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Site Specific Report
SSR-2240-ENV

SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM

SITE CHARACTERIZATION
AT MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

BUILDING 1115
AS 872

by

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EXECUTIVE SUMMARY

An investigation was conducted from 5 November to 15 December 1995 at Marine Corps Base, Camp Lejeune, North Carolina, Building 1115 and AS 872. Thirty five SCAPS pushes were completed and twelve soil samples were collected for laboratory analysis.

The near surface geology, as determined by the SCAPS investigation data consists primarily of sand with lesser amounts of clayey silt and isolated zones of organic material.

No clear pattern of petroleum hydrocarbon contamination emerged from Building 1115 fluorescent intensity data. However, there does appear to be isolated pockets of low level (<500 ppm as TPH) petroleum hydrocarbon contamination.

At AS 872, the highest fluorescent intensity results were from areas of organic material and are classified as false positive responses. However, the fluorescent response in push AS87203 from 3.3 to 4.56 feet below ground surface is from petroleum hydrocarbon contamination.

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This report documents the Site Characterization and Analysis Penetrometer System (SCAPS) investigation of the area around Building 1115 and AS 872 at Marine Corps Base (MCB), Camp Lejeune, North Carolina. The investigation consisted of pushing a penetrometer probe (known as a "push") into the subsurface at locations in and around the sites to determine soil lithology, and the vertical and lateral extent of hydrocarbon contamination. The investigation was conducted from 5 November to 15 December 1995. Thirty five SCAPS pushes were completed and twelve soil samples were collected for laboratory analysis.

1. INTRODUCTION

1.1 Objective

The objective of the SCAPS investigation was to define the extent of polynuclear aromatic hydrocarbon (PAH) contamination around Building 1115 and AS 872.

1.2 Site Location

MCB Camp Lejeune is located in the southeast North Carolina, near the Atlantic Ocean shoreline, see Figure 1. (NEESA, 1983)

1.3 Site Geology

The near surface geology, as determined by the SCAPS investigation data consists primarily of sand with lesser amounts of clayey silt and isolated zones of organic material.

The geology of the Atlantic Coastal Plain physiographic province is typically a seaward-thickening wedge of sediments on a basement complex of igneous and metamorphic rock similar to that at the surface in the Peidmont physiographic province. Sediments on the coastal plain vary in age from Cretaceous to Recent and consist of layers of sand, silt, clay, marl, limestone, and dolostone. (NEESA, 1983)

The uppermost 300 feet of sediments at MCB Camp Lejeune is the source of fresh water for the base. In general, the acquifer system consists of a water table aquifer and one or more semi-confined aquifers. Confining beds lie between the two aquifer systems and between the layers of the semi-confined aquifers. Variations in the local hydrogeology result form the complex depositional history of the area. (NEESA, 1983)

The uppermost hydrogeologic unit, the water table aquifer, extends from land surface to the first confining bed. This aquifer consists of sand, silt, limestone, and small amounts of clay. These sediments are usually Pliocene and younger. (NEESA, 1983)

Depth to the zone of saturation is 10 feet or less. Groundwater in the water table aquifer generally flows from upland areas toward stream valleys where it dis-charge to surface water. (NEESA, 1983)

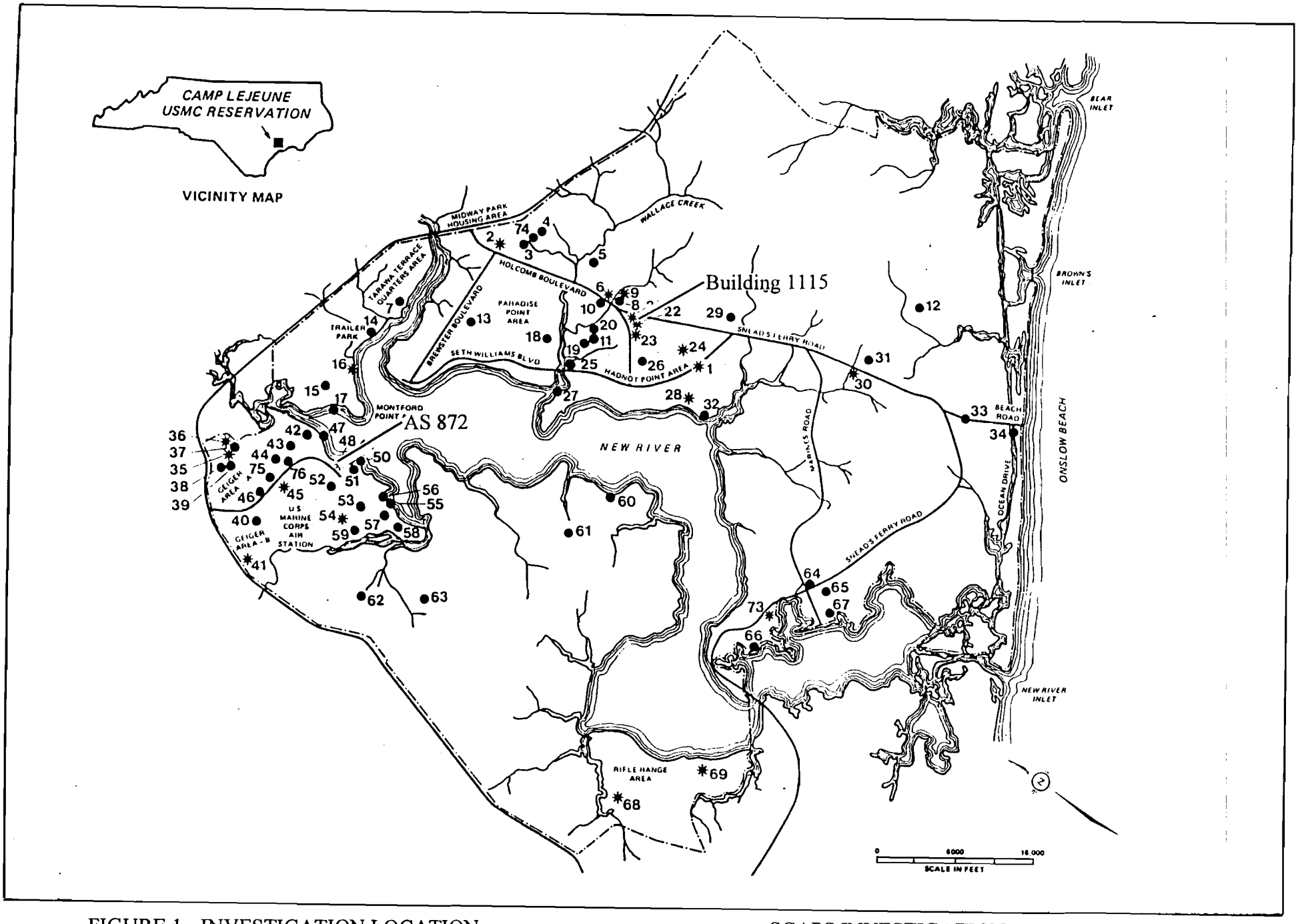

FIGURE 1 - INVESTIGATION LOCATION

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

1.4 Investigation Procedure

The investigation began by pushing holes near Building 1115. LANTDIV requested that pushes be completed to 90 feet below ground surface. The greatest depth achieved was 61.9 feet below ground surface during Push CL111503. A total of twenty five pushes were completed near Building 1115.

The investigation was completed near AS 872. A total of ten pushes were completed near AS 872.

Appendix A contains the methods used during the investigation.

2. INTERPRETATIONS

2.1 Interpreting Laser Induced Fluorescence Data

SCAPS is a field screening technique that detects petroleum hydrocarbons using the technique of laser induced fluorescence (LIF). SCAPS measures the presence of petroleum hydrocarbons by detecting polynuclear aromatic hydrocarbons (PAHs). PAHs are virtually found in all petroleum fuel mixtures. The PAHs fluorescence under ultra violet excitation, so that the amount of fluorescence is related to the amount of PAHs. A detailed system description is included in Appendix B.

The sensitivity of SCAPS varies with the portion of PAHs in the petroleum fuel. The present SCAPS system is most sensitive to PAHs with three or more rings like those found in heavy fuels such as diesel fuel and heating oils. The system has a reduced sensitivity to lighter fuels such as avgas, JP-5, and JP-4 which contain a smaller portion of three or more ringed PAHs.

The Laser Induced Fluorescence (LIF) system is quantitative in a known soil matrix with a known contaminant. However, when operated in the field the LIF system is semi-quantitative due to typical variations in the local soil matrix and contaminant type.

SCAPS results are intended to be used to gain a better understanding of contaminant distribution while reducing the number of investigation iterations at a site. Experience has shown that the measured fluorescence intensity is a good gross indicator of the location and amount of petroleum at a site, and that the SCAPS measurements are most effective when used in conjunction with a reduced number of soil samples that provide a quantitative measurement of the amount of contamination. The SCAPS results are not intended to define the extent of contamination for regulatory purposes.

Interpretation of the LIF response is completed by performing statistical analysis of the data collected to determine the Fluorescence Threshold (FT). The statistical analysis is included in Appendix C. A responding fluorescent intensity below the FT represents the normal population of responses that is expected from a complex soil system. A responding fluorescent intensity

above the FT represents a different population of responses that can be shown to represent petroleum hydrocarbon contamination. This is shown during each investigation by collecting soil samples from ten percent of the push locations and sending the samples to contracted laboratories for total petroleum hydrocarbon analysis.

2.2 Interpolation of Laser Induced Fluorescence Data

The Groundwater Modeling System version 2.0 is used to interpolate the LIF responses to give a visual summary of SCAPS results. Interpolations are performed by bounding all data by a grid. The distance between each grid node is selected to represent the average distance between push locations. The interpolation of results were made by using the Inverse Distance Weighted method which uses Gradient Hyperplane Nodal Functions to determine a scalar value at the nearest grid node. Appendix C, section 3 contains all assumptions used to generate the interpolations.

This interpolation is then combined with SCAPS soil data to create a stratigraphic cross section showing LIF results and the associated soil type. This visual aid is intended to be used to help guide in the selection of future sample locations, in the determination of monitoring well screen locations, and in the design of remediation systems.

2.3 LIF System Output

A push profile is generated after the LIF system collects the data. All the profiles are included in Appendix D. A profile consists of five columns of information. The first three columns are cone penetrometer data that is discussed in section 2.4. The last two columns of information are LIF system results. The first of the last two columns represents the Peak Wavelength in nanometers of the responding signal. This is used in real time to indicate:

- consistency with previous results
- consistency of the response with depth
- consistency with known contaminant responses from previous investigations

The second of the last two columns represents the peak Raw Fluorescent intensity of the responding signal. This is used in real time to indicate:

- the magnitude of the responding signal with respect to previous signals
- the depth and thickness of the positive response

Responses at or near the ground surface are considered false positives since they could represent plant materials.

2.4 Cone Penetrometer Data

As mentioned in the previous section, the push profile consists of six columns of information. The first three columns are cone penetrometer data results. The first of the three columns represents the cone pressure in tons per square foot (tsf). The cone pressure measurement, q_c, is recorded with a Wheatstone bridge strain gauge in terms of the voltage and converted to bearing

pressure expressed as tons per square foot (tsf). Results may be used in geotechnical design or along with sleeve friction to determine soil classification. The cone resistance is a measure of the grain-to-grain skeleton strength for sands and silts. Further advancement of the probe is stopped if this measurement exceeds 1000 tsf at any time during the push.

The second of the first three columns represents the sleeve friction in tons per square foot (tsf). The sleeve friction resistance, f_g, is the resistance of the soil as it slides past the friction sleeve. Further advancement of the probe is stopped if this measurement exceeds 8 tsf at any time during the push.

The third column represents the soil type as a number between 1 and 12. This is determined from the ratio of cone pressure and sleeve friction. Appendix E contains the chart used to convert the soil type number to a descriptive classification.

Techniques for using the soil strength measurements (cone pressure and sleeve friction) made with the cone penetrometer to determine soil type have been well-documented (Olsen and Farr, 1986). The classification scheme used by the SCAPS was devised by Robertson and Campanella (1989) to identify the types of soils encountered by cone penetrometer probes. For a detailed description of the output interpretation see Roberston and Campanella (1989), "Guidelines for Geotechnical Design Using the Cone Penetrometer Test and CPT with Pore Pressure Measurement." Hogentogler & Co., Inc., Columbia, MD.

SCAPS standard electrical cone penetrometer instrumentation consists of strain gauges measuring cone pressure and sleeve friction in accordance with American Society of Testing and Materials (ASTM) Standard D3441. The probe does not fully conform to ASTM standard because the diameter changes less than one foot above the friction sleeve.

3. RESULTS

Figure 2 shows the locations of SCAPS pushes completed near Building 1115. Figures 3, 4, and 6 provide a visual representation of the fluorescent intensity results near Building 1115 at approximately 6.25, 13.65, and 45.48 feet below ground surface respectively. Figure 5 provides a view that is 21 feet below ground surface in the northern portion of the drawing and 25.81 feet below ground surface in the southern portion of the drawing. The areas of highest fluorescent intensity are indicated by the colors red and green. The raw SCAPS results along with the confirmation sample results are in Appendix F.

These figures show no clear pattern in the distribution of fluorescent response near Building 1115.

Figures 7 and 8 are stratigraphic cross sections (looking west) of the area beneath Building 1115. The contour data in both figures show that the highest fluorescent intensity results were from areas with a variety of soil types. Based on the confirmation sample results and the SCAPS logs,

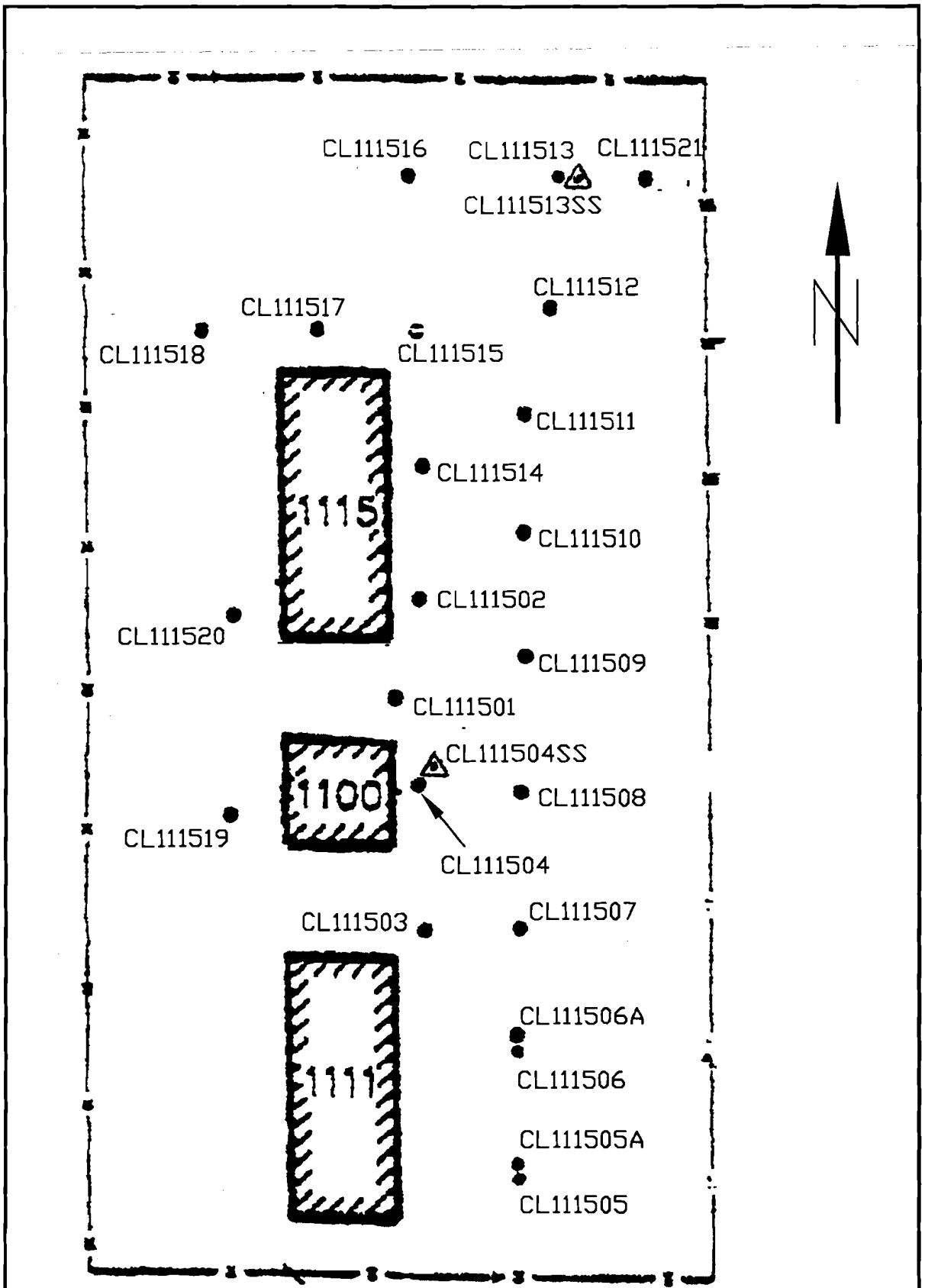

FIGURE 2 - SCAPS PUSH LOCATIONS
BUILDING 1115

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

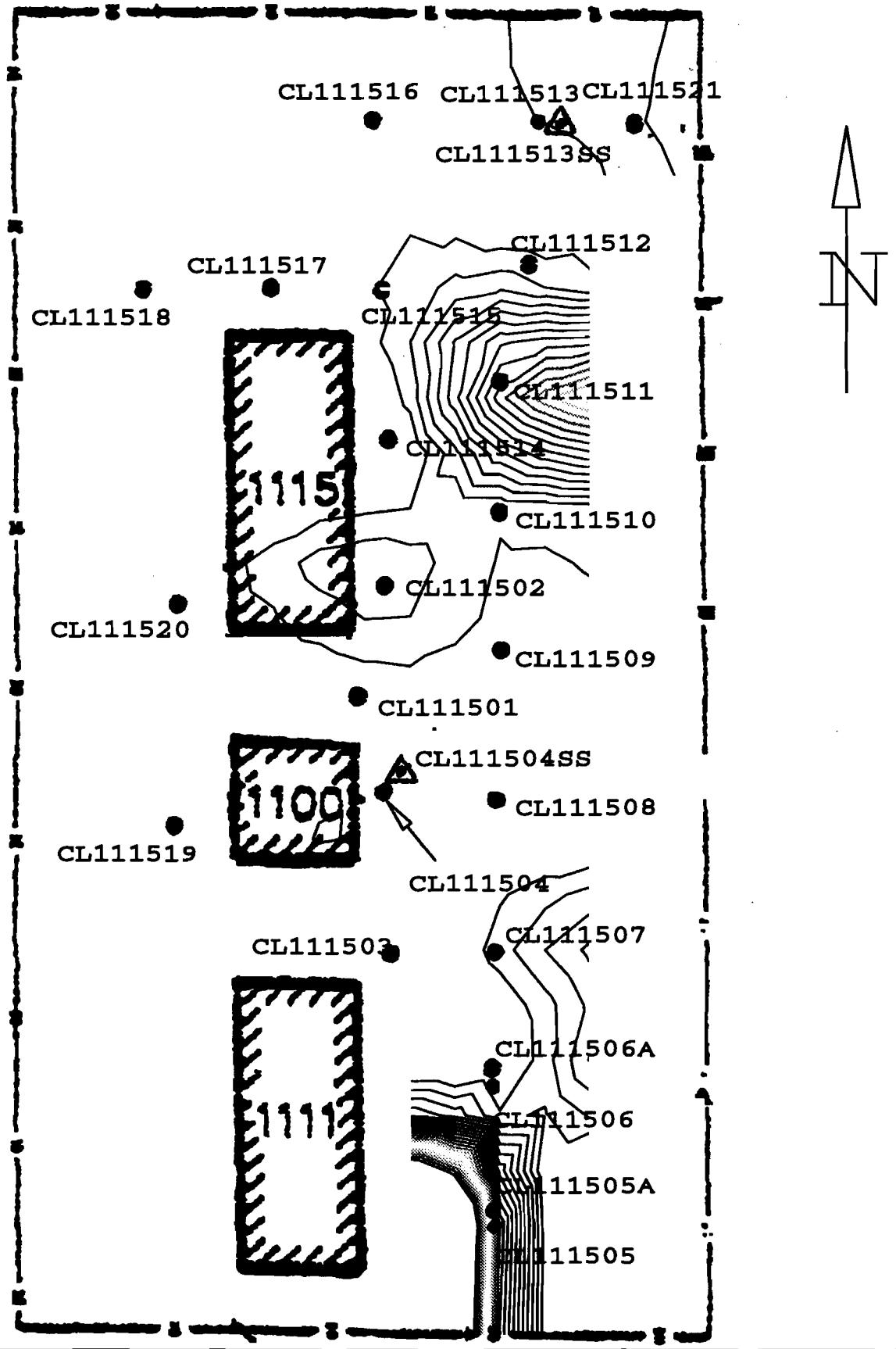

Figure 3 - Interpolation of Results
6.25 Feet Below Ground Surface

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

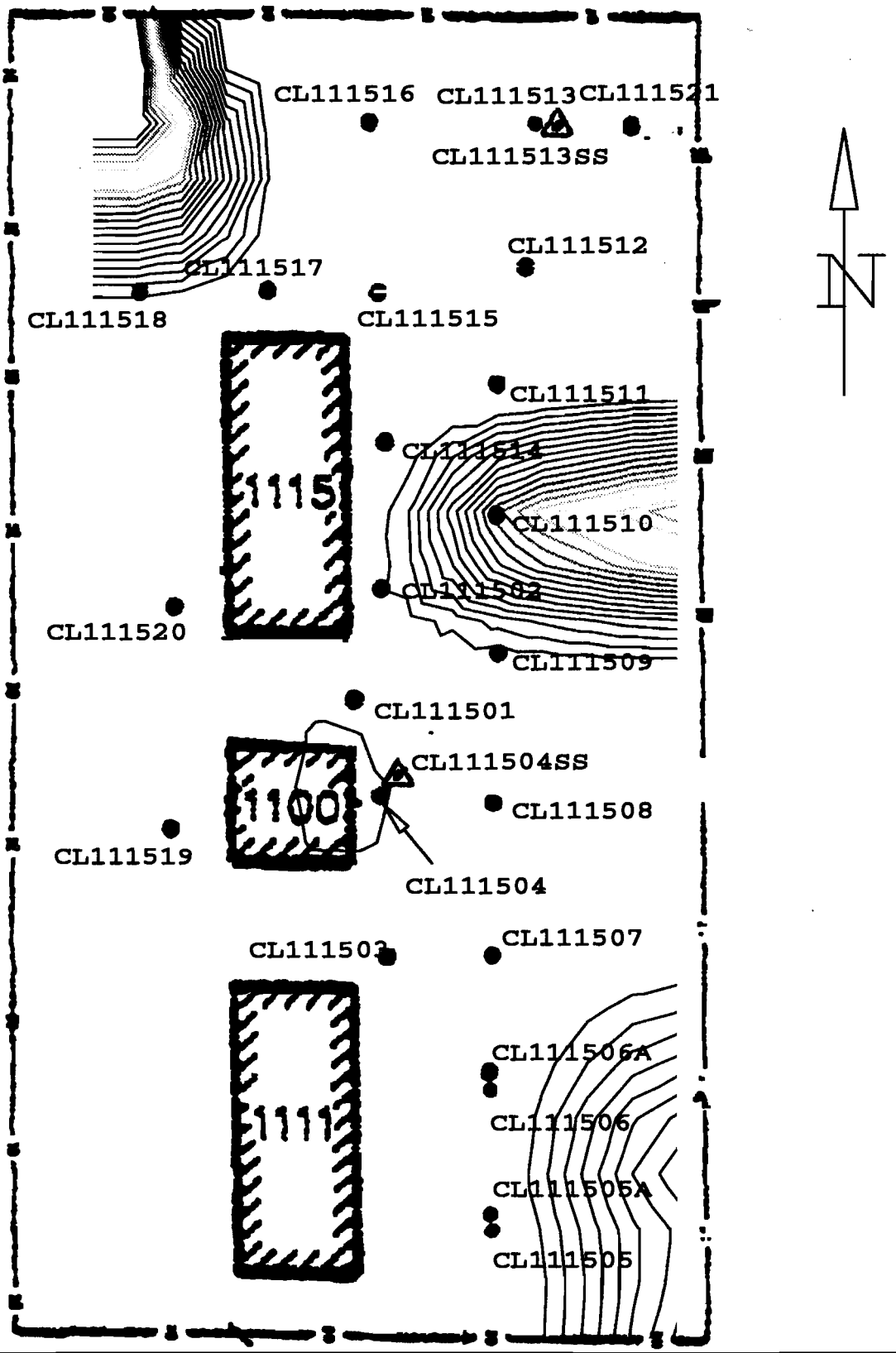

Figure 4 - Interpolation of Results
13.65 Feet Below Ground Surface

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

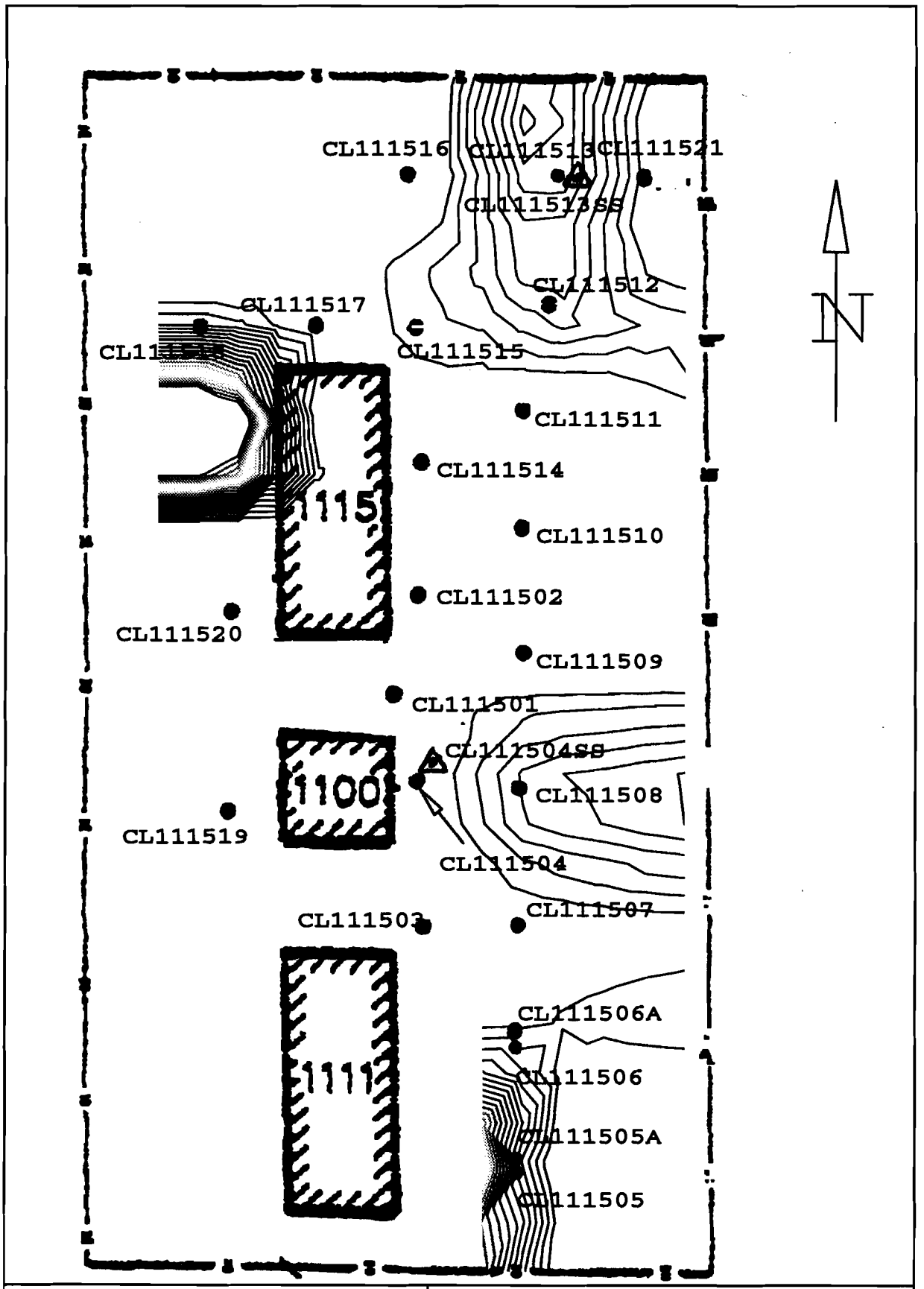

Figure 5 - Interpolation of Results
21 (north) to 25.81 (south) Feet BGS

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

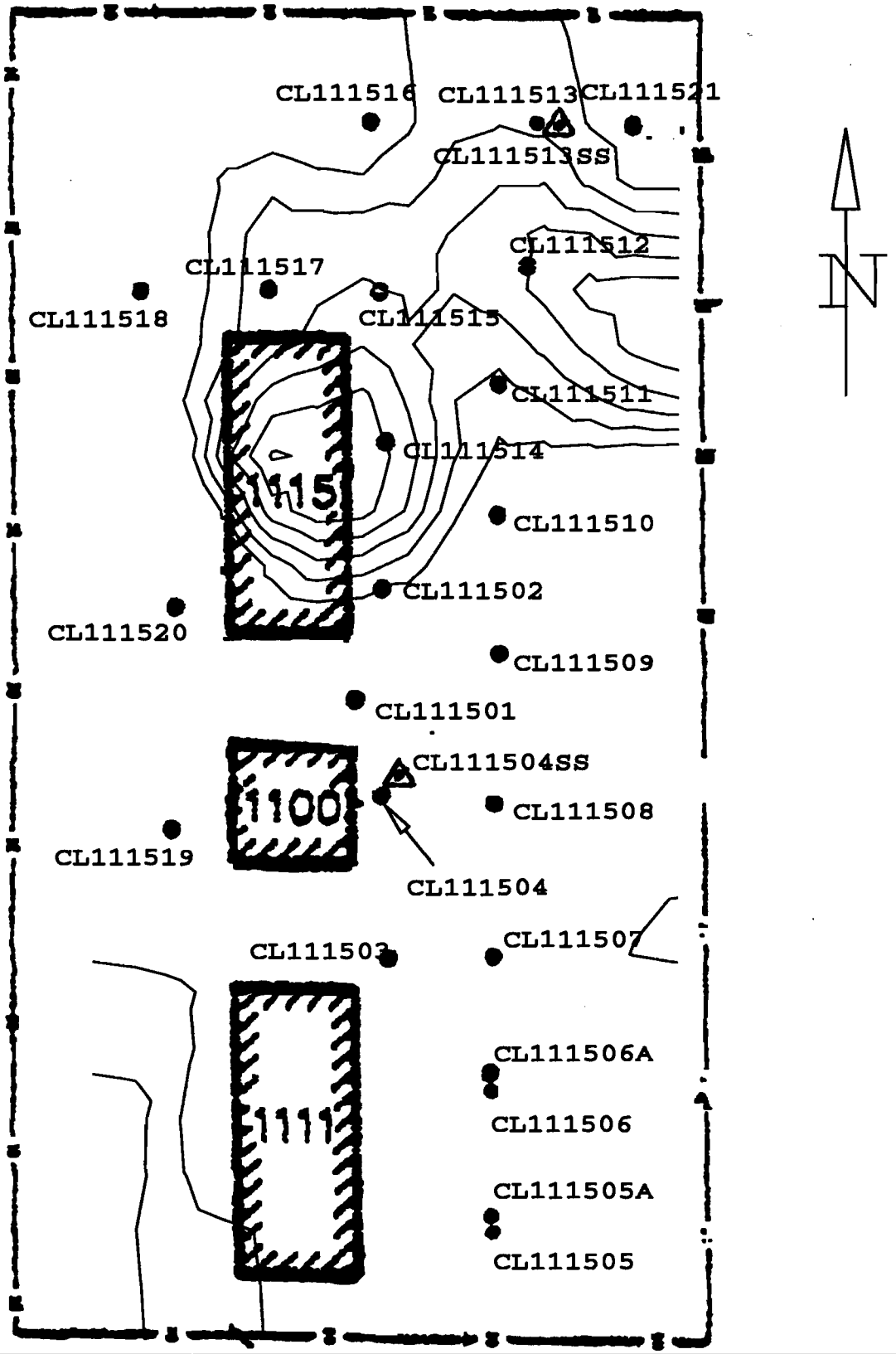

Figure 6 - Interpolation of Results
45.48 Feet Below Ground Surface

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

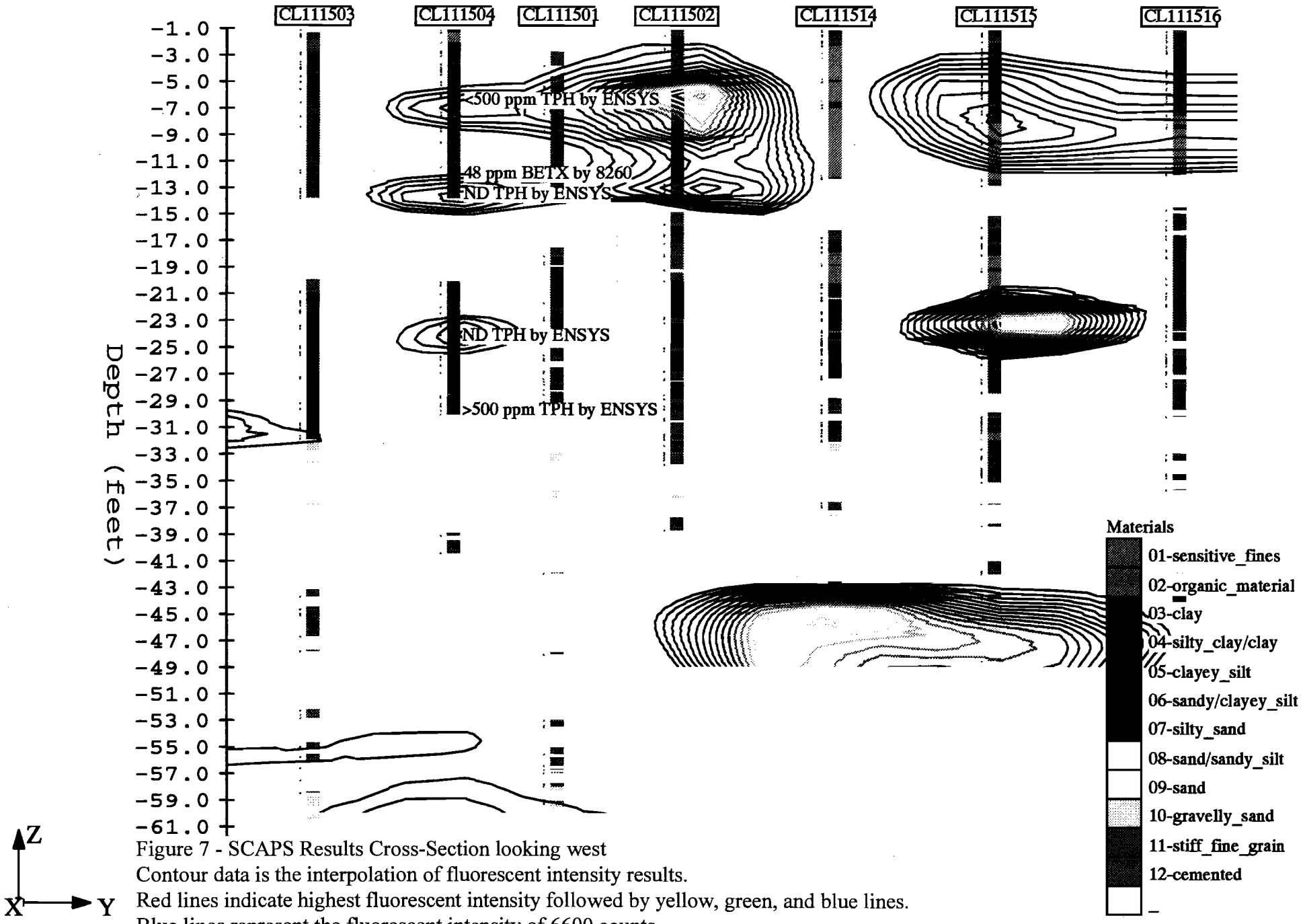

Figure 7 - SCAPS Results Cross-Section looking west
Contour data is the interpolation of fluorescent intensity results.
Red lines indicate highest fluorescent intensity followed by yellow, green, and blue lines.
Blue lines represent the fluorescent intensity of 6600 counts.
Vertical bars indicate soil types as interpreted from cone penetrometer data.

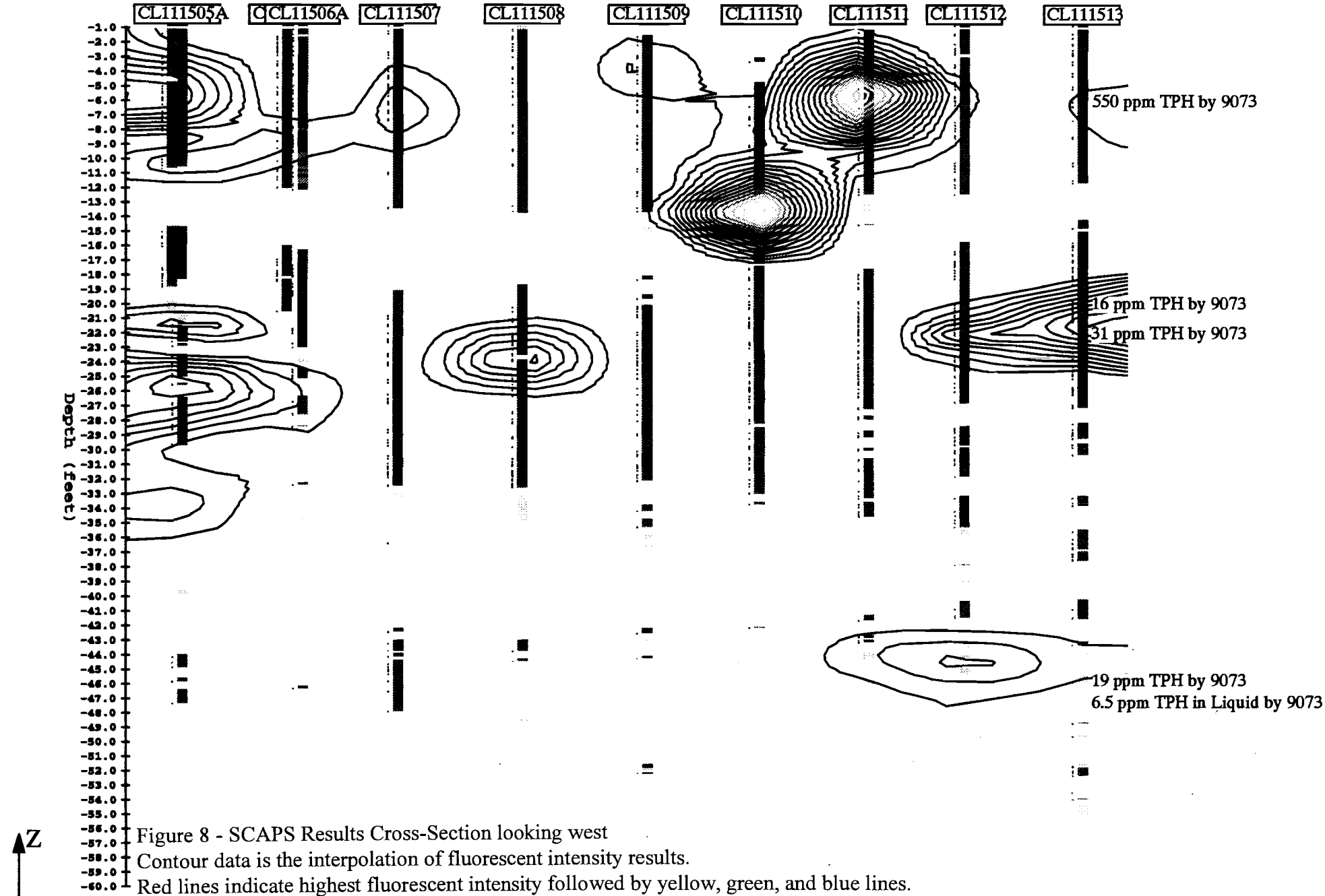

Figure 8 - SCAPS Results Cross-Section looking west
Contour data is the interpolation of fluorescent intensity results.
Red lines indicate highest fluorescent intensity followed by yellow, green, and blue lines.
Blue lines represent the fluorescent intensity of 6600 counts.
Vertical bars indicate soil types as interpreted from cone penetrometer data.

no clear pattern of PAH contamination has emerged. However, there does appear to be isolated pockets of low level (<500 ppm as TPH) petroleum hydrocarbon contamination.

Figure 9 shows the locations of SCAPS pushes completed near AS 872. Figure 10 provides a visual representation of the fluorescent intensity results near AS 872 at approximately 4.1 feet below ground surface. Figures 11 and 12 are stratigraphic cross sections (looking west) of the area beneath AS 872. The contour data in both figures show that the highest fluorescent intensity results were from areas of organic material and are classified as false positive responses. However, the fluorescent response in push AS87203 from 3.3 to 4.56 feet below ground surface is from petroleum hydrocarbon contamination.

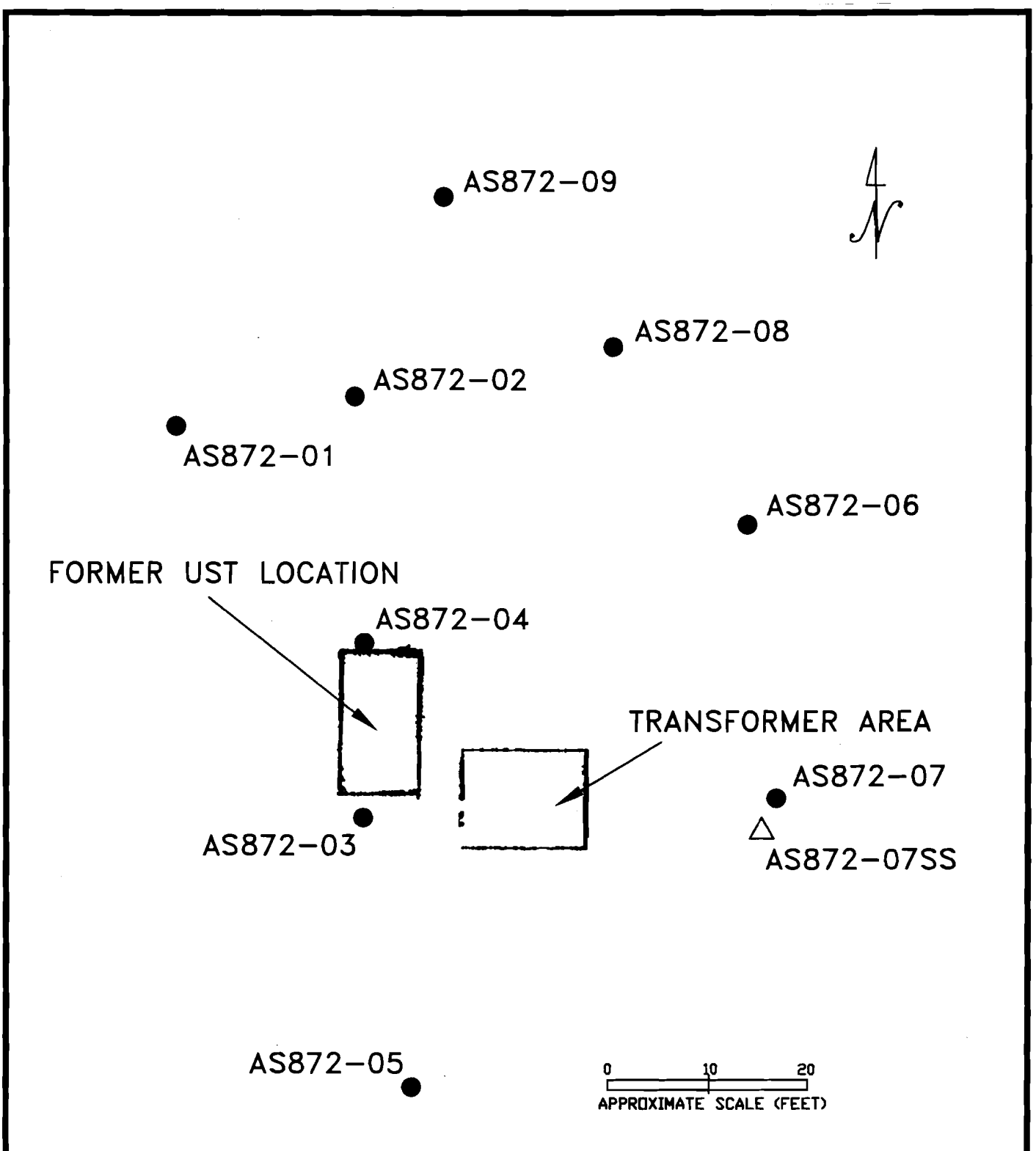

FIGURE 9 - SCAPS PUSH LOCATIONS
AS-872

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

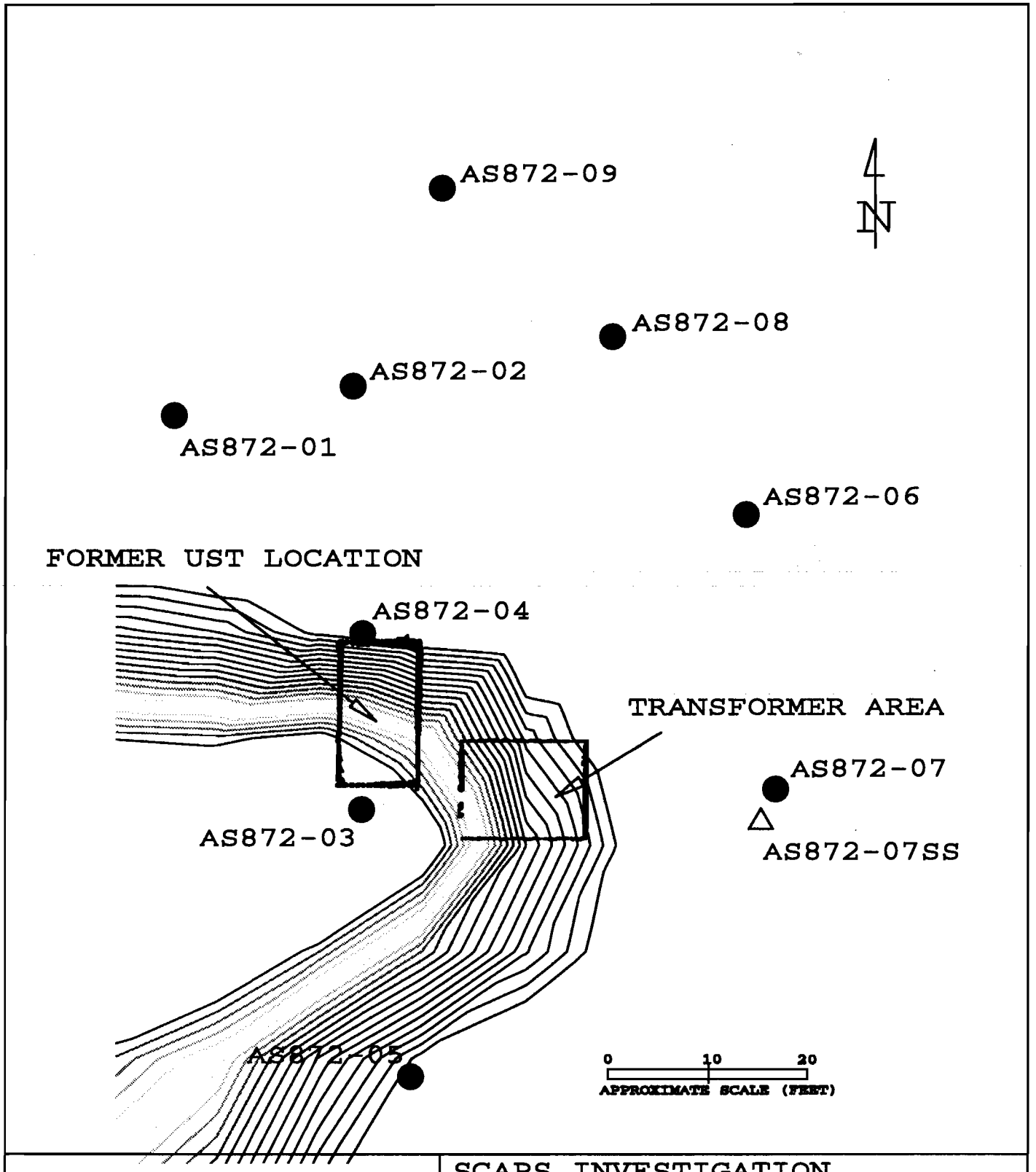

Figure 10 - Interpolation of Results
4.1 Feet Below Ground Surface

SCAPS INVESTIGATION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

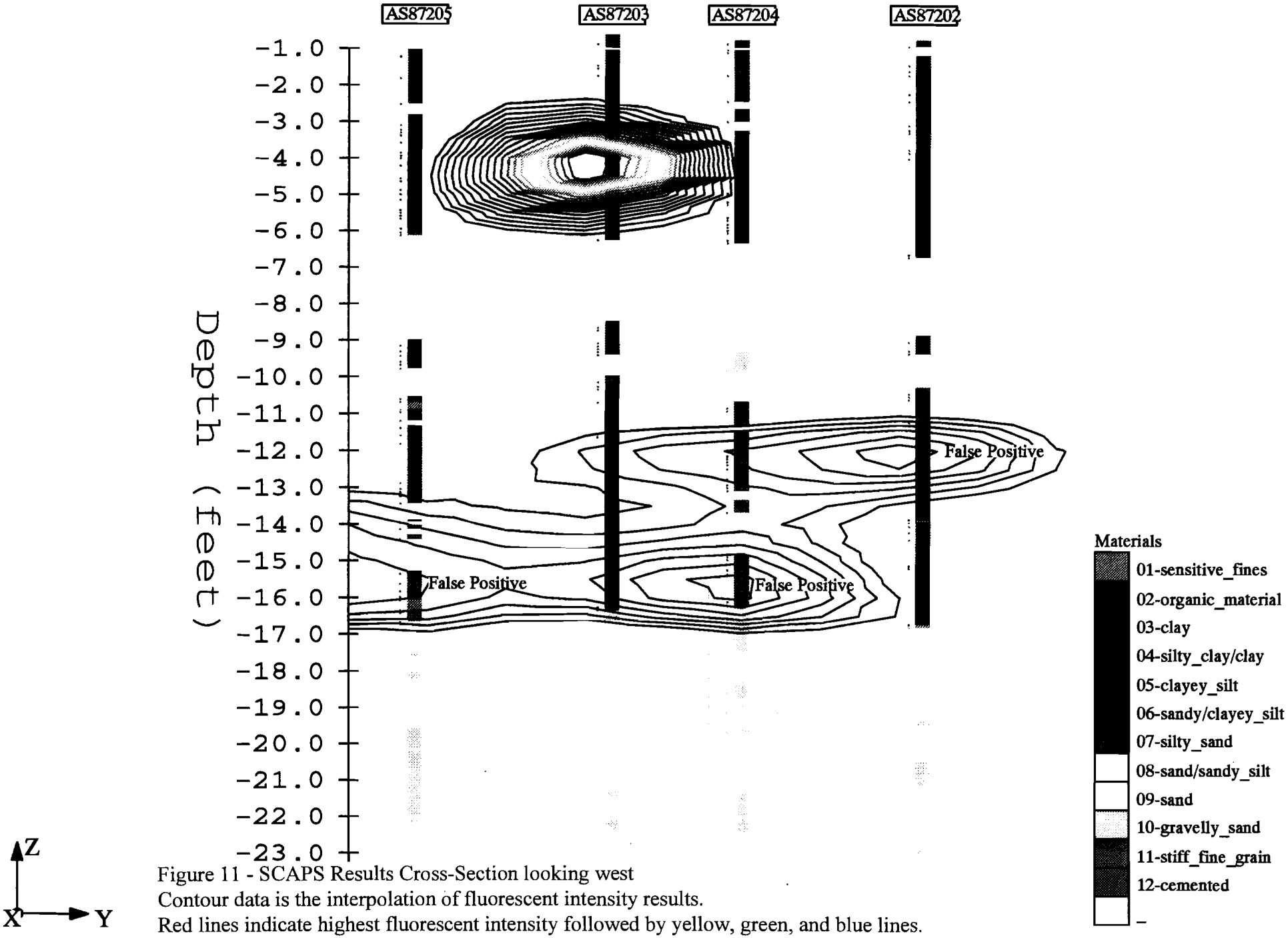

Figure 11 - SCAPS Results Cross-Section looking west
Contour data is the interpolation of fluorescent intensity results.
Red lines indicate highest fluorescent intensity followed by yellow, green, and blue lines.
Blue lines represent the fluorescent intensity of 6600 counts.
Vertical bars indicate soil types as interpreted from cone penetrometer data

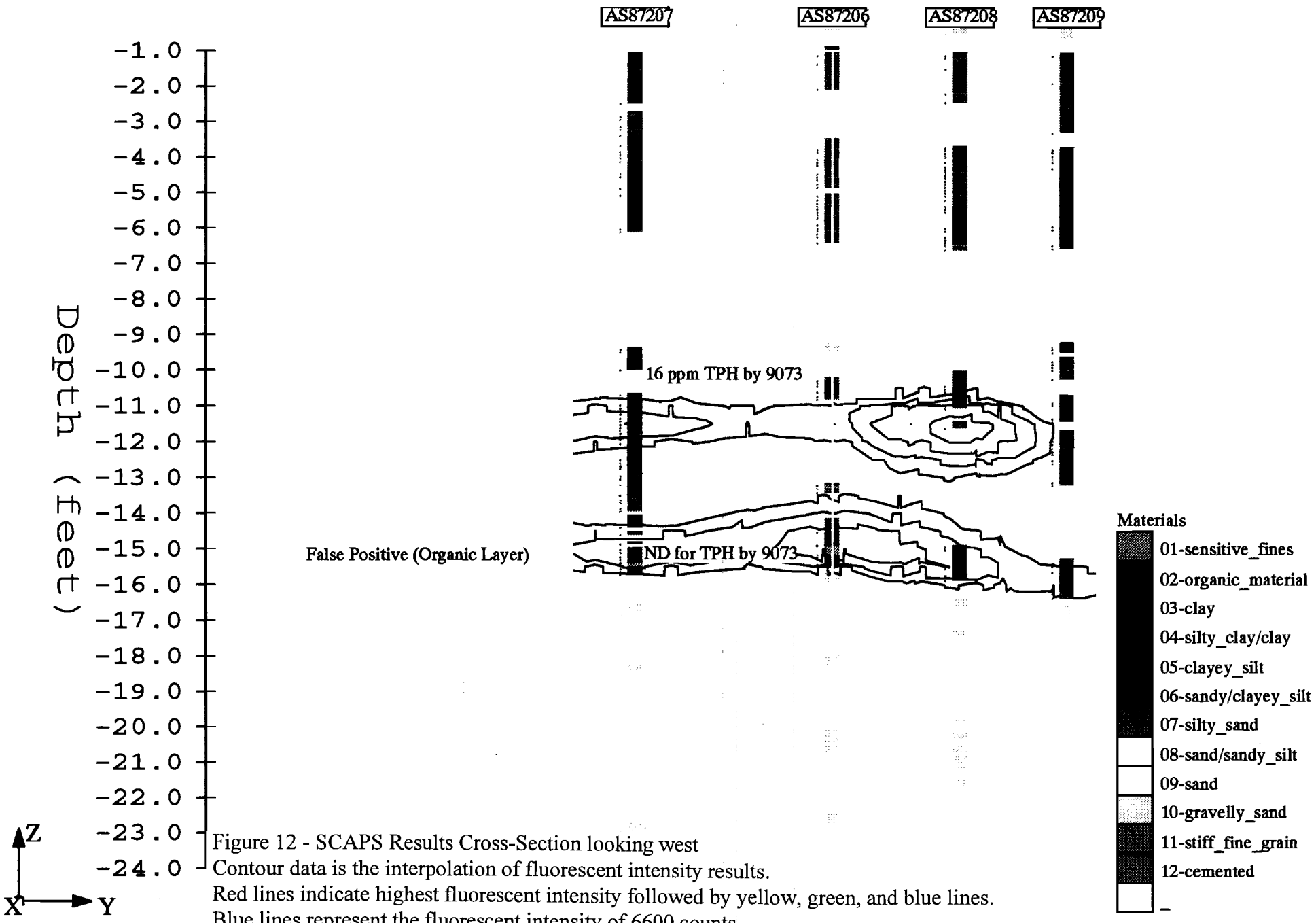

Figure 12 - SCAPS Results Cross-Section looking west
Contour data is the interpolation of fluorescent intensity results.
Red lines indicate highest fluorescent intensity followed by yellow, green, and blue lines.
Blue lines represent the fluorescent intensity of 6600 counts.
Vertical bars indicate soil types as interpreted from cone penetrometer data.

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NEESA, 1983: "Initial Assessment Study of Marine Corps Base Camp Lejeune, North Carolina" NEESA 13-011, April 1983.