OLSON ENGINEERING, Inc.

SPECIALIZING IN CONDITION EVALUATION OF THE CIVIL STRUCTURE & INFRASTRUCTURE

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NONDESTRUCTIVE TESTING INVESTIGATION
SHEET PILE FOUNDATION LENGTHS
NEW ORLEANS LEVEES
NEW ORLEANS, LOUISIANA

Prepared for:

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1.0 INVESTIGATION SCOPE AND SUMMARY OF FINDINGS

This report presents the Nondestructive Testing (NDT) investigation results for the determination of the unknown lengths of sheet piles below concrete walls of the New Orleans levee system. The levee sheet piles were tested with the Parallel Seismic (PS) method to determine their depths. The PS tests were conducted at the 17th Street, London Avenue, and the Inner Harbor Navigational Canal (IHNC) levees in 8 cased borehole locations at undamaged levee wall locations next to breaches.

The PS results indicate the presence of piles under the concrete wall, and showed that they extended to approximately 13-15 ft below the casing top for all of the sites tested as summarized in Table I. These sheet pile depths translate to elevations of approximately 10 feet below mean sea level (range of 9.3 to 11.8 feet below mean sea level). A discussion of the PS method and the investigation results are presented below.

2.0 PARALLEL SEISMIC METHOD

The Parallel Seismic (PS) method was used to estimate the depth of the foundations. The PS test equipment used in this investigation included a 3-lb instrumented impulse hammer, single hydrophone receiver, and a dynamic signal analyzer (Olson Instruments Freedom Data PC), as illustrated in Fig. 1. When the instrumented hammer directly impacted the supported concrete wall, it (or a nearby accelerometer) triggered the PC- based signal analyzer to capture the time records. A 16-channel National Instruments digital card was used to acquire the data in an Olson Instruments portable Freedom Data PC. Photographs of the field testing are shown in Figure 2.

The PS method involves impacting the exposed portion of the foundation or substructure attached to the foundation or a location which when impacted couples sufficient energy to the pile to generate a sound or stress wave which travels down the foundation. The wave energy is tracked by a hydrophone receiver suspended in a water-filled, cased and sometimes grouted borehole drilled

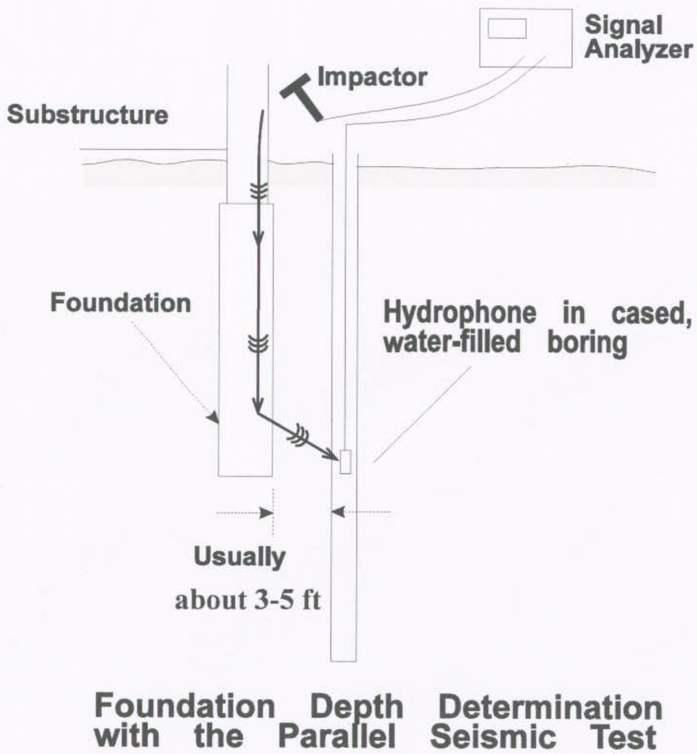

Figure 1 - PS test schematic

typically within 3-5 feet of the foundation edge. Note that for this investigation, the boreholes were found to be located as far as 21.1 feet from the levee wall, resulting in poorer quality data for some tests. The PS tests typically involve lowering the hydrophone(s) to the bottom of the borehole, impacting the exposed portion of the foundation structure and recording the hydrophone(s) responses. Then the hydrophone receiver(s) is raised to the next test elevation. This test sequence is repeated until the top of the casing (or the top of the water level in the casing) is reached. The pile depth is determined by plotting the hydrophone(s) response from all depths on a single display or page. For soils of constant velocity surrounding the piles, a break in the slope of the line occurs below the bottom of the piles indicating the pile depth. For soils with varying velocities, a break often cannot be identified from the slope of the lines, but the bottom of the piles can be identified by observing the traces of the hydrophone plot to identify changes in the response, such as a reduction in signal amplitude, change in signal frequency, or diffraction/reflection of tube wave energy from the foundation bottom.

Figure 2 - Photographs of impacting Wall of IHNC Levee at South Borehole of South Breach and Freedom Data PC at Cased Borehole with Hydrophone Receiver Downhole

3.0 INVESTIGATION RESULTS AND SUMMARY

The investigation was performed on October 27, 2005 and October 28, 2005 using the Parallel Seismic (PS) method by Mr. Larry D. Olson and Ms. Hunter Yarbrough of Olson Engineering, Inc., with assistance from U. S. Army Corps of Engineers personnel Mr. Richard Haskins and Mr. Don Yule. The 3 levee locations tested were at the 17th Street, London Avenue, and Inner Harbor Navigational Channel (IHNC). The PS test site at each test area was designated by the breach location and the position of the borehole. Hammer impacting was done horizontally on the levee wall face and vertically on the wall top where possible. The Parallel Seismic tests were performed with 5 impacts (horizontal and/or vertical) to the concrete walls at each of the hydrophone receiver depth intervals of nominally 1 ft for the entire water-filled length of the boreholes, starting typically 25 ft below the top of the borehole and continuing up to the top of the borehole casing at each site.

The Parallel Seismic tests were performed using a 3-lb hard-plastic tipped instrumented impulse hammer as a source and a single Olson Instruments hydrophone as a receiver. The pile locations were chosen to obtain a length measurement at the locations adjacent to levee breaks which occurred following Hurricane Katrina. Note that the reported data in Appendix A are pile tip depths measured from top of casing and that the PS predicted pile tip depths in true elevation as well as from the bottom wall chamfer can be found in Table I. Review of this table indicates sheet pile depths of 13-15 ft below the tops of the cased boreholes which corresponds to about 10 ft below mean sea level. Given the 1 ft hydrophone receiver measurement depth intervals, the PS results are believed to be accurate to within about 1 ft of the reported depths where data quality is high.

The Parallel Seismic data and results for the 17th Street Site can be found in Figures A-1 and A-2 in the Appendix. The Parallel Seismic data and results for the London Avenue Sites can be found in Figures A-3 to A-5, where Figures A-3 and A-4 are from the North breach and Figure A-5 is from the South breach. The Parallel Seismic data and results for the IHNC can be found in Figures A-6 to A-8, where Figure A-6 is from the breach near Florida Street and Figures A-7 and A-8 are from the South breach. The exposed parts of all locations consisted of concrete retaining walls which had embedded sheet piles underneath. For the eight tested sites, PS tests were performed to a depth of 25 feet below the top of the grouted, 5 inch PVC casings which were filled with water.

The PS results presented in Appendix A are from typically horizontal hammer hits (data quality was better in one location using a vertical hammer hit as presented in Figure A-3). The horizontal hammer hits were located on the thicker wall sections just below the bottommost chamfer corner and the vertical hammer hits were located on top of the approximately 7 foot concrete retaining wall. The vertical axis in Figures A-1 and A-2 represents depth below casing top, with each waveform at 1 feet intervals starting at 25 feet at the bottom of each casing. The horizontal axis represents acoustic wave travel time in milliseconds (ms).

The generally faster compressional wave velocities of the sheet piles are represented by the shallow, usually more negatively sloped data in the figures at depths near the apparent pile tips. The more gentle, usually less negatively sloped data of the first breaks of the deeper traces represent the slower soil velocities below the pile tips. This is not the case in several of the data sets due to higher soil layer velocities at depth, likely associated with the presence of ground water which results in velocities of about 5,000 ft/second. Where the boreholes could be drilled less than ten feet away from the wall/pile (preferred), such saturated faster soil layers did not have as significant of an impact on data quality.

The PS measured pile tip depths for the eight locations indicate that there are piles present underneath the concrete retaining walls. Some of the results are of lower quality data due to a significant distance (17 to 22 ft) between the wall impact points to the boreholes as indicated in Table I. This is evidenced by the relatively weak signals from the piles compared to the signals from the impacted concrete walls on top of the piles, and from the relatively great depth at which the high-velocity pile signals finally start to arrive sooner than the low velocity signals being carried down the water-filled boreholes (tube waves). Accordingly, data quality was rated as high, medium and low (H, M and L) in Table I based on the distance between the wall-borehole and the signal quality.

4.0 CLOSURE

The field NDT investigation was performed in accordance with generally accepted testing procedures. If there are any questions, or further information is required, please do not hesitate to call. If any additional information is developed pertinent to this study, please contact our office.

Respectfully submitted,

OLSON ENGINEERING, INC.

Hunter A. Yarbrough
Geophysical Project Engineer

Larry D. Olson, P.E.
Principal Engineer

(1 copy faxed and 2 copies mailed)

Table I: Summary of Sheet Pile Tip Depths and Elevations From Parallel Seismic Testing of New Orleans Levees

Levee Site	Sheet Pile Tip Depth From Top of Casing (ft) – (Data Quality)	Sheet Pile Tip Depth From Bottom Concrete Wall Chamfer (ft)	Sheet Pile Tip Elevation (ft above sea level)*	Distance Between Borehole and Levee Wall
17th Street North End	14.4 - H	15.5	-10.6	5.5 ft
17th Street South End	14.0 - H	15.0	-9.3	6.2 ft
London Avenue North Break North End	14.6 - L	16.1	-11.2	17.8 ft
London Avenue North Break South End	13.1 - M	14.9	-9.7	7 ft
London Avenue South Break	14.3 - M	15.3	-10.6	17.2 ft
IHNC Florida Street Break	14.8 - M	16.5	-10.3	21 ft
IHNC South Break North End	13.7 – H	16.6	-10.4	9.5 ft
IHNC South Break South End	14.4 – M	16.1	-11.8	21.1 ft

H – Indicates areas where the data quality is high and the borehole is positioned within 10 feet of the sheet pile.
M – Indicates areas where the data quality is medium and/or the borehole is positioned greater than 10 feet away from the sheet pile.
L – Indicates areas where the data quality is low and/or the bore hole is positioned greater than 10 feet away from the sheet pile.

*** The elevations of the borehole casing tops were provided by the US Army Corps of Engineers and are NAVD 88 Format.**

APPENDIX A
PS DATA AND RESULTS

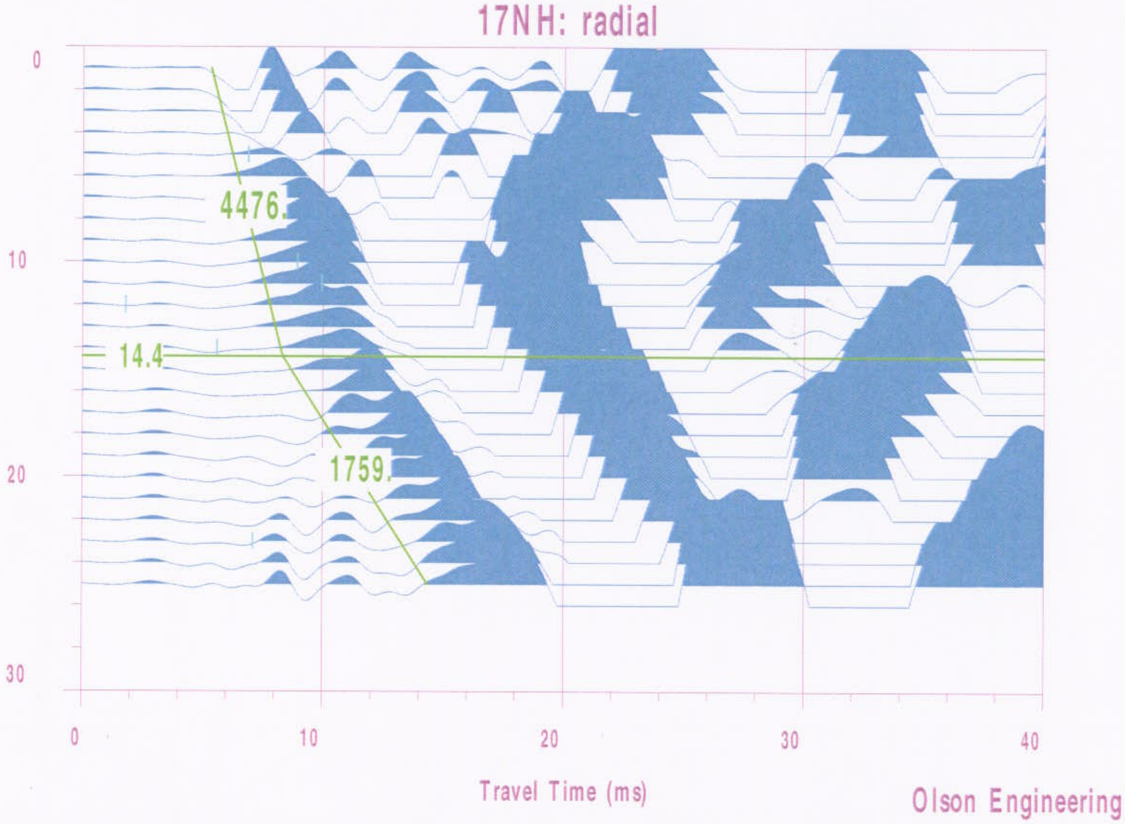

Figure A-1: 17th Street site, North borehole, depth is referenced to top of casing

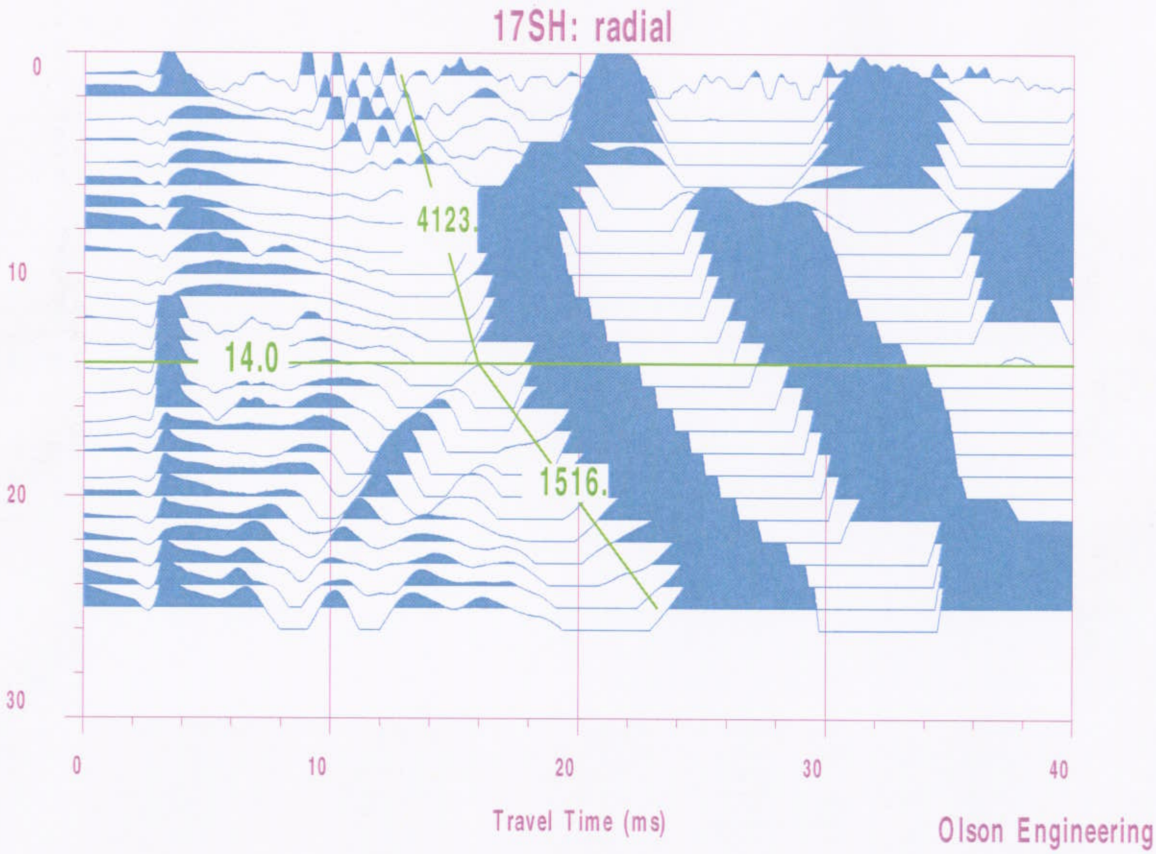

Figure A-2: 17th Street Site, South borehole, depth is referenced to top of casing

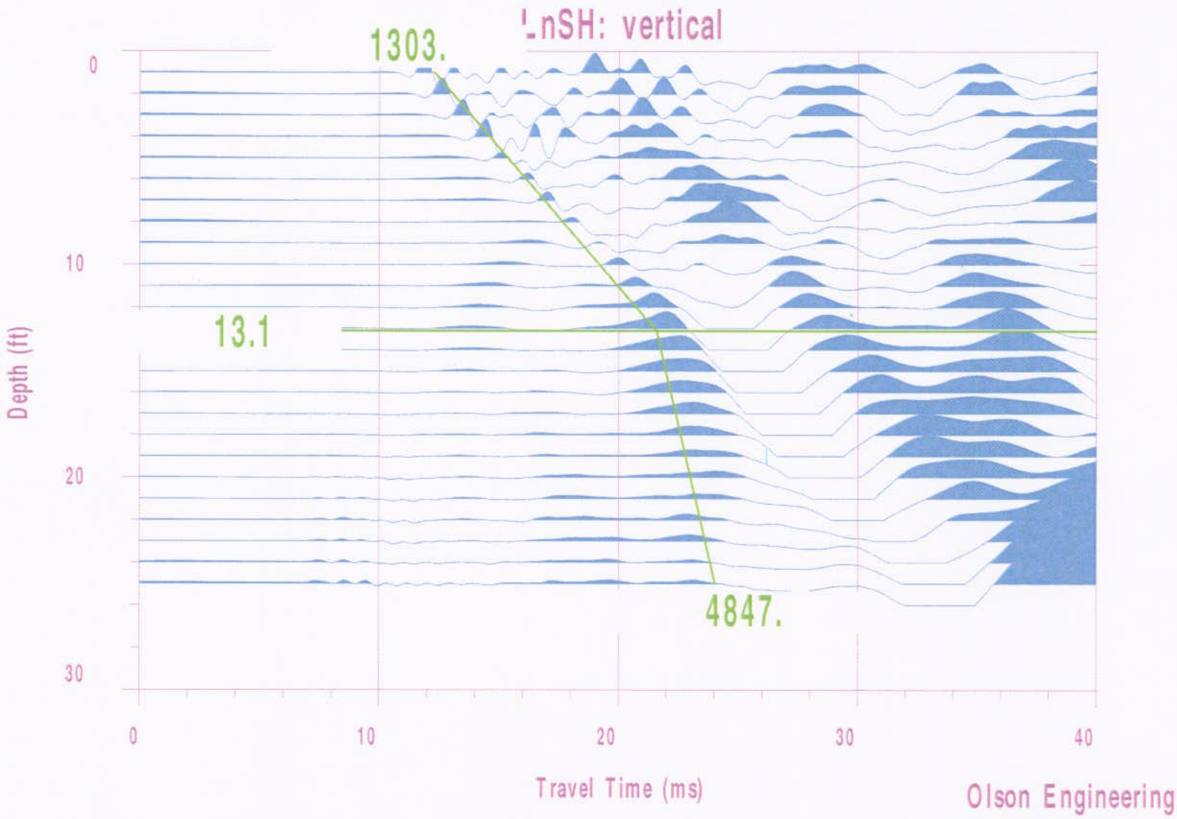

Figure A-3: London Avenue North site, North borehole, depth is referenced to top of casing

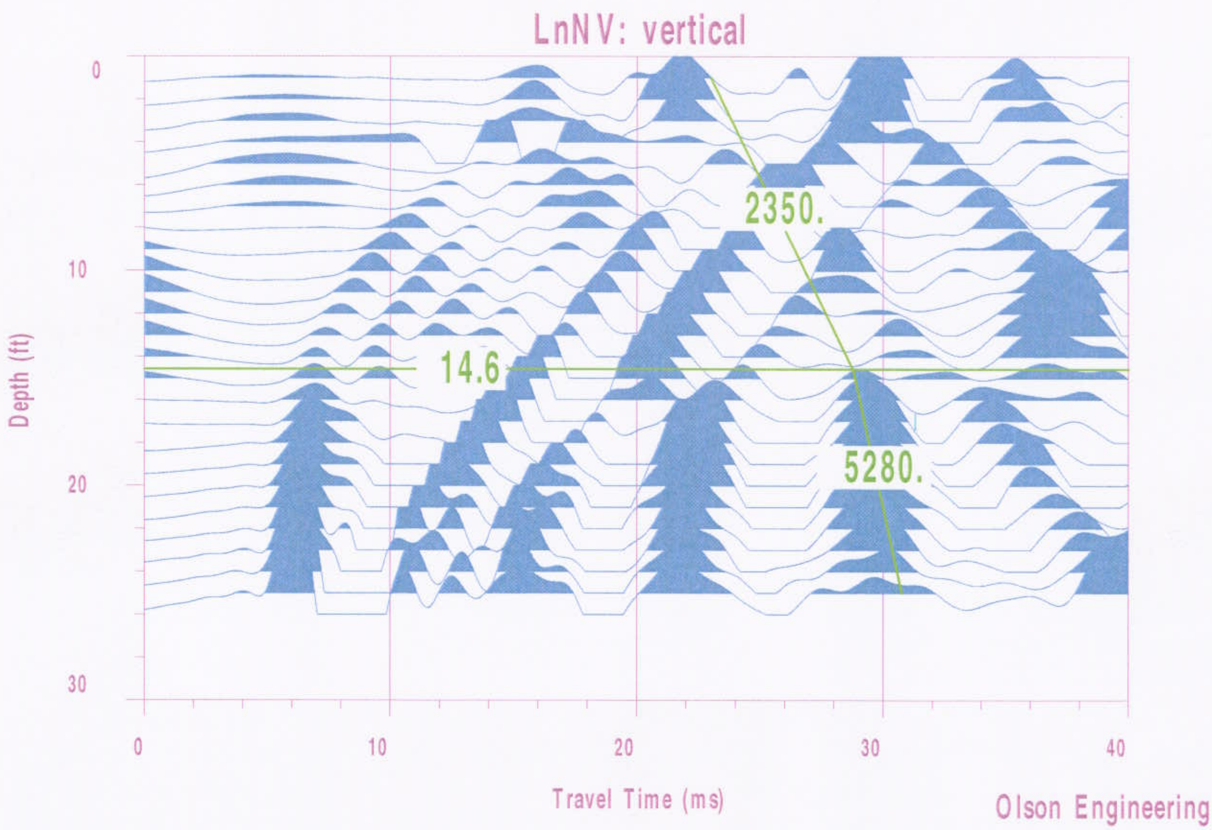

Figure A-4: London Avenue North site, South borehole, depth is referenced to top of casing

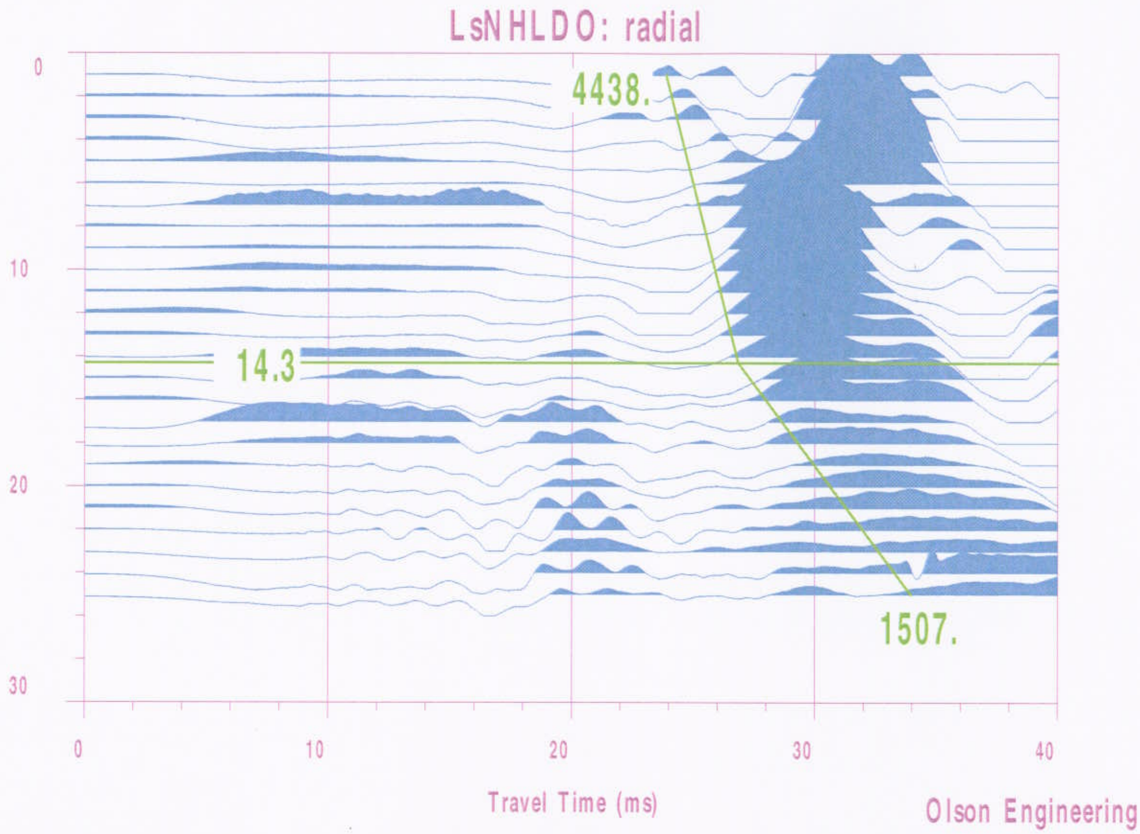

Figure A-5: London Avenue South site, North borehole, depth is referenced to top of casing

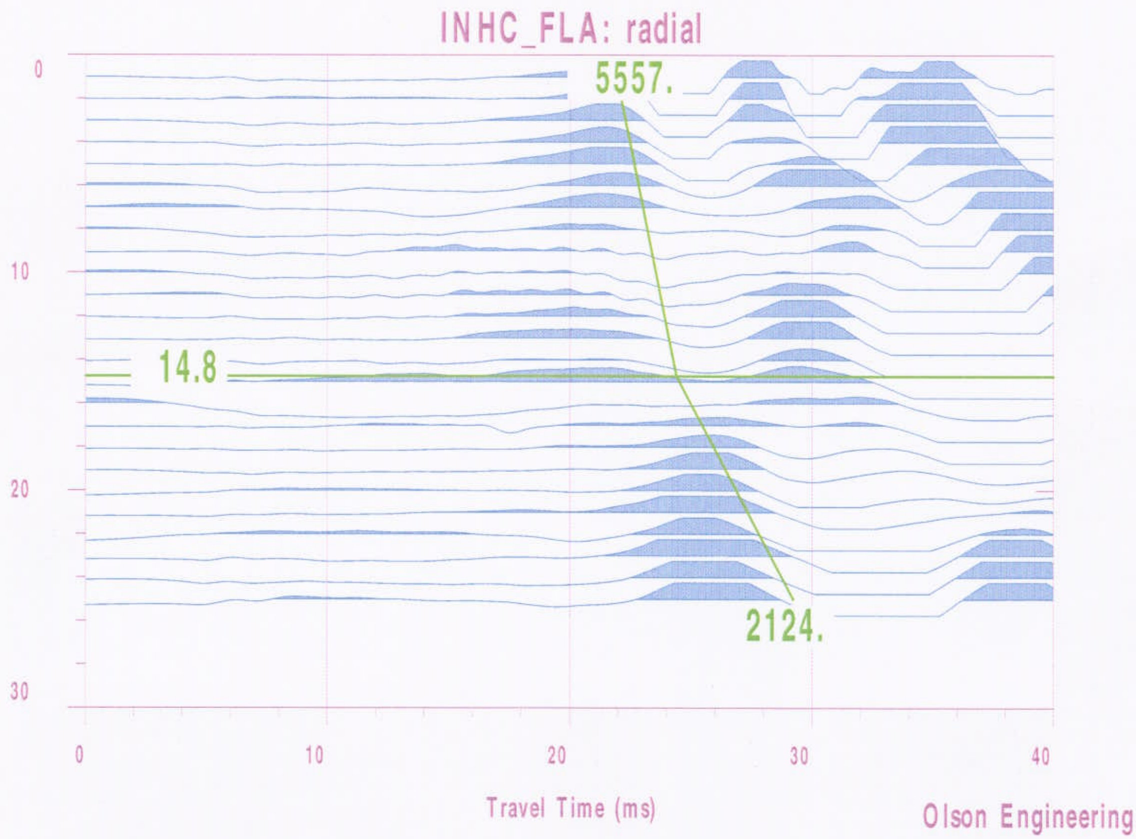

Figure A-6: IHNC Florida Street site, depth is referenced to top of casing

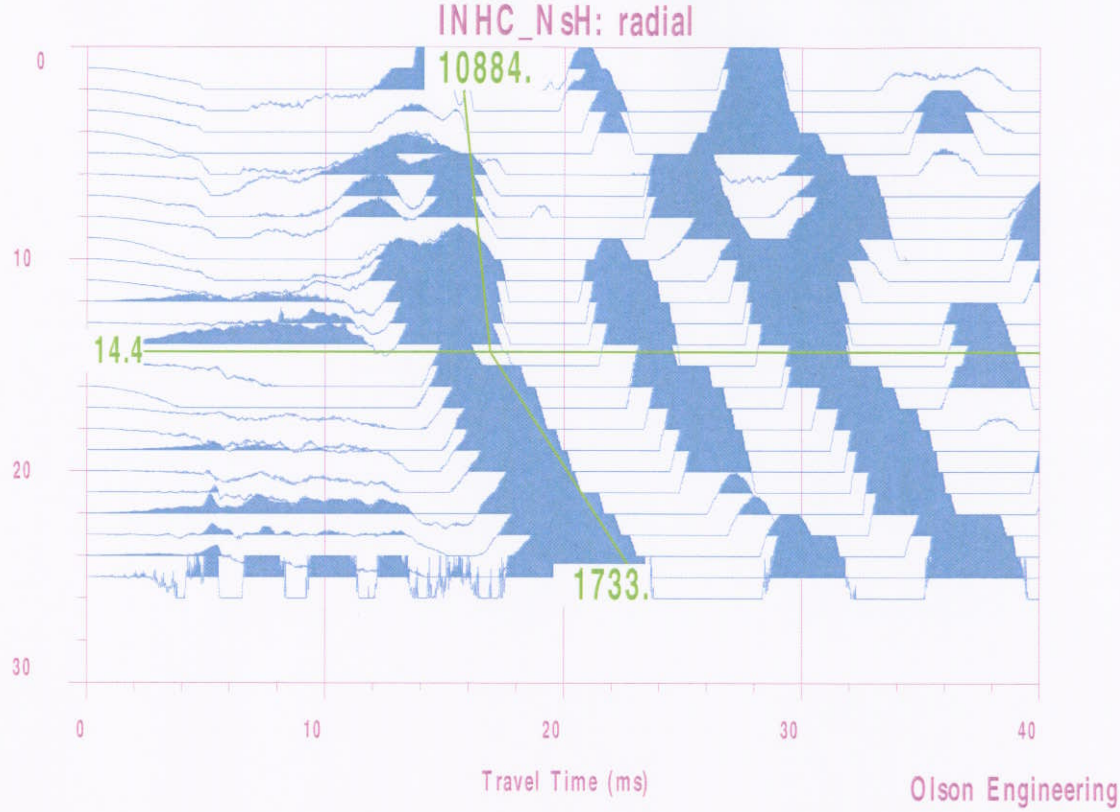

Figure A-7: IHNC South site, North borehole, depth is referenced to top of casing

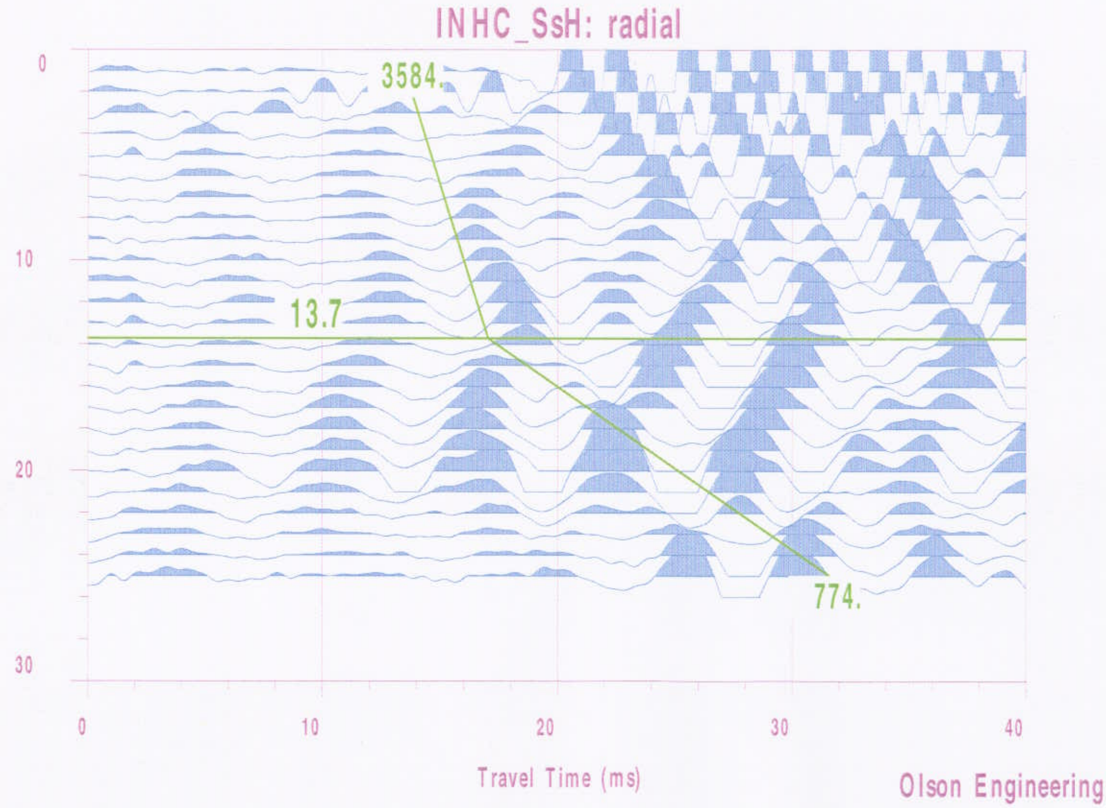

Figure A-8: IHNC South site, South borehole, depth is referenced to top of casing