Technical Memorandum

To:	Joan Taylor & Cynthia Gianfrancesco, RIDEM
From:	Ed Summerly and Richard Carlone, GZA
CC:	Michael Healey, Chabert Division of NFA Corporation Mary Morgan, Richmond Town Hall Clark Memorial Library, Charbert Repository
File No:	32795.12
Date:	February 23, 2007
Re:	Recommended Monitoring Well Installation Zones for Bedrock Boreholes Charbert Manufacturing Facility Alton, Rhode Island

The purpose of this technical memorandum is to provide recommendations for the monitoring well sampling zones to be installed within the newly drilled bedrock boreholes at the Chabert Manufacturing Facility, located in Alton, Rhode Island. GZA GeoEnvironmental, Inc. (GZA) conducted the bedrock drilling and testing program, and monitoring well sampling zone selection process. This memorandum specifically addresses the proposed placement of Waterloo System sampling zones in boreholes GZML-1, GZML-2, and GZML-3. As-built drilling locations for these boreholes are provided on Figure 1.

DATA EVALUATION

GZA in conjunction with the drilling contractor (New Hampshire Boring of Brockton, Massachusetts) and Hager GeoScience, Inc. (H-G) of Woburn, Massachusetts conducted an extensive in-situ testing program subsequent to drilling the three new boreholes. The following paragraphs briefly describe the testing program and our findings as they relate to the selection of sampling zones. Boring logs recorded during the drilling of each hole are included in Attachment A.

Borehole Geophysics

Subsequent to drilling H-G completed a suite of borehole geophysical testing of each of the three boreholes. The geophysical logging program consisted of digital acoustic televiewer (ATV), three-arm caliper, and heat pulse flow meter (HPFM) for ambient and stressed well conditions. A complete copy of Hagar GeoScience's report is provided as Attachment B. GZA reviewed the findings provided in Hager GeoScience's geophysical report, and carefully evaluated the individual well logs. The major geophysical parameters

considered in descending order during well screen/sampling zone selection were the ATV, the heat pulse flow meter, and the three-arm caliper logs. The ATV feature information is summarized in Table 1.

Pressure Testing and Discreet Zone Sampling

Following the completion of the borehole drilling and geophysical program, each of the boreholes was subjected to discreet zone groundwater quality sampling and pressure injection permeability testing. Test zones ranged in length from 10 feet to 11.8 feet. Samples of the extracted water from each zone were analyzed for volatile organic compounds (VOCs) by GZA GeoEnvironmental's Environmental Chemistry Laboratory of Hopkinton, Massachusetts employing EPA Method 8260B. The analytical results are summarized on Table 2 which lists detected compounds only.

Hydraulic conductivity values (K), derived from the pressure injection test data were calculated following methods presented in the Groundwater Manual[1] and are presented in Table 3. The accuracy of the test system is estimated based on the minimum discernable deflection of the flow meter (i.e., 0.1 gallons) divided by the time between meter readings (generally 1 minute) resulting in a minimum observable flow of 0.1 gallons/minute. The resulting minimum hydraulic conductivity values are dependant on the test zone length and applied pressure. The maximum quantifiable hydraulic conductivity was dependant on the flow capacity of the water supply pump at a given pressure.

Calculated K values range from a high of 1,840 feet/year to a low of 1.8 feet/year with an average hydraulic conductivity of 29.5 feet/year for the 27 zones tested as part of this program, excluding two zones with hydraulic conductivities greater than 500 ft. The two values were excluded because they are one order of magnitude higher than the other values in the data set and skew the average significantly. The tests performed in this study show that at Chabert, hydraulic conductivity generally decreases with increasing depth below top of bedrock, although some deep zones were found to have relatively high hydraulic conductivities. For this round of testing, the highest hydraulic conductivity in each borehole was found to be in the top zone of the borehole. In some boreholes it is unclear whether these higher values reflect the bedrock hydraulic conductivity or leakage at the rock/casing interface, as the top test straddled this interface in borehole GZML-2 and GZML-3. Eight zones had no flow at either test pressure (i.e., 0.5 pounds per square inch/foot of depth to the test zone and 0.75 psi/foot of depth).

[1] Groundwater Manual A Water Resources Technical Publication, United States Department of the Interior Bureau of Reclamation, Revised Reprint 1981

SAMPLE ZONE SELECTION

We utilized all available data from the boring logs, geophysical testing, and packer testing programs in our evaluation of potential sample zones. However, the primary parameters considered during the selection process, in order of priority, were hydraulic conductivity values (K), ATV fracture data, VOC results, HPFM, and the three-arm caliper data. Table 4 depicts the proposed monitoring zones and provides a summary of our rational for the selection of each of the recommended sampling zones.

The geophysical properties of the boreholes were relatively uniform. Large numbers of fractures are present in each zone tested. Therefore VOC results become a deciding factor in the selection of sampling zones.

In GZML-1 and GZML-2, which showed low VOC concentrations, well sampling zones were placed uniformly through the borehole, i.e., one sampling zone near the top of the borehole, one near the middle, and one near the bottom. This was done to evaluate changes in piezometric head and water quality with increasing within the aquifer at these two boreholes. VOC results for GZML-2 showed two low levels detects of two constituents (toluene and naphthalene) that are not typical site related contaminants, in a packer test zone (168.4 to 180.2 feet) with no flow. Neither constituent was detected in zones above or below and GZA believes the detects were likely due to contamination of the packer test equipment or laboratory error. For this reason, GZA does not propose to install a sampling zone at this location.

In GZML-3, zones showing VOC detects and detectable hydraulic conductivities were selected for sampling. Five of the ten zones in GZML-3 had no flow at either test pressure and had VOC detects. GZA believes these VOC detects where likely from residual contamination between the packers originating from zones with detectable hydraulic conductivities.

DEEP MULTI-LEVEL WELL INSTALLATIONS

The GZML series wells will have the Solinst Waterloo Systems installed. The Waterloo system consists of both a double valve water pump and vibrating wire pressure transducer. Three zones were selected for GZML-1 ranging in length from 10 to 12 feet, three zones were selected for GZML-2 ranging in length from 10 to 13 feet, and three zones were selected for GZML-3 ranging in length from 10 to 18 feet. Removable hydraulic packers will be used in the system because they can be removed in the event of equipment problems. Note that a top packer is not needed for a zone starting at the bottom of casing and a bottom packer is not needed for a zone ending at the bottom of the borehole. Provided in Attachment C is an information packet on the Solinst Waterloo System.

SCHEDULE

Solinst indicates that the Waterloo materials will take 3 to 4 weeks to construct and deliver to the site once an order is placed. We look forward to discussing this information with you and will await your approval of these recommendations prior to placing equipment order. As such we anticipate field installation will commence in early April and will require 6 to 8 days of field work to complete.

Richard A. Carlone, EIT
Project Engineer

Edward A. Summerly. P.G.
Associate Principal

Attachments: Tables 1 to 4
Figure 1
Attachment A: Boring Logs
Attachment B: Hager Geoscience, Inc Report
Attachment C: Solinist Waterloo System Information Packet

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TABLES

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-1	122.8	174.3	76.6
	122.9	174.6	76.7
	123.2	161.8	69.6
	123.8	160.4	78.4
	123.9	312.1	34.3
	124.0	309.1	33.4
	124.0	155.0	78.1
	124.3	157.7	78.1
	124.5	134.4	66.7
	124.9	150.6	72.7
	125.2	96.3	42.0
	125.3	152.2	70.2
	125.7	108.9	48.5
	126.1	281.3	53.6
	126.2	281.5	53.6
	126.3	110.1	43.6
	126.8	135.0	44.4
	126.9	293.2	52.3
	127.7	222.7	57.5
	128.3	275.3	47.7
	128.5	282.3	47.2
	128.6	284.9	47.2
	128.9	293.2	46.8
	129.3	281.8	47.5
	129.9	311.4	45.6
	130.5	300.9	46.3
	130.9	315.8	45.5
	131.4	320.7	45.4
	131.8	318.5	45.3
	132.6	11.4	61.5
	132.9	339.3	48.0
	133.2	320.7	49.3
	133.9	318.7	45.8
	134.1	114.4	68.6
	134.9	115.9	73.5
	134.9	306.0	46.0
	135.1	297.3	46.6
	136.5	190.2	19.8
	136.6	97.1	82.3
	136.8	263.3	26.6
	137.7	174.3	18.7
	139.1	165.9	39.0
	139.6	330.4	39.7
	139.8	326.6	39.7
	140.8	94.9	47.8
	140.9	92.8	48.0
	141.2	110.4	66.0

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-1	141.4	38.9	38.0
(Cont.'d)	141.7	26.6	38.1
	141.7	326.7	16.1
	141.8	311.8	57.8
	142.6	326.7	62.1
	142.9	335.5	63.5
	143.3	234.5	56.1
	144.1	238.1	56.6
	145.6	268.0	77.8
	145.8	358.6	66.9
	146.1	250.1	72.1
	146.6	259.1	76.8
	146.9	250.0	66.0
	147.3	241.5	66.0
	148.5	140.3	58.3
	148.8	322.6	77.0
	149.2	326.1	77.8
	149.5	315.8	64.9
	150.1	147.3	79.3
	150.1	308.0	84.5
	150.2	144.0	79.2
	152.5	278.6	79.0
	152.8	174.1	31.7
	154.5	251.0	43.5
	154.5	190.1	85.0
	156.2	264.1	51.8
	156.4	264.3	52.1
	156.7	272.8	51.3
	157.3	326.5	61.7
	157.5	327.9	68.5
	157.9	141.2	75.4
	157.9	336.4	70.0
	158.1	313.0	38.6
	158.2	142.7	76.0
	158.3	340.9	74.7
	158.5	250.5	23.5
	159.2	327.1	73.1
	160.2	327.3	78.9
	160.4	329.4	78.4
	160.8	43.0	54.8
	161.3	319.2	67.4
	161.7	316.9	66.4
	162.2	311.9	68.1
	162.2	339.4	78.9
	162.2	314.4	56.5
	162.7	295.6	38.6
	163.5	322.7	62.2

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TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-1	163.9	317.3	62.6
(Cont.'d)	164.1	344.4	81.0
	164.7	316.5	62.6
	164.9	182.6	29.7
	165.9	79.9	57.2
	167.4	167.9	37.5
	169.9	320.4	43.8
	170.8	316.9	44.0
	171.1	15.2	40.5
	171.5	309.3	46.8
	171.9	305.2	47.4
	172.2	44.4	63.0
	172.8	310.0	71.8
	173.2	296.4	47.3
	175.1	95.5	60.2
	175.8	318.6	68.6
	176.0	324.1	69.0
	176.4	313.4	71.6
	176.6	97.0	69.4
	176.9	320.5	71.3
	177.1	323.1	71.0
	177.2	87.7	61.2
	178.6	130.2	72.0
	178.7	333.0	55.7
	179.1	105.3	68.8
	179.3	97.4	70.2
	180.7	308.2	41.4
	180.8	320.7	37.6
	181.4	309.4	68.3
	181.9	311.8	72.3
	182.2	320.8	73.1
	182.3	318.6	74.0
	182.5	313.1	74.1
	182.8	315.9	74.6
	183.1	315.0	74.2
	183.3	310.9	73.9
	183.3	303.8	68.0
	184.8	285.0	74.9
	185.2	174.4	71.2
	186.2	180.7	69.8
	186.8	178.2	55.3
	187.0	173.5	51.1
	189.9	302.0	71.2
	190.1	99.6	59.7
	190.1	300.5	71.3
	190.4	299.4	71.7
	190.5	293.7	71.2

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Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-1	190.6	293.4	71.6
(Cont.'d)	190.8	94.5	63.2
	191.6	287.6	77.5
	192.1	281.9	68.7
	193.1	329.1	63.0
	193.6	302.0	61.5
	193.8	294.0	61.5
	193.9	288.3	62.0
	194.2	297.9	60.9
	194.3	293.9	62.3
	194.5	305.6	61.5
	194.6	299.5	61.4
	194.8	300.6	64.9
	195.1	313.6	60.5
	195.2	315.6	60.5
	195.3	312.4	60.7
	195.5	323.8	63.3
	195.7	152.0	57.2
	196.1	313.0	63.7
	196.1	248.7	49.4
	196.5	301.8	88.8
GZML-2	95.5	39.3	36.2
	95.6	255.1	29.5
	95.7	349.8	72.1
	95.8	134.2	53.4
	96.0	184.2	78.3
	96.4	4.4	36.4
	96.4	339.6	71.0
	96.5	326.9	65.6
	96.6	324.7	65.4
	96.8	327.4	68.5
	97.0	326.3	65.4
	97.1	148.2	49.9
	97.3	334.2	65.5
	97.4	145.3	34.7
	97.4	153.4	49.7
	97.5	331.4	67.7
	97.9	84.2	63.4
	98.1	152.9	63.1
	98.2	350.7	59.8
	98.5	337.7	59.9
	98.5	158.6	62.9
	98.9	158.2	62.9
	98.9	258.2	52.3
	99.3	178.8	57.9
	99.4	92.5	57.7
	99.5	263.8	48.6

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-2	99.6	187.5	57.8
(Cont.'d)	99.7	184.6	57.8
	99.7	187.9	57.8
	99.9	322.8	45.0
	100.1	338.2	39.3
	100.2	340.3	28.5
	100.3	333.1	28.3
	100.6	189.3	45.0
	100.8	348.6	61.4
	101.6	141.8	43.9
	102.6	344.4	47.5
	102.8	156.5	41.7
	103.3	150.0	42.1
	103.3	1.0	42.2
	103.7	1.9	47.8
	104.0	285.2	42.4
	104.1	281.3	42.3
	104.2	279.8	40.1
	104.3	279.7	40.1
	104.3	286.2	54.2
	105.2	347.8	32.2
	105.8	7.4	46.9
	106.0	48.1	53.3
	106.1	53.5	53.2
	106.5	331.4	79.1
	106.6	334.7	79.2
	106.6	271.5	45.4
	106.8	271.3	49.6
	106.9	127.5	47.0
	107.0	127.1	41.8
	107.0	254.1	26.4
	107.2	131.8	51.4
	107.3	129.5	45.8
	107.3	133.9	45.7
	107.7	116.7	45.2
	108.0	126.7	45.8
	108.1	129.0	45.7
	108.6	135.5	46.6
	109.1	127.0	52.5
	109.4	127.1	55.3
	109.4	125.7	55.3
	109.9	116.9	55.5
	110.5	127.4	65.5
	110.7	303.3	54.0
	111.0	103.5	31.8
	111.1	128.6	65.8
	111.1	310.8	44.4

TABLE 1
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Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-2	111.2	332.0	50.2
(Cont.'d)	111.4	279.4	24.1
	112.0	316.9	32.6
	112.3	338.9	51.7
	114.6	264.4	65.0
	114.8	271.8	65.4
	114.9	271.2	65.4
	115.0	266.7	65.4
	116.4	339.2	33.6
	117.1	322.6	53.9
	117.4	298.2	53.7
	117.6	316.0	53.7
	117.8	313.2	53.5
	118.4	270.8	67.6
	118.6	266.9	67.5
	118.9	257.1	67.3
	119.1	251.6	67.2
	119.5	256.7	67.3
	119.8	247.0	63.6
	120.1	251.0	63.7
	120.7	167.2	38.2
	121.0	146.0	58.1
	121.0	162.4	38.1
	121.0	0.2	56.9
	121.5	287.9	40.3
	121.6	156.1	58.1
	121.7	283.4	30.1
	122.2	320.8	44.6
	123.4	308.8	53.8
	124.4	309.3	53.6
	124.8	120.4	76.1
	124.8	242.7	24.6
	124.9	240.9	24.6
	125.3	113.6	53.4
	126.0	157.2	39.4
	127.1	278.0	72.6
	127.6	284.8	72.7
	127.6	286.6	72.7
	127.7	285.1	72.7
	127.8	285.4	72.7
	128.0	292.2	72.8
	129.3	146.9	38.9
	129.6	142.0	39.2
	130.4	282.0	49.6
	130.6	278.4	49.6
	130.8	275.2	47.6
	130.9	276.3	47.6

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Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-2	131.0	142.0	45.3
(Cont.'d)	131.1	263.7	51.9
	131.4	139.8	45.3
	132.4	259.3	44.4
	132.9	169.8	35.7
	134.0	160.7	47.9
	134.2	164.7	48.0
	134.4	164.8	48.0
	134.7	11.5	48.8
	134.9	14.9	48.8
	135.1	150.4	51.1
	135.6	315.1	49.4
	136.0	322.8	49.3
	136.2	322.0	49.6
	136.3	320.2	49.3
	137.3	8.0	60.4
	137.5	15.3	60.4
	137.6	12.3	60.1
	138.6	293.8	16.6
	138.8	301.9	16.6
	138.9	307.2	28.4
	140.0	297.8	78.5
	140.1	295.1	16.8
	140.7	304.6	38.7
	141.1	329.9	49.5
	141.2	313.9	75.9
	141.9	291.1	58.3
	142.5	260.3	62.9
	143.1	278.8	61.1
	143.1	100.7	63.1
	143.4	262.4	24.7
	144.2	326.6	28.2
	144.5	321.0	30.4
	144.5	133.4	69.4
	144.7	136.2	69.4
	144.7	320.0	30.4
	144.8	143.7	69.4
	144.8	323.9	30.4
	145.0	327.9	17.8
	145.1	133.8	34.6
	145.1	336.2	17.7
	145.4	308.6	35.8
	145.5	320.7	35.8
	145.8	343.5	16.3
	146.1	243.5	56.3
	146.5	250.7	55.9
	146.9	252.6	56.2

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TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-2	147.9	143.9	61.6
(Cont.'d)	149.2	295.8	32.2
	149.4	275.7	32.1
	149.5	280.3	32.2
	149.6	295.9	61.4
	149.9	289.3	61.6
	150.2	284.6	61.6
	150.3	284.6	59.9
	150.5	288.4	58.9
	151.2	231.3	59.3
	151.4	225.4	57.8
	152.4	167.7	61.2
	152.8	294.0	64.4
	153.2	289.0	71.0
	153.5	291.8	70.9
	153.8	291.7	70.9
	154.2	273.1	71.3
	154.2	274.8	71.2
	154.8	267.8	71.0
	155.0	278.9	71.2
	155.5	247.3	56.1
	155.7	110.9	67.7
	155.8	121.7	68.2
	156.0	123.6	68.2
	156.2	247.9	49.2
	156.4	249.9	49.1
	156.6	244.1	49.1
	156.9	145.8	21.6
	157.5	263.6	64.0
	157.8	273.7	64.8
	158.0	274.0	67.8
	158.2	280.5	67.8
	158.9	318.4	72.8
	159.0	316.7	70.7
	162.9	131.4	40.1
	162.9	134.1	40.1
	163.7	123.4	70.1
	164.0	252.7	66.2
	164.7	255.8	72.5
	164.7	273.9	43.9
	165.1	256.6	49.9
	166.4	123.1	83.3
	166.9	116.2	83.1
	167.2	83.7	65.8
	167.3	48.9	43.9
	170.3	285.7	67.3
	171.2	295.9	67.1

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-2	171.4	288.9	67.8
(Cont.'d)	172.0	281.7	67.1
	172.1	280.2	67.1
	172.4	277.8	67.0
	172.7	273.2	66.9
	172.9	276.1	67.0
	173.8	267.7	67.0
	174.0	110.6	60.1
	174.4	272.2	67.0
	175.2	81.2	66.2
	177.0	109.9	75.8
	177.2	266.6	27.8
	179.6	277.2	35.9
	179.7	347.3	20.8
	180.3	161.5	45.6
	181.4	142.6	46.4
	181.7	296.5	62.0
	182.3	165.6	52.5
	182.5	158.4	55.5
	182.7	107.4	79.1
	182.7	165.8	37.3
	183.1	312.8	24.2
	183.8	189.5	49.6
	184.0	173.4	49.3
	184.2	167.8	49.3
	184.5	3.5	16.3
	185.3	209.8	61.6
	187.6	338.2	53.4
	187.8	336.9	53.5
	188.0	330.1	53.3
	188.2	328.4	53.6
	188.5	15.3	69.4
	190.3	283.5	62.9
	190.5	280.9	56.6
	190.7	327.3	25.9
	190.7	143.4	55.5
	190.9	141.7	57.5
	191.0	288.3	80.7
	191.1	153.3	55.4
	191.3	148.1	57.8
	191.4	309.9	56.6
	191.5	148.8	57.7
	192.0	324.0	42.6
	192.1	323.8	41.7
	192.1	316.6	68.5
	192.3	311.2	53.7
	192.3	312.9	68.3

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-2	192.7	54.8	57.7
(Cont.'d)	193.2	294.9	34.5
	193.3	298.4	34.4
	193.7	304.2	69.1
	193.9	324.3	51.5
	193.9	146.4	48.1
	194.0	142.2	47.9
	194.9	272.6	58.3
	195.0	262.7	58.2
	195.4	309.3	56.2
	195.7	314.4	56.3
	195.7	318.4	45.1
	195.9	322.2	72.3
	197.0	96.3	63.7
	197.3	284.7	74.2
	197.6	84.6	66.1
	197.6	278.5	74.2
	197.7	285.2	49.1
	198.0	271.6	45.8
	198.2	278.4	76.2
	198.3	280.4	75.0
	198.3	269.8	60.3
	198.4	269.8	60.0
	198.5	270.1	59.5
	198.7	95.7	89.8
GZML-3	48.1	172.4	70.9
	48.7	191.8	36.1
	48.9	179.6	35.9
	49.2	181.3	36.0
	49.9	23.4	63.7
	50.1	189.5	37.2
	50.1	22.0	63.6
	50.3	20.9	63.6
	50.7	104.3	50.2
	50.7	101.1	70.0
	53.8	190.7	28.7
	54.3	200.2	52.8
	54.5	188.5	53.1
	54.7	198.9	53.2
	55.1	209.7	14.7
	55.5	100.6	69.2
	57.2	76.7	78.5
	57.4	183.4	32.2
	57.6	120.9	57.8
	57.9	136.5	71.8
	57.9	56.1	80.7
	59.5	282.8	73.7

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-3	59.6	33.6	44.6
(Cont.'d)	59.7	166.4	34.5
	59.7	285.1	73.6
	60.2	165.1	33.8
	60.5	171.0	34.4
	61.1	163.6	36.4
	61.3	139.9	71.8
	61.3	153.8	28.9
	61.5	139.9	71.7
	61.6	154.5	40.3
	62.1	169.7	32.6
	62.6	237.3	42.0
	63.0	226.7	48.5
	64.7	287.4	46.9
	65.0	151.1	44.6
	65.6	282.5	61.7
	65.7	111.3	60.3
	66.4	311.4	75.1
	66.8	119.6	73.1
	67.3	303.7	75.7
	67.9	259.2	67.9
	68.9	21.9	68.1
	69.9	187.7	53.3
	70.6	341.6	64.9
	70.8	341.9	65.0
	71.5	290.5	71.4
	71.7	291.0	71.5
	71.7	344.8	45.8
	72.0	271.2	72.4
	74.2	286.2	62.4
	75.2	282.8	66.8
	75.8	286.9	66.6
	75.9	293.8	66.5
	76.4	293.6	67.0
	76.7	100.6	69.7
	77.1	92.6	69.7
	77.2	311.9	66.8
	77.9	329.3	58.9
	78.1	338.1	59.0
	78.4	315.7	60.6
	78.8	320.5	63.3
	79.8	341.2	57.6
	80.2	77.0	65.2
	80.3	347.4	47.6
	80.6	284.1	42.4
	81.2	284.5	61.4
	81.5	285.1	61.3

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-3	82.1	14.3	75.4
(Cont.'d)	82.3	259.8	47.9
	83.5	348.7	79.6
	83.7	352.3	79.8
	84.8	338.0	61.9
	86.6	302.5	52.5
	86.8	303.9	52.3
	87.5	218.4	43.2
	87.7	225.8	43.5
	88.2	325.9	49.3
	89.3	29.9	64.1
	89.5	33.8	64.2
	89.7	40.2	67.1
	90.1	17.4	68.9
	90.4	19.0	70.0
	91.2	296.0	49.0
	91.4	269.9	52.5
	91.8	327.9	46.0
	93.6	208.5	47.2
	93.6	205.0	46.1
	94.6	279.8	32.6
	94.8	278.5	32.9
	95.1	298.5	47.9
	95.8	291.3	47.5
	96.0	257.5	47.6
	96.1	179.7	37.4
	96.2	261.8	47.3
	96.5	153.4	36.9
	96.9	278.8	35.8
	97.3	211.7	40.4
	99.8	311.6	45.6
	99.9	324.2	67.1
	99.9	144.8	40.9
	100.3	331.9	45.6
	101.2	154.0	29.8
	101.5	154.6	29.6
	101.7	148.0	29.3
	101.7	290.7	53.0
	102.3	310.9	69.5
	102.7	318.7	63.8
	103.5	318.0	42.4
	104.3	288.7	68.9
	104.6	290.5	68.7
	105.1	335.3	53.5
	106.7	271.1	58.9
	107.1	271.0	58.8
	108.1	149.2	59.3

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-3	108.5	154.3	59.7
(Cont.'d)	109.0	285.2	70.1
	109.3	282.0	69.7
	109.7	340.2	56.0
	110.7	275.3	73.5
	111.3	296.1	73.1
	111.4	316.7	47.9
	112.5	300.3	46.0
	112.6	298.8	45.9
	113.0	283.3	46.1
	113.1	134.1	53.3
	113.2	284.6	46.5
	113.6	272.5	46.1
	113.7	277.2	46.2
	113.9	268.6	46.1
	114.6	119.3	48.5
	114.8	126.6	48.3
	115.0	294.8	46.4
	115.6	351.3	37.9
	115.7	135.3	72.2
	115.9	322.5	45.7
	116.0	326.9	48.5
	116.2	331.5	47.8
	116.3	304.9	67.5
	116.6	300.8	44.4
	116.7	301.4	44.1
	117.1	341.9	30.7
	117.6	332.4	53.2
	117.8	332.6	53.3
	117.9	326.9	53.4
	118.2	318.5	31.8
	118.6	354.9	34.2
	118.7	2.8	39.5
	119.0	222.2	52.4
	119.2	313.0	59.9
	119.4	327.2	60.1
	119.6	315.8	60.0
	119.7	320.7	60.2
	119.9	308.9	60.4
	120.4	318.3	71.8
	120.8	295.9	71.8
	121.2	297.6	71.6
	121.4	278.9	71.0
	122.2	307.2	71.6
	122.4	311.8	72.1
	122.7	307.8	75.9
	123.1	298.1	71.6

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-3	123.8	275.2	61.4
(Cont.'d)	124.4	312.8	55.8
	124.6	308.8	55.9
	124.8	314.5	54.3
	125.0	321.3	54.1
	125.2	96.6	53.5
	125.3	316.9	54.5
	125.4	323.0	55.8
	125.7	320.2	55.0
	125.8	345.9	65.6
	126.1	304.8	65.3
	126.2	357.6	64.9
	126.3	300.6	65.7
	126.5	145.1	52.5
	126.5	298.9	65.6
	126.9	137.3	45.0
	127.1	307.1	30.9
	127.2	128.0	52.9
	127.4	314.9	34.1
	127.7	133.0	57.3
	127.7	326.6	34.3
	128.0	137.8	57.5
	128.0	316.4	58.2
	128.3	315.9	56.8
	128.4	150.5	55.3
	129.1	147.5	55.4
	130.2	318.3	59.4
	130.3	312.7	55.7
	130.7	315.6	61.1
	130.9	310.4	58.6
	131.1	122.9	52.8
	131.3	314.2	61.6
	131.7	128.6	62.7
	131.7	304.6	62.1
	132.1	307.8	61.5
	132.4	312.6	58.3
	132.7	308.3	58.3
	132.8	312.0	58.5
	133.0	317.3	58.3
	133.0	152.5	68.1
	133.4	326.9	45.6
	133.6	343.6	45.2
	133.8	341.6	45.1
	133.9	161.0	34.1
	134.1	330.7	42.9
	134.3	314.3	53.7
	134.6	311.7	53.8

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-3	135.1	306.6	47.4
(Cont.'d)	135.3	306.5	53.8
	135.9	345.9	36.6
	136.2	333.0	53.7
	136.7	319.2	43.8
	137.0	301.9	47.5
	137.3	321.9	29.5
	137.4	309.2	68.3
	137.8	318.7	29.6
	138.5	332.2	30.0
	138.6	233.2	45.0
	138.9	322.0	85.8
	139.3	351.7	37.3
	139.3	325.4	85.2
	139.7	254.9	87.2
	139.8	156.1	41.4
	140.2	321.1	30.2
	140.4	137.6	80.1
	140.6	165.7	42.3
	141.1	134.6	73.4
	141.2	319.5	36.8
	141.7	344.2	36.4
	142.2	328.2	35.9
	142.2	244.4	67.7
	142.4	320.6	36.2
	142.6	331.9	43.3
	142.7	157.0	48.5
	143.0	319.1	36.4
	143.2	329.7	36.7
	143.5	99.2	70.7
	143.7	317.3	24.9
	144.2	90.7	70.2
	144.5	278.0	63.9
	144.7	269.8	64.6
	145.2	283.8	66.6
	145.4	15.2	56.8
	145.4	142.0	58.4
	145.7	274.4	73.2
	145.7	147.9	58.4
	145.8	146.1	58.4
	145.9	270.7	73.1
	146.0	149.1	58.8
	146.1	273.5	73.5
	146.6	112.8	77.7
	146.6	284.8	73.7
	147.1	290.1	75.0
	148.8	144.3	49.3

TABLE 1
TELEVIEWER FRACTURE SUMMARY

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location	Depth	Azimuth	Dip
GZML-3	148.9	324.2	74.6
(Cont.'d)	149.0	148.2	52.4
	149.2	132.8	51.5
	149.2	320.2	74.6
	149.4	130.9	53.9
	149.6	312.0	75.0
	149.8	306.1	75.7
	150.1	304.3	75.1
	150.7	317.3	75.3
	151.4	321.1	54.3
	151.5	318.2	54.3
	151.8	311.9	54.8
	152.1	302.0	55.0
	153.0	175.6	33.1
	153.3	171.7	34.9
	153.9	255.3	46.1
	154.3	208.5	27.2
	154.7	298.2	56.9
	154.9	308.6	53.3
	155.1	305.0	51.1
	155.3	322.1	52.1
	155.5	80.4	63.9
	156.1	260.4	77.9
	156.2	184.3	87.4

Notes:

1. Information provided by Hager Geosciences, Inc., based on acoustic televiewer logging performed in 2006.

TABLE 2
VOLATILE ORGANIC ANALYTICAL RESULTS FROM ZONE EXTRACTION TESTS

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location/ Zone	Depth Interval (ft)	Parameter	Concentration (ug/L)
GZML-1	118.25-130	ND	ND
	126.25-138	ND	ND
	137.25-149	Toluene	1.1
	148.25-160	Toluene	1.8
	148.25-160	Tetrachloroethene	1.0
	159.25-171	Acetone	40.0
	159.25-171	Toluene	2.4
	159.25-171	Tetrachloroethene	1.5
	170.25-182	Acetone	70.0
	170.25-182	Toluene	2.6
	170.25-182	Tetrachloroethene	2.2
	181-192.75	Acetone	71.0
	181-192.75	Toluene	2.7
	191-201	Toluene	1.1
GZML-2	89.3-101.1	ND	ND
	100.6-112.4	ND	ND
	111.9-123.7	ND	ND
	123.2-135	ND	ND
	134.5-146.3	ND	ND
	145.8-157.6	ND	ND
	157.1-168.9	ND	ND
	168.4-180.2	Toluene	3.3
	168.4-180.2	Naphthalene	3.1
	179.7-191.5	ND	ND
	191-201	ND	ND
GZML-3	46.3-58.1	1,1,1-Trichloroethane	1.5
	46.3-58.1	Trichloroethene	14.0
	46.3-58.1	Tetrachloroethene	8300.0
	57.6-69.4	1,1,1-Trichloroethane	1.7
	57.6-69.4	Trichloroethene	15.0
	57.6-69.4	Tetrachloroethene	8800.0
	68.9-80.7	Trichloroethene	3.3
	68.9-80.7	Tetrachloroethene	1400.0
	80.2-92	Trichloroethene	5.5
	80.2-92	Tetrachloroethene	3200.0
	91.5-103.3	Trichloroethene	4.0
	91.5-103.3	Tetrachloroethene	2600.0
	102.8-114.6	Trichloroethene	2.1

TABLE 2
VOLATILE ORGANIC ANALYTICAL RESULTS FROM ZONE EXTRACTION TESTS

Bedrock Aquifer Evaluation - Chabert Division of NFA Corporation
Alton, Rhode Island

Location/ Zone	Depth Interval (ft)	Parameter	Concentration (ug/L)
GZML-3	102.8-114.6	Tetrachloroethene	1100.0
(Cont.'d)	114.1-125.9	Tetrachloroethene	160.0
	125.4-137.2	Trichloroethene	2.2
	125.4-137.2	Toluene	1.2
	125.4-137.2	Tetrachloroethene	560.0
	136.7-148.5	Trichloroethene	9.9
	136.7-148.5	Toluene	1.7
	136.7-148.5	Tetrachloroethene	2100.0
	148-158	Tetrachloroethene	11.0

Notes:

1. Information based on extraction packer testing collection methods.
2. ND indicates no detects in zone.
3. Analytical testing conducted by GZA, GeoEnvironmental Laboratory of Hopkinton, MA using EPA Method 8260.

TABLE 3
PACKER PRESSURE INJECTION TESTING RESULTS

Bedrock Aquifer Evaluation - Charbert Division of NFA Corporation, Alton, Rhode Island

BORING NO.	TEST ZONE	DEPTH INTERVAL (feet bgs)	FRACTURE FREQUENCY (# fractures/ft)	K1 FT/YR (0.75 psi/ft)	K2 FT/YR (0.5 psi/ft)	K RESULT FT/YR (Avg.)	Comments
GZML-1	1	123.5-135.25	2.89	NT	317.55	317.55	
	2	137.25-149	1.96	18.25	20.08	19.16	
	3	148.25-160	1.96	27.74	23.36	25.55	
	4	159.25-171	1.53	4.02	1.83	2.92	
	5	170.25-182	1.96	4.02	1.83	2.92	
	6	181-192.75	1.96	16.43	10.59	13.51	
	7	185.25-197	2.55	3.65	1.83	2.74	
GZML-2	1	89.3-101.1	2.97	77.75	89.43	83.59	
	2	100.6-112.4	3.73	75.92	82.86	79.39	
	3	111.9-123.7	2.29	2.19	2.92	2.56	No Flow
	4	123.2-135	2.46	1.83	2.92	2.37	No Flow
	5	134.5-146.3	3.14	3.29	2.56	2.92	
	6	145.8-157.6	2.80	12.78	12.05	12.41	
	7	157.1-168.9	1.44	10.22	10.95	10.59	
	8	168.4-180.2	1.36	1.46	2.19	1.83	No Flow
	9	179.7-191.5	2.46	20.81	21.17	20.99	
	10	191-201	3.50	30.30	32.85	31.57	
GZML-3	1	46.3-58.1	1.78	NT	1839.97	1839.97	
	2	57.6-69.4	2.20	NT	1566.95	1566.95	
	3	68.9-80.7	2.03	3.29	5.11	4.20	No Flow
	4	80.2-92	1.95	2.92	4.38	3.65	No Flow
	5	91.5-103.3	1.95	2.56	3.65	3.10	No Flow
	6	102.8-114.6	2.03	22.63	23.73	23.18	
	7	114.1-125.9	3.56	16.06	18.25	17.16	
	8	125.4-137.2	3.90	1.83	2.92	2.37	No Flow
	9	136.7-148.5	3.56	1.83	2.56	2.19	No Flow
	10	148-158	2.50	39.06	42.34	40.70	

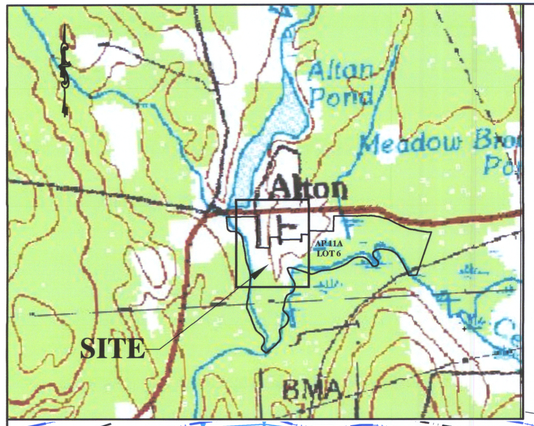
GZML Series:

1. **Hydraulic conductivity of bedrock was calculated based upon methods presented in the Groundwater Manual, (U.S. Department of the Interior, Revised Reprint 1981).**
2. **No Flow indicates that no water movement was recorded during the test.**
3. **Packer test depth intervals indicate the length of individual test zones with reference to ground surface.**
4. **Fracture traces per foot represent the number of apparent rock fractures within each depth interval divided by the length of the test interval. Fracture trace data was obtained from Acoustic Televiewer Logs performed by Hager-Geoscience Inc. Note, Hager indicates that not all features identified in the ATV logs are necessarily rock fractures. Other features such as filled fractures, foliation, and mineralized or weathered zones may be identified and would be included here as fractures**
5. **Packer tests were generally performed at approximately 0.5 to 0.75 psi per foot of depth from ground surface to the top of the test zone.**
6. **Televiewer logs for each borehole were interpreted by Hager Geosciences, Inc.**
7. **NT indicates that no pressure testing was performed over the indicated interval.**

TABLE 4
WELL ZONE SELECTION RATIONALE
Bedrock Aquifer Evaluation - Charbert, Division of NFA Corporation, Alton, RI

BOREHOLE ID	SAMPLE ZONE DESIGNATION	SAMPLE ZONE DEPTH (ft. bgs)	SELECTION RATIONALE
GZML-1	A	122-132	Packer testing indicates zone of highest hydraulic conductivity (K) in borehole
			Heat Pulse Flow Meter (HPFM) indicates two suggested inflow points between 125 ft and 130 ft
	B	148-160	Packer testing indicates zone of second highest hydraulic conductivity (K)
			Chemical testing indicates detects of one known site related contaminant (tetrachloroethene)
			HPFM indicates suggested inflow point at 154 ft
	C	170-182	Packer testing indicates detectably K
			Chemical testing indicates detects of two known site related contaminants (tetrachloroethene and acetone)
			HPFM indicates suggested inflow points at 170, 176, and 181 ft
	Total of 3 Zones		
GZML-2	A	98-110	Packer testing indicates zone of highest hydraulic conductivity (K)
			Acoustic teleview (ATV) indicates multiple small, one medium, and 2 large fractures in zone
	B	145-158	Packer testing indicates detectably K
			Heat Pulse Flow Meter (HPFM) indicates suggested inflow point at 150 ft.
	C	191-201	Packer testing indicates zone of third highest hydraulic conductivity (K)
			ATV indicates multiple small fractures in zone
	Total of 3 Zones		
GZML-3	A	49-65	Packer testing indicates zone of highest hydraulic conductivity (K)
			Chemical testing indicates zone of highest tetrachloroethene concentration
			HPFM indicates suggested inflow points at 49, 55, and 60 ft
	B	97-115	Packer testing indicates detectable K
			Chemical testing indicates relatively high tetrachloroethene concentration in zone
			HPFM indicates suggested inflow points at 100 and 110 ft
	C	148-158	Packer testing indicates detectable K
			Chemical testing indicates detect of tetrachloroethene in zone
			HPFM indicates suggested inflow point at 150 ft
	Total of 3 Zones		

FIGURE



LEGEND

- RIZ — RIZZO MONITORING WELL
- GZ — GZA MONITORING WELL
- GP — GZA GEOPROBE
- EW — EXTRACTION (PRODUCTION) WELL
- CB — CLAYTON TEMPORARY WELL
- SW — SURFACE WATER MONITORING STATION
- NOT — NON-LOCATABLE MONITORING WELL
- A64–RB — WETLAND/RIVER BANK FLAGS (WOOD RIVER A–RB SERIES)
- A8 — WETLAND FLAGS (A– SERIES)
- a–118 — WETLAND FLAGS (a– SERIES, BOTH RIVERS)
- a191/ rb — WETLAND/RIVER BANK FLAGS (a/rb SERIES, BOTH RIVERS)
- 200 FT. RIVER BANK BUFFER
- 50 FT. WETLAND BUFFER
- 35 — EXISTING SURFACE CONTOURS

TOWN OF HOPKINTON

WOOD RIVER
50' PERIMETER WETLAND
200' RIVER BANK
WETLAND
50' PERIMETER
PAWCATUCK
WETLAND
RIVER
200' RIVER BANK SETBACK
AS-BUILT LOCATION OF NEW LEACHING SYSTEM
GRAVEL BORROW AREA
TEMPORARY HOLDING POND
LAGOON #3
LAGOON #2
LAGOON #1
FORMER LAGOONS
CHARBERT MILL BUILDING
RIVER STREET
RIVER VIEW
CHURCH STREET (ROUTE 16)
MYRTLE AVENUE
POPLAR AVENUE
PRIVATE WELL
CESSPOOL
METER PIT-1
DRILL HOLE ELEV.: 54.43
PD-1 DRILL HOLE ELEV.: 53.53
GP-16 TPVC ELEV.=52.57
GP-17 TPVC ELEV.=73.88
GP-15 TPVC ELEV.=60.67
GP-20 TPVC ELEV.=67.66
GP-29 (UIC MW-1A) TPVC ELEV.= 66.90
GP-21 TPVC ELEV.=66.86
GP-22 TPVC ELEV.=48.55'
GP-25 TPVC ELEV.=47.86
GP-27A TPVC=52.16
GP-27B TPVC ELEV.=52.21
GZ-8 TPVC ELEV.=52.17
GZ-3 TPVC ELEV.=49.14
GZ-6 TPVC=48.32'
GZ-5 TPVC ELEV.=48.64
GZ-4A TPVC ELEV.=59.01
GP-18 TPVC ELEV.=62.08
GP-19 TPVC ELEV.=62.08
GZ-2 TPVC ELEV.=62.08
GZ-28 TPVC ELEV.=46.69
GZ-26 TPVC=49.23
GP-14 TPVC ELEV.=46.83
GZ-ML-3 TOC ELEV.= 49.39' GRADE ELEV.= 47.49'
GZ-ML-2 TOC ELEV.= 55.46' GRADE ELEV.= 55.03'
GZ-ML-1 TOC ELEV.= 61.50' GRADE ELEV.= 57.17'
RIZ-1 TPVC ELEV.= 50.24
RIZ-3 TPVC=48.64
RIZ-5 TPVC=48.58
RIZ-6 TPVC ELEV.=48.31
RIZ-7 TPVC=47.10
RIZ-10M (UIC MW 1) TPVC=64.45
RIZ-10S (UIC MW-6)
RIZ-12 TPVC ELEV. 46.56
RIZ-14 TPVC ELEV. 62.61
RIZ-15 UIC- MW 3 TPVC ELEV. 62.51
RIZ-16 TPVC ELEV.= 65.94
RIZ-19 TPVC ELEV.= 63.85
RIZ-21
UIC MW-2A TPVC ELEV.=63.59
CB-12 TPVC ELEV.= 61.53
SW-1
SW-3
LW-1
LW-2
LW-5
LW-5a
EW-1
EW-2
EW-3
EW-4
PT-2 (CB-10)
PT-4
PT-5
OEW-2
NECO-4-1
NECO-4-3
NECO-4-7
NECO-4-11
NECO-4-15
NECO-4-17
NECO-4-19
ELECT. BOX
PSFM
OHU
U/P 4
U/P 3435
1 INCH = 80 FEET
0 40 80 160

GENERAL NOTES

1 BASE MAP DEVELOPED FROM DRAWINGS PROVIDED BY CHERENZIA AND ASSOCIATES PREPARED BY RAYMOND F. CHERENZIA, PE, LS ENTITLED EXISTING CONDITIONS SITE PLAN DATED 02/05/2001. SCALED 1"= 100', DRAWING NO 2.

2 THE LOCATIONS AND ELEVATIONS OF MONITORING WELLS AND SAMPLING LOCATIONS WERE DETERMINED BY INSTRUMENT SURVEY CONDUCTED BY GZA IN SEPTEMBER 2004. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

J:\ENV\32795-12.eaa\cadd source\GZA DWG\FEB 07 BEDROCK.dwg [BEDROCK WELLS] February 23, 2007 – 9:47am carl.bergden

REV#	DESCRIPTION	BY	DATE

GZA GeoEnvironmental, Inc.
140 Broadway, Providence, RI 02903
(401) 421-4140 Fax: (401) 751-8613

PROJ. MGR.: MPD
CHK'D BY: EAS
REV'D BY: RAC
DRAWN BY: SMA
SCALE: AS NOTED
DATE: FEB., 2007

CHARBERT
A DIVISION OF NFA CORP.
299 CHURCH STREET ALTON, RHODE ISLAND 02832

BEDROCK AQUIFER EVALUATION
EXPLORATION LOCATION PLAN

PROJECT NO.
32795.12

FIGURE NO.
1