Geophysical Survey LLC
2200 W 8th Place
Kennewick, Washington 99336

August 7, 2009

Elizabeth Siping
Columbia Environmental Sciences, Inc.
6503 W. Okanogan Ave., Suite C
Kennewick, Washington 99336

Re: ***Geophysical Site Investigation***
H & H Farms
Grandview, Washington

Dear Ms. Siping:

Geophysical Survey LLC conducted a geophysical site investigation at the H & H Farms at 53 Bethany Road, Grandview, Washington. Two sites were surveyed, each is approximately 1.5 acres. Site B1 is part of the vineyard and was surveyed on July 15th and 17th, 2009. Site 2B is an alfalfa field and was surveyed on August 4, 2009. The objectives of the geophysical investigation were to detect and delineate buried debris piles.

Methodology

Electromagnetic Induction (EM-31)

EMI techniques are used to determine the electrical conductivity of the subsurface soil, rock, and groundwater. They are generally used for shallow investigations. The method is based on a transmitting coil radiating an electromagnetic (EM) field which induces eddy currents in the earth. A resulting secondary EM field is measured at a receiving coil as a voltage which is linearly related to the subsurface conductivity.

Terrain (or ground) conductivity is a function of the natural soil matrix and pore fluid electrical conductivity. The depth of investigation is dependent upon the electrical conductivity of the subsurface, the distance between the transmitting and receiving coils, sensitivity of the equipment, and the power of the source. The conductivity value resulting from a measurement is a composite, and represents the combined effects of the thickness of the stratigraphic layers, their depths, their specific conductivity, and any man-made conductive objects that may be present such as metal objects. The quadrature component indicates the bulk apparent conductivity of the volume of ground sampled, in milli-Siemens per metre (mS/m). The in-phase component is expressed in parts per thousand (ppt). Phase changes between the primary and secondary field are used to indicate the presence of metallic objects.

Ground-Penetrating Radar

Ground-penetrating radar (GPR) uses a transducer to transmit FM frequency electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in dielectric constants, magnetic susceptibility, and to some extent, electrical conductivity, reflect the transmitted energy. The GPR system then measures the travel time between transmitted pulses and arrival of reflected energy. Buried objects such as pipes, barrels, foundations, and buried wires can cause all or a portion of the transmitted energy to be reflected back towards a receiving antenna. Geologic features such as cross-bedding, lateral and vertical changes in soil properties, and rock interfaces can also cause reflections of a portion of the EM energy.

The dielectric constant and magnetic susceptibility of the medium primarily control the velocity of the EM energy. Values of EM velocities, for depth calculations, are determined by measurement, experience in an area, by ties to known buried reflectors, and from knowledge of the subsurface medium.

The depth of investigation is a function of the transmit power, receiver sensitivity, frequency of the antenna, and attenuation of the transmitted energy due to the geologic medium. The maximum depth of investigation may vary significantly as a result of the changing soil conditions. High attenuation, and therefore smaller penetration depths, of the EM energy typically occurs where the soil conductivity is greater than 25 milli-siemens per meter and/or in areas with numerous reflective interfaces. Depth of investigation is also affected by highly conductive material, such as metal drums and pipes that essentially reflect all the energy. The method cannot “see” directly below areas of highly reflective material because all of the energy is reflected.

FIELD SURVEY

Mapping Control

Mapping control was established using DGPS (differential global positioning system) with sub-meter accuracy.

EM Data Acquisition

Electromagnetic data were collected using a Geonics EM31 Ground Conductivity meter. Apparent conductivity and in-phase response data were collected at 0.2 second intervals on transects spaced approximately 3 meters apart (Figure 1). Data was digitally recorded with DGPS data on an Allegro Field PC. Electromagnetic data contours are shown on Figures 4 & 5.

GPR Data Acquisition

GPR data were acquired with a Geophysical Survey Systems, Inc. (GSSI) SIR3000 control unit and a 270 MHz antenna. Location control was established using a survey wheel and DGPS to map profile endpoints. GPR data were collected at 50 scans/meter on transects spaced approximately 3 meters apart (Figure 1) at Site B1. GPR data was not collected at Site B2 due to poor data quality.

RESULTS AND INTERPRETATION

Site B1

The ground conductivity survey provided high quality data in the area of the newer vines. The support wires running between posts did not provide significant interference and three anomalous areas were detected. The anomalies were digitized from EM contour plots and flagged. Four transects were run thru the length of the older vines but the data were affected by the support wires between vines. The ground conductivity meter is sensitive to linear conductors and the increased length of the wires in the older section of the vineyard provided a large source for cultural contamination. The EM anomalies below are shown on Figure 2.

Anomaly A;

Anomaly A (Figure 2) is an electromagnetic in-phase response indicating elevated metallic content. The anomaly shows a small increase over background levels and there is not an apparent conductivity anomaly associated with it. The anomaly is not characteristic of a debris pit containing large amounts of reinforced concrete.

Anomaly B;

Anomaly B (Figure 2) is an EM anomaly with elevated apparent conductivity values and an in-phase response typical of a metallic target.

Anomaly C & D;

Anomaly C (Figure 2) has a moderate increase in in-phase response and is coincident with Anomaly D (an apparent conductivity peak). GPR data in this area was poor but, the concurrent peaks in conductivity and metallic content are typical of a metallic target.

Ground penetrating radar data quality was moderate to poor. GPR is most effective in areas where ground conductivity is 25 milliSiemens per meter (mS/m) and below. The background conductivity values at the site are approximately 50 mS/m, typical of soils with silts, clays and heavily watered areas. GPR signal attenuated rapidly beyond one meter in depth, non-metallic targets and features would not be detected beyond this depth. A strong reflective horizon was evident in most radar records at the boundary of the new and old vines. The continuous horizon is typical of an undisturbed soil horizon and was at a depth of 0.6 meters. In the center of the survey area (thru Anomaly D) GPR data quality was poor. The most likely causes for this are a higher degree of water saturation of the soils or backfilled soils with a higher conductivity. There were a large number of isolated, low-frequency parabolic reflectors in the data. These low amplitude reflectors are typical of non-metallic reflectors such as pvc lines, pieces of concrete, and cobbles. Higher amplitude horizontal reflectors were delineated in several areas. These targets may represent pieces of reinforced concrete or strong soil horizons. Excavation features such as shallow sidewall features were interpreted in the data but no targets typical of a debris pit or landfill are evident due to the quality of the GPR data.

A Schonstedt magnetometer was used on the four EM transects thru the older vines. While the T-posts were evident along the rows, no metallic anomalies were detected. A Radiodetection RD7000 utility locator was used across the newer vines survey area. No live electrical or continuous conductive utility lines were detected. PVC lines in the area would not be detected.

Site B2

The ground conductivity survey across the alfalfa field yielded total of 16 in-phase targets of an amplitude typical of metallic targets. The anomalies were digitized from EM contour plots and flagged. The EM anomalies below are shown on Figure 3.

Anomaly E;

Twelve targets were flagged (Figure 3), each displayed elevated in-phase response characteristic of a metallic target.

Anomaly F;

Four targets were identified on the southern edge of the survey area as Anomalies F (Figure 3). The metallic targets are coincident with culverts and irrigation lines from the canal directly south of the survey area.

CLOSURE

Geophysical surveys performed as part of this survey may or may not successfully detect or delineate any or all subsurface objects or features present. Locations, depths and scale of buried objects or subsurface features mapped as a result of this survey are a result of geophysical interpretation only, and should be considered as confirmed, actual, or accurate only where recovered by excavation or drilling.

Geophysical Survey LLC performed this work in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No warranty, express or implied, beyond exercise of reasonable care and professional diligence, is made. This report is intended for use only in accordance with the purposes of the study described within.

Thank you for the opportunity to work with Columbia Environmental Sciences, Inc. Please feel free to call if you have questions or need additional information.

Respectfully,

Geophysical Survey LLC

Mark Villa L.G.
Geophysicist

Geophysical Site Investigation

H & H Farms

Grandview, Washington

LIST OF FIGURES