GZA
GeoEnvironmental, Inc.

Engineers and
Scientists

March 15, 2006
Job No. 32795.12-C

Ms. Cynthia Gianfrancesco
Rhode Island Department of Environmental Management
Office of Waste Management
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Re: Bedrock Aquifer Evaluation Work Plan
Phase III Subsurface Investigation Program
Charbert, Division of NFA Corporate Facility
Alton, Rhode Island

Dear Ms. Gianfrancesco:

GZA GeoEnvironmental, Inc. (GZA) is pleased to submit this ***Bedrock Aquifer Evaluation Work Plan*** (Work Plan) for the Phase III field studies at the Charbert Facility (Site) to the Rhode Island Department of Environmental Management (RIDEM). We prepared this Work Plan on behalf of our client, Charbert, a Division of NFA Corporation. The Site is located off Church Street in Alton, Rhode Island as shown on Figure E-1.

BACKGROUND

A number of studies have been completed at the facility by GZA and others, and a significant body of environmental information exists for the Site and surrounding area. These prior studies culminated in the preparation of a Site Investigation Report (SIR) for the facility which was submitted to RIDEM on June 2, 2005. As part of the work leading up to the SIR, RIDEM indicated that it would not consider the SIR complete until Charbert conducted a study of the bedrock aquifer in the vicinity of the facility. In our December 22, 2004 ***Phase II Subsurface Investigation Program Work Plan*** we recommended postponing the bedrock aquifer evaluation until the extensive Phase II field work program was completed. Our rationale was that this would give us the opportunity to better define source areas both laterally and vertically and expand our understanding of the bedrock topography, both of which are critical in planning an appropriate bedrock investigation program. RIDEM concurred with this recommendation.

Charbert and RIDEM subsequently agreed that Charbert was to submit this bedrock evaluation Work Plan by March 15, 2006.

PROJECT OBJECTIVES

The objective of the bedrock aquifer study is to characterize the type and physical condition of bedrock underlying the Site, and to evaluate the nature and extent of chemical contaminants within bedrock, if any. Although several releases of petroleum products and chlorinated hydrocarbons have been documented at the facility, as noted in the SIR, there is currently no evidence that these contaminants have migrated into the underlying bedrock aquifer. During previous explorations, bedrock (or refusal on what is believed to be bedrock) was encountered at depths between 36 feet below ground surface, in the northwestern portion of the site, and 86 feet bgs in the eastern-central portion of the Site.

The purpose of the work plan is to outline the proposed technical approach to be utilized for the bedrock aquifer evaluation in sufficient detail for RIDEM to review and approve the work. Studies include: 1) selecting several suitable/optimal bedrock aquifer assessment locations (borehole drilling locations); 2) drilling the selected boreholes; 3) assessing in-situ bedrock properties (e.g., degree and orientation of fractures, hydraulic conductivity); 4) selecting appropriate groundwater monitoring zones within the bedrock boreholes and installing multi-level monitoring equipment; 5) evaluating groundwater flow patterns and gradients within the bedrock; and 6) collecting and analyzing representative groundwater samples. As the investigation has several components that build upon, and are dependent upon, the findings of preceding steps, the work is described in general terms. Several milestones requiring decisions with regulatory input are included in the project. We propose to address these milestones through the use of monthly progress reports and/or technical memoranda.

SCOPE OF WORK

Our field program has been designed to obtain the additional information described above in Project Objectives and to address specific RIDEM comments regarding the bedrock aquifer characterization. The resultant data will augment that previously collected to support a remedy that is in keeping with the future intended use of the property.

In order to meet these objectives, the following scope of work is proposed.

Task 1 – Surficial Geophysical Investigations

Contaminants in groundwater at the facility can exist in two forms, dissolved and dense non-aqueous phase liquids (DNAPL). Dissolved phase contaminants will generally move with groundwater migration patterns without regard to gravitational forces. Dissolved contaminants could migrate into the underlying bedrock aquifer if hydraulic heads are lower within the bedrock compared to the overburden aquifer due either to natural conditions or the effects of groundwater pumping. Conversely, DNAPL tends to move vertically downward in the subsurface due to gravitational forces and without regard for groundwater migration patterns. DNAPL will therefore follow the slope of impermeable surfaces until a fracture or fissure is encountered that can allow continued downward movement to occur. As such, it is important to understand the subsurface stratigraphy (i.e., the depth and thickness of aquifers and potential aquitards such as till) and the topography of the bedrock surface.

The purpose of the surfical geophysical investigation is to provide information on the depth to and configuration of the bedrock surface at the Site. We propose to use seismic refraction as the primary tool to map competent bedrock. Figure 1, attached, shows the general location of six proposed transects totaling approximately 6,700 linear feet. The seismic surveys will be conducted using a 48-channel seismograph with 10 foot geophone spacing. Energy for the survey will be provided using a hydraulically accelerated weight drop or sledge hammer and steel plate, depending on access limitations. Five shots per cable spread will generally be utilized allowing for a stacked seismic signal that provides enhanced resolution of subsurface features. The seismic data will be interpreted using the Generalized Reciprocal Method (GRM). GRM allows the bedrock depth to be estimated at each geophone, rather than just below the shot points, and is less sensitive to dipping strata.

The seismic survey will be used in conjunction with existing borehole data to produce a bedrock contour map inclusive of any additional bedrock feature information discernable from the survey. We will utilize this information and existing contaminant release and migration data to select bedrock drilling locations. At this time, we anticipate conducting three bedrock explorations (designated GZ-ML-1, GZ-ML-2, GZ-ML-3) to total depths of 200 feet, and have tentatively targeted the down gradient area west of the facility in the vicinity of borehole GZ-3, the area between the facility and the homes on River Street in the vicinity of borehole GP-22, and the area to the north of Lagoon #1 in the vicinity of borehole GZ-2. However, the findings of the geophysical investigation will be utilized as the determining factor. The survey results, bedrock contour plan and recommended drilling location will be submitted to RIDEM in the form of a Technical Memorandum and drilling will not proceed until RIDEM has approved of the proposed locations and depths.

Task 2 – Drilling Program

The following subsections describe the proposed drilling methods. To minimize the potential that the proposed exploration program will further spread the distribution of DNAPL and/or dissolved phase contamination, if present, within the aquifer, we will not drill directly within known or suspected chlorinated compound release areas. A DNAPL identification and contingency action plan has been developed for the drilling program, and is attached as Appendix A. As noted in the plan, all drilling activities will be suspended and RIDEM will be notified in the event of the suspected detection of DNAPL to avoid spreading contamination within the aquifer.

A GZA geologist/engineer will be present during the field program to observe the investigation process, collect and screen soil and bedrock samples, and prepare boring/well logs describing subsurface conditions. Soil and water generated as part of the exploration program will be managed in accordance with the procedures provided in RIDEM's Guidelines for the Management of Investigation Derived Waste (Policy Memo 95-01).

Boreholes will be advanced approximately 200 feet below ground surface, which should result in penetrations between approximately 110 and 170 into bedrock. The borings will be drilled by a truck mounted drill rig using air-rotary drilling techniques and steel drill casing in soils. Once bedrock is encountered, the drill casing will advanced a minimum of 5 feet into rock, or until the rock is stable and self-supporting. A permanent steel well casing will then be installed to the base of the borehole and grouted in place, using a non-shrink cement-bentonite grout (SikaGrout or equivelent) tremied in place. The drill casing will be removed during the grouting process and the grout will be allowed to cure overnight before bedrock drilling commences.

This method was selected to minimize the potential for the downward migration of DNAPL, if present, from the overburden to the bedrock aquifer. It should be noted that if DNAPL is present, these precautions may not be sufficient to stop its spread.

Bedrock drilling will be conducted using air-percussion methods and a four-inch outer diameter down-hole air hammer. Compressed air and potable water (if necessary) will be used for the removal of drill cuttings from the boreholes. No other drilling fluids will be used during advancement of air percussion borings. A 4-inch hole was selected to facilitate the installation of the Solinst "Waterloo Multi-level Sampling System." No rock cores will be recovered using this method; as such, an extensive in-situ bedrock testing program has been developed as presented below.

To address health and safety concerns, the drilling contractor will direct the air (drilling fluids) and drill cuttings to an area outside the breathing zone while the drill rig is in operation. Waste streams (air, fluids, and solids) will be separated to facilitate handling and disposal.

Soil samples will be collected at a minimum of 5-foot intervals beginning at ground surface with a 24-inch, steel split-spoon sampler in accordance with ASTM D1586-67. The primary objectives of the soil sampling program are to identify any potential aquitard materials above the bedrock surface and to evaluate the levels of contamination within the soils to minimize the potential for DNAPL migration into the bedrock. The split-spoon samples will be opened and inspected on site for visual and olfactory evidence of contamination. Samples will be field screened for volatile organic compounds (VOCs) with a Foxboro Model TVA 1000 combination flame and photoionization detector device (FID/PID). If field screening suggests that there is a potential for elevated volatile organic compound (VOC) contamination (i.e., PID readings above 100 parts per million – ppm), samples of suspect soils will be taken for laboratory analysis of VOC by EPA Method 8260B. Each sample will be collected in a 40-ml methanol preserved VOA vial and an 8-ounce jar with a Teflon-lined lid will be collected, labeled and place in an ice filled cooler and transported to the laboratory under chain-of-custody.

Task 3 – In-Situ Testing Program

Consistent with prior exploration efforts at the site, an in-situ physical and chemical testing program will then be implemented to assess subsurface conditions focusing on bedrock and groundwater chemistry. This program will include oriented borehole televiewer (sonic or optical depending on borehole water clarity), caliper logging, heat pulse flow meter logging injection, and extraction packer testing with point source groundwater sampling and analysis. The results of the in-situ testing program will be used to select appropriate monitoring well installation depths. Following the well installations, a comprehensive round of groundwater sampling and analysis will be conducted, including piezometric water level measurements for the new wells, and a select set of surrounding wells. The new physical and chemical data will then be incorporated with existing site information to develop an expanded conceptual model of groundwater flow, contaminated migration and the potential for DNAPL occurrence at the site.

The following section describes the equipment to be used in performing the suite of in situ borehole testing. These sections reflect GZA's anticipated order of completion; however, this sequence may be modified based on the availability of contractors and equipment.

Borehole Geophysical Analysis

Based on our prior experience completing explorations of this type, we propose the following suite of geophysical analysis: 1) borehole televiewer, either the optical borehole imaging system (BIPS) or the acoustic borehole televiewer (BHTV); 2) 3-arm caliper log; 3) heat pulse/heat tag vertical flow meter. We have used this combination successfully in conjunction with hydraulic conductivity testing to select well screen locations.

Discrete Groundwater Sampling and Screening

Based on the findings of the borehole geophysical analysis, we will select appropriate zones for the collection of point source groundwater samples. Target zones will consist of those with visible fracturing based on the borehole televiewer logging. Water samples will be collected from the 10-foot packer test interval within each borehole using a stainless-steel and Teflon submersible pump (Grundfos Rediflo 2 or equivalent) suspended between the packers. These samples will be recovered using the packer testing equipment and test zones prior to injecting fluid for the permeability testing. Prior to sample collection, the packed-off zone will be purged by removing a volume of water approximately equal to the volume of "standing water" within the zone. Note that zones with no yield or low yield may not be purged or sampled. Refer to Figure No. 1 of Appendix B for a generalized packer test assembly diagram.

Groundwater samples will be collected for field screening of total VOCs using a PID, temperature, pH, specific conductance, dissolved oxygen and oxidation/reduction potential. In addition, samples will be obtained for quick turnaround laboratory analysis consisting of EPA Method 8260B VOCs. If the selected zones do not yield sufficient water volume to allow the zone to be purged of at least one well volume within 1 hour, no analytical sample will be collected.

Analytical testing results from the boreholes will be used as a relative indicator of the degree of chemical contamination, if any, issuing from individual rock fracture within the borehole. This data will then be used in conjunction with the other in-situ testing data to select sampling zones for long term groundwater monitoring at these locations.

Bedrock Packer Permeability Testing

Bedrock packer permeability testing will be performed in 10 foot intervals starting below the steel casing. Test zones will coincide with those selected for Discrete Groundwater Sampling. A minimum of two additional zones will be tested in each borehole in areas with no apparent fracturing based on the borehole televiewer logging to confirm that areas with no visible fractures have no measurable permeability. The data will be used to calculate the bedrock hydraulic conductivity. Standard injection packer techniques will be used, a copy of the relevant procedures is attached as Appendix B along with a schematic diagram of a typical injection packer test assembly (see Figure No. 1 of Appendix B).

At the completion of testing individual boreholes, the packer unit and associated downhole piping will be disassembled and steam cleaned prior to the start of further packer testing.

Hydraulic conductivity will be estimated using methods provided in the Ground Water Manual[1]. The head loss due to friction will either be measured by means of pressure transducer located within the test zone and compensated for or, it will be calculated using pipe flow methods and accounted for in estimation of the test zone hydraulic conductivity.

Task 4 - Monitoring Well Installation Procedures

The geophysical data will be used in conjunction with the rock core samples, permeability test results, and chemical testing data to select the most appropriate depths for the placement of well screens/sampling zone within the bedrock boreholes. At the completion of the in-situ testing program, GZA will compile all of the results into schematic diagrams of each borehole. We will then select from 2 to 3 permanent groundwater sample collection zones from within each borehole. Our goal will be to select zones with the highest levels of observed contamination (if any), highest relative hydraulic conductivity, and largest degree of observable fractures, as well as zones that provided representative coverage of the depth of bedrock penetrated. Our recommended sampling zones and associated rational will be provided to RIDEM for review and approval in a Technical Memorandum.

After RIDEM approval, each borehole will receive a Solinst Waterloo Multilevel Groundwater Monitoring System. This system allows up to seven zones per 4-inch borehole using a double valve sampling pump and a vibrating wire pressure transducer for piezometric measurements; however, we do not anticipate the need to install more than three monitoring zones in the bedrock in any individual borehole. The Solinst system multi-level installations are proposed based on the high sample quality they provide employing a low flow purge and sampling process, their ease of installation, and relative ease of sample and piezometric data collection.

[1] Ground Water Manual, A water Resources Technical Publication, U.S. Department of the Interior Bureau of Reclamation, 1977.

All installations will be protected using a locking steel guard pipe or flush mounted road box, painted fluorescent orange for visibility and secured in place. Each wellhead will be surveyed with respect to the Rhode Island State Plane Coordinate System (1983 datum) and the National Geodetic vertical datum (1988 datum).

Task 5 - Groundwater Sampling and Analytical Methods

We propose to sample and analyze groundwater from the three proposed new locations (likely representing 6 to 9 discrete sampling zones) and select existing groundwater monitoring wells, as needed. Groundwater samples will be collected utilizing the permanently installed, nitrogen driven double valve pumps. Ultra-high purity nitrogen will be used for purging and sample collection.

A comprehensive round of water levels will be recorded at the Site prior to sampling the multi-level wells. Samples will be field screened for stabilization prior to sample collection using a Horiba Model U22 multi-meter. Electrical conductivity, pH, turbidity, dissolved oxygen, and temperature measurements will be recorded periodically until readings from two successive rounds have less than a 10 percent difference.

Groundwater samples will be analyzed by the following methods:

- TPH Fingerprint w/Organo-siloxanes (Massachusetts DEP Protocol)
- Volatile Organic Compounds (EPA Method 8260B)
- Semi-volatile organic compounds (EPA Method 8270),
- 13 Priority Pollutant Metals, Iron and Manganese (EPA Method 6010B/7470A).

The resultant data will be used to evaluate the Site's compliance status with respect to the GA Groundwater Objectives and the potential for the occurrence of DNAPL within bedrock at the Site.

Quality Assurance/Quality Control

To assess potential laboratory induced contamination, the project laboratory will prepare and analyze Trip Blanks and Method Blanks. Trip Blanks follow the sample containers, and subsequently the collected samples, through the monitoring process and can be used to assess the presence of non–site related contaminants that may be introduced from the environment during the sampling and transportation process (e.g., benzene, toluene, or xylene from automobile exhaust fumes). Method Blanks are used to ensure that no contamination is introduced to the samples during the preparation and analytical process (e.g., methylene chloride and acetone that are commonly used laboratory reagents).

There is no need to prepare equipment blanks, which represent rinsates from non-dedicated field sampling equipment, as all field sampling equipment used for the Solinst system is dedicated to the individual wells. One blind duplicate will be prepared. The blind duplicate provides an indication as to the reproducibility of the sampling and laboratory analytical procedures.

Task 6 – Bedrock Site Investigation Report

At the completion of the bedrock investigation, GZA will prepare a final *Bedrock Site Investigation Report* (SIR) that addresses applicable sections of the Remediation Regulations. This SIR will focus on the findings of the bedrock evaluation and will serve to supplement the existing June 2, 2005 SIR.

We look forward to your approval of this work plan. Please feel free to call Ed or Rick at (401) 421-4140 (or via email at *esummerly@gza.com* or *mponti@gza.com*) with any questions or comments.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Maurice A. Ponti, Jr. P.G.
for Senior Technical Specialist

Edward A. Summerly, P.G
Associate Principal

MAP/EAS:mac

Attachments: Figure E-1 – Proposed Exploration Location Plan
Appendix A – DNAPL Contingency Plan
Appendix B – Packer Testing Procedures

cc: Joan Taylor, RIDEM (2 copies)

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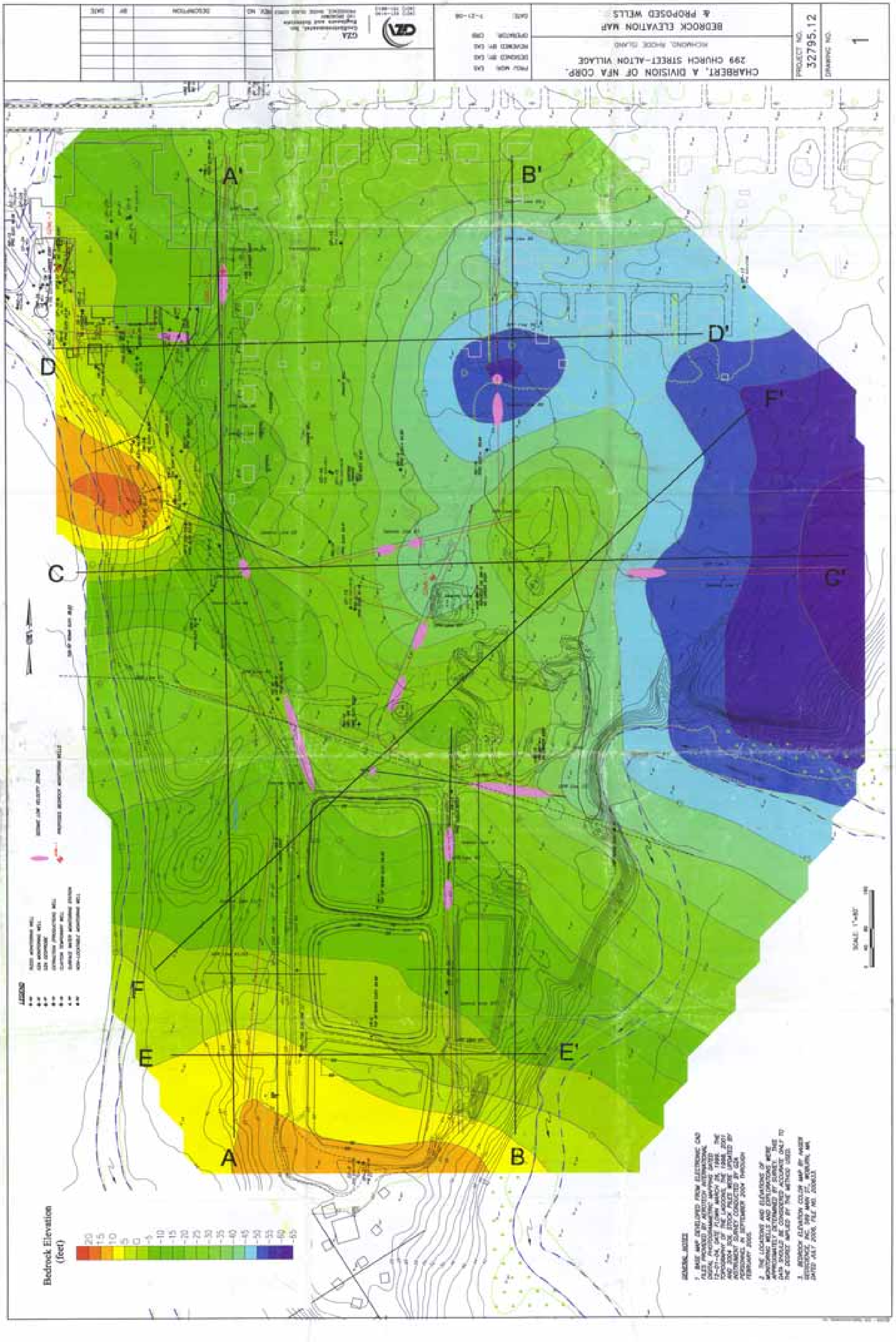
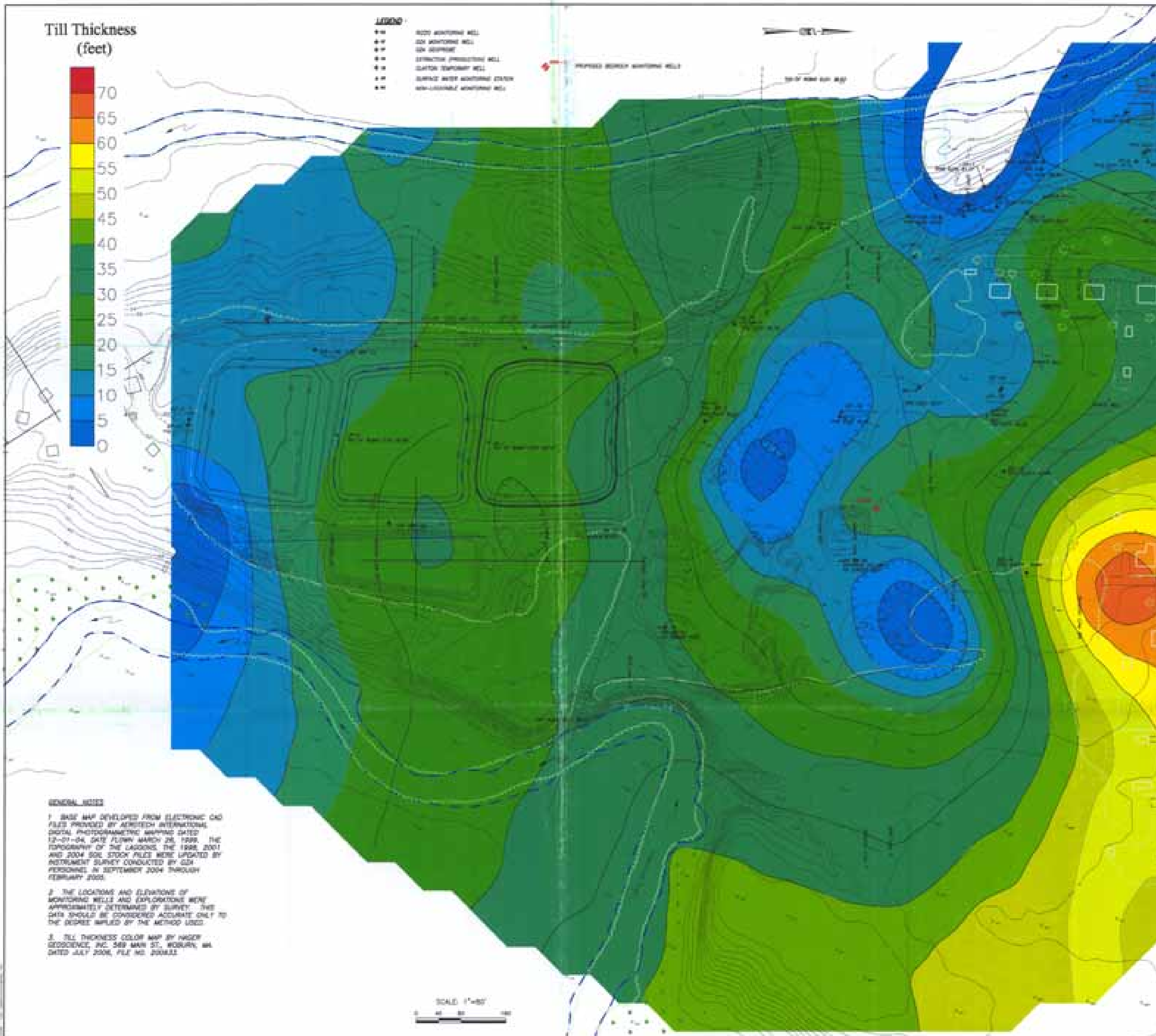
FIGURES



BEDROCK ELEVATION MAP
& PROPOSED WELLS
CHARBERT, A DIVISION OF NFA CORP.
299 CHURCH STREET-ALTON VILLAGE
RICHMOND, RHODE ISLAND
PROJECT NO. 32795.12
DRAWING NO. 1
GZA
A'
B'
D'
D
F'
C
C'
F
E
E'
A
B
Bedrock Elevation (feet)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65



REV. NO.	DESCRIPTION	BY	DATE

GZA GeoEnvironmental, Inc. Engineers and Scientists

PROJ. MGR.: EAS
DESIGNED BY: EAS
REVIEWED BY: EAS
OPERATOR: CRB
DATE: 7-21-06

CHARBERT, A DIVISION OF NFA CORP.
299 CHURCH STREET-ALTON VILLAGE
RICHMOND, RHODE ISLAND

TILL THICKNESS MAP & PROPOSED WELLS

PROJECT NO. 32795.12

DRAWING NO. 2