APPENDIX K – CPT SIGNATURE COMPARISON

FINAL REMEDIAL INVESTIGATION REPORT
CASMALIA RESOURCES SUPERFUND SITE
CASMALIA, CALIFORNIA

Prepared By: URS Corporation

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LIST OF ACRONYMS

ARCH	air-rotary casing hammer
ASTM	American Society for Testing and Materials
bgs	below ground surface
CPT	cone penetrometer testing
CSC	Casmalia Steering Committee
DQO	data quality objective
EPA	Environmental Protection Agency
ERM	Environmental Resources Management
LHSU	Lower Hydrostratigraphic Unit
MIP	Membrane Interface Probe
P.G.	Professional Geologist
RI/FS	Remedial Investigation/Feasibility Study
UHSU	Upper Hydrostat graphic Unit

1.0 INTRODUCTION

The Casmalia Steering Committee (CSC) completed the CPT Signature Comparison Investigation in accordance with the June 2004 *RI/FS Work Plan* (Work Plan) which was prepared by the CSC and approved by the EPA. The following sections describe the nature and findings of the work completed as part of this investigation.

2.0 PURPOSE OF INVESTIGATION

The purpose of this investigation was to establish the relationship of the Cone Penetrometer Testing (CPT) signature to the predominant lithology that occurs at the Casmalia Resources Superfund Site (Site). CPT responses observed during the earlier Pesticide/Solvent Landfill CPT investigations, as well as during other CPT work and CPT-borehole correlation analyses performed, indicate that CPT technology could, in the right conditions, be used to accurately assess subsurface conditions. It was believed that the signatures could be used to identify claystone presence and accurately indentify the contact depth between the Upper Hydrostratigraphic Unit (UHSU) and the Lower Hydrostratigraphic Unit (LHSU). Because CPT is an indirect method for soil lithology determination, some inherent uncertainty exists with regard to the meaning of the test results, and it may be possible that observed increases in tip resistance with depth are due to natural or anthropogenic subsurface anomalies, rather than presence of claystone or the unweathered contact. Therefore, as a part of the RI, additional “confirmation” CPT signatures were developed and evaluated to assess their effectiveness in identifying the UHSU/LHSU contact. The validity of the CPT method was to be confirmed based on calibration of the observed CPT response with known lithologic conditions at the adjacent cored confirmation boreholes.

3.0 SCOPE OF INVESTIGATION

The investigation included seven of the originally proposed collocated CPT locations as prescribed in Table 5-1a of the RI/FS work plan. Seven additional locations from the CPT/membrane interface probe (MIP) investigations were chosen which had CPT signatures that were collocated with borings where both the CPT and the boring penetrated the contact between the weathered and unweathered units. All of the locations were chosen to spatially and lithologically represent the site conditions. Table K-1 lists the confirmation CPT locations and the boring most closely associated with the CPT location, and lithologic conditions encountered. Attachment K-1 contains the graphical boring logs scaled and presented together with the corresponding CPT traces for correlation. The CPT locations and corresponding boring locations are depicted in Figure K-1.

3.1 Methodology

3.1.1 Detailed Approach

The work was performed by first pushing a CPT at each of the seven planned locations listed in work plan Table 5-1a. The rig used was a 30-ton truck capable of pushing a 15-cm^2 cone at up to 1,000 tons per square foot (tsf) of tip energy.

3.1.2 Contractors and Subcontractors

3.1.2.1 Principal Contractors – ERM and URS Corporation

ERM coordinated and oversaw all aspects of the CPT signature comparison investigation. ERM staff coordinated the pre-locating of each of the planned CPT push locations listed in Table 5-1a of the work plan. These CPT locations were placed as close to the targeted boreholes/wells as was practical within the constraints of the equipment. ERM staff professionals were present during all of the CPT push activities. URS Corporation staff, in conjunction with ERM, interpreted CPT profiles and performed the comparative analysis.

3.1.2.2 Surveying Subcontractor – Pacific Engineering

All field surveying and demarcation activities were subcontracted to Pacific Engineering, Incorporated of Santa Maria, California, (now Cannon Associates – California Contractors License No. A717253). All surveying activities were conducted under the direct supervision of a California registered Civil Engineer (Leroy Cadena, California registered Civil Engineer No. C55373).

3.1.2.3 Drilling Subcontractor – Gregg Insitu, Inc.

All CPT data collection activities were subcontracted to Gregg Insitu of Signal Hill, California. Gregg Insitu is a licensed CPT contractor, C57 license No. 656407. Gregg Insitu used a 30-ton CPT direct-push rig for the collection of the CPT traces.

3.1.3 Equipment and Tools

3.1.3.1 CPT Direct Push Apparatus

Gregg Insitu used a Marl™ 30-ton Cone Penetrometer Testing push rig that can produce up to 1,000 tons per square foot of reaction energy with a 15-cm^2 cone. The rig uses a twin ram hydraulic system that is linked to the data acquisition system to record the depth intervals and soil properties every 5-cm during each CPT push.

3.1.3.2 Cone Penetrometer Equipment

The Adara Systems™ 15-cm^2 cone system recorded three-channels, including tip resistance, skin friction, and pore pressure. ASTM 5778-95 revision 2000 is the method standard that was used to record the cone return signal. The method requires that baseline readings be conducted before and after each push, and these data are used to determine zero-load offset for each run. The standard has specific constraints in which the cone can vary before the apparatus is taken offline and returned to the manufacturer for calibration.

3.1.3.3 Drilling and Sampling Equipment

The boreholes were continuously cored and logged during previous site investigations using an air rotary casing hammer (ARCH) drilling rig. Mactec Engineering performed this work during the spring and summer of 2000. The coring system was a 94-mm Christianson wireline sampler, which allowed for continuous and relatively undisturbed sampling of the lithologic material.

3.1.4 Deviations from Work Plan

There were no deviations from the Work Plan methodologies for this activity. While the original RI/FS Work Plan did not require the seven additional locations that were included in this evaluation, they were included to add additional spatial and lithologic variability support to the study.

3.2 Investigation Results

3.2.1 Boring Logs

Each of the borings used in this comparison study were cored and logged in the field by a geologist. These logs are presented in Attachment K-3, and the reader should refer to the logs for specific descriptions for each of the locations in the study. In all of the cases the general characteristics of the upper weathered unit are similar around the site. This unit is comprised of a grayish brown mottled claystone with significant amounts of secondary mineralization in the fractures. The unweathered material is uniformly much more massive in nature with a greenish-gray to bluish-gray color. In all of the logs the geologist was able to identify a transition zone, up to 3 feet thick, between the upper and lower hydrostratigraphic units. In some cases the contact is a sharp and distinct change in lithology and in others it is more transitional in nature.

3.2.2 CPT Traces

There are two dominant features in the CPT signatures that can be used to determine the contact between the upper and lower hydrostratigraphic units. The primary indicator of the contact is a sharp increase in both the tip resistance and dynamic pore pressure. In most cases the increase in both of these traces is sudden and significantly greater in magnitude in the unweathered material than that in the weathered material. In some cases the tip resistance is not significantly higher but the pore pressure shows a marked increase that corresponds to a slight increase in the tip resistance. The CSC has presented below a discussion of CPT logs which best represent the variability in conditions and CPT signatures on the site. Attachment K-1 contains the graphical boring logs scaled and presented together with the corresponding CPT traces for correlation. A side-by-side comparison of CPT logs for all 14 locations investigated is presented in Figure K-2. The CPT logs for all of the locations are presented in Attachment K-2, and the accompanying soil boring logs are presented in Attachment K-3.

3.2.2.1 RICPT-01

This location is a good example of a shallow CPT signature through a relatively dense weathered unit and a less sharply defined contact with the unweathered unit. In this case the tip resistance does not have a significant increase within the unweathered material but the dynamic pore pressure has a very significant and clearly defined increase at 17-18 feet below ground surface. This corresponds well with the contact as it is called out in the adjacent boring, RG-6B, which has the contact at 16 feet below ground surface.

3.2.2.2 RICPT-03

This location is an example of a deeper CPT signature through a moderately dense weathered unit and a sharply defined contact with the unweathered stratigraphic unit. The tip resistance shows a clear deflection that corresponds well with a significant increase in pore pressure at 42 feet below ground surface. The boring log, RG-11B, has a gradational contact starting at 40 feet below ground surface. Again, the CPT-derived contact is very close to the gradational contact noted in the boring log.

3.2.2.3 RICPT-05

This is an example of a deeper CPT signature with a moderately dense weathered unit and a poorly defined contact with the unweathered stratigraphic unit. The trace shows a deflection that corresponds with a decrease at approximately 56 feet and an increase in pore pressure at approximately 63-64 feet below ground surface, but virtually no deflection in tip resistance. This location is good example of where CPT must be used in conjunction with other empirical data such as boring logs or isopach maps in order to determine contact depth. In this case, the boring log for RG-PZ-12D calls out a transitional contact with the unweathered claystone at 61 feet below ground surface, approximately the mid-point of the pore pressure deflection between 56 and 64 feet.

3.3 Conclusion of Comparison of CPT to Lithologic Conditions

The results of this study indicate that the CPT is a very useful tool in evaluating the contact between the upper and lower hydrostratigraphic units. Indeed, the boring log – CPT trace comparisons indicated that in most cases the contact identified on the boring log was within one to several feet of the CPT-derived contact. There did not appear to be any one specific feature of the CPT traces that would distinguish the contact between the two units. Rather, it was a combination of the tip resistance and dynamic pore pressure that were used to establish the contact depth. When both the pore pressure and the tip resistance provide a sharp response then the contact can be determined with confidence. When there is only a minor response in one or both of the traces, then CPT would be more applicable as a means of approximating contact depth.

It is clear that in many situations the CPT trace will give an accurate depth to the contact when the transition zone from the weathered to unweathered hydrostratigraphic units is narrow (e.g., RICPT-03). In other circumstances, such as in the case of areas where there is a very dense weathered zone with a thick transition zone, the CPT traces should be considered more an estimating tool rather than a means of accurately defining the contact depth. The use of the CPT for positively determining the contact between the weathered and unweathered hydrostratigraphic units will be limited to those locations displaying a relatively thin transition zone.

4.0 EVALUATION OF ADDITIONAL DATA NEEDS

The findings of this investigation have been successful in demonstrating the usefulness of using CPT profiles in determining the depth to the contact between the weathered and unweathered hydrostratigraphic units on the site. While data quality objectives (DQOs) have been established for many elements of the RI, no DQOs exist for this specific activity. Because the CPT signature comparison was successful in characterizing the utility of the method, the objectives for this task as stated in the RI/FS Work Plan have been met. Based upon the success of this program as well as the probable limited future needs to use a CPT signature to identify the clay contact, there are no remaining data needs.