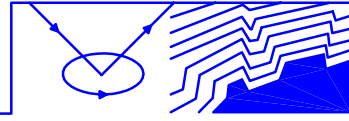


# ADVANCED GEOSCIENCE, INC.

Geology and Geophysics  
Subsurface Exploration

Non-Destructive Evaluation



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April 8, 2008

Mead & Hunt, Inc.  
17100 West Capital Drive  
Brookfield, Wisconsin 53005

Attention: Mr. Greg Kulpins, P.E.

Re: **Summary Report  
Ground-Penetrating Radar Survey  
For Investigation of Underground Utilities and Pipelines  
At California Army National Guard Long Beach CSMS  
Long Beach, California**

This letter report and the attached site plans (in Sheets 1 and 2) summarize the ground-penetrating radar (GPR) surveys performed at the referenced site. These surveys were performed across the 117,000 square-foot asphalt-covered area where the construction of a new concrete pavement is planned. The GPR data was used together with ground surface observations and observations from a limited subsurface potholing investigation to estimate the orientation and approximate depth of underground utilities and pipelines. This information was also used to estimate the type of underground line and its approximate outside diameter.

The GPR surveys were performed during a four-day field program conducted on February 26 through 29, 2008. The surveys recorded a series of closely-spaced GPR profiles across the areas designated by Mead & Hunt surrounding Building A, B, C, and D. The GPR profiles across these areas were used to image and map reflection patterns from pipelines and other larger structures buried in the upper 4 to 5 feet.

The following sections provide a summary of our survey procedures, the potholing investigation, and the resulting data mapping and utility line and pipeline evaluation shown in Sheets 1 and 2. An AutoCAD format file containing Sheets 1 and 2 was previously forwarded to Mead & Hunt by electronic mail.

## **Ground-Penetrating Radar Survey Procedures**

Advanced Geoscience performed GPR surveys in the areas designated by Mead & Hunt surrounding Building A, B, C, and D. These surveys were recorded across the open, accessible areas of the asphalt surface. Site personnel from the California Army National Guard removed most all of the parked cars, storage bins, and other obstacles from the survey area. However, along the asphalt edge west of Building A and outside the fence east of Building C there were heavy storage bins which could not be easily moved. This resulted in limited data coverage in these border areas.

Two overlapping survey grids were setup to reference the location of the GPR profiles. These rectangular grids were orientated parallel to the building walls as shown on the site plans in Sheets 1 and 2. Several 300-foot measuring tapes were used to layout the grids. Aerosol paint was used to mark the grid patterns on the ground surface.

The GPR profiles were recorded across each survey grid using a 500-Mega Hertz GPR antenna. These 500-MHz GPR profiles were setup to image radar reflections from near the surface to a depth of approximately 5 feet. The profiles were recorded along north-south and east-west grid lines spaced 10-feet apart. Near the buildings selected profiles were also recorded on 5-foot spaced grid lines and on selected diagonal lines. Additional 900-MHz GPR profiles were also recorded near the west end of Buildings B and D where several underground lines converged.

All of GPR profiles were digitally recorded using a Geo-Physical Survey Systems, Inc., SIR System-2000. This system recorded the radar signals with 16-bit analog to digital resolution and applied various filtering enhancements to the data as it was recorded and printed out in the field. More technical information on the capabilities of this ground radar equipment is available at [www.geophysical.com](http://www.geophysical.com).

The resulting GPR profiles were evaluated for reflection patterns indicating pipelines and other possible subsurface features. The patterns of “point-like” radar reflections indicating the crossing of pipelines were mapped on to the grid maps. Broader patterns of reflections indicating the bounds of the underground fuel storage tanks and possible parallel-orientated features were also mapped. The locations of these reflection patterns are shown on the site plans in Sheets 1 and 2.

The GPR profiles were also used to estimate the depths of the upper surface of the pipelines and other subsurface features. The depth estimates are annotated on Sheets 1 and 2. These depth estimates were first based on an assumed average radar-wave speed through the ground and later revised based on the depth observations from the potholing investigation.

### **Potholing Investigation**

A limited potholing investigation was conducted on March 19, 2008. A vacuum air knife was used to expose underground lines detected by the GPR surveys at ten locations. These locations were designated as PH-1 through PH-10 and are shown on the site plan in Sheet 1.

The types of pipelines observed at each pothole location and their approximate outside diameter and depth are listed on Sheet 1.

During the potholing investigation a Fischer Gemini-3 metal detector and Schonstedt magnetic locator were also used to further investigate the exposed lines. Additional 500-MHz GPR profiles were also recorded in certain areas.

### **Discussion of Results**

The site plans in Sheets 1 and 2 provide our interpretation of the orientations of reflection patterns indicating pipelines and other possible subsurface features. The estimated depth, outside diameter dimension, and type of subsurface line detected are also annotated on these site plans. Much of this information is based on comparison of the GPR reflections to the potholing observations and observations of the utility lines emerging from the ground.

Several of the mapped reflection patterns indicating subsurface lines were located along trench cuts visible on the asphalt surface. Most of these lines could be tied to visible utility lines emerging from the ground near the building walls. Other reflection patterns were also mapped where no trench cuts were observed. Some of these lines are interpreted as “possible abandoned lines” because they show limited segments of reflections and also in some cases weaker amplitude reflections indicating older, oxidized lines.

Near the northwest corner of Building D reflection patterns from several lines are mapped very close together. In this area there are most likely other lines that could not be clearly detected and mapped by the GPR surveys. Additional potholing and a higher density of GPR coverage (on 2-foot grid line spacing) would probably better resolve the subsurface lines in this area.

Mead & Hunt, Inc.  
April 8, 2008  
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Advanced Geoscience appreciates the opportunity to be of service to Mead & Hunt and the California Army National Guard. If you have any questions or additional requests concerning these surveys please contact the undersigned. Thank you.

Sincerely,

**Advanced Geoscience, Inc.**

A handwritten signature in black ink, appearing to read "Mark G. Olson". The signature is fluid and cursive, with a large initial "M" and "O".

Mark G. Olson  
Principal Geophysicist  
California Registered Professional Geophysicist No. GP970

Attachments: Sheets 1 and 2

ZONE	REV	DESCRIPTION	DATE	APPROVED

**EXPLANATION OF GPR SURVEY RESULTS**

Shows Interpreted Alignment of Radar Reflection Patterns Indicating Evidence of Subsurface Lines. Lines are Dashed Where Interpretation is Less Certain.

Depth Below Ground Surface (BGS) of Lines is Estimated at Various Points. Circled Points Indicate Where Reflection Patterns Were Detected from Crossing Linear Subsurface Objects Such as Pipelines.

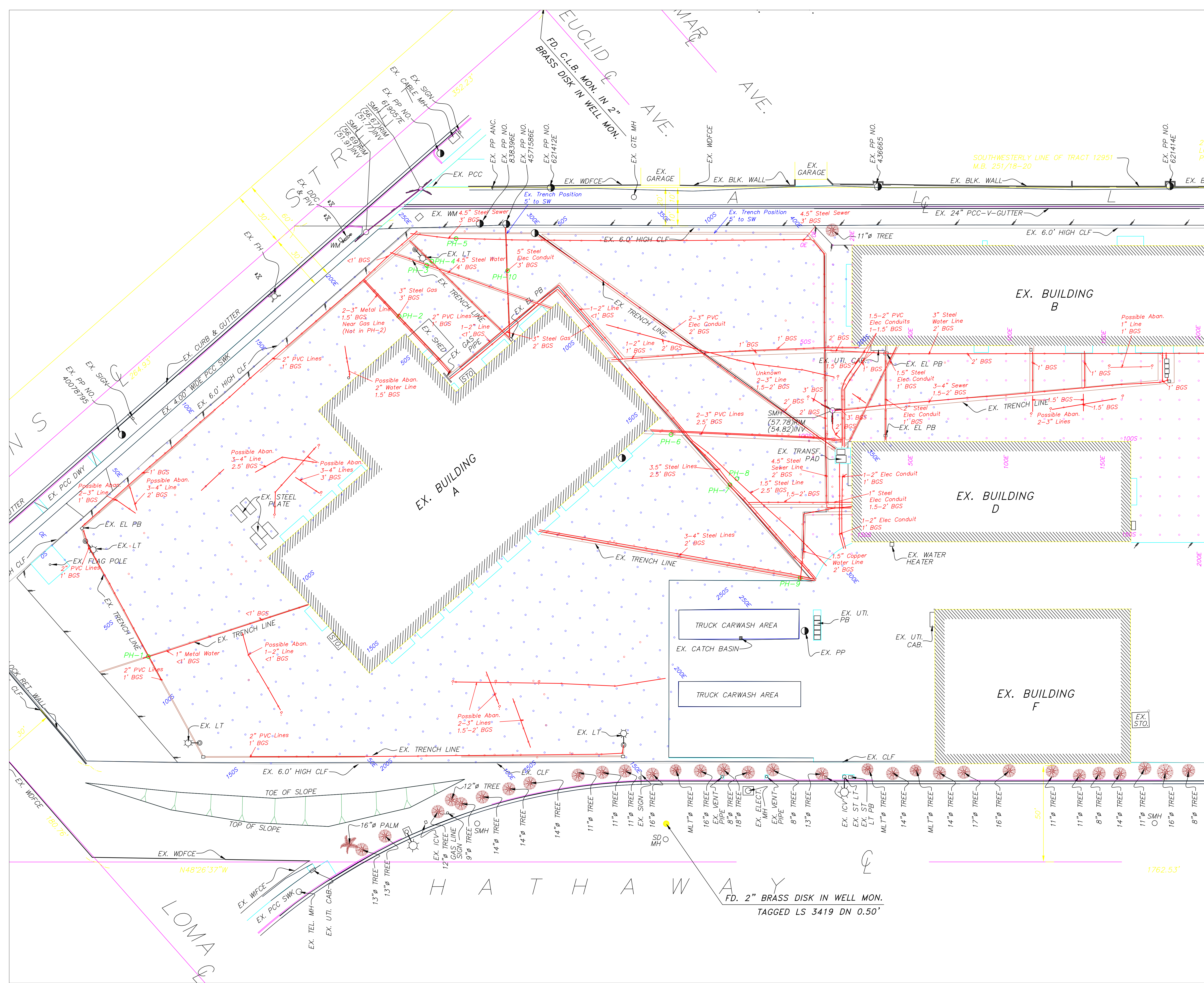
The Approximate Outside Diameter and Type of Subsurface Line are Also Estimated. This Information is Based on Potholing Results and Observations of the Utility Lines Emerging from the Ground Near Building Walls.

**POTHOLE INFORMATION**

Shows Locations of Limited Excavation Areas Where a Vacuum Air Knife was used to Expose Subsurface Lines for Direct Observations.

**Pothole Observations:**

- PH-1 Three Lines:  
2" and 1.5" PVC Lines, Orientated North-South, 10" BGS.  
1" Metal Line, Orientated East-West, 6" Below Ground Surface (BGS).
- PH-2 One Line:  
3" Steel Gas Line, Orientated North-South, 36" BGS.
- PH-3 One Line:  
4.5" Steel Water Line, Orientated North-South, 48" BGS.
- PH-4 Two Lines:  
2" and 1.5" PVC Elec Lines, Orientated North-South, 12" BGS.
- PH-5 One Line:  
4.5" Steel Sewer Line, Orientated NW-SE, 39" BGS.
- PH-6 Two Lines:  
2" and 3" PVC Lines, Orientated NW-SE, 33" BGS.
- PH-7 Two Lines:  
3.5" Steel Lines, Orientated North-South, 28" BGS.
- PH-8 One Line:  
1.5" Steel Line, Orientated North-South, 30" BGS.
- PH-9 Three Lines:  
3" and 4" Steel Lines, Orientated NW-SE, 25" BGS.  
1.5" Copper Line, Orientated NE-SW, 24" BGS.
- PH-10 One Line:  
5" Steel Elec Conduit, Orientated NE-SW, 41" BGS.  
Possible Second Line Beneath.

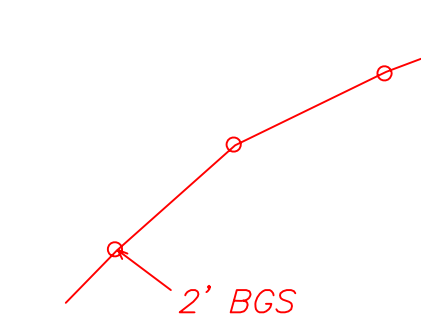


**GROUND-PENETRATING RADAR INVESTIGATION OF SUBSURFACE UTILITIES AND PIPELINES**

Prepared By: ADVANCED GEOSCIENCE, INC. 346 Tejon Place Palos Verdes Estates, CA Tele (310) 378-7480	Site Plan California Army National Guard Long Beach CSMS Facility Long Beach, California
March, 2008	SCALE 1" = 20'
	SHEET 1 of 2

REVISING		DATE	APPROVED
ZONE	REV	DESCRIPTION	

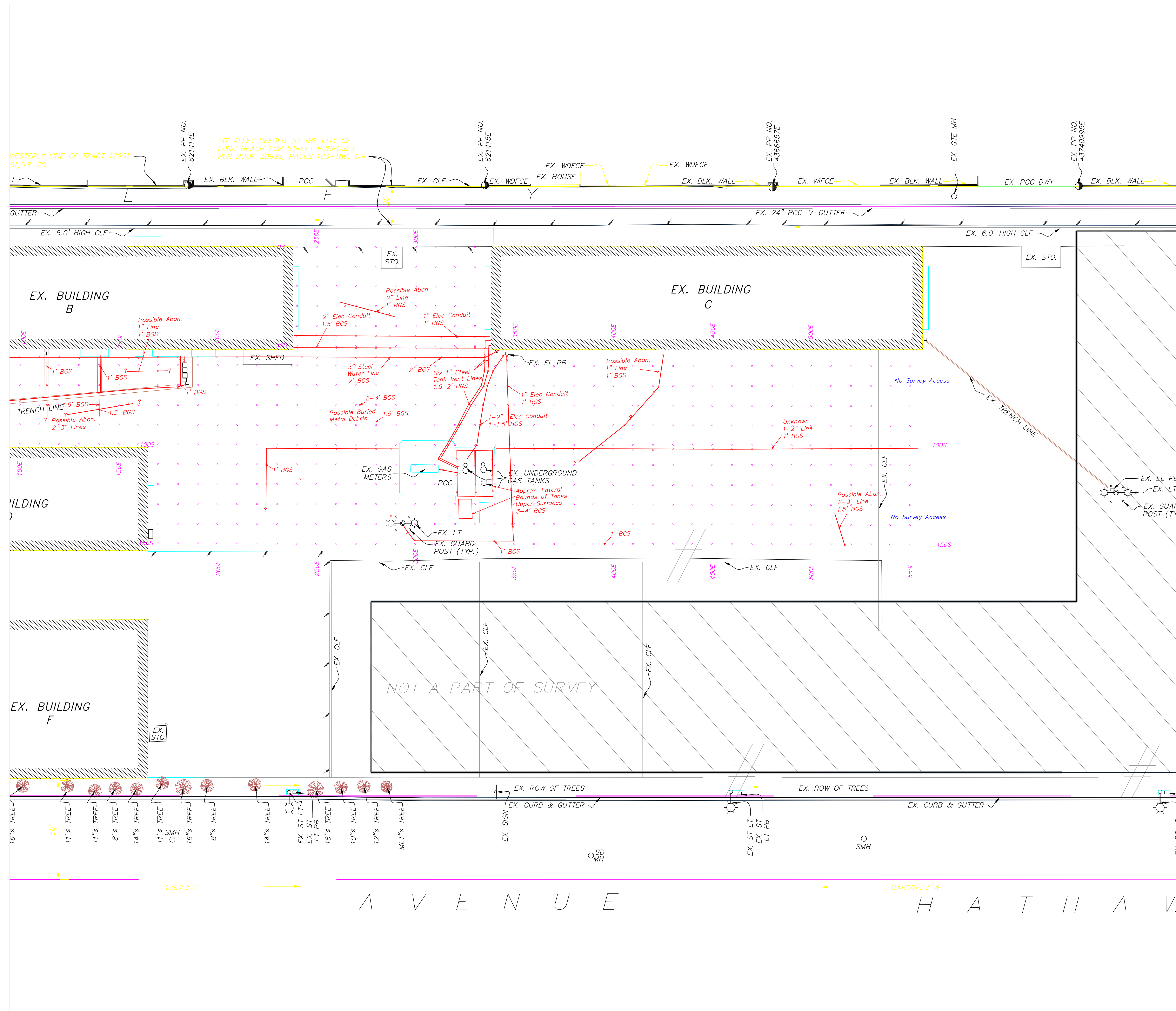
EXPLANATION OF GPR SURVEY RESULTS



Shows Interpreted Alignment of Radar Reflection Patterns Indicating Evidence of Subsurface Lines. Lines are Dashed Where Interpretation is Less Certain.

Depth Below Ground Surface (BGS) of Lines is Estimated at Various Points. Circled Points Indicate Where Reflection Patterns Were Detected from Crossing Linear Subsurface Objects Such as Pipelines.

The Approximate Outside Diameter and Type of Subsurface Line are Also Estimated. This Information is Based on Potholing Results and Observations of the Utility Lines Emerging from the Ground Near Building Walls.



GROUND-PENETRATING RADAR INVESTIGATION OF SUBSURFACE UTILITIES AND PIPELINES

Prepared By: ADVANCED GEOSCIENCE, INC. 346 Tejon Place Palos Verdes Estates, CA Tele (310) 378-7480 March, 2008	Site Plan California Army National Guard Long Beach CSMS Facility Long Beach, California
SCALE 1" = 20'	SHEET 2 of 2