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Date: June 23, 2006
Refer to: EP2006-0620

RECEIVED
JUN 2006
NMED Hazardous
Waste Bureau

Ms. Kathryn Chamberlain
NMED – Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

SUBJECT: GEOPHYSICAL AND SEISMIC INVESTIGATION REPORTS OF MDA C

Dear Ms. Chamberlain:

Enclosed please find two copies of the geophysical and seismic investigation reports conducted at Material Disposal Area (MDA) C in April 2006. The objectives of the investigations were to delineate the vertical and lateral extent of Pits 1 through 4 and locate anomalies that may be attributed to disposal shafts at MDA C. These reports are being submitted to you for your early review and continued involvement in the project. We would like to schedule a follow-up meeting to discuss these results and the current status of the characterization activities at MDA C. Kent Rich (505) 665-4272 will contact you to coordinate a meeting next week.

Sincerely,

Gordon L. Dover, Corrective Actions Project Director
Environmental Programs
Los Alamos National Laboratory

GD:db

Enclosure: 1) Two hard copies – Geophysical and Seismic Investigation Reports of MDA C, May 2006

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Cy:
J. Bearzi, NMED HWB
A. Dorries, EP-ERSS, MS M992
G. Dover, EP-CA, MS M992
D. McInroy, EP-CA, MS M992
A. Phelps, ADEP, MS J591
D. Gregory, DOE LASO, MS A316
T. Trujillo, DOE LASO, MS A316 (w/enclosure)
Corrective Actions File, MS M992
RPF, MS M707
IM-9, MS A150

QUANTUMGEOPHYSICS, INC.
Engineering, Groundwater & Environmental Geophysics

June 16, 2006

Joe Sena
Los Alamos Technical Associates (LATA)
999 Central Ave., Suite 300
Los Alamos, NM 87544

Re: Report
MASW Survey
MDA C
Los Alamos, New Mexico

Dear Mr. Sena:

This report presents the findings of Quantum Geophysics, Inc.'s MASW (multi-channel analysis of surface waves) to identify and map the walls between Pits 1, 2, 3 and 4 at MDA C, Los Alamos National Labs, Los Alamos, New Mexico.

The survey was carried-out April 17, 18, and 19, 2006 by Quantum's principal geophysicist Richard Lee, with assistance from geophysicist Brian Brunette of the ARM Group, Inc., and helpers with the onsite drilling company under contract to LATA. LATA provided an electronic file of a basemap (MDAC NewShapes v2000.dwg) for the purpose of plotting the geophysical survey lines and findings.

The survey was conducted along a total of 6 lines spaced approximately 100 feet apart. They are designated Lines A through F and begin at or just south of the southern fence line, and trend northwards across Pits 1 through 5. The survey incorporated a Geometrics StrataVisor NZXP 24-channel seismograph and a Geometrics Geode 24-channel seismograph with Oyo Geospace 4.5 Hz geophones connected by 2 24-takeout seismic spread cables. Seismic waves were generated by striking an aluminum plate coupled to the ground surface with a 12 lbs. sledge hammer.

For control, each line was marked in the field with pin-flags and the ARM Group located each flagged location into the local state plane system using GPS.

MASW

The propagation velocity (also known as phase velocity) of surface waves is frequency (wavelength) dependent. This property is known as dispersion. The dispersiveness of soils is determined mainly by the vertical variation in shear wave velocity (Vs). By recording fundamental-mode Rayleight waves propagating from the source to the receiver, the dispersive properties directly beneath the seismic spread can be measured and represented by a curve (dispersion curve). This curve is used to estimate the vertical variation of Vs (1-D Vs profile) through a process called inversion.

The MASW (multi-channel analysis of surface waves) method utilizes pattern recognition techniques. It employs multiple receivers (geophones) equally-spaced along a linear survey line and measures the travel-times of seismic waves generated by an implosive source (e.g., sledge hammer). This approach allow3s recognition of the various propagation characteristics of the seismic wavefield. Once the dispersive properties of the fundamental mode Rayleigh waves are identified (via pattern recognition), a corresponding signal curve is extracted and used in the inversion of a 1-D V_s profile. This profile best represents the vertical V_s distribution at the middle of the receiver spread. By moving the same shot-receiver configuration incrementally along a preset survey line, multiple measurements can be made, each producing a 1-D V_s profile that, when all gathered together, is used to construct a 2-D V_s cross-section along the survey line.

MASW has been used to map bedrock topography, identify bedrock fractures, abandoned mine workings, waste pits and trenches, and evaluate sink activity (e.g., voids, pinnacles, zones of enhanced weathering). It has several advantages over more traditional seismic methods. Unlike refraction, MASW does not require that velocities increase with depth. And because of the stronger amplitude associated with surface waves (compared with body waves such compressional and shear waves), MASW can be carried-out in an urbanized setting with minimal interference from ground vibrations and electrical noise that normally shut-down a traditional seismic refraction survey.

FIELD PROCEDURES AND DATA PROCESSING

For each seismic line, a series of 48 geophones was laid-out spaced 3 feet apart, with the initial shot located 15 feet from the first geophone (a.k.a. shot offset). Data were acquired using the following parameters:

record length = 0.7 seconds (700 milliseconds)
sampling interval = 62.5 *u*sec
rolling interval = 3 feet (1 geophone spacing)
all acquisition filters "out"
shot gather = 24 traces
staked shots/station = 3

The data were processed using the software program Surfseis by the Kansas Geological Survey (KGS), in the following sequence:

1. convert raw seismic data (SEG-2) into KGS processing format, and combine all shot gathers into a single file (for each seismic line),
2. assign field geometry and recompile into a roll-along mode data set,
3. identify range of surface wave velocities for each shot gather,
4. conduct dispersion-curve analysis for all shot gathers,
5. inversion analysis for all dispersion curves analyzed to determine 1-D V_s, and
6. construct 2-D V_s profile by interpolating 1-D V_s profiles using a Kriging algorithm.

Representative dispersion curves are provided in Appendix A.

ANALYSIS

Geophysical data are typically analyzed with respect to known, suspected, or reported conditions, much like what doctors do when they evaluate test results with respect to a patient's medical history.

To guide the analysis, we constructed a conceptual model of the pits based upon known, suspected, or reported conditions. It is our understanding that the walls between Pits 1, 3, 2, and 4 are about 10' wide. The wall between Pit 4 and Pit 5 is nominally about 50' wide but narrows to about 40' wide towards the east end of the MDA. The pits are 25 +/- feet deep, and Pits 1 through 4 are approximately 40' wide. The cover is about 6' thick. The original ground surface is unknown.

Shear waves velocities are a measure of “stiffness”. Rock is stiffer (higher shear wave velocity) than soil. Undisturbed soils and/or more compacted soils tend to be stiffer (higher shear wave velocity) than disturbed soils. Based upon the conceptual model, a 3-layer seismic model was constructed whereby:

- Materials forming walls and the bottom of pits will have the highest seismic velocities because the materials are undisturbed.
- Cover material should have the lowest seismic velocities because the layer represents the most recently placed, and therefore, the most highly disturbed material.
- Materials in the pits and between the walls and cover probably have intermediate velocities (more than cover but less than wall and bottom of pits) because of consolidation from settlement and compaction over time.

A cross-section of the conceptual model is shown in Figure 1. Basically, we look for features in the geophysical data that represent, mimic, or best fit features in the conceptual model.

FINDINGS

A fully annotated sitemap is shown in Figure 2. Shear wave profiles along the 6 lines are shown in Figures 3 through 8. Based upon the geophysical data:

- Wall-like structures resembling those in the conceptual model were identified on all 6 MASW lines. The height of the wall-like structures varies but it appears to be nominally 25 feet.

- The wall between Pits 3 and 2 was the most prominent and bear the closest resemblance to the conceptual model in terms of size and width. It was observed on all 6 lines and plots to within approximately 2 to 3 feet of its' reported location.

- The wall between Pits 1 and 3 is not as pronounced or well-defined as the wall between Pits 3 and 2. But like the wall between Pits 3 and 2, it is traceable across all 6 seismic lines, and plots to within about 3 feet at some locations.

- No apparent wall structure was observed between Pits 2 and 4, at least within close proximity to its' reported location.

- The wall between Pits 4 and 5 does not appear to be a consistent 40 to 50-foot width across the MDA. There is good agreement between the geophysics and the conceptual model at 1 location (Line F, Figure 8) where the wall is approximately 40' wide and plots to within a few feet of where it is reported. At 3 other locations (Lines B, C, and D, Figures 4, 5 and 6, respectively), the wall appears to be only 10' wide.

- The cover appears to be between 10 and 12 feet thick (nominal), about twice as thick as shown in the conceptual model.

Quantum appreciates this opportunity to be of service to LATA. Please call if you have any questions or if we can be of further assistance.

Sincerely,

***Quantum** Geophysics, Inc.*

Richard K. Lee

Richard K. Lee, P.G., R. GP.
President and Principal Geophysicist

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