US EPA RECORDS CENTER REGION 5
505735

EPA-Approved Geophysical Investigation Letter Work Plan

Karen Cibulskis to: Quigley, Steve, KBrown, jrc, Loney, Adam, Almeida, Luis, Paul Jack, roger.mccready 05/06/2008 11:28 AM

Cc: mankowski.matthew, vanderpool.luanne, matt.justice, mark.allen, brett.fishwild, tccampbell, nash.thomas, david.boehnker

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Hi Steve.

Attached is the EPA-Approved Geophysical Investigation Letter Work Plan with the following modifications:

1. In "Surveying", last paragraph, delete: "based on the findings of the other proposed investigative activities". Additional settlement monuments may be required based on existing Site information.
2. In "Geophysical Investigation", paragraph 4, add: "The usefulness of GPR at this Site may be limited by any heterogeneity of landfilled materials and uneven terrain. It may be difficult to determine whether GPR survey results have been affected by de-coupling (bouncing) on the ground or signal scatter due to ground matrix." (See discussion below).
3. In "Attachment A", paragraph 2, delete: "which is considered adequate for the purposes of detecting buried objects beneath the Site." Some parts of the landfill are as thick as 50 feet, and a significant portion of the landfill is below the water table. An effective depth of 17 feet will not detect buried metal objects in these areas.

If you agree with these changes, please make the attached redline/strikeout corrections in the work plan and resubmit it as a .pdf for EPA's records. It would also help if you could change the letter heading to "Final Geophysical Investigation Letter Work Plan" or something similar to avoid any confusion.

Also, although EPA is approving the Geophysical Investigation Letter Work Plan with the above modifications, EPA would like to add the following points:

1. EPA cautions CRA that it is very difficult to predict how GPR will work in Region 5 due to the complexity of Region 5 soils. Basically the only guarantee is to try it and see what results are obtained. When working over landfills, the problem becomes even more complex due to the matrix of the fill, and whether a clay cap exists which will denigrate the signal further. At best GPR can provide data to show where the landfill is present and where it is not, and maybe other details.

At this Site, EPA recommends a practice that is sometime used in Region 5 for the application of geophysical methods. First, run the magnetometer and try to determine if the anomaly size and mass (from the magnetometer data) matches the expected target. Then, use EM data to see if the refined shape (from EM data) of the anomaly matches the expected target. Comparing EM anomalies to magnetometer anomalies should provide a general indication of depth (provided the anomalies are ferrous).

After making these comparisons, then consider using GPR. If good ground coupling can be obtained (no tree stumps, or other obstacles that can cause the antenna to leave the ground) and assuming most of the signal is getting though to the target, one could expect to determine a more accurate depth measurement to the top (and the top only) of the anomaly. The GPR could also indicate whether the top(s) of the anomaly are flat, slanted or rounded, provided they are close enough to the surface and not randomly deformed (crushed drums-for example). However, EPA cautions that GPR may not provide any good data over the landfill.

When GPR is applied with the guidance of magnetometer and EM data to significantly narrow the scope of the anomalous areas, it also allows the GPR to be applied with tighter GPR grid spacing. GPR is best applied when used in a "lawn mower mode", that is each traverse is run next to the

previous run.

2. Although EPA is not requiring any additional modifications to the Geophysical Investigation Letter Work Plan, EPA also expects the GPR report to include discussions of methodology, data processing and interpretation. Specific components expected in the GPR report are listed below, and should be included in the FSP as specific items to be included/addressed in the GPR report:

- Justification of antenna frequency
- Discussion of software and removal of noise (subtracting the avg. trace).
- Justification of applied gain functions
- Selection of time frames chosen for signal amplification
- Justification of soil velocities used in calculating primary wavelength and theoretical minimum vertical resolution
- Calculation of the signal wavelength and theoretical minimum vertical resolution of each interpreted trace. For example, a signal with a 100 MHz frequency traveling through soil with a presumed soil velocity of 0.06 m/ns (wet clay), would have a primary wavelength of 60 cm. The resulting theoretical resolution would then be 15 cm (one quarter of the wavelength).
- Discussion of whether the scanned media is expected to contain objects with dimensions corresponding to the signal wavelength
- Discussion of whether suspected debris has created scatter or interference
- Potential attenuation from fluids
- Depth calculation of any interpreted reflectors (depth = soil velocity x one way travel time)
- Inclusion of radargrams for all scanned traces.

3. EPA and OPEA would prefer to have CRA provide the agencies with an opportunity to review the radargrams from the 40-foot scans before making any decisions to exclude scanning along a tighter 20-foot grid. However, EPA recognizes that this is not necessary to support EPA's presumptive remedy for the Site.

4. EPA thought the intent of the Site survey was to verify the accuracy of the topographic maps in Figures 2.2 and 2.3 of the draft RI/FS Work Plan and the Payne Firm Survey, which are based on 2-foot contour intervals. As such, EPA is not certain how useful a Site survey with 10-foot contour intervals will be. Although EPA is not requiring CRA to provide EPA with a higher resolution map, EPA will continue to rely on Figures 2.2, 2.3 and the Payne Firm Survey when more detailed topograph information is needed.

Thanks again for all of your work on this. If you have any questions or would like to discuss EPA's comments or the Site further please feel free to contact me via email or at 312-886-1843.

Karen.

EPA-Approved-Geophysics-WP 05-06-08.doc

April 18, 2008 Reference No. 038443

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Dear Karen:

Re: Land Survey, Bathymetry Survey, and Geophysical Investigation
South Dayton Dump and Landfill Site, Moraine, Ohio (Site)

This Letter Work Plan presents the South Dayton Dump and Landfill Potentially Responsible Party Group's (PRP Group's) approach for a land survey, bathymetry survey, and geophysical investigation of the Site. The work will help address data gaps and provide information to aid in the completion of a Feasibility Study (FS). The work will also allow for identification of surveyed areas that may require additional investigation or consideration prior to the beginning of intrusive fieldwork.

The PRP Group has prepared this Letter Work Plan based on discussions between the PRP Group and USEPA in February 2008 and April 2008. The Letter Work Plan incorporates comments received from USEPA on April 8, 2008.

SURVEYING

The objectives of the Site Survey are as follows:

- conduct a complete topographical survey of the entire Site by aerial photometry;
- survey locations of existing structures and features such as access roads, buildings, building foundations, fences monitoring wells, etc.;
- establish benchmarks for future surveying uses including but not limited to Site settlement monitoring;
- generate a current Site plan for use in future investigation and remedial alternative evaluation activities; and
- generate an accurate topographical map of the Site for use in determining current Site drainage patterns and for use in evaluating various landfill cap designs.

All survey work completed throughout this project will be performed by a State of Ohio registered land surveyor.

Survey data will be collected to obtain current topographic information in the area of the Site as bounded by the Great Miami River (GMR) to the north and west, Dryden Road to the east, East River Road to the southeast and Parcel 3264 to the south. The topographical survey will be completed utilizing aerial survey techniques. The Site was flown over April 2, 2008. Ten targets were placed on the ground in the survey area to act as control points for ground truthing the survey. In additional the horizontal locations of all boreholes, test trenches, test pits, monitoring wells, gas probes and staff gauges will be surveyed by ground personnel and reported in Ohio State Plane Grid Coordinates and in Decimal Degrees and elevations will be verified against the closest USGS benchmark monuments. Elevations will be surveyed according to the 1988 North American Vertical Datum (NAVD 88) for vertical coordinates and the 1983 North American Datum (NAD 83) for horizontal coordinates. Horizontal locations will be surveyed to the nearest 0.5-foot accuracy. Elevations for all monitoring well reference points (new and existing) will be surveyed to the nearest 0.01-foot accuracy. Elevations for all other locations will be surveyed to the nearest 0.1-foot accuracy. Five settlement monuments will be established within the PRP Group's preliminary direct contact risk presumptive remedy area in the central portion of the landfill on Lot 5177 for future use in settlement monitoring. The settlement monuments will be surveyed to the nearest 0.01-foot accuracy. The settlement monument locations are provided on Figure 1. Additional settlement monuments may be required in other areas of the Site ~~based on the findings of the other proposed investigative activities~~. The need for additional settlement monuments will be discussed with USEPA as further data with respect to the location of landfill material are obtained.

SURFICIAL METALLIC DEBRIS COLLECTION/STAGING

Prior to completing a geophysical investigation at the Site, CRA will retain a contractor to collect surfical metallic debris, empty drums and/or drum carcasses previously observed along the central access road and other areas across the Site, as necessary. The contractor will relocate this material to a central staging area located on-Site for interim storage in order to minimize its impact on the geophysical investigation. This debris will be managed as part of future waste characterization and consolidation activities, which will be conducted prior to implementing a remedy at the Site. Drums that are intact and have liquid or solid contents and are visually determined to be in poor condition will be left in place. The location and contents (based on visual observation) of these drums will documented in a logbook and also marked on a Site plan. The location of drums left in place will be surveyed with a global positioning system (GPS) receiver, and reported in Ohio State Plane Grid Coordinates and in Decimal Degrees.

These drum locations will be referenced to the same coordinate system used for the geophysical investigation, to allow surface metal locations to be easily matched to the geophysical maps.

The staging area will first be surveyed using the geophysical techniques identified below before it is constructed or used. After the geophysical investigation of the staging area, a staging pad will be constructed. The staging area will be installed with a containment berm and a 20-mil synthetic liner for leak and spill protection. The staging area will be located on Lot 5177 within the fenced in area of the Site for security purposes. Once debris collection is completed the area will be covered with polyethylene sheeting to prevent the accumulation of storm water within the area.

More than one staging pad may be constructed depending on how much debris is relocated. A typical staging cell construction detail is presented on Figure 2.

BATHYMETRY SURVEY

The objectives of the bathymetry survey are as follows:

- generate topographical information for the bottom of the Quarry Pond; and
- generate information for use in future investigation and remedial alternative evaluation activities.

A bathymetry survey will be completed to define the bottom of the Quarry Pond utilizing an echosounder attached to a GPS receiver to maintain control of sub-meter positioning. The bathymetry data and survey line locations will be stored in a digital format using Bathylog (or equivalent) software. The Echosounder and GPS will be programmed to collect respective data at 0.5- to 1.0-second time intervals. The bathymetry survey will be completed along pre-determined survey lines spaced 40 feet apart and oriented in an approximate north-south direction, which have been uploaded into the associated navigational software. Bathymetry data will also be collected on cross-lines oriented in an approximate east-west direction, and spaced 150 feet apart. Survey data will be used to complete a map of the Quarry Pond. Based on the results of the bathymetry survey an electromagnetic (EM) or magnetometer survey of the Quarry Pond will be completed to identify metallic anomalies (i.e., drums) on the bottom of the Quarry Pond.

Land versions of the EM and magnetometer will be used if the pond is shallow, and marine versions will be used if the pond is deep. Specifically, if the pond is less than 10 feet deep, EM61 and magnetometer surveys will be completed using raft-mounted land instruments. If

the pond is between 10 and 20 feet deep, EM31 and magnetometer surveys will be completed using raft-mounted land instruments. If the pond is between 20 and 30 feet deep, the EM survey will be completed using a marine EM instrument or an EM instrument with a 30-foot-depth of investigation; the magnetometer survey will be completed using raft-mounted land instruments. If the pond is more than 30 feet deep, EM and magnetometer surveys will be completed using marine instruments.

GEOPHYSICAL INVESTIGATION

The objectives of the geophysical investigation are as follows:

- identify buried metals and objects at the Site at surveyed locations; and
- identify Site areas which may require additional investigation.

The investigation will use magnetic, EM, and ground penetrating radar (GPR) techniques to identify both ferrous and non-ferrous buried metal objects at surveyed locations to depths of up 20 feet below ground surface. The magnetic survey will consist of total field and vertical gradient data collection. Magnetic field readings will be recorded at a background base station location during the course of the survey, to allow for correction of diurnal variation (i.e., magnetic drift), if necessary. The EM surveys will utilize an EM31-MK2 instrument (or equivalent), operating simultaneously in metal detection and conductivity modes, and an EM61 buried metal detector.

The EM61 survey will be used to detect the presence of buried metal objects in the shallow subsurface. The EM61 is a time domain instrument, which has an effective depth of investigation of approximately 10 feet below ground surface (bgs), and operates at a frequency of 150 Hz. The EM61 exhibits good lateral (or horizontal) resolution of buried metal objects (in the presence of one object or several objects situated in close proximity) in comparison to other EM methods, due to its stacked coil configuration. The coil separation for the EM61 is one foot. The EM31 survey will used to detect the presence of buried metal objects in the deeper subsurface. The EM31 is a frequency domain instrument, which has an effective depth of investigation of approximately 17 feet bgs when carried at hip level and operating in horizontal dipole mode. The EM31 exhibits good lateral (or horizontal) resolution for individual buried metal objects but in situations where two or more objects are in close proximity to each other, the EM31 cannot delineate individual responses. This limitation can be attributed to the location of transmitter and receiver coils at either end of a 13-foot long cylindrical boom. The EM31 operates at a frequency of 9.8 kiloHertz (kHz).

The depth of investigation of a GPR survey is inversely proportional to the frequency of the instrument. That is, the higher the frequency, the more rapidly the GPR signal will attenuate or

dissipate in the subsurface. Thus, the GPR survey will utilize a Ramac Rough Terrain Concept (RTC) low frequency system, with a 100-Mhz antenna (or equivalent) to optimize the depth of investigation. This instrument is characterized by an in-line transmitter-receiver antenna configuration, which allows for relatively rapid GPR data acquisition in comparison to other instruments. The EM and GPR surveys will also identify buried conduits or pipelines at the Site, the locations of which will be recorded for future reference. Conduits can include electric, communication, water, and gas lines as well as sewers and field tiles. Smaller conduits, however, may not be seen in surveyed areas where the ground is mostly clay with a high moisture content. The usefulness of GPR at this Site may be limited by any heterogeneity of landfilled materials and uneven terrain. It may be difficult to determine whether GPR survey results have been affected by de-coupling (bouncing) on the ground or signal scatter due to ground matrix.

The areas of the Site in which the geophysical investigation will occur are presented on Figure 3. It should be noted that existing material storage piles located on and adjacent to the Valley Asphalt and Custom Delivery properties (Lots 5054 and 5177) and existing building structures at the Site (Lots 4610, 5054, 5171, 5172, 5173, 5174, and 5175) will physically limit the extent of the geophysical survey to be conducted. Minor amounts of brush and tree cutting will be required to facilitate the geophysical survey. Survey lines will be cleared to a minimum width of 4 feet, to facilitate geophysical surveying activities and to provide good GPR contact, or coupling. The in-line transmitter-receiver configuration will ensure adequate coupling is maintained during the GPR survey, since the width of the antennas along the geophysical survey lines is relatively narrow (approximately 6 inches wide). Any cleared brush will be removed from the survey lines to mitigate slip, trip and fall hazards, and to facilitate progress of the geophysical surveys.

Prior to conducting the surveys, a grid consisting of parallel lines will be established over the area of investigation (shown on Figure 3). The grid will utilize a number of control points that will be surveyed for horizontal and vertical location at 150-foot intervals in the approximate north-south direction, and 160-foot intervals in the approximate east-west direction. Geophysical survey lines spaced 40 feet apart will be established between the control points, and will be designated with a Cartesian coordinate system as required by instrument data loggers. In addition, perpendicular (approximate east-west) geophysical survey lines will be established at 150-foot intervals, along the lines joining the control points. Magnetic, EM, and GPR measurements will be recorded at 0.5 second time intervals or, at a minimum, 0.7- foot distance intervals along these grid lines, and stored automatically in data loggers.

The anticipated vertical beam widths or effective investigative depths for the EM31 and EM61 are approximately 17 feet bgs (at hip level) and 10 feet bgs, respectively, as specified by the manufacturer. The vertical beam width or effective depth of investigation for the GPR survey

will be dependant on conditions encountered in the field and will be evident on the trace plots, once compiled. The horizontal beam width of these three surveys (EM31, EM61, and GPR) is relatively poor, and will generally be restricted to the trend of the geophysical survey line and immediate surrounding area (i.e., 2 to 3 feet off-line). The magnetometer survey is a passive geophysical method; therefore, beam width is perhaps not the most appropriate term in describing the radius of detection for this instrument. The concentration of magnetic flux of the induced field in a buried object is a function of the magnetic susceptibility of the buried object, the degree of degradation (i.e., rusting out) it has undergone, and the size and orientation of the buried object. However, magnetometer surveys can typically yield an anomaly on the order of several hundred nanoTeslas (nT) over objects such as drums buried approximately 20 feet bgs. In addition, the lateral or horizontal resolution of a magnetometer survey is good, whereby an elevated magnetic response can be observed 10 to 20 feet adjacent to the buried object.

The purpose of the proposed geophysical investigation will be to act as a "screening tool", by providing potential targets for intrusive work based on anomalous metal detection responses. As such, it is impossible to speculate what the nature or composition of any suspected metal detection targets are, or how many may be present, until the anomalies are excavated and ground-truthed. Further, the configuration of the instrument (EM31) or measured quantity (magnetic field) of some geophysical instruments precludes identification of individual buried metal objects when two or more of these objects are present adjacent to, or in close proximity to each other, both vertically and horizontally. The only exception whereby discrete anomalies in close proximity to each other may be delineated is with the EM61 survey results, in the shallow subsurface.

The data loggers will be referenced to the Site survey grid, and will not be tied into GPS automatically. This will allow for more rapid data acquisition and data assessment on-Site (since the coordinates will already be in a Cartesian system and won't require conversion from latitude/longitude). This will also allow for more accurate locating of anomalous responses along the geophysical survey lines. Following completion of the geophysical investigation, the location and extent of anomalous responses will be surveyed with a GPS system, and reported in Ohio State Plane Grid Coordinates and in Decimal Degrees (i.e., the same approach for the drums left in place).

The magnetometer, EM31, EM61, and GPR land surveys will be carried by operators, without the aid of a mobile system such as an ATV.

The geophysical investigation results will be presented as colored, contoured plots. The results will be used to finalize the locations of test pits and trenches.

The surface geophysical investigation will consist of collecting data on 40-foot spaced grid lines with intermediate 20-foot spaced grid lines over anomalous areas. The decision to perform 20-foot grid spacings will be evaluated at a minimum on a weekly basis on-Site, following a preliminary data assessment, which is scheduled to occur on the weekends or on rain days. The 20-foot grid spacings will be surveyed immediately following this evaluation, or following brush-clearing of the 20-foot grid lines, where required. CRA will discuss the results with USEPA and Ohio EPA's Site representative(s) as the work progresses; however, to accommodate the schedule, CRA does not intend to discuss the preliminary results with USEPA and Ohio EPA before starting 20-foot grids/concluding the survey.

Contour plots will be provided at appropriate intervals and color scales, to clearly accentuate anomalous responses.

The geophysical instruments used to collect the geophysical data will include:

- GEM GSM-19 Overhauser Proton Precession Magnetometer (or equivalent such as EG&G Geometrics G-858G cesium vapor magnetometer) to collect total magnetic field and magnetic gradient data;
- Geonics, Inc. EM-31 Ground Conductivity Meter to collect quadrature (terrain conductivity) and in-phase (metal detection) data;
- Geonics, Inc. EM-61 Buried Metal Detector to collect focused metal detection data; and
- Ramac RTC low frequency GPR system with a 100-Mhz antenna.

Instrument descriptions and survey procedures are provided in Attachment A.

The various geophysical surveys will be completed concurrently, to the extent practicable. Only one instrument of each type will be operated at any given time, to avoid potential interference of multiple signals, especially in the case of the EM31. Further, a minimum distance of 150 feet will be maintained between instruments at any given time, to avoid another source of potential interference.

An EM or magnetometer survey of the Quarry Pond will be conducted after the completion of the bathymetry survey. The bathymetry survey of the Quarry Pond will allow for the proper selection of the geophysical survey equipment, based on the depth of the water column. The Quarry Pond geophysical survey will be completed using a GPS to ensure complete and effective coverage of the area has been completed. The survey will be conducted using a small boat with an outboard motor towing a non-metallic raft with the GPS and survey equipment.

Specifically, the non-metallic raft will be constructed of wood, or other non-conductive material such as fiberglass.

The data will be used to identify areas of the Site that may require further investigation as part of the soil or groundwater sampling programs (under separate cover).

All work will be performed in accordance with the Field Sampling Plan, and Site Specific Health and Safety Plan pending USEPA's approval of these documents. Prior to conducting the work, local utility location services will be contacted to locate any known utilities.

SCHEDULE

The land survey, bathymetry survey, and the geophysical investigation work will be initiated within fifteen days of USEPA approval of this Letter Work Plan. These field tasks will be conducted concurrently and will be completed within an eight-week period of time. The PRP Group will provide the USEPA with verbal notification of field activities at least 15 days in advance of the initiation of field activities. Data processing, plotting, and drafting requirements for the bathymetry survey, land geophysics surveys, and waterborne surveys will take six weeks to complete, after which draft plots of the survey results will be provided to the PRP Group.

REPORTING

An updated Site plan and topographical map, and AutoCAD files with coordinates will be provided to the USEPA within one month of completion of the proposed work (i.e., the aerial photometry survey and survey of existing features (e.g. monitoring wells, surface water gauges, etc.). A preliminary topographical map will be provided to USEPA one month after the completion of the aerial photometry survey. The topographic map will be prepared with a 10-foot contour interval. The contour interval may be adjusted if Site conditions warrant the use of a finer interval. Geophysical and bathymetry reports will be forwarded to the USEPA within two weeks of the PRP Group's receipt of the reports.

A map showing known and found utilities and other conduits will be provided concurrent with the geophysical and bathymetry reports.

Should you have any questions on the above, please do not hesitate to contact us.

Yours truly,

CONESTOGA-ROVERS & ASSOCIATES

Stephen M. Quigley

LA/ca/28
Encl.

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Matt Justice, Ohio EPA (PDF)
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Robin Lunn, Mayer Brown (PDF)
Roger McCready, NCR (PDF)
Karen Mignone, Pepe & Hazard (PDF)
Adam Loney, CRA (PDF)

ATTACHMENT A

INSTRUMENT DESCRIPTION AND SURVEY PROCEDURES

Instrumentation Description and Survey Procedures

The magnetometer records total magnetic field data from two sensors, top and bottom. The difference in total magnetic field between the two sensors divided by the vertical distance between the sensors equals the magnetic gradient. Magnetometers detect the presence of ferro-metallic objects, and are capable of lateral resolution of anomalies (i.e. anomalous responses are often observed adjacent to the buried object in addition to directly over the object). This allows for greater line and station spacings, and relatively rapid coverage of an investigative area. During the course of the survey, repeat readings will be recorded at a base station location situated away from any source(s) of magnetic interference to assess the degree of naturally-occurring diurnal variation (i.e. magnetic drift).

The EM31 consists of transmitter and receiver coils located at opposite ends of a 14-foot long boom. In vertical dipole mode, this coil configuration yields an approximate depth of penetration of 20 feet. As indicated by the manufacturer of the EM31, Geonics Limited (www.geonics.com), the effective depth of investigation for the EM31 is 6 meters, or approximately 20 feet below ground surface (bgs) in horizontal dipole mode. At hip level, this depth decreases to approximately 17 feet bgs~~, which is considered adequate for the purposes of detecting buried metal objects beneath the Site~~. The EM31 is capable of operating simultaneously in both terrain conductivity and metal detection modes. The EM31 will be utilized in metal detection mode, since this instrument is capable of inducing secondary fields in all conductive buried metallic objects. Terrain conductivity readings will also be measured, in order to delineate areas of conductive fill.

EM31 metal detection anomalies can be characterized by two types of responses. Large anomalies covering a relatively wide area are identified by elevated responses, whereas smaller anomalies are characterized by very low (negative responses). The explanation of these results can be attributed to the 14-foot separation between the transmitter and receiver coils of the EM31. When sources of anomalies are much larger than the 14-foot coil spacing, the signal received by the EM31 becomes saturated, resulting in an elevated reading. When an object is smaller than the 14-foot coil spacing, the secondary field induced in the object opposes the primary field, yielding a negative resultant field (expressed as a percentage of the primary field). Both elevated and negative metal detection anomalies indicative of buried metal will be identified in the EM31 survey results.

The EM61 is a time-domain buried metal detector that consists of two rectangular transmitting and receiving coils in a stacked configuration, connected to a data logger. The coils measure approximately 1.5 by 3 feet, and are mounted to a wheeled cart. The transmitting coil emits 150 EM pulses per second into the ground at each measuring point. During the off time between transmitted pulses, receiver coils measure the decay of the transient electrical currents induced by the pulses. Electrical currents in moderately conductive earth materials (including moist clays, mineralized soils, etc.) dissipate rapidly, leaving only the more prolonged currents due to buried metal objects. The EM61 detects and measures the prolonged transient currents, yielding a result in millivolts (mV) proportional to the metallic content of the buried object, and inversely proportional to its depth of burial. Due to its stacked coil configuration, the EM61 is less susceptible to potential sources of interference including parked vehicles, fence lines, staged drums, power lines, etc. The EM61 survey will be completed along the survey lines by automatically triggering a reading at 0.7-foot stations. The effective depth of penetration of the EM61 is approximately 10 feet.

The Ramac™ Rough Terrain Concept (RTC) low frequency GPR system transmits at 100 Mhz, and is characterized by an in-line transmitter-receiver antenna configuration. GPR systems utilize pulsed EM waves, which are emitted from a transmitting antenna. They are propagated into the ground, and travel at velocities determined by the electrical properties of earth materials. As a GPR wave moving downward in the subsurface hits a buried object or boundary with different electrical properties, part of the wave energy is reflected back to the surface and is detected by a receiving antenna. The reflected wave is stored digitally, and processed as a trace of signal versus amplitude. As the antennas are moved along a survey line, a series of traces are recorded at discrete points. When presented collectively, these traces display a profile of the subsurface. The depth of subsurface penetration is directly dependent upon the frequency of the GPR system, and the conductivity of the soil. Signal attenuation is greater for higher frequencies, and also greater for conductive soils.

The geophysical survey procedures will be as follows:

1. The geophysical survey grid setup will commence with surveying of the control points at 150-foot intervals in the north-south direction and 160-foot intervals in the east-west direction, as indicated on Figure 3. Concurrently, brush clearing will commence between these control points, to facilitate additional grid setup described below;
2. The geophysical survey grid will be set up such that survey lines are spaced 40 feet apart. Wooden survey stakes labeled with the grid coordinates will be placed at 150-foot intervals along each gridline via surveying. Horizontal locations will be surveyed relative to the Ohio State Plane Grid Coordinates and Decimal Degrees. Elevations will

be surveyed relative to NAVD 88. Horizontal locations will be surveyed to the nearest 0.5-foot accuracy relative to NAD 83. Elevations will be surveyed to the nearest 0.1-foot accuracy;

3. Geophysical data will be collected using a data logger on each geophysical instrument. The data recording for the magnetometer, EM31, EM61 and Ramac GPR system will be initiated for each station by the operator pressing the recording button. The station spacing for the magnetometer and EM31 will be approximately 5 feet, and will be determined via pacing. The EM61, will be utilized in wheeled mode, and will automatically trigger the data logger to record a reading at 0.7-foot intervals.

4. The magnetometer survey will also include the use of a base station to determine diurnal variation. The base station(s) will be set up in area(s) free of ferromagnetic waste and base station readings will be recorded several times a day during the course of the survey. Base station readings will be recorded at a minimum of every 4 hours, to verify that the diurnal variation in the earth's magnetic field is negligible (i.e. <50 nT). Solar forecasts will be reviewed on a daily basis and in instances where increased solar activity is forecast, the magnetic survey will be temporarily suspended;

5. Data reduction will include downloading from the data loggers to a computer. The downloaded data will be processed for location. Magnetometer data may be corrected for diurnal variation, if required; and

6. The data will be contoured using SURFER® (Golden Software, Inc.). Separate contour plots for each data type will be prepared. Manual interpretation of the plots will be performed to assess the identified anomalies. This interpretation will include identification of anomalous areas for further investigation.

The 20-foot grid spacing will be completed for anomalies exhibiting the following responses: an in-phase response of 10ppt above background for the EM31, a metal detection response of 500 mV above background for the EM61, and a total magnetic field response of 500 nT above background for the Overhauser magnetometer. Geophysical and bathymetry reports will be forwarded to the USEPA within two weeks of the PRP Group's receipt of the reports. The decision to perform 20-foot grid spacings will be evaluated at a minimum on a weekly basis, following a preliminary data assessment which is scheduled to occur on the weekends or on rain days. Grid spacings at intervals less than 20 feet are presently not being considered. Thus, an anomalous response that is detected along a trend between 2 or more adjacent survey lines will be considered to be continuous between these adjacent survey lines.

The GPR data processing will consist of background (noise) removal, application of low- and high-pass filters, and Automatic Gain Control (AGC) gain to optimize the response

of the GPR traces. GPR reflectors suspected of representing buried metal drums will be interpreted on the basis of a characteristic arch-shaped response.