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LOCKHEED MARTIN

DATE: 31 October 2003

TO: Alan Humphrey, U.S. EPA/ERTC Work Assignment Manager

THROUGH: Gary Newhart, REAC Operations Section Leader
Scott Grossman, REAC Task Leader

FROM: Gordon Shields, REAC Geophysicist

SUBJECT: WATERBORNE GEOPHYSICAL SURVEYS AND SEDIMENT CORING, CENTERDALE MANOR SITE
WORK ASSIGNMENT R1A00270 – TRIP REPORT

INTRODUCTION

The objectives of the field activities described in this Trip Report were to map soft sediment thickness, and to obtain sediment cores for the purpose of investigating dioxin contamination in two ponds at the Centerdale Manor Site in North Providence, Rhode Island (RI). Lockheed Martin personnel were tasked by the United States Environmental Protection Agency (U.S. EPA) Environmental Response Team Center (ERTC) under the Response Engineering and Analytical Contract (REAC) to perform waterborne geophysical surveys and sediment coring. U.S. EPA Region 1 and U.S. Army Corps of Engineers (USACE) personnel were also involved with these field activities, and with aspects of a larger and ongoing action.

This Trip Report documents the waterborne geophysical surveys performed at the Centerdale Manor Site from 1 through 10 October 2002, and from 22 through 24 October 2002. Preliminary draft results were delivered to the ERTC Work Assignment Manager on 13 March 2003. Lithological descriptions from subsequent sediment coring on 6 through 9 May 2003, which was subcontracted and overseen by U.S. EPA ERTC and REAC personnel, have since been used to refine the geophysical interpretations.

BACKGROUND

The Centerdale Manor Site is located in North Providence, RI. The areas investigated were the high-water boundaries of the Allendale and Lymansville Ponds. The ponds have been created as impoundments on the Woonasquatucket River. The ponds are downstream and south of the Centerdale Manor Apartments (Figure 1).

Prior to 1936 the properties were occupied by Centerdale Worsted Mills, a woolens mill. Atlantic Chemical began operating on the properties in approximately 1943. Atlantic Chemical Company changed its name in 1953 to Metro-Atlantic, Inc. and continued to operate until the early 1970s. New England Container Company, Inc. operated an incinerator-based drum reconditioning facility on a portion of the site from 1952 until 1971. A major fire in 1972 destroyed most of the structures at the site. The Brook Village Apartments were constructed, and opened in 1977.

In November 1981, a Notice of Violation and Order was issued by the RI Department of Environmental Management (DEM) to the property owners for violations of the State Hazardous Waste Management Act. This order required that the property owners immediately identify all hazardous material on-site, and dispose of all hazardous wastes off-site. The response of the property owners to the order is unknown.

In February 1982, according to RI DEM records, approximately 400 drums were excavated from the site. About 30 drums had chemical residue that was analyzed. The empty drums were crushed and sent to a solid waste facility and at least eight drums containing hazardous material were manifested as hazardous waste. RI DEM required that soil samples be collected in the area of the building footprint prior to the construction of the Centerdale Manor Apartments. As a result of the sample analyses, approximately 6,000 cubic yards of soil were excavated and disposed of as non-hazardous solid waste. The Centerdale Manor Apartments were opened in 1983.

Dioxin was first identified in 1996 in fish collected from the Woonasquatucket River. Since that time, the U.S. EPA has documented elevated levels of several contaminants in soil, sediment, and surface water at the site. In addition to dioxin, the contaminants included polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals.

In January 1999 the U.S. EPA initiated a time-critical removal action that included sampling, the installation of fencing, and the installation of interim soil caps. The U.S. EPA began the initial remedial investigation activities at the site in August 1999, including a pilot tree-swallow study which was completed in spring 2000. Additional site evaluations for the ecological risk assessments and human fish consumption were expected to continue. In Autumn 2000 through Summer 2001, the U.S. EPA also conducted a source area investigation. This included the installation of groundwater monitoring wells, the collection of surface and downhole geophysical data, and the collection and analyses of soil and groundwater samples. A final report with recommended long-term response action was expected in late 2002.

The U.S. EPA started a non time-critical removal action in February 2000, by signing an Approval Memorandum concerning the performance of two Engineering Evaluation/Cost Analyses (EE/CAs). These two EE/CAs were later combined into one, resulting in an EE/CA report issued in September 2000 recommending restoration of the Allendale Dam and removal of dioxin-impacted soil and flood plain sediment from the residential and recreational-use properties. Following a 60-day public comment period, the EPA issued an action memorandum in January 2001, approving the removal action. The initial phase of the non time-critical removal action plan involved the reconstruction of the Allendale Dam. Rebuilding of the dam began in Summer 2001 and was completed in February 2002. The dam's spill-way was closed completely prior to the waterborne geophysical surveys to achieve the maximum water level.

METHODS

A 16-foot, flat-bottomed, wooden Garvey boat with a 8.0 horsepower outboard motor was used for the waterborne geophysical surveys (Figure 2). The low draft and wide beam of this boat were ideal for the surveys. Several geophysical methods were attempted initially. However, only one method appeared to be useful to map the sub-bottom sediments at this site, and was applied in all areas.

Global Positioning System (GPS) data were collected simultaneously with the geophysical data using a Trimble® Pro XRS receiver. The data were corrected in real-time for differential error. Post processing was also performed using the nearest available, public base-station data from Delhi, New York (180 miles from the site).

Sidescan sonar was attempted in two modes using SeaScan® PC equipment. The sidescan sonar data recorded the time and the amplitude of acoustic energy or "pings" that were transmitted into the water to both sides of the survey path, reflected off objects on the bottom of the pond, and received back at the towfish. The first mode used a 600 kilohertz (kHz) towfish in the standard side-looking orientation. This mode was not expected to penetrate the sub-bottom and was only attempted to image the pond floor. However, it appeared to not even penetrate suspended organic growth that was present in many places. The second mode used 300 kHz towfish with a single channel oriented straight down, but had the same negative result.

Sub-bottom profiling was attempted using a Datasonics® Chirp II system (Figure 2). The sub-bottom profiling data recorded time and amplitude of acoustic energy in a manner similar to the sidescan sonar equipment but with much greater power that was aimed directly beneath the towfish. The purpose was to penetrate soft sediments, to reflect off possible layering within, and/or to reflect off the underlying hard material. This employed a model DSP-662 transceiver and a DSP-661 processor. The system was capable of operating in two frequencies centered between 2 to 7 kHz and 10 to 20 kHz at a maximum power of 4 kilowatts (kW) per channel and featured a separate hydrophone. Various trigger rates, gains, and chirp rates were attempted. However, this system also did not appear to penetrate the suspended organic growth with either frequency. Another Datasonics transducer (model AT-471) that operated in a variable 2 to 7 kHz range was also tried but with similar, negative results. Gas bubbles within the organic growth, and/or within a layer of decaying material probably further attenuated the acoustic energy.

Ground penetrating radar (GPR) was the only geophysical method that appeared to be useful for mapping soft sediment thickness at this site (Figure 2). The GPR method used principles similar to sub-bottom profiling but with electromagnetic energy as a source. This responded to changes in electrical properties of the sediment, which were usually related to hardness and/or bulk density. It employed a GSSI® 200 megahertz (MHz) antennae deployed in a small rubber raft. A 250 nanosecond (ns) range was chosen and time varying gains were set at 10, 30, 50, 55, 60, and 65 decibels (dB). A vertical low pass filter was set at 1,000 MHz and a high pass filter was set at 125 MHz. The instrument recorded six traces per second. The usual boat speed was about 1.0 knots, which resulted in a sample interval of about eight traces per foot. A trace number was stored on the GPS console with current navigation data once per second.

Post processing of the GPR data was performed using GSSI's RADAN NT software. This consisted of a 10 times linear gain, followed by a vertical low pass filter of 200 MHz. The data were converted to bit-map (BMP) format, flipped horizontally if the survey direction was westerly, and then saved in Joint Photographic Experts Group® (JPG) format. The resultant horizontal scale was 1 trace per pixel, and the vertical scale was 250 ns per 1,024 pixels. Each image was imported into Geosoft® "Oasis montaj" data processing and mapping software to be displayed as a "pseudosection".

The pseudosections did not represent sub-bottom conditions directly, although they often appeared to graphically depict features of interest such as stratification (Figure 3). Objects to about five feet in diameter appeared as hyperbola shaped anomalies in the sections, and objects less than about two feet were probably not detected. To estimate vertical depths in the pseudosections, nomographs for water and sediments were generated based on assumed two-way travel times (TWT = 18 and 9 ns/foot, respectively). A simple, linear, horizontal distance normalization was applied to the pseudosections to account for different boat speeds. This resulted in some positional error if the boat speed varied one or more times within a transect. Where the boat was slow to reach cruising speed, or where the boat became stuck, a suspiciously uniform and apparent horizontal stratification was observed. However, the distance normalization was adequate to correlate general features from line to line.

The GPS coordinates posted along each pseudosection were used to reference all absolute positions, such as for sediment sampling and for mapping soft sediment thickness. Small features that occurred between UTM postings were located using an interpolation between both northing and easting coordinates. Due to the wide line spacing, the pseudosections indicated more detailed features than the resultant plan view contour maps of water depth, or sediment thickness data.

Stratigraphic interpretation of the GPR data was based mainly on the assumption that a strong sub-bottom reflector with few underlying reflectors indicated "hard sediments". However, even a thin layer of sediments with unfavorable electrical properties, could have reflected most of the transmitted signal energy and created the same impression while not being related to bulk density. Further, the total depth of signal penetration was limited by the cumulative attenuation of the water column plus a limited thickness of soft sediment. Generally, however, the signal penetration appeared to be good at this site.

The apparent bottom and sub-bottom reflectors in the GPR data were digitized using raw pseudosection pixel coordinates. These coordinates were transposed to three dimensional, world coordinates in a two step process. The first step used spreadsheet macros to correlate the horizontal pixel (trace) data with the GPS observations in Universal Trans Mercator (UTM) coordinates. The second step used the assumed vertical two-way travel times described above. These assumptions and the interpretation of the reflectors were confirmed in many places by collecting sediment thickness data using manual probing.

Sediment thickness data were collected using manual probing in a systematic manner to estimate the actual depth to soft sediments and depth to hard sediments. The probing apparatus consisted of two 10-foot sections of common half-inch steel pipe. The pipes were graduated with feet and inches using duct tape and a marking pen. One pipe was fitted with a three-inch diameter flange and lowered gently in order to measure the depth to soft sediments. The other pipe was fitted with a threaded cap, to prevent sediment from becoming trapped, and was pounded into the soft sediments with a sledge hammer until "refusal" was achieved. Although refusal was somewhat qualitative, this was expected to be a measure of the depth to hard sediments. The two pipes could also be fitted together with a threaded coupling for probing areas deeper than ten feet.

Another form of manual probing data were available from sediment coring locations (Appendix A). The locations were selected by U.S. EPA ERTC, REAC, and USACE personnel based on the GPR data, and the site geomorphology. A barge was positioned as close as possible to desired sample locations and anchored (Figure A-1). Real-time differential GPS positions were collected using a Trimble PRO XRS and the depth of water was measured using a lead line. A non-dedicated outer metal casing and tip were decontaminated, and a new dedicated acetate sleeve was inserted. Samples were collected using vibra-core technology to a depth of at least four feet, unless refusal occurred prior to reaching that depth. The depth to refusal, if encountered, was determined by subtracting the water depth from the total amount of vibra-core casing deployed (Table A-1).

The acetate sleeve was removed from the metal casing, and was capped on both ends. When removing the acetate sleeve, care was taken to minimize the disturbance to the sediment core. Each core was labeled with sample location, time and date of sampling, and an arrow pointing to the top of the sample. Six 2-inch hand cores were also collected from the northern portion of Lymansville pond. The core samples were stored in a cooler with wet ice until transferred to USACE personnel.

USACE personnel compiled lithological descriptions (Appendix A), and performed sampling for dioxin and radiological dating. The lithological descriptions of the cores were used for assessing the general stratigraphy of the ponds, and for refinement of the geophysical interpretations. However, large amounts of compression in the cores, which probably varied greatly with sediment type, rendered the absolute depth and thickness data ambiguous.

Acoustic depth sounding data were also collected during the geophysical surveys and the manual sediment probing. However, these data did not appear to be accurate, especially in shallow water. Further, the sounding sensor often became fouled with vegetation. The ability of this acoustic method to penetrate the suspended organic growth was in question, given the failure of both the sidescan sonar and sub-bottom profiling acoustic methods.

ACTIVITIES AND OBSERVATIONS

Allendale Pond

On Allendale Pond, about 2.1 linear miles of waterborne GPR data were chosen to provide the most even coverage (Figure 4). In a few places the coverage was sparse due to obstacles and difficulty navigating. The survey area covered was about 12.5 acres. This area was considerably larger than the low-water level area indicated by aerial photography. At low-water level, the main flow channel was evident down past the middle of the survey area. Several adjacent areas of either erosion or migrating point bars were also evident.

The maximum water depth measured manually was 8.4 feet at the southeastern part of Allendale Pond (Figure 4). The thickest soft sediment probed was 6.8 feet. Thick soft sediments were probed in many areas of the pond. A hard bottom of gravel and coarse sand with little or no soft sediments appeared to characterize the flow channels. Apparent bedrock was observed at the middle-eastern side of the pond.

Thirty pseudosections were generated for the Allendale Pond and compiled into four stacked composites (Figures 5, 6, 7, and 8). The water depths indicated by the GPR data were in general agreement with the manual measurements. Some discrepancy was expected due to differences between the two positions. However, many of the manual depths measured were about 0.5 ft deeper than the GPR indicated depths. This indicated that the "first break" in the GPR data, or the 0 depth point, may have been chosen at the wrong one of two high amplitude peaks that were clearly visible in all the data. A less likely explanation may be that the assumption of a standard two-way travel time for fresh water was incorrect. However, the depth discrepancy would only be important if absolute values need to be considered.

The soft sediment thickness indicated by the GPR data was also in general agreement with the measurements collected from manual probing. The soft sediment appeared to be represented in the GPR data by numerous, coherent reflectors of various orientations. This appeared to be consistent with the depositional environments expected at this site. A fairly simple two layer sequence was apparent in most of the GPR data. The second layer was interpreted to be relatively hard sediment or possible bedrock. Occasionally some deep layering was apparent beneath the top of the hard sediment layer. Semi-soft sediment was interpreted to occur in some places that probably contained sand or gravel. This appeared to result in noisy patterns in the first or second layer GPR data. Rock appeared to result in very quiet GPR data, beyond an initial strong reflector.

In some places the soft sediment – hard sediment boundary appeared to be clear and logical. In others, however, the boundary faded (as may be expected with a facies change), or the boundary had to be chosen from two or more reflective horizons. There were also places where the boundary appeared to be quite hummocky and difficult to follow.

Plan view maps were compiled using interpreted water depth (Figure 9) and soft sediment thickness (Figure 10) at selected positions from each section. The water depth contours indicated one main flow channel that appeared to cut into the bottom on the western side of the pond. In the southern parts of the pond, the main flow channel appeared to cut across to the eastern side. It then curved around towards the dam, in a clockwise vortex-like pattern. Smaller tributary or abandoned flow channel scars were also detected. The apparent soft sediment thickness contours indicated several areas where the greatest accumulations may have occurred. Generally, thick sediments appeared to occur away from the present flow channel, where the water depths were shallow. However, thick sediments also appear to be coincident with deep water in southern parts of the pond.

Lymansville Pond

On Lymansville Pond, about 2.8 linear miles of GPR data were processed (Figure 11). The survey area covered was about 14.8 acres. Navigational GPS data were lost occasionally during some lines, and for a few lines in the northern part of the pond were completely unusable. In these instances a linear interpolation of the vessel position was performed. The dam on Lymansville Pond has probably maintained a constant water level over the years. The shoreline apparent in the aerial photograph of 1995 represents the approximate navigable boundaries of the pond during the survey of 2002.

The maximum water depth measured manually was 9.0 feet at the southeastern part of Lymansville Pond (Figure 11). The thickest soft sediment probed was 7.1 feet. Refusal was not achieved at a few locations in the southeastern part of the pond because only the 10-foot length of pipe was used and deep water was encountered. No outcrop was observed but bedrock was probably close to surface in the central part of the pond, particularly near the middle of Line 217.

Forty one pseudosections were generated for the Lymansville Pond and compiled into four stacked composites (Figures 12, 13, 14 and 15). Two other pseudosections were plotted separately from survey lines that followed the main river channel north of the survey area (Figures 16 and 17), and a small tributary creek to the northeast (Figure 18).

In contrast to the Allendale Pond, the Lymansville Pond appeared to have an additional layer of a sludge-like material in most areas. This was first evident in discrepancies between the geophysical water depth data (obtained from acoustic and GPR methods), and the manual water depth data (obtained from probing and sampling). The lithological descriptions of the sludge found in the top part of many of the core samples often included clay and organic material, with a hydrocarbon odor. The manual water depth data was obtained using methods that probably easily sank through the sludge layer. The sludge layer appeared to have a GPR two-way travel time similar to that of the soft sediment and therefore that side of the nomograph was used when plotting that portion of the manual water depth data on the pseudosections. The sludge layer was considered to be part of the total soft sediment thickness. However, its individual thickness could be estimated from the pseudosections if it was of interest for separate removal or treatment purposes.

The interpretation of soft sediment, semi-soft sediment, hard sediment or possible bedrock was similar to that at the Allendale Pond. The soft sediment thickness indicated by the GPR data was usually the same as from the manual probing. However, the additional layer at the Lymansville pond posed additional interpretation problems, and there appeared to be more deep reflectors than at the Allendale Pond.

Plan view maps were compiled using interpreted water depth data (Figure 19) and soft sediment thickness data (Figure 20) from selected positions along each pseudosection. Shallow water in the northern part of the pond corresponded with thick sediments. A deep flow channel was apparent along the eastern side of Lymansville Pond. This corresponded to thin sediments in the north and thick sediments in the south. Erosion had probably taken place in the north, and subsequent deposition was possible in the south due to a widening in the pond. A very prominent ridge of sand and gravel divided the southernmost part of the pond. The soft sediments were thin at this location and thickened to the east and west in an apparent on-lapping fashion.

CONCLUSIONS AND RECOMMENDATIONS

Acoustic methods such as sidescan sonar and sub-bottom profiling did not appear to yield useful information for mapping sub-bottom sediments at this site. The presence of dense organic growth and/or a thick layer of decaying material, which was also filled with gas bubbles, probably greatly attenuated the transmitted signal. Acoustic methods with more powerful sources, such as boomers or sparkers as used in seismic exploration, may penetrate this difficult sub-bottom environment.

The GPR method appeared to achieve about 10 to 15 feet of soft sediment penetration in most areas and provided numerous detailed pseudosections across the ponds. However, the interpretation of the GPR pseudosections was not simple and some ambiguity can be expected. Often there appeared to be numerous reflectors that could equally represent the true "hard sediment" surface.

Several different sources of secondary depth data were considered during the interpretation of the GPR pseudosections. The acoustic depth sounder data appeared to be consistently shallower than the manual probing depth data and the core sampling depth data, possibly because it was responding to the top of the organic growth. In the lower pond, however, the acoustic depth sounder data may have provided the only secondary estimate of depth to top of the pervasive sludge-like layer. The depths provided from the core sampling activities were probably biased by compression of soft, incompetent layers.

The GPR pseudosections appeared to indicate several different depositional environments that provided numerous targets for sediment coring. These included migrating point bars (and associated scour channels), basin-like pools, and small isolated pockets. The apparent layering could have significant chronostratigraphic, and geomorphological significance. The GPR data may be useful to estimate volumes of material for excavation if the contamination appears to be restricted to certain horizons, and/or areas.

The resultant bathymetric and soft sediment thickness isopach maps indicated features that crossed several transects. Features such as long paleochannels and large accumulations of sediment provided general sediment coring targets. Possible areas of unfavorable ground or hazards to coring, such as hard sand or rock, were also avoided using the GPR data.

FUTURE ACTIVITIES

No future geophysical or sampling activities are planned for this site.

cc: Central File - WA # R1A00270 (w/attachment)
Electronic File - I:/Archive/REAC3/270/D/TR/073103
REAC Program Manager (cover page only)

Figures

FIGURES
Centerdale Manor Site
North Providence, Rhode Island
October 2003

Note: Figures 5 through 8 and Figures 12 through 15 have been plotted "fit-to-page" for this main volume of the Trip Report, and therefore are not to scale. These figures are available on E-size sheets in a separate volume, by request.

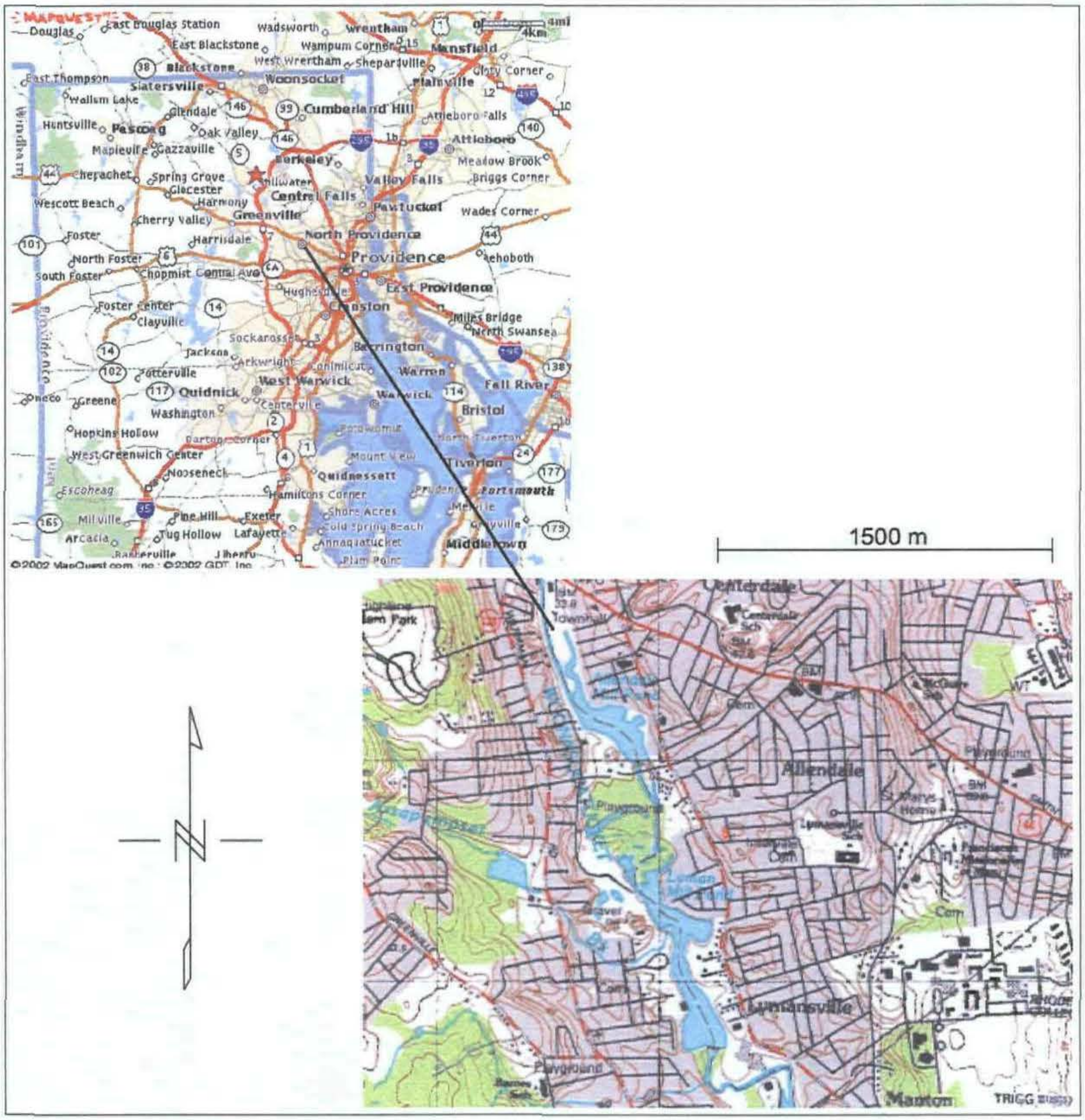

Figure 1. Location

Centerdale Manor Site

North Providence, Rhode Island

October 2003

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200 MHz Ground Penetrating Radar Antennae

Global Positioning System Antenna

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Figure 2. Waterborne Ground Penetrating Radar

Centerdale Manor Site

North Providence, Rhode Island

October 2003

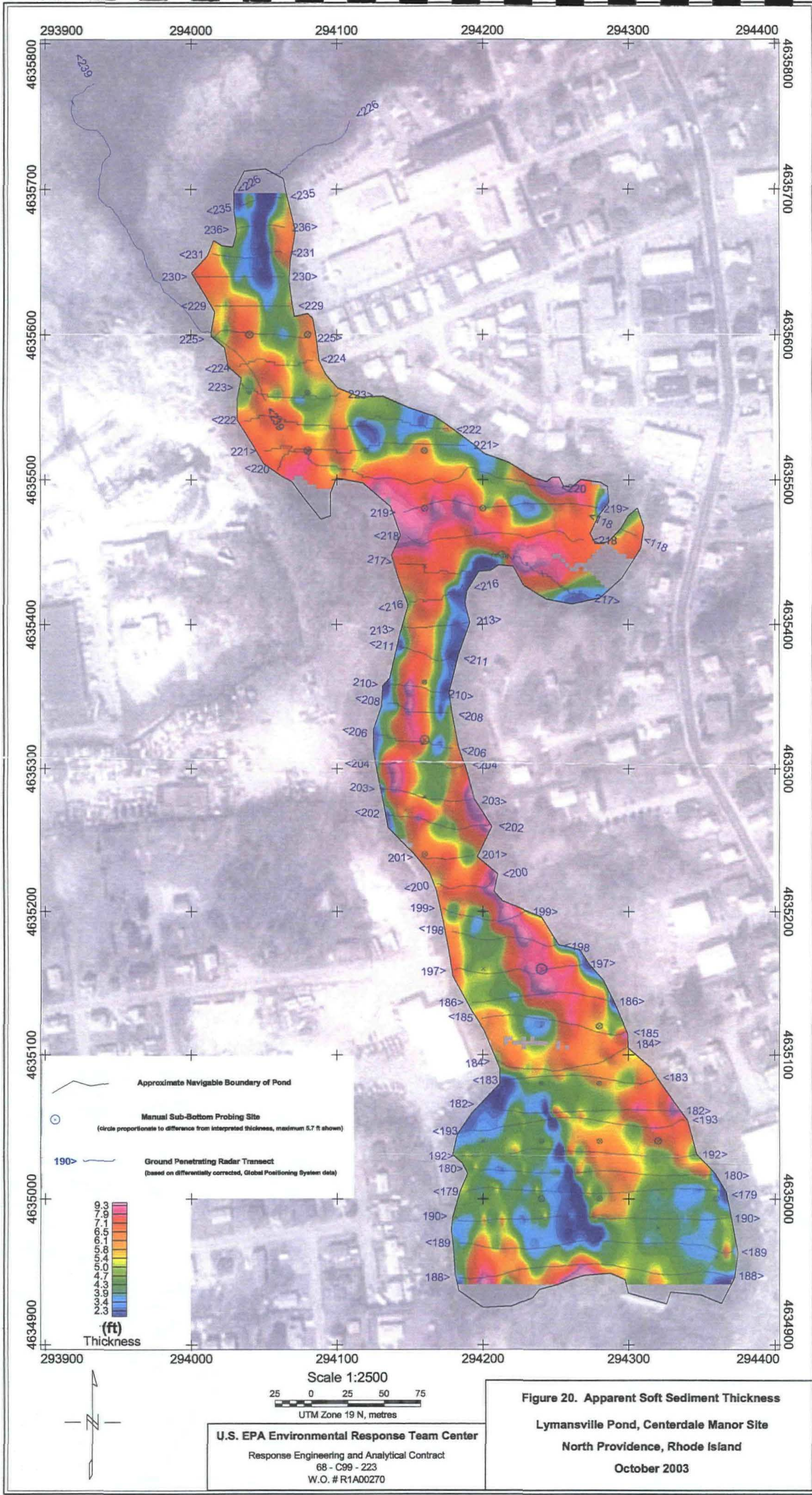

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Figure 20. Apparent Soft Sediment Thickness

Lymansville Pond, Centerdale Manor Site

North Providence, Rhode Island

October 2003

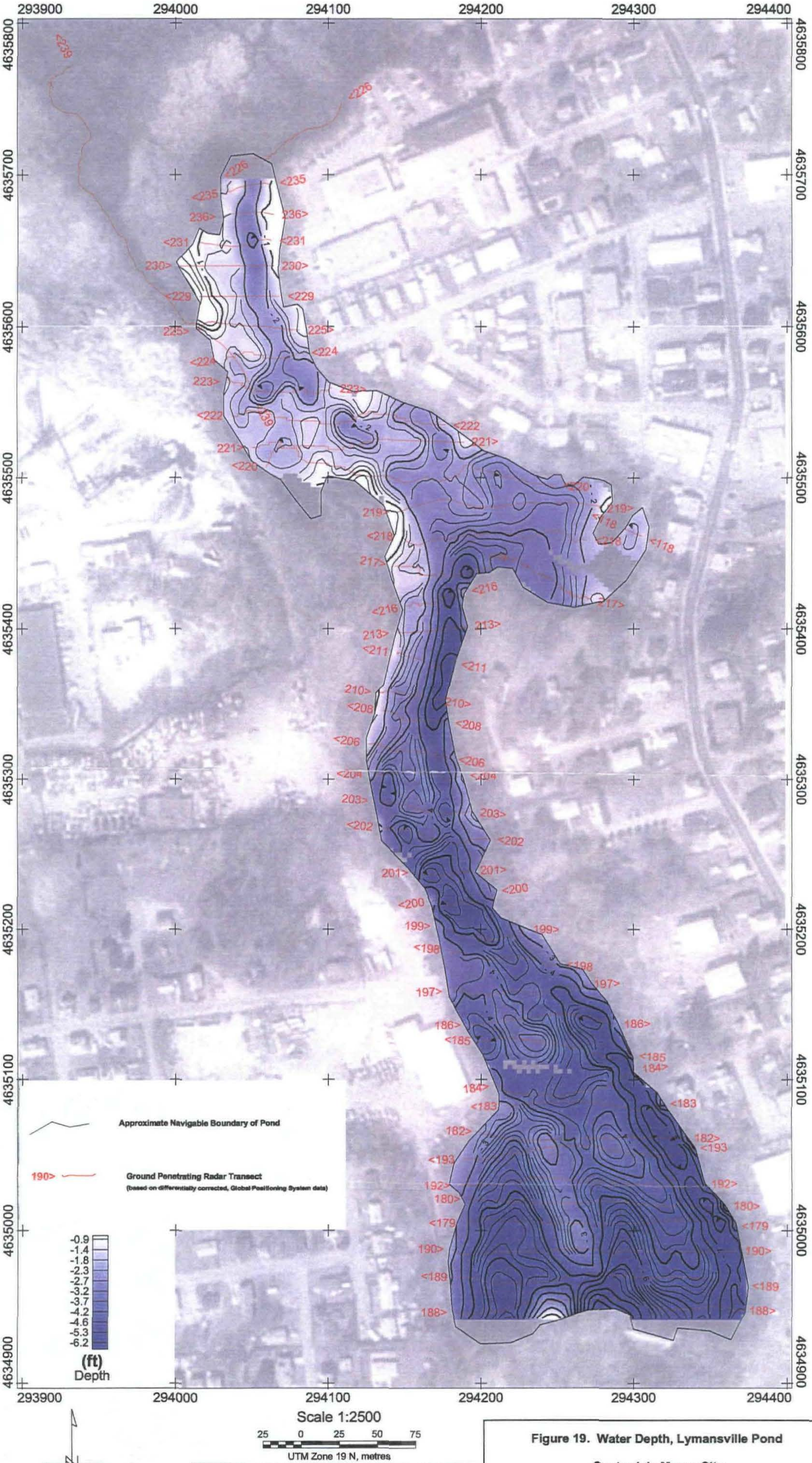

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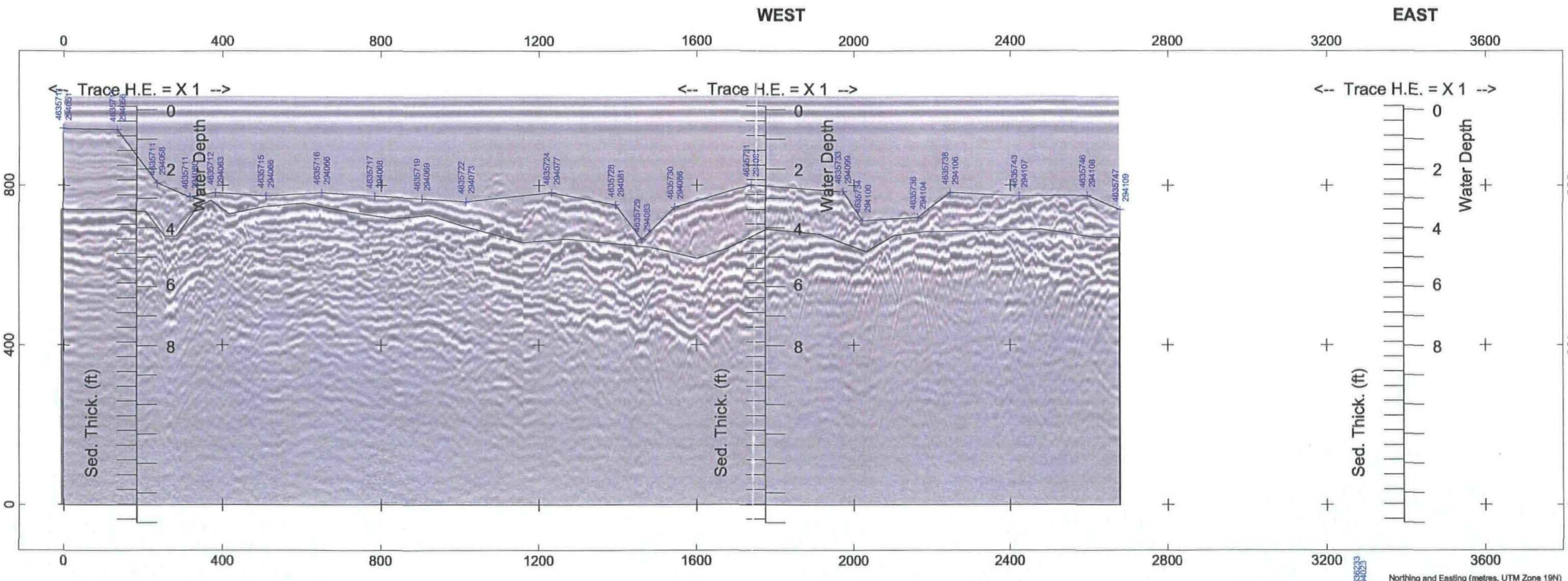
Figure 19. Water Depth, Lymansville Pond

Centerdale Manor Site

North Providence, Rhode Island

October 2003



Vertical Nomograph Based On Estimated TWTs:

18 ns / ft (Water) and 9 ns / ft (Soft Sediment)

Vertical Axis Marked as 1024 Pixels (inverted) over a 250 ns Range

Response Amplitude Gained at 10, 30, 50, 55, 60, and 65 dB

Interpreted Bottom Reflector

Interpreted Sub-Bottom Reflector

Sub-Bottom from Nearby Probing

Horizontal Scale by Trace, Exageration as Marked

500 0 500 1000 1500

West-course Lines Flipped on Vertical Axis

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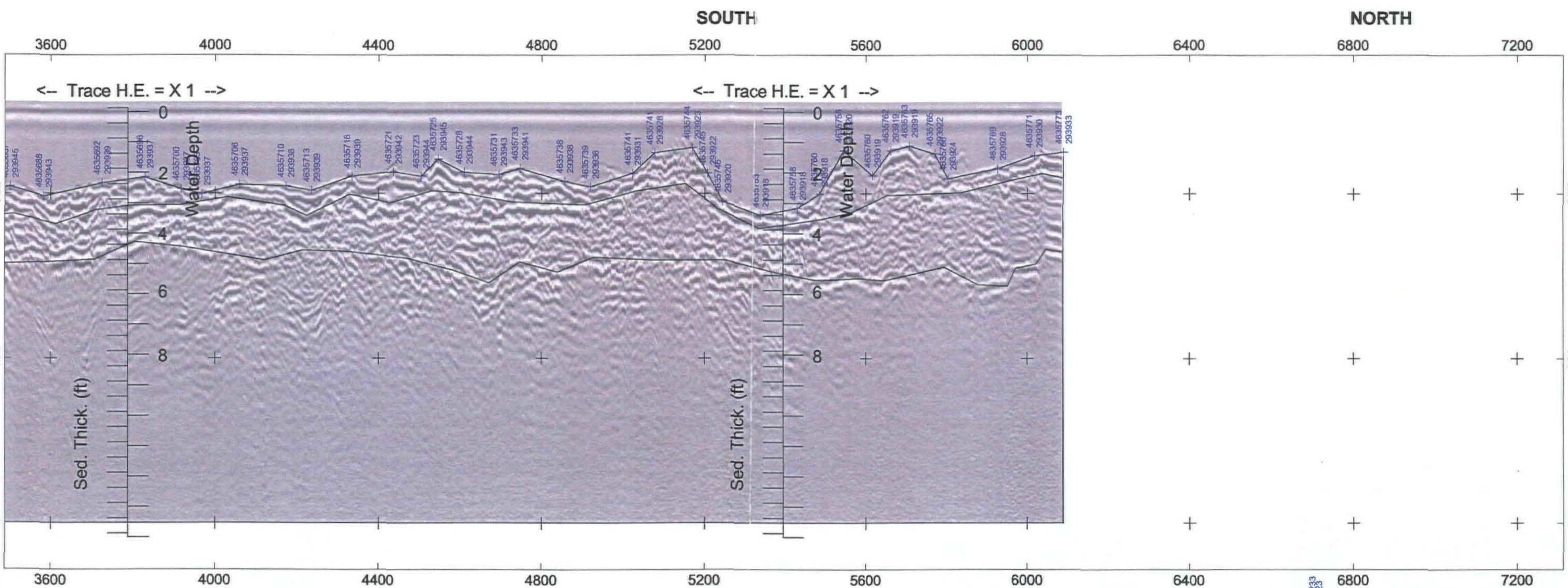
Figure 18. Line 226, GPR Pseudosection

Lymansville Pond, Centerdale Manor Site

North Providence, Rhode Island

October 2003



Vertical Nomograph Based On Estimated TWTs:

18 ns / ft (Water) and 9 ns / ft (Soft Sediment)

Vertical Axis Marked as 1024 Pixels (inverted) over a 250 ns Range

Response Amplitude Gained at 10, 30, 50, 55, 60, and 65 dB

Interpreted Bottom Reflector

Interpreted Sub-Bottom Reflector

Sub-Bottom from Nearby Probing

Horizontal Scale by Trace, Exageration as Marked

500 0 500 1000 1500

West-course Lines Flipped on Vertical Axis

Northing and Easting (metres, UTM Zone 19N)

Estimated Soft Sediment Thickness (feet)

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Figure 17. Line 239B, GPR Pseudosection

Lymansville Pond, Centerdale Manor Site

North Providence, Rhode Island

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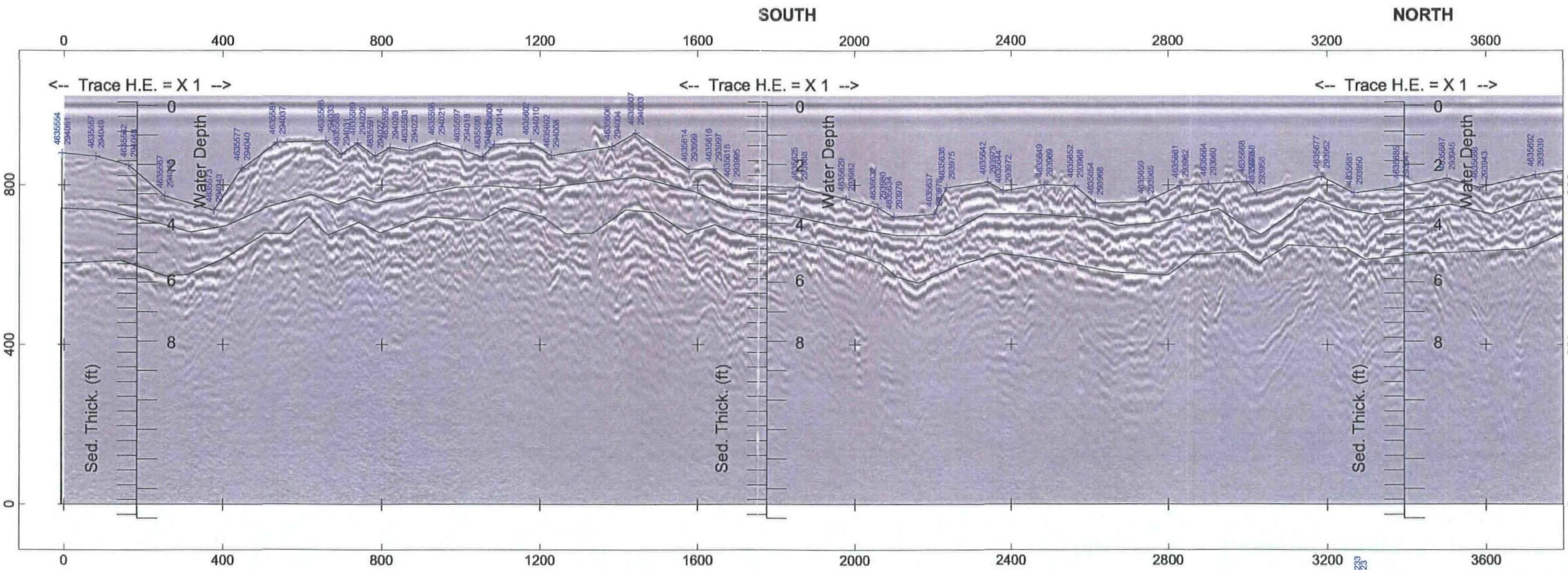

Northing and Easting (metres, UTM Zone 19N)

Estimated Soft Sediment Thickness (feet)

Vertical Nomograph Based On Estimated TWTs:

18 ns / ft (Water) and 9 ns / ft (Soft Sediment)

Vertical Axis Marked as 1024 Pixels (inverted) over a 250 ns Range

Response Amplitude Gained at 10, 30, 50, 55, 60, and 65 dB

Interpreted Bottom Reflector

Interpreted Sub-Bottom Reflector

Sub-Bottom from Nearby Probing

Horizontal Scale by Trace, Exageration as Marked

500 0 500 1000 1500

West-course Lines Flipped on Vertical Axis

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Figure 16. Line 239A, GPR Pseudosection

Lymansville Pond, Centerdale Manor Site

North Providence, Rhode Island

October 2003

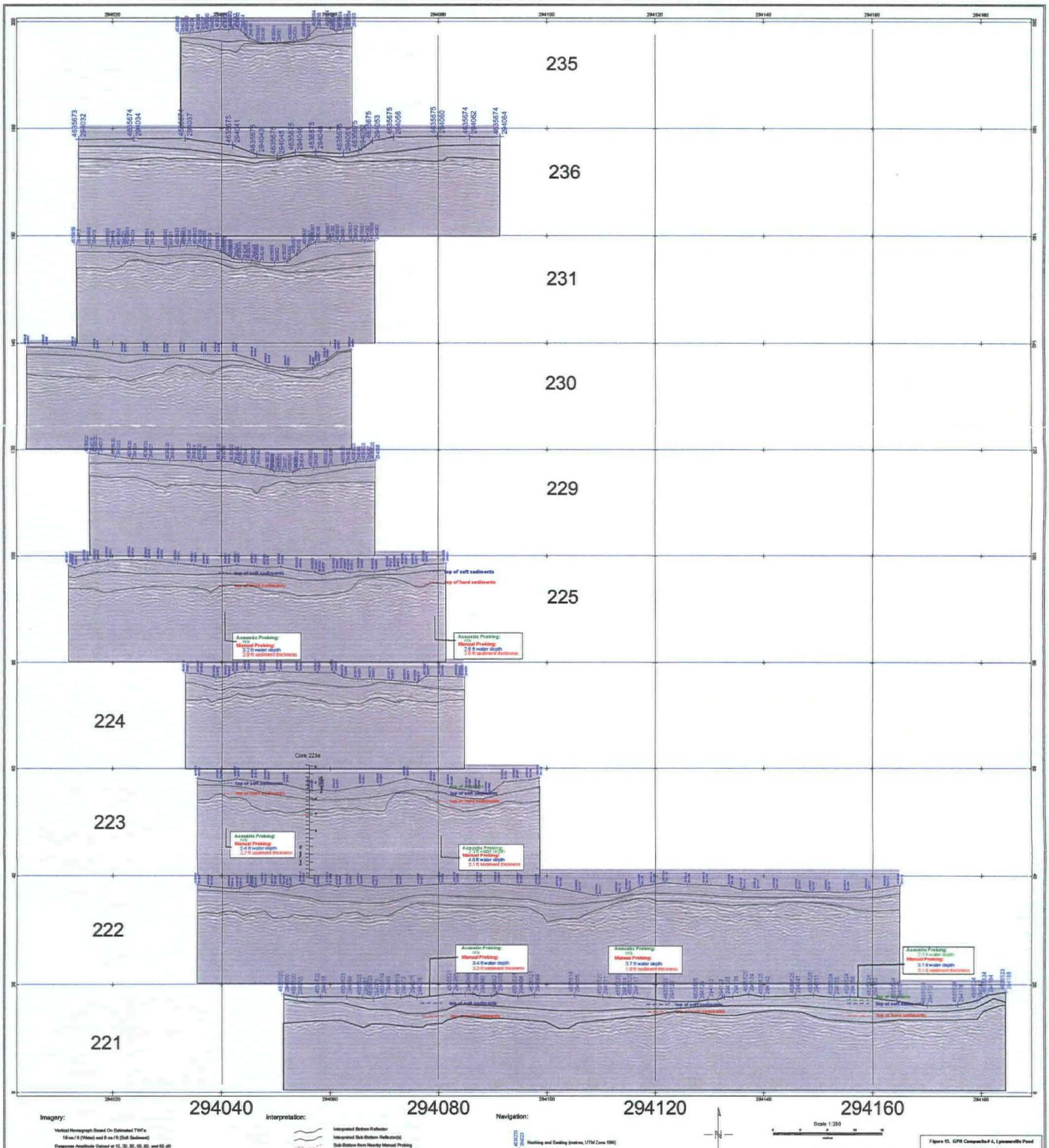
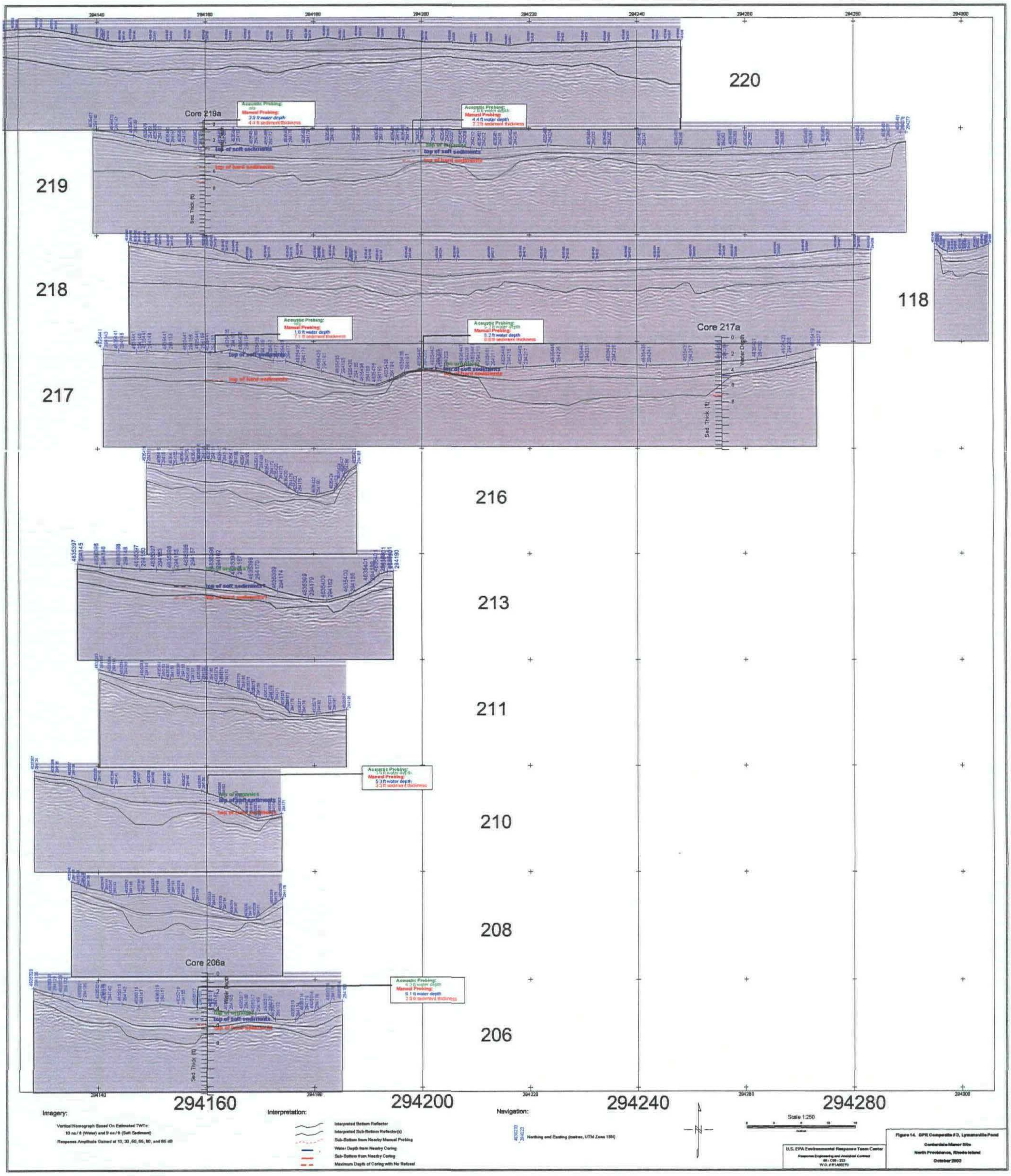
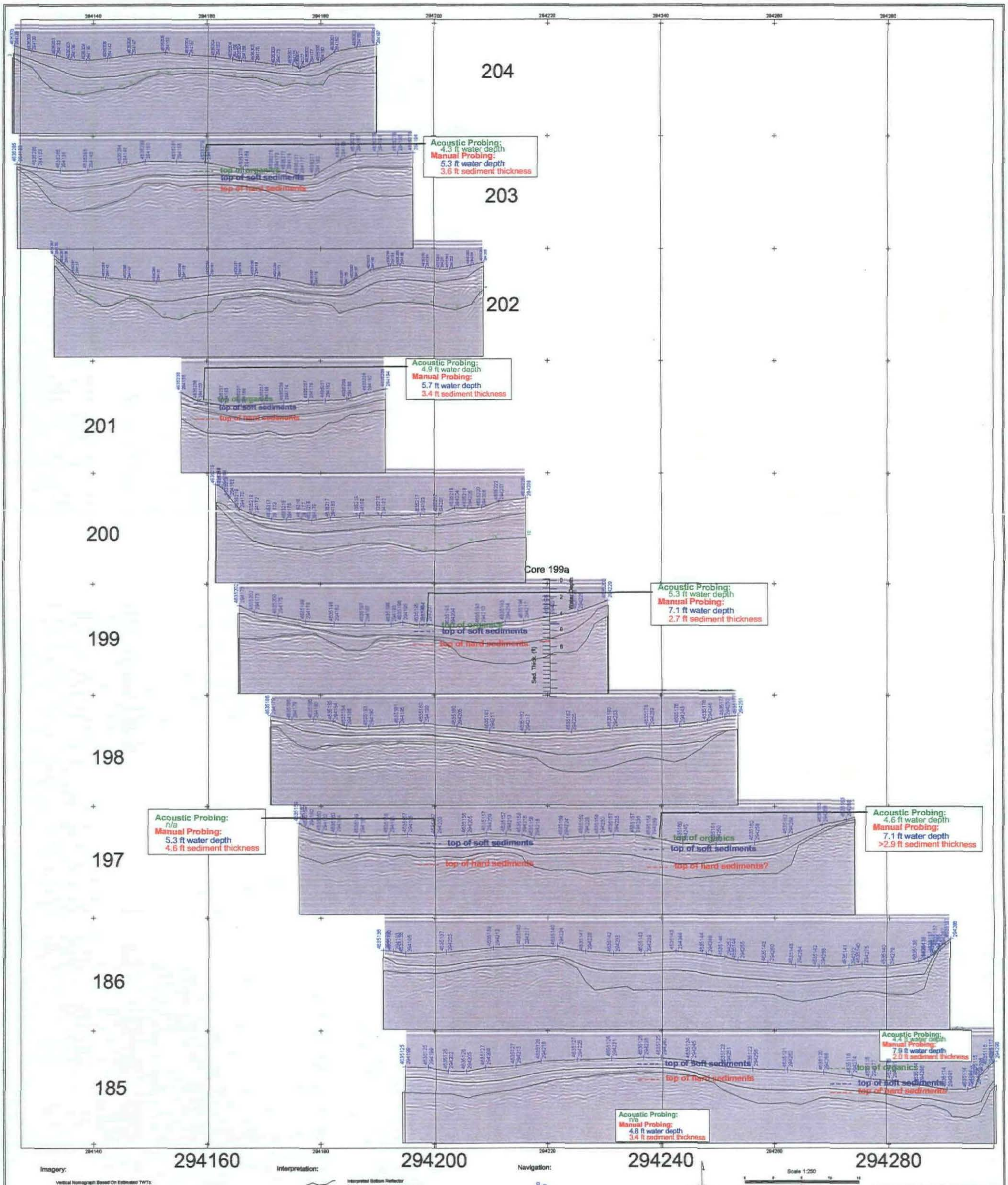
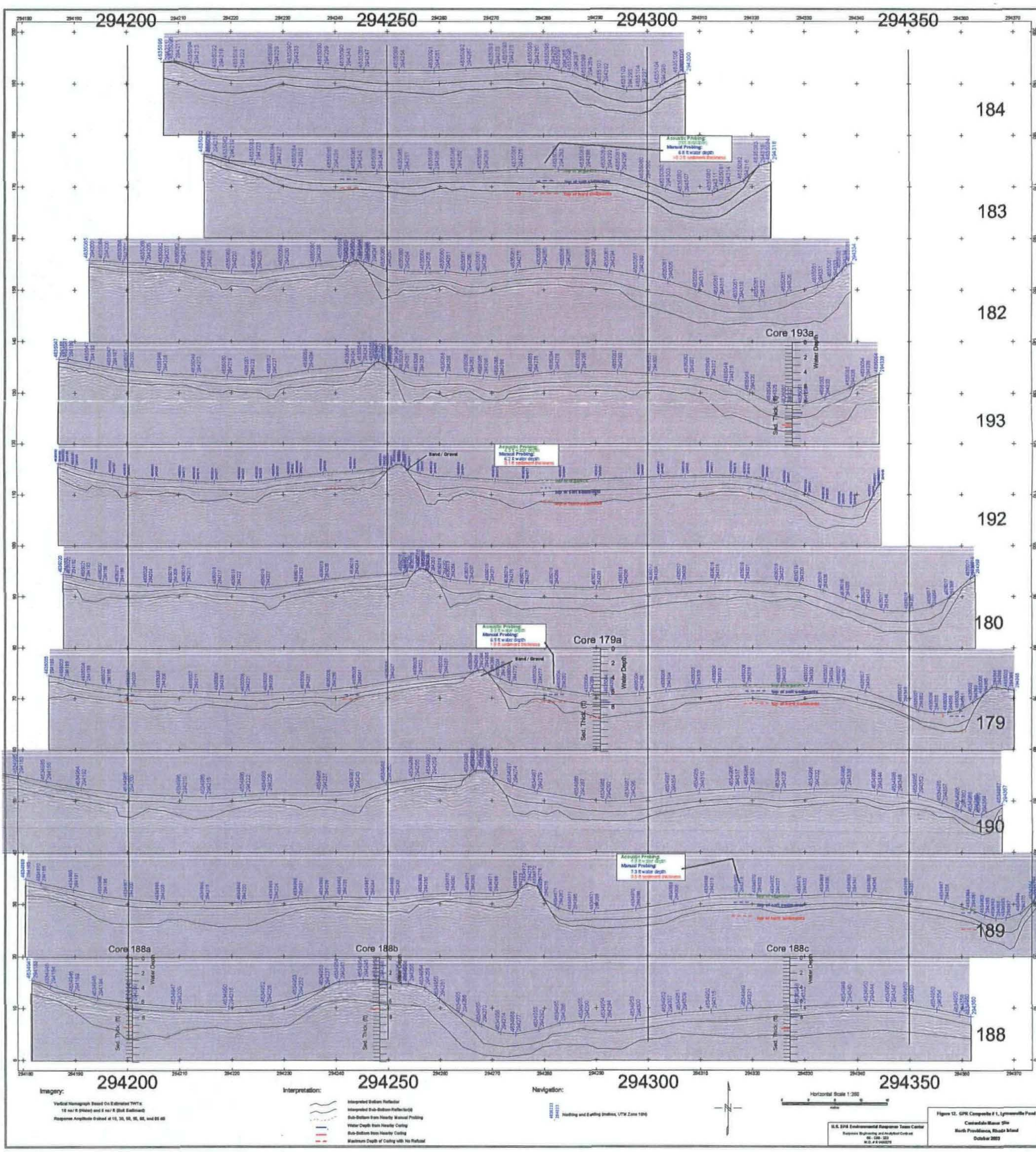


Figure 15. GPR Composite # 4, Lymansville Pond
Centerdale Manor Site
North Providence, Rhode Island
October 2003


220
Core 219a
219
218
118
Core 217a
217
216
213
211
210
208
Core 206a
206
top of soft sediments
top of hard sediments
Sed. Thick (ft)
294160
294200
294240
294280
Imagery:
Interpretation:
Navigation:
Scale 1:250
U.S. EPA Environmental Response Team Center
Figure 14. GPR Composite #3, Lymansville Pond
Centerdale Manor Site
North Providence, Rhode Island


204
Acoustic Probing:
4.3 ft water depth
Manual Probing:
5.3 ft water depth
3.6 ft sediment thickness
top of organics
top of soft sediments
top of hard sediments
203
202
Acoustic Probing:
4.9 ft water depth
Manual Probing:
5.7 ft water depth
3.4 ft sediment thickness
top of organics
top of soft sediments
top of hard sediments
201
200
Core 199a
Acoustic Probing:
5.3 ft water depth
Manual Probing:
7.1 ft water depth
2.7 ft sediment thickness
top of organics
top of soft sediments
top of hard sediments
199
198
Acoustic Probing:
n/a
Manual Probing:
5.3 ft water depth
4.6 ft sediment thickness
197
top of soft sediments
top of hard sediments
top of organics
top of soft sediments
top of hard sediments?
Acoustic Probing:
4.6 ft water depth
Manual Probing:
7.1 ft water depth
>2.9 ft sediment thickness
186
Acoustic Probing:
4.4 ft water depth
Manual Probing:
7.9 ft water depth
2.0 ft sediment thickness
top of soft sediments
top of hard sediments
top of organics
top of soft sediments
top of hard sediments
185
Acoustic Probing:
n/a
Manual Probing:
4.8 ft water depth
3.4 ft sediment thickness
294160
294200
294240
294280
Imagery:
Interpretation:
Interpreted Bottom Reflector
Interpreted Sub-Bottom Reflector(s)
Sub-Bottom from Nearby Manual Probing
Water Depth from Nearby Coring
Navigation:
Scale 1:250



294200
294250
294300
294350
184
183
182
Core 193a
193
192
180
Core 179a
179
190
189
Core 188a
Core 188b
Core 188c
188
Sand / Gravel
Acoustic Probing:
Manual Probing:
Water Depth
Sed. Thick. (ft)
Imagery:
Interpretation:
Navigation:
Interpreted Bottom Reflector
Water Depth from Nearby Coring
Sub-Bottom from Nearby Coring
Maximum Depth of Coring with No Refusal
Horizontal Scale 1:250
U.S. EPA Environmental Response Team Center
North Providence, Rhode Island

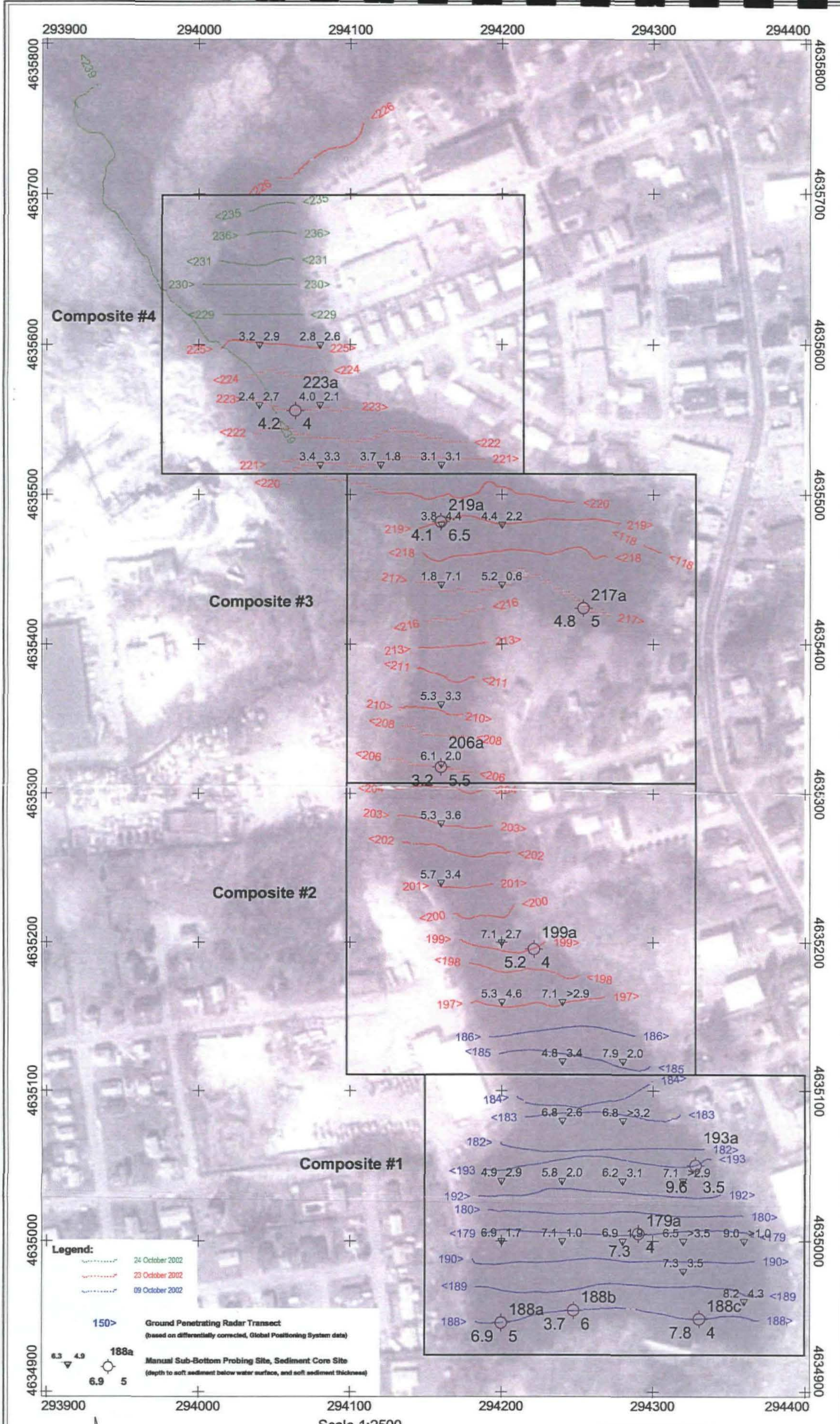


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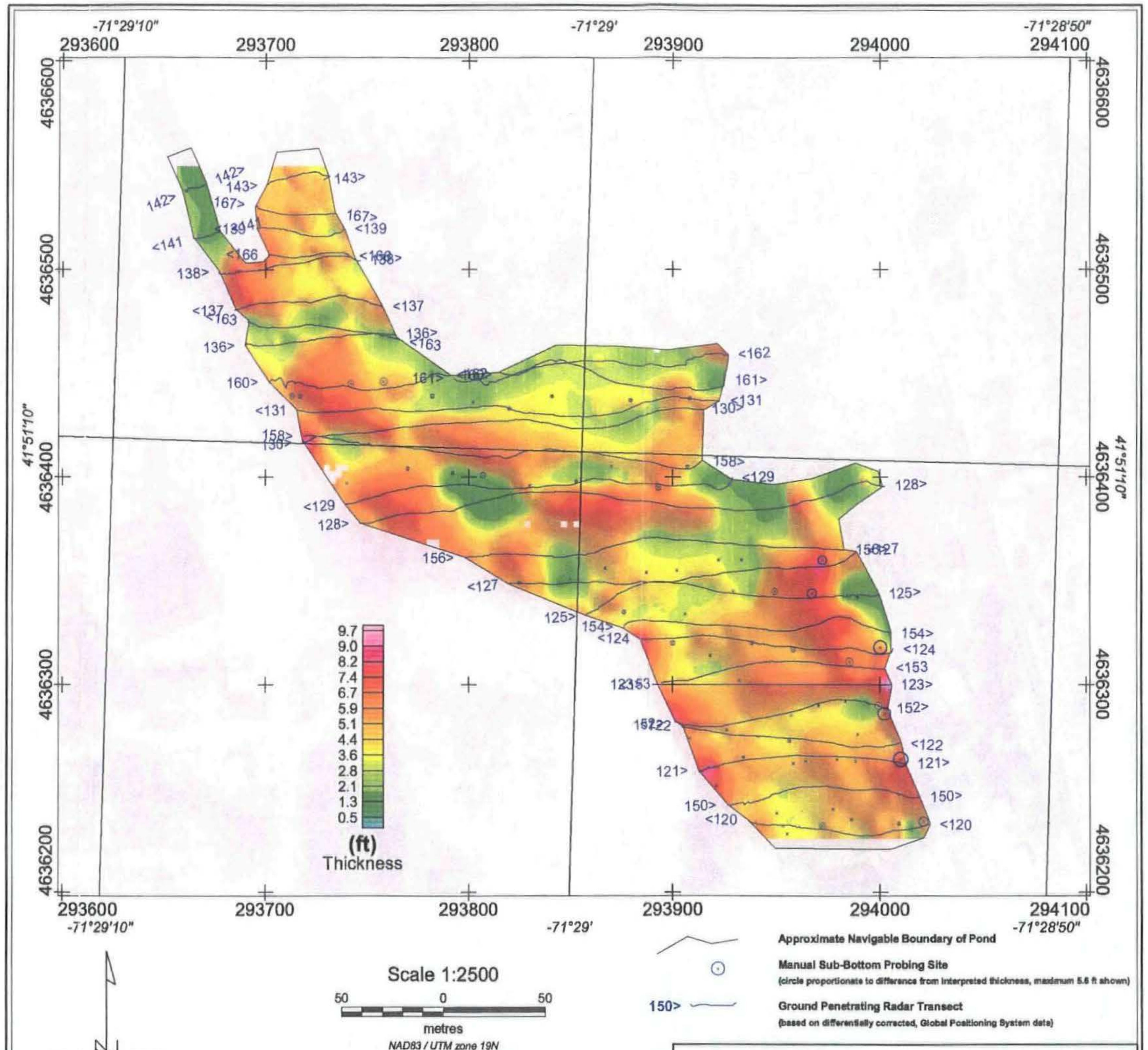
Figure 11. Lymansville Pond Index

Centerdale Manor Site

North Providence, Rhode Island

October 2003



Aerial Photography, 29 Mar 1995

U.S. EPA Environmental Response Team Center

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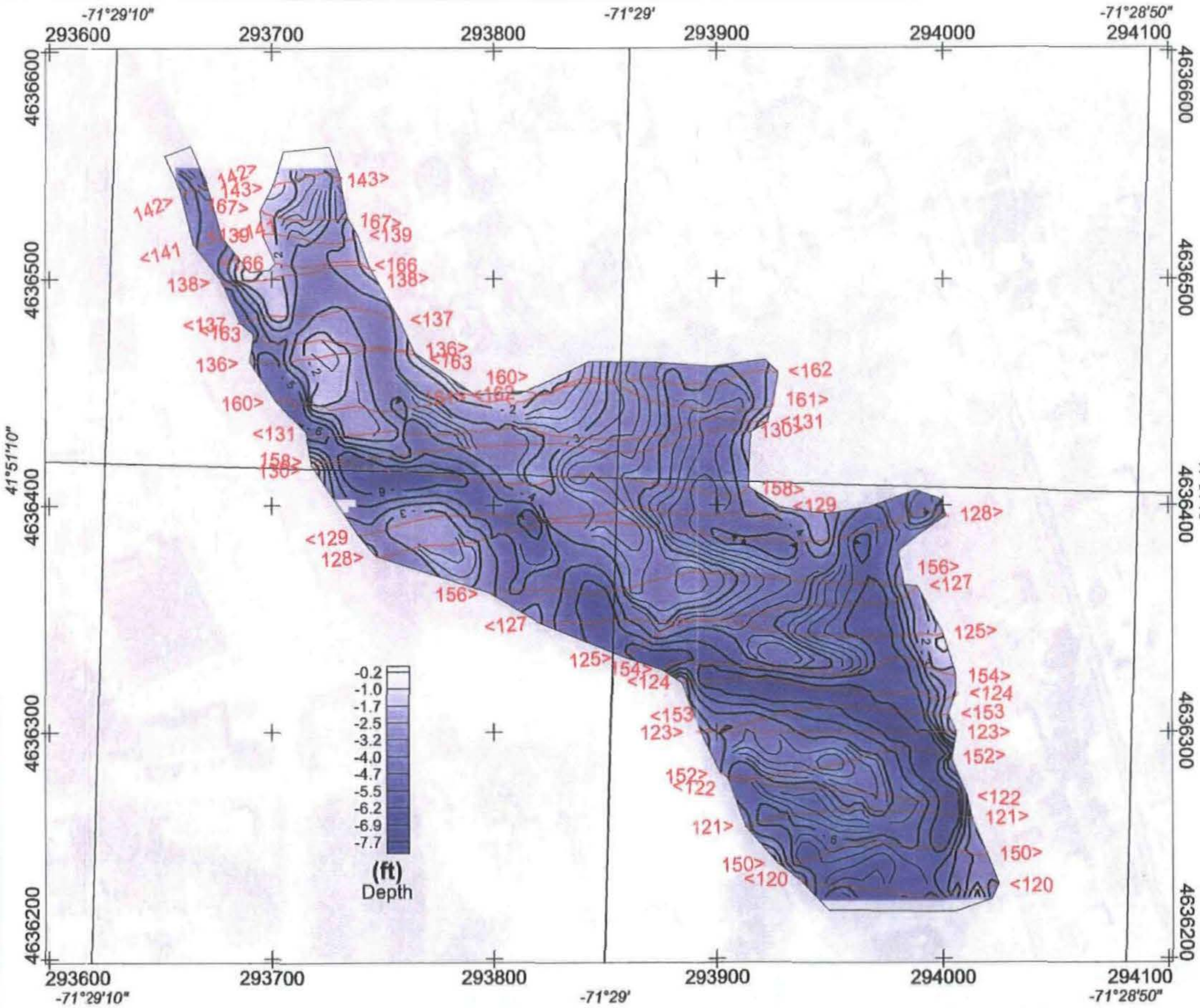
Figure 10. Apparent Soft Sediment Thickness
Allendale Pond, Centerdale Manor Site
North Providence, Rhode Island
October 2003



150> Ground Penetrating Radar Transect (based on differentially corrected, GPS data)

Approximate Navigable Boundary of Pond

Scale 1:2500

50 0 50

metres

NAD83 / UTM zone 19N

Aerial Photography, 29 Mar 1995

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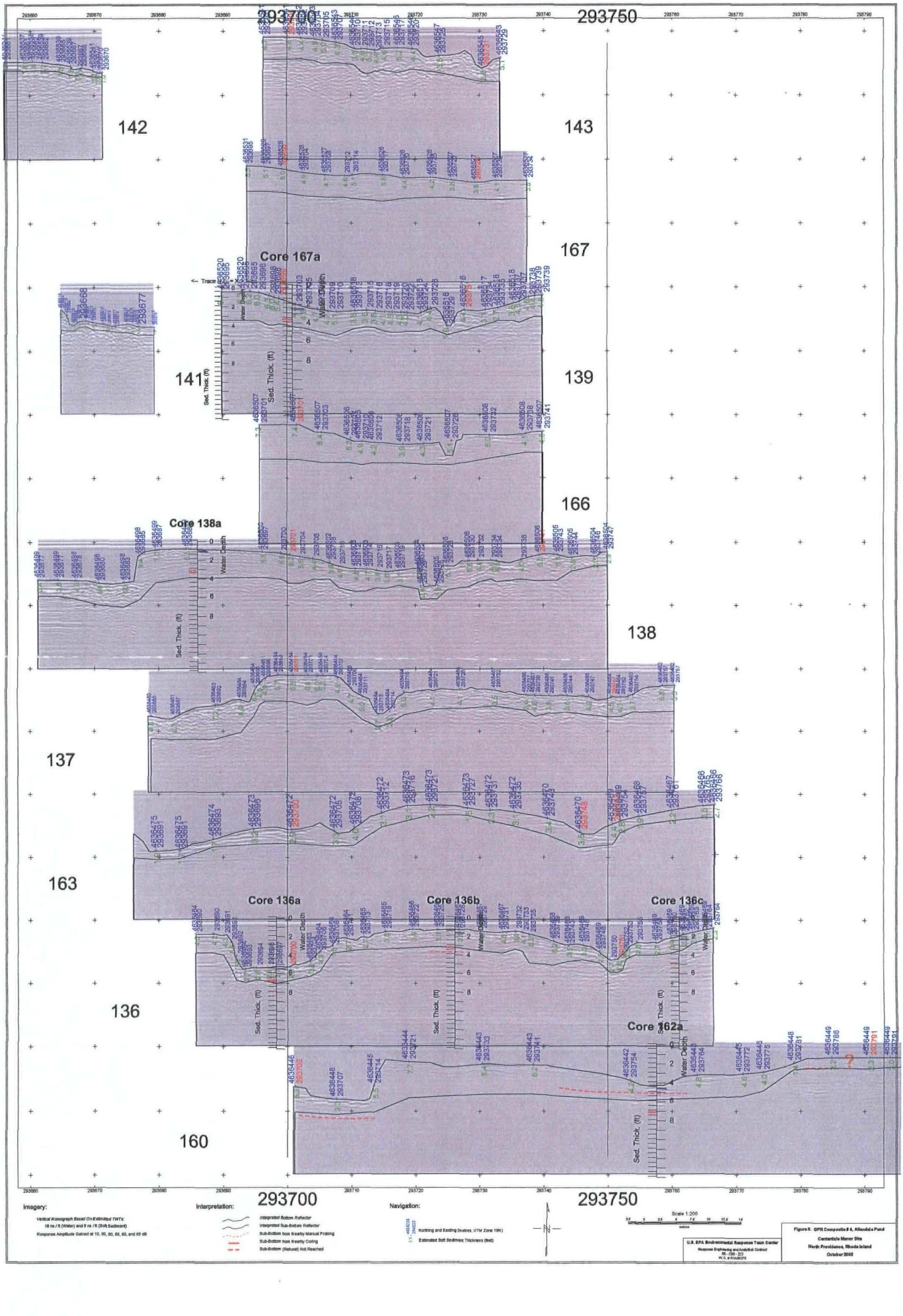
Figure 9. Water Depth, Allendale Pond

Centerdale Manor Site

North Providence, Rhode Island

October 2003



293700
293750
142
143
167
Core 167a
141
139
166
Core 138a
138
137
163
Core 136a
Core 136b
Core 136c
136
Core 162a
160
Water Depth
Sed. Thick. (ft)
Imagery:
Vertical Nomograph Based On Estimated TWTs:
18 ns / ft (Water) and 8 ns / ft (Soft Sediment)
Response Amplitude Gained at 10, 30, 50, 55, 60, and 65 dB
Interpretation:
Interpreted Bottom Reflector
Interpreted Sub-Bottom Reflector
Sub-Bottom from Nearby Manual Probing
Sub-Bottom from Nearby Coring
Sub-Bottom (Refusal) Not Reached
Navigation:
Northing and Easting (metres, UTM Zone 19N)
Estimated Soft Sediment Thickness (feet)
Scale 1:200
metres
U.S. EPA Environmental Response Team Center
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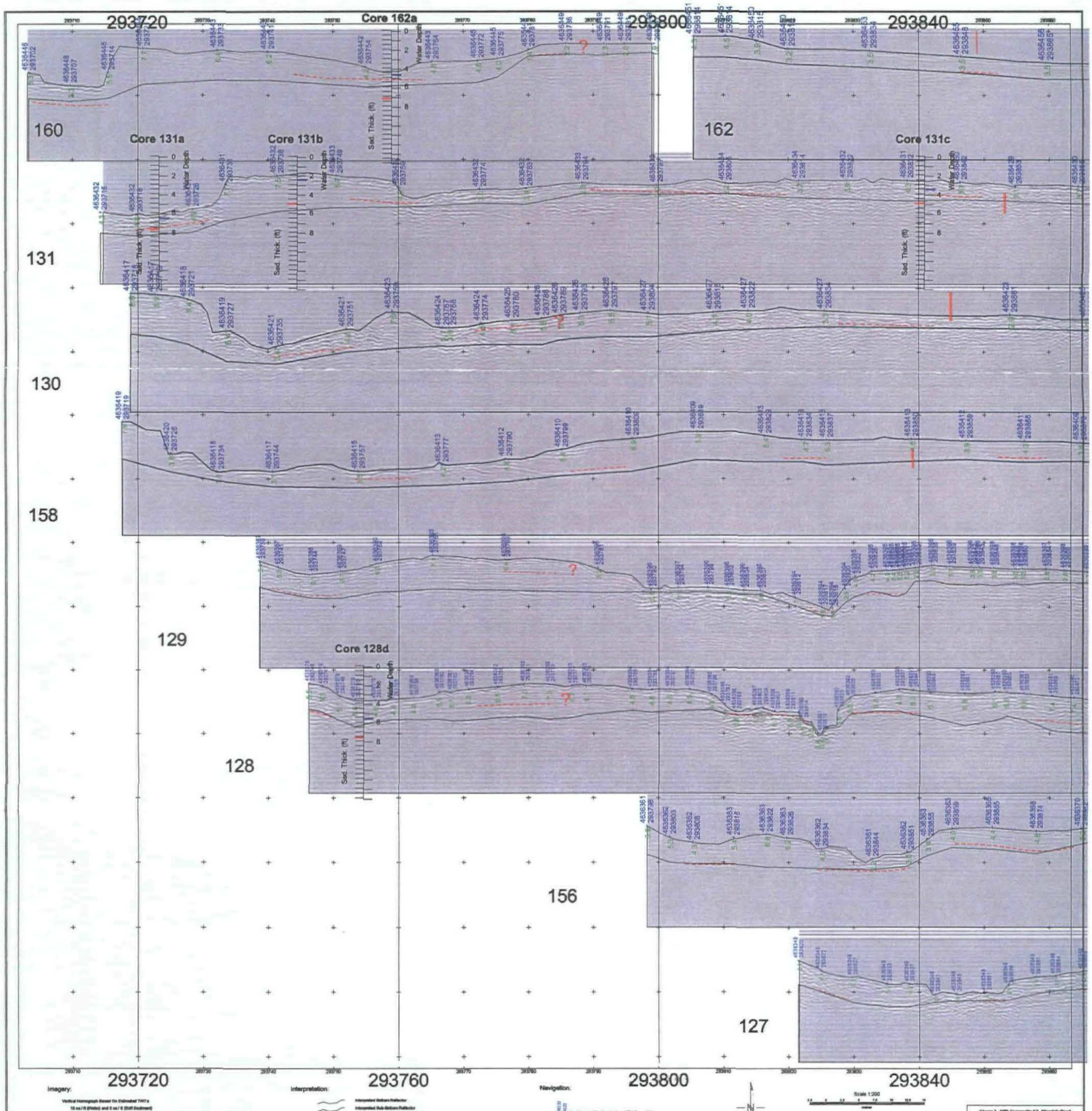
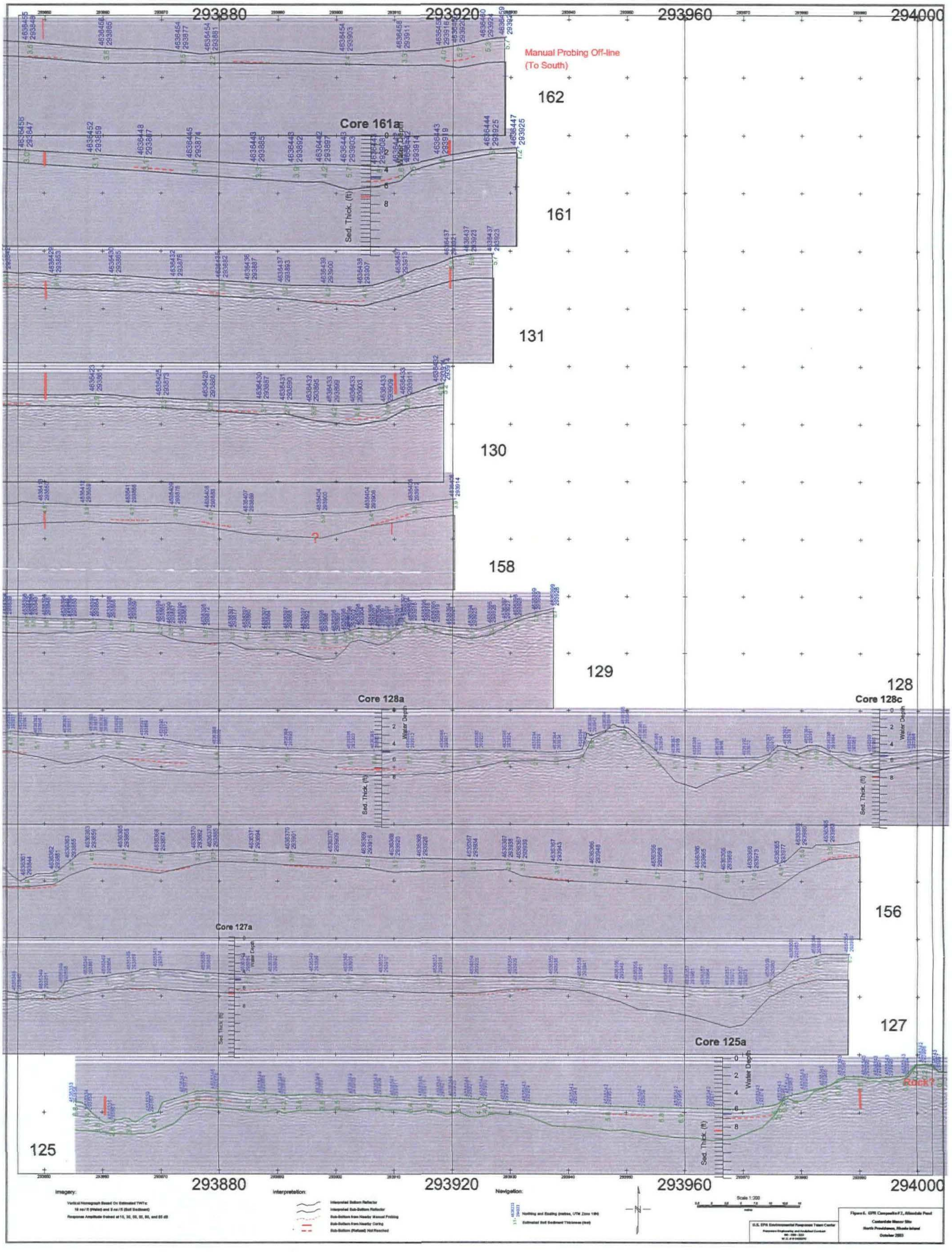
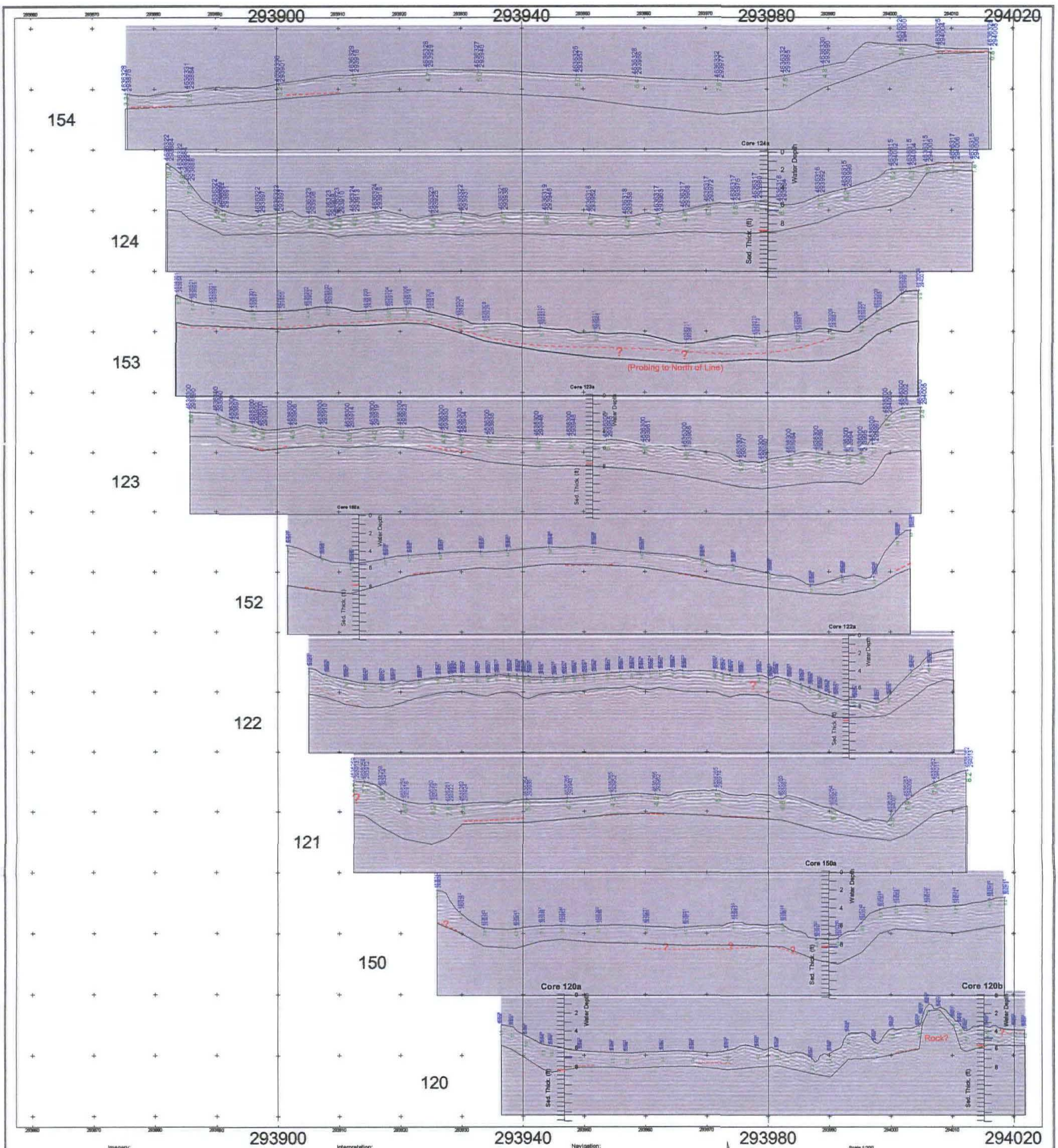
Figure 8. GPR Composite # 4, Allendale Pond
Centerdale Manor Site
North Providence, Rhode Island
October 2003

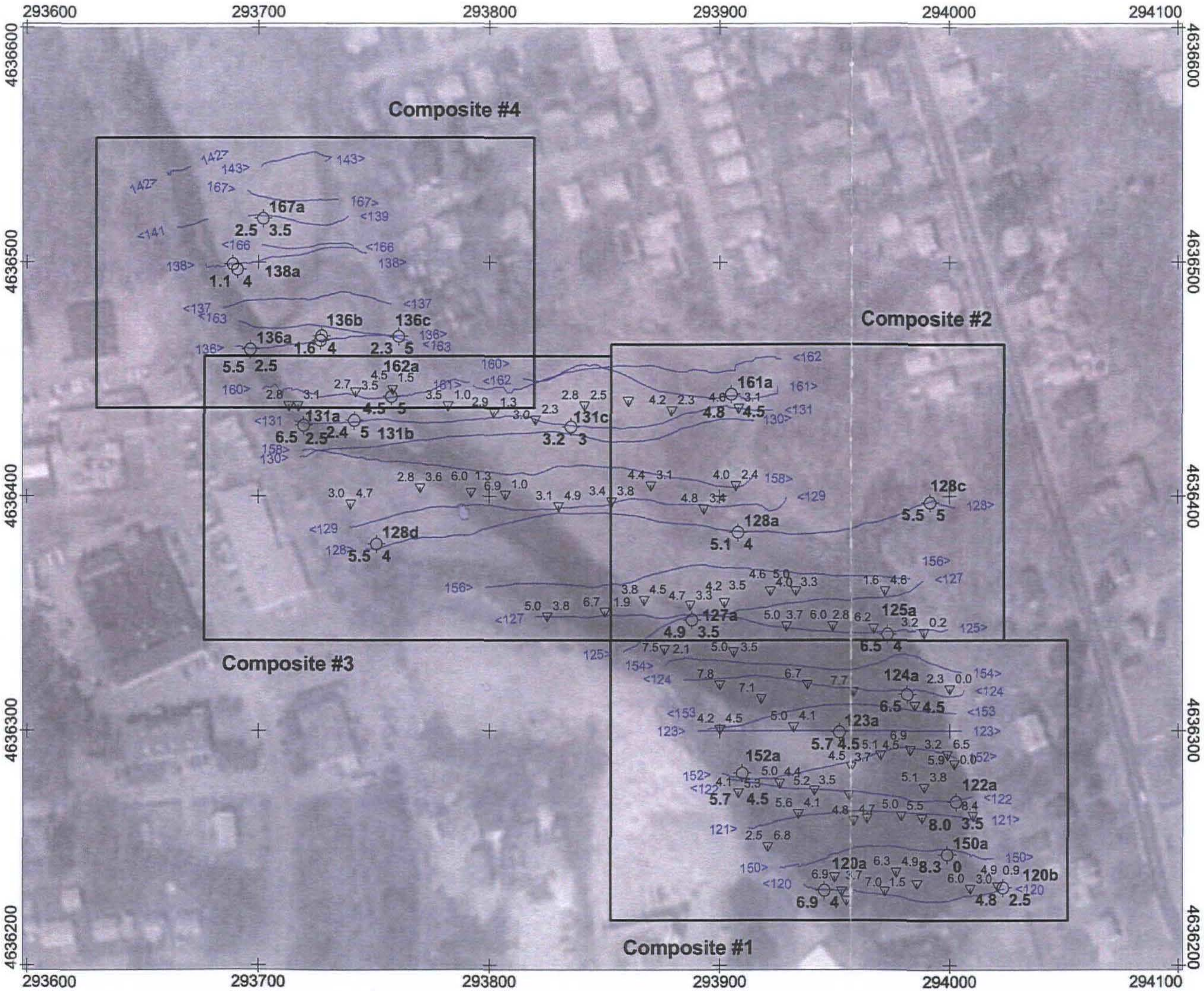

293720
Core 162a
293800
293840
160
162
Core 131a
Core 131b
Core 131c
131
130
158
129
Core 128d
128
156
127
293720
293760
293800
293840
Imagery:
Interpretation:
Navigation:



293880
293920
293960
294000
Manual Probing Off-line
(To South)
162
Core 161a
Water Depth
Sed. Thick. (ft)
161
131
130
158
129
128
Core 128a
Core 128c
156
Core 127a
127
Core 125a
Rock?
125
Imagery:
Interpretation:
Navigation:
Scale 1:200



293900
293940
293980
294020
154
124
153
123
152
122
121
150
120
Core 124a
Core 123a
Core 152a
Core 122a
Core 150a
Core 120a
Core 120b
Water Depth
Sed. Thick. (ft)
(Probing to North of Line)
Rock?
Imagery:
Interpretation:
Navigation:
Scale 1:200
Figure 5. GPR Composite # 1, Allendale Pond



Scale 1:2000

25 0 25 50 75 100 125

metres

NAD83 / UTM zone 19N

Legend:

150>	**Ground Penetrating Radar Transect** (based on differentially corrected, GPS data)
6.7 3.7	**Manual Sub-Bottom Probing Site** (with water depth, soft sediment thickness)
120a 6.9 4	**Sediment Core Site** (with water depth, soft sediment thickness)

Aerial Photography, 29 Mar 1995

U.S. EPA Environmental Response Team Center
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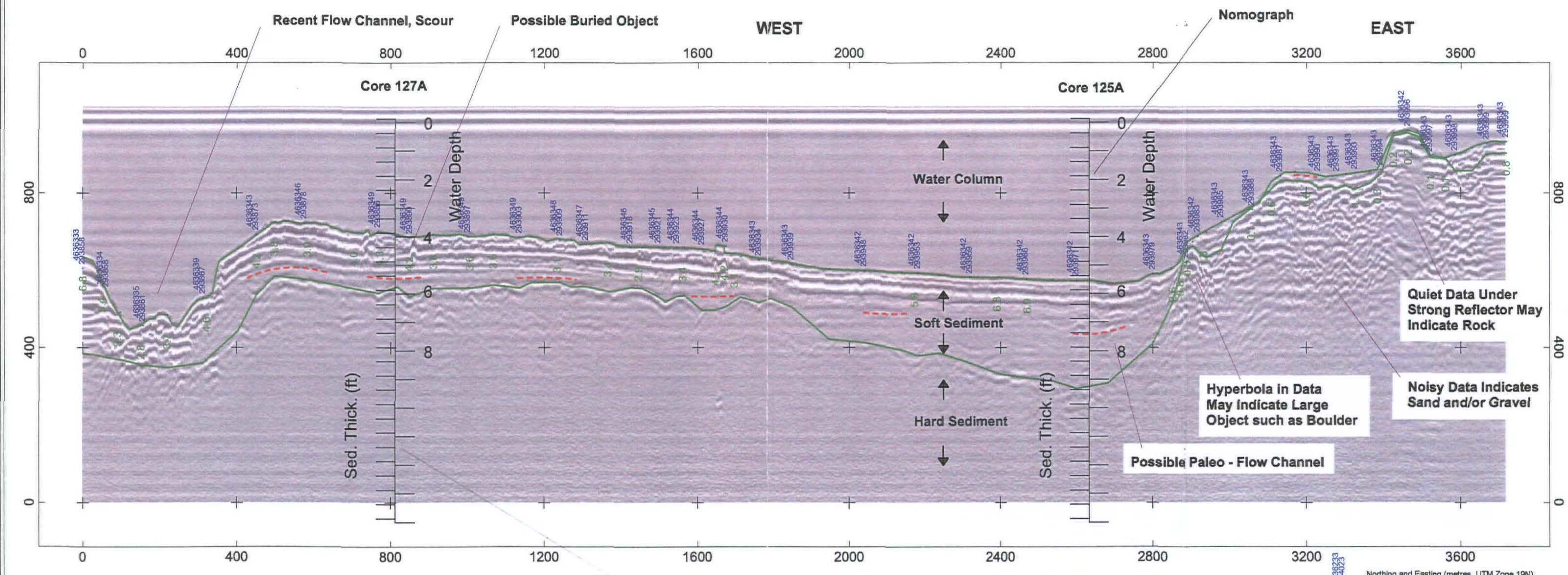
W.O. # R1A00270

Figure 4. Allendale Pond Index
Centerdale Manor Site
North Providence, Rhode Island
October 2003



Vertical Nomograph Based On Estimated TWTs:

18 ns / ft (Water) and 9 ns / ft (Soft Sediment)

Vertical Axis Marked as 1024 Pixels (inverted) over a 250 ns Range

Response Amplitude Gained at 10, 30, 50, 55, 60, and 65 dB

Interpreted Bottom Reflector

Interpreted Sub-Bottom Reflector

Sub-Bottom from Nearby Probing

Horizontal Scale by Trace

500 0 500 1000 1500

West-course Lines Flipped on Vertical Axis

4636233 . 294423 Northing and Easting (metres, UTM Zone 19N)

3.5 Estimated Soft Sediment Thickness (feet)

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W.O. # R1A00270

Figure 3. Line 125, GPR Pseudosection, Allendale Pond

Centerdale Manor Site

North Providence, Rhode Island

October 2003

Appendix A

APPENDIX A
Lithological Sediment Core Logs
(Compiled By U.S. Army Corps Of Engineers)
Centerdale Manor Site
North Providence, Rhode Island
October 2003

U.S. EPA Environmental Response Team Center

Response Engineering and Analytical Contract
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W.O. # R1A00270

Figure A-1. Sediment Coring

Centerdale Manor Site

North Providence, Rhode Island

October 2003

Table A-1. Sediment Core Data Centerdale Manor Site North Providence, Rhode Island October 2003									
Sample Location	Sample Number	UTM North (meters)	UTM East (meters)	Pond	Lead-Line (ft)	Depth of Core (ft)	Time of Sampling	Date of Sampling	Comments
120a	CMS-SD-4222	4,636,232	293,946	Allendale	6.9	4.0	925	8 May 2003	refusal (sand and gravel in catcher)
120b	*CMS-SD-4223*	*4,636,233*	*294,023*	*Allendale*	*4.8*	*2.5*	*1018*	*8 May 2003*	*gravel*
122a	CMS-SD-4220	4,636,270	294,003	Allendale	8.0	3.5	1845	7 May 2003	refusal (sand and gravel in catcher)
123a	CMS-SD-4214	4,636,299	293,952	Allendale	5.7	4.5	1415	7 May 2003	no refusal
124a	CMS-SD-4213	4,636,316	293,982	Allendale	6.5	4.5	1325	7 May 2003	refusal
125a	CMS-SD-4212	4,636,341	293,973	Allendale	6.5	4.0	1156	7 May 2003	refusal (wood in catcher)
127a	CMS-SD-4219	4,636,347	293,888	Allendale	4.9	3.5	1805	7 May 2003	refusal (sand and gravel in catcher)
128a	CMS-SD-4211	4,636,385	293,908	Allendale	5.1	4.0	1110	7 May 2003	refusal (sand and gravel in catcher)
128c	CMS-SD-4210	4,636,397	293,992	Allendale	5.5	5.0	1038	7 May 2003	no refusal
128d	CMS-SD-4215	4,636,380	293,751	Allendale	5.5	4.0	1509	7 May 2003	refusal (sand and gravel in catcher)
131a	CMS-SD-4208	4,636,430	293,720	Allendale	6.5	2.5	930	7 May 2003	refusal (resampled. bad core)
131b	CMS-SD-4209	4,636,432	293,742	Allendale	2.4	5.0	950	7 May 2003	no refusal
131c	CMS-SD-4207	4,636,430	293,835	Allendale	3.2	3.0	1726	6 May 2003	refusal
136a	CMS-SD-4202	4,636,463	293,696	Allendale	5.5	2.5	1147	6 May 2003	sample not intact, discarded - refusal (gravel in catcher)
136b	CMS-SD-4203	4,636,467	293,727	Allendale	1.6	4.0	1249	6 May 2003	no refusal
136c	CMS-SD-4204	4,636,468	293,761	Allendale	2.3	5.0	1506	6 May 2003	no refusal
138a	CMS-SD-4201	4,636,497	293,691	Allendale	1.1	4.0	1600	7 May 2003	no refusal
150a	NA	4,636,247	293,999	Allendale	8.3	0.0	1010	8 May 2003	immediate refusal - location not used
152a	CMS-SD-4218	4,636,282	293,910	Allendale	5.7	4.5	1715	7 May 2003	no refusal
161a	CMS-SD-4206	4,636,444	293,905	Allendale	4.8	4.5	1631	6 May 2003	no refusal
162a	CMS-SD-4205	4,636,443	293,758	Allendale	4.5	5.0	1552	6 May 2003	refusal
167a	CMS-SD-4221	4,636,519	293,702	Allendale	2.5	3.5	850	8 May 2003	refusal
179a	LPX-SD-4204	4,635,005	294,290	Lymansville	7.3	4.0	1550	8 May 2003	no refusal
188a	LPX-SD-4201	4,634,946	294,200	Lymansville	6.9	5.0	1400	8 May 2003	no refusal
188b	LPX-SD-4202	4,634,954	294,248	Lymansville	3.7	6.0	1440	8 May 2003	no refusal
188c	LPX-SD-4203	4,634,948	294,331	Lymansville	7.8	4.0	1515	8 May 2003	refusal
193a	LPX-SD-4210	4,635,050	294,328	Lymansville	9.6	3.5	1000	9 May 2003	hard refusal (sheen)
199a	LPX-SD-4205	4,635,196	294,221	Lymansville	5.2	4.0	1635	8 May 2003	no refusal
206a	LPX-SD-4206	4,635,318	294,160	Lymansville	3.2	5.5	1710	8 May 2003	no refusal
217a	LPX-SD-4207	4,635,424	294,254	Lymansville	4.8	5.0	1740	8 May 2003	no refusal
219a	LPX-SD-4209	4,635,482	294,160	Lymansville	4.1	6.5	915	9 May 2003	no refusal
223a	LPX-SD-4208	4,635,556	294,064	Lymansville	4.2	4.0	849	9 May 2003	refusal (gravel in catcher)
HC1*	LPX-SD-4301	4,635,720	294,031	Lymansville	1.0	3.0	916	9 May 2003	no refusal
HC2*	LPX-SD-4302	4,635,733	294,086	Lymansville	1.0	3.0	938	9 May 2003	no refusal
HC3*	LPX-SD-4303	4,635,771	294,121	Lymansville	1.0	3.5	949	9 May 2003	no refusal
HC4*	LPX-SD-4304	4,635,672	294,014	Lymansville	1.0	3.5	1013	9 May 2003	no refusal
HC5*	LPX-SD-4305	4,635,762	293,910	Lymansville	1.0	3.5	1043	9 May 2003	no refusal
HC6*	LPX-SD-4306	4,635,728	293,958	Lymansville	1.5	3.0	1101	9 May 2003	no refusal

*Hand core sample.

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River** **TOTAL DEPTH:** 3.1'

BORING NUMBER: CMS-SD-4222 120-A **DRAFT** **DATE:** 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 3/1					Organics, roots	PT
	10Y 3/1					Organics, very dark, possible contamination	PT
-1	10Y 2/1					Organics	PT
-2							
						Did not take sample - coarse sand mixed with this layer of organics - poss. crossing of sediments	
-3	10Y 4/1					Coarse sand, channel	SM

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 1.2'

BORING NUMBER: CMS-SD-4223 120-B

DRAFT

DATE: 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2/1					Sludge	Sludge
						Gap in core	
-1	10Y 2/1					Clay layer	CL
	10Y 2/1					Channel lag deposits, subrounded	GM

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 2.1'

BORING NUMBER: CMS-SD-4220 122-A

DRAFT

DATE: 5/7/03

Depth (ft)	Color	Sample			Lithology	Description	USCS Symbol
		210 Pb	Dioxin	Geo Tech			
0						Dark organic layer - rootlets on top	PT
						Lighter than previous layer	PT
-1						Dark organic layer - roots	PT
-2						Small, subrounded gravel @ very bottom - interval too small to sample	GP

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

TOTAL DEPTH: 2.6'

BORING NUMBER: CMS-SD-4214 123-A **DRAFT** **DATE:** 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10 Y 3/1					Recent sediments - coarse sand, (subrounded, quartz), some organics; about 1/4" sludge on top, odor	SM
	10Y 2/1					Organics, rootlets mixed with coarse sand, boundary not defined	PT
-1	10Y 2/1					Organics, rootlets, sticky, some root debris	PT
-2							
	10Y 4/1					Channel lag deposits, gravel clast (1) subrounded, poorly sorted gravel ~ 1"	GP

* Wood debris made it difficult to cut with wire. The wood moved through the sediment with the wire.

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

TOTAL DEPTH: 2.5'

BORING NUMBER: CMS-SD-4213 124-A **DRAFT** DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2/1					Organics, rootlets on top	PT
	10Y 2/1					Leaf litter (flood event)	PT
-1	10Y 2/1					Organics, wood debris @ 1.7'	PT
-2							

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 2.5'

BORING NUMBER: CMS-SD-4212 125-A

DRAFT

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	7.5Y 2.5/1					Heavy organics, wood debris @ bottom, leaf debris @ top 1"	PT
-1							
-2							

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 3.7'

BORING NUMBER: CMS-SD-4219 127-A

DRAFT

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	2.5 Y 2.5/1					Organic silt, rootlets, wood, leaf litter @top	PT
-1	10Y 3/1					Peat, organics, silt, more moist @ top	PT
	10Y 4/3					Fine grained sand, silt, rootlets, moist	SM
-2							
	2.5Y 4/1					Fine grained sand, pebbles, cobble (1.5-2")	GM
-3							

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

BORING NUMBER: CMS-SD-4211 128-A

DRAFT

TOTAL DEPTH: 3.4'

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	5Y 2.5/1					Organics (grass, rootlets), silt	PT
-1	5Y 3/1					Organics, silt	PT
-2	10Y 2.5/1					Silt, sheen	PT
	10Y 3/1					Silt, fine-grained sand, mica flakes	SM
-3	2.5Y 4/1					Pebbles, rounded gravel clasts (1-3"), coarse, subrounded quartz sand	GP

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 3.4'

BORING NUMBER: CMS-SD-4210 128-C

DRAFT

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	7.5Y 2.5/1					Odor, black	PT
	7.5Y 3/1					Clay layer, light tan, confining layer	CL
	7.5Y 3/1					Clay, silt (v. fine grain), heavy organics	PT
	7.5Y 2.5/1					3.5" wood debris, organic layer, increase in color with depth	PT

Depth axis: 0, -1, -2, -3

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 4.5'

BORING NUMBER: CMS-SD-4215 128-D

DRAFT

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	5Y 2.5/1					Organic silt to peat, rootlets @ top	PT
-1	7.5Y 2.5/1					Silt, organics, wood fragments, fine grained sand (foil wrapper @1.4')	PT
-2	10Y 2/1					Poor recovery here - gap noticed here before core was cut; organics, silt, odor, very moist; foil wrapper @ 2'	PT
-3	7.5Y 2.5/1					Coarse sand, cobble (1-2") moist	SW
-4	10Y 4/1					Coarse sand, cobbles	GM

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 2.5'

BORING NUMBER: CMS-SD-4208 131-A **DRAFT**

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2/1					Organics @ top, odor, dark color, broken glass, some coarse gravel, pebbles (subrounded - rounded)	GM
	7.5Y 6/3					Coarse sand, subrounded-rounded, quartz pebbles, cobbles	GM
-1							
-2							

* Note: Due to poor recovery, samples taken only for grain size.

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 3.8'

BORING NUMBER: CMS-SD-4209 131-B

DRAFT

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	7.5Y 2.5/1					Silt, rootlets, organics, moist	PT
	7.5Y2.5/1					Peat, dryer, plastic drink lid @ .88'	PT
-1	10Y 2/1					Organic silt, dark color, odor, fine-grained sand, wood @ 1.3'	PT
-2	7.5Y 2.5/1					Organic silt, rootlets, moist, sheen, odor	PT
	7.5Y 2.5/1					Organic silt, wood pieces, fine-grained sand	PT
-3	5Y 2.5/1					Silt, wood pieces, odor	PT
	7.5Y 2.5/1					Coarse sand, subrounded quartz	SM

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

TOTAL DEPTH: 2.6'

BORING NUMBER: CMS-SD-4207 131-C **DRAFT**

DATE: 5/6/03

Depth (ft)	Color	Sample			Lithology	Description	USCS Symbol
		210 Pb	Dioxin	Geo Tech			
0						Organics, black, strong odor when cutting core, roots	PT
-1	10Y 3/2					Pea-sized gravel in sand matrix, root	GM
						Large gravel	GM
-2	2.5Y 4/3					Gravel	GM

PROJECT NAME: Centredale Restoration, North Providence, RI
LOCATION: Woonasquatucket River TOTAL DEPTH: 3.4'
BORING NUMBER: CMS-SD-4217 136-B **DRAFT** DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 3/1					Leaves, roots, organics	PT
	10Y 4/1					Coarse sand	SM
-1	10Y 3/1					Organics, silt?	PT
	10Y 3/1					Clay	CL
-2	10Y 3/1					Fine-grained sand @ base, 10% mica	SM
-3							

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

TOTAL DEPTH: 2.3'

BORING NUMBER: CMS-SD-4204 136-C

DRAFT

DATE: 5/6/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2/1					Heavy organics	PT
	10Y 2/1					Strong organics, roots; wood debris @ 1'	PT
-1	7.5Y 3/1					Sandy	SM
	10Y 2/1					Dark, organic rich	PT
-2	5Y 4/1					Sandy, higher clay content; large piece of gravel @ 2', large piece of gravel @ bottom (1/2" size), subrounded.	SC

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

TOTAL DEPTH: 3.2'

BORING NUMBER: CMS-SD-4216 138-A

DRAFT

DATE: 5/7/03

Depth (ft)	Color	Sample 210 Pb	Sample Dioxin	Sample Geo Tech	Lithology	Description	USCS Symbol
0	5Y 2.5/1					RI PT Heavy organics, roots at top. Some woody debris at top	PT
-2	10Y 5/2					RI CL Clay layer (may be acting as a confining layer for dioxin)	CL
	10Y 4/1					RI SM Sand, coarse, one large clast	SM
-3							

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

BORING NUMBER: CMS-SD-4218 152-A

DRAFT

TOTAL DEPTH: 4'

DATE: 5/7/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10 Y 2.5/1					Organics, silt, grass, leaf litter	PT
-1	7.5Y 2.5/1					Peat, darker color, wood pieces (1.1' - 1.2' odor, DNAPL?)	PT
-2	7.5Y 3/1					Silt, *fine-grained sand*	SM
	10Y 2.5/1					Peat, darker color, very moist	PT
-3	10Y 4/1					Coarse to fine sand (subangular quartz), silt, fining upward sequence	SM
-4	10Y 4/1					Coarse grained sand, pebbles (1/2 - 1" size); second fining upward sequence.	GM

PROJECT NAME: **Centredale Restoration, North Providence, RI**

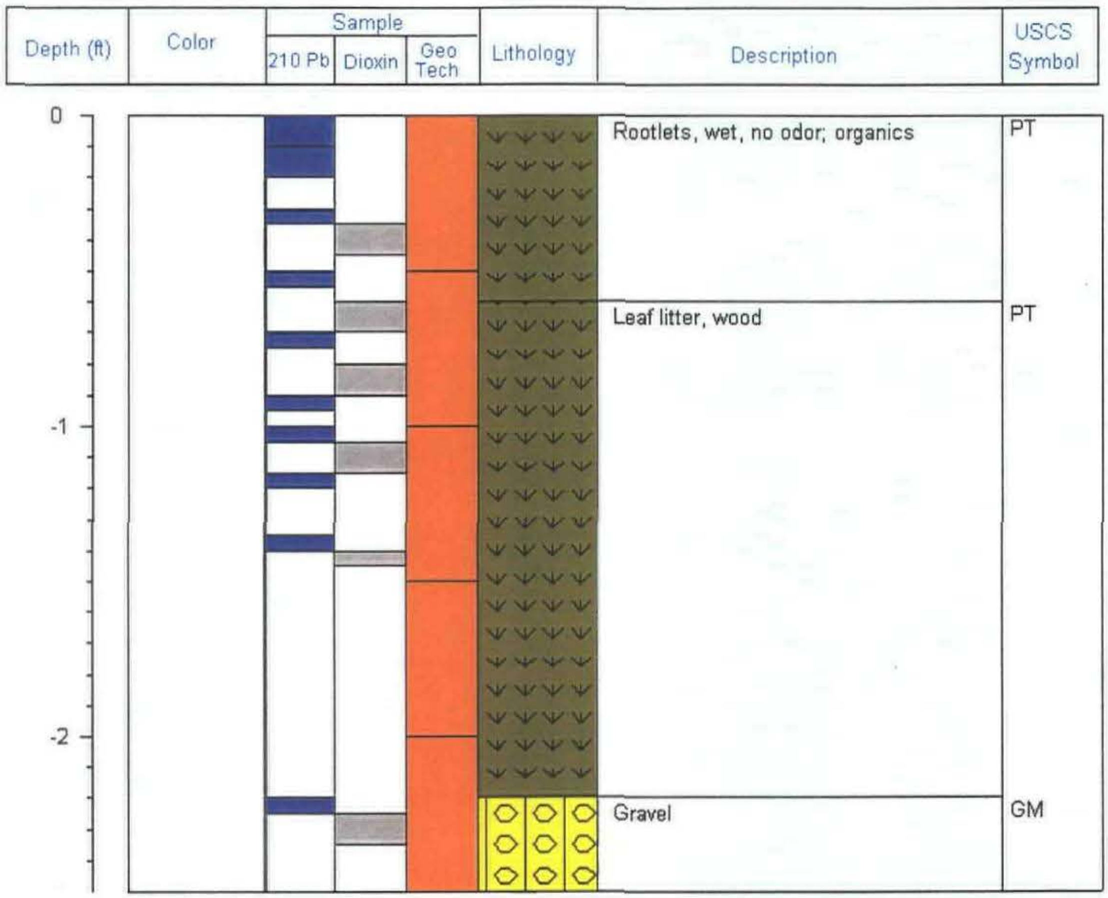
LOCATION: **Woonasquatucket River**

TOTAL DEPTH: 2.5'

BORING NUMBER: CMS-SD-4206 161-A

DRAFT

DATE: 5/6/03



PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 1.9'

BORING NUMBER: CMS-SD-4205 162-A **DRAFT**

DATE: 5/6/03

Depth (ft)	Color	Sample			Lithology	Description	USCS Symbol
		210 Pb	Dioxin	Geo Tech			
0						Garbage and cultural debris	PT
	5Y 2.5/1					Fine grained sand, some organics, mica	SM
-1							
	10Y 2.5/1					Distinct transition to coarse sand, mainly subrounded quartz and feldspar	SM

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

BORING NUMBER: CMS-SD-4221 167-A

DRAFT

TOTAL DEPTH: 3.0'

DATE: 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0						Organics, rootlets @ top; color change @ 0.6'	PT
						Organics (rootlets); woody debris throughout organic layer	PT
-1							
-2							
						Cultural debris (plastic) - gravel lag deposits - subrounded	GP
-3							

PROJECT NAME: Centredale Restoration, North Providence, RI

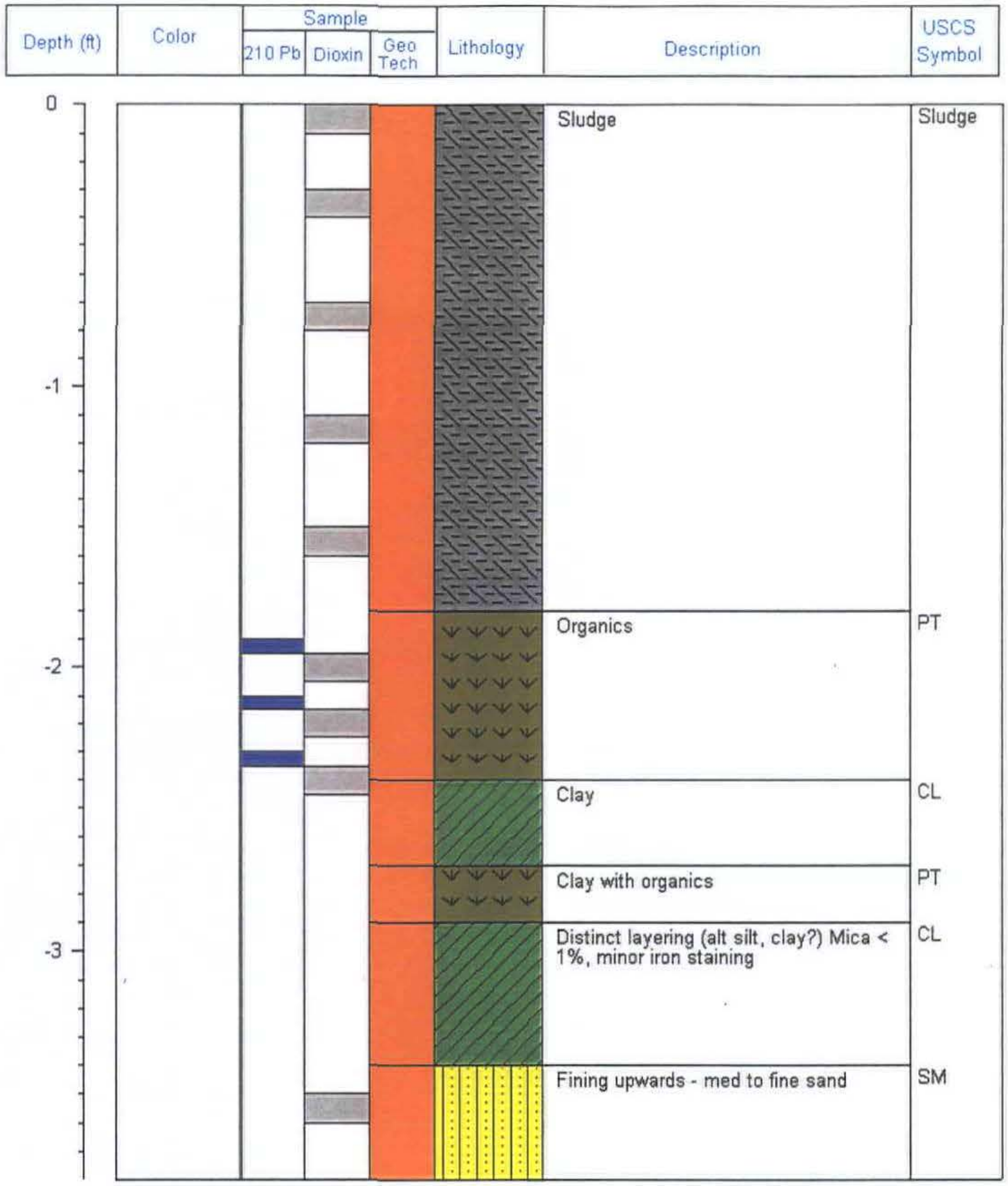
LOCATION: Woonasquatucket River

TOTAL DEPTH: 3.8'

BORING NUMBER: LPX-SD-4204 179-A

DRAFT

DATE: 5/8/03



PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 4.4'

BORING NUMBER: LPX-SD-4201 188-A

DRAFT

DATE: 5/8/03

Depth (ft)	Color	Sample 210 Pb	Sample Dioxin	Sample Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2/1					Sludge	Sludge
-1	10Y 2/1					Organics, roots	PT
-3	2.5Y 2.5/1					Clay	CL
	10Y 2/1					Peat, roots	PT
	2.5Y 6/1					Silt (light)	SM
-4	10Y 2/1					Organics, roots	PT
	10Y 4/1					Gravel - lag deposits	GM

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

BORING NUMBER: LPX-SD-4202 188-B

DRAFT

TOTAL DEPTH: 4.2'

DATE: 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2.5/1					Sand (fine)	SM
	2.5Y 4/1					Sand (med) with organics	SM
	2.5Y 4/1					Sand (fine) with gravel clasts throughout, subrounded to rounded	GM
-1							
-2							
-3							
	2.5Y 2.5/1					Clay (brown)	CL
	2.5Y 5/1					Sand (fine to med)	SM
	10Y 2/1					Organics with mica (<1%)	GP
-4							

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

TOTAL DEPTH: 3.7'

BORING NUMBER: LPX-SD-4203 188-C

DRAFT

DATE: 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2.5/1					Sludge, wet	Sludge
-1	10Y 2/1					Sludge, darker (black) than above interval, wet	Sludge
-2	10Y 4/2					Fine sand	SM
-3	10Y 4/2					Clay	CL
	10Y 2/1					Organics, rootlets	PT

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

BORING NUMBER: LPX-SD-4210 193-A

DRAFT

TOTAL DEPTH: 2.9'

DATE: 5/9/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2/1					Sludge	Sludge
-1	10Y 2/1					Sludge (possible clay - more cohesive than above)	Sludge
-2	10Y 2/1					Sandy with sludge - some wood debris	Sludge
	10Y 5/1					Sand lens (low deposition)	SM

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

BORING NUMBER: LPX-SD-4205 199-A

DRAFT

TOTAL DEPTH: 3.5'

DATE: 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0						Sludge, odor	Sludge
						Sludge, more silt	Sludge
						Sludge (organics), rootlets	Sludge

Depth scale: 0, -1, -2, -3

PROJECT NAME: **Centredale Restoration, North Providence, RI**

LOCATION: **Woonasquatucket River**

BORING NUMBER: LPX-SD-4206 206-A

DRAFT

TOTAL DEPTH: 2.3'

DATE: 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0						Sludge, clay @ 1' - not very consolidated	Sludge
-1						Sudge, organic debris (sticks) right above gravel	Sludge
-2						Gravel, channel lag, subrounded, poorly graded	GM

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River **TOTAL DEPTH:** 2.0'

BORING NUMBER: LPX-SD-4207 217-A **DRAFT** **DATE:** 5/8/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0 to -2	10Y 2.5/1					Sludge! Color change @ 1.5'; no *lithology, odor, organic debris @ top*	Sludge

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

TOTAL DEPTH: 3.6'

BORING NUMBER: LPX-SD-4209 219-A

DRAFT

DATE: 5/9/03

Depth (ft)	Color	Sample: 210 Pb	Sample: Dioxin	Sample: Geo Tech	Lithology	Description	USCS Symbol
0	10Y 2/1					Sludge - hydrocarbon odor	Sludge
	10Y 5/2					Clay (wet) tan	CL
-1	10Y 2.5/1					Organics, wood debris	PT
-2	10Y 2.5/1					Clay with some wood debris, very stiff	CL
-3	10Y 2.5/1					Lag deposits	GM

PROJECT NAME: Centredale Restoration, North Providence, RI

LOCATION: Woonasquatucket River

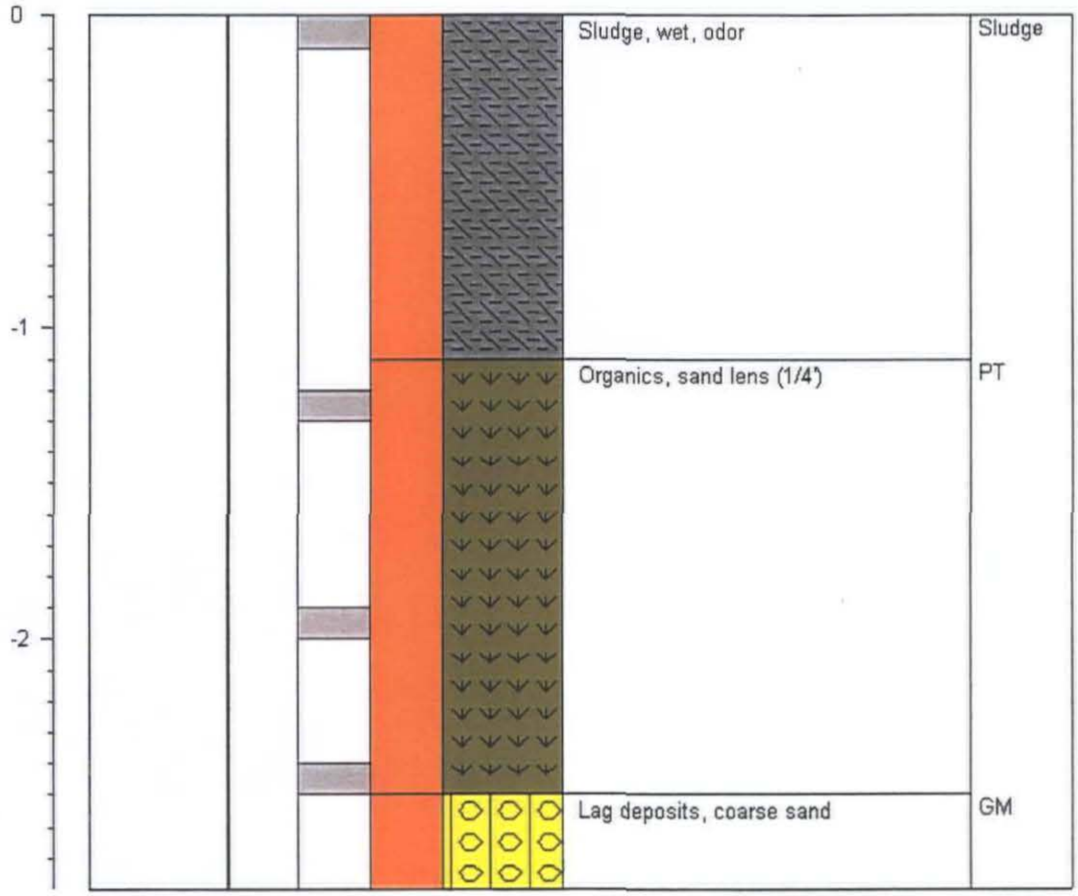
TOTAL DEPTH: 2.8'

BORING NUMBER: LPX-SD-4208 223-A

DRAFT

DATE: 5/09/03

Depth (ft)	Color	Sample			Lithology	Description	USCS Symbol
		210 Pb	Dioxin	Geo Tech			



REAC, Edison, NJ
(732) 321-4200
EPA Contract 68-C99-223

CHAIN OF CUSTODY RECORD

Project Name: CMS
Project Number: R1A00270
LM Contact: Grossman Phone: (732) 321-4233

No: 14742
Sheet 01 of 01 (Do not copy)
(for addnl. samples use new form)

Sample Identification / **Analyses Requested**

REAC#	Sample No	Sampling Location	Matrix	Date Collected	# of Bottles	Container/Preservative	Core Processing				
	CMS-SD-4201	138A ⊛	SD	6 May 2003	1	Core / 4°C	✓				
	CMS-SD-4202	136A ⊛									
	CMS-SD-4203	136B ⊛									
	CMS-SD-4204	136C									
	CMS-SD-4205	162A									
	CMS-SD-4206	161A									
	CMS-SD-4207	131C									
	~~CMS-SD-4208~~ (SD)										
	CMS-...										
	CMS-...										
	CMS-...										

Matrix:
A- Air
AT-Animal Tissue
DL- Drum Liquids
DS- Drum Solids
GW- Groundwater
O- Oil
PR-Product
PT-Plant Tissue
PW- Potable Water
S- Soil
SD- Sediment
SL- Sludge
SW- Surface Water
TX-TCLP Extract
W- Water
X- Other

Special Instructions:
⊛ Core ~~layers~~ may not be intact

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #:

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished by	Date	Received by	Date	Time
ALL/ANALYSIS	[signature]	5/6/03	Margaret Cock	5/6/03							

☆ U.S. GPO: 2000-521-151

REAC, Edison, NJ
(732) 321-4200
EPA Contract 68-C99-223

CHAIN OF CUSTODY RECORD

Project Name: CMS
Project Number: RIA00270
LM Contact: S.GROSSMAN Phone: (732)321-4730

No: 14743
Sheet 01 of 01 (Do not copy)
(for addnl. samples use new form)

Sample Identification | **Analyses Requested**

REAC#	Sample No	Sampling Location	Matrix	Date Collected	# of Bottles	Container/Preservative	Core Processing				
	CMS-SD-4208	131A	SD	7MAY2003	1	Core / 4°C	✓				
	CMS-SD-4209	131B									
	CMS-SD-4210	128C									
	CMS-SD-4211	128A									

Matrix:

A- Air
AT-Animal Tissue
DL- Drum Liquids
DS- Drum Solids
GW- Groundwater
O- Oil
PR-Product
PT-Plant Tissue
PW- Potable Water
S- Soil
SD- Sediment
SL- Sludge
SW- Surface Water
TX-TCLP Extract
W- Water
X- Other

Special Instructions:

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #:

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished by	Date	Received by	Date	Time
All/Analysis	[illegible]	5/7/03	Maureen [illegible]	5/7/03							

RDA, Edison, NJ
(732) 321-4200
EPA Contract 68-C99-223

CHAIN OF CUSTODY RECORD

Project Name: CMS
Project Number: RIA 06KD 270
LM Contact: S. GROSSMAN Phone: (732) 321-4233

No: 14744
Sheet 01 of 01 (Do not copy)
(for addnl. samples use new form)

Sample Identification | **Analyses Requested**

EAC#	Sample No	Sampling Location	Matrix	Date Collected	# of Bottles	Container/Preservative	see Procedure				
	CMS-SD-4213	124A	SD	7 MAY 2003		Core / 4°C	✓				
	CMS-SD-4214	123A									
	CMS-SD-4215	128D			3						
	CMS-SD-4216	138A									
	CMS-SD-4217	136B									
	CMS-SD-4218	152A									
	CMS-SD-4219	127A									
	CMS-SD-4212	125A									

Matrix:
A- Air
AT- Animal Tissue
DL- Drum Liquids
DS- Drum Solids
GW- Groundwater
O- Oil
P- Product
PT- Plant Tissue
PW- Potable Water
S- Soil
SD- Sediment
SL- Sludge
SW- Surface Water
TX- TCLP Extract
W- Water
X- Other

Special Instructions:

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #:

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished by	Date	Received by	Date	Time
ALL ANALYSIS	[illegible signature]	5/7/03	[illegible signature]	5/7/03							

REAC, Edison, NJ
(732) 321-4200
EPA Contract 68-C99-223

CHAIN OF CUSTODY RECORD

Project Name: CMS
Project Number: RIA00270
LM Contact: S. Gronendal Phone: (732) 321-4230

No: 14749
Sheet 01 of 01 (Do not copy)
(for addnl. samples use new form)

Sample Identification							Analyses Requested				
REAC#	Sample No.	Sampling Location	Matrix	Date Collected	# of Bottles	Container/Preservative	[illegible]				
	CMS-SD-4220	122A	SD	7 MAY 2003	1	Core / 4°C	X				
	CMS-SD-4221	167A		8 MAY 2003							
	CMS-SD-4222	120A									
	CMS-SD-4223	120B									
	ALD-FP-0002	FP2	S								

Matrix:

A- Air
AT-Animal Tissue
DL- Drum Liquids
DS- Drum Solids
GW- Groundwater
O- Oil
PR-Product
PT-Plant Tissue
PW- Potable Water
S- Soil
SD- Sediment
SL- Sludge
SW- Surface Water
TX-TCLP Extract
W- Water
X- Other

Special Instructions:

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #:

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished by	Date	Received by	Date	Time
ALL / ANALYSIS	[signature]	5/8/03	Maurice H. Dean	5/8/03							

REAC, Edison, NJ
(732) 321-4200
EPA Contract 68-C99-223

CHAIN OF CUSTODY RECORD

Project Name: CMS
Project Number: R1A00270
LM Contact: S GROSSMAN Phone: (732) 321-4230

No: 14748
Sheet 01 of 01 (Do not copy)
(for addnl. samples use new form)

Sample Identification

Analyses Requested

REAC#	Sample No	Sampling Location	Matrix	Date Collected	# of Bottles	Container/Preservative	Core Processing				
	LPX-SD-4201	188A	SD	8MAY2003	1	Core / 4°C	✓				
	LPX-SD-4202	188B									
	LPX-SD-4203	188C									
	LPX-SD-4204	179A									
	LPX-SD-4205	199A									
	LPX-SD-4206	206A									
	LPX-SD-4207	217A									

Matrix:
A- Air
AT- Animal Tissue
DL- Drum Liquids
DS- Drum Solids
GW- Groundwater
O- Oil
P- Product
PT- Plant Tissue
PW- Potable Water
S- Soil
SD- Sediment
SL- Sludge
SW- Surface Water
TX- TCLP Extract
W- Water
X- Other

Special Instructions:

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #:

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished by	Date	Received by	Date	Time
ALL ANALYSIS	[signature]	5/7/03	[signature]	5/8/03							

REAC, Edison, NJ
(732) 321-4200
EPA Contract 68-C99-223

CHAIN OF CUSTODY RECORD

Project Name: CMS
Project Number: R1A00270
LM Contact: S. GROSSMAN Phone: (732) 321-1273

No: 14750
Sheet 01 of 01 (Do not copy)
(for addnl. samples use new form)

Sample Identification / Analyses Requested

REAC#	Sample No	Sampling Location	Matrix	Date Collected	# of Bottles	Container/Preservative	Processing				
	LPX-SD-4208	223A	SD	9MAY2003	1	Core / 4°C	✓				
	LPX-SD-4209	219A									
	LPX-SD-4210	193A									
	LPX-SD-4301	HC-1				Hand Core / 4°C					
	LPX-SD-4302	HC-2									
	LPX-SD-4303	HC-3									
	LPX-SD-4304	HC-4									
	LPX-SD-4305	HC-5									
	LPX-SD-4306	HC-6									

Matrix:

- A - Air
- AT - Animal Tissue
- DL - Drum Liquids
- DS - Drum Solids
- GW - Groundwater
- O - Oil
- PR - Product
- PT - Plant Tissue
- PW - Potable Water
- S - Soil
- SD - Sediment
- SL - Sludge
- SW - Surface Water
- TX - TCLP Extract
- W - Water
- X - Other

Special Instructions:

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #:

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished by	Date	Received by	Date	Time
ALL ANALYSIS	[signature]	5/9/03	Bart Bergen	5/9/03	12:05						