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RSI Geophysics for the 21st Century
Radar Solutions International™

October 17, 2002

Mr. John Berry, P.E.
Mr. Peter Gorton
Mr. Robert Ossman
Panamerican Environmental, Inc.
2390 Clinton Street
Buffalo, NY 14227

Subject: Geophysical Services to Detect USTs
Trinidad Park
Buffalo, New York

Dear Gentlemen:

In accordance with your authorization, Radar Solutions International (RSI) conducted an electromagnetic terrain conductivity survey and a metal detection survey on September 30 and October 1, 2, and 3, 2002 at the above-referenced site. The purpose of the geophysical surveys was to determine the location of possible underground storage tanks (USTs). Our survey results and interpretations are summarized below.

LOCATION AND SURVEY CONTROL

The site is located in Buffalo, Erie County, New York, at Trinidad Park, on the south side of Kensington Avenue and is adjacent to Trinidad Place. An active railroad track system abuts the park to the east. The area of investigation is L-shaped and includes open playing fields, a basketball court, playgrounds, a wading pool, and a site building. The inside of the site building was not surveyed, and additional small areas remained inaccessible to RSI, such as areas occupied by fences, park benches, playground equipment, and the fountain portion of the swimming pool.

The geophysical survey was carried out by Ms. Ariadna Heinz-Vallribera and Ms. Stephanie Watts of Radar Solutions, with the assistance of Mr. Robert Ossman and Mr. Justin Ryszkiewicz of Panamerican Environmental. A 20 foot geophysical survey grid was established at the site oriented parallel to the fence located on the eastern side of the site. The grid nodes are numbered such that they increase to the east and to the north, with grid node (0+00E, 0+00N) located at the imaginary southwest corner of the park on Gillette Avenue, and grid node (0+00E, 1+80N) located at the west edge of the more northerly of the east-west fences around the playing fields. The survey area extends from 0+00E to 4+20E and from 0+02N to 8+30N.

EM-terrain conductivity data were acquired using a GEONICS EM-31 DL terrain conductivity meter. Data were acquired for the entire site, excepting the previously mentioned inaccessible areas. Data were collected at 2 foot intervals along north-south oriented survey lines spaced 5 feet apart, and were recorded on a portable data-logger. Both components (i.e. the quadrature phase or conductivity, and the in-phase) of the induced EM field were recorded. The EM data were then transferred to desktop computer and contoured (i.e. data with similar values were shaded similarly to bring out patterns of high and low conductivity and in-phase values). Appendix A describes the EM terrain conductivity method in more detail.

The metal detection survey was completed with a GEONICS EM-61 metal detector. Data were collected for the site area located from 2+90E to 4+20E and 0+02N to 8+30N, excepting the previously mentioned inaccessible areas. Data were collected at 2 foot intervals along north-south oriented survey lines spaced 5 feet apart, and were recorded on a portable data-logger. Four components were recorded: the top coil response, the bottom coil response, the filtered response from the bottom coil (i.e. "noise" response), and the differential response between the two coils. The EM data were then transferred to desktop computer and the bottom coil, filtered bottom coil and differential responses were contoured (i.e. data with similar values were shaded similarly to bring out patterns of high and low responses). Appendix B describes the EM-61 metal detection method in more detail.

RESULTS

Figures 1 through 5 summarize geophysical results and are presented at a scale of 1 inch = 60 feet. The first two figures display the results from the EM-31 terrain conductivity survey, with Figure 1 showing contoured conductivity results, and Figure 2 showing contoured in-phase component results. **In both contour maps, buried metal is indicated coincident or nearly coincident where filled contours are dark blue or black**. In some instances, such as if there were multiple targets, buried metal may also be indicated by red and magenta-filled contours. **However, typically, red and magenta-filled contours are located in proximity to above-ground interference sources**.

Results from the metal detection survey are exposed in the next three figures. Figures 3 and 4 show the raw and filtered bottom coil response results, respectively, and Figure 5 shows the differential response between the top and bottom coils. **In these contour maps, metal is indicated where filled contours appear dark blue and black, or red and magenta. The**

differential response (see Figure 5) also distinguishes between above-ground sources of metal, in dark blue or black contours, and buried metal, which is displayed with red and magenta-filled contours.

The most important anomalies that could indicate the presence of large buried metal objects, such as large USTs, are highlighted on each figure with black dashed rectangles as recommended test pit locations. Key results are also summarized below, and are classified ranging from highest to lowest priority.

Highest priority:

- **3+85E to 4+23E , 6+15N to 6+35N**: southeastern corner of basketball court; large metal object; **possible large UST**
- **4+05E to 4+23E , 6+45N to 6+70N**: just north of previous anomaly; large metal object; **possible large UST**
- **3+95E to 4+23E , 5+80N to 6+05N**: just south of basketball court, by eastern fence; large metal object; **possible large UST**
- **3+95E to 4+23E , 5+45N to 5+75N**: just south of previous anomaly; large metal object; **possible large UST**
- **3+40E to 3+60E , 2+20N to 2+30N**: probable large buried metal object
- **2+95E to 3+10E , 4+45N to 4+60N**: probable buried metal object; **possible UST**
- **3+50E to 3+70E , 4+05N to 4+20N**: probable buried metal object
- **3+70E to 3+90E , 8+15N to 8+25N**: by bridge wall at northern boundary of park; probable buried metal object; **possible UST or drum**

Medium priority:

- **0+85E to 1+00E , 1+30N to 1+50N**: probable buried metal
- **0+95E to 1+05E , 0+00N to 0+25N**: probable buried metal

Lowest priority:

- **2+25E to 2+35E , 0+95N to 1+10N**: possible small buried metal object
- **2+65E to 2+85E , 0+00N to 0+25N**: possible small buried metal object
- **3+90E to 4+10E , 4+15N to 4+25N**: possible small buried metal object

RECOMMENDATIONS

Four possible large USTs are present beneath or immediately adjacent to the east fence, from 5+45N to 6+70N and from 3+85E to the east fence. Test pits should be conducted at or near the fence at locations below and extended to the west:

1) 4+20E, 6+20N
2) 4+20E, 6+65N
3) 4+15E, 5+95N
4) 4+15E, 5+65N

Other high and medium priority test pits can be conducted at:

5) 3+50E, 2+25N
6) 3+00E, 4+50N
7) 3+60E, 4+10N
8) 3+80E, 8+20N
9) 0+92E, 1+40N
10) 1+00E, 0+10N

***

We appreciate this opportunity to work with Panamerican Environmental, Inc. Please call should you have any inquiries regarding this or future assignments.

Sincerely,
RADAR SOLUTIONS INTERNATIONAL

Ariadna Heinz-Vallribera
Physicist

Doria L. Kutrubes

Doria Kutrubes
President and Senior Geophysicist

APPENDIX A

EM TERRAIN CONDUCTIVITY METHOD OF INVESTIGATION

EM-terrain conductivity data were acquired using a GEONICS EM-31 DL terrain conductivity meter. Data were collected at 2 foot intervals along survey lines spaced 5 feet apart, and were recorded on a portable data-logger. Both components (i.e. the quadrature phase or conductivity, and the in-phase) of the induced EM field were recorded. The EM data were then transferred to desktop computer and contoured (i.e. data with similar values were shaded similarly to bring out patterns of high and low conductivity and in-phase values).
The EM-terrain conductivity meter is an induction-type instrument which measures terrain conductivity without electrodes or direct soil contact. The terrain conductivity method operates on the principle that secondary electric and magnetic currents can be induced in metal objects and conductive bodies, such as iron or steel USTs, when an electric field is applied. This instrumentation measures the secondary magnetic field strength relative to the primary magnetic field and converts it directly into a conductivity value, measured in millimhos per meter (mmhos/m), with a resolution of 1 mmho/m.

The EM-31 also records the amount of phase-shift occurring between primary and secondary magnetic fields. The in-phase component measures that portion of the secondary magnetic field that is aligned with the primary field. Because metal objects are almost perfect conductors, there is often no phase shift between primary and secondary magnetic fields. Hence, metal objects are detectable using the in-phase component (measured in parts per thousand or ppt). Additionally, in the presence of metal, conductivity values are often negative ("polarity reversals") and highly irregular.

The transmitting and receiving coils in the EM31-DL have a fixed separation of 3 meters, and when used in its normal operating mode (vertical dipole mode), the EM-31 achieves a depth of penetration of about 6 meters. The instrument response is more affected by near-surface than by deeper material, especially when used in the vertical dipole mode.

SURVEY LIMITATIONS

EM terrain conductivity data is influenced by above-ground metal, such as cars, dumpsters, and buildings, and by electrical sources of noise, such as overhead power lines and radio broadcasting stations. These above-ground sources can create noise which may adversely effect an EM survey, and create unreliable conductivity data.

Buried metal may be concealed by highly conductive soils, such as sludge and landfill materials. This effect may be mitigated by using the in-phase component of the induced magnetic field in conjunction with the conductivity for data interpretation.

To obtain accurate conductivity readings, the terrain conductivity meter must first be calibrated in an area free of buried metal and overhead power lines. Because the survey area had significant sources of cultural noise, the EM-31 instrument was calibrated off-site, and hence there may be up to a 5% error in absolute conductivity and in-phase values.

EM-31 terrain conductivity meter.
Conductivity data is used to locate buried metal objects, leachate plumes, and conductive soils like sludge and soils filled with heavy metals.

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APPENDIX B

EM-61 METHOD OF INVESTIGATION

Manufactured by Geonics, Inc., the EM-61 is a time-domain electromagnetic instrument developed to find unexploded ordinances (UXOs) and other buried metal targets in environments where there may be a lot of interference from surface metal and overhead power lines. According to tests conducted by the manufacturer and reports from other geophysical service providers, the EM-61 is has a sensitivity sufficient to detect metal objects as small as a few centimeters.

The EM-61 operates on the principle that the time-decay rate (i.e. transient pulse) of a signal induced in metal decays proportionally to the mass of the metal object. The EM-61 works by generating an EM signal of known frequency and voltage at the transmitter, located in the backpack configuration. In the presence of metal objects, an EM signal is induced when the transmitted signal is applied. When the transmitter is switched off, the induced field decays at a rate specific to the metal mass in which it is induced. The EM-61 top and bottom receiver coils measure the decay voltage at a specific time (i.e. "time gate") after the transmit pulse has been shut off. The amplitude of the voltage after the transmit pulse has been shut off is proportional to the size of the metal object: the larger the voltage (as measured in millivolts) at the time of the measurement, the larger the metal object. High voltages indicate metal objects. Negative voltages can also indicate both above-ground and buried metal.

The EM-61 operates by pulling or pushing the instrumentation along survey lines spaced 5 feet apart. Data can be collected using an encoder or "DMI" - distance measurement instrument, which is built into the EM-61's left wheel, or manually. The station spacing varies, depending upon the application. For this survey, data were collected manually using a 2 foot station spacing as the main focus of the survey was to locate large metal objects (6,000 to 10,000 gallons each).

Four different data sets are generated from the two measurements made at top and bottom receiver coils: bottom, top, differential, and noise. Data obtained from the bottom receiver coil is considered to be most representative of buried and above-ground metal. Information from the top receiver coil is used with bottom coil measurements to calculate the differential data, which result from subtracting top coil measurements from bottom. Differential measurements help determine whether the source is from the above or below ground sources. Differential data are used to can also minimize the response from at or very near surface (i.e. 1 cm deep or less) metal. Positive voltages in the differential contour map shown in red, magenta, and pink, indicate buried metal. Blue or black filled contours indicate above-ground sources of metal. The "noise" calculations represent the bottom coil data that has been filtered to reduce the noise from spurious EM interference from overhead power lines, etc.

SURVEY LIMITATIONS

While differential and noise measurements help reduce EM noise from adjacent power lines, cell phone and radio towers, etc., the may not eliminate them completely. Therefore, in urban environments, data may appear noisy and not have a lot of continuity.

For maximum sensitivity, the EM-61 meter should be calibrated in an area free of buried metal and overhead power lines. Because the survey area had significant sources of cultural noise, the EM-61 instrument was not calibrated on site.

EM-61 being towed along to locate UXOs. Note GPS receiver attached several feet above the top coil. A GPS receiver was not used for this survey.

FIGURE 1
CONTOURED CONDUCTIVITY RESULTS
TRINIDAD PARK
BUFFALO, NEW YORK

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OCTOBER 2002

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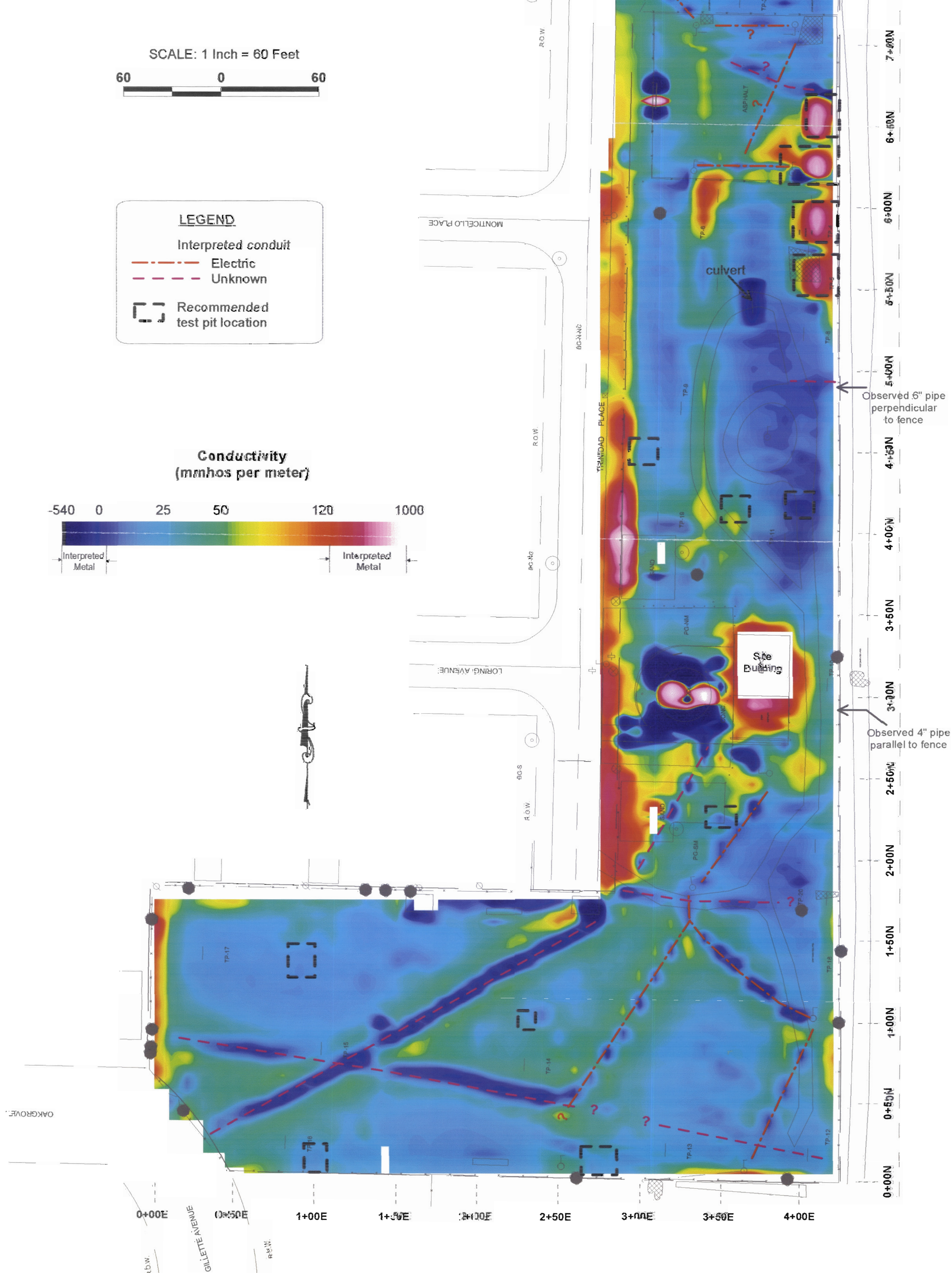

FIGURE 2
CONTOURED IN-PHASE RESULTS
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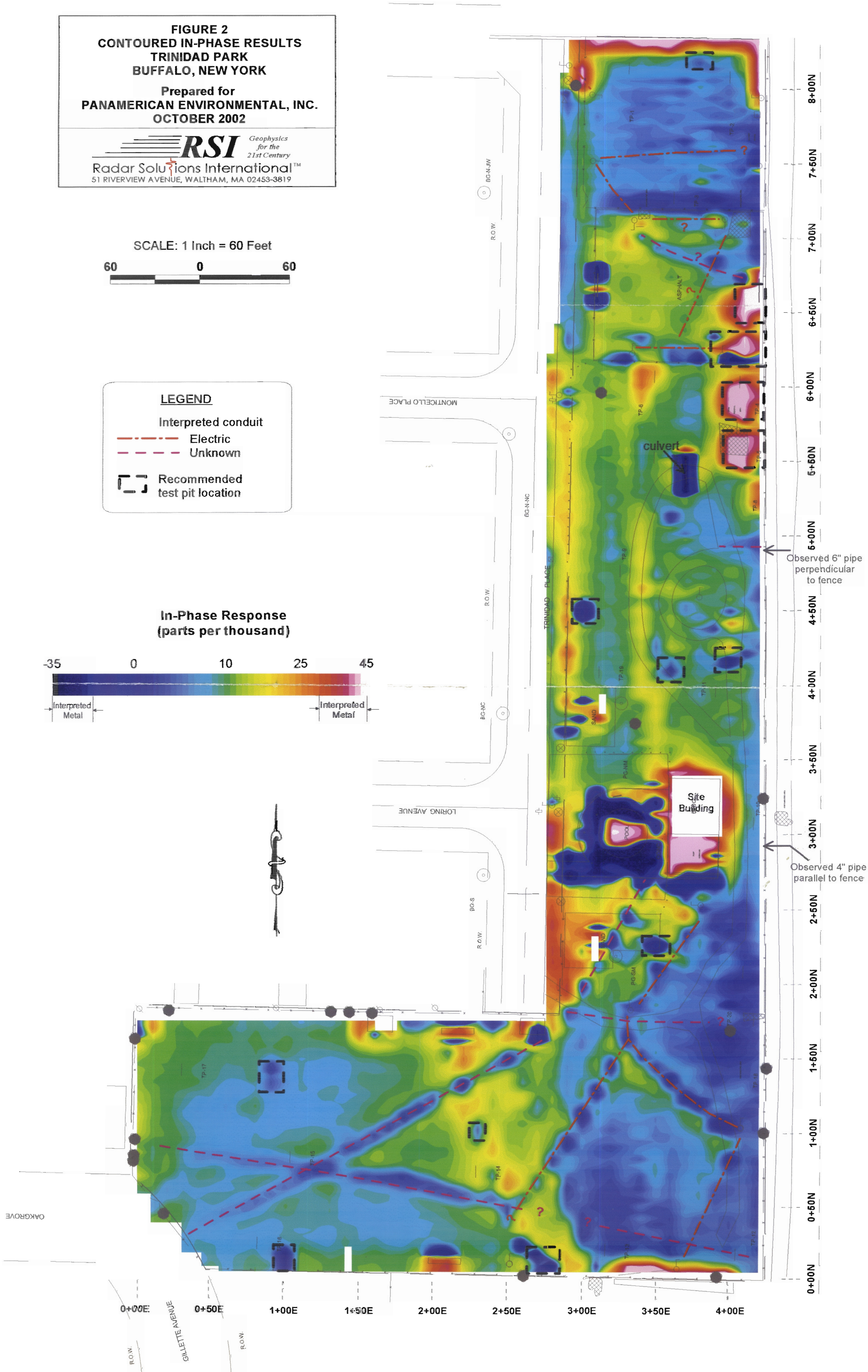

FIGURE 3
CONTOURED BOTTOM COIL RESPONSE RESULTS
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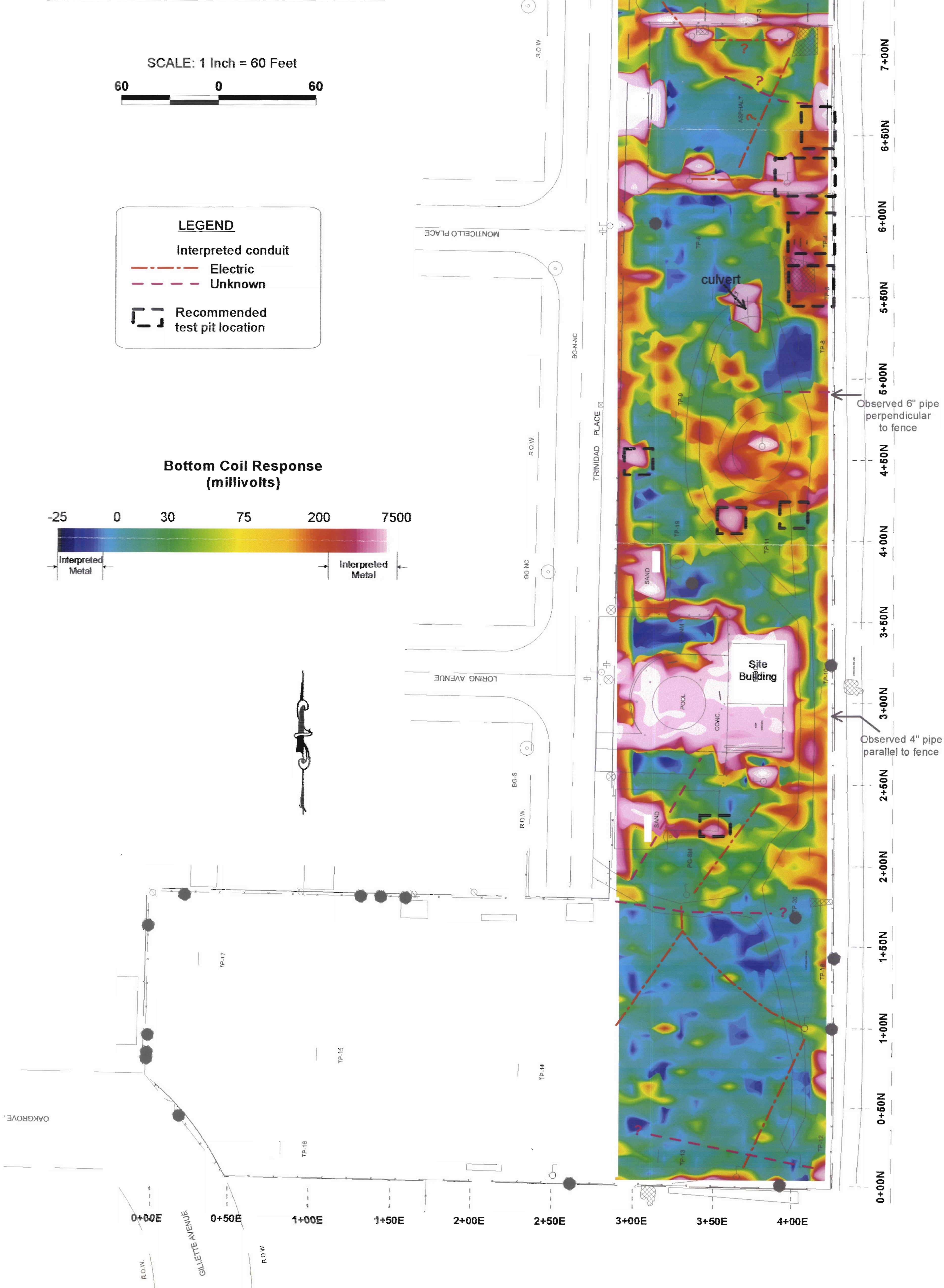

FIGURE 4
CONTOURED FILTERED BOTTOM COIL RESPONSE RESULTS
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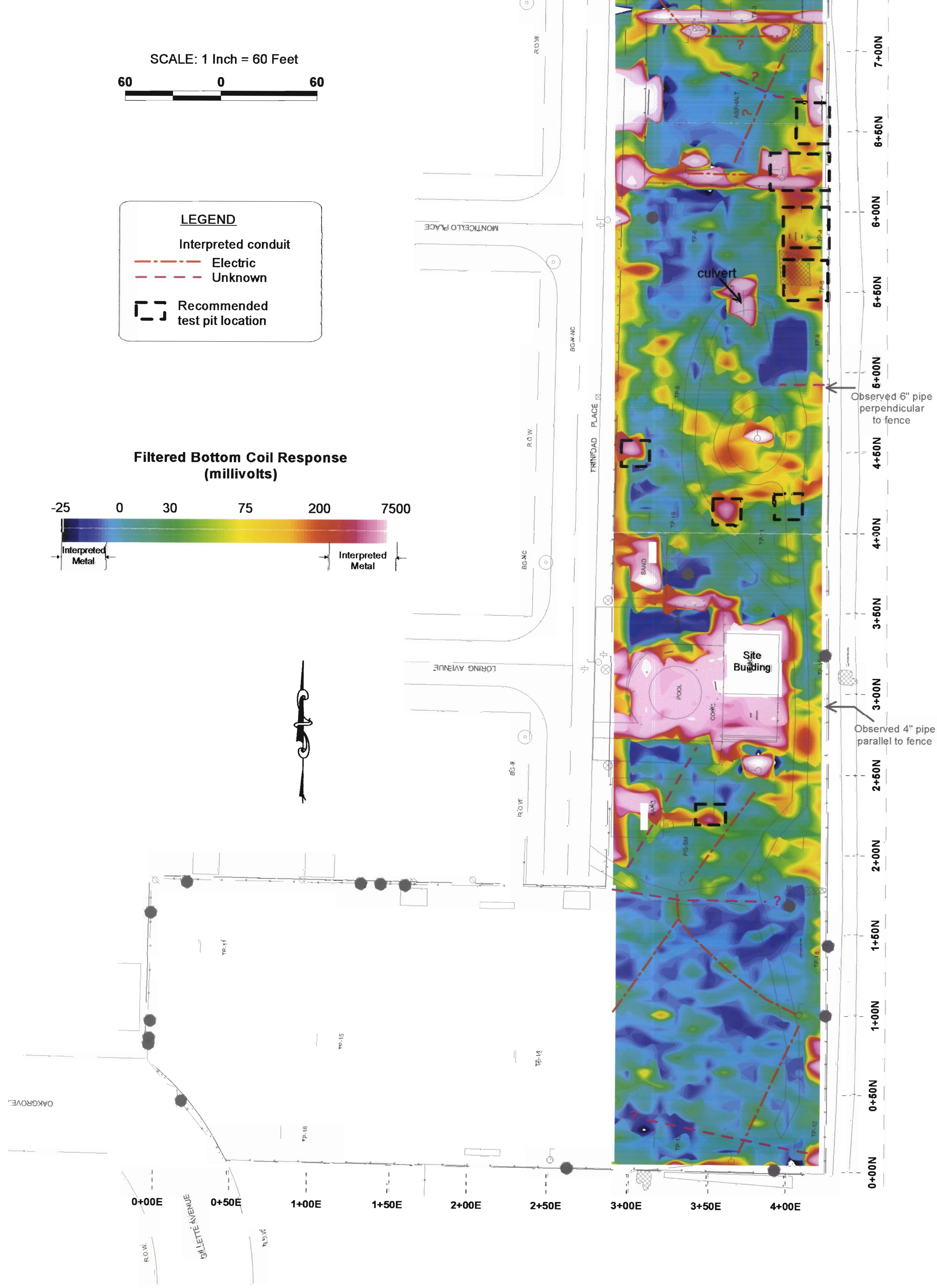

FIGURE 5
CONTOURED DIFFERENTIAL RESPONSE RESULTS
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SCALE: 1 Inch = 60 Feet

60 0 60

LEGEND

Interpreted conduit
Electric
Unknown

Recommended test pit location

Differential Response (millivolts)

-5000 0 20 50 2500

Interpreted Above-Ground Metal
Interpreted Buried Metal