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APPENDIX E

MIP REPORTS (COLUMBIA TECHNOLOGIES, LLC)

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SmartData Solutions®

Subsurface Characterization Using Membrane Interface Probe (MIP) and Soil Conductivity (SC) Technologies Lee Street - Area A Buffalo, New York

PREPARED FOR

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August 22, 2007

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Introduction

Mactec contracted **COLUMBIA Technologies, LLC (COLUMBIA)** to conduct an investigation of subsurface contamination at the Lee Street - Area A site, located in Buffalo, New York. This investigation involved delineating the depth and horizontal extent of contamination using Membrane Interface Probe (MIP) and Soil Conductivity (SC) technologies. The purpose of this investigation was to characterize subsurface soils in the vadose and saturated zones, and delineate the nature and extent of soil and groundwater contamination.

The investigation was conducted June 25, 2007 through July 3, 2007 by COLUMBIA.

Objectives

The objectives of the MIP/SC investigation were to:

1. Characterize subsurface soils in the vadose and saturated zones.
2. Delineate the lateral boundaries of the contaminant in soil and groundwater.
3. Delineate the vertical extent of contamination in soil and groundwater.

Equipment Description

The MIP/SC probe is approximately 12-inches (30 cm) in length and 1.5-inches (3.8 cm) in diameter. The probe is driven into the ground at the nominal rate of one foot per minute using a Geoprobe® or similar direct push rig.

Soil conductivity, the inverse of soil resistivity, is measured using a dipole arrangement. In this process, an alternating electrical current is transmitted through the soil from the center, isolated pin of the probe. This current is then passed back to the probe body. The voltage response of the imposed current to the soil is measured across these same two points. Conductivity is measured in Siemens/meter, and due to the low conductivity of earth materials, the SC probe uses milliSiemens/meter (mS/m). The probe is reasonably accurate in the range of 5 to 400 mS/m. In general, at a given location, lower conductivity values are generally characteristic of larger particles such as sands, while higher conductivities are characteristic of finer sized particles such as silts and clays.

The MIP portion of the probe was developed and patented by Geoprobe Systems, Inc. The operating principle is based on heating the soil and/or water around a semi-permeable polymer membrane to 121°C, which allows volatile organic compounds (VOCs) to partition across this membrane. The MIP can be used in saturated or unsaturated soils, as water does not pass through the membrane. Nitrogen is used as a carrier gas, and travels from a surface supply down a transfer tubing which sweeps across the back of the membrane and returns any captured VOCs to the installed detectors at the surface. It takes approximately 37 seconds for the nitrogen gas stream to travel through 100 feet of inert tubing and reach the detectors.

COLUMBIA utilizes three detectors: a Photo Ionization Detector (PID), a Flame Ionization Detector (FID) and an Electron Capture Detector (ECD), mounted on a laboratory grade Shimadzu Model 14A gas chromatograph. The output signal from the detectors is captured by a MIP data logging system installed on a MIP Field Computer or laptop computer. Conductivity, speed, detector data and temperature are displayed continuously in real time during each push of the probe. In addition, the data logs can be printed for display and analysis following the data logging run or exported to common spreadsheet software for further analysis using COLUMBIA's ***SmartData Solutions***^{tm} technology.

The PID detector consists of a special UV lamp mounted on a thermostatically controlled, low volume, flow-through cell. The temperature is adjustable from ambient temperature to 250°C. The 10.2 electron volt (eV) UV lamp emits energy at a wavelength of 120 nanometers, which is sufficient to ionize most aromatics (benzene, toluene, xylene, etc.) and many other molecules (e.g. H_2S, hexane, ethanol) whose ionization potential is below 10.2 eV. The PID also emits a lower response for chlorinated compounds such as TCE and PCE. Methanol and water, which have ionization potentials greater than 10.2 eV, do not respond on the PID. Detection limits for aromatics are in the low picogram range at the detector. Since the PID is non-destructive, it is often run first in series with other detectors for multiple analyses from a single injection. Use of the PID is mandated in several EPA methods (8021, TO-14 etc.) because of its sensitivity and selectivity.

The most commonly used GC detector is the FID, which responds linearly over several orders of magnitude from its minimum detectable quantity of about 100 picograms. The FID response is very stable from day to day, and is not susceptible to contamination from dirty samples or column bleed. This detector responds to any molecule with a carbon-hydrogen bond, but poorly to compounds such as H_2S, CCl_4, or NH_3. The carrier gas effluent from the GC column is mixed with hydrogen and burned. Hydrogen supports a flame and ionizes the analyte molecules. A collector electrode attracts the negative ions to the electrometer amplifier, producing an analog signal, which is directed to the data system input.

The ECD detector consists of a sealed stainless steel cylinder containing radioactive Nickel-63. The Nickel-63 emits beta particles (electrons), which collide with the carrier gas molecules, ionizing them in the process. This forms a stable cloud of free electrons in the ECD cell. When electro-negative compounds (especially chlorinated, fluorinated or brominated molecules) such as carbon tetrachloride or TCE enter the cell, they immediately combine with the free electrons, temporarily reducing the number remaining in the electron cloud. The detector electronics, which maintain a constant current of about 1 nanoampere through the electron cloud, are forced to pulse at a faster rate to compensate for the decreased number of free electrons. The pulse rate is converted to an analog output, which is transmitted to the data system.

System Performance Testing

Prior to logging each MIP location, performance tests with specific compounds are conducted to evaluate the sensitivity of the particular probe, transfer line and detector suite to be used. An aqueous phase test is performed prior to each location using neat benzene and neat TCE. The resulting values are recorded and compared to predetermined values.

Investigation Methods

MIP/SC profiling was conducted at 20 locations total on the property of the Lee Street - Area A, selected by Mactec's representative onsite. Location, MIP-20 was advanced at an offset to MIP-04 to confirm the results obtained from MIP-04. Because of the close proximity of these locations, one label may obscure the other in the graphics. Drilling was completed using a Geoprobe® rig, and termination of MIP logging was determined by Mactec's representative onsite. The results from each location are shown in Appendix A. Maps and 3D graphics of the site have been prepared for easier visualization of the subsurface. .

MIP Log Interpretation

Each MIP log includes six separate graphs of data. The first graph is conductivity and is measured in mS/M. In general, lower conductivities are indicative of coarser grained particles, such as sands, and higher conductivities indicate finer grained particles, such as silts and clays. The second graph is the rate of penetration (speed of the probe) and is measured in feet/min.

This information can be used to determine how hard the subsurface is. The next three graphs are chemical data: PID, FID, and ECD, measured in microvolts (uV). These graphs are a linear scale, and give relative concentrations of contamination. The last graph displays the temperature of the probe as it is advanced in the subsurface. This graph can be useful to determine where the groundwater table is located.

SmartData Solutions®

COLUMBIA's SmartData Solutions® is a patent pending process that enables the rapid processing of field data into easy to understand 3D visualizations posted to a password protected website. This process includes quality assurance, formatting and rapid visualization of the data for the project team and enables a complete check of the dataset prior to completion of fieldwork.

Plume Delineation and Volume

The SmartData Solutions® graphics display a 3-dimensional view of the contamination plume. These plumes are calculated by extrapolating data between measured data points. The plume is calculated only within the bounds of the outermost measured points. A plume is considered to be unbounded when it extends to the bounds of those outermost measured points. A fully bounded plume will exist entirely within the confines of the outermost measured points.

The SmartData Solutions® graphics also display a plume volume calculation in the heading. This volume is based on the minimum response level listed in the heading. Volume is calculated by using the scale of the map provided. As a result, the plume calculation is only as accurate as the scale and details of the map. It is important to note that the plume volume calculation reflects only the portion of the plume that exists within the outermost measured points. The volume reported of an unbounded plume may be greatly understated. In any case, the volumes reported are intended for general planning purposes only and may vary from actual volumes.

3-Dimensional Orientation

The SmartData Solutions® graphics use a relative azimuth system to describe map orientation because many maps are not oriented with true North at the top of the map. The relative azimuth system uses a 360° compass to describe the position from which the graphic is being viewed. For example, a viewer "looking east" on a North oriented map would have a relative azimuth of 270°., i.e. the viewer would be standing on the "western" 270° azimuth point looking through the center to the "east".

The header also describes elevation. Elevation is the number of degrees that the graphic is rotated on the vertical Z axis. A plan view has an elevation of 90°; a transect view has an elevation of 0°.

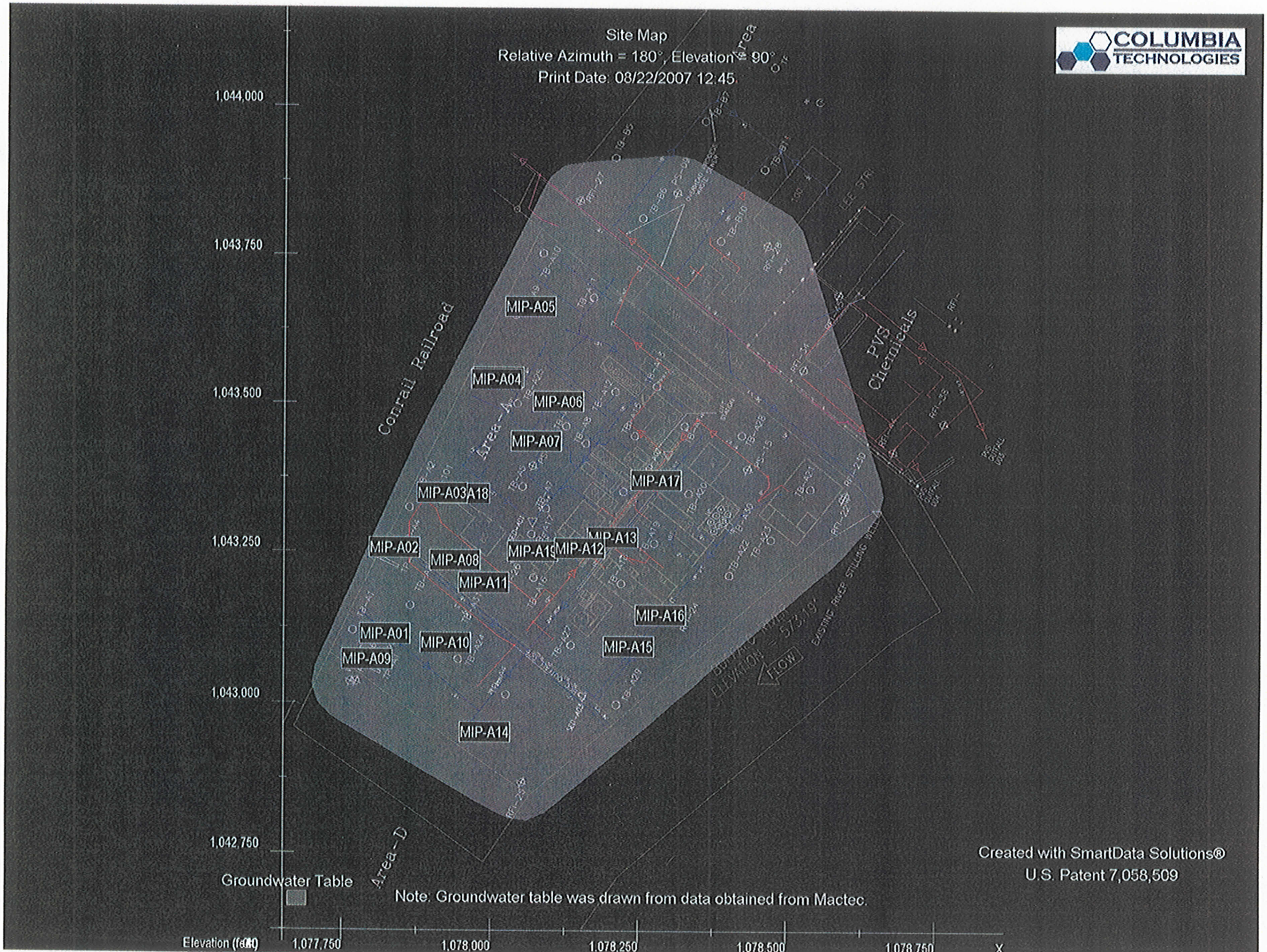

Figure 1 Sitemap and MIP Locations
June 25, 2007 – July 3, 2007

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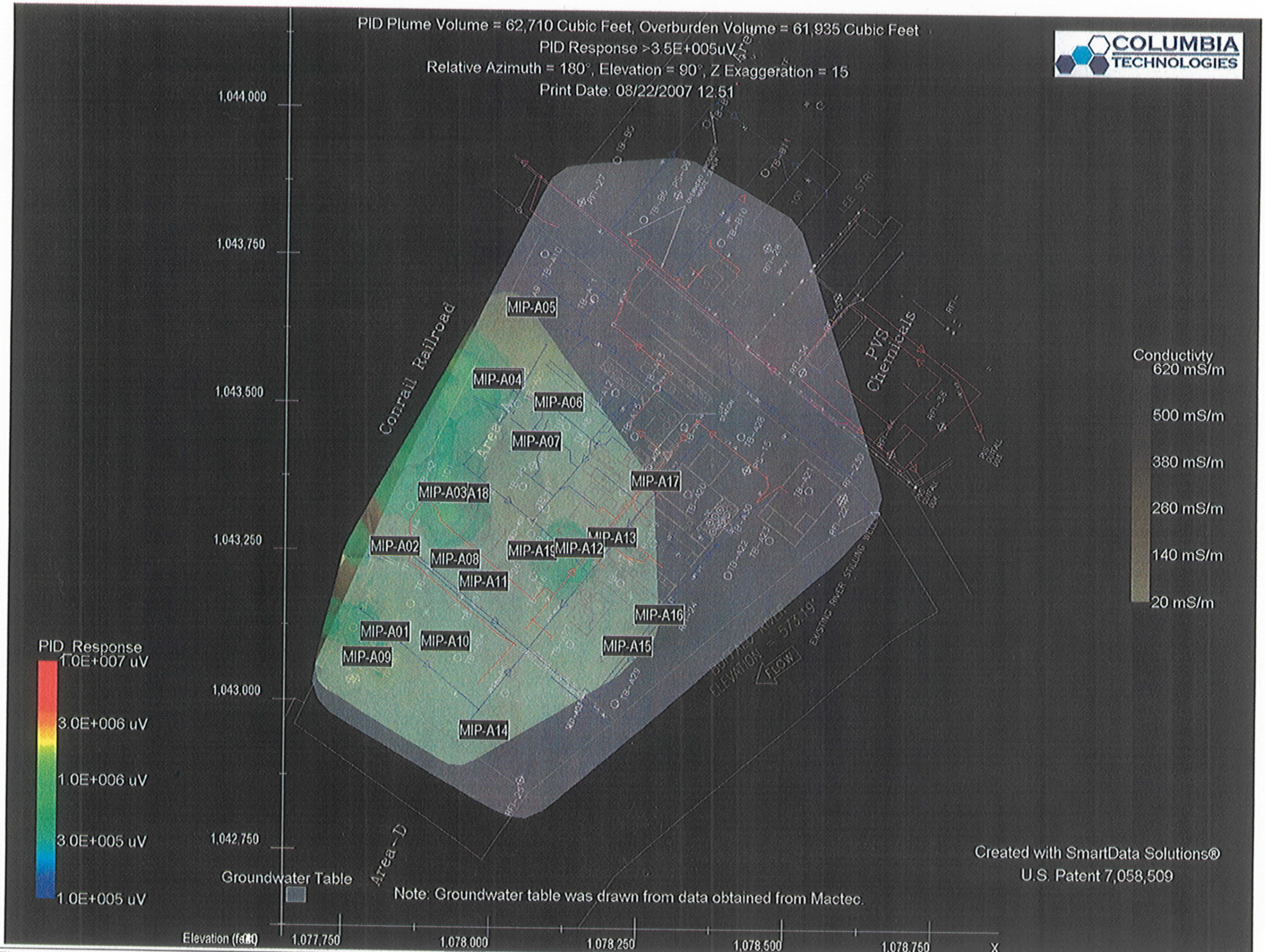

Figure 2 Plan View Relative Azimuth 180°
June 25, 2007 – July 3, 2007

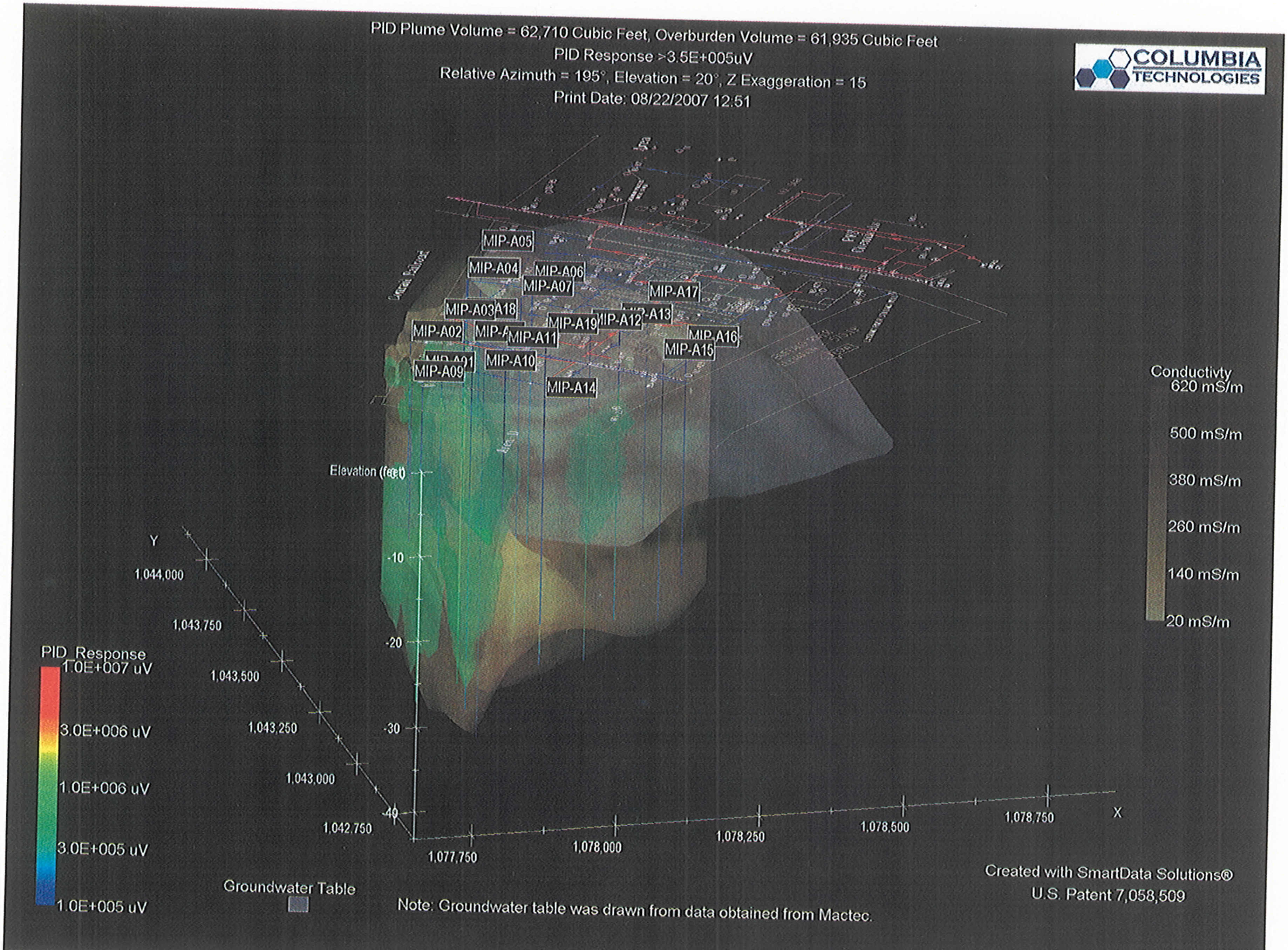

Figure 3 Oblique View Relative Azimuth 195°
June 25, 2007 – July 3, 2007

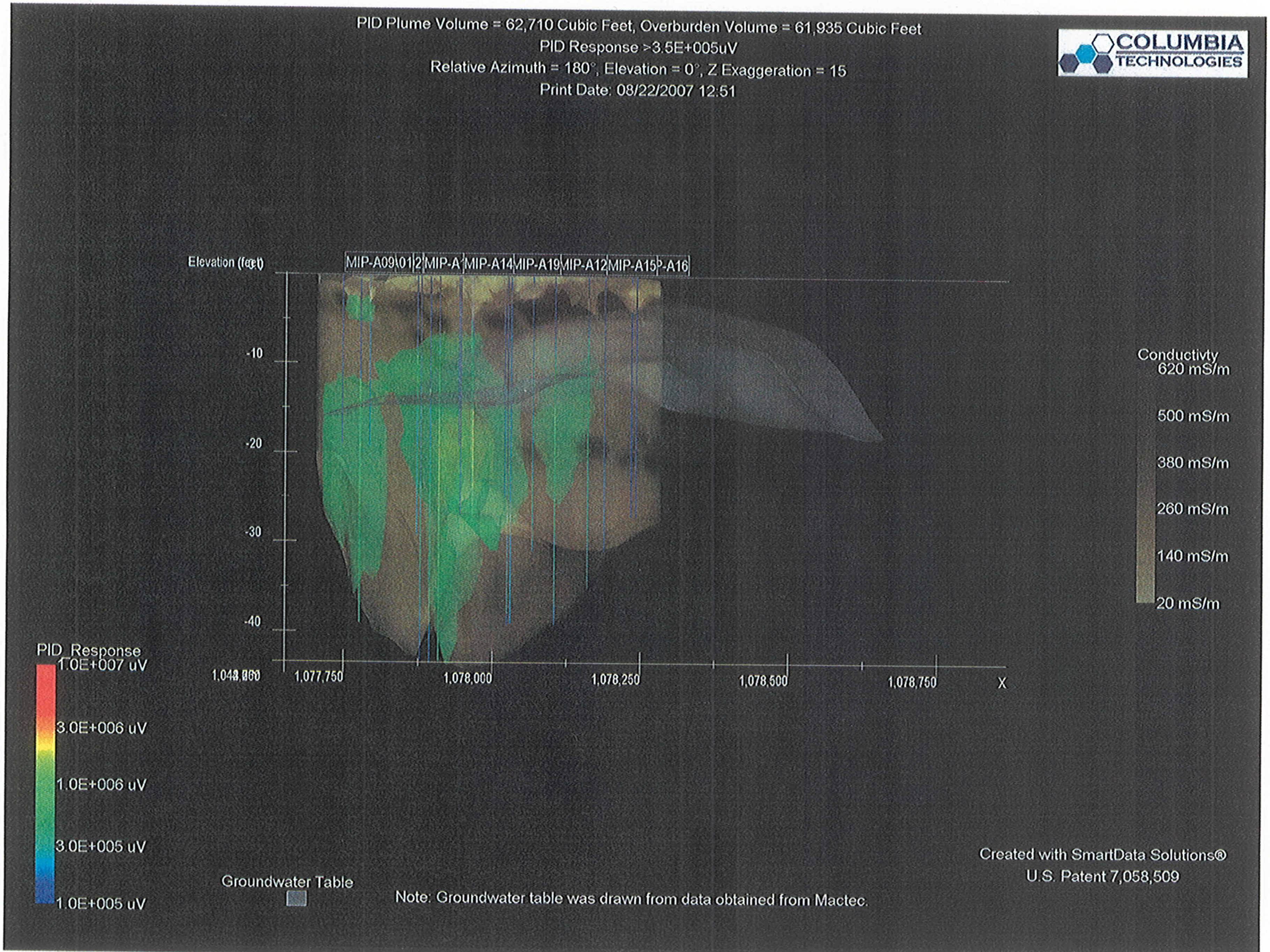

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Figure 4 Transect View Relative Azimuth 180°
June 25, 2007 – July 3, 2007

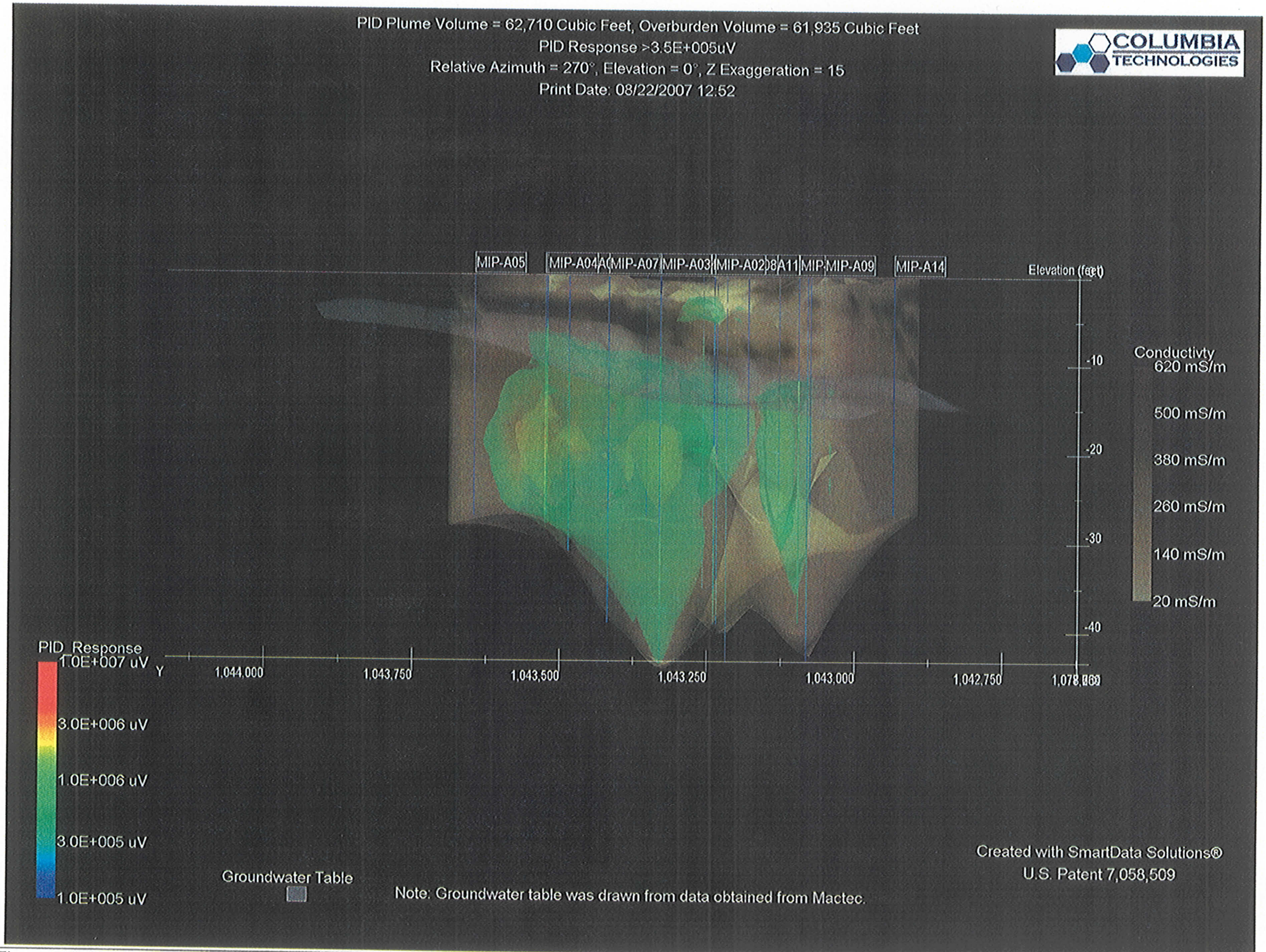

Figure 5 Transect View Relative Azimuth 270°
June 25, 2007 – July 3, 2007

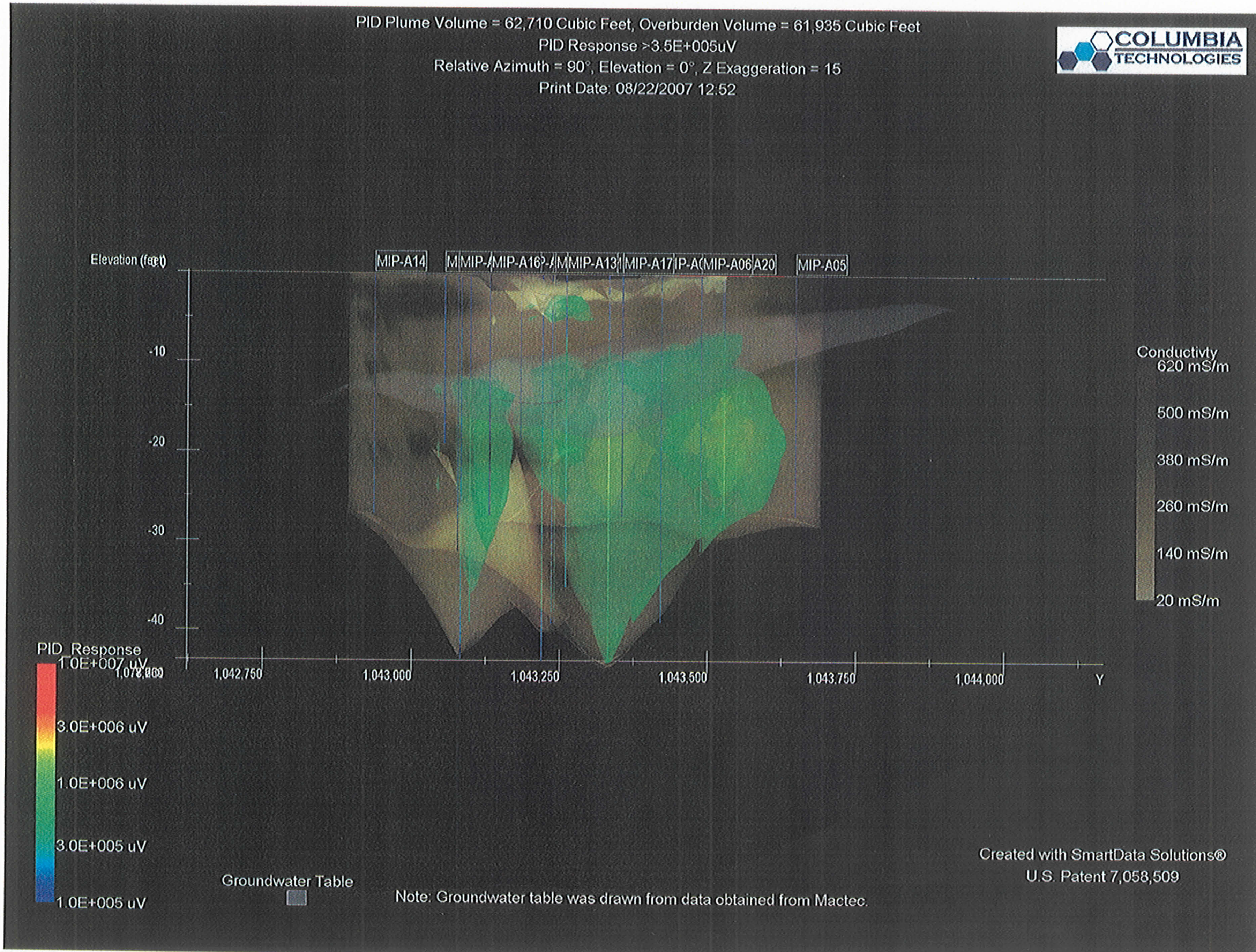

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Figure 6 Transect View Relative Azimuth 90°
June 25, 2007 – July 3, 2007

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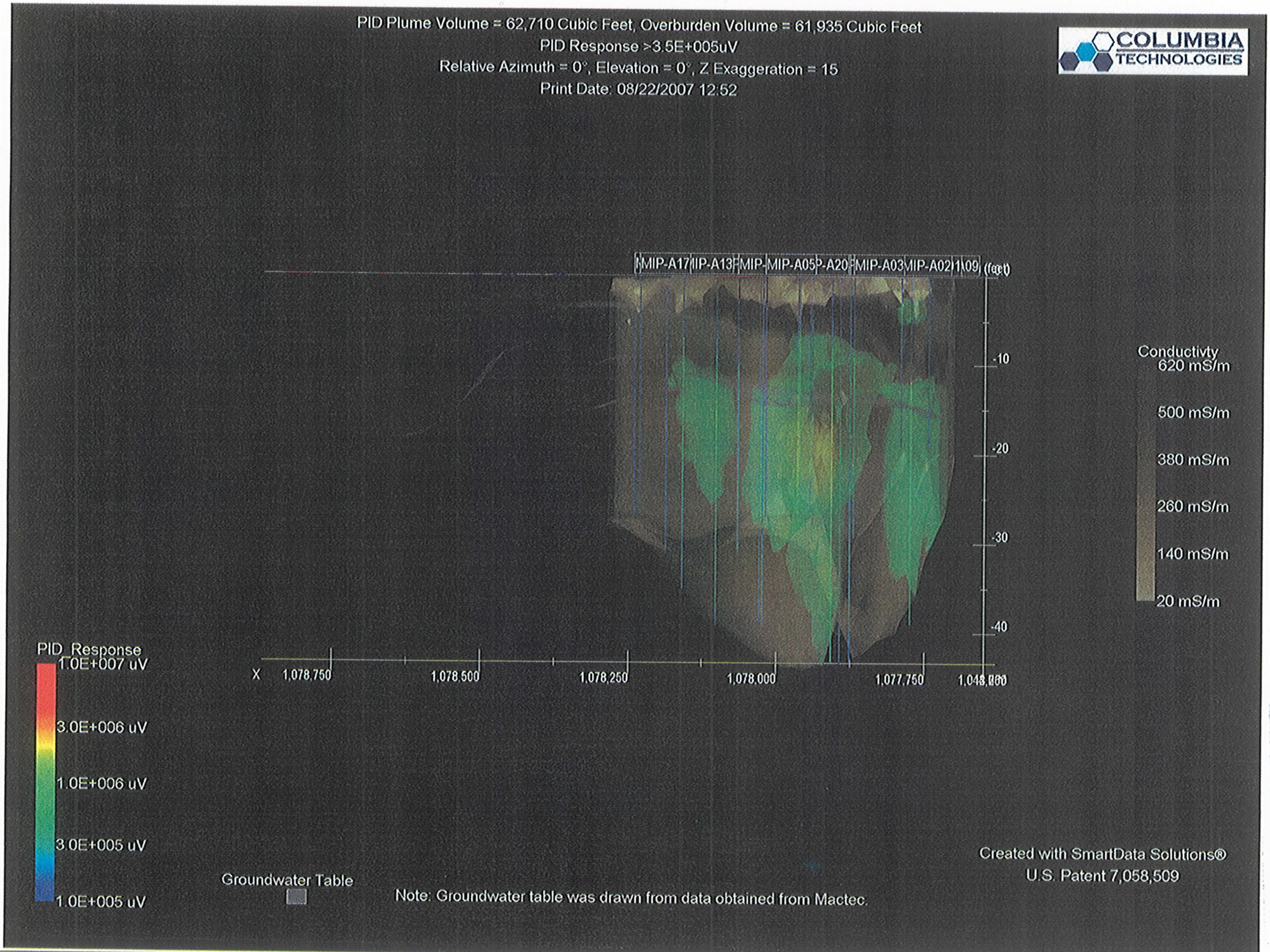

Figure 7 Transect View Relative Azimuth 0°
June 25, 2007 – July 3, 2007

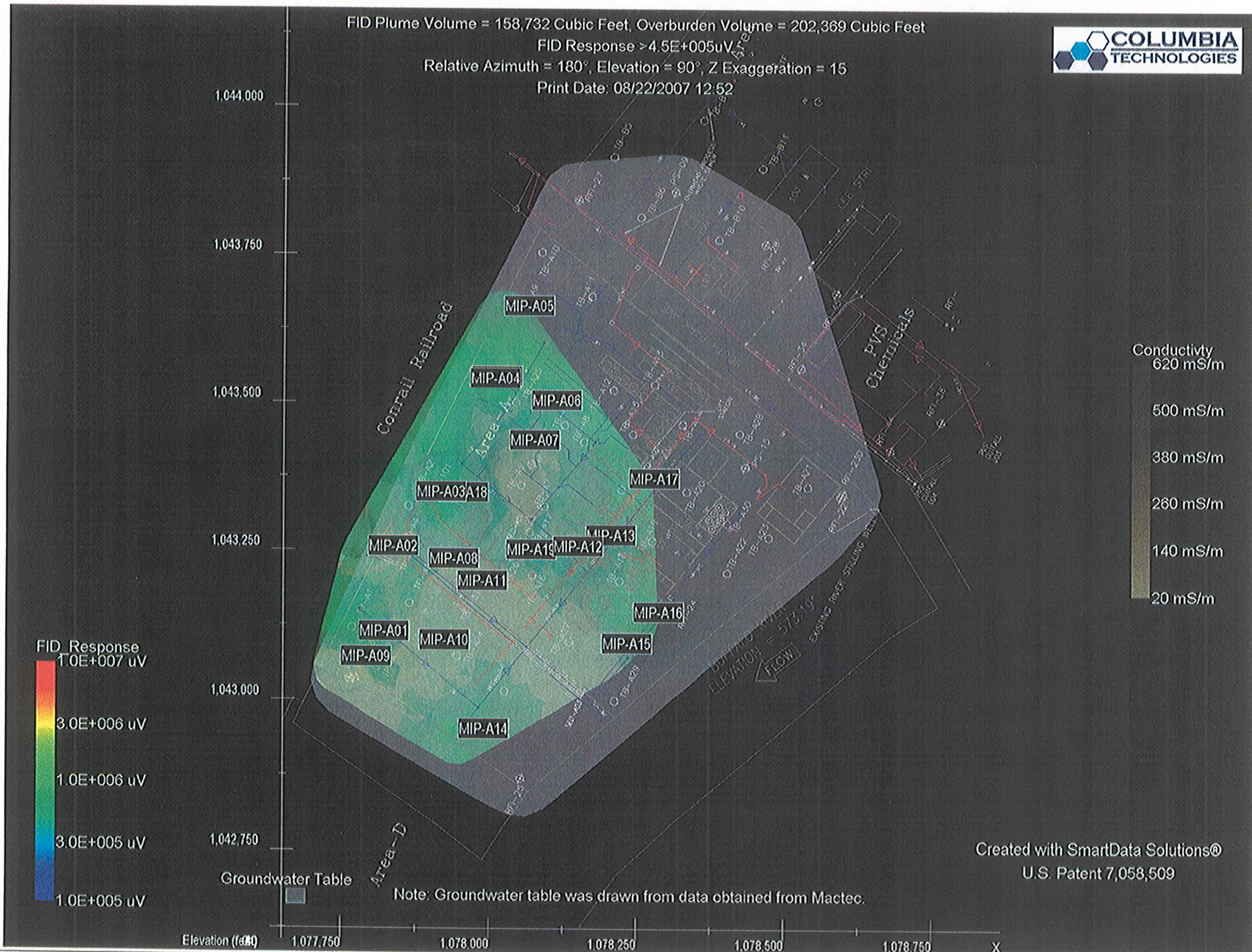

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Figure 8 Plan View Relative Azimuth 180°
June 25, 2007 – July 3, 2007

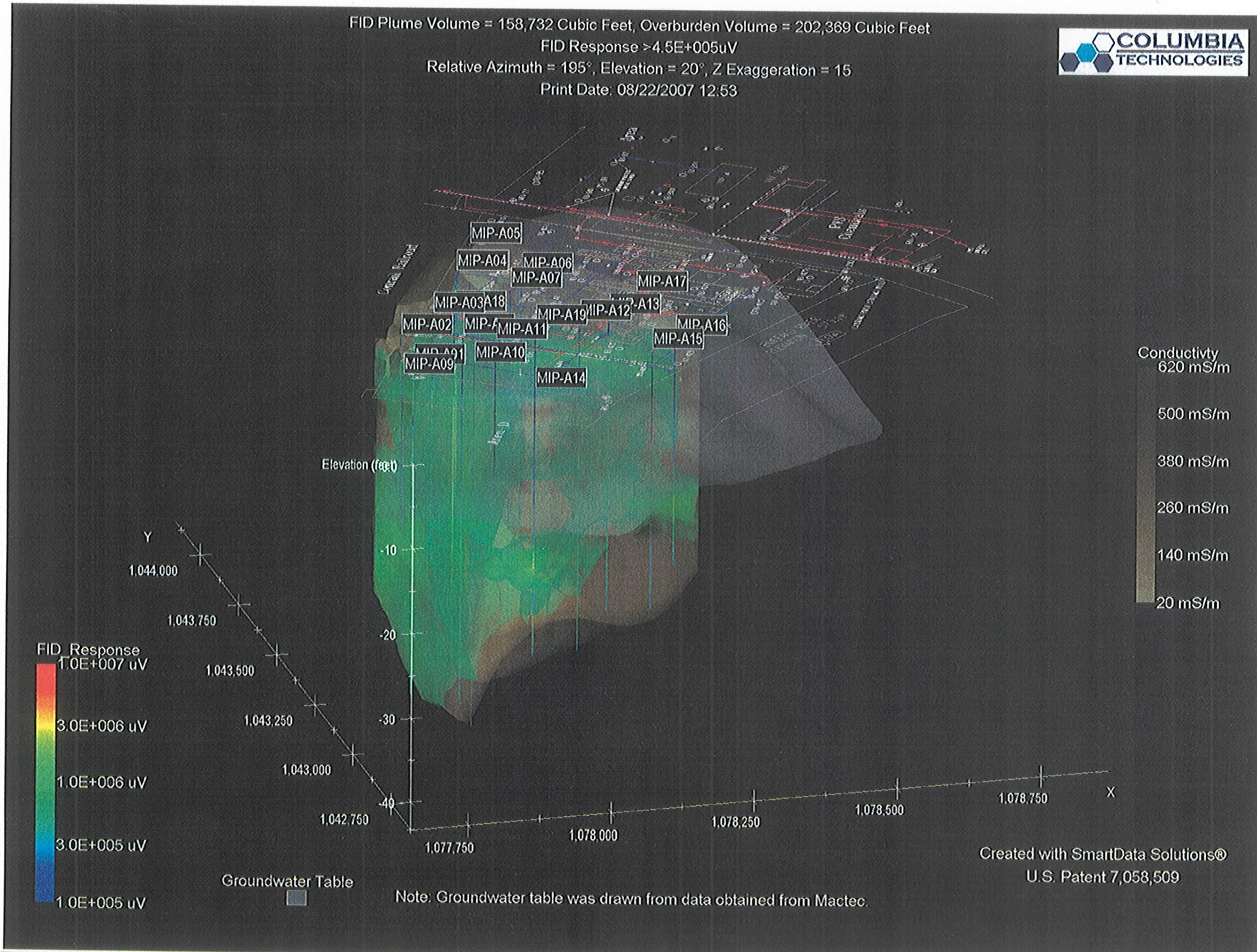

Figure 9 Oblique View Relative Azimuth 195°
June 25, 2007 – July 3, 2007

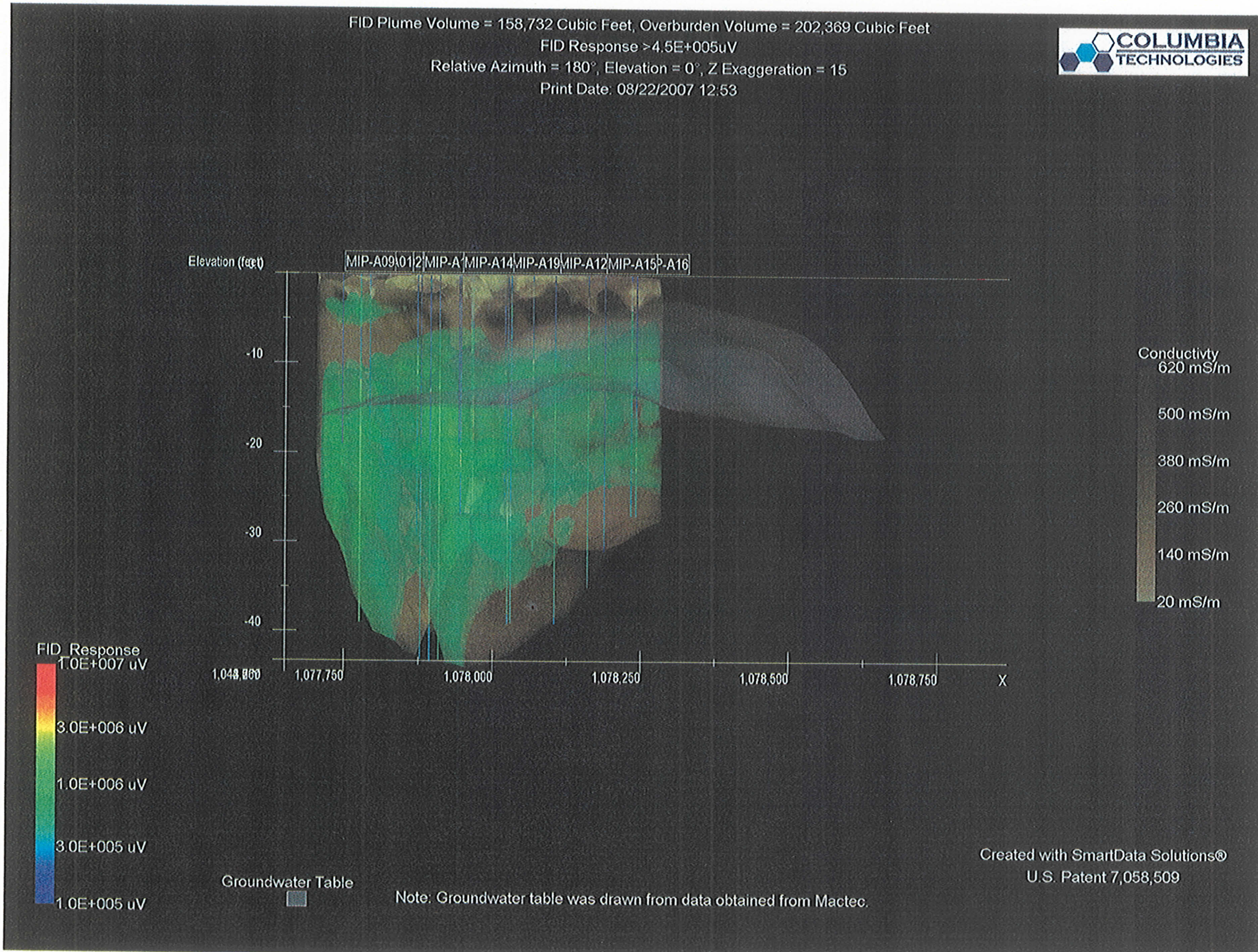

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Figure 10 Transect View Relative Azimuth 180°
June 25, 2007 – July 3, 2007

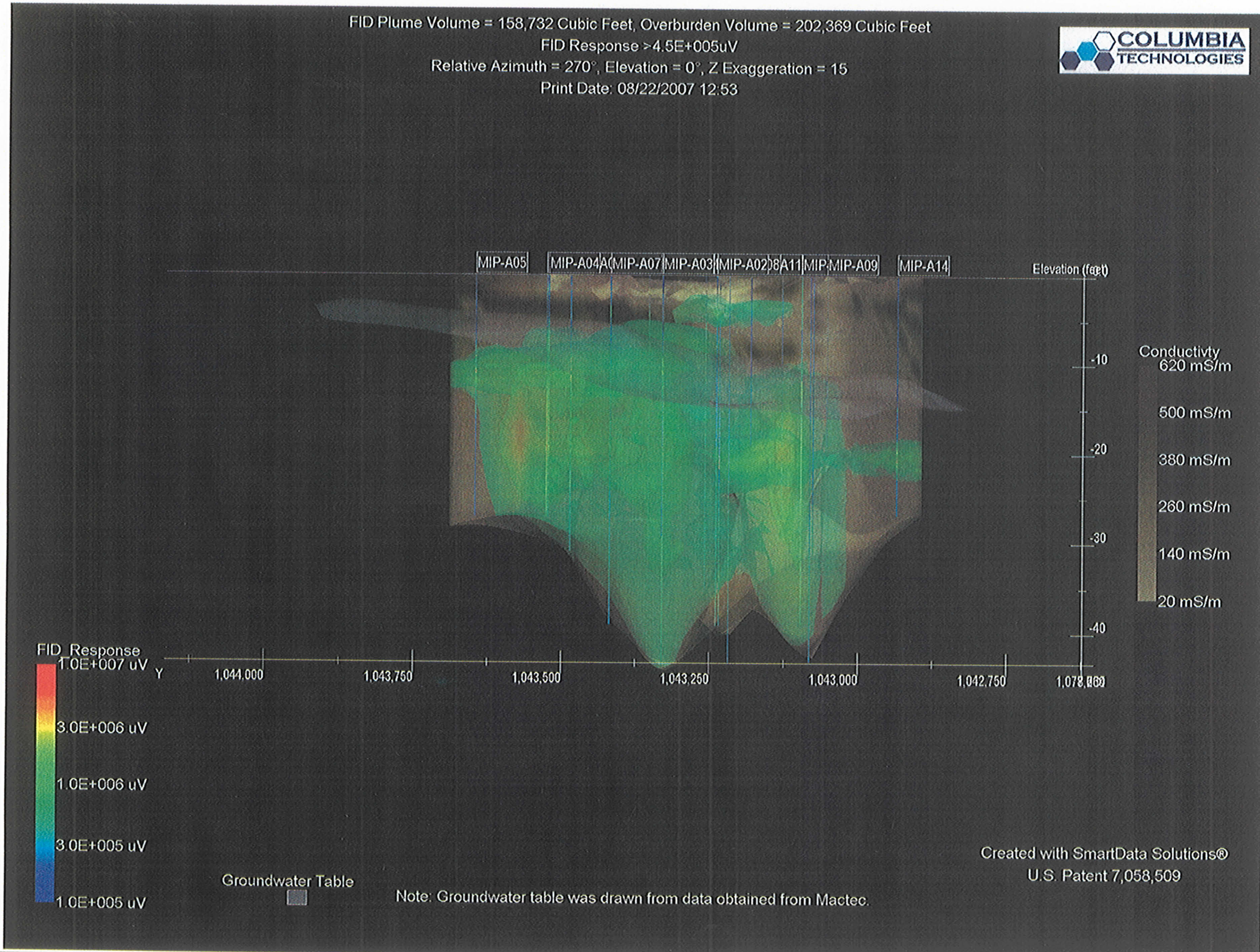

Figure 11 Transect View Relative Azimuth 270°
June 25, 2007 – July 3, 2007

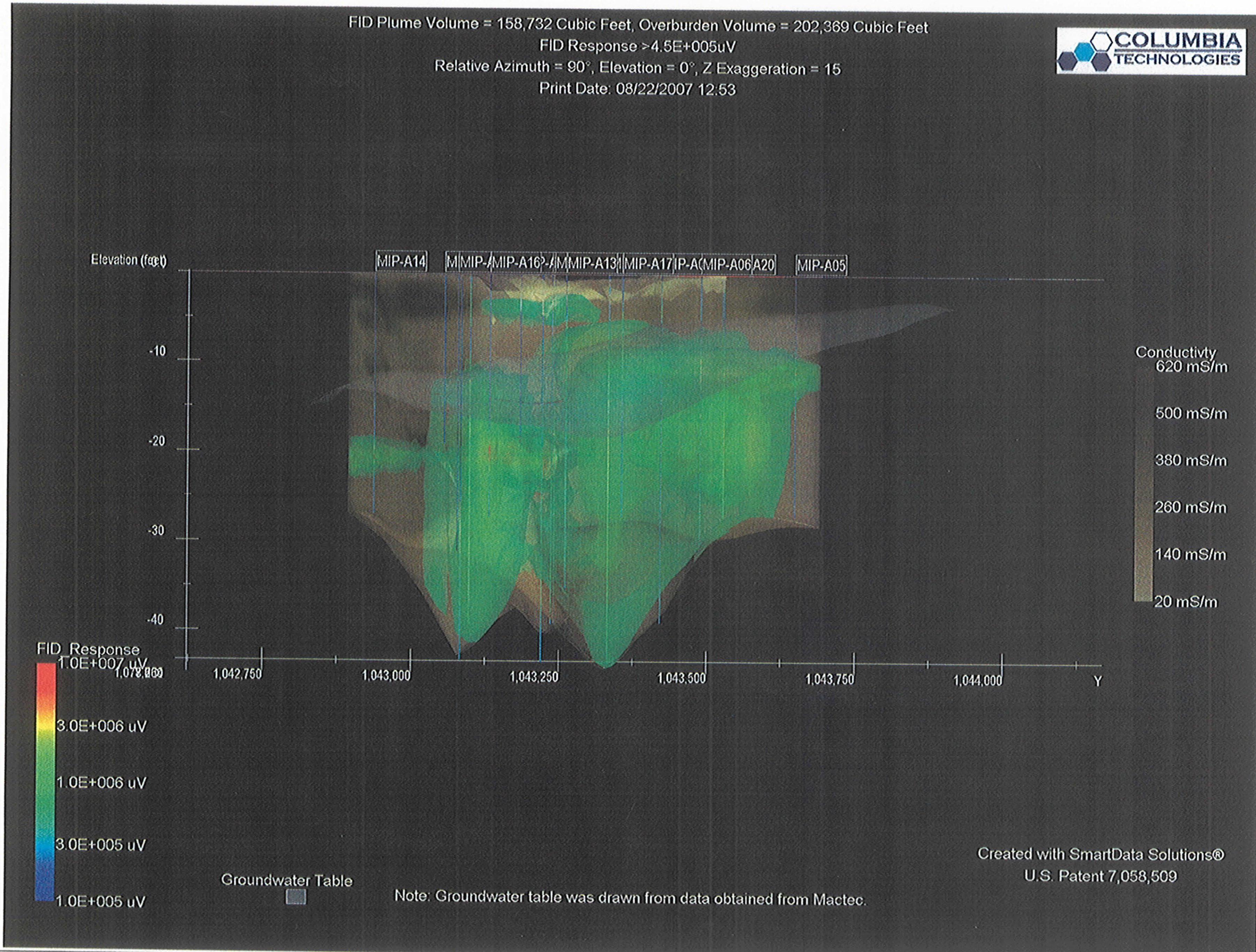

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Figure 12 Transect View Relative Azimuth 90°
June 25, 2007 – July 3, 2007

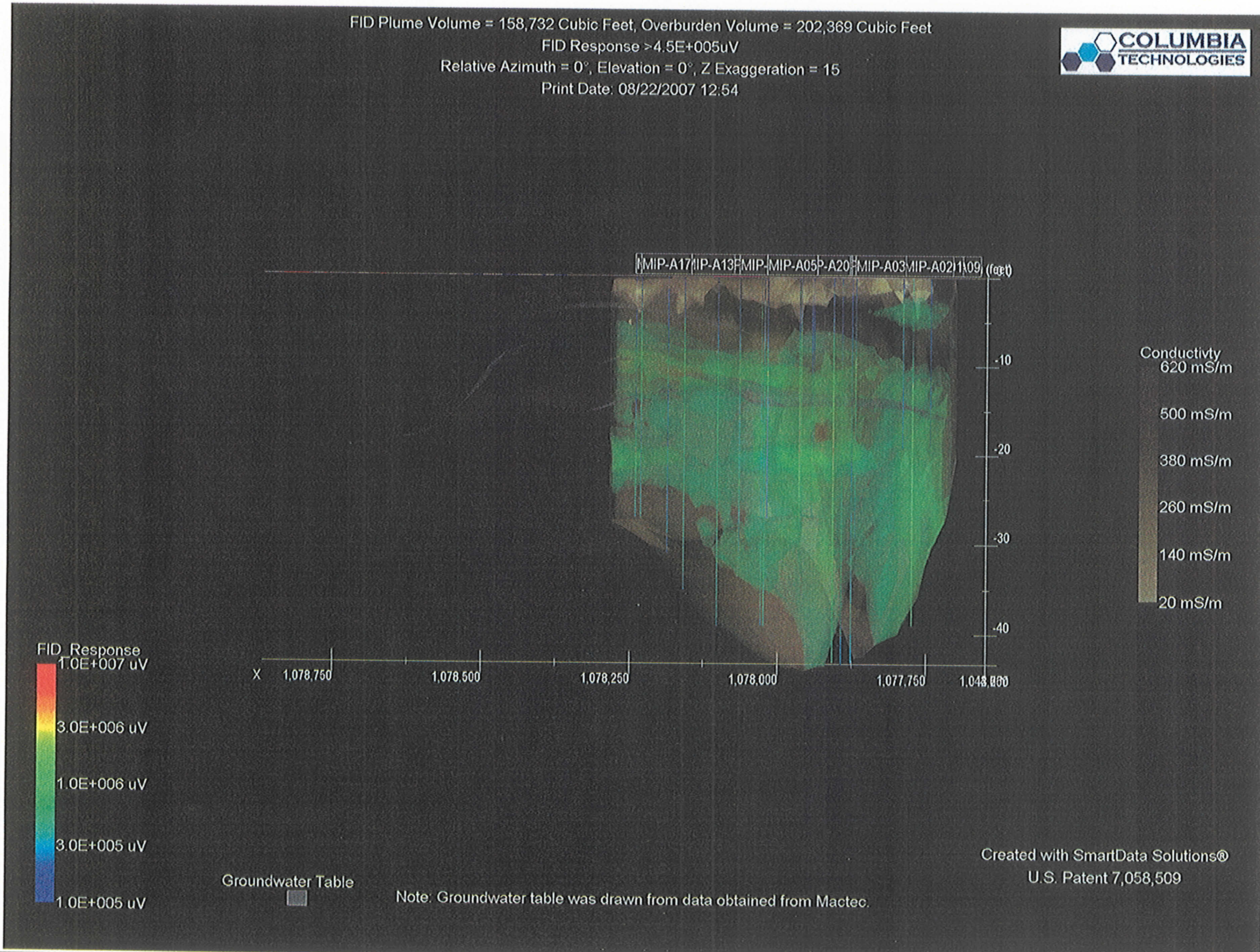

Figure 13 Transect View Relative Azimuth 0°
June 25, 2007 – July 3, 2007

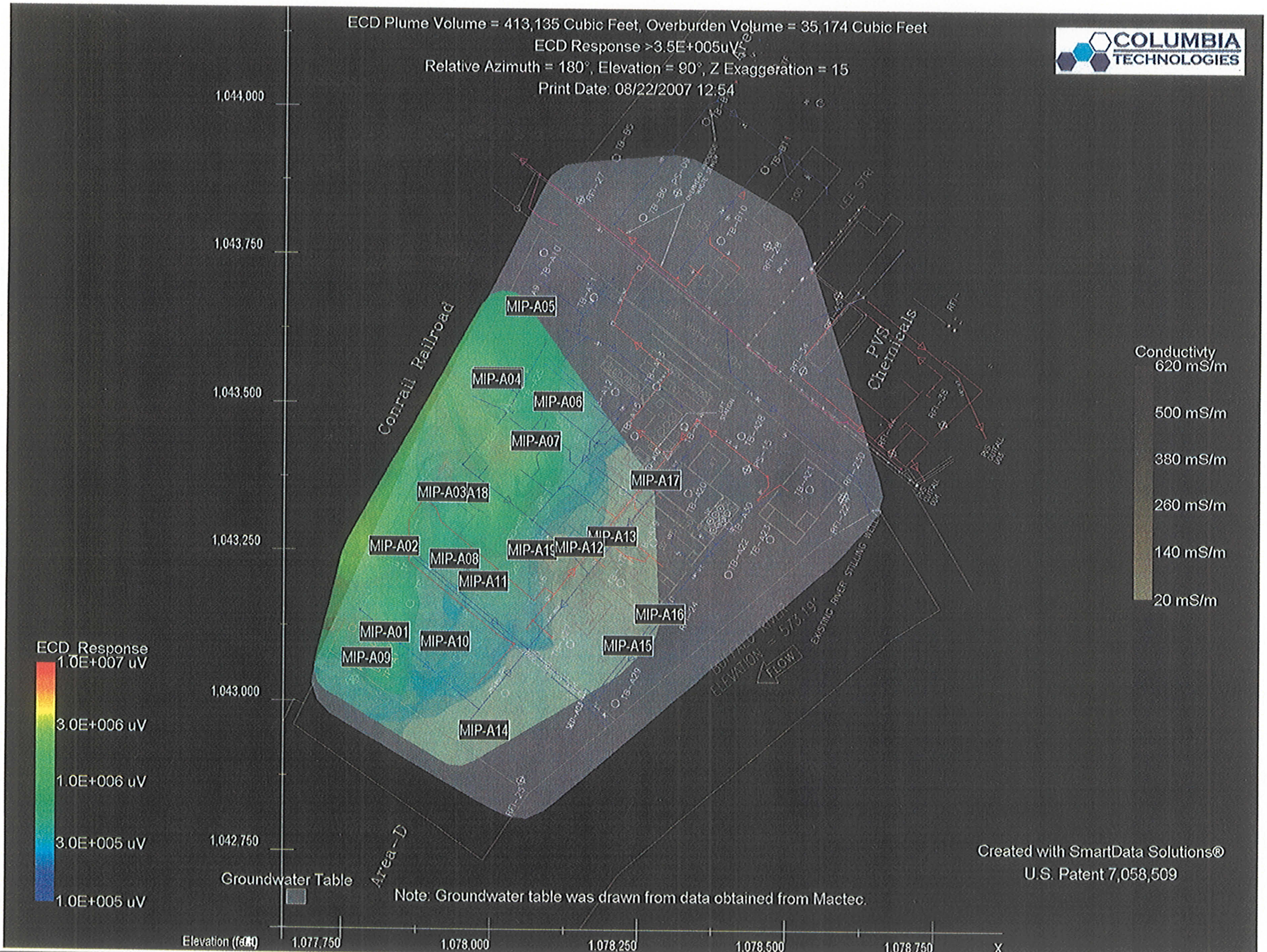

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Figure 14 Plan View Relative Azimuth 180°
June 25, 2007 – July 3, 2007

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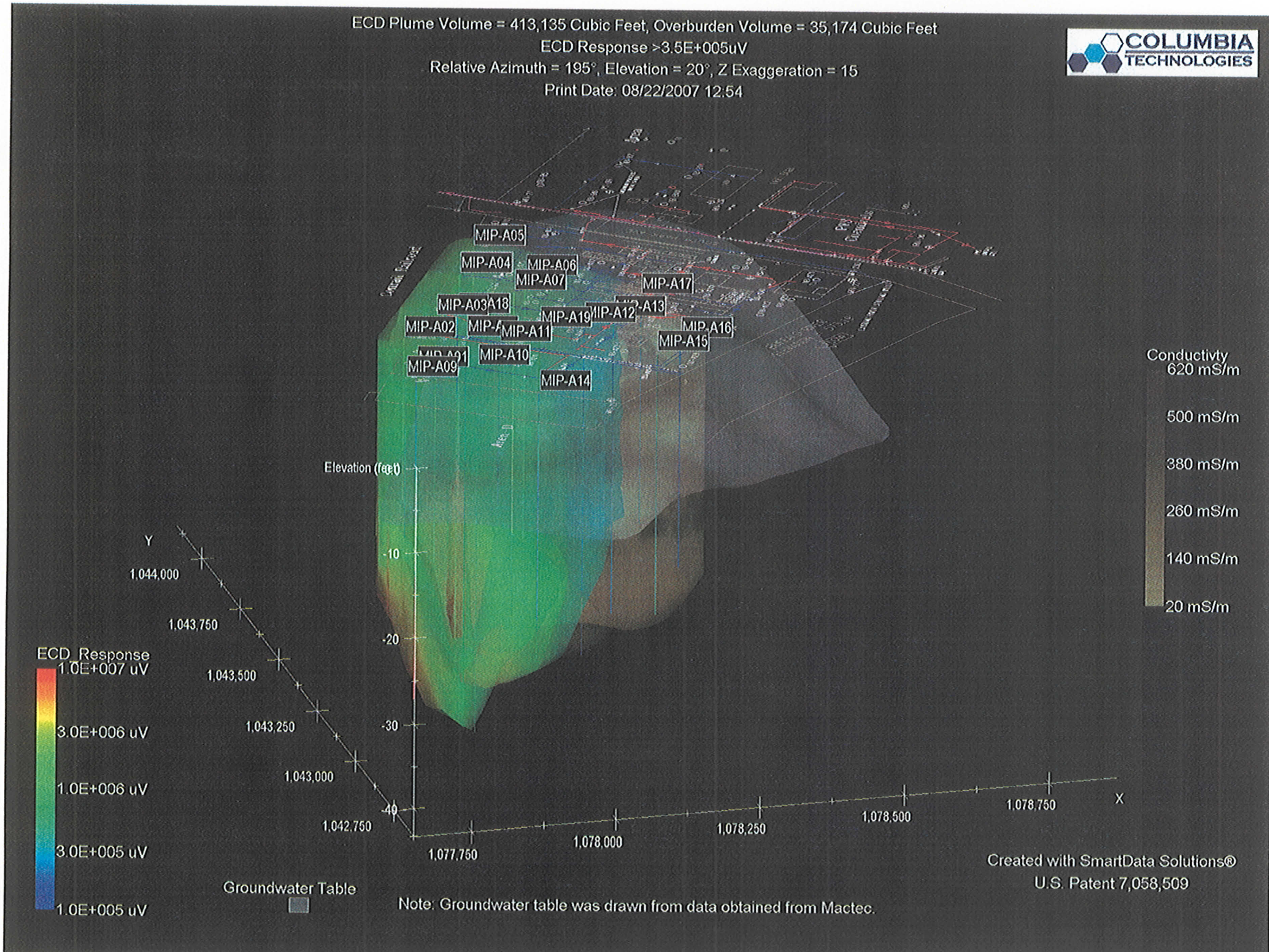

Figure 15 Oblique View Relative Azimuth 195°
June 25, 2007 – July 3, 2007

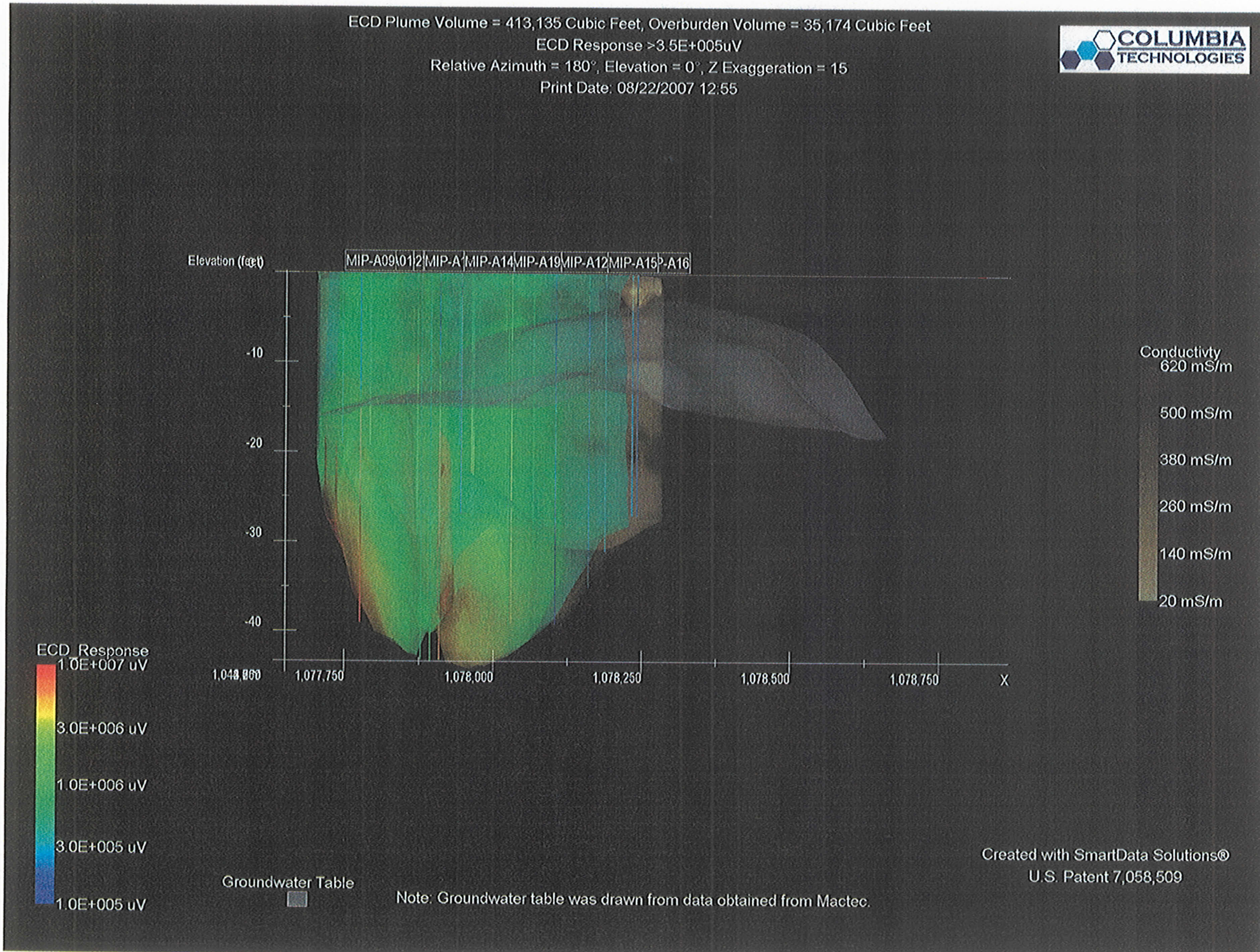

Figure 16 Transect View Relative Azimuth 180°
June 25, 2007 – July 3, 2007

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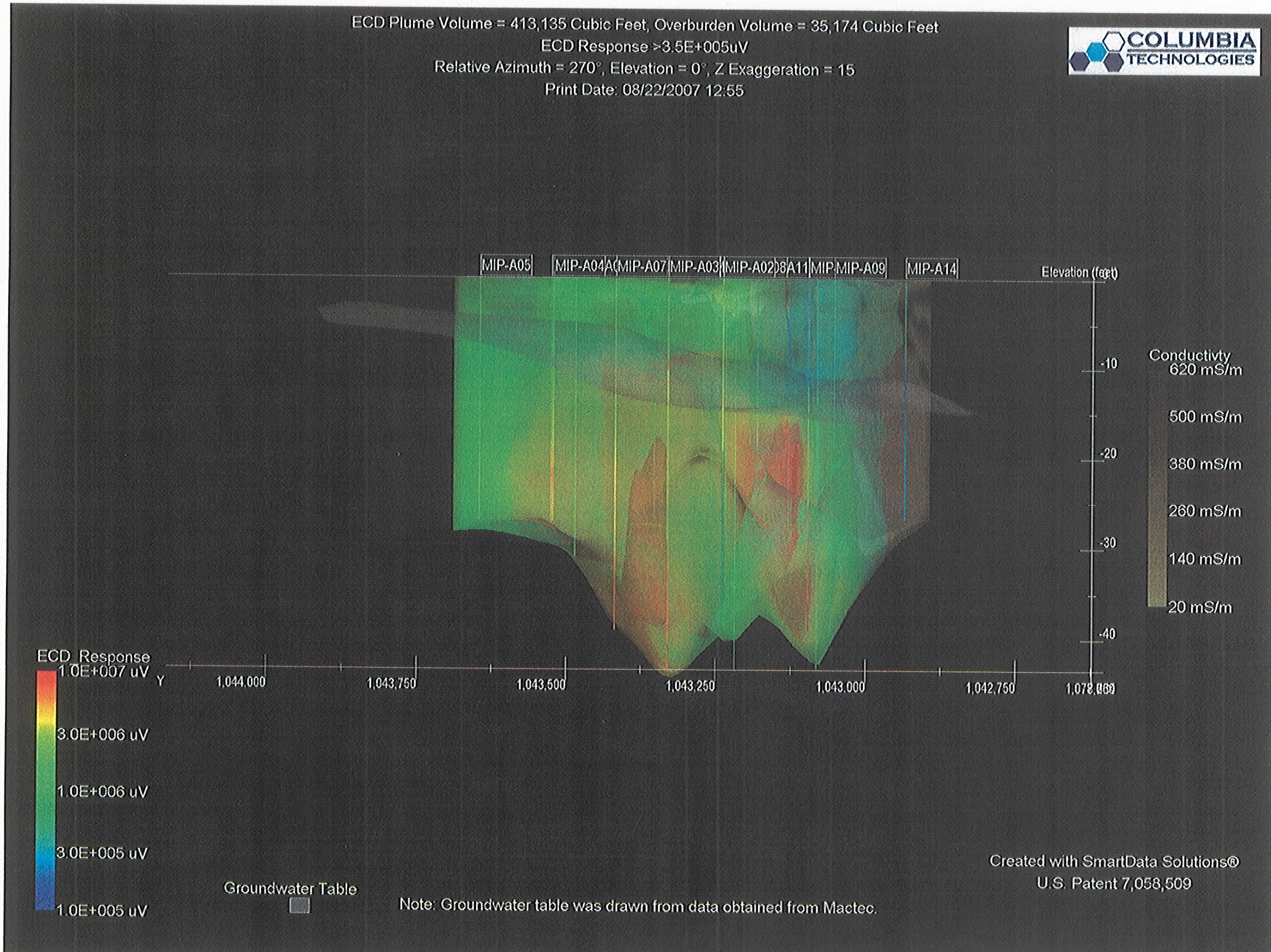

Figure 17 Transect View Relative Azimuth 270°
June 25, 2007 – July 3, 2007

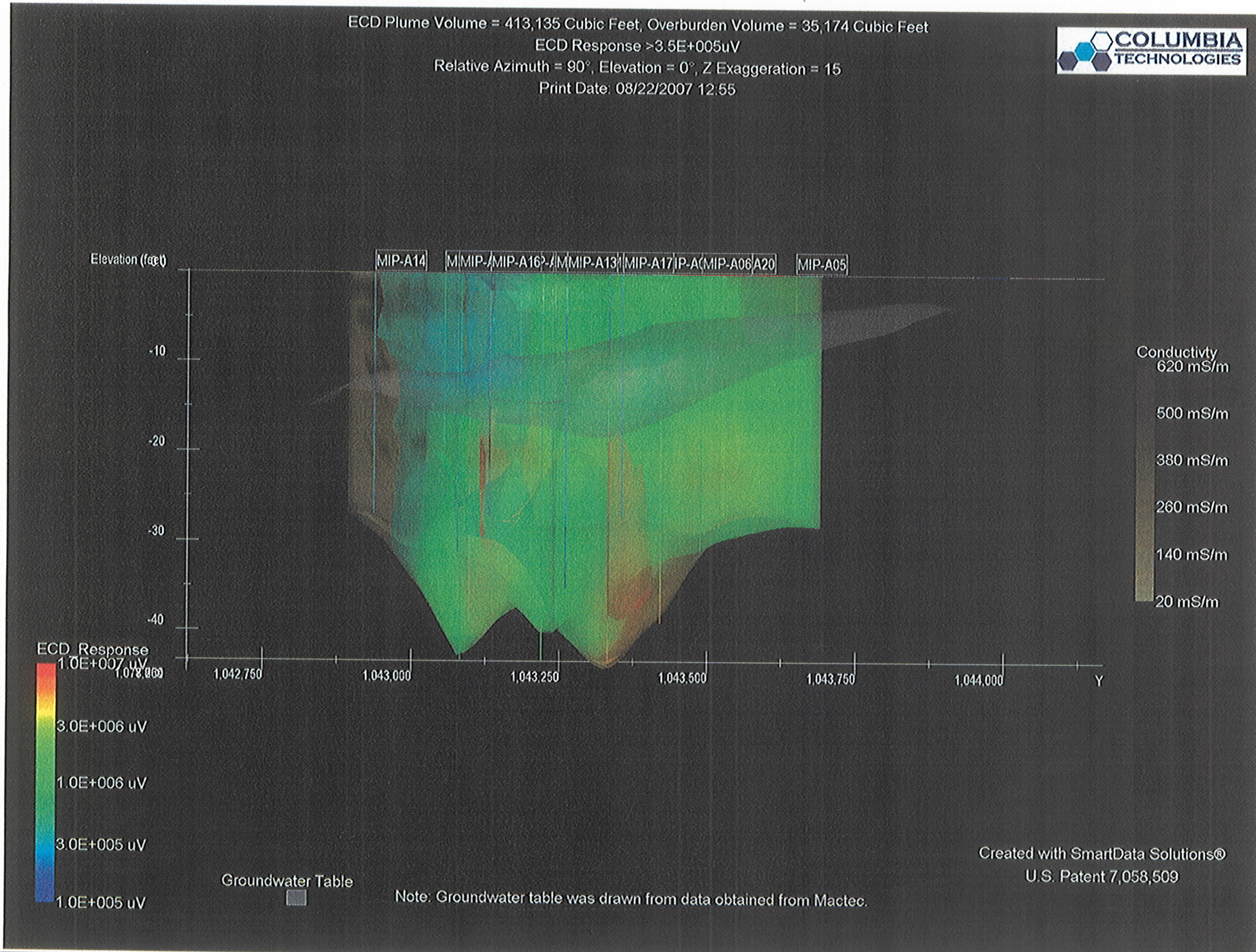

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Figure 18 Transect View Relative Azimuth 90°
June 25, 2007 – July 3, 2007

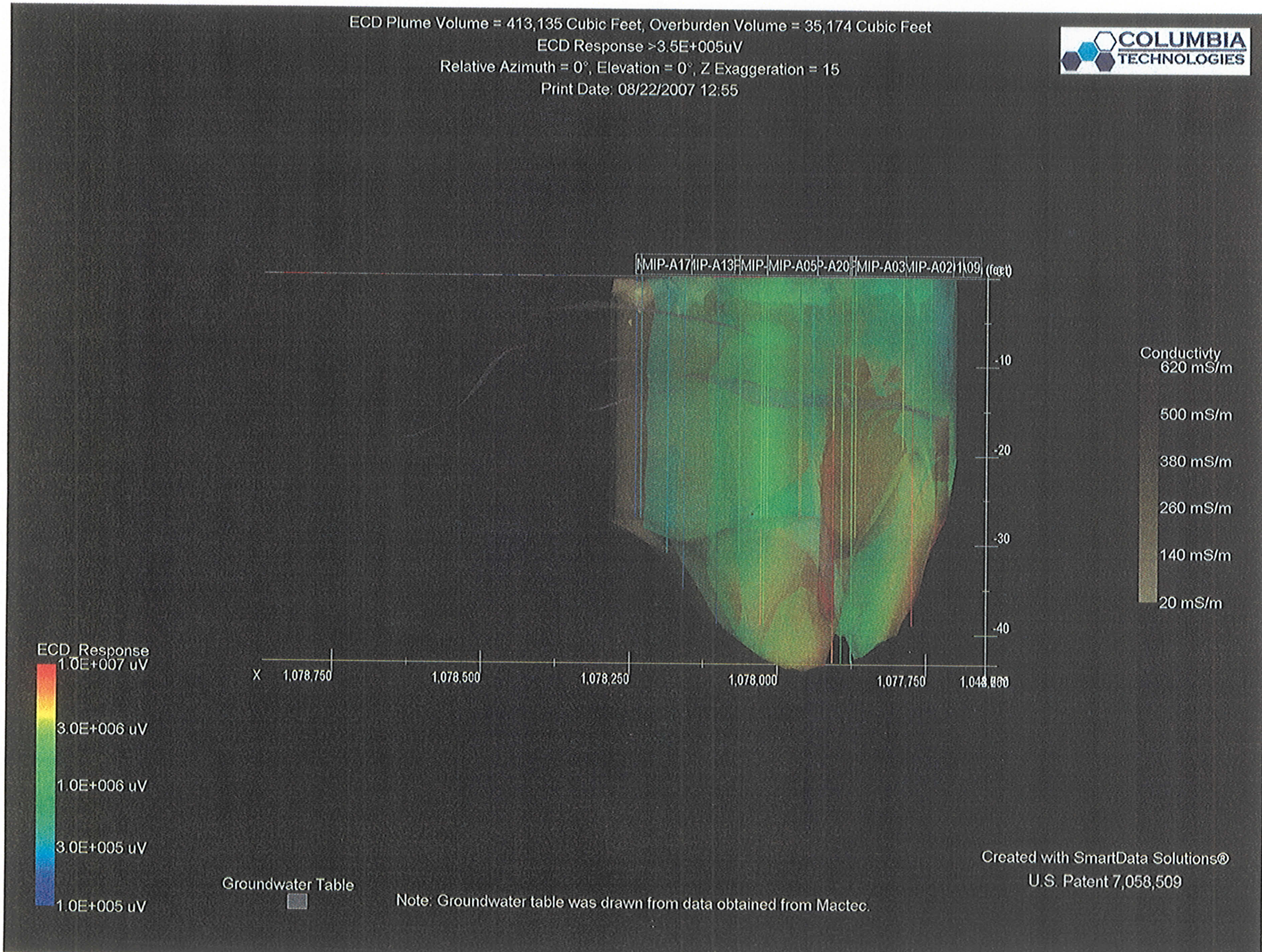

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Figure 19 Transect View Relative Azimuth 0°
June 25, 2007 – July 3, 2007