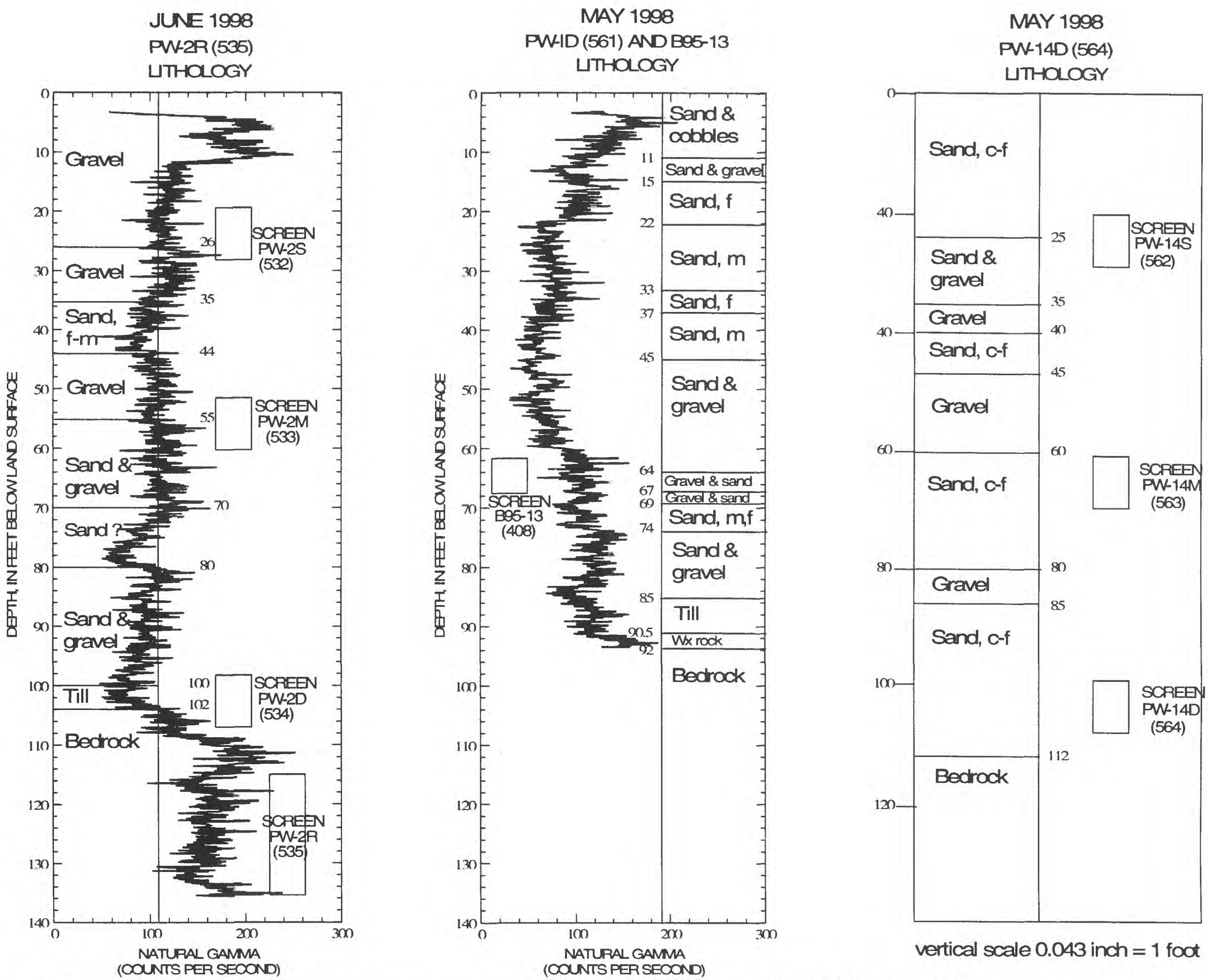


Figure 7. Lithologic and borehole logs for wells in the source area along a west to east transect, including wells PW-2R, B95-13, and PW-14D. (See abbreviations page)

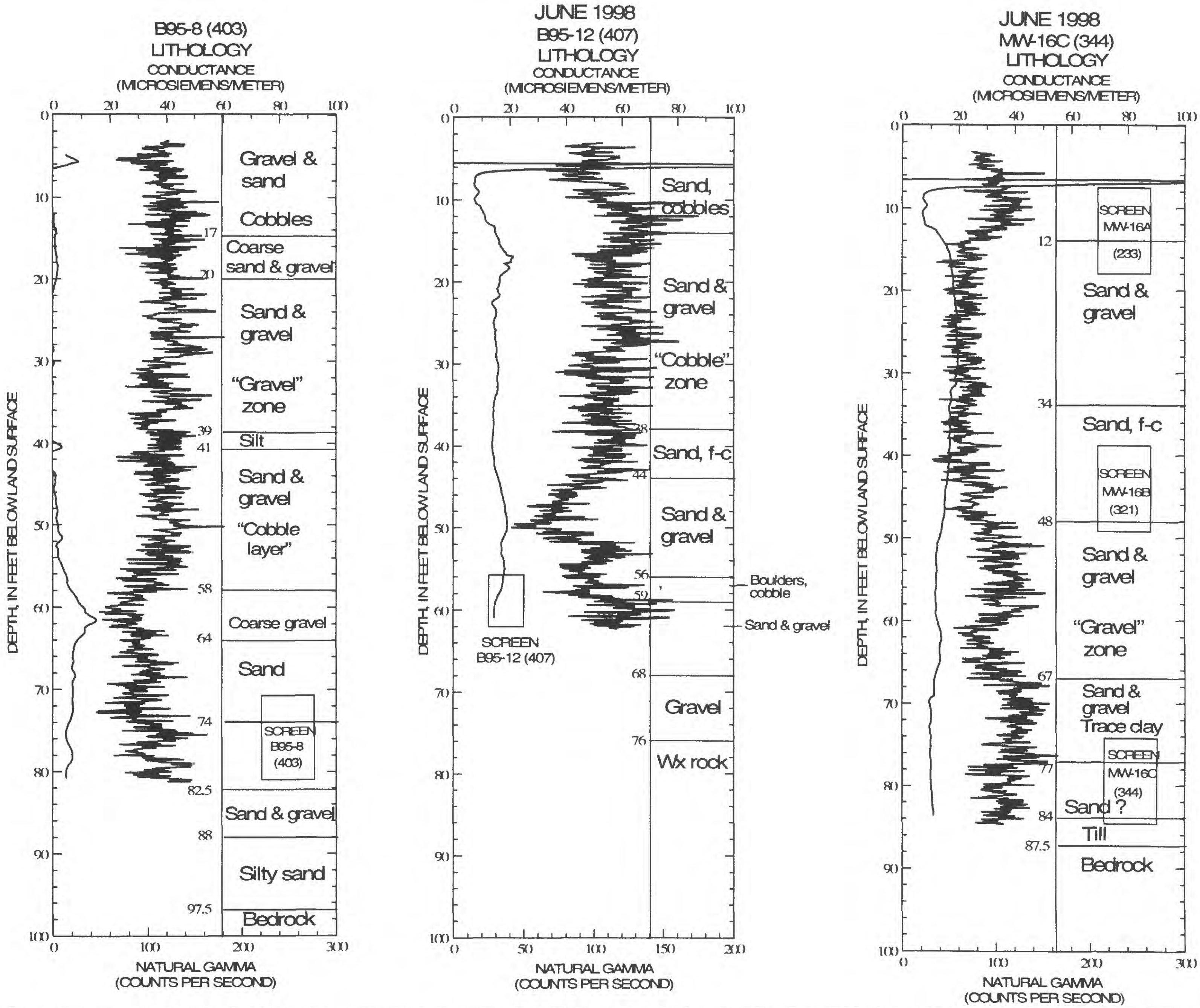


Figure 8. Lithologic and borehole logs for wells in the source area along a west to east transect, including wells B95-8, B95-12, and MW-16C. (See abbreviations page)

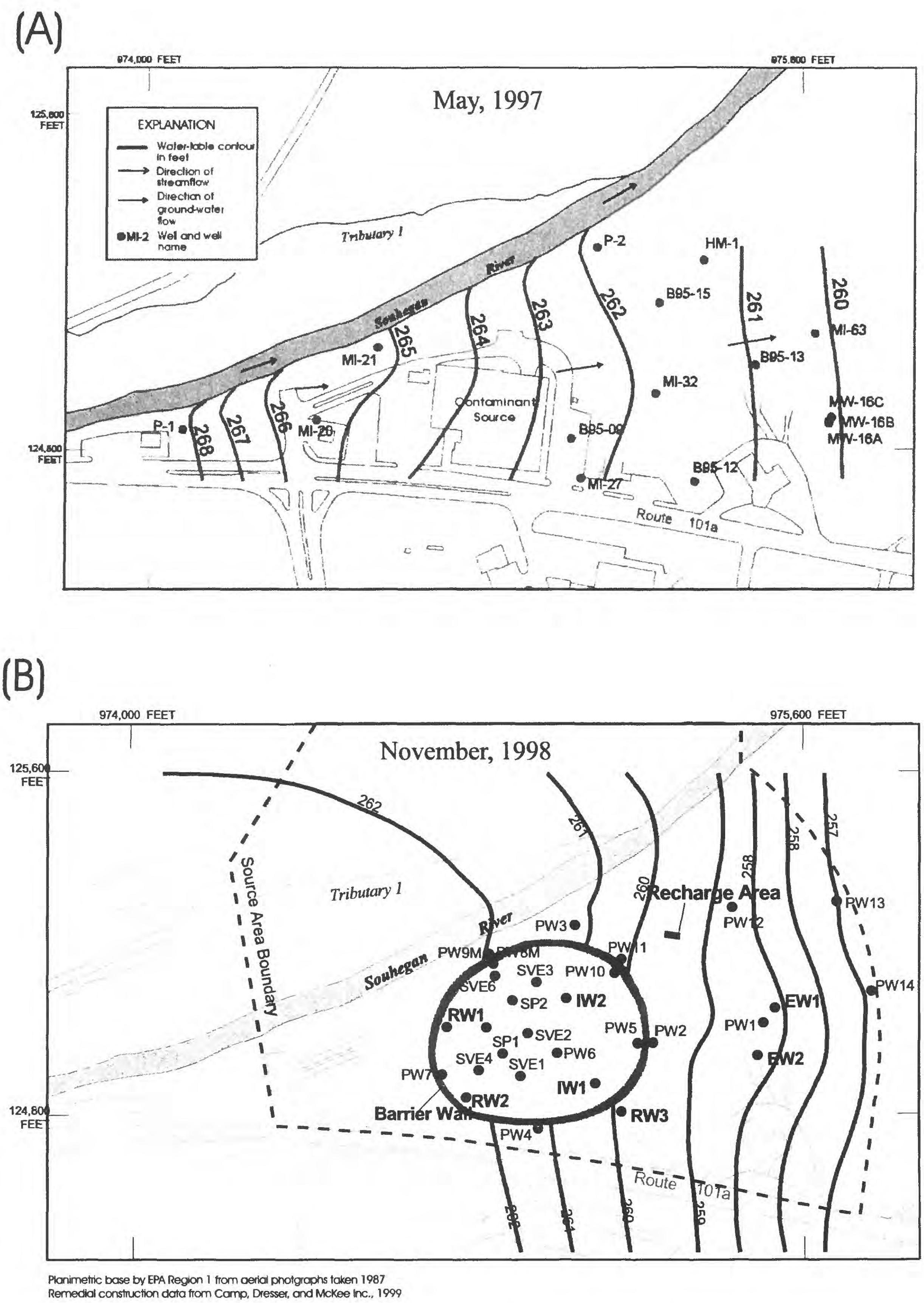
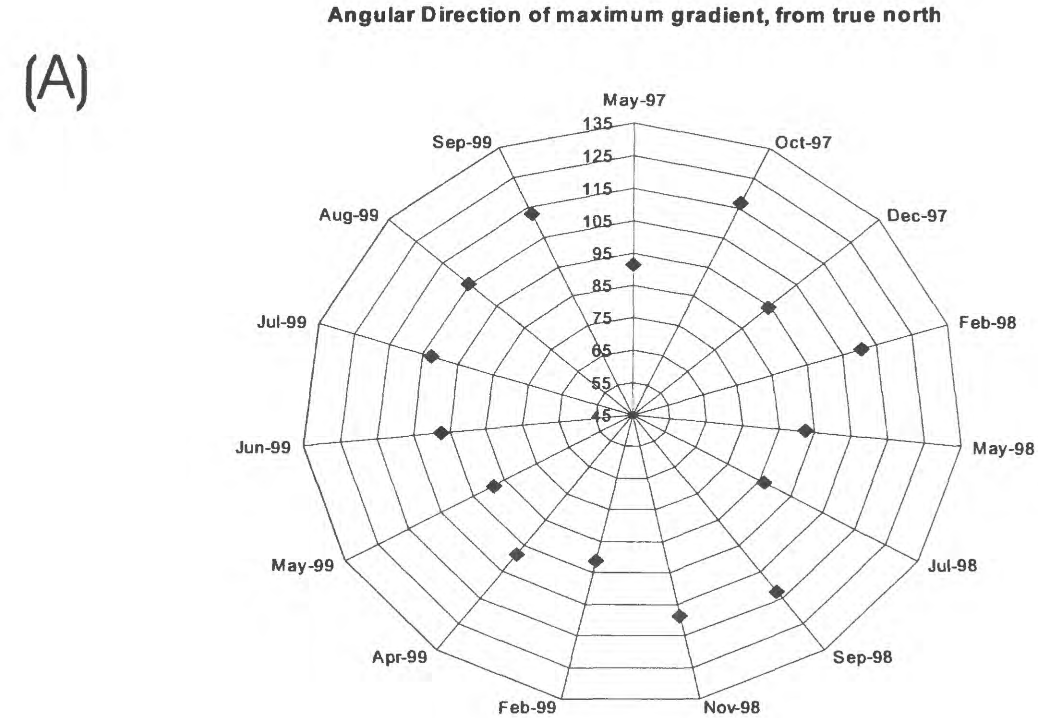


Figure 9. Water-table surface for pre-remedial construction (May 1997) (A) and post-remedial construction (November 1998) (B).



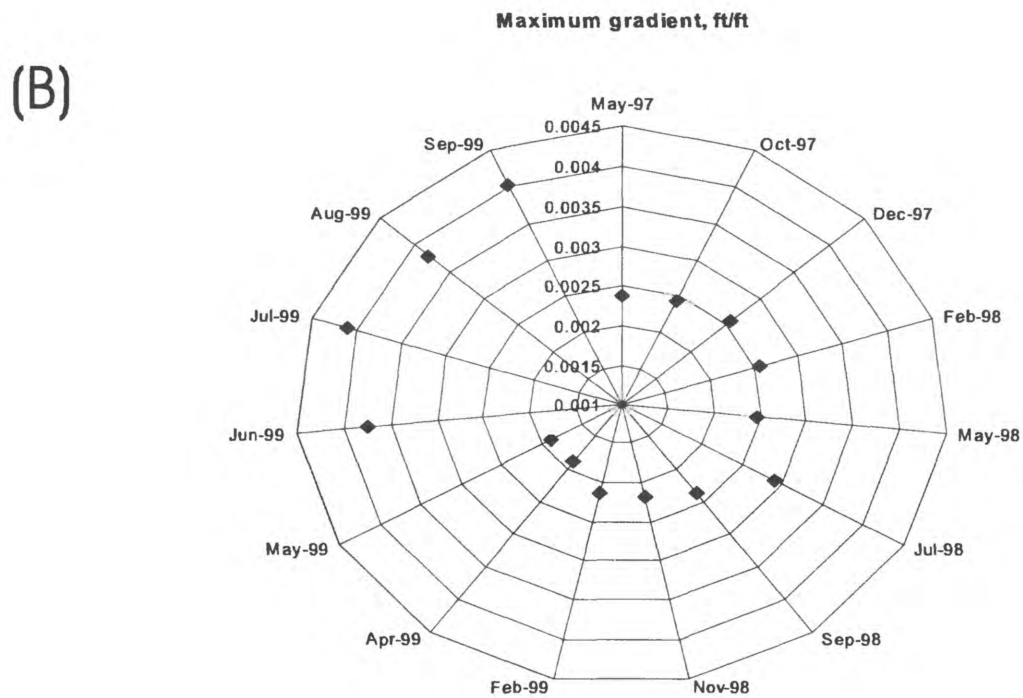


Figure 10. Angular direction of maximum ground-water gradient from true north (A) and gradient (B) computed from three-point planar solution from wells B95-12, B95-15, and B95-13.(Well locations shown in figure 3)

Table 2. Median concentrations of key geochemical parameters in uncontaminated and contaminated with volatile organic (compounds) water samples from the study area

[Deep wells greater than 80 feet; Medium wells from 40-80 feet; Shallow wells are from 0-40 feet below land surface; mg/L means milligram per liter; ppm means part per million; < means less than; data from May 1997 to April 1999]

	Deep wells		Medium wells		Shallow wells	
	Uncontaminated	Contaminated	Uncontaminated	Contaminated	Uncontaminated	Contaminated
Number of samples	5	10	17	12	15	4
pH	6.3	7.11	5.83	5.86	5.9	5.8
Eh	214	0	279	292	194	230
Dissolved oxygen (mg/L)	0.4	0.55	3	0.7	2	0.8
Carbon dioxide (mg/L)	15	18.8	20.5	25	23.5	30
Water temperature (degrees celsius)	11.5	13.6	12.1	11.1	11	11.4
Ferrous iron (mg/L)	0	0	0	0	0	0
Methane (ppm)	3.5	3.0	1.79	3.15	1.91	6.1
Total organic carbon (mg/L)	0.83	0.94	1.13	0.86	1.67	0.9
Alkalinity (mg/L as $CaCO_3$)	17.5	58.4	9.2	14.8	13.5	15
Nitrate (mg/L)	<0.05	0.32	0.34	0.55	0.12	1.03
Nitrate+nitrite (mg/L)	<0.05	0.72	1.3	0.55	0.27	1.79
Sulfate (mg/L)	9	12	13	10	11	24.5
Chloride (mg/L)	9	29	13	21	20.5	22.5

METHODS OF DATA COLLECTION

Well data are referenced by local name as assigned by driller or principal investigative party. Well data are also referenced in several locations by a project number to allow for cross-referencing in this report, as well as with previous reports of the area. For example, well B95-15 is the principal local name and well number 409 is the number assigned by the project. Only the principal local name will be used in the report after the first cross reference.

Description of Chemical-Monitoring Program

From May 1997 to April 1999, water samples were collected bimonthly at a minimum of 2 wells (B95-15 (well number 409) and B95-13 (well number 408) and a maximum of 6 wells (B95-15, B95-13, B95-12 (well number 407), PW-13M (well number 560), PW-14M (well number 563)(fig. 3)). Samples were collected by multiple methods including diffusion samplers and low-flow purged samplers: peristaltic, bladder, and Voss pumps. Additional wells were sampled using low-flow sampling techniques on several occasions including May 1997, June 1997, December 1997, May 1998, July 1998, September 1998, November and December 1998, and April 1999. From May 1999 to September 1999 samples were collected with diffusion samplers.

A list of constituents analyzed, methods of analysis, and detection limits is provided in table 3. Measured constituents are subdivided by field and laboratory methods. Samples for analysis of volatile organic compounds were collected in 40 mL septum vials and analyzed within 2 weeks of sample collection by USEPA method 8260B (U.S. Environmental Protection Agency, 1996a). Samples were analyzed by State of New Hampshire Department of Environmental Services Laboratory. During a detailed sampling test in April 1999, a USEPA, Region 1 mobile laboratory was used to analyze samples. Aqueous samples were analyzed using USEPA Region's 1 standard operating procedures for head-space screening for VOC's with a Shimadzu Gas Chromotogram 14A equipped with a 30 m, 0.53 mm DBPS-624 column and a photoionization detector (PID). Concentrations were calculated using the external standard technique (Clifford, Scott, U.S. Environmental Protection Agency, written commun., 1999).

Table 3. Instruments used, instrumentation method code, and method detection limits, for analyses of water samples

[A complete listing of constituent names are provided in appendix 2; cm mean centimeter; mg/L means milligrams per liter; ppm means part per million; NTU means neophelometric turbidity units; EPA means Environmental Protection Agency]

Location of analysis	Constituent	Instrument or method code	Method detection limit or range
Field	Temp	YSI Model 54A Oxygen Meter	1.0 degrees Celsius
	SC	Hach Model 44600 Conductivity/TDS Meter	0.1 micro-seimens/cm
	pH	Orion 915600 combination pH probe	0.02 pH units
	DO	YSI Model 54A Oxygen Meter	0.1 mg/L
	DO	Chemetrics kit 7501,7512	0-1 ppm,1-10 ppm
	CO_2	Chemetrics kit K1910	10-100 ppm
	Fe^{2+}	Hach kit #26672	0.0-10.0 mg/L
	Turbidity	Hach 2100P turbidimeter	0.01-1000 NTU
	Eh	Orion 9678BN ion selective probe	millivolts
Laboratory	NH^{4+}	EPA 350.1	0.25 mg/L
	S_{2-}	EPA 376.2	0.1 mg/L
	Cl-	EPA 325.2	2 mg/L
	SO_4^{2-}	EPA 300.0	1 mg/L
	NO_2- and NO_3-	EPA 353.2	0.05 mg/L
	NO_3-	EPA 353.2	0.05 mg/L
	NO_3-	Chemetrics R6923 after 12/98	0-70 mg/L
	NO_2-	EPA 353.2	0.05 mg/L
	PO_4^{3-}	EPA 365.3	0.001 mg/L
	CA^{2+}	EPA 200.7	1 mg/L
	Fe total	EPA 200.7	0.05 mg/L
	Mg^{2+}	EPA 200.7	0.1 mg/L
	Mn^{2+}	EPA 200.7	0.01 mg/L
	K+	EPA 200.7	0.4 mg/L
	Na+	EPA 200.7	1 mg/L
	CH_4	Methods described by McAuliffe (1971) and Crill and others, (1988)	0.01 mg/L
	TOC	EPA 415.1	2 mg/L
	Br-	Orion 9635BN ion selective probe	0.001 mg/L
	$CaCo_3$	Titration to 4.5 endpoint using Hach digital titrator	0.1 mg/L
	Volatile organic compounds	EPA Schedule 8260	0.002 to 0.250 mg/L

Sampling Methods and Techniques

Ground-water samples for VOC analysis were collected by four different sampling techniques: diffusion sampler, peristaltic pump, Voss sampler, and bladder pump. Purged samples using pumps were collected on the same day immediately after diffusion samplers were retrieved. Samples were collected in order of increasing cumulative volume purged in the following sequence: diffusion, Voss, peristaltic, and bladder. For the peristaltic and bladder pumps, samples were collected according to USEPA, Region 1, Standard Operating Procedures (SOP) for low-flow purging and sampling (U.S. Environmental Protection Agency, 1996b).

Diffusion-bag samples were placed at the midpoint of a well screen from a typical period of 2 weeks to 2 months. Diffusion-bags samples were created from a sealed polyethylene bag filled with VOC-free-deionized water. After retrieval of the bags from the well, a small hole is cut in the bag and contents are poured into a 40-mL septum vial. Bags were enclosed in either a mesh screen or a short section of polyvinyl-chloride (PVC) screen and suspended in the well with teflon coated wire and a stainless steel weight. The steps involved in the preparation, installation, and retrieval of diffusion samplers are described in appendix 1.

A Voss sample was collected once at one well. A Voss sampler is a modified bailer approach to sampling. An inflatable bladder above the bailer separates the water in the well casing from the water in the well screen. A pump inside the bailer extracts water from the volume below the bladder and discharges water above the bladder. Bladder integrity can be monitored by the rise in water levels in the sealed water column above the bladder. After extracting a minimum of one volume of water from the sample interval, the pump is shut off and the bailer removed to the surface where water samples are drawn from the bailer. For the well sampled, the top of the Voss sampler was lowered to 1.0 ft above the top of the well screen. At this depth, the sampler intake is at the midpoint of the well screen and the bladder is at 0.8 ft above the top of the screen. Purging lasted for 7 minutes at a rate of 0.71 L/min or 1.4 volumes of water from the sample interval. Because no water discharges to the surface, no field parameters were monitored during purging. The Voss sampler was then withdrawn to land surface and the contents of the sampler were then poured into a 40-mL septum vial.

Peristaltic-pump samples were collected by inserting a dedicated polyethylene tube for each well at the midpoint of the well screen, attaching the tube to the pump, and purging water following low-flow sampling techniques. Field parameters monitored during purging include water level, pumping rate, specific conductance, pH, Eh, dissolved oxygen, water temperature, and turbidity. Specific conductance, pH, Eh, dissolved oxygen, and water temperature were monitored in a flow-through chamber. In addition, for about 20 percent of the samples, downhole dissolved oxygen and water-temperature probes were placed directly below the purge intake for comparison with readings made at land surface with the flow-through chamber (appendix 2a). Purge rates from the peristaltic pump ranged from 0.1 L/min to 0.5 L/min. Samples for VOC analysis were collected in 40-mL septum vials after field parameters stabilized. Criteria for parameter stabilization followed USEPA (1996), Region 1 Standard Operating Procedures.

Bladder-pump samples were collected on five dates by placing a bladder pump at the midpoint of the well screen and withdrawing water through 1/4-in. copper tubes. Copper tubes were used because of their ability to prevent degassing of chemicals, particularly chlorofluorocarbons (CFC's), which were collected during this study (but not included in this report). The bladder pump and lines were not dedicated to specific wells but were cleaned before use at each well according to standard operating practices, which included using nutrient-free detergent, methanol, and deionized washes. Water was purged following low-flow sampling procedures. Purge rates from bladder pumps ranged from 0.5 to 1.0 L/min. Samples were collected in 40-mL septum vials after field-parameter stabilization.

Quality Assurance and Control

Ground-water samples were collected in cooperation with NHDES. Selected constituents were analyzed at the NHDES laboratory and at the USGS office in Pembroke, N.H. Field-parameter data were collected by NHDES and USGS field personnel. Specific analytical methods used for particular constituents are listed in table 3.

On all VOC sampling dates, a trip blank accompanied the sampling party to and from the collection site. Samples were delivered to the NHDES laboratory and transferred with a chain of custody form after visual inspection by receiving laboratory personnel. Project method protocols included the use of method (equipment) blanks, trip blanks, field duplicates, and split samples. Equipment blanks were collected for diffusion samplers by methods described in appendix 1.

Equipment blanks were contaminated on four out of ten sample dates. This contamination could have occurred during blank sample preparation and transport or during handling at the analyzing laboratory. Three of the four equipment-blank samples showed detectable levels of acetone on September 30, 1998, February 8, 1999, and April 15, 1999, but no detection of primary constituents (PCE, TCE, and *cis*-1,2DCE). Acetone was not detected in ground-water samples for those dates. PCE was detected in one of the four equipment blanks on February 19, 1998, but the concentration (3.5 ppb) was only marginally greater than the detection limit (2 ppb) and was insignificant in relation to the PCE concentrations of ground-water samples (ranging from 830 to 4,100 ppb). No VOC's were detected in the trip blanks.

Differences between duplicates and split samples were evaluated by use of the Absolute Relative Percent Difference (ARPD) formula:

$$ARPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100, \tag{1}$$

where

x_1 is original sample, and
x_2 is replicate sample.

Differences between samples collected by different methods (for example, low-flow and diffusion) were evaluated by use of the Relative Percent Difference (RPD) formula:

$$RPD = \frac{x_1 - x_2}{\frac{x_1 + x_2}{2}} \times 100, \tag{2}$$

Duplicate VOC field samples were analyzed by NHDES Laboratory following USEPA schedule 8260B. Laboratory standard-operating procedure included the use of the following steps: initial instrument calibration, check sample, laboratory blanks, matrix spikes, matrix duplicates, and laboratory fortified blanks (which include five of the primary expected VOC constituents). Approximately 3.5 percent of 350 total VOC samples were analyzed as field duplicates. The mean ARPD of duplicates with positive detections was 4.5 percent for PCE, 4.8 percent for TCE, and 4.1 percent for *cis*-1,2DCE. Standard deviations of ARPD between duplicates were less than 5 percent. The maximum ARPD of a duplicate was 10.9 percent and occurred for PCE and *cis*-1,2DCE (appendix 6).

Detailed testing of the effect of volume, flow rate, and pump type on PCE and TCE concentrations was done at well B95-13 on April 14, 1999. Two pump types were used, bladder and peristaltic, in a sequentially higher purge rate and volumetric order of sampling. The USEPA mobile laboratory was used to analyze results. A split sample was analyzed by the NHDES laboratory. The split sample was collected using a peristaltic pump and yielded an 18.5 percent ARPD in PCE concentration and a 9.5 percent ARPD in TCE concentration. Three sets of duplicate samples were analyzed by the USEPA mobile lab for samples collected using a peristaltic (2 sets) and a bladder pump (1 set). In addition, a laboratory duplicate was done on a peristaltic sample. The laboratory sample yielded a PCE ARPD of 6.8 percent and a TCE ARPD of 13.2 percent. The remaining duplicates all had lower ARPD than the laboratory duplicate. The peristaltic duplicates had ARPD of 4.5 to 8.7 percent for PCE. The bladder duplicate had a ARPD of 1 percent for PCE and a ARPD of 1.7 for TCE.

A split sample was shared with members of the USGS New England Coastal Basins National Water Quality Assessment Program (NAWQA). Samples were sent for analyses to the USGS National Water-Quality Laboratory and NHDES laboratory and analyzed for major ions, metals, and VOC's (data are on file at the Pembroke, N.H. office). The USGS national laboratory analyzes approximately 15 more VOC constituents than the NHDES laboratory. Constituent concentrations of less than 15 percent ARPD resulted except for magnesium, which varied by more than 50 percent. The only positive detection for VOC's occurred for methyl tert-butyl ether (MTBE), which had a ARPD of 13 percent.

Field-parameter data collected by the USGS followed water-quality sampling methods and criteria in the USGS National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, 1998). Field techniques of USGS personnel trained to make water-quality measurements are verified annually by participation in the National Field Quality Assurance Program, which sends unknown samples to participants to test parameters such as pH, alkalinity, and specific conductance. Field probes and instruments are calibrated using known standards. Laboratory analysis conducted by USGS include testing for bromide, alkalinity, and nitrate. Bromide testing was conducted on approximately 160 samples from October 1997 to September 1999, using an ion-specific probe. Ten percent of these samples were duplicate samples with matching concentrations of less than 15 percent ARPD. Alkalinity titrations were performed on 196 samples from May 1997 to September 1999, following USGS national water-quality procedures (U.S. Geological Survey, 1998). Five percent of these samples were duplicate samples with matching concentrations of less than 5 percent ARPD. Nitrate testing using colorometric kits in the laboratory was performed from November 1998 to September 1999 on 90 samples. Nine percent of these samples were duplicate samples with generally less than 25 percent ARPD.

Additional field parameters tested for quality assurance and control included carbon dioxide, ferrous iron, and dissolved oxygen. Field-testing equipment are listed in table 3. Approximately five to ten percent of measurements were duplicates with generally less than 20 percent ARPD for carbon dioxide and ferrous iron and less than 5 percent ARPD for dissolved oxygen.

CONCEPTUALIZATION OF CONTRIBUTING AREA OF WATER SAMPLES

Understanding the differences in the volume of aquifer contributing to a specific water sample may help explain variations in water-sample concentrations. Both passive (diffusion sampling) and low-flow sampling methods collect water from a relatively small volume of the aquifer around the well opening. Diffusion samplers collect water from the smallest volume around the well, whereas, low-flow sampling potentially collects water from a slightly larger area, probably less than 10 ft from the well.

In diffusion sampling there is no drawdown and the sample represents an equilibrium condition between water in the diffusion sampler and ground water flowing through the well under natural flow conditions. Therefore, the natural flushing rate of the well is an important mechanism in collecting representative diffusion samples. The natural flushing rate can be relatively large and approach rates of several liters per minute in properly constructed wells tapping high-permeability aquifers.

In low-flow sampling, drawdown can range from negligible amounts (less than 0.01 ft) to large amounts (more than 10 ft). For the case of negligible drawdowns, the horizontal area contributing water is primarily upgradient from the well. For large drawdowns, the horizontal contributing area also will encompass areas downgradient of the well if drawdowns reach an equilibrium. Prior to equilibrium, sampled waters include borehole water as well as aquifer water. The effect of drawdown on the size and configuration of the horizontal contributing area is shown in figure 11 for a simplified case as semi-elliptical areas around the well.

The vertical contributing area also will affect the horizontal contributing area. Purged low-flow samples may interrogate relatively short radial distances over the full screen length or large lateral distances for a fraction of the screen length.

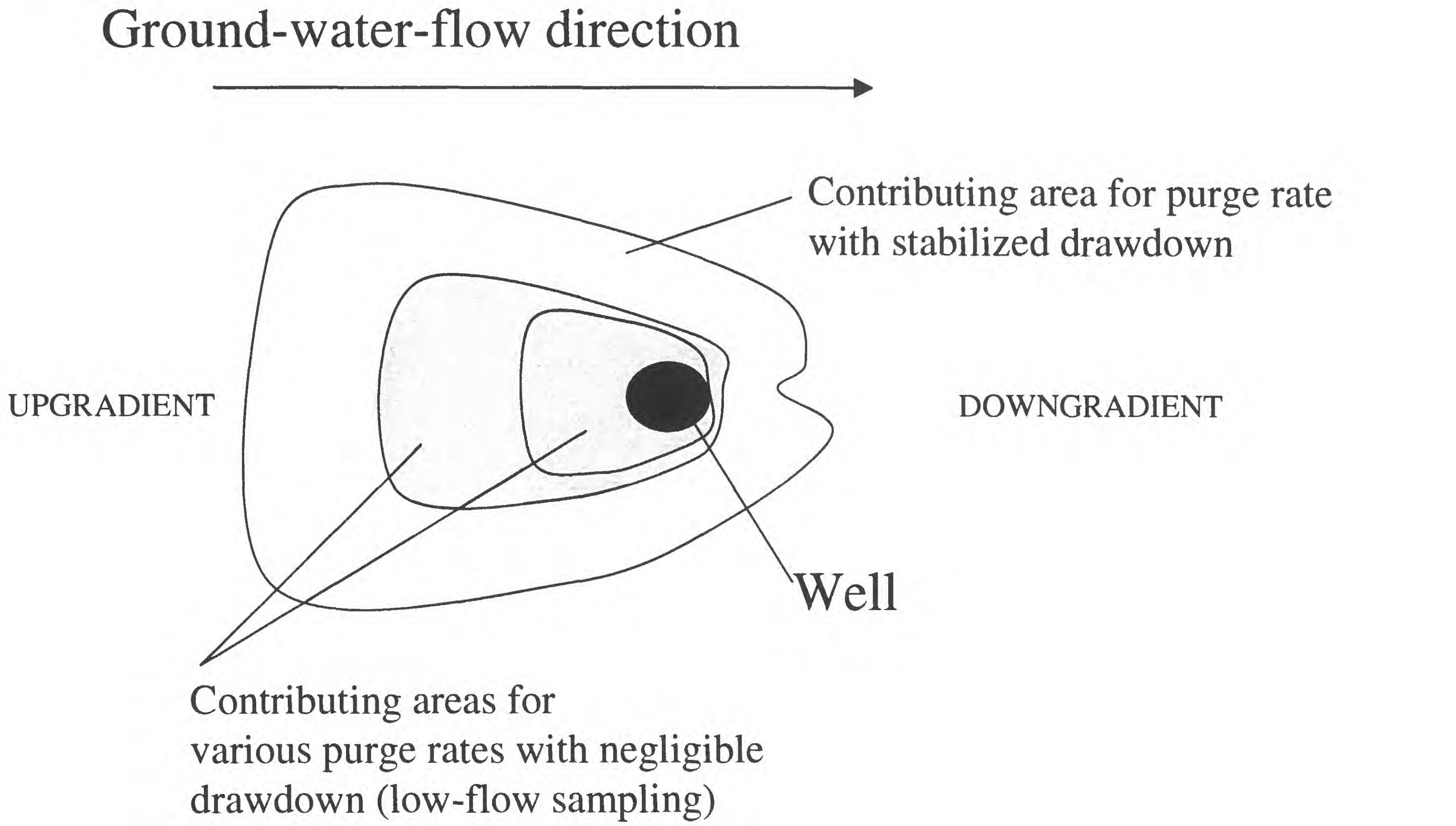


Figure 11. Conceptual diagram showing horizontal contributing areas to a well for various purge rates.

RESULTS OF TESTING

Testing of diffusion samplers involved comparing results of VOC analyses of samples collected from diffusion samplers with those collected by purge methods. Similarity of results with standard low-flow methods suggest that diffusion samplers are suitable for use in sampling ground water for VOC's. Differences in results, however, particularly in cases in which diffusion samples have VOC concentrations greater than those collected by another method may also suggest an acceptable test given the potential difference in contributing areas associated with the two methods. For example, water samples from purged methods may originate from a longer vertical length of the well opening than waters from diffusion samples. Therefore, because of vertical heterogeneity of contaminant concentrations in the aquifer, variations in contributing areas of waters will affect sample concentrations producing dissimilar results between diffusion and purged methods. The fact that the results are different does not necessarily constitute that diffusion sampling is necessarily inferior to purge sampling.

Comparison of Diffusion Samplers with Other Samplers

The list of VOC's analyzed (USEPA schedule 8260B) and comparison of detections between peristaltic and diffusion, and bladder and diffusion samples are given in tables 4 and 5. For the bladder and diffusion comparison, which consist of only three samples, there is exact agreement of VOC's detected. For the peristaltic and diffusion comparison, which consists of twenty samples, three compounds other than the primary VOC's (PCE, TCE, and *cis*-1,2DCE) were detected and include 1,1,1-trichloroethane and carbon disulfide, which were detected in the peristaltic samples but not in the diffusion samples, and methylene chloride, which was detected in the diffusion sample but not in the peristaltic sample. All VOC's detected by only one of the two methods have relatively high vapor pressures (more than 100 mm of mercury at 25 degrees Celsius). Therefore, differences in diffusion rates may not be the primary mechanism in causing positive detections in only one of the methods. The primary mechanism is more likely analytical precision, because the detected concentrations were all just slightly greater than the detection level (table 4).

PCE concentration results from the two primary wells in which multiple sample methods were utilized and waters withdrawn for comparison (wells B95-13 and B95-15) are shown in figures 12 and 13. Diffusion samplers provided results comparable to samples obtained with a peristaltic pump (see well B95-15 and B95-13 results in appendix 3). VOC concentrations in samples obtained using bladder pumps were higher than concentrations in samples from the diffusion bags and peristaltic pumps (see well B95-13 results in appendix 4).

The repeated similarity between VOC concentrations in purged peristaltic samples and concentrations in diffusion samples indicates that diffusion samples provide results effectively contemporaneous to the time of retrieval. For example, diffusion samplers were installed at the end of the previous sampling round (anywhere from 2 weeks to 2 months) yet the concentrations of contaminants in the diffusion sampler reflect the concentration of the water passing through the well at the time of retrieval because VOC concentrations compare to VOC concentrations in the purged samples collected within hours of diffusion bag retrieval. This point is illustrated by the November 1998 sample at well B95-15 (fig. 13). Water collected from the diffusion sampler (which had been installed in September when PCE concentrations were 2,000 ppb) in November yielded a concentration of 500 ppb of PCE, a concentration comparable to the 375 ppb of PCE detected in the peristaltic sample also in November.

Concentrations of VOC's in 20 samples collected by diffusion samples in 7 glacial-drift wells[1] correlate well with concentrations from low-flow peristaltic samples from the same wells (fig. 14). The linear regressions produce root-mean squares of 0.966 for PCE, 0.942 for TCE, and 0.979 for *cis*-1,2DCE. The PCE and *cis*-1,2DCE regression lines are virtually identical to the 1:1 line. The TCE regression line shows that TCE concentrations for the diffusion samples are greater than concentrations for the peristaltic samples.

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[1]Results from bedrock wells were not corroborated against purged samples due to limitations on the scope of the project.

Table 4. Volatile-organic compounds analyzed and detected in water samples collected by peristaltic pump and diffusion samplers from wells in Milford, New Hampshire, from May 1998 to July 1999

[Detected compounds are in boldface type; ppb means parts per billion; RDL means reporting detection limit]

Compound name	Fraction of detects to total number of samples	
	Peristaltic	Diffusion
1,1,2,2-Tetrachloroethane	0/ 20	0/ 20
1,1,1,2-Tetrachloroethane	0/ 20	0/ 20
[1]1,1,1-Trichloroethane	1/ 20	0/ 20
1,1-Dichloroethylene	0/ 20	0/ 20
1,1-Dichloroethane	0/ 20	0/ 20
1,1,2-Trichloroethane	0/ 20	0/ 20
1,1-Dichloropropene	0/ 20	0/ 20
1,2,4-Trimethylbenzene	0/ 20	0/ 20
1,3,5-Trimethylbenzene	0/ 20	0/ 20
1,2-Dibromo-3-chlororpropane	0/ 20	0/ 20
trans-1,2-Dichloroethene	0/ 20	0/ 20
trans-1,3-Dichloropropene	0/ 20	0/ 20
1,2,3-Tricholoropropane	0/ 20	0/ 20
1,3-Dichloropropane	0/ 20	0/ 20
1,2-Dichloroethane	0/ 20	0/ 20
1,2-Dichloropropane	0/ 20	0/ 20
1,2-Dichlorobenzene	0/ 20	0/ 20
1,2,3-Trichlorobenzene	0/ 20	0/ 20
1,2,4-Trichlorobenzene	0/ 20	0/ 20
2,2-Dichloropropane	0/ 20	0/ 20
cis-1,2-Dichloroethene (*cis*-1,2DCE)	20/20	20/20
2-Butanone (MEK)	0/ 20	0/ 20
2-Hexanone	0/ 20	0/ 20
4-Methyl-2-Pentanone (MIBK)	0/ 20	0/ 20
Acetone	0/ 20	0/ 20
Bromobenzene	0/ 20	0/ 20
Benzene	0/ 20	0/ 20
Bromochloromethane	0/ 20	0/ 20
Bromoform	0/ 20	0/ 20
Bromomethane	0/ 20	0/ 20
n-Butylbenzene	0/ 20	0/ 20
sec-Butylbenzene	0/ 20	0/ 20
tert-Butylbenzene	0/ 20	0/ 20
Carbon tetrachloride	0/ 20	0/ 20
[2]Carbon disulfide	1/ 20	0/ 20
o-Chlorotoluene	0/ 20	0/ 20
p-Chlorotoluene	0/ 20	0/ 20
Chloroethane	0/ 20	0/ 20
Chloromethane	0/ 20	0/ 20
Chloroform	0/ 20	0/ 20
Chlorobenzene	0/ 20	0/ 20
Dibromomethane	0/ 20	0/ 20
Dibromochloromethane	0/ 20	0/ 20
Dichlorobromomethane	0/ 20	0/ 20
Dichlorodifluoromethane	0/ 20	0/ 20
Diethyl ether	0/ 20	0/ 20
Ethylene dibromide	0/ 20	0/ 20
Ethylbenzene	0/ 20	0/ 20
Hexachlorobutadiene	0/ 20	0/ 20
Isopropylbenzene	0/ 20	0/ 20
Methyl-*tert*-butyl ether (MTBE)	0/ 20	0/ 20
[3]Methylene chloride	0/ 20	1/20
Naphthalene	0/ 20	0/ 20
Para-isopropyltoluene	0/ 20	0/ 20
n-Propylbenzene	0/ 20	0/ 20
Styrene	0/ 20	0/ 20
Tetrachloroethylene (PCE)	20/20	20/20
Tetrahydrofuran (THF)	0/ 20	0/ 20
Trichlorofluoromethane	0/ 20	0/ 20
Trichloroethylene (TCE)	20/20	19/20
Toluene	0/ 20	0/ 20
Vinyl chloride	0/ 20	0/ 20
Xylenes (total)	0/ 20	0/ 20

[1]Detected value 12 ppb (RDL 10 ppb).
[2]Detected value 2.7 ppb (RDL 2.0 ppb).
[3]Detected value 21 ppb (RDL 20 ppb).

Table 5. Volatile-organic compounds analyzed and detected in water samples collected by bladder pump and diffusion samplers from wells in Milford, New Hampshire, from May 1998 to April 1999

[Detected compounds are in boldface type]

Compound name	Fraction of detects to total number of samples	
	Bladder	Diffusion
1,1,2,2-Tetrachloroethane	0/ 3	0/ 3
1,1,1,2-Tetrachloroethane	0/ 3	0/ 3
1,1,1-Trichloroethane	0/ 3	0/ 3
1,1-Dichloroethylene	0/ 3	0/ 3
1,1-Dichloroethane	0/ 3	0/ 3
1,1,2-Trichloroethane	0/ 3	0/ 3
1,1-Dichloropropene	0/ 3	0/ 3
1,2,4-Trimethylbenzene	0/ 3	0/ 3
1,3,3-Trimethylbenzene	0/ 3	0/ 3
1,2-Dibromo-3-chlororpropane	0/ 3	0/ 3
trans-1,2-Dichloroethene	0/ 3	0/ 3
trans-1,3-Dichloropropene	0/ 3	0/ 3
1,2,3-Tricholoropropane	0/ 3	0/ 3
1,3-Dichloropropane	0/ 3	0/ 3
1,2-Dichloroethane	0/ 3	0/ 3
1,2-Dichloropropane	0/ 3	0/ 3
1,2-Dichlorobenzene	0/ 3	0/ 3
1,2,3-Trichlorobenzene	0/ 3	0/ 3
1,2,4-Trichlorobenzene	0/ 3	0/ 3
2,2-Dichloropropane	0/ 3	0/ 3
cis-1,2-Dichloroethene (*cis*-1,2DCE)	3/ 3	3/ 3
2-Butanone (MEK)	0/ 3	0/ 3
2-Hexanone	0/ 3	0/ 3
4-Methyl-2-Pentanone (MIBK)	0/ 3	0/ 3
Acetone	0/ 3	0/ 3
Bromobenzene	0/ 3	0/ 3
Benzene	0/ 3	0/ 3
Bromochloromethane	0/ 3	0/ 3
Bromoform	0/ 3	0/ 3
Bromomethane	0/ 3	0/ 3
n-Butylbenzene	0/ 3	0/ 3
sec-Butylbenzene	0/ 3	0/ 3
tert-Butylbenzene	0/ 3	0/ 3
Carbon tetrachloride	0/ 3	0/ 3
Carbon disulfide	0/ 3	0/ 3
o-Chlorotoluene	0/ 3	0/ 3
p-Chlorotoluene	0/ 3	0/ 3
Chloroethane	0/ 3	0/ 3
Chloromethane	0/ 3	0/ 3
Chloroform	0/ 3	0/ 3
Chlorobenzene	0/ 3	0/ 3
Dibromomethane	0/ 3	0/ 3
Dibromochloromethane	0/ 3	0/ 3
Dichlorobromomethane	0/ 3	0/ 3
Dichlorodifluoromethane	0/ 3	0/ 3
Diethyl ether	0/ 3	0/ 3
Ethylene dibromide	0/ 3	0/ 3
Ethylbenzene	0/ 3	0/ 3
Hexachlorobutadiene	0/ 3	0/ 3
Isopropylbenzene	0/ 3	0/ 3
Methyl-*tert*-butyl ether (MTBE)	0/ 3	0/ 3
Methylene chloride	0/ 3	0/ 3
Naphthalene	0/ 3	0/ 3
Para-isopropyltoluene	0/ 3	0/ 3
n-Propylbenzene	0/ 3	0/ 3
Styrene	0/ 3	0/ 3
Tetrachloroethylene (PCE)	3/ 3	3/ 3
Tetrahydrofuran (THF)	0/ 3	0/ 3
Trichlorofluoromethane	0/ 3	0/ 3
Trichloroethylene (TCE)	3/ 3	3/ 3
Toluene	0/ 3	0/ 3
Vinyl chloride	0/ 3	0/ 3
Xylenes (total)	0/ 3	0/ 3

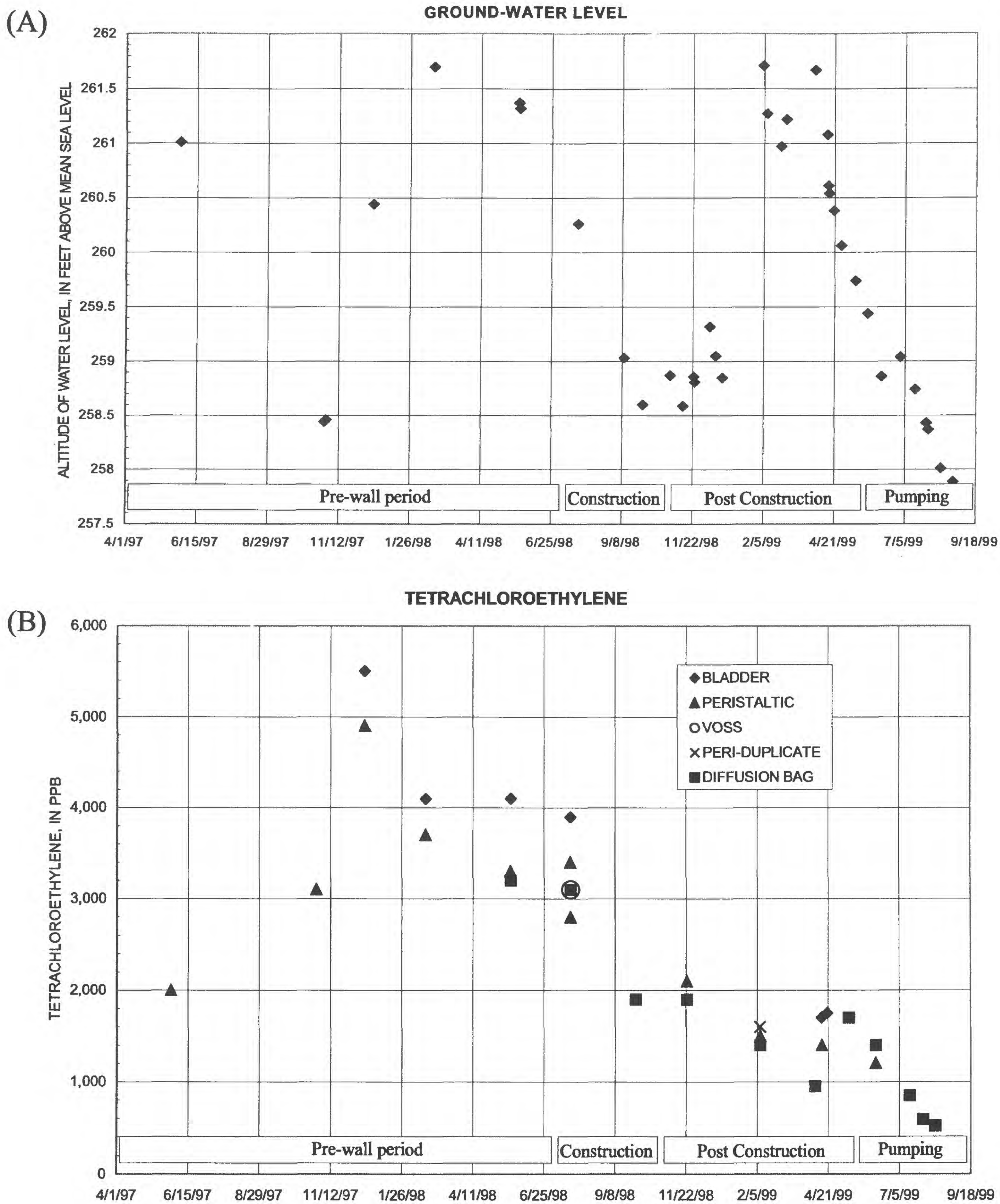

Figure 12. Ground-water levels (A) and concentration of tetrachloroethylene (PCE) in samples collected by various methods (B) for well B95-13.

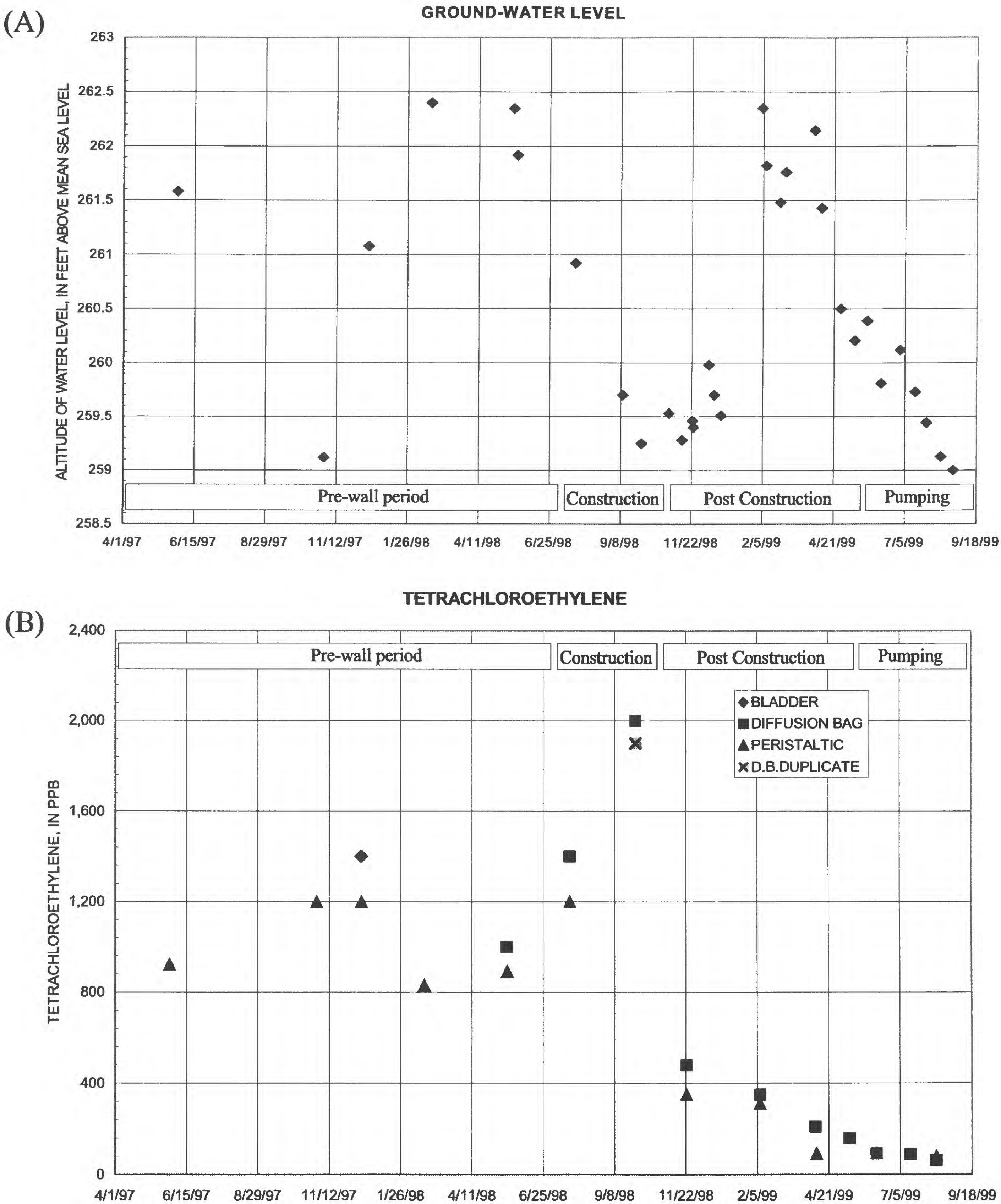

Figure 13. Ground-water levels (A) and concentration of tetrachloroethylene (PCE) in samples collected by various methods (B) for well B95-15.

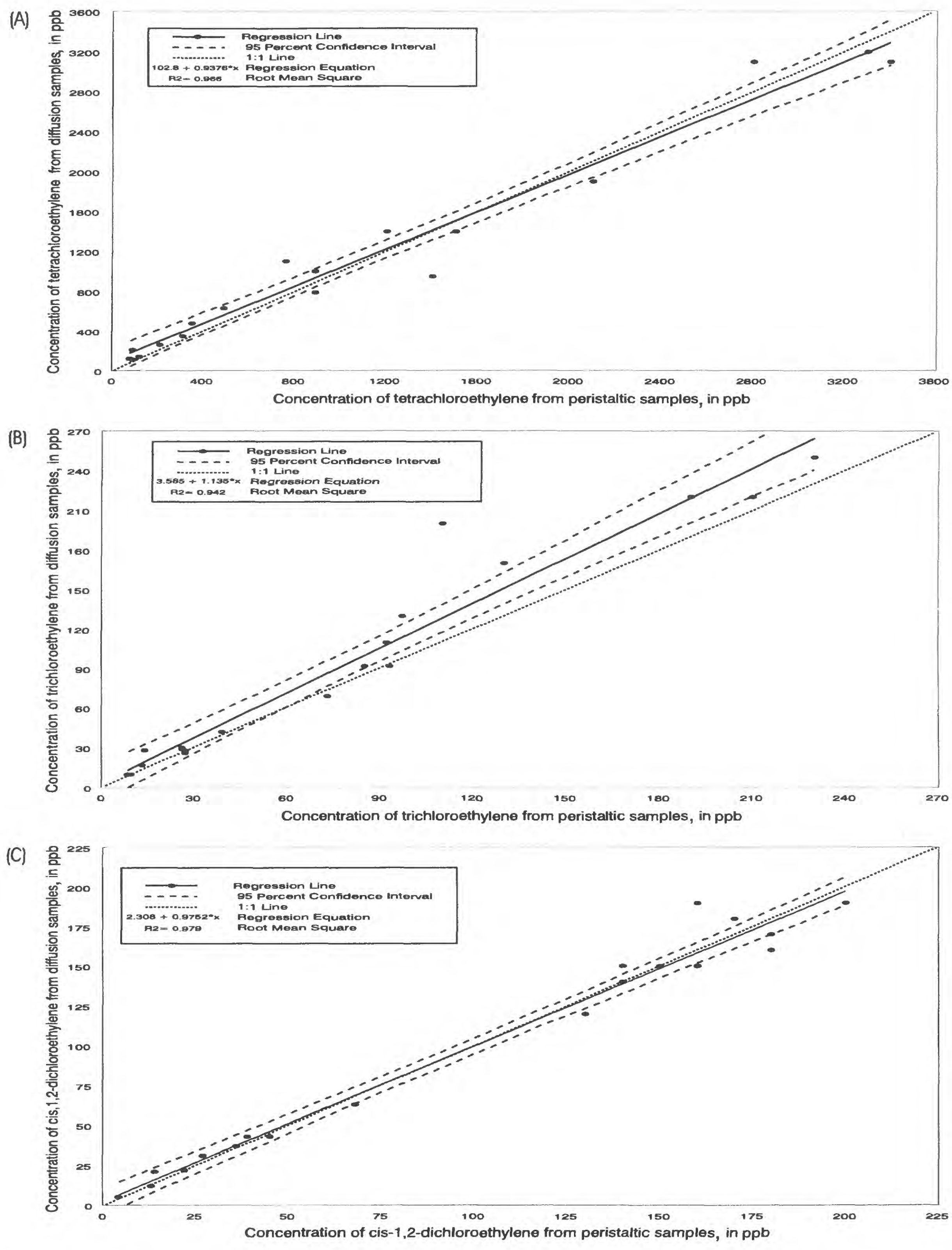

Figure 14. Linear regression of concentrations from peristaltic and diffusion samples for tetrachloroethylene (PCE) (A), trichloroethylene (TCE) (B), and *cis*-1,2-dischloroethane (*cis*-1,2DCE) (C).

The mean PCE concentration for diffusion samples is 1 152 ppb and the mean from the peristaltic samples is 1,119.1 ppb (table 6). The standard deviations also are similar. A two-tailed students t-test of equal variance between the two data sets indicates a 96-percent probability that the means are from the same population. Comparison of results for other VOC's also shows excellent agreement. The mean TCE concentration for diffusion samples is slightly higher than the mean concentration for peristaltic samples, whereas, the means for *cis*-1,2DCE are identical for both methods.

Relative Percent Differences (RPD) of VOC concentrations between peristaltic and diffusion samples indicate that diffusion samples provide "on average" higher concentrations than peristaltic samples (table 7). Compared to duplicate results that show much smaller differences (except for *cis*-1,2DCE), diffusion sample results are larger than differences associated with analytical inaccuracies.

The effects of deployment time on VOC concentration from diffusion samplers were evaluated by plotting the measured concentration differences between the diffusion samples and peristaltic samples against deployment time of diffusion samplers. A plot of linear scatter (fig. 15a) of the data shows a wide spread of data relative to the y-axis and thus a poor linear correlation (R^2 of 0.157). The percent difference in differential concentrations also were plotted (fig. 15b) and also shows a wide scatter of data. In figure 15b a natural log (Ln) regression was fitted to the data but a poor fit (R^2 of 0.15) resulted as well. In both graphs, the effect of deployment time is not observable and the wide scatter of data points suggest differences are caused by factors other than the time required for equilibration, such as differences in contributing areas of sampled water.

The evidence discussed in this section indicates that whereas diffusion samples provide VOC concentrations that are slightly higher than concentrations from peristaltic samples, the differences are not statistically different at a 96 percent probability. The mean concentration of VOC's, the RPD's, and graphical illustrations all show a tendency for slightly higher concentrations from diffusion samples than peristaltic pump samples.

Vertical Variations

Vertical variations in concentrations of VOC's were detected in strings of diffusion samplers installed in two wells (B95-13 and MW-16 (well number 345) table 8) in July 1999. The first string of samplers consisted of three bags with a 2-ft spacing and installed in a 5-ft long, 2-in.-diameter screen (well B95-13) in sand and gravel. The uppermost diffusion sampler was placed 1/2 ft below the top of screen and the lowermost sampler was 1/2 ft above the bottom of screen. Concentrations of PCE were one-third lower in the sample from the uppermost sampler, set near the top of the screen, than concentrations from the middle and lowermost samplers. The uppermost sampler is adjacent to a slightly finer grained sand layer, whereas the middle and lowermost samplers are adjacent to a coarser grained layer of sands and gravels. The variation in concentrations of TCE and *cis*-1,2DCE was much smaller than the variation in concentrations of PCE.

The second string of samplers consisted of four bags with a 6-ft spacing installed in a 38-ft long, 6-in-diameter open borehole in bedrock well MW-16R (well number 345). Two of the four samplers were placed side by side at the midpoint between upper and lower samplers to test the effects of different enclosures (mesh sleeve versus a pvc-slotted pipe) on water flow and diffusion to the diffusion bag. PCE concentrations differ vertically and also between enclosure types. TCE concentrations show little difference vertically or between types of enclosures. *Cis*-1,2DCE concentrations increase with depth and show little differences between enclosure types.

The string of samplers test was repeated in bedrock well MW-16R in October 1999 because of the differences in PCE concentrations between enclosures in July. The results of the October test show a much smaller difference in PCE concentrations between the enclosures, with a nine percent APRD as opposed to a 48 percent APRD for the July test. Furthermore, larger vertical variations were encountered for PCE in October 1999 than in July. In addition, vertical variations in concentrations were measured for TCE and *cis*-1,2DCE in October, unlike July concentrations that indicated negligible differences.

Table 6. Statistical summary of concentrations of volatile-organic compounds from peristaltic and diffusion samples

[ppb means part per billion]

	Tetrachloroethylene (PCE)		Trichloroethylene (TCE)		*cis*-1,2-dichloroethene (*cis*-1,2DCE)	
	Peristaltic	Diffusion	Peristaltic	Diffusion	Peristaltic	Diffusion
Number of samples	20	20	20	20	20	20
Mean, in ppb	1,119.1	1,152.	75.4	89.2	95.0	95.0
Median, in ppb	890	975	56	55.5	99	91.5
Standard deviation of sample, in ppb	1,048.4	1,000.3	69.7	81.5	70.5	69.5
Maximum, in ppb	3,400.	3,200.	230	250	200	190.
Minimum, in ppb	78	110	8.4	10	4.2	5.2

Table 7. Summary of absolute relative percent differences (ARPD) between laboratory duplicate samples and relative percent difference (RPD) between peristaltic samples and diffusion samples

[PCE, Tetrachloroethylene; TCE, Trichloroethylene; *cis-1,2*DCE, *cis*-1,2-dichloroethylene; negative values indicate that sample concentrations from diffusion sampler were greater than those from the perstaltic pump; % means percent; see appendix 5 for individual calculation of RPD; see appendix 6 for individual calculation of ARPD; only duplicate results from NHDES laboratory which include all three primary constiuents (PCE, TCE, and *cis*-1,2DCE) are considered for ARPD calculations]

	Duplicate samples	Method samples	Duplicate samples	Method samples	Duplicate samples	Method samples
	ARPD PCE	RPD PCE	ARPD TCE	RPD TCE	ARPD *cis*-1,2DCE	RPD *cis*-1,2DCE
Mean	4.50%	-13.42%	4.81%	-16.30%	4.10%	-3.00%
Median	4.32%	-15.38%	4.20%	-12.60%	4.30%	0.00%
Standard deviation	4.04%	24.40%	4.18%	18.49%	1.74%	12.53%
Number of samples	10	20	6	20	5	20
Maximum	10.91%	38.30%	10.91%	5.63%	5.41%	11.76%
Minimum	0.00%	-79.07%	0.00%	-66.67%	1.16%	-40.00%

Table 8. Variations in concentrations of PCE, TCE, and *cis*-1,2DCE in vertical strings of diffusion samplers, in July and October 1999

[Residence times for July sample was 14 days; residence times for October sample was 49 days; tetrachloroethylene (PCE), trichloroethylene (TCE); *cis*-1,2-dichloroethane (*cis*-1,2DCE); ppb means parts per billion; mesh means polyethylene mesh holder; -- means no data; pvc means poly vinyl chloride holder]

Well name and number (fig. 3)	Open interval, in feet below land surface	Location of midpoint of sampler, in feet below land surface	Type of sample enclosure	July 1999			October 1999		
				PCE, in ppb	TCE, in ppb	*cis*-1,2 DCE, in ppb	PCE, in ppb	TCE, in ppb	*cis*-1,2 DCE, in ppb
B95-13 (well number 408)	60-65	60.5	mesh	290	40	100	--	--	--
		62.5	mesh	590	40	100	--	--	--
		64.5	mesh	590	40	110	--	--	--
MW-16R (well number 345)	100-138	108.5	pvc	78	25	32	270	37	43
		114.5	pvc	180	32	35	340	83	110
		114.5	mesh	110	29	38	310	66	98
		120.5	pvc	110	49	110	630	98	190

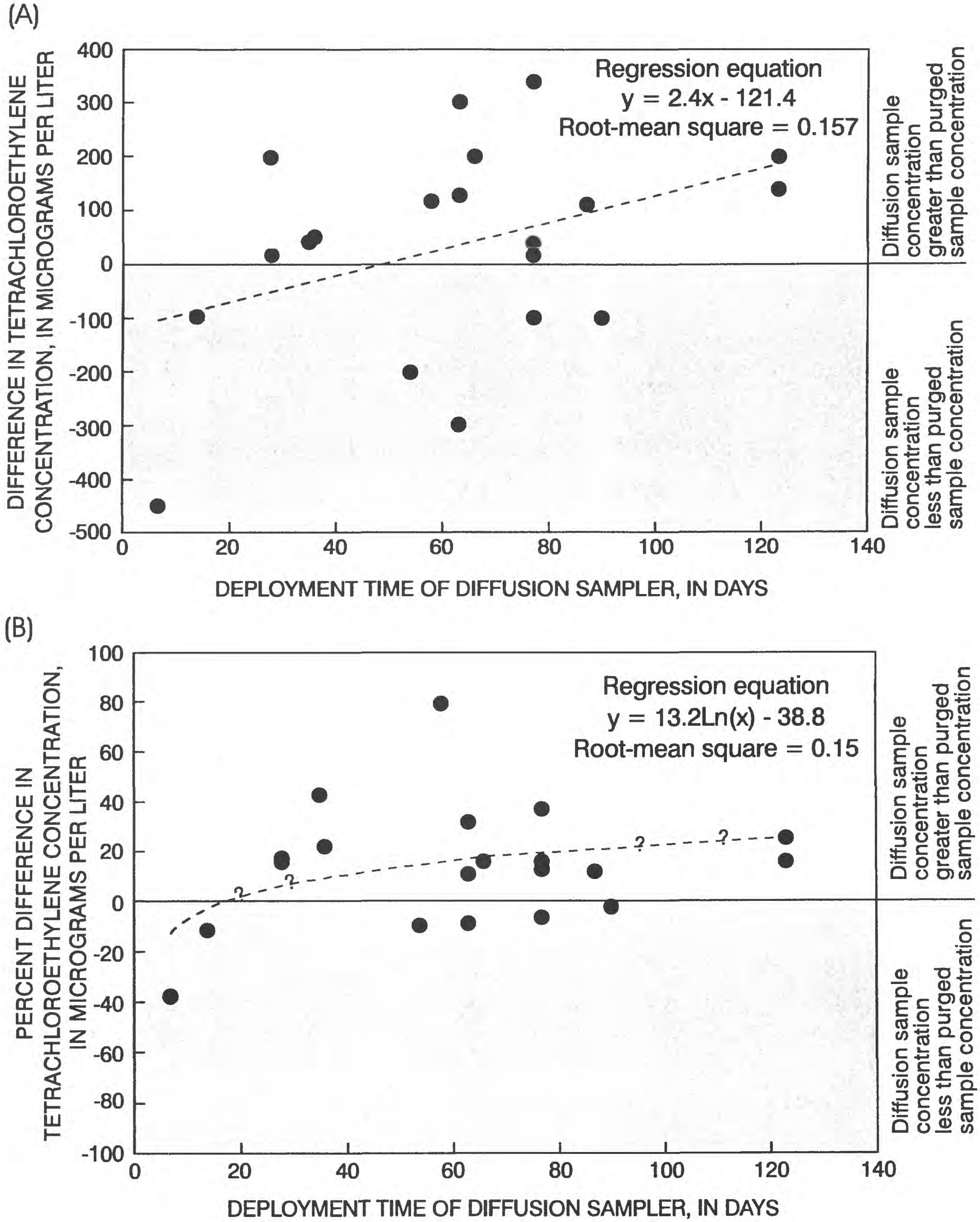

Figure 15. Comparison between deployment time of diffusion sampler and difference of measured concentrations of tetrachloroethylene (PCE) from diffusion and peristaltic-pump samples (A) and comparison of percent difference (B).

Comparison of Purge Samplers

Because most of the diffusion-sample results were compared to results from samples collected with a peristaltic pump, an additional test was performed at well B95-13 to evaluate differences in PCE and TCE concentrations between samples retrieved by bladder and peristaltic pumps. The test was designed not only to evaluate differences in concentration of samples retrieved by these pumps, but also to investigate differences in concentrations with changes in purge rates and volume. Nine samples were collected at ascending and then descending purge rates (table 9). Samples are labeled in table 9 (column 1) by pump type, purge rate, and whether the samples were collected during a forward sequence (ascending rate of purge) or reverse sequence (descending rate of purge). For example, samples p. 25f and p. 48f denote samples collected with the peristaltic pump, during an ascending purge rate, 0.25 and 0.48 L/min, respectively. Under all cases, drawdowns were negligible during the test.

A sequential plot (fig. 16a) of PCE concentrations shows an increase in concentration during the ascending rate of purging and a small decline during the descending rate of purging, which indicates that purge rates affect PCE concentrations more than the cumulative volume purged. A plot of purge rate in relation to concentration shows a moderate trend toward higher concentrations with higher purge rates (fig. 16b). The type of pump also appears to effect the PCE concentration. Three of the four bladder samples had higher PCE concentrations than the five peristaltic samples (table 9).

Sample statistics indicate that PCE concentrations of bladder-pump samples are generally greater than concentrations from peristaltic-pump samples but not statistically different at the 95 percent confidence level (table 10). The computed [2]p-values from the students two tailed t-test are greater than the confidence level of 0.05 indicate that the bladder results are statistically similar to the peristaltic results. The difference in mean concentrations between bladder and peristaltic results is larger, although not statistically different, when all samples are analyzed then when only samples of similar purge rates are compared. The p-value from the student's two-tailed t-test for all samples is much smaller (0.06) than the p-value for samples with similar purge rates (0.34). This large difference suggests that purge rates affect PCE concentrations more than pump type. The mean TCE concentrations also are generally greater for bladder-pump samples than peristaltic-pump samples (table 10) but at the levels detected, differences are within the margin of analytical precision.

The effect of purge rate on PCE concentrations is a consequence of the physical and chemical heterogeneity of the plume. Imbrigiotta and others (1988) reported similar results and hypothesized that sampled observation wells, which showed increases in contaminants for high purge rates, were screened in low concentration zones adjacent to high concentration zones. Therefore, during high purge rates, water was pulled from the high to low concentration zones.

General chemical parameters of waters withdrawn by different types of pumps suggest that higher concentrations of PCE in bladder-pump samples than peristaltic-pump samples are neither the result of increased turbidity in the bladder samples, nor conversely, decreased concentrations of dissolved gases like oxygen or carbon dioxide, but probably the result of [3]degassing of samples collected with the peristaltic pump. Turbidity concentrations from peristaltic samples were similar to bladder samples (except for sample b.1). Dissolved oxygen and carbon dioxide concentrations were also similar between peristaltic and bladder samples regardless of purge rate. Values of pH, however, were higher for peristaltic samples, and indicate some degassing occurred with the peristaltic pump. This may also explain the slightly lower VOC concentration in the peristaltic sample compared to the bladder sample.

The results of the detailed test comparing sampling with bladder and peristaltic pumps show that PCE and TCE concentrations from samples collected with both pumps are similar for the range in concentrations tested. The RPD of the mean concentration of PCE between bladder and peristaltic samples for similar purge rates

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[2]The p-value is also called the attained significance level (Helsel and Hirsch, 1992).

[3]Degassing of constituents occurs when water samples are subjected to negative pressures, which can occur with use of peristaltic pumps.

Table 9. Water-quality results from test comparing peristaltic and bladder pumps at well B95-13 (well number 408), April 14, 1999

[min=minute, L=liters, ppb= part per billion, mg/L = milligrams per liter, ppmv=parts per million, µmhos/cm=micromhos per centimeter, mv=millivolts, ntu=neophelometric turbidity units, -- means no data]

[1]Sample name	Pump type (p=peristaltic, b=bladder)	Time, in hrs and min	Cumulative time, in min	Purge rate, in L/min	Volume purged, in L	Equivalent volume of water purged, in volumes of casing	Tetrachloroethylene (PCE), in ppb	Trichloroethylene (TCE), in ppb	Dissolved oxygen, in mg/L	Carbon dioxide, in mg/L	Methane, in ppmv	pH	Water temperature, in degrees Celsius	Total organic carbon, in mg/L	Specific conductance, in umhos/cm	Eh, in mv	Turbidity, in ntu
p.25f	p	1326	100	0.26	26	0.7	1,685	100	0.2	25	--	--	10.6	--	145	253	0.55
p.48f	p	1425	159	0.48	54.32	1.5	1,717	96	0.1	22	14.36	--	10.9	0.84	124	270	0.59
b.45f	b	1611	404	0.45	87.17	2.4	2,010	101	0.5	25	14.84	6.61	10.7	1.33	138	245	0.99
b.97f	b	1725	480	0.97	151.19	4.2	2,006	99	1.	22	13.18	6.98	10.5	--	126	247	10
p.1+	p	1830	545	1.08	221.39	6.1	1,877	113	0.7	19	15.49	6.82	10.2	--	128	246	2.2
b.1+	b	1850	565	1.08	243	6.7	2,032	118	0.2	19	14.28	6.58	9.8	--	--	242	0.36
b.5r2	b	1908	583	0.5	252	6.9	1,738	105	--	--	--	6.55	9.7	--	127	372	--
p.49r2	p	1920	595	0.49	257.9	7.1	1,841	98	0.6	20	--	7.14	10	--	128	165	1.88
p.33r	p	1950	625	0.33	267.8	7.4	1,783	104	0.4	18	--	7.13	9.8	--	128	156	0.97

[1]Sample names are denoted by pump type, purge rate, and whether sampled during an ascending purge rate sequence (f) or descending (r). The symbols + indicates that two pumps were actively purging, in this case the peristaltic (p.1+) and bladder (b.1+). Therefore, the combined rate is listed in the purge rate.

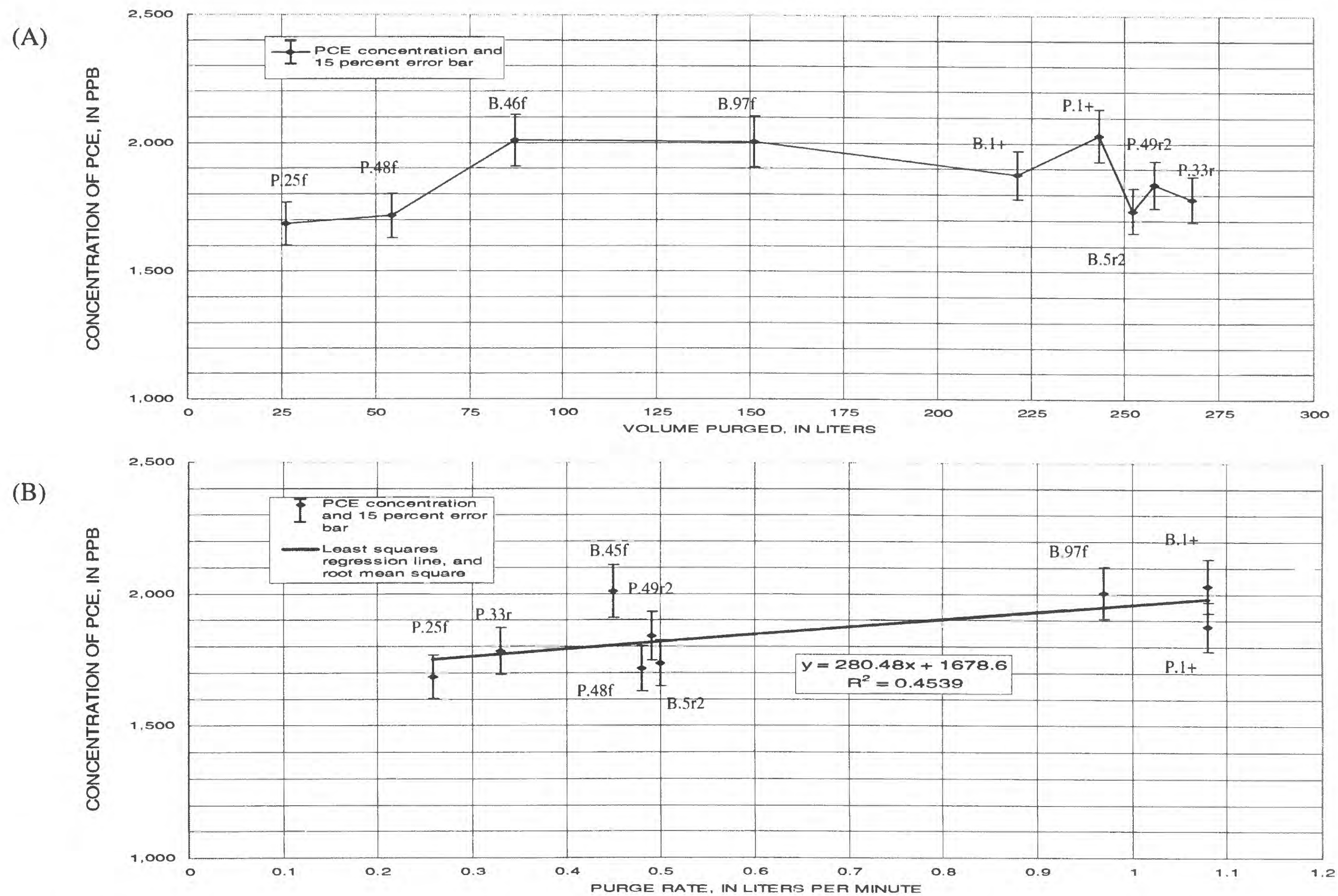

Figure 16. Concentrations of tetrachloroethylene (PCE) from tests comparing peristaltic and bladder pumps, for PCE and volume purged (A), and PCE and purge rate (B), April 14, 1999 (data point labels denote pump type, purge rate and sequence of pumping; P = peristaltic, B = bladder, f = ascending purge rate, r = descending purge rate, + = pumps both operating, 2 = duplicate).

Table 10. Summary statistics comparing concentrations of tetrachloroethylene (PCE) and trichloroethylene (TCE) grouped by pump type from samples collected at well B95-13 (well number 408), April 14, 1999

[L/min means liter per minute; ppb means part per billion; % means percent; -- means no data]

	All samples		Comparable purge rates (excluding b.97, p.25f, and p.33r samples; table 9)	
	Bladder pump	Peristaltic pump	Bladder pump	Peristaltic pump
Number of samples	4	5	3	3
Mean purge rate, in L/min	0.75	0.53	0.68	0.68
Mean concentration of PCE, in ppb	1,947.	1,781.	1,927.	1,812.
Standard deviation of sample	139.5	80.8	163.8	83.9
95% confidence interval	2,065-1,829	1,844-1,718	2,078-1,776	1,890-1,734
p-value from students t-test (two-tailed)	0.06	--	0.34	--
Mean TCE, in ppb	105.8	102.2	108.	102.8
Standard deviation of sample	7.4	6.0	7.3	6.6

(bladder samples, 1,927 ppb, and peristaltic, 1,812 ppb, table 10) is 6.2 percent. This RPD is one-half the RPD of the mean concentration of PCE between peristaltic and diffusion samples (-13.42 percent, table 7). Therefore, because the difference in concentrations of PCE between bladder and peristaltic samples is less than that of peristaltic and diffusion samples, peristaltic samples are considered to be adequate for validation of diffusion sampler results at tested wells.

RESULTS OF APPLICATION TO MONITOR TRENDS

The preceding sections document the evidence supporting the suitability of diffusion samplers in collecting high-frequency time-series data on VOC's if a minimum deployment time of 1 week or more is used. The following section discusses results of this high-frequency sampling, which occurred from November 1998 to October 1999.

Fifteen wells were chosen to collect detailed time-series data of post-wall construction conditions. All of the fifteen wells are located outside of the barrier wall (fig. 3). Trends were analyzed for the concentration of individual primary detected VOC's (PCE, TCE, and *cis*-1,2DCE), the ratios between the concentration of these compounds, and the total VOC's, which were determined by summing the concentration of the three detected VOC's (PCE, TCE, and *cis*-1,2DCE). As in the testing phase, VOC's other than the primary compounds were largely undetected.

PCE was the primary VOC detected prior to construction of the barrier wall. Concentrations of PCE show declines of at least a half order of magnitude at 8 of the 15 wells sampled (figs. 17-21) since the start of barrier wall construction in July 1998 (the barrier wall was constructed from July to November 1998, and remedial operations of wells were tested between December 1998 to March 1999, but full operation started in May 1999). These wells include PW-12M, PW-12D, PW-12R, MW-16R, B95-15, B95-13, PW-13M, and PW-13D. Wells with the largest declines in PCE (PW-12M, B95-15, and PW-13D) are screened in coarse-grained gravel layers and are along the northern flank of the plume where ground-water flow is rapid from recharge of the river. Several wells where small declines in PCE have occurred are screened in slightly finer grained layers of sand, including wells PW-14M and PW-14D, and MW-16B and MW-16C. These wells are in the central to southern flank of the plume. At well B95-13, located adjacent to remedial extraction wells EW-1 and EW-2 (fig. 3), PCE declines appear to increase after remedial wells were placed into full operation in mid-May 1999.

Several short-term changes in PCE also are evident in addition to the gross overall declines measured over the time of study. Transient declines and rises in concentration, including a sharp decline and rise in PCE at well PW-12S were detected in June and July of 1999 (fig. 18). This well is near a recharge gallery (fig. 3) where

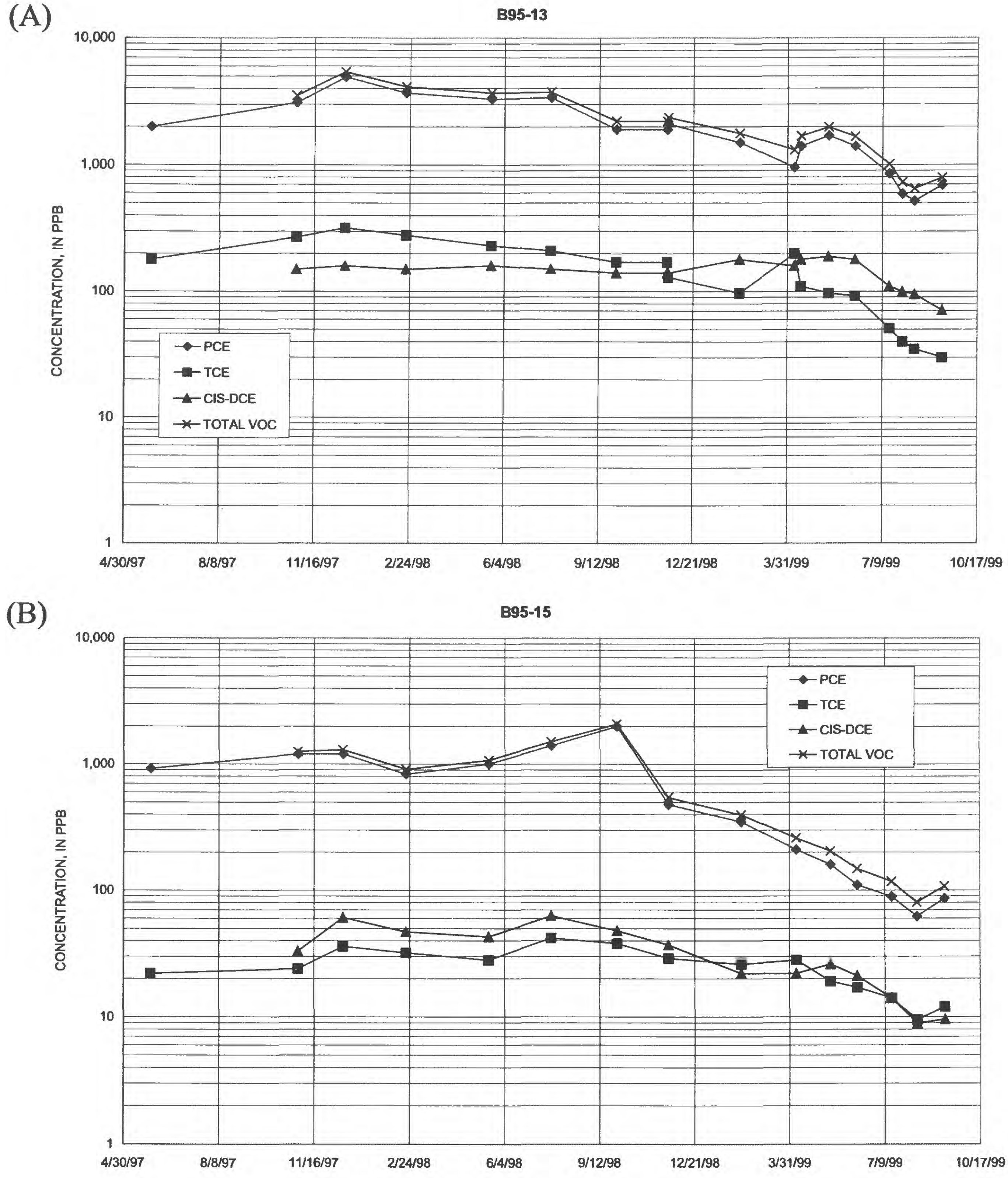

Figure 17. Concentrations of volatile organic compounds (VOC's) tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethane (CIS-DCE), and total VOC's (TOTAL VOC) from diffusion samplers for wells B95-15 and B95-13. (Well locations are shown in figure 3.)

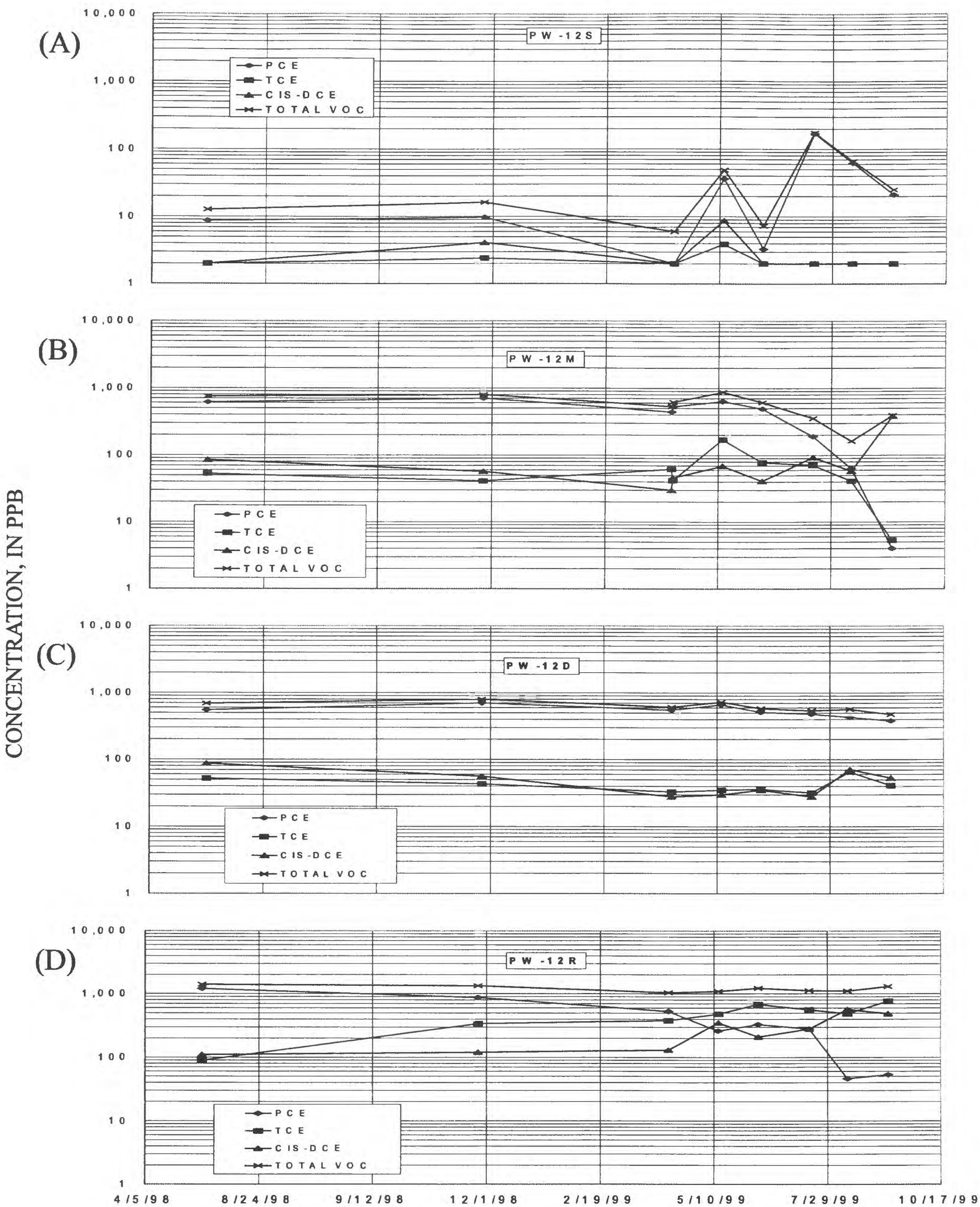

Figure 18. Concentrations of volatile organic compounds (VOC's) tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethane (CIS-DCE), and total VOC's (TOTAL VOC) from diffusion samplers for PW-12 cluster wells.

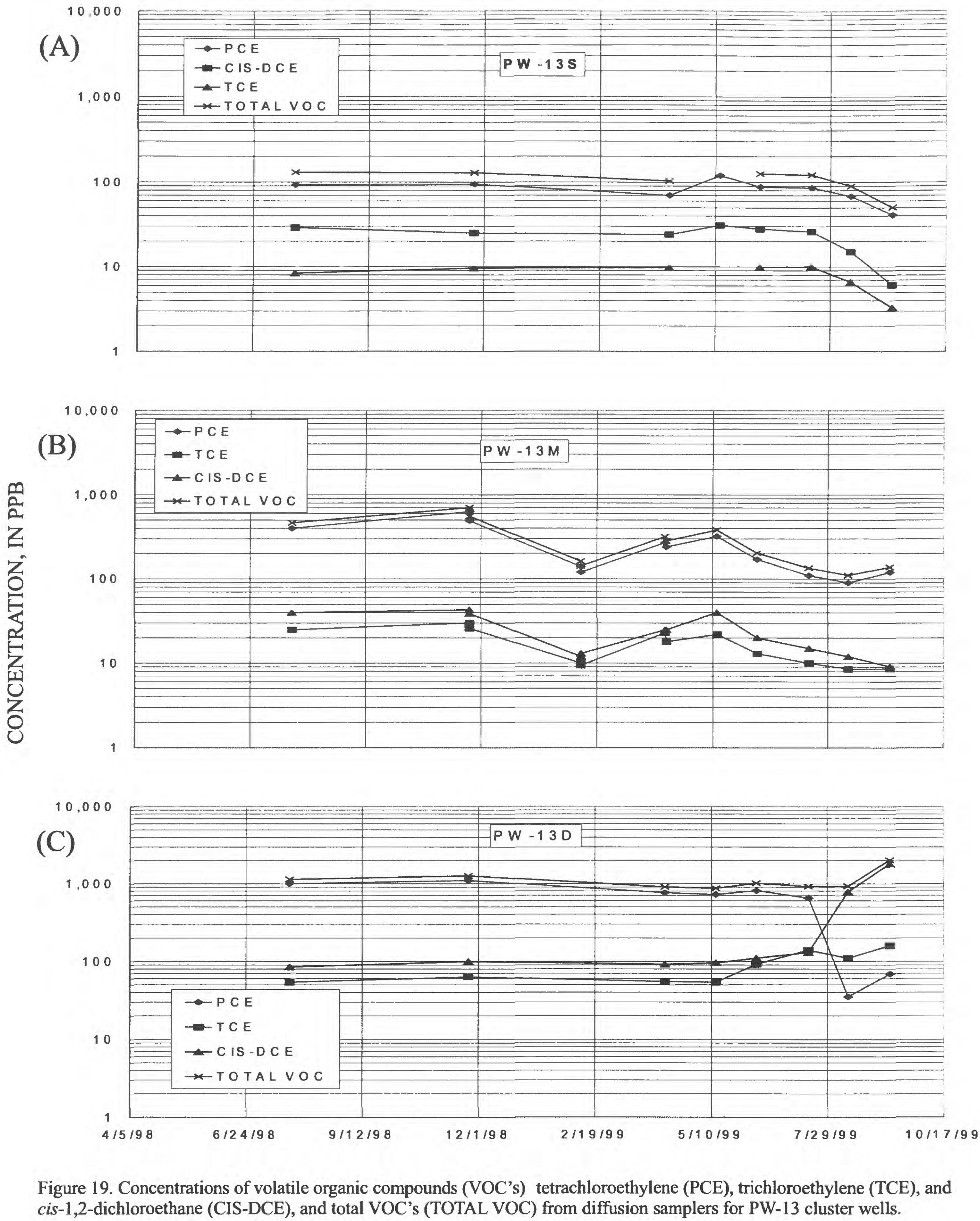

Figure 19. Concentrations of volatile organic compounds (VOC's) tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethane (CIS-DCE), and total VOC's (TOTAL VOC) from diffusion samplers for PW-13 cluster wells.

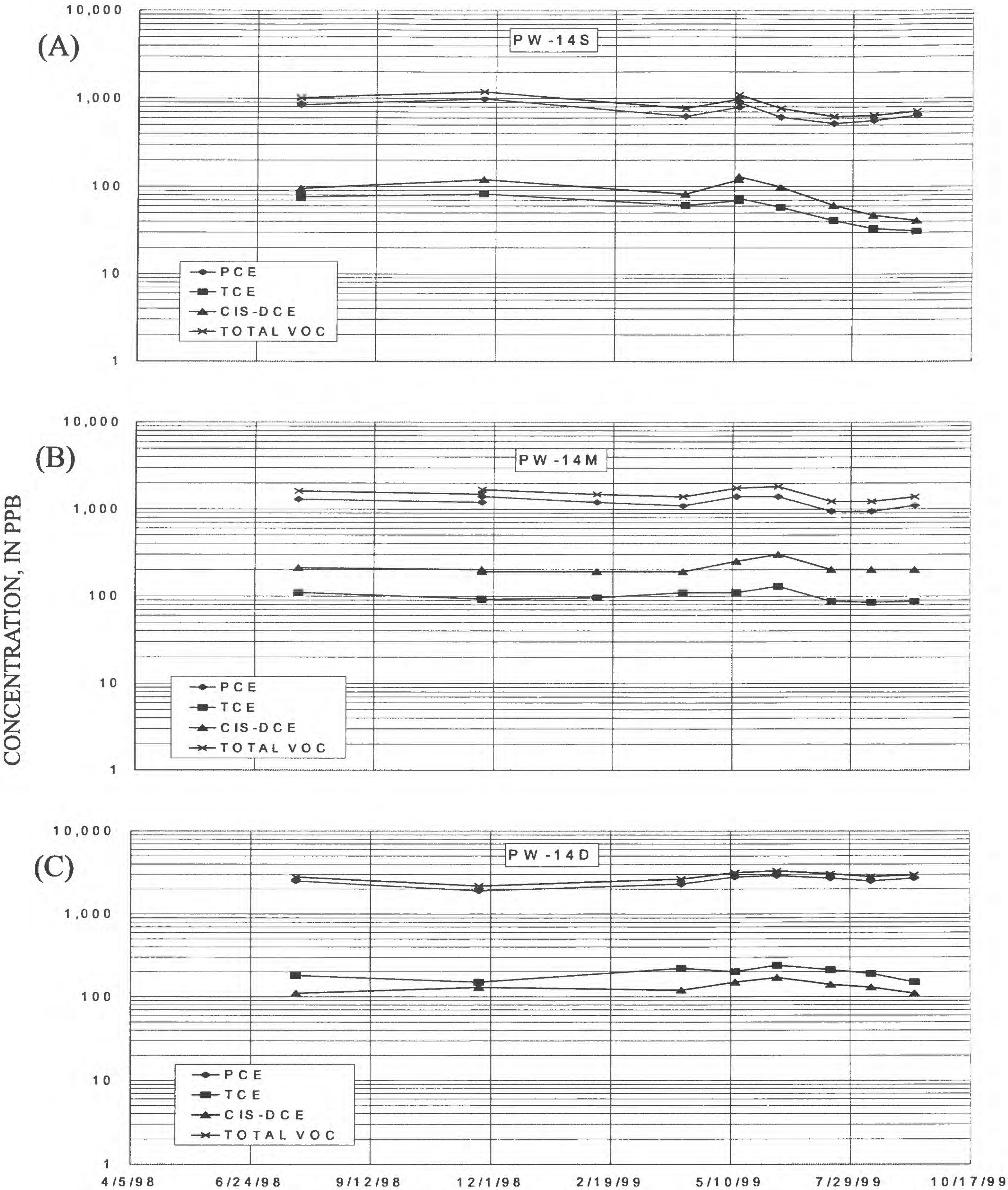

Figure 20. Concentrations of volatile organic compounds (VOC's) tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethane (CIS-DCE), and total VOC's (TOTAL VOC) from diffusion samplers for PW-14 cluster wells.

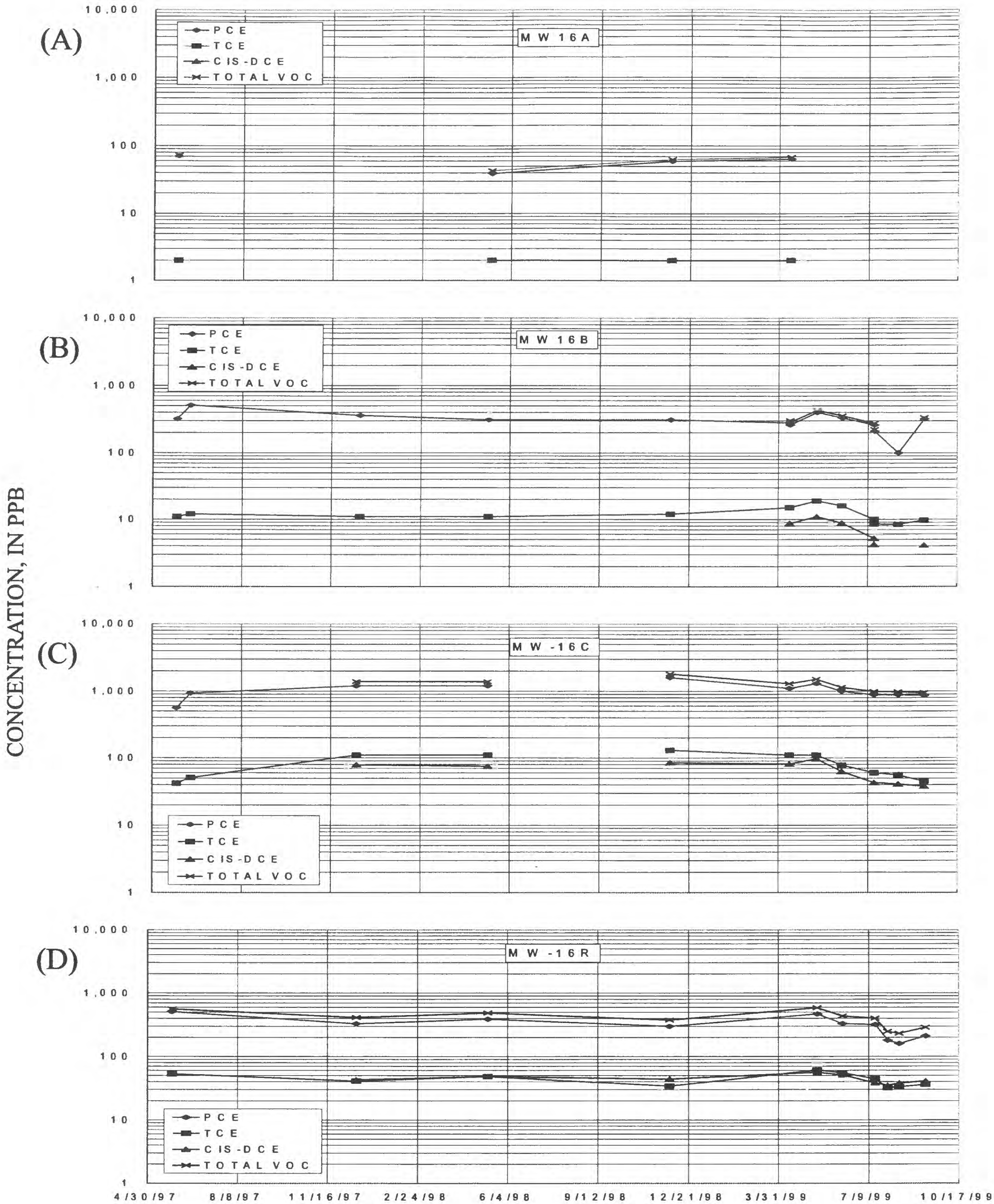

Figure 21. Concentrations of volatile organic compounds (VOC's) tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethane (CIS-DCE), and total VOC's (TOTAL VOC) from diffusion samplers for MW-16 cluster wells.

treated water is injected back into the aquifer at a rate of approximately 60 gal/min. Many wells show transient rises in PCE in May and September of 1999, which are likely the result of large precipitation events during those months. Large precipitation events, and subsequent recharge to ground water, may help desorb additional contaminants from the aquifer matrix and increase concentrations in the dissolved phase.

Time trends in concentrations of TCE and *cis*-1,2DCE at most of the sampled wells match the trends in concentrations of PCE. At several wells that had large declines in PCE concentration, however, only small declines occurred in TCE and(or) *cis*-1,2DCE concentrations. Furthermore, at three wells (wells PW-12M, PW-12R, and PW-13D), concentrations of *cis*-1,2DCE increased while concentrations of PCE decreased. *Cis*-1,2DCE is primarily formed from the degradation of PCE and TCE and increases in *cis*-1,2DCE at selected wells suggest spatial and temporal variations in rates of biodegradation. Wells PW-12R and PW-13D are fully and partially set in bedrock, respectively, and some bedrock waters show a tendency of higher daughter-to-parent compound ratios than drift waters. In general, because most wells do not show increases in *cis*-1,2DCE, biodegradation is evidently occurring only on a local scale. The increase in *cis*-1,2DCE at three wells since the construction of the barrier wall suggests that the source of PCE probably is isolated by the wall, otherwise PCE concentrations would be higher relative to TCE and *cis*-1,2DCE concentrations.

At several wells where *cis*-1,2DCE has increased, sampled waters contain above-background concentrations of methane. The median methane values for contaminated shallow, medium, and deep wells ranged from 3 to 6.1 ppm. Well PW-12M, which shows increases of more than 1order of magnitude of *cis*-1,2DCE, had a methane concentration of 9.0 and 7.7 ppm (appendix 2b).

Methane concentrations have increased over time and coincide with increases in *cis*-1,2DCE and TCE at wells where high frequency collection of methane occurred (B95-13 and B95-15). The ratio of *cis*-1,2DCE to PCE and methane (CH_4) for wells B95-13 and B95-15 is shown in figure 22. Methane concentrations have increased from 1997 to maximum levels in November 1998 when the barrier wall was completed. Increases in the ratio of *cis*-1,2DCE to PCE correspond to increases in methane and suggest an increase in biologic activity and methanogenesis in some zones of the aquifer.

VOC decreases in wells downgradient of the source area probably indicate the success of the barrier-wall construction in preventing the migration of contaminants. The average concentration of PCE and total VOC's (PCE, TCE, and *cis*-1,2DCE) have decreased since the completion of the barrier wall in November 1998. The average concentration of PCE in wells at the farthest downgradient part of the source area (PW13, PW14, and MW16 clusters) declined by 23 percent from November 1998 to September 1999; whereas, total VOC's declined by only 5 percent. The slow decline in total VOC's is the result of increases in TCE and *cis*-1,2DCE at several wells.

A first-order exponential equation (Wiedemeier and others, 1998) was used to quantify observed concentration declines at the downgradient wells:

$$C = C_o \exp^{-kt} \qquad (3)$$

where

C is concentration at t (time),
C_o is initial concentration at time = 0,
k is the first-order decay constant (1/yr), and
t is time (years).

The average concentration of PCE and total VOC's from sampling rounds in April through October 1999 were divided by average concentrations from November 1998 (the initial concentration, Co) and plotted on graphs (fig. 23). An exponential function was fitted by least squares method and is shown as the regression line. The 95-percent confidence level was also plotted to bracket trendlines. The results show that the computed exponential slopes for PCE are steeper than for total VOC's. The computed decay constants (k) are 0.4304/year for PCE and 0.3189/year for total VOC. After 10 years, the range in C/Co values for PCE is from 0.08 to virtually 0; the range in total VOC's is from 0.2 to 0. As additional data are collected, the exponential trendlines may shift and residual errors also may be reduced, which would result in more representative trends.

The ease of use of diffusion samplers and associated decrease in sampling time allowed for high frequency sampling and detailed analyses of trends, but also allowed for a more instantaneous picture of the plume. For example, depending on the number of wells, it may take 2-3 weeks to sample a round of wells at the site. During that time, sample concentrations can vary because of short-term trends. VOC data collected on July 16, July 30, and August 12, 1999, at well B95-13 (appendix 2c), all at 2-week intervals, show PCE concentrations of 850 ppb, 590 ppb, and 520 ppb. Thus, the analysis of plume concentrations are less likely to be influenced by errors associated with the length of time required to collect a complete round of data at a site.

SUMMARY AND CONCLUSIONS

The concentrations of volatile-organic compounds (VOC's), principally tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethane (*cis*-1,2DCE), in ground-water samples collected with diffusion samplers correlate well with concentrations in samples collected by low-flow purging procedures. Twenty coupled diffusion and peristaltic-pump samples were collected from seven wells completed in glacial drift. Linear regressions of concentrations from diffusion and peristaltic-pump samples produced root-mean squares of 0.966 for PCE, 0.942 for TCE, and 0.979 for *cis*-1,2DCE. The PCE and *cis*-1,2DCE regression lines are essentially identical to the 1:1 line. The TCE regression line shows that TCE concentrations in the diffusion samples tend to be greater than concentrations in the peristaltic samples.

The mean concentration of PCE in diffusion samples was 1,152 parts-per-billion (ppb) and the mean from the peristaltic samples was 1,119 ppb. The standard deviations also were similar. The mean TCE concentration from diffusion samples (89.2 ppb) was slightly higher than the mean concentration from peristaltic samples (75.4 ppb), whereas the means for *cis*-1,2DCE with both sample methods were identical. The Relative Percent Differences (RPD) of PCE, TCE, and *cis*-1,2DCE concentrations between peristaltic-pump and diffusion samples indicate that diffusion samples provide, on average, higher concentrations (3 to 16 percent) than peristaltic-pump samples. Compared to duplicate results, which show a small difference in concentration (4 percent on average in samples with positive detects), the differences in concentrations between samples collected by different methods are larger than differences in concentrations associated with analytical inaccuracies.

Trends in VOC's, which were corroborated by both diffusion samples and purged samples following low-flow procedures, indicate that diffusion samplers equilibrate relatively quickly to concentrations of VOC's in the well water at the time of bag retrieval. Declines in PCE concentration in diffusion samples of several hundred parts-per-billion between consecutive coupled sampling periods matched declines in PCE in purged samples and indicate that water concentrations inside the diffusion samplers were equivalent to concentrations in the purged samples collected the same day as bag retrieval.

The use of diffusion samplers in this setting was a cost-effective alternative to more expensive sampling procedures. Diffusion sampling costs less and can be done in one-fifth the time of low-flow sampling, allowing for more frequent data collection, and resulting in the understanding of several contaminant transport conditions at the study site.

The most significant contaminant transport condition identified was the spatial variability in declines of PCE and the small scale increases in TCE and *cis*-1,2DCE at several wells since a barrier wall was constructed. Rates of PCE decline at wells correspond with variations in sediment lithology at the screen interval and location of the well within the plume. Wells screened in coarse-grained gravel layers along the northern flank of the plume showed the largest declines in PCE. At several wells, concentrations of TCE and *cis*-1,2DCE increased, whereas PCE decreased suggesting that small scale biodegradation is occurring. Most wells that showed concentration increases of TCE or *cis*-1,2DCE are partially set in the bedrock. Increased methane concentrations following wall construction point to a short-term increase in methanogenesis, which also may help explain the small scale increases in TCE and *cis*-1,2DCE. Temporary increases in VOC's occurred following recharge events on several occasions, suggesting desorbtion of VOC's from the aquifer matrix.

Vertical variations in VOC's were detected from strings of diffusion samplers installed in one short-screened (5-ft long) well screened in the glacial drift and one open-hole (38-ft long) bedrock well. Variations in vertical concentrations were as much as 100 percent, much larger than the maximum RPD between duplicates of 11 percent. Preliminary results indicate the technique may be applied as a screening tool to estimate vertical concentrations.

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Appendix 1. Procedures for preparation, installation, and collection of diffusion bag samples in wells.

1) Get trip blank from analyzing laboratory. Trip blank water will remain in 40-mL septum vial and will travel with samplers to the field. Septum viles should be stored in a clean laboratory refrigerator and transported in a cooler with ice.
2) Ensure adequate supply and check quality of 40-mL septum vials to be used in the field.
3) **Bag preparation:** Cut off a 13 in. length of 2-in.wide, polyethylene 2-mL thick sleeves. When filled, sleeves (bags) are 1.5 in. diameter. Seal one end of the sleeve multiple times with a heat-impulse sealer. The last seal and first seal should be approximately 2 in. apart. Rinse the inside of the newly created "bag" with VOC-free water several times. Pour VOC-free water into bag opening, filling to a length of 9 in. (approximately 260 mL). Seal open end of bag with heat sealer multiple times with care to minimize air space in the tube. Ideally, the same source of VOC-free water should be used for all blanks and the diffusion bags that will be placed in wells.
4) Create laboratory environment blank. This bag will remain in the laboratory, exposed to ambient laboratory conditions until the next sampling round (the next time diffusion bags are created).
5) Create equipment blank. This diffusion bag will travel with samplers into the field and represents a check of the sampling device as well as the working environment.
6) Create diffusion bags for the wells. Know in advance how many diffusion bags need to be installed. Make two extra bags in case of accidental puncture.
7) Store all bags in a sealed container.
8) Collect laboratory environment sample from previous sampling period by cutting bag open and filling two 40-mL septum vials. This sample has been equilibrating to ambient laboratory conditions for several weeks.
9) Transport all diffusion bags and blanks to the field.

First Time Installation

Holders and associated equipment for installing bags in wells should be assembled and ready for use before the start of sampling.

Two types of diffusion bag holders (shrouds) can be used. Mesh holders are ideal for cased and screened wells. PVC pipe holders are useful in open- walled rock holes where bag puncture can be an issue. Mesh holders are thick netted flexible devices coated with polyethylene materials and of a minimum diameter of 1.5 in. Diffusion bags will fit inside mesh holders. PVC pipe holders are 1 3/8 in. inner diameter, and 1.5 in. outer diameter, slotted to allow water contact with bag, and pipe material. Diffusion bags will also fit inside PVC pipe holders. Bottom of holders should be fitted with a stainless steel weight. All materials should be properly decontaminated before usage.

Verify well depth by sounding with a measuring tape from known measurement point. Take a water-level measurement from same measurement point and compute height of water column above open interval and potential placement of bag inside well. **It is important to fully submerge diffusion bag in water so this step of verifying well**

construction and water levels must be done. For short screens or open holes (less than 5 ft), diffusion bags are typically installed at the midpoint of well opening. For long screens or open holes (more than 5 ft), bags can be installed with several bags in a vertical string (series) up and down opening or at designated locations such as fractures.

Install bag inside holder. Tie a spool of teflon line to one end of holder and lower inside the well to the desired depth. Cut off teflon line so as to set the midpoint of the diffusion bag at desired depth and then secure top part of line to a fixed object such as a padlock anchor.

10) Make a water-level measurement from a known point at monitoring wells.
11) Retrieve samples from all wells by hoisting holders to the surface. Cut open the top part of the diffusion bag with special care not to spill the bag, and fill two 40-mL septum vial's. If duplicates are needed, fill two more vials with remaining water. Otherwise, remaining water can be poured into a small beaker for purposes of recording water temperature with a small temperature probe.
12) Store collected samples in a cooler with ice.
13) Install newly created clean diffusion bags into holder and lower to designated position in well.
14) After last bag is installed, cut open equipment blank diffusion bag and pour contents into two 40-mL septum vials.
15) Fill out chain of custody form and make copies.
16) Transport and submit all samples and blanks to analyzing laboratory.

Appendix 2. Explanation of abbreviations

<u>Source of Data</u>

DES = New Hampshire Department of Environmental Services
USGS = U.S. Geological Survey
EPA = U.S. Environmental Protection Agency

<u>Sample Collection Method</u>

peri = peristaltic pump
GRAB = grab sample in surface water
BL = bladder pump
DB = passive diffusion bag sampler
VOSS = voss bailer pump

<u>Units</u>

mg/L = miligrams per liter
L = liters
min = minutes
ft = feet
cm = centimeter
mv = milivolts
^{o}C = degrees celcius
NTU = neophlemetirc turbidity unit

<u>Chemical Compounds</u>

CO_2 = carbon dioxide
Fe2+ = iron cation, plus two charge
S^{2-} = sulfide anion
NH_4^+ = ammonium
Cl- = chloride anion
SO_4^{2-} = sulfate
NO_3^- = nitrate
NO_2^- = nitrite
PO_4^{3-} = total phosphate
Ca^{2+} = calcium cation
Fe(total) = total iron
Mg^{2+} = magnesium cation
Mn^{2+} = manganese cation
K^+ = potassium cation
Na^+ = sodium cation
CH_4 = methane
TOC = total organic carbon
Br- = bromide
$CaCO_3$ = alkalinity, measured as total calcium carbonate
PCE = tetrachloroethene

TCE = trichloroethene
CIS-DCE = cis-1,2 dichloroethene
111-Tri = 1,1,1-trichloroethene
MTBE= methyl-tertiary-butyl-ether
THF = tetrahydrofuran
Meth.Chl = methylene chloride

Other Explanations
= number
-- = no data
< less than
© = field colorimetric chemical test kit
SC = specific conductance
DO = dissolved oxygen
hole = downhole measuring device
flowthru = flow-through chamber
Temp = temperature
(d) = duplicate sample
SC-lab = specific conductance as measured from sample bottle in the lab
U "x"= undected at a limit of "x" ppb
equip blank = equipment blank
lab blank = laboratory blank
umhos/cm = micromhos per centimeter
Eh = redox potential measurement
river = river sample

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
233	MW-16A	5/27/97	DES	peri	0.1	55	5.5	0.02	407	5.62	--	0.49	--	11.81	6	35	0	0.53	359
321	MW-16B	5/27/97	DES	peri	0.1	57	5.7	0.01	239	5.8	--	0.51	--	11.4	0.3	19	0	0.5	262
344	MW-16C	5/27/97	DES	peri	0.08	65	5.2	0	447	5.41	--	0.3	--	13.23	1	--	0	0.03	299
345	MW-16R	5/27/97	DES	peri	0.03	153	4.6	0	196	8.38	--	0.63	--	14.59	0.8	<10	0	2.3	157
407	B95-12	5/28/97	DES	peri	0.11	105	11.6	0	665	5.66	--	11.89	--	13.28	3	15	0	0.5	376
407	B95-12(d)	5/28/97	DES	peri	0.11	105	11.6	0	665	5.66	--	--	--	--	3	15	0	0.5	376
408	B95-13	5/28/97	DES	peri	0.09	72	6.5	0.02	120	5.53	--	0.09	--	14.84	1	16	0	1.71	318
409	B95-15	5/28/97	USGS	peri	0.12	79	9.5	0.01	71	5.79	--	0.44	--	11.21	<1	15.5	0	0.5	291
385	P-2, river	5/28/97	DES	GRAB	--	--	--	--	62	--	6.8	--	17.2	--	9	<10	0	0	353
398	B95-3	5/29/97	DES	peri	0.08	62	5.0	0	95	5.92	--	0.2	--	14.59	0.5	20	1.5	0.21	250
404	B95-9	5/29/97	DES	peri	0.09	40	3.6	0	647	5.7	--	0.12	--	14.94	2	16	0	0.17	292
299	HM-1	5/29/97	DES	peri	0.09	84	7.6	0.01	103	5.59	--	0.02	--	12.22	0.5	18	0	0.65	101
42	MI-27	5/29/97	DES	peri	0.12	65	7.8	0	703	5.71	--	0.14	--	15.4	5	16	0	0.28	387
203	MI-63	5/29/97	DES	peri	0.12	80	9.6	0	60	5.76	--	0.23	--	11.78	0.2	16	0	0.2	310
30	MI-19	5/30/97	DES	peri	0.07	190	13.3	0.01	220	8	--	0.65	--	14.89	0.8	<10	0	99	253
31	MI-20	5/30/97	DES	peri	0.08	45	3.6	0	206	5.47	--	2.59	--	13.11	2.5	16	0	<1	328
33	MI-21	5/30/97	DES	peri	0.03	55	1.7	0.02	79	5.6	--	1.02	--	16.46	1	100	0	<1	321
400	B95-5	6/2/97	DES	peri	0.1	58	5.8	0	88	5.83	--	8.58	--	10.79	5.5	100	0	0.4	230
40	MI-25	6/2/97	DES	peri	0.05	195	9.8	0.01	185	7	--	1.03	--	13.75	0.7	100	0.8	147	<90
46	MI-32	6/2/97	DES	peri	0.11	85	9.4	0	140	5.57	--	4.2	--	11.56	--	--	--	3	257
321	MW-16B	6/11/97	USGS	BL	1.69	218	368.4	0.01	340	5.39	--	--	--	--	0.4	14.5	0	--	309
344	MW-16C	6/12/97	USGS	BL	1.89	222	419.6	0	547	5.67	--	--	--	--	0.9	14	0	--	205
401	B95-6	6/16/97	USGS	BL	1.23	175	215.3	0.02	326	5.72	--	--	--	--	<0.5	20	3.6	--	139
403	B95-8	6/16/97	USGS	BL	1.43	218	311.7	0.03	550	5.81	--	--	--	--	3	16	0	--	209
398	B95-3	6/17/97	USGS	BL	1.37	187	256.2	0.06	102	5.97	--	--	--	--	<0.5	25	1.2	--	183
407	B95-12	10/28/97	DES	peri	0.5	100	50.0	0	761	5.31	--	--	--	--	4.2	23	--	0.06	--
408	B95-13	10/28/97	USGS	BL	0.45	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	10/28/97	DES	peri	0.49	78	38.2	0.02	194	5.55	1.2	--	--	--	0.5	19	0	0.09	--
409	B95-15	10/30/97	USGS	BL	0.51	15	7.7	--	113	--	--	--	--	--	--	--	--	--	--
409	B95-15	10/30/97	DES	peri	0.48	80	38.4	0	113	6.96	--	0.4	--	--	0.2	19	0	0.05	298
407	B95-12	12/15/97	DES	peri	0.44	62	27.3	0.02	813	5.2	--	4	--	9	3	25	0	--	273
299	HM-1	12/15/97	DES	peri	0.13	65	8.5	0.03	113	5.95	--	0.4	--	7.8	0.3	>100	1	0.45	77
40	MI-25	12/15/97	DES	peri	0.02	90	1.8	2.09	500	6.27	--	1.59	--	6.3	1	--	0.6	2.25	156
42	MI-27	12/15/97	DES	peri	0.11	35	3.9	0	747	5.52	--	4.9	--	--	1.5	30	0	<1	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mV)
203	MI-63	12/15/97	DES	peri	0.1	43	4.3	0	113	5.79	--	0.6	--	8	0.7	19	0	<1	--
344	MW-16C	12/15/97	DES	peri	0.12	33	4.0	0	370	5.5	--	0.6	--	9	0.3	--	0	<1	--
398	B95-3	12/16/97	DES	peri	0.14	43	6.0	0	89	6.33	--	0.5	--	11	0.5	40	0.8	<1	231
403	B95-8	12/16/97	DES	peri	0.13	50	6.5	0	466	5.72	--	1.98	--	0.3	1.5	13	0	0.92	--
404	B95-9	12/16/97	DES	peri	0.12	61	7.3	0	595	5.74	--	2.25	--	10	1	40	0	0.17	--
404	B95-9(d)	12/16/97	DES	peri	0.12	61	7.3	0	--	--	--	--	--	--	--	--	--	--	--
35	MI-22	12/16/97	DES	peri	0.05	138	6.9	0	194	7.3	--	1	--	9	1	15.5	0	4	--
37	MI-23	12/16/97	DES	peri	0.13	52	6.8	0	108	5.5	--	2.4	--	9	2	20	0	<1	--
400	B95-5	12/17/97	DES	peri	0.17	50	8.5	0	71	5.8	--	8	--	11	3	30	0	<1	--
401	B95-6	12/17/97	DES	peri	0.13	48	6.2	0	111	5.99	--	0.52	--	0.9	0.4	23	1	0.17	204
402	B95-7	12/17/97	DES	peri	0.16	70	11.2	0	385	5.7	--	2.6	--	11	1.5	16	0	<1	--
31	MI-20	12/17/97	DES	peri	0.11	98	10.8	0	519	5.35	--	1.78	--	1.8	--	--	0	0.96	--
321	MW-16B	12/18/97	DES	peri	0.12	81	9.7	0	386	5.72	--	0.38	--	9.9	0.4	27	0	0.09	289
345	MW-16R	12/18/97	DES	peri	0.02	200	4.0	0.24	197	8.92	--	0.31	--	8.9	0.9	<10	0	0.56	10
385	P-2,river	12/18/97	DES	GRAB	--	--	--	--	90	6.42	--	--	--	--	14.7	<10	0	--	122
233	MW-16A	12/19/97	DES	peri	0.29	72	20.9	0	636	5.92	--	--	--	--	1.5	16	0	--	166
402	B95-7	1/12/98	DES	peri	0.3	95	28.5	0.02	454	6	--	--	--	--	--	--	--	--	243
407	B95-12	2/19/98	DES	peri	0.53	61	32.3	0	869	5.57	3.8	--	11.8	--	3	23	0	0.18	--
	equip blank	2/19/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Trip blank	2/19/98	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	2/20/98	USGS	BL	0.67	75	50.3	0	160	5.73	--	--	--	--	--	--	--	0.7	163
408	B95-13	2/20/98	USGS	peri	0.52	56	29.1	0	158	5.77	1.45	--	11.2	--	0.7	17	0	0.25	303
409	B95-15	2/20/98	USGS	peri	0.51	48	24.5	0	110	5.68	0.7	--	10	--	0.7	21	0	0.1	244
	(trip blank)	5/11/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	5/11/98	DES	peri	0.14	85	11.9	0	404	5.71	--	0.56	--	10.1	0.4	--	0	0.2	--
344	MW-16C	5/11/98	DES	peri	0.14	70	9.8	0	394	5.7	--	0.4	--	10	0.3	--	0	<1	--
398	B95-3	5/12/98	DES	peri	0.18	50	9.0	0	98	5.9	--	0.1	--	11	0.7	--	1	<1	--
400	B95-5	5/12/98	DES	peri	0.17	53	9.0	0	96	5.8	--	4.3	--	10	4	--	0	<1	--
401	B95-6	5/12/98	DES	peri	0.15	62	9.3	0	180	5.9	--	0.54	--	12.2	0.3	--	2.5	0.18	--
403	B95-8	5/12/98	DES	peri	0.16	40	6.4	0	470	5.82	--	2.71	--	12	3	--	0	0.2	--
404	B95-9	5/12/98	DES	peri	0.17	50	8.5	0	514	5.79	--	2.6	--	11.5	2	--	0	0.21	--
404	B95-9(d)	5/12/98	DES	peri	0.17	50	8.5	0	--	--	--	--	--	--	--	--	--	--	--
46	MI-32	5/12/98	DES	peri	0.15	153	23.0	0	174	5.7	--	0.7	--	11	1	--	0	5	--
	(trip blank)	5/13/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
35	MI-22	5/13/98	DES	peri	0.06	230	13.8	0.09	187	6.92	--	1.02	--	12.1	1	--	0	82.1	--
37	MI-23	5/13/98	DES	peri	0.18	55	9.9	0.01	117	5.57	--	0.82	--	9.4	--	--	--	0.48	--
233	MW-16A	5/13/98	DES	peri	0.16	80	12.8	0	609	5.6	--	5.7	--	11	6	--	0	<1	--
345	MW-16R	5/13/98	DES	peri	0.02	110	2.2	0.01	212	8.6	--	0.8	--	11	0.9	--	0	<1	--
385	P-2,river	5/13/98	DES	GRAB	--	--	--	--	58	6.21	--	--	--	--	--	--	--	--	--
33	MI-21	5/14/98	DES	peri	0.13	50	6.5	0	63	5.9	--	2	--	1	2	--	0	<1	--
555	PW-12S	5/14/98	DES	peri	0.16	265	42.4	0	118	6.2	--	0.4	--	10	0.4	--	4.7	1	--
531	PW-1D	5/14/98	DES	peri	0.16	72	11.5	0.01	186	5.8	--	0.51	--	12.3	0.3	--	0	0.21	--
530	PW-1S	5/14/98	DES	peri	0.16	120	19.2	0	144	5.79	--	1.99	--	12.3	2	--	0	0.25	--
557	PW-12D	5/15/98	DES	peri	0.19	82	15.6	0.01	106	5.87	--	0.36	--	10.8	0.3	--	0	0.33	--
556	PW-12M	5/15/98	DES	peri	0.21	60	12.6	0	105	5.87	--	0.37	--	11.5	--	--	--	0.35	--
558	PW-12R	5/15/98	DES	peri	0.14	245	34.3	0	161	7.3	--	0.3	--	12	0.3	--	0	15	--
	(trip blank)	5/18/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
407	B95-12	5/18/98	DES	peri	0.52	153	79.6	0.01	732	5.6	5	--	11.8	--	5	35	0	0.25	213
409	B95-15	5/18/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	5/18/98	DES	peri	0.49	62	30.4	0	104	5.73	--	--	9.9	--	0.3	35	0	0.19	--
534	PW-2D	5/18/98	DES	peri	0.17	87	14.8	0	595	5.6	--	1.1	--	12	1	--	0	<1	--
532	PW-2S	5/18/98	DES	peri	0.19	123	23.4	0.01	119	5.87	--	8.34	--	11.2	8	--	0	0.62	--
	(trip blank)	5/19/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
552	PW-10D	5/20/98	DES	peri	0.16	190	30.4	0	539	11.5	--	0.6	--	12	0.6	--	0	4	--
551	PW-10M	5/20/98	DES	peri	0.16	125	20.0	0	103	5.9	--	6.2	--	13	6	--	0	1	--
533	PW-2M	5/20/98	DES	peri	0.19	75	14.3	0.02	146	6.2	--	6.4	--	11.6	6	--	0	0.9	--
535	PW-2R	5/20/98	DES	peri	0.03	192	5.8	0	208	9.91	--	1.43	--	--	--	--	--	44.4	--
	(trip blank)	5/21/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	5/21/98	USGS	BL	0.62	100	62.0	0	154	5.86	--	--	--	--	--	--	--	1.21	--
408	B95-13	5/21/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	5/21/98	DES	peri	0.5	104	52.0	0.01	151	5.86	0.4	--	11	--	0.4	30	0	0.24	292
344	MW-16C	5/21/98	DES	peri	0.44	55	24.2	0.01	384	--	--	--	--	--	--	--	--	--	311
545	PW-6D	5/21/98	DES	peri	0.17	230	39.1	0	338	8.5	--	1.7	--	13	1.5	--	0	17	--
545	PW-6D(d)	5/21/98	DES	peri	0.17	230	39.1	0	--	--	--	--	--	--	--	--	--	--	--
544	PW-6M	5/21/98	DES	peri	0.17	90	15.3	0	142	5.8	--	2.66	--	12.9	2	--	0.6	0.81	--
543	PW-6S	5/21/98	DES	peri	0.2	174	34.8	0	143	5.78	--	6.47	--	12.7	7	--	0.2	1.1	--
	(trip blank)	7/21/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
407	B95-12	7/22/98	USGS	peri	0.51	20	10.2	0.01	739	5.73	--	--	--	--	--	--	--	1.4	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
	(trip blank)	7/23/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	7/23/98	USGS	BL	0.88	96	84.5	0.02	185	5.82	--	--	--	--	0.5	--	--	4.39	65
408	B95-13	7/23/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	7/23/98	USGS	peri	0.24	133	31.9	0.01	181	6.11	0.5	--	11	--	0.9	35	0	3.11	193
408	B95-13	7/23/98	USGS	peri	0.5	28	14.0	0.02	181	6.1	0.3	--	11	--	0.9	35	0	1.69	--
408	B95-13	7/23/98	USGS	voss	0.84	9	7.6	0	178	5.88	--	--	--	--	--	--	--	--	--
409	B95-15	7/23/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	7/23/98	USGS	peri	0.49	110	53.9	0	110	5.79	1	--	10	--	0.5	27	0	1.57	300
560	PW-13M	7/23/98	USGS	peri	0.17	105	17.9	0	89	6.76	--	0.44	--	13.5	0.6	27	0.6	0.33	--
559	PW-13S	7/23/98	USGS	peri	0.18	100	18.0	0.01	79	5	--	7.71	--	13.2	7	27	--	0.8	--
563	PW-14M	7/23/98	USGS	peri	0.16	110	17.6	0	102	5.7	--	0.4	--	13	0.6	35	0.5	<1	--
562	PW-14S	7/23/98	USGS	peri	0.16	115	18.4	0	178	5.8	--	2.5	--	13	2.5	40	0	<1	--
562	PW-14S(d)	7/23/98	USGS	peri	0.16	115	18.4	0	178	5.8	--	--	--	--	2.5	40	0	<1	--
561	PW-13D	7/24/98	USGS	peri	0.15	98	14.7	0.12	173	7.16	--	0.21	--	13.6	0.6	13	0.8	6.57	--
564	PW-14D	7/24/98	USGS	peri	0.16	94	15.0	0.02	226	5.8	--	0.4	--	13	0.5	35	0.6	<1	--
	(trip blank)	9/18/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	(eq. blank)	9/30/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	(trip blank)	9/30/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	9/30/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	9/30/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15(d)	9/30/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
310	MW-2A	9/30/98	DES	peri	0.13	55	7.2	0.01	60	6	--	0.6	--	11	0.6	12	0	<1	--
210	MW-2B	9/30/98	DES	peri	0.14	155	21.7	0	82	6.3	--	0.4	--	12	0.4	15	0.8	6	--
210	MW-2B(d)	9/30/98	DES	peri	0.14	155	21.7	0	82	6.3	--	--	--	--	0.4	15	0.8	6	--
311	MW-2R	9/30/98	DES	peri	0.024	230	5.5	0.03	151	8.75	--	1.41	--	17.2	1	11	--	10.8	--
	(trip blank)	10/20/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	(trip blank)	11/23/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	11/23/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	11/23/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	11/23/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	11/23/98	DES	peri	0.156	95	14.8	0	91	6	--	0.5	--	11	0.6	20	0.5	<1	--
564	PW-14D	11/23/98	DES	peri	0.1	90	9.0	0	255	5.9	--	0.5	--	10	0.6	21	0	<1	--
563	PW-14M	11/23/98	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	11/23/98	DES	peri	0.17	60	10.2	0.02	97	5.83	--	0.43	--	10.9	0.6	35	0	0.18	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well	Well			Pump	Pump Rate	Duration	Volume Pumped	Drawdown	SC		DO hole	DO flowthru	Temp hole	Temp flowthru	DO©	CO_2©	Fe2+©	Turbidity	Eh
#	Name	Date	Source	TYPE	(L/min)	(min)	(L)	(ft)	(µmhos/cm)	pH	(mg/l)	(mg/l)	(°C)	(°C)	(mg/l)	(mg/l)	(mg/l)	(NTU)	(mV)
562	PW-14S	11/23/98	DES	peri	0.172	98	16.9	0.01	173	6	--	2.4	--	10.6	2	25	0	0.1	--
408	B95-13	11/24/98	DES	peri	0.164	75	12.3	0	132	5.86	--	0.73	--	11.1	0.8	30	0	0.18	--
409	B95-15	11/24/98	DES	peri	0.207	60	12.4	0	178	5.8	--	0.3	--	10	0.4	27	0	<1	--
561	PW-13D	11/24/98	DES	peri	0.134	133	17.8	0.12	130	6.69	--	0.31	--	10.5	0.1	17	2.9	0.73	--
559	PW-13S	11/24/98	DES	peri	0.19	70	13.3	0	78	5.8	--	1.9	--	11	2	19	0	<1	--
557	PW-12D	11/25/98	DES	peri	0.19	85	16.2	0.01	100	5.81	--	0.38	--	10.6	0.4	30	0	1	--
556	PW-12M	11/25/98	DES	peri	0.206	45	9.3	0	104	5.8	--	0.4	--	11	0.6	25	0	<1	--
558	PW-12R	11/25/98	DES	peri	0.13	115	15.0	0	188	7.4	--	0.3	--	11	0.4	<10	1.1	<1	--
555	PW-12S	11/25/98	DES	peri	0.164	55	9.0	0.01	113	5.92	--	0.34	--	11.3	0.1	25	2	0.1	--
	(trip blank)	11/30/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
233	MW-16A	11/30/98	DES	peri	0.164	65	10.7	0	559	5.6	--	4.9	--	11	5	23	0	<1	--
321	MW-16B	11/30/98	DES	peri	0.188	50	9.4	0	428	5.7	--	0.4	--	11	0.5	21	0	<1	--
344	MW-16C	11/30/98	DES	peri	0.17	65	11.1	0	313	5.7	--	0.4	--	12	0.5	30	0	<1	--
345	MW-16R	11/30/98	DES	peri	0.02	125	2.5	0	185	9	--	1.7	--	10	2	<10	0	<1	--
	(trip blank)	12/1/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
531	PW-1D	12/1/98	DES	peri	0.168	65	10.9	0	164	5.88	--	0.41	--	11.2	0.3	30	0	0.75	--
530	PW-1S	12/1/98	DES	peri	0.19	70	13.3	0	131	5.8	--	0.3	--	11	0.4	21	0	<1	--
407	B95-12	12/2/98	DES	peri	0.198	50	9.9	0.01	727	5.62	--	4.9	--	12.8	4	30	0	0.18	--
400	B95-5	12/2/98	DES	peri	0.168	60	10.1	0	65	5.8	--	8.7	--	13	8	17	0	<1	--
401	B95-6	12/2/98	DES	peri	0.202	60	12.1	0	103	5.9	--	0.53	--	12.1	0.3	20	0.8	0.18	--
235	MW-27	12/2/98	DES	peri	0.136	100	13.6	0	120	6.2	--	0.5	--	11	0.6	23	4.2	1	--
235	MW-27 (d)	12/2/98	DES	peri	0.136	100	13.6	0	120	6.2	--	--	--	--	0.6	23	4.2	1	--
	(trip blank)	12/3/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
398	B95-3	12/3/98	DES	peri	0.206	90	18.5	0.02	91	5.84	--	0.35	--	12.3	0.2	21	1.4	0.17	--
404	B95-9	12/3/98	DES	peri	0.208	35	7.3	0	366	5.6	--	0.8	--	13	0.9	27	0	<1	--
554	PW-11D	12/3/98	DES	peri	0.208	75	15.6	0	174	5.7	--	0.3	--	11	0.4	21	0	<1	--
553	PW-11M	12/3/98	DES	peri	0.214	35	7.5	0.01	118	5.8	--	0.3	--	11	0.4	21	0	<1	--
537	PW-3D	12/3/98	DES	peri	0.218	45	9.8	0	105	6	--	0.3	--	11	0.4	20	0	<1	--
536	PW-3S	12/3/98	DES	peri	0.22	30	6.6	0	111	5.8	--	3.9	--	11	4	12	0	<1	--
46	MI-32	12/4/98	DES	peri	0.17	125	21.3	0	320	5.7	--	1.3	--	13	1.4	30	0	3	--
534	PW-2D	12/4/98	DES	peri	0.21	83	17.4	0.01	282	5.98	--	0.53	--	12.9	0.4	25	0	0.19	--
533	PW-2M	12/4/98	DES	peri	0.212	61	12.9	0	298	5.7	--	0.6	--	12	0.6	27	0	<1	--
535	PW-2R	12/4/98	DES	peri	0.02	65	1.3	0	232	10.1	--	2	--	17	2	<10	0	20	--
532	PW-2S	12/4/98	DES	peri	0.196	68	13.3	0.01	194	6.06	--	3.91	--	12.7	4	30	0	0.54	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
	(trip blank)	12/7/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
403	B95-8	12/7/98	DES	peri	0.21	75	15.8	0	491	5.7	--	2.9	--	16	3	30	0	1	--
552	PW-10D	12/7/98	DES	peri	0.218	110	24.0	0	256	10.68	--	0.32	--	13.6	0.2	<10	0	0.59	--
551	PW-10M	12/7/98	DES	peri	0.226	61	13.8	0.01	145	5.6	--	0.38	--	12.6	0.4	40	0	0.71	--
539	PW-4D	12/7/98	DES	peri	0.206	55	11.3	0	462	6	--	2.6	--	14	3	21	0	<1	--
538	PW-4M	12/7/98	DES	peri	0.226	85	19.2	0	442	5.9	--	3.9	--	15	5	30	0	<1	--
538	PW-4M (d)	12/7/98	DES	peri	0.226	85	19.2	0	442	5.9	--	--	--	--	5	30	0	<1	--
541	PW-5D	12/7/98	DES	peri	0.208	65	13.5	0	305	5.73	--	0.56	--	11.1	0.5	20	0	0.2	--
	(trip blank)	12/8/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	(trip blank)	12/8/98	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
540	PW-5M	12/8/98	DES	peri	0.2	50	10.0	0	122	5.72	--	3.32	--	10.6	3.5	23	0	0.47	--
542	PW-5R	12/8/98	DES	peri	0.02	170	3.4	0.07	2751	12.5	--	2.3	--	6	5	<10	0	<1	--
385	P-2,river	12/9/98	DES	GRAB	--	--	--	--	98	6.67	--	--	--	--	--	--	--	--	--
548	PW-7M	12/9/98	DES	peri	0.194	55	10.7	0	138	6.4	--	0.5	--	11	0.6	17	0.5	1	--
547	PW-7S	12/9/98	DES	peri	0.202	50	10.1	0	150	6.2	--	0.5	--	12	0.6	16	1.4	<1	--
545	PW-6D	12/10/98	DES	peri	0.416	232	96.5	1.66	393	8.58	--	1.21	--	10.5	1	25	0	218	--
544	PW-6M	12/10/98	DES	peri	0.185	65	12.0	0	185	5.8	--	0.4	--	11	0.5	25	0	1	--
546	PW-6R	12/10/98	DES	peri	0.02	180	3.6	0.39	2189	12.3	--	2.3	--	8	3	<10	0	5	--
543	PW-6S	12/10/98	DES	peri	0.211	165	34.8	0.02	226	5.6	--	0.6	--	11	0.6	30	0	<1	--
	(DB blank)	2/8/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	(trip blank)	2/8/99	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	2/8/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	2/8/99	USGS	peri	0.49	65	31.9	0.01	127	5.76	--	0.7	--	9.6	0.3	14.5	0	0.53	278
408	B95-13 (d)	2/8/99	USGS	peri	0.49	65	31.9	0.01	127	5.76	--	--	--	--	0.3	14.5	0	0.53	278
409	B95-15	2/8/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	2/8/99	USGS	peri	0.47	132	62.0	0.01	189	5.79	--	0.9	--	9.2	0.3	25	0	0.12	302
560	PW-13M	2/8/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	2/8/99	USGS	peri	0.45	79	35.6	0.02	95	9.82	--	0.7	--	8.4	0.5	13	0.6	0.55	140
563	PW-14M	2/8/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M(d)	2/8/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
565	EW-1	3/1/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
566	EW-2	3/1/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
566	EW-2dup	3/1/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	Trip blank	3/1/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
563	PW-14M	4/7/99	DES	peri	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	4/7/99	DES	peri	0.182	130	23.7	0.01	212	5.8	--	0.3	--	9	0.5	22	0	<1	158
409	B95-15	4/7/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	4/7/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	4/7/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	4/7/99	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	4/7/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/7/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	4/7/99	DES	peri	0.166	195	32.4	0.01	138	5.99	--	5.09	--	9	5	26	0	0.59	208
558	PW-12R	4/8/99	DES	peri	0.125	95	11.9	0.28	199	7.5	--	0.4	--	10	0.6	<10	1.1	<1	-139
555	PW-12S	4/8/99	DES	peri	0.142	115	16.3	0.03	174	5.62	--	2.96	--	10.6	3	24	1.4	0.75	146
559	PW-13S	4/8/99	DES	peri	0.212	80	17.0	0.01	84	5.7	--	1	--	11	1.1	18	0	<1	128
561	PW-13D	4/8/99	DES	peri	0.162	55	8.9	0.14	129	6.4	--	0.4	--	11	0.4	18	3.2	<1	-19
557	PW-12D	4/8/99	DES	peri	0.212	74	15.7	0.02	106	5.77	--	0.35	--	9.7	0.35	55	0	0.1	185
0	trip blank	4/8/99	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	4/8/99	DES	peri	0.22	80	17.6	0	102	5.8	--	0.3	--	10	0.5	22	0.7	<1	76
560	PW-13M	4/8/99	DES	peri	0.19	40	7.6	0	97	5.75	--	0.46	--	10.1	0.6	32	0.1	0.24	134
409	B95-15	4/8/99	USGS	peri	0.414	110	45.5	0	152	5.86	--	0.7	--	10.9	0.4	22	0	0.17	281
530	PW-1S	4/9/99	DES	peri	0.194	92	17.8	0	119	5.8	--	0.3	--	10	0.4	25	0	<1	148
531	PW-1D	4/9/99	DES	peri	0.204	75	15.3	0	143	5.8	--	0.3	--	10	0.5	27	0	<1	162
0	trip blank	4/12/99	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
233	MW-16A	4/13/99	DES	peri	0.22	95	20.9	0.01	477	5.6	--	5.4	--	10	5	25	0	<1	211
321	MW-16B	4/13/99	DES	peri	0.213	95	20.2	0.01	372	5.5	--	0.3	--	10	0.5	20	0	<1	147
321	MW-16B(d)	4/13/99	DES	peri	0.213	95	20.2	0.01	372	5.5	--	0.3	--	10	0.5	20	0	<1	147
344	MW-16C	4/13/99	DES	peri	0.168	90	15.1	0.01	317	5.57	--	0.48	--	9.7	0.4	20	0	0.15	175
407	B95-12	4/13/99	DES	peri	0.198	112	22.2	0	719	5.58	--	5.23	--	11.5	4	25	0	0.11	308
408	B95-13	4/14/99	USGS/EPA	peri	0.258	100	26.0	0	145	--	--	0	--	10.6	0.2	25	--	0.55	--
532	PW-2S	4/14/99	DES	peri	0.197	202	39.8	0.02	665	5.92	--	3.07	--	9.7	3	40	0	0.52	286
533	PW-2M	4/14/99	DES	peri	0.23	95	21.9	0.01	260	5.6	--	0.8	--	11	1	20	0	<1	175
534	PW-2D	4/14/99	DES	peri	0.204	70	14.3	0.01	294	5.7	--	0.5	--	11	0.7	18	0	<1	195
536	PW-3S	4/14/99	DES	peri	0.215	45	9.7	0.01	125	6.7	--	3.4	--	6	4	11	0	<1	212
537	PW-3D	4/14/99	DES	peri	0.202	60	12.1	0.01	84	6.01	--	0.27	--	8.4	0.4	18	0	0.12	175
408	B95-13	4/14/99	USGS/DES	peri	0.48	159	54.0	0.01	124	--	--	0	--	10.9	0.1	22	--	0.59	--
408	B95-13	4/14/99	USGS/DES	BL	0.45	404	87.0	0.01	138	--	--	0	--	10.7	0.5	25	--	0.99	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
0	trip blank	4/14/99	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/14/99	USGS/EPA	BL	0.97	480	151.0	0	127	--	--	0	--	0	>1	22	--	>10	--
408	B95-13	4/14/99	USGS/EPA	peri	1.08	545	221.0	0.06	128	6.82	--	0	--	10.2	0.7	19	0	2.2	--
408	B95-13	4/14/99	USGS/EPA	BL	1.08	565	243.0	0.06	128	6.58	--	0	--	9.8	0.2	19	--	0.36	--
408	B95-13	4/14/99	USGS/EPA	BL	0.5	583	252.0	0.01	127	6.55	--	0	--	9.7	--	--	--	--	--
408	B95-13	4/14/99	USGS/EPA	peri	0.49	595	258.0	0.01	128	7.14	--	0	--	10	0.6	20	--	1.88	--
408	B95-13	4/14/99	USGS/EPA	peri	0.33	625	268.0	0.02	128	7.13	--	0	--	9.8	0.4	18	--	0.97	--
408	B95-13(d)	4/14/99	USGS/EPA	peri	1.08	545	221.0	0.06	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	USGS/EPA	peri	1.08	545	221.0	0.06	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	USGS/EPA	BL	1.08	565	243.0	0.06	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	USGS/EPA	peri	0.33	625	268.0	0.02	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	USGS/EPA	peri	0.48	159	54.0	0.01	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	USGS/EPA	BL	0.45	404	87.0	0.01	--	--	--	--	--	--	--	--	--	--	--
547	PW-7S	4/15/99	DES	peri	0.202	60	12.1	0.02	116	6.32	--	0.22	--	11.9	0.4	20	1.1	0.6	67
554	PW-11D	4/15/99	DES	peri	0.212	90	19.1	0.02	148	5.6	--	0.4	--	10	0.6	17	0	<1	141
553	PW-11M	4/15/99	DES	peri	0.22	55	12.1	0.01	122	5.7	--	0.3	--	10	0.6	19	0	<1	163
548	PW-7M	4/15/99	DES	peri	0.198	103	20.4	0.19	130	6.48	--	0.15	--	11.5	0.3	20	0.04	0.61	82
0	equip blank	4/15/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	4/19/99	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
540	PW-5M	4/19/99	DES	peri	0.176	60	10.6	0.03	121	5.72	--	2.14	--	11.5	1.5	26	0	0.13	263
541	PW-5D	4/19/99	DES	peri	0.2	90	18.0	0.03	201	5.8	--	0.4	--	12	0.5	23	0	<1	144
551	PW-10M	4/19/99	DES	peri	0.19	75	14.3	0.01	174	5.75	--	7.24	--	11.9	0.6	53	0	0.21	221
552	PW-10D	4/19/99	DES	peri	0.19	185	35.2	0.02	345	11	--	0.3	--	12	0.5	<10	0	<1	60
385	P-2,River	4/19/99	DES	GRAB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
46	MI-32	4/20/99	DES	peri	0.194	62	12.0	0	257	5.61	--	0	--	11.9	2	35	0	0.29	286
398	B95-3	4/20/99	DES	peri	0.218	50	10.9	0.01	98	5.9	--	0.4	--	11	0.5	16	0.8	<1	124
549	PW-8M	4/20/99	DES	peri	0.202	90	18.2	0.01	259	6.76	--	2.22	--	11.7	3	19	0	1.96	155
550	PW-9M	4/20/99	DES	peri	0.218	95	20.7	0	213	5.5	--	1.4	--	9	1.3	30	0	<1	175
550	PW-9M(d)	4/20/99	DES	peri	0.218	95	20.7	0	213	5.5	--	1.4	--	9	1.3	30	0	<1	175
408	B95-13	4/20/99	USGS/EPA	BL	0.85	45	38.0	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/20/99	USGS/EPA	BL	0.8	65	54.0	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/20/99	USGS/EPA	BL	0.63	75	61.0	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/20/99	USGS/EPA	BL	0.63	85	67.0	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	4/21/99	DES	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
235	MW-27	4/21/99	DES	peri	0.216	55	11.9	0.9	141	6.3	--	0.6	--	7	0.5	19	2.8	1	22
400	B95-5	4/21/99	DES	peri	0.19	75	14.3	0	71	6.03	--	8.82	--	10.9	9	20	0	0.43	357
401	B95-6	4/21/99	DES	peri	0.214	50	10.7	0	104	6	--	0.4	--	11	0.6	23	1.6	<1	96
543	PW-6S	4/21/99	DES	peri	0.19	70	13.3	0.01	250	5.76	--	1.83	--	11.8	1	45	0	0.26	230
544	PW-6M	4/21/99	DES	peri	0.183	47	8.6	0.02	131	5.96	--	1.48	--	12.1	1	25	0	0.48	185
545	PW-6D	4/21/99	DES	peri	0.192	240	46.1	0.1	372	8.7	--	0.3	--	12	0.6	<10	0	1	-158
385	P2-RIVER	4/21/99	USGS/EPA	GRAB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
403	B95-8	4/22/99	DES	peri	0.234	65	15.2	0.02	482	6	--	3.8	--	12	3	30	0	<1	220
404	B95-9	4/22/99	DES	peri	0.232	90	20.9	0	295	5.6	--	2.9	--	10	3	18	0	<1	203
538	PW-4M	4/22/99	DES	peri	0.224	60	13.4	0.03	415	5.98	--	5.03	--	11.7	5	25	0	0.35	297
539	PW-4D	4/22/99	DES	peri	0.216	65	14.0	0.06	512	5.93	--	2.89	--	11.5	3	22	0	0.25	199
0	trip blank	5/12/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	5/13/99	USGS	peri	0.42	35	14.7	0.03	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	5/13/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	5/13/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	5/13/99	USGS	peri	0.43	36	15.5	0.01	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
546	PW-6R	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
535	PW-2R	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
542	PW-5R	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	5/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well	Well			Pump	Pump Rate	Duration	Volume Pumped	Drawdown	SC		DO hole	DO flowthru	Temp hole	Temp flowthru	DO©	CO_2©	Fe2+©	Turbidity	Eh
#	Name	Date	Source	TYPE	(L/min)	(min)	(L)	(ft)	(µmhos/cm)	pH	(mg/l)	(mg/l)	(°C)	(°C)	(mg/l)	(mg/l)	(mg/l)	(NTU)	(mv)
409	B95-15	6/10/99	USGS	peri	0.47	41	19.3	0.02	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	6/10/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
546	PW-6R	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
542	PW-5R	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
535	PW-2R	6/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	6/10/99	USGS	peri	0.45	48	21.6	0	--	--	--	--	--	--	--	--	--	--	--
	trip blank	7/14/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	7/15/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
565	EW-1	7/16/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
566	EW-2	7/16/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	7/16/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
321	MW-16B	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	7/16/99	USGS	peri	0.33	86	28.4	0	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	7/16/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	7/27/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-A	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-B	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-C	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-D	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13-A	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13-B	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13-C	7/30/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	8/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2a. Sampling information and field parameters, May 1997 to September 1999, Milford, New Hampshire.

Well #	Well Name	Date	Source	Pump TYPE	Pump Rate (L/min)	Duration (min)	Volume Pumped (L)	Drawdown (ft)	SC (µmhos/cm)	pH	DO hole (mg/l)	DO flowthru (mg/l)	Temp hole (°C)	Temp flowthru (°C)	DO© (mg/l)	CO_2© (mg/l)	Fe2+© (mg/l)	Turbidity (NTU)	Eh (mv)
557	PW-12D	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	8/12/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	8/13/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	9/9/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
535	PW-2R	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
542	PW-5R	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
546	PW-6R	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
565	EW-1	9/10/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
566	EW-2	9/10/99	USGS	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	9/10/99	USGS	peri	0.4	60	24.0	0.01	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	9/10/99	USGS	DB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	NH_4^+ (mg/l)	S_2^- (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)	NO_3-&NO_2- (mg/l)	NO_3^- (mg/l)	NO_2^- (mg/l)	PO_4^{3-} (mg/l)	Ca^{2+} (mg/l)	Fe(total) (mg/l)	Mg^{2+} (mg/l)	Mn^{2+} (mg/l)	K^+ (mg/l)	Na^+ (mg/l)	CH_4 (mg/l)	TOC (mg/l)	Br- (mg/l)	SC-lab (µmhos/cm)	$CaCO_3$ (mg/l)
233	MW-16A	5/27/97	<0.25	--	140	12	1.57	--	--	--	12.9	<0.05	1.79	0.021	2.68	72.9	0.261	<2	--	--	12
321	MW-16B	5/27/97	0.5	--	72	10	1.75	--	--	--	9	<0.05	1.21	0.163	2.77	41.2	0.159	<2	--	--	13.2
344	MW-16C	5/27/97	<0.25	--	138	12	1.11	--	--	--	17.3	<0.05	3.04	0.277	2.82	64.8	0.495	<2	--	--	11.6
345	MW-16R	5/27/97	0.5	--	27	5	<0.05	--	--	--	20.7	0.235	2.62	0.062	1.69	17.5	967.12	<2	--	--	58.6
407	B95-12	5/28/97	<0.5	--	185	14	2.27	--	--	--	12.2	<0.05	2.01	0.03	3.71	100	0.151	<2	--	--	10.6
407	B95-12(d)	5/28/97	<0.25	--	190	14	2.27	--	--	--	12.2	<0.05	2	0.03	3.7	98.9	0.209	<2	--	--	--
408	B95-13	5/28/97	<0.25	--	40	9	0.9	--	--	--	11.5	<0.05	2.26	0.406	1.79	17.3	1.335	<2	--	--	13.6
409	B95-15	5/28/97	<0.25	--	12	13	0.82	--	--	--	8.49	<0.05	1.78	0.134	1.44	6.79	1.155	<2	--	--	14
385	P-2, river	5/28/97	<0.25	--	13	5	0.06	--	--	--	--	--	--	--	--	--	--	3	--	--	7.8
398	B95-3	5/29/97	<0.25	--	11	9	<0.05	--	--	--	6.15	1.3	1.42	0.323	0.95	6.7	0.202	<2	--	--	16.6
404	B95-9	5/29/97	<0.25	--	180	11	1.2	--	--	--	13	<0.05	1.8	0.056	2.83	97.8	0.013	<2	--	--	13.4
299	HM-1	5/29/97	<0.25	--	13	10	0.32	--	--	--	7.29	0.112	1.58	0.524	1.32	7.78	4.436	<2	--	--	14
42	MI-27	5/29/97	<0.25	--	205	12	1.67	--	--	--	15.8	<0.05	2.89	0.017	4.64	107	<0.01	<2	--	--	12.2
203	MI-63	5/29/97	<0.5	--	16	9	0.5	--	--	--	7.09	0.062	1.38	0.745	1.07	9.1	2.91	<2	--	--	14.4
30	MI-19	5/30/97	<0.25	--	<2	15	<0.05	--	--	--	19.6	4.75	5.13	0.143	2.45	23.9	2.282	<2	--	--	98
31	MI-20	5/30/97	<0.5	--	51	7	0.2	--	--	--	1.54	<0.05	0.277	0.016	0.658	35.7	<0.01	2.2	--	--	11.8
33	MI-21	5/30/97	<0.25	--	14	5	0.08	--	--	--	3.01	0.054	0.626	0.018	0.832	9.36	0.06	<2	--	--	7.4
400	B95-5	6/2/97	<0.25	--	3	14	1.3	--	--	--	6.56	<0.05	1.32	<0.01	4.08	2.88	<0.01	<2	--	--	8.4
40	MI-25	6/2/97	<0.25	--	18	10	0.11	--	--	--	10.4	5.18	2.79	0.361	2.31	22	31.78	<2	--	--	41.2
46	MI-32	6/2/97	<0.25	--	29	7	1.22	--	--	--	8.26	0.1	1.07	<0.01	1.78	15.6	0.396	<2	--	--	11
321	MW-16B	6/11/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.01	--	--	--	11
344	MW-16C	6/12/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.01	--	--	--	12.4
401	B95-6	6/16/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.035	--	--	--	14
403	B95-8	6/16/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.01	--	--	--	12.8
398	B95-3	6/17/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.012	--	--	--	9.4
407	B95-12	10/28/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.01	--	1.65	747	8.8
408	B95-13	10/28/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	10/28/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.39	--	<0.4	184	12.6
409	B95-15	10/30/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	10/30/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.35	--	0.19	111	12.2
407	B95-12	12/15/97	--	--	230	14	--	2.36	<0.05	0.005	13.5	<0.05	2.2	0.033	4.24	123	<0.01	<1	1.67	805	9
299	HM-1	12/15/97	--	<0.1	14	10	--	0.12	<0.05	0.015	7.07	0.711	1.55	0.501	1.26	7.56	15.26	1	<0.4	108	10
40	MI-25	12/15/97	--	--	130	13	--	0.24	<0.05	0.013	21	0.968	3.92	0.532	2.83	65.7	1.48	<1	0.92	500	33.4
42	MI-27	12/15/97	--	--	220	12	--	1.52	<0.05	0.004	14.3	<0.05	2.59	0.015	4.51	106.4	--	<1	1.67	741	9
203	MI-63	12/15/97	--	--	16	10	--	0.3	<0.05	0.004	6.43	0.322	1.3	0.73	1.09	9.09	3.28	1.1	<0.4	104	12.6

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3-&NO_2-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
344	MW-16C	12/15/97	--	--	86	10	--	1.09	<0.05	0.005	12.7	--	2.27	0.223	2.04	42	0.24	<1	0.54	345	11.6
398	B95-3	12/16/97	--	<0.1	13	8	--	<0.05	<0.05	0.007	5.36	1.86	1.23	0.241	1.13	7.12	1.74	1.1	<0.4	89	10.2
403	B95-8	12/16/97	--	--	125	7	--	0.97	<0.05	0.006	20.8	<0.05	4.3	<0.01	3.06	48.8	0.13	<1	0.94	108	11.6
404	B95-9	12/16/97	--	--	164	12	--	0.86	<0.05	0.006	12.4	<0.05	1.66	0.079	2.68	88.4	0.06	<1	1.16	595	14.4
404	B95-9(d)	12/16/97	--	--	162	12	--	0.86	<0.05	0.008	12.3	<0.05	1.63	0.079	2.62	87.9	--	<1	--	--	--
35	MI-22	12/16/97	--	--	8	13	--	1.16	0.08	0.013	22.9	0.144	2.86	0.026	0.99	8.66	0.49	<1	<0.4	194	58.4
37	MI-23	12/16/97	--	--	13	6	--	1.15	<0.05	0.006	6.2	<0.05	1.05	<0.01	1.61	8.6	<0.01	2.1	<0.4	--	12.2
400	B95-5	12/17/97	--	--	3	13	--	0.78	<0.05	0.004	5.66	<0.05	1.13	<0.01	3.77	2.6	0.02	<1	<0.4	71	8.2
401	B95-6	12/17/97	--	--	17	7	--	<0.05	<0.05	0.004	3.86	1.49	0.82	1.1	1.38	11.6	50.22	1.6	<0.4	111	13.2
402	B95-7	12/17/97	--	--	104	11	--	0.86	<0.05	0.004	11.6	<0.05	2.36	0.051	3.23	53	0.02	<1	0.86	385	11.8
31	MI-20	12/17/97	--	--	142	10	--	0.06	<0.05	0.019	8.59	0.808	1.47	0.06	1.79	74.1	--	2.2	1.5	519	6.6
321	MW-16B	12/18/97	--	<0.1	94	9	--	1.58	<0.05	0.004	12	<0.05	1.65	0.203	2.9	49.3	0.68	<1	1	386	11.2
345	MW-16R	12/18/97	--	<0.1	24	3	--	<0.05	<0.05	0.027	15.6	0.114	1.98	0.013	1.65	18.2	1147.61	1.1	<0.4	197	54.4
385	P-2,river	12/18/97	--	<0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.4	--	6
233	MW-16A	12/19/97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.172	--	1.47	645	9
402	B95-7	1/12/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.99	447	--
407	B95-12	2/19/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.009	--	1.38	845	8.4
--	equip blank	2/19/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	Trip blank	2/19/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	2/20/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	2/20/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.16	--	<0.2	155	13.6
409	B95-15	2/20/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.91	--	<0.2	114	11.6
--	(trip blank)	5/11/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	5/11/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.96	0.67	--	--	--
344	MW-16C	5/11/98	--	--	101	9	--	--	--	--	15.2	<0.05	2.69	0.255	2.36	50.4	2	0.58	1.05	397	9.8
398	B95-3	5/12/98	--	--	--	--	--	--	--	--	7.52	<0.05	1.48	<0.01	4.41	4.06	1.8	1.54	--	--	--
400	B95-5	5/12/98	--	--	9	13	--	--	--	--	--	--	--		--	--	1.79	0.55	0.199	98	9
401	B95-6	5/12/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	31.06	0.86	--	--	--
403	B95-8	5/12/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.82	0.46	--	--	--
404	B95-9	5/12/98	--	--	138	11	--	--	--	--	12.2	<0.05	1.72	0.067	2.39	79.2	3.16	0.76	1.23	516	12.6
404	B95-9(d)	5/12/98	--	--	138	11	--	--	--	--	12.2	<0.05	1.72	0.065	2.35	78.7	2.65	0.63	1.33	519	11.8
46	MI-32	5/12/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.83	0.71	--	--	--
--	(trip blank)	5/13/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
35	MI-22	5/13/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
37	MI-23	5/13/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3-&NO_2-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
233	MW-16A	5/13/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--
345	MW-16R	5/13/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	29.86	1.04	--	--	--
385	P-2,river	5/13/98	--	--	10	4	--	--	--	--	2.06	0.279	0.476	0.039	0.497	7.12	2.09	3.8	0.21	58	3.6
33	MI-21	5/14/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8	3.06	--	--	--
555	PW-12S	5/14/98	--	--	17	6	--	--	--	--	4.62	5.04	0.924	0.661	1.06	10.7	2.29	1.1	0.35	108	15.2
531	PW-1D	5/14/98	--	--	36	10	--	--	--	--	11.6	0.272	2.3	0.371	1.62	17.4	3.06	0.84	0.513	186	13
530	PW-1S	5/14/98	--	--	24	10	--	--	--	--	9.43	0.058	1.81	0.055	1.18	12.5	4488.47	0.9	0.418	144	13
557	PW-12D	5/15/98	--	--	14	9	--	--	--	--	7.09	0.1	1.56	0.363	1.31	8.59	8.87	0.98	0.288	107	13
556	PW-12M	5/15/98	--	--	14	9	--	--	--	--	6.64	0.203	1.46	0.296	1.3	9.78	9.02	0.82	0.315	106	12.6
558	PW-12R	5/15/98	--	--	12	9	--	--	--	--	21.5	1.03	2.24	0.316	1.11	8.07	4.2	0.91	0.285	169	48.2
--	(trip blank)	5/18/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
407	B95-12	5/18/98	--	--	205	14	--	--	--	--	12.7	<0.05	2.03	0.032	3.86	117	1.75	0.47	1.72	743	9
409	B95-15	5/18/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	5/18/98	--	--	12	12	--	--	--	--	8.14	<0.05	1.71	0.119	1.37	7.27	3.47	0.45	0.259	107	12.6
534	PW-2D	5/18/98	--	--	160	14	--	--	--	--	20.1	0.222	3.65	0.075	3.59	83.3	1.83	0.55	1.41	588	9.6
532	PW-2S	5/18/98	--	--	15	11	--	--	--	--	7.4	<0.05	0.912	<0.01	2.09	13.2	2.07	1.13	0.281	126	11
--	(trip blank)	5/19/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
552	PW-10D	5/20/98	--	--	37	11	--	--	--	--	59	0.574	0.993	0.044	17.1	17.6	2.99	1.85	0.457	475	82.2
551	PW-10M	5/20/98	--	--	16	6	--	--	--	--	5.17	0.072	0.952	0.016	2.65	10.7	4.46	1.57	0.309	110	14
533	PW-2M	5/20/98	--	--	21	7	--	--	--	--	12.7	<0.05	1	<0.01	4.45	13	1.97	1.02	0.382	161	20
535	PW-2R	5/20/98	--	--	25	7	--	--	--	--	13	1.74	2.3	0.104	12.2	21.3	2.21	0.88	0.291	203	65
--	(trip blank)	5/21/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	5/21/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.12	--	--	--	--
408	B95-13	5/21/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	5/21/98	--	--	25	10	--	--	--	--	9.69	<0.05	1.92	0.326	1.43	13.2	4.36	0.57	0.368	151	12.8
344	MW-16C	5/21/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.14	--	1.02	380	10.6
545	PW-6D	5/21/98	--	--	28	39	--	--	--	--	12.8	0.802	2.61	0.188	38.4	23	2.32	3.22	0.399	322	61.2
545	PW-6D(d)	5/21/98	--	--	28	38	--	--	--	--	12.5	0.76	2.54	0.183	37.9	22.3	2.3	3.13	0.386	318	61.8
544	PW-6M	5/21/98	--	--	21	10	--	--	--	--	8.39	0.382	1.25	0.418	3.48	13.8	2.5	1.9	0.328	149	16.8
543	PW-6S	5/21/98	--	--	19	10	--	--	--	--	10.3	0.28	1.47	0.395	3.17	13	2.45	1.7	0.321	144	16.8
--	(trip blank)	7/21/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
407	B95-12	7/22/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.86	0.75	1.91	712	10.8
--	(trip blank)	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.34	1.03	0.156	184	13.8
408	B95-13	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	NH_4^+ (mg/l)	S_2^- (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)	NO_3^-&NO_2^- (mg/l)	NO_3^- (mg/l)	NO_2^- (mg/l)	PO_4^{3-} (mg/l)	Ca^{2+} (mg/l)	Fe(total) (mg/l)	Mg^{2+} (mg/l)	Mn^{2+} (mg/l)	K^+ (mg/l)	Na^+ (mg/l)	CH_4 (mg/l)	TOC (mg/l)	Br- (mg/l)	SC-lab (µmhos/cm)	$CaCO_3$ (mg/l)
408	B95-13	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.29	0.86	0.059	180	17.8
408	B95-13	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.45	0.83	0.077	180	15.2
408	B95-13	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.089	178	14.6
409	B95-15	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	7/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.98	0.93	0	107	14
560	PW-13M	7/23/98	--	--	13	7	<0.05	--	--	0.005	5.14	0.272	1.12	1.13	0.732	7.86	2.9	1.31	0	89	10.2
559	PW-13S	7/23/98	--	--	10	6	0.23	--	--	0.005	5.3	<0.05	0.767	<0.01	2.06	6.62	2.24	0.91	0	80	11.6
563	PW-14M	7/23/98	--	--	15	7	0.06	--	--	0.005	6.59	0.246	1.43	1.12	0.724	7.82	3.39	0.92	0	101	13.2
562	PW-14S	7/23/98	--	--	24	15	1.5	--	--	0.005	11.6	0.079	3.41	0.051	3.37	13.5	1.97	0.82	0	178	23
562	PW-14S(d)	7/23/98	--	--	24	15	1.47	--	--	0.007	11.4	0.063	3.34	0.044	3.37	13.4	2.19	1.02	0	178	21.6
561	PW-13D	7/24/98	--	--	12	11	<0.05	--	--	0.098	15.9	0.963	1.33	0.205	4.26	12.6	6.09	1.8	0	170	47.2
564	PW-14D	7/24/98	--	--	50	11	0.89	--	--	0.005	15.1	0.374	2.9	0.695	1.62	20.1	--	0.96	0.159	235	18
--	(trip blank)	9/18/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	(eq. blank)	9/30/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	(trip blank)	9/30/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	9/30/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	9/30/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15(d)	9/30/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
310	MW-2A	9/30/98	--	--	7	7.33	--	<0.05	<0.05	<0.001	3.45	<0.05	0.824	0.025	0.876	5.95	1.91	1.75	--	--	8.6
210	MW-2B	9/30/98	--	--	9	7.42	--	<0.05	<0.05	0.026	6.35	0.669	1.41	0.466	1.02	5.87	4.67	0.75	--	--	16
210	MW-2B(d)	9/30/98	--	--	9	7.89	--	<0.05	<0.05	0.011	6.27	0.642	1.38	0.459	0.996	5.86	4.71	0.76	--	--	15.6
311	MW-2R	9/30/98	--	--	3	7.24	--	<0.05	<0.05	0.003	14.8	1.7	2.12	0.065	0.705	14.2	250.55	0.76	--	--	62
--	(trip blank)	10/20/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	(trip blank)	11/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	11/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	11/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	11/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	11/23/98	--	--	13	7	<0.05	0.02	--	0.003	5.54	0.408	1.12	1.11	0.687	8	3.8	0.78	0.2	95	11.6
564	PW-14D	11/23/98	--	--	56	11	0.82	0.74	--	0.009	15.9	0.08	3.11	0.718	1.69	23.3	3.18	0.42	0.66	259	16.2
563	PW-14M	11/23/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	11/23/98	--	--	14	7	<0.05	0.02	--	0.009	6.47	0.211	1.44	1.15	0.759	8.24	2.72	0.74	0.19	106	12.6
562	PW-14S	11/23/98	--	--	23	13	1.51	0.94	--	0.005	11.4	<0.05	2.59	0.013	3.2	13.3	2.15	0.59	0.32	177	21
408	B95-13	11/24/98	--	--	20	10	0.48	0.28	--	0.004	8.86	<0.05	1.8	0.311	1.19	10.9	66.63	0.85	0.3	146	15.2
409	B95-15	11/24/98	--	--	15	38	0.1	0.07	--	0.008	10.3	<0.05	2.06	0.198	2.02	19	15.64	1.1	0.27	195	16.6
561	PW-13D	11/24/98	--	--	13	8	<0.05	0.01	--	0.023	8.52	4.65	1.44	0.569	2.37	9.44	3.9	0.64	0.21	118	23.8

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3-&NO_2-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
559	PW-13S	11/24/98	--	--	10	6	0.35	0.17	--	0.003	5.32	<0.05	0.845	0.014	2.15	6.67	2.15	0.94	0.1	89	11
557	PW-12D	11/25/98	--	--	13	10	<0.05	0.01	--	0.006	7.02	<0.05	1.54	0.466	1.16	8.6	5.44	0.94	0.3	112	14
556	PW-12M	11/25/98	--	--	13	9	<0.05	0.01	--	0.009	6.69	0.134	1.43	0.386	1.34	8.4	7.69	0.9	0.25	111	13.8
558	PW-12R	11/25/98	--	--	12	8	<0.05	0.01	--	0.024	23.5	1.2	2.31	0.425	1.18	8.21	6.62	0.96	0.33	207	60.8
555	PW-12S	11/25/98	--	--	16	10	<0.05	0.03	--	0.009	5.32	3.23	1.05	0.671	0.915	10.7	2.26	1.2	0.3	119	11.6
--	(trip blank)	11/30/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
233	MW-16A	11/30/98	--	--	150	12	1.48	0.76	--	0.004	11.1	<0.05	1.55	0.021	2.58	85.6	2	0.52	1.41	567	9.6
321	MW-16B	11/30/98	--	--	108	8	1.25	0.47	--	0.006	14.6	<0.05	2.02	0.195	2.89	58.5	2.21	0.54	1.75	441	10.6
344	MW-16C	11/30/98	--	--	74	9	1.09	0.65	--	0.005	13.3	<0.05	2.38	0.272	1.92	38.8	2.62	0.43	0.78	323	11.2
345	MW-16R	11/30/98	--	--	21	1	0.57	0	--	0.049	13.7	<0.05	1.69	0.012	1.4	20.7	1763.35	1.5	0.64	212	54.8
--	(trip blank)	12/1/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
531	PW-1D	12/1/98	--	--	29	12	0.52	0.24	--	0.004	10.6	0.054	2.11	0.33	1.36	16.2	6.05	0.58	0.34	169	14.4
530	PW-1S	12/1/98	--	--	20	9	0.55	0.25	--	0.004	9.63	0.103	1.82	0.257	1.23	11	6.05	0.8	0.34	140	16
407	B95-12	12/2/98	--	--	200	13	2.39	1.03	--	0.005	13.3	<0.05	2.27	0.032	3.74	114	1.887	0.34	2.01	745	9.4
400	B95-5	12/2/98	--	--	2	13	0.69	0.34	--	0.005	4.98	<0.05	0.954	<0.01	3.39	2.81	1.819	0.43	0	69	8.8
401	B95-6	12/2/98	--	--	13	10	0.08	0	--	0.006	4.87	0.684	1.06	1.73	1.2	10.4	3.014	1.13	0.14	112	8.4
235	MW-27	12/2/98	--	--	18	5	0.05	0.03	--	0.007	3.78	6.36	0.926	0.544	1.15	12.2	301.778	1.58	0.22	104	15.2
235	MW-27 (d)	12/2/98	--	--	18	5	0.05	0.05	--	0.008	3.77	6.35	0.904	0.543	1.12	12	233.254	1.27	0.21	105	16
--	(trip blank)	12/3/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
398	B95-3	12/3/98	--	--	12	9	<0.05	0	--	0.01	5.84	1.28	1.34	0.323	1	6.64	2.105	0.92	0.14	91	12.2
404	B95-9	12/3/98	--	--	71	32	2.3	1.63	--	0.006	15.8	<0.05	2.76	0.455	2.98	43.5	2.25	1.99	0.75	376	14
554	PW-11D	12/3/98	--	--	14	38	0.29	0.26	--	0.004	10.4	0.106	2.13	0.195	2.07	17.6	4.985	0.98	0.16	181	15.6
553	PW-11M	12/3/98	--	--	16	14	<0.05	0.02	--	0.003	5.78	<0.05	1.07	0.093	2.81	12.7	17.606	1.24	0.19	125	13.4
537	PW-3D	12/3/98	--	--	10	13	0.18	0.13	--	0.005	9.63	<0.05	1.89	0.602	1.61	6.41	1.933	0.89	0.27	117	19
536	PW-3S	12/3/98	--	--	17	14	0.24	0.12	--	0.004	5.58	<0.05	1.07	<0.01	1.22	12.1	1.909	2.68	0.25	96	5.8
46	MI-32	12/4/98	--	--	80	11	1.02	0.67	--	0.009	11.7	0.109	1.71	0.077	2.96	42.2	1.983	0.61	0.83	332	10.8
534	PW-2D	12/4/98	--	--	65	10	0.91	0.44	--	0.004	12.4	<0.05	2.01	0.036	2.18	34.5	1.965	0.69	--	--	--
533	PW-2M	12/4/98	--	--	69	11	0.97	0.64	--	0.005	16.7	<0.05	1.92	0.014	5.79	30.1	2.3	0.99	0.78	310	15.2
535	PW-2R	12/4/98	--	--	8	16	0.07	0.04	--	0.109	8.44	0.764	1.66	0.047	18.1	24.9	4.786	0.98	0.31	239	73.4
532	PW-2S	12/4/98	--	--	30	12	1.72	1.04	--	0.004	14.6	<0.05	1.15	<0.01	3.52	16.9	1.983	1.04	0.73	207	20.4
--	(trip blank)	12/7/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
403	B95-8	12/7/98	--	--	130	11	1.26	0.67	--	0.003	16.7	<0.05	3.47	<0.01	3.46	63.6	2.038	0.49	1.54	502	13.6
552	PW-10D	12/7/98	--	--	15	13	0.85	0.34	--	0.103	39.4	<0.05	1.34	<0.01	3.51	7.82	5.023	0.91	0.61	252	86.6
551	PW-10M	12/7/98	--	--	17	20	0.33	0.07	--	0.007	9.91	<0.05	1.79	0.027	2.95	11.9	52.262	1.97	0.33	161	18.4
539	PW-4D	12/7/98	--	--	110	12	1.16	0.63	--	0.005	17.2	<0.05	3.06	0.037	3.53	60	2.476	0.46	1.25	478	22.2

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3-&NO_2-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
538	PW-4M	12/7/98	--	--	116	17	1.17	0.53	--	0.003	5.9	<0.05	0.92	0.014	2.6	74.6	5.191	0.9	1.2	454	21.2
538	PW-4M (d)	12/7/98	--	--	115	17	1.15	0.52	--	0.004	5.88	<0.05	0.915	0.014	2.55	73.8	1.85	0.75	1.19	459	20.6
541	PW-5D	12/7/98	--	--	80	9	0.93	0.56	--	0.003	14.7	<0.05	2.99	0.044	2.32	34	1.941	0.61	0.65	317	12.4
--	(trip blank)	12/8/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	(trip blank)	12/8/98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
540	PW-5M	12/8/98	--	--	17	8	1.14	0.35	--	0.006	7.13	<0.05	1.06	<0.01	2.6	11.8	1.973	0.76	0.5	248	66.4
542	PW-5R	12/8/98	--	--	10	11	0.64	0.48	--	0.009	146	<0.05	<0.1	<0.01	35.9	41.2	7.493	5.51	1.03	2490	517
385	P-2,river	12/9/98	--	--	16	6	0.12	0.06	--	0.021	3.47	0.36	0.79	0.021	1.1	11.2	2.063	3.43	0.28	98	7.4
548	PW-7M	12/9/98	--	--	9	18	0.09	0.04	--	0.011	10.2	0.243	2.83	0.223	2.21	11	4.396	0.64	0.1	144	31
547	PW-7S	12/9/98	--	--	14	20	<0.05	0.02	--	0.007	11.3	1.05	2.68	0.239	2.71	10.2	7.139	5.47	0.23	156	22
545	PW-6D	12/10/98	--	--	8	76	0.26	0.22	0.05	0.351	25.9	9.91	3.95	0.167	5.29	57.7	2.418	7.74	0.28	415	91.2
544	PW-6M	12/10/98	--	--	21	21	1.26	0.55	--	0.002	11.9	0.088	1.64	0.586	3.2	14.3	3.383	1.86	0.27	186	19
546	PW-6R	12/10/98	--	--	25	20	0.31	0.31	--	0.021	113	0.213	<0.1	<0.01	87.5	38.6	6.427	5.67	1.47	2030	-400
543	PW-6S	12/10/98	--	--	21	39	3.03	1.81	--	0.006	19.8	<0.05	1.95	0.271	3.57	15.5	3.752	1.96	0.44	235	15
--	(DB blank)	2/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	(trip blank)	2/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	2/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	2/8/99	--	--	--	--	--	0.29	--	--	--	--	--	--	--	--	10.519	0.79	0.389	132	16
408	B95-13 (d)	2/8/99	--	--	--	--	--	0.26	--	--	--	--	--	--	--	--	11.19	0.64	0.351	130	16
409	B95-15	2/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	2/8/99	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	0.739	0.99	0.428	188	13.6
560	PW-13M	2/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	2/8/99	--	--	--	--	--	0.01	--	--	--	--	--	--	--	--	2.434	1.03	0.241	98	14.4
563	PW-14M	2/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M(d)	2/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
565	EW-1	3/1/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.76	0.502	128	14.8
566	EW-2	3/1/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.57	0	39	9.8
566	EW-2dup	3/1/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	Trip blank	3/1/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	4/7/99	--	--	16	8	0.09	0.12	--	0.018	6.86	0.144	1.44	1.01	1.29	8.36	--	0.84	0.134	--	15
564	PW-14D	4/7/99	--	--	40	11	0.58	0.29	--	0.006	11.6	<0.05	2.31	0.531	1.55	19.6	--	0.92	0.43	--	17
409	B95-15	4/7/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.11	0.149	--	13.8
556	PW-12M	4/7/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.89	0.058	--	14
560	PW-13M	4/7/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.86	0.062	--	11.2
0	trip blank	4/7/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3^-&NO_2^-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
563	PW-14M	4/7/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/7/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	4/7/99	--	--	18	12	1.08	0.46	--	0.004	9.98	<0.05	2.12	<0.01	2.55	10.3	--	0.7	0.223	--	20
558	PW-12R	4/8/99	--	--	12	7	<0.05	0.07	--	0.027	22.4	1.13	2.31	0.383	1.37	8.12	--	0.94	0.104	--	61
555	PW-12S	4/8/99	--	--	35	10	0.47	0.24	--	0.004	7.84	1.12	1.32	0.432	1.53	16.5	--	0.9	0.283	--	7.4
559	PW-13S	4/8/99	--	--	10	6	0.49	0.21	--	0.005	5.47	<0.05	0.834	0.02	2.23	6.72	--	0.8	0.012	--	12
561	PW-13D	4/8/99	--	--	13	8	0.06	0.02	--	0.022	6.91	6.06	1.41	0.59	1.69	9.39	--	0.91	0.181	--	21.2
557	PW-12D	4/8/99	--	--	14	10	0.07	0.09	--	0.007	6.71	<0.05	1.53	0.449	1.25	8.11	--	0.73	0.117	--	13
0	trip blank	4/8/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	4/8/99	--	--	13	9	0.1	0.07	--	0.001	6.23	0.454	1.39	0.433	1.53	8.26	--	--	0.058	--	14
560	PW-13M	4/8/99	--	--	13	7	<0.05	0.03	--	0.007	5.27	0.401	1.08	1.03	0.767	7.9	--	--	0.062	--	11.2
409	B95-15	4/8/99	--	--	18	24	0.09	0.09	--	0.005	7.97	<0.05	1.53	0.248	1.87	14.8	--	--	0.149	--	13.8
530	PW-1S	4/9/99	--	--	17	8	0.553	0.19	--	0.002	8.02	<0.05	1.59	0.287	1.37	9.12	--	--	0.221	--	16.4
531	PW-1D	4/9/99	--	--	20	16	0.19	0.06	--	0.007	8.68	<0.05	1.81	0.27	1.33	13	--	--	0.248	--	15
0	trip blank	4/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
233	MW-16A	4/13/99	--	--	131	13	1.74	0.67	--	0.004	8.41	<0.05	1.2	0.016	2.31	72.6	--	--	1.07	--	10.8
321	MW-16B	4/13/99	--	--	102	9	1.32	0.36	--	0.006	11.1	<0.05	1.6	0.142	2.62	48.1	--	--	0.821	--	11.2
321	MW-16B(d)	4/13/99	--	--	101	9	1.34	0.48	--	0.005	11.4	<0.05	1.61	0.144	2.67	49	--	--	0.896	--	13
344	MW-16C	4/13/99	--	--	80	11	1.03	0.24	--	0.005	13.4	<0.05	2.48	0.3	2.03	37.5	--	--	0.658	--	12.8
407	B95-12	4/13/99	--	--	205	14	2.07	0.75	--	0.003	11.5	<0.05	1.96	0.028	3.85	111	--	--	1.57	--	10.2
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
532	PW-2S	4/14/99	--	--	27	200	5.57	1.36	--	0.004	88.2	<0.05	8.19	0.015	5.36	26.3	--	--	0.171	--	31.4
533	PW-2M	4/14/99	--	--	54	16	1.24	0.49	--	0.005	12	<0.05	1.46	0.013	4.5	29.6	--	--	0.576	--	18.4
534	PW-2D	4/14/99	--	--	74	10	1.22	0.32	--	0.005	13.7	<0.05	2.25	0.063	2.56	35	--	--	0.601	--	18
536	PW-3S	4/14/99	--	--	16	22	0.29	0.06	--	0.004	8.56	<0.05	1.37	<0.01	1.2	10.2	--	--	0.175	--	7.6
537	PW-3D	4/14/99	--	--	9	9	<0.05	0	--	0.004	5.9	<0.05	1.17	0.414	1.28	6.22	--	--	0.115	--	13
408	B95-13	4/14/99	--	--	19	9	0.48	0.17	--	0.003	8.34	<0.05	1.7	0.323	1.29	9.43	14.36	0.84	--	--	42.6
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.84	1.33	0.242	124	17.6
0	trip blank	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13.18	--	--	--	17.2
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15.49	--	--	--	--
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.28	--	--	--	16.4
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.6
408	B95-13	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.4

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	NH_4^+ (mg/l)	S_2^- (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)	NO_3-&NO_2- (mg/l)	NO_3^- (mg/l)	NO_2^- (mg/l)	PO_4^{3-} (mg/l)	Ca^{2+} (mg/l)	Fe(total) (mg/l)	Mg^{2+} (mg/l)	Mn^{2+} (mg/l)	K^+ (mg/l)	Na^+ (mg/l)	CH_4 (mg/l)	TOC (mg/l)	Br- (mg/l)	SC-lab (µmhos/cm)	$CaCO_3$ (mg/l)
408	B95-13(d)	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13(d)	4/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.4
547	PW-7S	4/15/99	--	--	9	18	--	--	--	--	7.94	1.33	1.97	0.236	2.14	8.9	--	--	0.017	--	25
554	PW-11D	4/15/99	--	--	19	30	0.06	0	--	0.005	6.91	0.118	1.44	0.34	1.67	16.8	--	--	0.381	--	12.2
553	PW-11M	4/15/99	--	--	19	14	0.18	0.04	--	0.001	6.04	<0.05	1.25	0.099	2.69	12.5	--	--	0.228	--	12.8
548	PW-7M	4/15/99	--	--	10	14	--	--	--	--	8.87	0.208	2.53	0.171	1.83	9.84	--	--	0.239	--	29.6
0	equip blank	4/15/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	4/19/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
540	PW-5M	4/19/99	--	--	16	8	--	--	--	--	6.62	<0.05	1.01	0.01	2.49	10.7	--	--	0.103	--	55.6
541	PW-5D	4/19/99	--	--	34	20	--	--	--	--	8.98	<0.05	1.66	0.094	1.91	22.5	--	--	0.25	--	18
551	PW-10M	4/19/99	--	--	17	31	--	--	--	--	11.8	<0.05	2.2	0.05	2.97	13.4	--	--	0.086	--	20
552	PW-10D	4/19/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.079	--	5.6
385	P-2,River	4/19/99	--	--	17	5	0.09	0.02	--	0.01	2.9	0.181	0.67	0.023	0.684	10.6	--	--	--	--	--
46	Mi-32	4/20/99	--	--	55	18	--	1.35	<0.05	<0.001	11.7	<0.05	1.62	0.028	2.24	28.5	--	--	0.641		12.2
398	B95-3	4/20/99	--	--	17	8	--	<0.05	<0.05	0.002	4.48	0.511	1.09	0.177	1.3	10.11	--	--	0.119	--	10.2
549	PW-8M	4/20/99	--	--	9	36	--	--	--	--	28.4	0.107	3.14	0.031	11	13.1	--	--	0.147	--	76.4
550	PW-9M	4/20/99	--	--	13	53	--	0.62	<0.05	0.001	19.5	0.078	2.78	0.043	1.54	12.1	--	--	0.184	--	16.4
550	PW-9M(d)	4/20/99	--	--	23	53	--	0.63	<0.05	0.002	19.9	0.069	2.84	0.045	1.56	12.3	--	--	0.147	--	16.2
408	B95-13	4/20/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/20/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/20/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	4/20/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	4/21/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
235	MW-27	4/21/99	--	--	26	4	--	0.06	<0.05	0.002	4.04	7.04	1.17	0.497	1.38	13.9	--	--	0.42	--	11.8
400	B95-5	4/21/99	--	--	4	11	--	0.76	<0.05	0.002	5.7	<0.05	1.18	<0.01	3.56	2.54	--	--	0.094	--	9.8
401	B95-6	4/21/99	--	--	13	10	--	<0.05	<0.05	<0.001	4.26	1.71	0.96	1.51	1.29	10.1	--	--	0.195	--	15.4
543	PW-6S	4/21/99	--	--	34	47	--	--	--	--	22.3	<0.05	2.49	0.366	3.36	16.3	--	--	0.154	--	15.4
544	PW-6M	4/21/99	--	--	24	6	--	--	--	--	7.33	0.05	1.13	0.395	2.18	12.4	--	--	0.381	--	15.8
545	PW-6D	4/21/99	--	--	27	44	--	--	--	--	24.3	0.127	1.82	0.064	7.43	45	--	--	0.445	--	96.4
385	P2-RIVER	4/21/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
403	B95-8	4/22/99	--	--	127	12	0.99	--	--	0.004	21.8	<0.05	4.36	0.016	2.51	54	--	--	1.29	--	15.6

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	NH_4^+ (mg/l)	S_2^- (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)	NO_3^-&NO_2^- (mg/l)	NO_3^- (mg/l)	NO_2^- (mg/l)	PO_4^{3-} (mg/l)	Ca^{2+} (mg/l)	Fe(total) (mg/l)	Mg^{2+} (mg/l)	Mn^{2+} (mg/l)	K^+ (mg/l)	Na^+ (mg/l)	CH_4 (mg/l)	TOC (mg/l)	Br- (mg/l)	SC-lab (µmhos/cm)	$CaCO_3$ (mg/l)
404	B95-9	4/22/99	--	--	62	27	1.9	--	--	0.002	13.6	0.081	2.34	0.127	2.47	33.5	--	--	3.44	--	11.4
538	PW-4M	4/22/99	--	--	109	12	1.1	--	--	0.001	6.98	<0.05	1.09	0.014	2.44	65.9	--	--	1.32	--	16.2
539	PW-4D	4/22/99	--	--	141	12	0.74	--	--	0.001	13.5	0.075	2.56	0.03	3.67	72	--	--	1.37	--	15.2
0	trip blank	5/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
546	PW-6R	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
535	PW-2R	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
542	PW-5R	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	5/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3^-&NO_2^-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
561	PW-13D	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
546	PW-6R	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
542	PW-5R	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
535	PW-2R	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	6/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	trip blank	7/14/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	7/15/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
565	EW-1	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
566	EW-2	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	7/16/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3^-&NO_2^-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
0	trip blank	7/27/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-A	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-B	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-C	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R-D	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13-A	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13-B	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13-C	7/30/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	8/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	8/12/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	8/13/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	trip blank	9/9/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
345	MW-16R	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
555	PW-12S	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
556	PW-12M	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
557	PW-12D	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
558	PW-12R	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
408	B95-13	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2b. Detected ions and compounds, May 1997 to September 1999, Milford, New Hampshire.

Well			NH_4^+	S_2^-	Cl^-	SO_4^{2-}	NO_3-&NO_2-	NO_3^-	NO_2^-	PO_4^{3-}	Ca^{2+}	Fe(total)	Mg^{2+}	Mn^{2+}	K^+	Na^+	CH_4	TOC	Br-	SC-lab	$CaCO_3$
#	Name	Date	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(µmhos/cm)	(mg/l)
535	PW-2R	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
542	PW-5R	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
546	PW-6R	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
565	EW-1	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
566	EW-2	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
409	B95-15	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	lab blank	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
0	equip blank	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
562	PW-14S	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
563	PW-14M	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
564	PW-14D	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
559	PW-13S	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
560	PW-13M	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
561	PW-13D	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
321	MW-16B	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
344	MW-16C	9/10/99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Vinyl Chloride	Comments
233	MW-16A	5/27/97	peri	71	U 2	--	U 2	2.7	U 10	U 2	
321	MW-16B	5/27/97	peri	320	11	--	3.3	U 2	U 10	U 2	
344	MW-16C	5/27/97	peri	560	42	--	5.5	2.2	U 10	U 2	
345	MW-16R	5/27/97	peri	510	53	--	U 2	3.9	11	U 2	
407	B95-12	5/28/97	peri	U 2	U 2	--	U 2	U 2	U 10	U 2	
407	B95-12(d)	5/28/97	peri	U 2	U 2	--	U 2	U 2	12	U 2	
408	B95-13	5/28/97	peri	2000	180	--	11	U 2	U 10	U 2	
409	B95-15	5/28/97	peri	920	22	--	U 2	U 2	U 10	U 2	
385	P-2, river	5/28/97	GRAB	--	--	--	--	--	--	--	
398	B95-3	5/29/97	peri	U 2	U 2	--	U 2	U 2	U 10	U 2	
404	B95-9	5/29/97	peri	52	2.1	--	U 2	17	U 10	U 2	
299	HM-1	5/29/97	peri	670	66	--	U 2	U 2	U 10	U 2	
42	MI-27	5/29/97	peri	U 2	U 2	--	U 2	U 2	U 10	U 2	
203	MI-63	5/29/97	peri	2100	130	--	2.7	U 2	U 10	4.1	
30	MI-19	5/30/97	peri	U 2	U 2	--	U 2	U 2	U 10	U 2	
31	MI-20	5/30/97	peri	U 2	U 2	--	U 2	U 2	U 10	U 2	
33	MI-21	5/30/97	peri	U 2	U 2	--	U 2	U 2	U 10	U 2	
400	B95-5	6/2/97	peri	U 2	U 2	--	U 2	U 2	U 10	U 2	
40	MI-25	6/2/97	peri	85	18	--	U 2	U 2	U 10	25	
46	MI-32	6/2/97	peri	1000	79	--	59	U 2	U 10	U 2	
321	MW-16B	6/11/97	BL	510	12	--	U 2	U 2	U 10	U 2	
344	MW-16C	6/12/97	BL	930	51	--	U 2	U 2	U 10	U 2	
401	B95-6	6/16/97	BL	U 2	U 2	--	U 2	U 2	U 10	U 2	
403	B95-8	6/16/97	BL	9.3	U 2	--	U 2	2.5	U 10	U 2	
398	B95-3	6/17/97	BL	U 2	U 2	--	U 2	U 2	U 10	U 2	
407	B95-12	10/28/97	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	10/28/97	BL	--	--	--	--	--	--	--	
408	B95-13	10/28/97	peri	3100	270	150	U 40	U 40	U 200	U 40	
409	B95-15	10/30/97	BL	--	--	--	--	--	--	--	
409	B95-15	10/30/97	peri	1200	24	33	U 20	U 20	U 100	U 20	
407	B95-12	12/15/97	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
299	HM-1	12/15/97	peri	500	120	70	U 10	U 10	U 50	U 10	
40	MI-25	12/15/97	peri	13	4.7	6.2	U 2	U 2	U 10	4.5	
42	MI-27	12/15/97	peri	U 2	U 2	U 2	U 2	3.2	U 10	U 2	
203	MI-63	12/15/97	peri	1700	120	170	U 28.6	U 28.6	U 143	U 28.6	
344	MW-16C	12/15/97	peri	1200	110	79	22	U 10	U 50	U 10	
398	B95-3	12/16/97	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
403	B95-8	12/16/97	peri	240	2.6	6.4	U 2	2.4	U 10	U 2	
404	B95-9	12/16/97	peri	140	3.8	U 2	U 2	6.5	U 10	U 2	
404	B95-9(d)	12/16/97	peri	140	3.5	U 2	U 2	6.5	U 10	U 2	
35	MI-22	12/16/97	peri	3400	160	57	U 50	U 50	U 250	U 50	
37	MI-23	12/16/97	peri	340	61	320	U 6.66	U 6.66	U 33.3	U 6.66	
400	B95-5	12/17/97	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
401	B95-6	12/17/97	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
402	B95-7	12/17/97	peri	15	2.1	U 2	U 2	3.8	U 10	U 2	
31	MI-20	12/17/97	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
321	MW-16B	12/18/97	peri	360	11	U 10	U 10	U 10	U 50	U 10	
345	MW-16R	12/18/97	peri	330	41	43	U 10	U 10	U 50	U 10	

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Vinyl Chloride	Comments
385	P-2,river	12/18/97	GRAB	--	--	--	--	--	--	--	
233	MW-16A	12/19/97	peri	--	--	--	--	--	--	--	
402	B95-7	1/12/98	peri	--	--	--	--	--	--	--	
407	B95-12	2/19/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
	equip blank	2/19/98	DB	3.5	U 2	U 2	U 2	U 2	U 10	U 2	
	Trip blank	2/19/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	2/20/98	BL	4100	290	150	U 100	U 100	U 500	U 100	
408	B95-13	2/20/98	peri	3700	280	150	U 100	U 100	U 500	U 100	
409	B95-15	2/20/98	peri	830	32	47	U 20	U 20	U 100	U 20	
	(trip blank)	5/11/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
321	MW-16B	5/11/98	peri	310	11	U 5	U 5	U 5	U 25	U 5	
344	MW-16C	5/11/98	peri	1200	110	75	U 20	U 20	U 100	U 20	
398	B95-3	5/12/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
400	B95-5	5/12/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
401	B95-6	5/12/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
403	B95-8	5/12/98	peri	34	2.5	3	U 2	8.2	U 10	U 2	
404	B95-9	5/12/98	peri	120	2.6	U 2	U 2	4.4	U 10	U 2	
404	B95-9(d)	5/12/98	peri	120	2.9	U 2	U 2	5.2	U 10	U 2	
46	MI-32	5/12/98	peri	1100	65	44	39	U 20	U 100	U 20	
	(trip blank)	5/13/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
35	MI-22	5/13/98	peri	2400	130	U 40	U 40	U 40	U 200	U 40	
37	MI-23	5/13/98	peri	180	68	140	U 2	U 2	U 10	U 2	
233	MW-16A	5/13/98	peri	39	U 2	U 2	U 2	13	U 10	U 2	
345	MW-16R	5/13/98	peri	390	48	48	U 10	U 10	U 50	U 10	
385	P-2,river	5/13/98	GRAB	--	--	--	--	--	--	--	
33	MI-21	5/14/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
555	PW-12S	5/14/98	peri	8.7	U 2	U 2	U 2	U 2	U 10	U 2	
531	PW-1D	5/14/98	peri	2600	220	130	U 40	U 40	U 200	U 40	
530	PW-1S	5/14/98	peri	3400	250	160	U 50	U 50	U 250	U 50	
557	PW-12D	5/15/98	peri	550	52	87	U 10	U 10	U 50	U 10	
556	PW-12M	5/15/98	peri	610	53	85	U 10	U 10	U 50	U 10	
558	PW-12R	5/15/98	peri	1200	89	110	U 20	U 20	U 100	U 20	
	(trip blank)	5/18/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
407	B95-12	5/18/98	peri	U 2	U 2	U 2	U 2	3.3	U 10	U 2	
409	B95-15	5/18/98	DB	1000	28	43	U 20	U 20	U 100	U 20	
409	B95-15	5/18/98	peri	890	27	45	U 10	U 10	U 50	U 10	
534	PW-2D	5/18/98	peri	170	9.4	4.7	U 2	3.8	U 10	U 2	
532	PW-2S	5/18/98	peri	830	120	110	43	U 20	U 100	U 20	
	(trip blank)	5/19/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
552	PW-10D	5/20/98	peri	2200	80	U 40	U 40	U 40	U 200	U 40	
551	PW-10M	5/20/98	peri	130	30	130	U 2	U 2	U 10	U 2	
533	PW-2M	5/20/98	peri	1100	190	180	120	U 20	U 100	U 20	
535	PW-2R	5/20/98	peri	36	6.2	2.1	U 2	U 2	U 10	U 2	
	(trip blank)	5/21/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	5/21/98	BL	4100	270	160	U 100	U 100	U 500	U 100	
408	B95-13	5/21/98	DB	3200	250	150	U 100	U 100	U 500	U 100	
408	B95-13	5/21/98	peri	3300	230	160	U 40	U 40	U 200	U 40	
344	MW-16C	5/21/98	peri	--	--	--	--	--	--	--	

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Vinyl Chloride	Comments
545	PW-6D	5/21/98	peri	4900	U 100	U 100	U 100	U 100	U 500	U 100	
545	PW-6D(d)	5/21/98	peri	4800	U 100	U 100	U 100	U 100	U 500	U 100	
544	PW-6M	5/21/98	peri	3300	1300	800	U 66	U 66	U 330	U 66	
543	PW-6S	5/21/98	peri	1700	1400	1100	U 50	U 50	U 250	U 50	
	(trip blank)	7/21/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
407	B95-12	7/22/98	peri	--	--	--	--	--	--	--	
	(trip blank)	7/23/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	7/23/98	BL	3900	230	150	U 50	U 50	U 250	U 50	
408	B95-13	7/23/98	DB	3100	220	150	U 50	U 50	U 250	U 50	
408	B95-13	7/23/98	peri	2800	190	140	U 50	U 50	U 250	U 50	
408	B95-13	7/23/98	peri	3400	210	150	U 50	U 50	U 250	U 50	
408	B95-13	7/23/98	voss	3100	200	140	U 50	U 50	U 250	U 50	
409	B95-15	7/23/98	DB	1400	42	63	U 20	U 20	U 100	U 20	
409	B95-15	7/23/98	peri	1200	39	68	U 20	U 20	U 100	U 20	
560	PW-13M	7/23/98	peri	400	25	40	U 2	U 2	U 10	U 2	
559	PW-13S	7/23/98	peri	93	8.4	29	U 2	U 2	U 10	U 2	
563	PW-14M	7/23/98	peri	1300	110	210	5.5	U 2	U 10	2.8	
562	PW-14S	7/23/98	peri	840	76	95	12	U 2	U 10	U 2	
562	PW-14S(d)	7/23/98	peri	870	75	91	12	U 2	U 10	U 2	
561	PW-13D	7/24/98	peri	1000	54	85	U 2	U 2	U 10	2	
564	PW-14D	7/24/98	peri	2500	180	110	8.4	U 2	U 10	U 2	
	(eq. blank)	9/30/98	DB	U 2	U 2	U 2	U 2	U 2	60	U 2	
	(trip blank)	9/29/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	9/30/98	DB	1900	170	140	U 50	U 50	U 250	U 50	
409	B95-15	9/30/98	DB	2000	38	48	U 50	U 50	U 250	U 50	
409	B95-15(d)	9/30/98	DB	1900	U 50	46	U 50	U 50	U 250	U 50	
310	MW-2A	9/30/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
210	MW-2B	9/30/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
210	MW-2B(d)	9/30/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
311	MW-2R	9/30/98	peri	26	5.9	U 2	U 2	U 2	U 10	U 2	
	(trip blank)	10/20/98	NA	U 0.5	U 0.5	U 0.5	U 0.5	U 0.5	U 10	U 0.5	
	(trip blank)	11/23/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	11/23/98	DB	1900	170	140	U 40	U 40	U 200	U 40	
409	B95-15	11/23/98	DB	480	29	37	U 20	U 20	U 100	U 20	
560	PW-13M	11/23/98	DB	630	30	43	U 10	U 10	U 50	U 10	
560	PW-13M	11/23/98	peri	490	26	39	U 10	U 10	U 50	U 10	
564	PW-14D	11/23/98	peri	1900	150	130	U 40	U 40	U 200	U 40	
563	PW-14M	11/23/98	DB	1400	92	190	U 40	U 40	U 200	U 40	
563	PW-14M	11/23/98	peri	1200	93	200	U 40	U 40	U 200	U 40	
562	PW-14S	11/23/98	peri	990	82	120	U 20	U 20	U 100	U 20	
408	B95-13	11/24/98	peri	2100	130	140	U 40	U 40	U 200	U 40	
409	B95-15	11/24/98	peri	350	26	36	U 20	U 20	U 100	U 20	
561	PW-13D	11/24/98	peri	1100	63	100	U 20	U 20	U 100	U 20	
559	PW-13S	11/24/98	peri	94	9.6	25	U 2	U 2	U 10	U 2	
557	PW-12D	11/25/98	peri	700	43	56	U 2	U 2	U 10	U 2	
556	PW-12M	11/25/98	peri	700	41	57	U 2	U 2	U 10	U 2	
558	PW-12R	11/25/98	peri	870	340	120	U 2	U 2	U 10	U 2	
555	PW-12S	11/25/98	peri	9.7	2.4	4.1	U 2	U 2	U 10	U 2	

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Vinyl Chloride	Comments
	(trip blank)	11/30/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
233	MW-16A	11/30/98	peri	59	U 2	U 2	U 2	4	U 10	U 2	
321	MW-16B	11/30/98	peri	310	12	U 10	U 10	U 10	U 50	U 10	
344	MW-16C	11/30/98	peri	1600	130	85	23	U 20	U 100	U 20	
345	MW-16R	11/30/98	peri	300	34	44	U 10	U 10	U 50	U 10	
	(trip blank)	12/1/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
531	PW-1D	12/1/98	peri	2400	160	110	U 40	U 40	U 200	U 40	
530	PW-1S	12/1/98	peri	3000	170	190	U 40	U 40	U 200	U 40	
407	B95-12	12/2/98	peri	U 2	U 2	U 2	U 2	3.2	U 10	U 2	
400	B95-5	12/2/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
401	B95-6	12/2/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
235	MW-27	12/2/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
235	MW-27 (d)	12/2/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
	(trip blank)	12/3/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
398	B95-3	12/3/98	peri	2.1	U 2	U 2	U 2	U 2	U 10	U 2	
404	B95-9	12/3/98	peri	610	U 6.6	U 6.6	U 6.6	U 6.6	U 33.3	U 6.6	
554	PW-11D	12/3/98	peri	1200	44	U 20	U 20	U 20	U 100	U 20	
553	PW-11M	12/3/98	peri	45	13	26	U 2	U 2	U 10	U 2	
537	PW-3D	12/3/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
536	PW-3S	12/3/98	peri	2.1	U 2	U 2	U 2	U 2	U 10	U 2	
46	MI-32	12/4/98	peri	700	38	19	17	U 10	U 50	U 10	
534	PW-2D	12/4/98	peri	1700	170	91	20	U 20	U 100	U 20	
533	PW-2M	12/4/98	peri	1600	130	68	23	U 20	U 100	U 20	
535	PW-2R	12/4/98	peri	20	3.6	U 2	U 2	U 2	U 10	U 2	27 THF, 5.1 Carbon disulfide
532	PW-2S	12/4/98	peri	1400	140	110	65	U 20	U 100	U 20	
	(trip blank)	12/7/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
403	B95-8	12/7/98	peri	65	U 2	U 2	U 2	5.2	U 10	U 2	
552	PW-10D	12/7/98	peri	6300	U 100	U 100	U 100	U 100	U 500	U 100	
551	PW-10M	12/7/98	peri	140	32	110	U 2	U 2	U 10	3.3	
539	PW-4D	12/7/98	peri	38	5.9	U 2	U 2	4.2	U 10	U 2	
538	PW-4M	12/7/98	peri	2.1	U 2	U 2	U 2	U 2	U 10	U 2	
538	PW-4M (d)	12/7/98	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
541	PW-5D	12/7/98	peri	1500	190	100	U 20	U 20	U 100	U 20	
	(trip blank)	12/8/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
	(trip blank)	12/8/98	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
540	PW-5M	12/8/98	peri	1400	160	120	57	U 20	U 100	U 20	
542	PW-5R	12/8/98	peri	95	14	9.6	4.5	U 2	28	U 2	2.9 Toluene
385	P-2,river	12/9/98	GRAB	--	--	--	--	--	--	--	
548	PW-7M	12/9/98	peri	12	2.3	U 2	U 2	U 2	U 10	U 2	
547	PW-7S	12/9/98	peri	40	2.5	U 2	U 2	U 2	U 10	U 2	
545	PW-6D	12/10/98	peri	610	U 10	U 10	U 10	U 10	U 50	U 10	
544	PW-6M	12/10/98	peri	3600	1300	650	U 40	U 40	U 200	U 40	
546	PW-6R	12/10/98	peri	940	43	U 20	U 20	U 20	U 100	U 20	
543	PW-6S	12/10/98	peri	3100	1600	850	U 40	U 40	U 200	U 40	
	(DB blank)	2/8/99	DB	U 2	U 2	U 2	U 2	U 2	52	U 2	
	(trip blank)	2/8/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	2/8/99	DB	1400	130	170	U 25	U 25	U 125	U 25	
408	B95-13	2/8/99	peri	1500	97	180	U 40	U 40	U 200	U 40	

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.											
Well			Pump							Vinyl	
#	Name	Date	TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Chloride	Comments
408	B95-13 (d)	2/8/99	peri	1600	100	190	U 40	U 40	U 200	U 40	
409	B95-15	2/8/99	DB	350	26	22	U 4	U 4	U 20	U 4	
409	B95-15	2/8/99	peri	310	27	22	U 4	U 4	U 20	U 4	
560	PW-13M	2/8/99	DB	140	10	12	U 2	U 2	U 10	U 2	
560	PW-13M	2/8/99	peri	120	9.4	13	U 2	U 2	U 10	U 2	2.7,carbon disulfide
563	PW-14M	2/8/99	DB	1200	96	190	U 20	U 20	U 100	U 20	
563	PW-14M(d)	2/8/99	DB	1200	91	180	U 20	U 20	U 100	U 20	
565	EW-1	3/1/99	NA	2500	160	U 100	U 100	U 100	U 500	U 100	
566	EW-2	3/1/99	NA	10	U 2	U 2	U 2	U 2	34	U 2	
566	EW-2dup	3/1/99	NA	11	U 2	U 2	U 2	U 2	44	U 2	
0	Trip blank	3/1/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
563	PW-14M	4/7/99	peri	760	92	160	12	U 10	U 50	U 10	
564	PW-14D	4/7/99	peri	2300	220	120	U 40	U 40	U 200	U 40	
409	B95-15	4/7/99	DB	210	28	22	U 4	U 4	U 20	U 4	
556	PW-12M	4/7/99	DB	440	62	30	U 10	U 10	U 10	U 10	
560	PW-13M	4/7/99	DB	270	23	25	U 4	U 4	U 20	U 4	
0	trip blank	4/7/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
563	PW-14M	4/7/99	DB	1100	110	190	U 20	U 20	U 100	U 20	
408	B95-13	4/7/99	DB	950	200	160	U 20	U 20	U 100	U 20	
562	PW-14S	4/7/99	peri	620	61	82	U 20	U 20	U 100	U 20	
558	PW-12R	4/8/99	peri	530	380	130	U 10	U 10	U 50	U 10	
555	PW-12S	4/8/99	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
559	PW-13S	4/8/99	peri	70	9.8	24	U 2	U 2	U 10	U 2	
561	PW-13D	4/8/99	peri	760	55	92	U 20	U 20	U 100	U 20	
557	PW-12D	4/8/99	peri	550	33	28	U 10	U 10	U 50	U 10	
0	trip blank	4/8/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
556	PW-12M	4/8/99	peri	530	42	46	27	U 10	U 50	U 10	
560	PW-13M	4/8/99	peri	240	18	25	U 4	U 4	U 20	U 4	
409	B95-15	4/8/99	peri	91	14	22	U 2	U 2	U 10	U 2	
530	PW-1S	4/9/99	peri	1200	87	200	U 40	U 40	U 200	U 40	
531	PW-1D	4/9/99	peri	940	80	65	U 40	U 40	U 200	U 40	
0	trip blank	4/12/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
233	MW-16A	4/13/99	peri	64	U 2	U 2	U 2	2.8	U 10	U 2	
321	MW-16B	4/13/99	peri	280	15	8.7	7.2	U 4	U 20	U 4	
321	MW-16B(d)	4/13/99	peri	260	15	8.6	U 4	U 4	U 20	U 4	
344	MW-16C	4/13/99	peri	1100	110	81	U 20	U 20	U 100	U 20	
407	B95-12	4/13/99	peri	U 2	U 2	U 2	U 2	3.7	U 10	U 2	
532	PW-2S	4/14/99	peri	530	73	63	27	U 20	U 100	U 20	
533	PW-2M	4/14/99	peri	950	110	89	26	U 20	U 100	U 20	
534	PW-2D	4/14/99	peri	1000	140	88	U 20	U 20	U 100	U 20	
536	PW-3S	4/14/99	peri	2	U 2	U 2	U 2	U 2	U 10	U 2	
537	PW-3D	4/14/99	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	trip blank	4/14/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	4/14/99	peri	1400	110	180	U 20	U 20	U 100	U 20	(split with p.48f)
408	B95-13	4/14/99	BL	1700	120	190	U 50	U 50	U 250	U 50	(split with b.45f)
408	B95-13	4/14/99	peri	1685	100	--	--	--	--	--	name= p.25f
408	B95-13	4/14/99	peri	1717	96	--	--	--	--	--	name= p.48f
408	B95-13	4/14/99	BL	2010	101	--	--	--	--	--	name= b.45f

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Vinyl Chloride	Comments
408	B95-13	4/14/99	BL	2006	99	--	--	--	--	--	name= b.97f
408	B95-13	4/14/99	peri	1877	113	--	--	--	--	--	name= p.1+
408	B95-13	4/14/99	BL	2032	118	--	--	--	--	--	name= b.1+
408	B95-13	4/14/99	BL	1738	105	--	--	--	--	--	name= b.5r2
408	B95-13	4/14/99	peri	1841	98	--	--	--	--	--	name= p.49r2
408	B95-13	4/14/99	peri	1783	104	--	--	--	--	--	name= p.33r
408	B95-13(d)	4/14/99	peri	1945	101	--	--	--	--	--	(duplicate with p.25f)
408	B95-13(d)	4/14/99	peri	1963	103	--	--	--	--	--	(duplicate with p.48f)
408	B95-13(d)	4/14/99	BL	2052	116	--	--	--	--	--	(duplicate with b.45f)
408	B95-13(d)	4/14/99	peri	2010	99	--	--	--	--	--	(duplicate with p.49r2)
547	PW-7S	4/15/99	peri	8.5	U 2	U 2	U 2	U 2	U 10	U 2	
554	PW-11D	4/15/99	peri	330	41	20	U 20	U 20	U 100	U 20	
553	PW-11M	4/15/99	peri	8.6	3.2	3.8	U 2	U 2	U 10	U 2	
548	PW-7M	4/15/99	peri	5.8	U 2	U 2	U 2	U 2	U 10	U 2	
0	equip blank	4/15/99	NA	U 2	U 2	U 2	U 2	U 2	25	U 2	
0	trip blank	4/19/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
540	PW-5M	4/19/99	peri	520	98	150	21	U 10	U 50	U 10	
541	PW-5D	4/19/99	peri	770	100	97	U 20	U 20	U 100	U 20	
551	PW-10M	4/19/99	peri	66	22	82	U 2	U 2	U 10	2.3	
552	PW-10D	4/19/99	peri	1800	62	45	U 40	U 40	U 200	U 40	
385	P-2,River	4/19/99	GRAB	--	--	--	--	--	--	--	
46	MI-32	4/20/99	peri	550	41	29	21	U 10	U 50	U 10	
398	B95-3	4/20/99	peri	20	7.2	6	U 2	U 2	U 10	U 2	
549	PW-8M	4/20/99	peri	540	12	U 10	U 10	U 10	U 50	U 10	
550	PW-9M	4/20/99	peri	2.9	U 2	U 2	U 2	U 2	U 10	U 2	
550	PW-9M(d)	4/20/99	peri	2.6	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	4/20/99	BL	1608	86	--	--	--	--	--	
408	B95-13	4/20/99	BL	1702	91	--	--	--	--	--	
408	B95-13	4/20/99	BL	1750	92	--	--	--	--	--	
408	B95-13	4/20/99	BL	1674	89	--	--	--	--	--	
0	trip blank	4/21/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
235	MW-27	4/21/99	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
400	B95-5	4/21/99	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
401	B95-6	4/21/99	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
543	PW-6S	4/21/99	peri	4000	2000	1400	U 50	U 50	U 250	U 50	
544	PW-6M	4/21/99	peri	2300	390	240	U 50	U 50	U 250	U 50	
545	PW-6D	4/21/99	peri	3600	U 100	U 100	U 100	U 100	U 500	U 100	
385	P2-RIVER	4/21/99	GRAB	U 0.2	U 0.2	U 0.2	U 0.2	U 0.2	U 1	U 0.2	
403	B95-8	4/22/99	peri	79	3.6	U 2	U 2	7	U 10	U 2	
404	B95-9	4/22/99	peri	440	U 10	U 10	U 10	U 10	U 50	U 10	
538	PW-4M	4/22/99	peri	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
539	PW-4D	4/22/99	peri	U 2	U 2	U 2	U 2	6.1	U 10	U 2	
0	trip blank	5/12/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
559	PW-13S	5/13/99	peri	78	8.4	27	U 2	U 2	U 10	U 2	
0	lab blank	5/13/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	equip blank	5/13/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
562	PW-14S	5/13/99	peri	890	73	130	U 20	U 20	U 100	U 20	
562	PW-14S	5/13/99	DB	790	69	120	U 20	U 20	U 100	U 20	

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Vinyl Chloride	Comments
563	PW-14M	5/13/99	DB	1400	110	250	U 20	U 20	U 100	U 20	
564	PW-14D	5/13/99	DB	2800	200	150	U 40	U 40	U 200	U 40	
555	PW-12S	5/13/99	DB	36	3.9	8.7	U 2	U 2	U 10	U 2	
556	PW-12M	5/13/99	DB	630	170	69	U 10	U 10	U 50	U 10	
557	PW-12D	5/13/99	DB	660	35	30	U 10	U 10	U 50	U 10	
558	PW-12R	5/13/99	DB	260	480	350	U 20	U 20	U 100	U 20	
321	MW-16B	5/13/99	DB	400	19	11	U 5	U 5	U 25	U 5	
344	MW-16C	5/13/99	DB	1300	110	97	22	U 20	U 100	U 20	
345	MW-16R	5/13/99	DB	470	61	56	U 5	U 5	U 25	U 5	
546	PW-6R	5/13/99	DB	1200	62	30	U 20	U 20	U 100	U 20	
535	PW-2R	5/13/99	DB	29	4.4	U 2	U 2	U 2	U 10	U 2	15,THF
542	PW-5R	5/13/99	DB	170	21	15	6.5	U 2	U 10	U 2	3.9,Toluene
409	B95-15	5/13/99	DB	160	19	26	U 3.34	U 3.34	U 16.7	U 3.34	
559	PW-13S	5/13/99	DB	120	U 20	31	U 20	U 20	U 100	U 20	
560	PW-13M	5/13/99	DB	320	22	40	U 10	U 10	U 50	U 10	
561	PW-13D	5/13/99	DB	720	54	96	U 20	U 20	U 100	U 20	
408	B95-13	5/13/99	DB	1700	97	190	U 20	U 20	U 100	U 20	
409	B95-15	6/10/99	peri	93	13	14	U 2	U 2	U 10	U 2	
0	trip blank	6/10/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
558	PW-12R	6/10/99	DB	330	680	210	U 10	U 10	U 50	U 10	
555	PW-12S	6/10/99	DB	3.3	U 2	U 2	U 2	U 2	U 10	U 2	
556	PW-12M	6/10/99	DB	490	78	41	U 10	U 10	U 50	U 10	
557	PW-12D	6/10/99	DB	510	36	35	U 10	U 10	U 50	U 10	
409	B95-15	6/10/99	DB	110	17	21	U 5	U 5	U 25	U 5	
0	equip blank	6/10/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	lab blank	6/10/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
561	PW-13D	6/10/99	DB	810	92	110	U 20	U 20	U 100	U 20	
559	PW-13S	6/10/99	DB	88	9.9	28	U 2	U 2	U 10	U 2	
560	PW-13M	6/10/99	DB	170	13	20	U 4	U 4	U 20	U 4	
564	PW-14D	6/10/99	DB	2900	240	170	U 40	U 40	U 200	U 40	
563	PW-14M	6/10/99	DB	1400	130	300	U 20	U 20	U 100	U 20	21,methylene chloride
562	PW-14S	6/10/99	DB	610	58	99	8.1	U 6.66	U 33.33	U 6.66	
345	MW-16R	6/10/99	DB	330	55	51	U 3.34	U 3.34	U 16.67	U 3.34	
344	MW-16C	6/10/99	DB	1000	78	63	U 20	U 20	U 100	U 20	
321	MW-16B	6/10/99	DB	330	16	8.8	U 4	U 4	U 20	U 4	
408	B95-13	6/10/99	DB	1400	92	180	U 20	U 20	U 100	U 20	21,methylene chloride
546	PW-6R	6/10/99	DB	1600	64	U 20	U 20	U 20	U 100	U 20	
542	PW-5R	6/10/99	DB	170	24	16	7	U 2	U 10	U 2	2.1,Xylene; 4.3,Toluene
535	PW-2R	6/10/99	DB	28	5.1	U 2	U 2	U 2	U 10	U 2	11,THF
408	B95-13	6/10/99	peri	1200	85	170	U 20	U 20	U 100	U 20	
	trip blank	7/14/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	lab blank	7/15/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
555	PW-12S	7/16/99	DB	170	U 2	U 2	U 2	U 2	U 10	U 2	
556	PW-12M	7/16/99	DB	190	71	93	U 10	U 10	U 50	U 10	
557	PW-12D	7/16/99	DB	480	32	28	U 10	U 10	U 50	U 10	
558	PW-12R	7/16/99	DB	280	560	280	U 10	U 10	U 50	U 10	
409	B95-15	7/16/99	DB	89	14	14	U 2	U 2	U 10	U 2	
565	EW-1	7/16/99	NA	880	59	75	U 20	U 20	U 100	U 20	

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tr	MTBE	Acetone	Vinyl Chloride	Comments
566	EW-2	7/16/99	NA	520	89	54	8.7	U 6.67	U 33.33	U 6.67	
0	equip blank	7/16/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
408	B95-13	7/16/99	DB	850	51	110	U 20	U 20	U 100	U 20	
321	MW-16B	7/16/99	DB	260	10	5.2	U 5	U 5	U 25	U 5	
321	MW-16B	7/16/99	peri	210	8.5	4.2	U 4	U 4	U 20	U 4	
344	MW-16C	7/16/99	DB	880	60	43	U 20	U 20	U 100	U 20	
345	MW-16R	7/16/99	DB	320	44	38	U 4	U 4	U 20	U 4	
562	PW-14S	7/16/99	DB	520	41	61	U 10	U 10	U 50	U 10	
563	PW-14M	7/16/99	DB	940	87	200	U 20	U 20	U 100	U 20	
564	PW-14D	7/16/99	DB	2700	210	140	U 40	U 40	U 200	U 40	
559	PW-13S	7/16/99	DB	86	10	26	U 2	U 2	U 10	U 2	
560	PW-13M	7/16/99	DB	110	10	15	U 2	U 2	U 10	U 2	
561	PW-13D	7/16/99	DB	650	140	130	U 10	U 10	U 50	U 10	
0	trip blank	7/27/99	NA	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	equip blank	7/30/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	lab blank	7/30/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
345	MW-16R-A	7/30/99	DB	78	25	32	U 2	U 2	U 10	U 2	
345	MW-16R-B	7/30/99	DB	110	29	38	U 5	U 5	U 25	U 5	
345	MW-16R-C	7/30/99	DB	180	32	35	U 4	U 4	U 20	U 4	
345	MW-16R-D	7/30/99	DB	110	49	110	U 5	U 5	U 25	U 5	
408	B95-13-A	7/30/99	DB	290	40	100	U 5	U 5	U 25	U 5	
408	B95-13-B	7/30/99	DB	590	40	100	U 20	U 20	U 100	U 20	
408	B95-13-C	7/30/99	DB	590	40	100	U 20	U 20	U 100	U 20	
0	trip blank	8/10/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	lab blank	8/12/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
321	MW-16B	8/12/99	DB	100	8.4	U 5	U 5	U 5	U 25	U 5	
344	MW-16C	8/12/99	DB	880	56	41	U 20	U 20	U 100	U 20	
345	MW-16R	8/12/99	DB	160	33	38	U 5	U 5	U 25	U 5	
562	PW-14S	8/12/99	DB	560	33	47	U 10	U 10	U 50	U 10	
563	PW-14M	8/12/99	DB	940	85	200	U 20	U 20	U 100	U 20	25,Meth.Chl;76,Benzene;200,THF
564	PW-14D	8/12/99	DB	2500	190	130	U 40	U 40	U 200	U 40	
559	PW-13S	8/12/99	DB	68	6.6	15	U 2	U 2	U 10	U 2	
560	PW-13M	8/12/99	DB	90	8.5	12	U 2	U 2	U 10	U 2	
561	PW-13D	8/12/99	DB	35	110	780	U 10	U 10	U 50	U 10	
408	B95-13	8/12/99	DB	520	35	95	U 10	U 10	U 50	U 10	
555	PW-12S	8/12/99	DB	62	U 2	U 2	U 2	U 2	U 10	U 2	
556	PW-12M	8/12/99	DB	63	41	58	U 2	U 2	U 10	U 2	
557	PW-12D	8/12/99	DB	430	65	71	U 5	U 5	U 25	U 5	
558	PW-12R	8/12/99	DB	46	490	570	U 10	U 10	U 50	U 10	
0	equip blank	8/13/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	trip blank	9/9/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
345	MW-16R	9/10/99	DB	210	36	41	U 2	U 2	U 10	U 2	
409	B95-15	9/10/99	DB	86	12	9.6	U 2	U 2	U 10	U 2	
555	PW-12S	9/10/99	DB	21	U 2	U 2	U 2	U 2	U 10	U 2	
556	PW-12M	9/10/99	DB	U 4	5.3	380	U 4	U 4	U 20	U 4	
557	PW-12D	9/10/99	DB	380	41	53	U 5	U 5	U 25	U 5	
558	PW-12R	9/10/99	DB	53	760	490	U 10	U 10	U 50	U 10	
408	B95-13	9/10/99	DB	690	30	71	U 10	U 10	U 50	U 10	

Appendix 2c. Major detected volatile organic compounds (VOCs), May 1997 to September 1999, Milford, New Hampshire.

Well #	Name	Date	Pump TYPE	PCE	TCE	CIS-DCE	111-Tri	MTBE	Acetone	Vinyl Chloride	Comments
535	PW-2R	9/10/99	DB	38	4	U 2	U 2	U 2	U 10	U 2	
542	PW-5R	9/10/99	DB	190	22	13	5.8	U 2	U 10	U 2	3.9 Toluene
546	PW-6R	9/10/99	DB	2000	47	U 40	U 40	U 40	U 200	U 40	
565	EW-1	9/10/99	NA	820	41	54	U 20	U 20	U 100	U 20	
566	EW-2	9/10/99	NA	520	44	77	U 10	U 10	U 50	U 10	
409	B95-15	9/10/99	peri	82	9.3	7.9	U 2	U 2	U 10	U 2	
0	lab blank	9/10/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
0	equip blank	9/10/99	DB	U 2	U 2	U 2	U 2	U 2	U 10	U 2	
562	PW-14S	9/10/99	DB	640	31	41	U 10	U 10	U 50	U 10	
563	PW-14M	9/10/99	DB	1100	87	200	U 20	U 20	U 100	U 20	
564	PW-14D	9/10/99	DB	2700	150	110	U 40	U 40	U 200	U 40	
559	PW-13S	9/10/99	DB	41	3.3	6.1	U 2	U 2	U 10	U 2	
560	PW-13M	9/10/99	DB	120	8.6	9.1	U 2	U 2	U 10	U 2	
561	PW-13D	9/10/99	DB	69	160	1800	U 40	U 40	U 200	U 40	
321	MW-16B	9/10/99	DB	320	9.7	4.1	U 4	U 4	U 20	U 4	
344	MW-16C	9/10/99	DB	860	45	38	U 20	U 20	U 100	U 20	

Appendix 3.Comparison of concentrations of volatile-organic compounds (tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2,-dichloroethene (*cis*-1,2DCE) from diffusion and peristaltic-pump samples at coincident sampled depth intervals

[All units in part per billion (ppb)]

Well number	Well name	Retrieval date	Peristaltic samples					Diffusion samples			
			Pump rate (liter/ minute)	Pumped volume (liters)	PCE	TCE	*cis*-1,2DCE	Deployment time (days)	PCE	TCE	*cis*-1,2DCE
321	MW-16B	07/16/99	0.33	28.4	210	8.5	4.2	36	260	10	5.2
408	B95-13	05/21/98	0.5	52.0	3300	230	160	90	3200	250	150
408	B95-13	07/23/98	0.5	14.0	3400	210	150	63	3100	220	150
408	B95-13	07/23/98	0.24	31.9	2800	190	140	63	3100	220	150
408	B95-13	11/23/98	0.16	12.3	2100	130	140	54	1900	170	140
408	B95-13	02/08/99	0.49	31.9	1500	97	180	77	1400	130	170
408	B95-13	04/14/99	0.48	54.0	1400	110	180	7	950	200	160
408	B95-13	06/10/99	0.45	21.6	1200	85	170	28	1400	92	180
409	B95-15	05/18/98	0.49	30.4	890	27	45	87	1000	28	43
409	B95-15	07/23/98	0.49	53.9	1200	39	68	66	1400	42	63
409	B95-15	11/23/98	0.21	12.4	350	26	36	63	480	29	37
409	B95-15	02/08/99	0.47	62.0	310	27	22	77	350	26	22
409	B95-15	04/07/99	0.41	45.5	91	14	22	58	210	28	22
409	B95-15	06/10/99	0.47	19.3	93	13	14	28	110	17	21
559	PW-13S	05/13/99	0.42	15.5	78	8.4	27	35	120	[1]10	31

Appendix 3. Comparison of concentrations of volatile-organic compounds (tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2,-dichloroethene (*cis*-1,2DCE) from diffusion and peristaltic-pump samples at coincident sampled depth intervals

[All units in part per billion (ppb)]

Well number	Well name	Retrieval date	Peristaltic samples					Diffusion samples			
			Pump rate (liter/minute)	Pumped volume (liters)	PCE	TCE	*cis*-1,2DCE	Deployment time (days)	PCE	TCE	*cis*-1,2DCE
560	PW-13M	11/23/98	0.16	14.8	490	26	39	123	630	30	43
560	PW-13M	02/08/99	0.45	35.6	120	9.4	13	77	140	10	12
562	PW-14S	05/13/99	0.43	15.5	890	73	130	14	790	69	120
563	PW-14M	11/23/98	0.17	10.2	1200	93	200	123	1400	92	190
563	PW-14M	04/07/99	--	--	760	92	160	77	1100	110	190

[1]Concentration estimated at one half of detection level.

Appendix 4. Comparison of concentrations of volatile-organic compounds (tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2,-dichloroethene (*cis*-1,2DCE) from diffusion and bladder-pump samples at coincident sampled depth intervals

[All units in parts per billion (ppb)]

Well number	Well name	Retrieval date	Bladder samples					Diffusion samples			
			Pump rate (liter/minute)	Pumped volume (liters)	PCE	TCE	*cis*-1,2DCE	Deployment time (days)	PCE	TCE	*cis*-1,2DCE
408	B95-13	05/21/98	0.62	62.0	4100	270	160	90	3200	250	150
408	B95-13	07/23/98	0.88	84.5	3900	230	150	63	3100	220	150
408	B95-13	04/14/99	0.45	87.0	1700	120	190	7	950	200	160

Appendix 5. Relative percent difference (RPD) for individual well comparison of peristaltic samples and diffusion samples. (PCE, Tetrachloroethylene; TCE, Trichloroethylene; CIS-1,2DCE, cis,1,2-dichloroethylene; negative values indicate that sample concentrations from diffusion sampler were greater than those from the perstaltic pump; % means percent; ppb, parts per billion)

		Peristaltic				Diffusion						
USGS Number	Well Name	Sample Date	PCE (ppb)	TCE (ppb)	CIS-1,2DCE (ppb)	Sample Date	PCE (ppb)	TCE (ppb)	CIS-1,2DCE (ppb)	RPD PCE	RPD TCE	RPD CIS
559	PW-13S	5/13/99	78	8.4	27	5/13/99	120	10	31	-42.42%	-17.39%	-13.79%
409	B95-15	6/10/99	93	13	14	6/10/99	110	17	21	-16.75%	-26.67%	-40.00%
560	PW-13M	2/8/99	120	9.4	13	2/8/99	140	10	12	-15.38%	-6.19%	8.00%
321	MW-16B	7/16/99	210	8.5	4.2	7/16/99	260	10	5.2	-21.28%	-16.22%	-21.28%
409	B95-15	2/8/99	310	27	22	2/8/99	350	26	22	-12.12%	3.77%	0.00%
560	PW-13M	11/23/98	490	26	39	11/23/98	630	30	43	-25.00%	-14.29%	-9.76%
563	PW-14M	4/7/99	760	92	160	4/7/99	1100	110	190	-36.56%	-17.82%	-17.14%
409	B95-15	5/18/98	890	27	45	5/18/98	1000	28	43	-11.64%	-3.64%	4.55%
562	PW-14S	5/13/99	890	73	130	5/13/99	790	69	120	11.90%	5.63%	8.00%
409	B95-15	7/23/98	1200	39	68	7/23/98	1400	42	63	-15.38%	-7.41%	7.63%
563	PW-14M	11/23/98	1200	93	200	11/23/98	1400	92	190	-15.38%	1.08%	5.13%
408	B95-13	6/10/99	1200	85	170	6/10/99	1400	92	180	-15.38%	-7.91%	-5.71%
408	B95-13	2/8/99	1500	97	180	2/8/99	1400	130	170	6.90%	-29.07%	5.71%
408	B95-13	4/14/99	1400	110	180	4/7/99	950	200	160	38.30%	-58.06%	11.76%
408	B95-13	7/23/98	2800	190	140	7/23/98	3100	220	150	-10.17%	-14.63%	-6.90%
408	B95-13	5/21/98	3300	230	160	5/21/98	3200	250	150	3.08%	-8.33%	6.45%
408	B95-13	7/23/98	3400	210	150	7/23/98	3100	220	150	9.23%	-4.65%	0.00%
408	B95-13	11/23/98	2100	130	140	11/23/98	1900	170	140	10.00%	-26.67%	0.00%
409	B95-15	11/23/98	350	26	36	11/23/98	480	29	37	-31.33%	-10.91%	-2.74%
409	B95-15	4/7/99	91	14	22	4/7/99	210	28	22	-79.07%	-66.67%	0.00%

Appendix 6. Absolute relative percent difference (ARPD) information for positive detections in duplicate sample comparison.

("U", undetected at given level; --, not analyzed; PCE, Tetrachloroethylene; TCE, Trichloroethylene;CIS-1,2DCE, cis-1,2-dichloroethane;
ppb, parts per billion; % means percent; peri, peristaltic; DB, diffusion bag; NA, sample outflow of extraction well port)

							DUPLICATE					
USGS Number	Well Name	Sample Date	Pump Type	PCE (ppb)	TCE (ppb)	CIS-1,2DCE (ppb)	PCE (ppb)	TCE (ppb)	CIS-1,2DCE (ppb)	ARPD PCE	ARPD TCE	ARPD CIS-1,2DCE
321	MW-16B	4/13/99	peri	280	15	8.7	260	15	8.6	7.41%	0.00%	1.16%
404	B95-9	12/16/97	peri	140	3.8	U 2	140	3.5	U 2	0.00%	8.22%	--
404	B95-9	5/12/98	peri	120	2.6	U 2	120	2.9	U 2	0.00%	10.91%	--
407	B95-12	5/28/97	peri	U 2	U 2	--	U 2	U 2	--	--	--	--
408	B95-13	2/8/99	peri	1500	97	180	1600	100	190	6.45%	3.05%	5.41%
409	B95-15	9/30/98	DB	2000	38	48	1900	U 50	46	5.13%	--	4.26%
538	PW-4M	12/7/98	peri	2.1	U 2	U 2	U 2	U 2	U 2	--	--	--
545	PW-6D	5/21/98	peri	4900	U 100	U 100	4800	U 100	U 100	2.06%	--	--
550	PW-9M	4/20/99	peri	2.9	U 2	U 2	2.6	U 2	U 2	10.91%	--	--
562	PW-14S	7/23/98	peri	840	76	95	870	75	91	3.51%	1.32%	4.30%
563	PW-14M	2/8/99	DB	1200	96	190	1200	91	180	0.00%	5.35%	5.41%
566	EW-2	3/1/99	NA	10	U 2	U 2	11	U 2	U 2	9.52%	--	--