#247
Complete Set

Humanities and Social Sciences Building
University of California
Santa Barbara, California

# GEOTECHNICAL ENGINEERING REPORTS

Prepared by,
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## FOR

## HUMANITIES AND SOCIAL SCIENCES BUILDING GEOTECHNICAL ENGINEERING REPORTS

Proposed Humanities and Social Sciences Building
El Colegio Road
University of California
Santa Barbara, California

**PRELIMINARY GEOTECHNICAL ENGINEERING REPORT**

File No. KC-1405-06
June 11, 1990

Mr. Dave Inouye
Facilities Management, Building 439
University of California
Santa Barbara, California 93106

Subject: Proposed Humanities and Social Sciences Building
El Colegio Road
University of California
Santa Barbara, California
**PRELIMINARY GEOTECHNICAL ENGINEERING REPORT**

Dear Mr. Inouye:

K-C Geotechnical Associates (K-C) is pleased to present this Preliminary Geotechnical Engineering Report for the proposed Humanities and Social Sciences Building site on El Colegio Road, University of California, Santa Barbara, California. This report completes our assignment in accordance with our proposal of January 19, 1990, and authorized by the University of California Authorization No. 80-89/90, dated February 23, 1990.

Based on our evaluation of the data acquired and presented in this report, it is our opinion that the proposed site development is geotechnically feasible, provided the preliminary geotechnical information given in this report are incorporated into the project design phase, and implemented during construction. In addition, it is our opinion that active or potentially active faults are not likely to be present within the limits of our exploration. It is our preliminary opinion that foundation support for the proposed Humanities and Social Sciences Building, and related structures, can be obtained from spread footings for relatively lightly-loaded structures (one- and two-story buildings), and on spread footings or drilled cast-in-place piers for relatively heavily-loaded structures (building higher than two stories).

The accompanying report summarizes data gathered in during our investigation and provides preliminary recommendations based on those data. The conclusions and recommendations contained therein are based upon the generally accepted standards of our profession at the location and time this report was prepared.

Please contact the undersigned if there are any questions concerning the report.

Very truly yours,
K-C Geotechnical Associates
a California Corporation

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PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

FOR

PROPOSED HUMANITIES AND SOCIAL SCIENCES BUILDING

EL COLEGIO ROAD

UNIVERSITY OF CALIFORNIA

SANTA BARBARA, CALIFORNIA

# 1. INTRODUCTION

K-C Geotechnical Associates (K-C) is pleased to present this Preliminary Geotechnical Engineering Report for the proposed Humanities and Social Sciences Building on El Colegio Road, University of California, Santa Barbara, California. This report completes our assignment in accordance with our proposal of January 19, 1990, and authorized by the University of California Authorization No. 80-89/90, dated February 23, 1990.

## 1.1 Purpose and Scope

The purpose of our geotechnical engineering investigation was to explore and evaluate the subsurface soil conditions at the site, and to provide preliminary geotechnical recommendations and considerations for the conceptual development of the site. In addition to the geotechnical evaluation, the site geologic conditions were evaluated with respect to faults and potential faults reportedly located in the vicinity of the project site. A design level geotechnical investigation would be performed based on the building layouts selected, and the information needed for the project design. The recommendations are based on the geotechnical conditions revealed by the exploration and testing programs. The proposed project consists of constructing up to three structures at the site. As presently planned, the structures could consist of a 2-story, a 3-story, and a 5-story building. Our understanding of the proposed project and the general scope of geotechnical services is based on our review of selected geotechnical reports and maps available in the vicinity of the site, our review of "Aerial Topography plans of the Campus" provided by the University, discussions and meetings with Mr. Dave Inouye, Mr. Tom Tomeoni, and Mr. Bill Hanna of the Facilities Management Department of UCSB on March 16, and April 11, 1990, and preliminary structural loading information provided by Ms. Catherine Wells of Ove Arup & Partners (Structural

Engineer). Information from our discussions and meetings, and from our field exploration, laboratory testing, literature review, and preliminary engineering analysis has been used in preparing this report.

Our scope of services was presented in our January 19, 1990 proposal. A summary of the completed work presented in this report is the following:

- An exploratory program involving excavating and sampling two exploratory borings, and one exploratory trench approximately 365 feet in length;
- Laboratory tests on soil samples selected from materials obtained from the exploratory borings;
- Evaluation of field and laboratory tests, assessment and organization of the data, and project evaluation with other members of the design team;
- Evaluation of geologic data and field information relating to fault locations in the vicinity of the site, and
- This written report, with graphics, based on data obtained from the exploration and testing program. The report presents the results of laboratory tests, boring logs of the subsurface soil strata, a discussion of the soil characteristics with respect to the planned project, and our preliminary geotechnical opinions and recommendations for:
    - Site preparation;
    - Foundation support of the structures, slabs-on-grade, soil bearing pressures, foundation embedment depths, foundation design, and anticipated settlement;
    - Lateral earth pressure for design of retaining walls, backfill, compaction, and drainage;
    - Groundwater considerations for the design of the structure and foundations;

- Site preparation and grading, for constructing backfill, and for the support of the structure.

## 1.2 Limitations

K-C Geotechnical Associates (K-C) prepared the conclusions and professional opinions presented herein in accordance with generally accepted geotechnical engineering principles and practices at the location and time the report was prepared. This statement is in lieu of all warranties, express or implied.

This report has been prepared for use by the University of California and their authorized agents only. It may not contain sufficient information for the purposes of other parties or other uses. Our conclusions and geotechnical recommendations presented in this report are based on preliminary plans and discussions with members of the design team. The conclusions and recommendations contained herein should be considered preliminary. Design level recommendations can be provided based on final design data and structural loading information, and on additional field exploration. This report and the drawings contained herein are intended for preliminary design-input purposes; they are not intended to act as design level information, construction drawings, or specifications.

Soil and rock deposits may vary in type, strength, and many other geotechnical properties between points of observations and exploration. Groundwater and soil moisture conditions can also vary seasonally or for other reasons. Therefore, it must be recognized that we do not and cannot have a complete knowledge of the subsurface conditions underlying the site. The criteria presented herein are based upon the findings at the points of exploration and upon interpretive data, that is, interpolation and extrapolation of information obtained at points of observation.

## 2. LOCATION AND DESCRIPTION OF SITE

The proposed Humanities and Social Sciences Building, and related structures, are planned to be located at the eastern terminus of El Colegio Road on the Main Campus of the University of California, Santa Barbara, California. The location of the site relative to nearby streets and local landmarks is shown on the Vicinity Map, Figure 1. The project site is presently occupied by an existing parking lot (Lot 28), and two single-story structures (Buildings 440 and 419) as shown on Figure 3. The site with elevations ranging from approximate elevation 45 to 48 feet in the parking area, slope to the southwest to approximate elevation 38 feet on the west side of Building 440.

A 1930 topographic plan (UCSB, 1930 circa, undated) indicates that a gully previously existed near the western boundary of the site. Reports prepared by LeRoy Crandall and Associates (LCA 1962 and 1967) indicate that up to 20 feet of "trash fill", and uncompacted silt and silty sand fill was encountered in this area. Geotechnical investigations (Evans, 1956; LCA, 1962; LCA, 1967; and LCA, 1976) performed for the surrounding sites (Arts Building, Speech and Drama Building, and Campus Events Center) generally indicate that the subsurface conditions consist of 3 to 20 feet of overburden soils (fill and terrace deposit), overlying Sisquoc Formation. For these sites, the structures were typically supported on cast-in-place drilled piers, or shallow foundations, bearing directly on the underlying formational materials (Sisquoc).

## 3. PLANNED DEVELOPMENT

We understand that the project is in the conceptual stage of development. As presently planned, the project could consist of constructing up to three structures at the site, one of which will serve as the proposed Humanities and Social Sciences Building. The three buildings are expected to consist of a two-story, a three-story, and a five-story structure of either concrete or steel frame construction. We understand that single-story basements up to 15 feet in depth are being considered to provide parking space for the proposed development. Based on preliminary information for a 30 foot by 30 foot bay provided by Ove Arup & Partners, the estimated structural dead loads for columns could range from approximately 160 to 260 kips for two-story buildings, 250 to 390 kips for three-story buildings, and 400 to 650 kips for five-story buildings. Uplift loads for the structures are estimated between 50 and 180 kips.

## 4. WORK PERFORMED

### 4.1 Report Review

Selected geotechnical and geologic reports prepared for the University in the vicinity of the project site were provided by Facilities Management. We reviewed these reports to evaluate the local geologic conditions as they relate to faults and potential faults reported and/or mapped at or near the site, and to review the general range of geotechnical conditions in the surrounding area. Reports that we have reviewed are referenced.

### 4.2 Field Exploration and Laboratory Testing

The geotechnical engineering investigation for this project consisted of a program of field exploration, laboratory testing, and engineering evaluation.

Field exploration consisted of excavation and sampling of two exploratory borings to depths ranging between approximately 42 and 53 feet below the ground surface. An exploratory trench was excavated in approximately a northwest - southeast alignment. The alignment was selected because faults are reported to trend towards the project area in generally northeast - southwest trending alignments. The length of the trench was approximately 365 feet and the depth ranged from approximately 7 to 14 feet. The approximate locations of the borings, and exploratory trench are shown on the Site Plan, Figure 3.

Laboratory testing was conducted on selected soil samples obtained from the borings to characterize general geotechnical engineering properties of the soils. The field and laboratory data generated for this study are presented in Appendices A and B, respectively.

## 5. GENERAL SUMMARY OF SITE CONDITIONS

### 5.1 Regional Geology

The University is situated within the western portion of the Transverse Range Province. The province is locally dominated by the east-west trending Santa Ynez Mountain Range, which extends continuously from Point Arguello eastward for 75 miles into Ventura County. The Santa Ynez Mountains and adjacent lowlands are composed mostly of sedimentary rocks ranging in age from Cretaceous to Recent. Structural geology in the Santa Barbara and Goleta area consists of a south-dipping homocline and adjacent coastal plain cut by a series of subparallel faults and folds that extend from the mountains into the Santa Barbara Channel.

### 5.2 Geologic Setting

The project site is located on the central portion of an elevated mesa that is bound by the Pacific Ocean to the south, the Goleta slough to the north and east, and the Devereaux slough to the west. The mesa is generally a flat lying marine terrace elevated 20 to 45 feet above the sea level. Tectonic uplift during the Pleistocene is believed to be the cause of the elevated feature (Dibblee, 1966). Stream erosion has dissected the marine terrace to produce the present isolated mesa.

The general geology of the main campus consists of a relatively thin cap of Pleistocene terrace deposits unconformably overlying Tertiary sedimentary rocks. The geologic formations that are present in the subsurface area of the main campus vary, depending on location, from Miocene through recent age deposits. These deposits are the Monterey

Shale (Miocene), the Sisquoc Formation (Miocene-Pliocene), the Santa Barbara Formation (Plio-Pleistocene), Terrace deposits (Pleistocene), Older Alluvium (Late Pleistocene), and Alluvium (Recent).

As encountered in the exploratory trench and borings, the project site is underlain by fill material, terrace deposits and Sisquoc Formation bedrock. A description of the materials encountered is presented in Section 5.3.2, Exploration Trenching, and in Section 5.4, Soil Conditions.

## 5.3 Site Faulting

### *5.3.1 Fault Setting*

Regional compressive forces acting on the Santa Barbara and Goleta area have resulted in generally east-west trending near vertical faults with associated northeast and northwest splays. Displacement along the faults is believed by previous investigators to be mainly vertical, with the majority of faults having upthrown south blocks. In the vicinity of the campus, active, or potentially active, faults are reportedly the Goleta Point Fault, the Cambell Fault, the Campus Fault, and faults within the More Ranch Fault zone. In addition to these faults, a linear feature termed the Briggs Lineation is inferred by previous investigations to trend toward the site from the east. Activity levels of faults are a function of the age of materials documented to be displaced by faulting. An active fault, as defined by the Santa Barbara County Seismic Element, is a fault that shows displacement during the last 11,000 years (Holocene); whereas, a potentially active fault is defined as displacing deposits of late Pleistocene age (11,000 to 500,000 years), but not showing signs of Holocene displacement. Faults are also located in the Goleta Valley North of the project site; among them are the Dos Pueblos Fault, the Glenn Annie Fault, the Carneros Fault, the Goleta Fault, and the San Jose Fault (Dibblee, 1987).

### *5.3.2 Exploration Trenching*

An exploratory trench was excavated at the site. The approximate location of the trench is indicated on the Site Plan, Figure 3. Cross sections of the trench are shown on the Exploratory Trench Log, Figures A-8 and A-9. The trench exposed relatively continuous strata of sedimentary materials. The soil conditions exposed within the trench generally consisted of 1/2-foot to 3-1/2 feet of fill material overlying Pleistocene-age terrace deposits. The terrace deposits generally consisted of sands and silts with lenses of silty clay and clayey sand, and ranged in thickness from approximately 7 to 9 feet. The Pleistocene terrace deposit was composed of an upper sand unit overlying a paleosol horizon, which in turn was underlain by sand, silt and clay terrace material. The terrace deposits were observed to overly the Miocene-Pliocene age Sisquoc Formation composed of siltstone and shale. The contact between the terrace deposits and Sisquoc Formation appeared to be an erosional unconformity, and as indicated on the Exploratory Trench Log, the surface was somewhat irregular. The upper Pleistocene sand/paleosol was observed to be generally continuous within the trench. The elevation of the unconformable Terrace/Sisquoc contact was found to be generally consistent across the length of the trench, at depths ranging between 10 and 12 feet below the existing ground surface.

The description of the strata exposed in the trench, when compared to the general description of the geologic units reported in the vicinity of the campus is mapped in the vicinity of the site, indicates that the age of the terrace materials are pre-Holocene and possibly several tens of thousands of years old.

### *5.3.3 Site Fault Conditions*

The approximate locations of faults in the vicinity of the project are shown on Figure 2, Fault Location Map. Faults located in the vicinity of the project site reportedly are the More Ranch fault zone and the Campus Fault. Also, a linear feature named the Briggs Lineation is mapped in the vicinity of the site. The More Ranch Fault and the North Ellwood Fault have been mapped by previous investigations approximately 2,000 feet and 3,000 feet north of the project, respectively. These faults are part of the More Ranch Fault zone. The Campus Fault has been mapped (Hoover, 1987) trending southwest approximately 600 feet southeast of the project site. The Briggs Lineation, as the name implies, is a linear feature that is shown on a structural contour map (provided by Facilities Management) as a variation in elevations of the Sisquoc/Terrace contact ranging from approximately 6 to 8 feet. The Briggs Lineation has been mapped trending southwest towards the southeast corner of the project site.

Based on the relative uniformity observed in the exploration trench, it is indicated that active or potentially active faults are not present within the area covered by the limits of the exploration. Our review of the offsite investigations for the Campus Events Center (LCA, 1976) and Student Services Building (PML, 1982), as well as the observations in our exploratory trench and borings, indicates that the variation in elevations of the Sisquoc/Terrace contact within the project area was relatively small, on the order of 2 feet. This smaller variation, plus the relative uniformity of the contact and the overlying paleosol horizon, indicates that the Briggs Lineation does not pass through the project site.

## 5.4 Soil Conditions

The description of soil conditions is based on visual classification of samples obtained from our field explorations, and laboratory tests performed on selected samples from Borings 1 and 2. Relative densities and consistency of the soil were estimated from penetration resistances recorded in the borings, and observations within the exploratory trench. The explorations were conducted in an existing parking area (Parking Lot 28) on the east side of Building 440, see Figure 3, Site Plan.

Field explorations performed at the site encountered surficial fill materials, and relatively loose terrace deposits within the upper approximately 3 to 5 feet of the proposed development area. Explorations performed in the parking area encountered 0.1 to 0.4 feet of asphalt, which was underlain by approximately 0.5 feet of a silty sand base material. Loose to medium dense silty sand and sand fill was encountered below the pavement materials. The upper units of the terrace deposit were encountered below the surficial fills to depths between 1 and 3 feet below the ground surface, and consist of loose poorly graded sand and silty sands. Dry densities estimated from laboratory data ranged from approximately 97 to 107 pounds per cubic foot (pcf) within the surficial fills. The moisture content of fill ranged from approximately 6 to 17 percent. Deeper fill materials could be encountered in the areas of existing buildings and buried utilities, and in the area of a filled gully that existed near the western edge of the proposed site development (see Figure 3, and discussion, Section 2).

Based on a comparison of the present site topography, and an approximate 1930 topographic survey (UCSB, 1930 circa undated), we estimate the fill thickness could be up to approximately 20 feet thick near western end of the proposed development area (see Figure 2).

Medium dense to dense, older terrace deposits were encountered below the surficial fill and upper terrace deposit in the explorations. The older terrace deposit generally consists of sand, silty sand and clayey sand. Swell tests performed on samples obtained from the upper and older terrace deposits, indicate that these soils have a low to medium potential for expansion. Dry density test results performed on soil samples obtained from the older terrace deposit ranged from approximately 106 to 109 pcf, and the moisture ranged from approximately 14 to 19 percent.

Sisquoc Formation bedrock, classified as "silt" and "elastic silt", was encountered below the terrace deposits at depths ranging between approximately 9 and 12 feet below the ground surface. The Sisquoc Formation initially encountered at the site generally consists of firm to hard, weathered siltstone to approximately 15 to 22 feet below the ground surface. Below this zone, the Sisquoc Formation grades to a hard to very hard, dark green-gray, siltstone that was encountered to the maximum depths explored, approximately 53 feet below the ground surface. The moisture content data obtained for the bedrock ranges from approximately 14 to 52 percent in the weathered zone, to approximately 31 to 50 percent in the relatively hard to very hard bedrock.

### 5.5 Groundwater Conditions

At the time of exploration, saturated soils, and relatively light seepage was encountered at a depth of approximately 3 to 4 feet below the ground surface in Boring 247-1 and in the exploration trench. Caving did occur during excavation of the exploratory trench, mostly in the upper three to four feet. The caving was aggravated by localized areas of wet soils and seepage. Previous explorations performed by others (LCA, 1962; LCA, 1967; and LCA, 1976) at neighboring sites (Campus Events Center, and Speech and Drama building) indicate that "minor" groundwater seepage from seams within the Sisquoc Formation were encountered at depths ranging between 9 and 35 feet below the ground surface. An investigation performed for the Arts Building (Evans, 1956) reported no groundwater. Variations in the groundwater level can occur, especially as they might relate to perched water and areas of wet soil and seepage, as a result of variations in irrigation schedules, rainfall, temperature, and other factors.

## 6. CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

The following conclusions and preliminary recommendations are based on the data obtained from the exploration and testing programs described in this report and on our understanding of the project as currently planned. A summary of our conclusions and recommendations presented below is as follows:

- The site is considered geotechnically suitable for the proposed site development, provided that the earthwork and foundation designs consider the presence of existing fill materials encountered at the site, and appropriate selection of shallow versus deep foundation alternatives as presented in this report.

- Based on our review of selected geotechnical documents prepared for other University projects in the vicinity of the site, existing fill materials could be encountered along the west side of Building 440 in the vicinity of a gully that was previously filled. The depth of fill that could be encountered would depend on the building layout in relation to the gully but we estimate from approximately 1930 and present day topography that the depth of fill could be approximately 20 feet within this portion of the site. Approximately 2 to 4 feet of fill was encountered in the existing parking lot during our present phase of work.

- o It is our preliminary opinion that relatively lightly-loaded structures (with one or two stories, column loads less than approximately 100 kips, and wall loads less than approximately 5 kips per foot) can be supported on shallow foundations bearing on a mat of compacted on-site or imported soil. The shallow foundations can consist of continuous footings below walls and isolated pad footings to support column loads.

- o It is our preliminary opinion that relatively heavily-loaded (column loads greater than 75 to 100 kips, or wall loads greater than approximately 5 kips per foot) structures without basements can be supported on drilled pier foundations bearing into relatively hard to very hard bedrock (Sisquoc Formation). We anticipate that the pier lengths could range between 20 and 40 feet below the ground surface depending on the pier diameters selected, structural loads, and the actual depth to relatively hard to very hard bedrock.

- o It is our preliminary opinion that relatively heavily loaded structures with basements may be supported on either spread footings or bearing piers into relatively hard to very hard bedrock (Sisquoc Formation).

- o In our opinion the soils at the site are not susceptible to liquefaction or landsliding.

- o We recommend that the structures be designed to at least the code standards for Seismic Zone 4, as designated by the latest approved edition of the Uniform Building Code.

- o Based on comparison of subsurface data from previous explorations in the vicinity of the project site with observations made during our field exploration, it is our opinion that active or potentially active faults do not underlie the project site within the limits of our exploratory work. In addition, the closest known active or potentially active fault, the Campus Fault, is reported approximately 600 feet east of the project site at its closest point.

## 6.1 Site Development and Grading - General

Fill placement and grading operations should be performed in accordance with the grading recommendations for the design level geotechnical engineering report. The recommendations presented below are based on preliminary geotechnical information obtained for the site, and represent geotechnical considerations that we feel should be considered for the site development, and the subsequent design-level geotechnical investigation.

### *6.1.1 Clearing and Grubbing*

Our field explorations encountered approximately 4 feet of existing fill material in the proposed building area, and depths of fill could be as much as 20 feet near the western end of the site. Prior to commencing grading operations, existing non-complying fills and soil containing debris, organics, pavement, and other unsuitable materials, should be excavated and removed. Demolition areas should be cleared of old foundations, slabs, abandoned utilities, and soils disturbed during the demolition process. Depressions or disturbed areas left from the removal of such material should be replaced with compacted fill.

### *6.1.2 On-site Materials*

On-site soils, free of organic and other deleterious materials, could be used as compacted fill. The terrace deposit encountered during this phase of work were generally classified as having a medium potential for expansion. We anticipate that this material and on-site fills, cleansed of non-complying materials, can be used as fill material in structure areas, provided the design of foundations and slab-on-grade accounts for their expansion potential. Materials encountered at the site during the design-level exploration program, and during grading operations, should be checked for organic content and expansion potential at that time.

## 6.2 Grading and Site Preparation for Building Areas

Existing fill materials encountered within the proposed building area should be excavated to their full depth and compacted to help provide a uniform bearing surface for slabs-on-grade and shallow foundations. Where fill materials are not encountered at the footing depth, the upper few feet of the foundation support soils (terrace deposit) could be overexcavated and compacted to help provide uniform support for shallow foundations and slab-on-grade. Where deep foundations are used to support structural and floor loads, or a basement is provided, the depth of excavation and recompaction may be able to be reduced. The limits of removal in building areas, and the recommended relative compaction, should be provided for the design phase of the project, based on the structural loading information available at that time.

## 6.3 Groundwater Considerations

Based on our subsurface exploration program and review of groundwater conditions observed at adjacent sites (see Section 5.5), the groundwater table should not be encountered within the anticipated depths of excavation. Zones of saturated soil, and groundwater seepage, were encountered at the top of the terrace deposit. Groundwater levels will fluctuate depending on the weather conditions, and other factors.

## 6.4 Structure Foundations

Two criteria that should be satisfied in evaluating an adequate foundation are bearing capacity and settlement. The foundation should be capable of supporting the anticipated structural loads, and the settlement of the foundation should be within tolerable limits. Shallow and deep foundations have reportedly been used to support structures in the vicinity of the site. Relatively light structures, single story buildings on the Campus have been supported on shallow foundations bearing on the natural terrace deposits, or on a mat of compacted on-site soil or imported material. Relatively heavy structures (the Speech and Drama Building, Campus Events Center, and Arts Building) have been supported on drilled cast-in-place straight shaft and/or belled piers bearing in the Sisquoc Formation. The reasons for selecting either shallow or deep foundations alternatives could be; the presence of potentially compressible existing fill or surficial soils within the proposed building areas, or that the structural loads were heavy enough (column loads in the range of 100 to 360 kips, and wall loads up to 10 kips per foot) such that shallow foundation alternatives were not considered feasible for the soil conditions encountered at these sites.

Based on our preliminary review of the site conditions, in our opinion relatively light structures could be supported on shallow foundations bearing on a mat of compacted on-site soil, conditioned as discussed in Section 7.2. For footings founded in compacted soils, a maximum allowable bearing pressure of approximately 2,000 to 3,000 psf could be used for isolated pad footing and continuous footing design. We understand that an approximately 15-foot deep basement may be provided below the structures. If the basement extends through existing fills and into the relatively hard to very hard bedrock, the structure could be supported on spread footings. For isolated pad footings and continuous footings bearing in bedrock (for example, below basements) a minimum allowable bearing pressure of 3,000 to 4,000 psf could be used for footing design. Footings typically would be embedded at least 24 to 36 inches below the lowest adjacent ground or finished slab elevation. Continuous footings are generally designed with a width of at least 12 inches, and isolated pad footings are designed with a least dimension of 24 inches depending on the magnitude of the column loads. A one-third increase in the maximum allowable bearing pressures is typically recommended, when considering short-term wind or seismic loads.

The Structural Engineer responsible for foundation design should specify reinforcing of foundations based on loading conditions. Based on the soil conditions encountered during our preliminary field exploration program, it is our opinion that at least two Number 4 reinforcing bars should be placed in continuous footings, one near the top and one near the bottom. Number 3 reinforcing bar should be placed in isolated pad footings, at least 24 inches on center both ways where the footing dimensions permit. Soils should also be tested for expansion during the design level geotechnical investigation, and at the time of grading. If the conditions encountered are more expansive than anticipated during this phase of work, the amount of reinforcement may need to be increased, or we could recommend that a mat of non-expansive soil (swell potential less than 3 percent under a 100 psf surcharge) could be provided below shallow foundations, and concrete slab-on-grade.

It has been a matter of practice on campus to support relatively heavily loaded structures in the vicinity of the site on foundations bearing in Sisquoc Formation. Based on our preliminary review of the subsurface conditions at the site, in our opinion the Sisquoc Formation is capable of providing relatively high bearing capacities for the anticipated range of column loads (160 to 650 kips dead loads, and 50 to 180 kips live loads). Deep foundations should be extended into the relatively hard to very hard bedrock to approximately 20 to 40 feet below the existing ground surface, or 15 to 25 feet below the depth of the basement.

We anticipate that skin friction and end bearing capacity for the piers would be obtained from the Sisquoc Formation, and that frictional resistance obtained from the overburden soils (terrace deposit and fill) would be neglected for foundation design. Drilled, cast-in-place piers could be designed as combined friction and end-bearing piers, or as friction piers alone. For friction piers, the bottom of the pier excavation can generally be prepared using augering equipment. End bearing piers may provide higher capacities than friction piers at shallower depths, and should be cleaned more carefully, perhaps using hand excavation techniques or "special" cleaning augers/buckets. Additional pier capacity could be provided for end bearing piers, by providing an enlarged base to the pier ("belled pier").

For piers designed for axial compression, we have estimated that for the portion of the pier founded in relatively hard to very hard bedrock (estimated to be encountered below approximately 15 to 20 feet below the existing ground surface) a maximum allowable skin friction of approximately 750 to 2,000 pounds per square foot (psf) could be used for design. For the portion of the shaft founded in weathered bedrock (estimated to be encountered at approximately 10 feet below the ground surface), a maximum allowable skin friction of approximately 400 to 750 psf could be used. Skin friction is typically not used for belled piers. We estimate that for belled piers, or piers with straight shafts, founded in relatively hard to very hard bedrock, a maximum allowable end bearing pressure of approximately 5,000 to 10,000 psf could be provided. For the anticipated structural loads, the piers would probably need to be extended approximately 20 to 40 feet below the existing ground the surface, and have diameters approximately 2 to 5 feet in diameter.

Uplift capacity of the piers could be estimated as 1/2 to 2/3 of the maximum allowable skin friction plus the dead weight of the pier. Higher uplift capacities could potentially be provided for belled piers. A 1/3 increase in the pier capacities is typically recommended when considering short term wind or seismic loads.

## 6.5 Settlement Considerations

Under static loading conditions, foundations are generally sized based on the allowable foundation settlements for the structure. For shallow foundations, tolerable settlements are generally in the range of approximately 1-inch total, and 1/2-inch differential between foundation members. Previous investigators have estimated smaller settlements for structures founded on deep foundations in the vicinity of the site.

## 6.6 Frictional and Lateral Coefficients

Resistance to lateral loading can be provided by sliding friction acting on the base of shallow foundations, and passive earth pressures on the sides of shallow and deep foundations. Based on the anticipated soil conditions, a coefficient of friction of 0.25 to 0.45 could be recommended for dead load forces acting on shallow foundations. A value of 300 to 450 pcf could be recommended, equivalent fluid weight, for passive resistance acting on the sides of foundation stems, with concrete placed neat against cut or compacted soils for resistance to lateral loads. The passive resistance could possibly be increased for deep foundations founded in bedrock. No passive resistance is generally included for soils within 1 foot of the ground surface, unless they are confined by pavement or slab-on-grade. A 1/3 increase in the passive value is typically recommended for wind or seismic loads.

## 6.7 Slab-on-Grade Construction

Concrete slab-on-grade are generally designed at least 4 inches thick. Additional thickness and steel reinforcement are typically recommended based on the expected soil conditions and traffic loading. For the soils encountered at the site, we would typically recommend that slabs be reinforced with at least Number 3 reinforcing bars placed at 24 inches on center both ways, at mid-depth of the slab. Additional reinforcing should be provided as recommended by the Structural Engineer. A vapor barrier is sometimes provided in the interior of buildings, not subjected to vehicular traffic, where it is desired to help reduce the potential for condensation forming on the floor. The soil conditions are generally reviewed at the time of grading, to evaluate the expansion potential and the soil resistance to traffic loading. Additional, geotechnical recommendations can be provided at the time of grading, if needed.

## 6.8 Asphalt Pavements

We understand that asphalt pavements are being considered for driveways and parking areas. Recommendations for the design of asphalt pavements should be provided for in the design phase of the project based on R-value tests and traffic information available at that time. Based on our review of the soil conditions encountered at the site, we have estimated that a pavement section consisting of approximately 3 to 4 inches of asphalt concrete over approximately 5 to 12 inches of aggregate base would be needed for a traffic index (TI) ranging between 4 and 6. In accordance with the California State Design method the upper 12 inches of the subgrade should be compacted to at least 95 percent relative compaction. The pavement section is typically reevaluated at the time of grading, based on R-value test results obtained from the exposed subgrade.

## 6.9 Retaining Walls

We understand that below grade walls, which would act as basement walls or retaining walls, could be constructed as part of the proposed structures to provide subterranean parking. Foundations for retaining walls should be designed and constructed in accordance with recommendations provided for site grading and foundation design (Sections 7.2, 7.4, and 7.6). Assuming the use of on-site or similar soil as backfill, and that the backfill is graded level behind retaining walls, we have estimated the following range of lateral earth pressures (equivalent fluid weights) for the design of retaining walls:

| Wall Loading Condition | Lateral Earth Pressure Condition | Equivalent Fluid Pressure (pcf) |
|---|---|---|
| Free Standing | Active | 35-45 |
| Constrained | At-rest | 50-65 |

The tabulated values are based on a soil unit weight of 120 pounds per cubic foot (pcf) and would be increased for surcharge conditions. The values do not provide for hydrostatic forces, and drainage is generally recommended behind retaining walls. If conditions are to be expected, such as surcharge resulting from vehicular loads, footings, or hydrostatic forces, higher lateral earth pressures should be anticipated.

Placement of permeable filter materials as backfill, or providing drainage through synthetic drains, are typically used to help reduce the potential for hydrostatic pressures behind retaining or below grade walls. As an alternative, clean sand backfill or open graded gravel can be used, if the materials are encased in a geotextile filter material.

## 6.10 Seismic Considerations

Based on the latest edition of the Uniform Building Code (1988), the site is located within Seismic Zone 4. We recommend that the structures be designed to at least the code standards for Seismic Zone 4, as designated by the latest edition of the Uniform Building Code.

## 6.11 Additional Geotechnical Engineering Services

We recommend that K-C be retained to provide design-level geotechnical engineering services for the design and construction of the project. At that time, additional field exploration should be planned based on the building layout selected, and structural loading information. Based on this information, we can provide additional geotechnical recommendations for the design of foundations, slab-on-grade, site grading, and other geotechnical considerations for the project.

END OF TEXT

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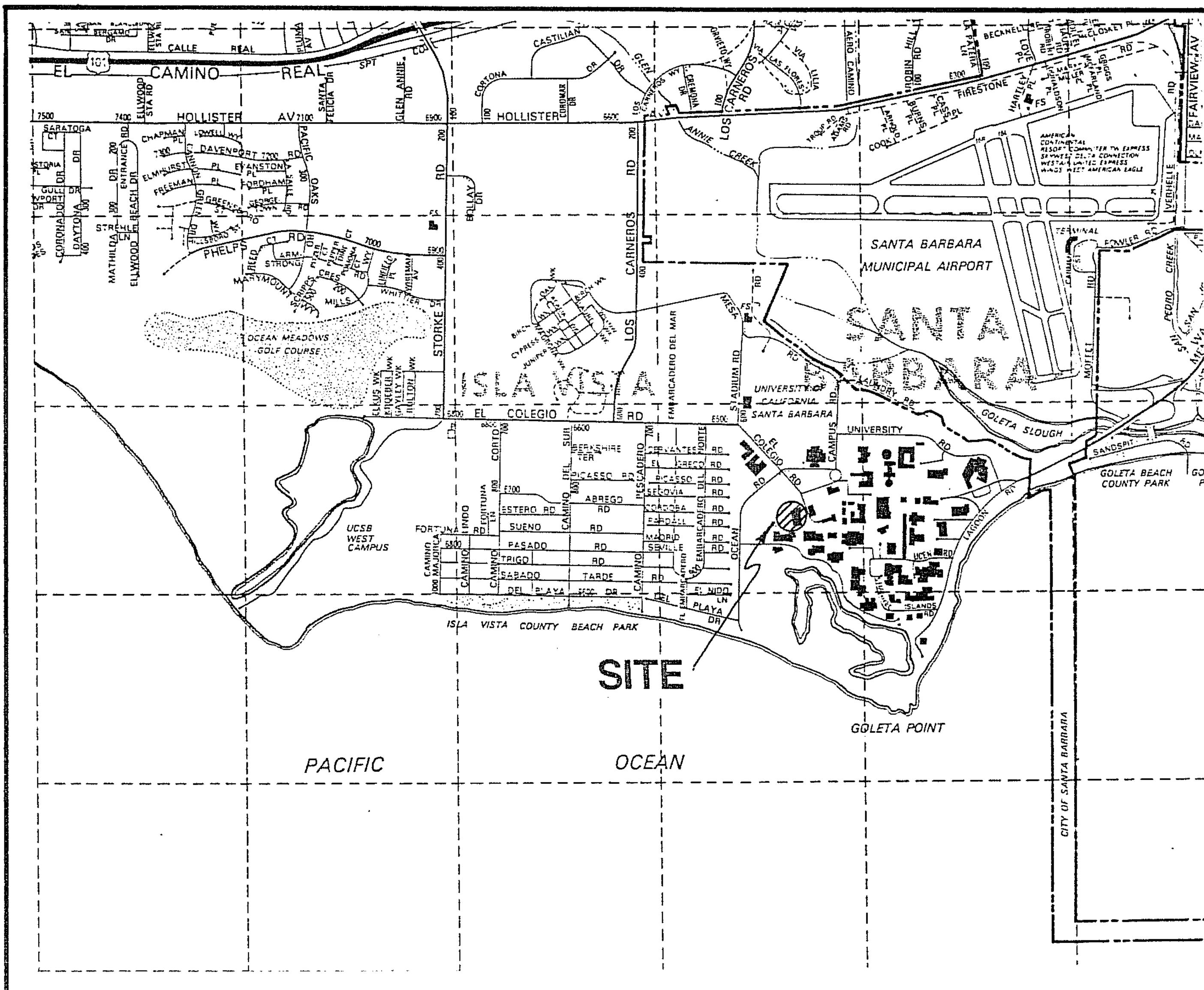



# VICINITY MAP

**Proposed Humanities and Social Sciences Building**

**El Colegio Road**

**University of California**

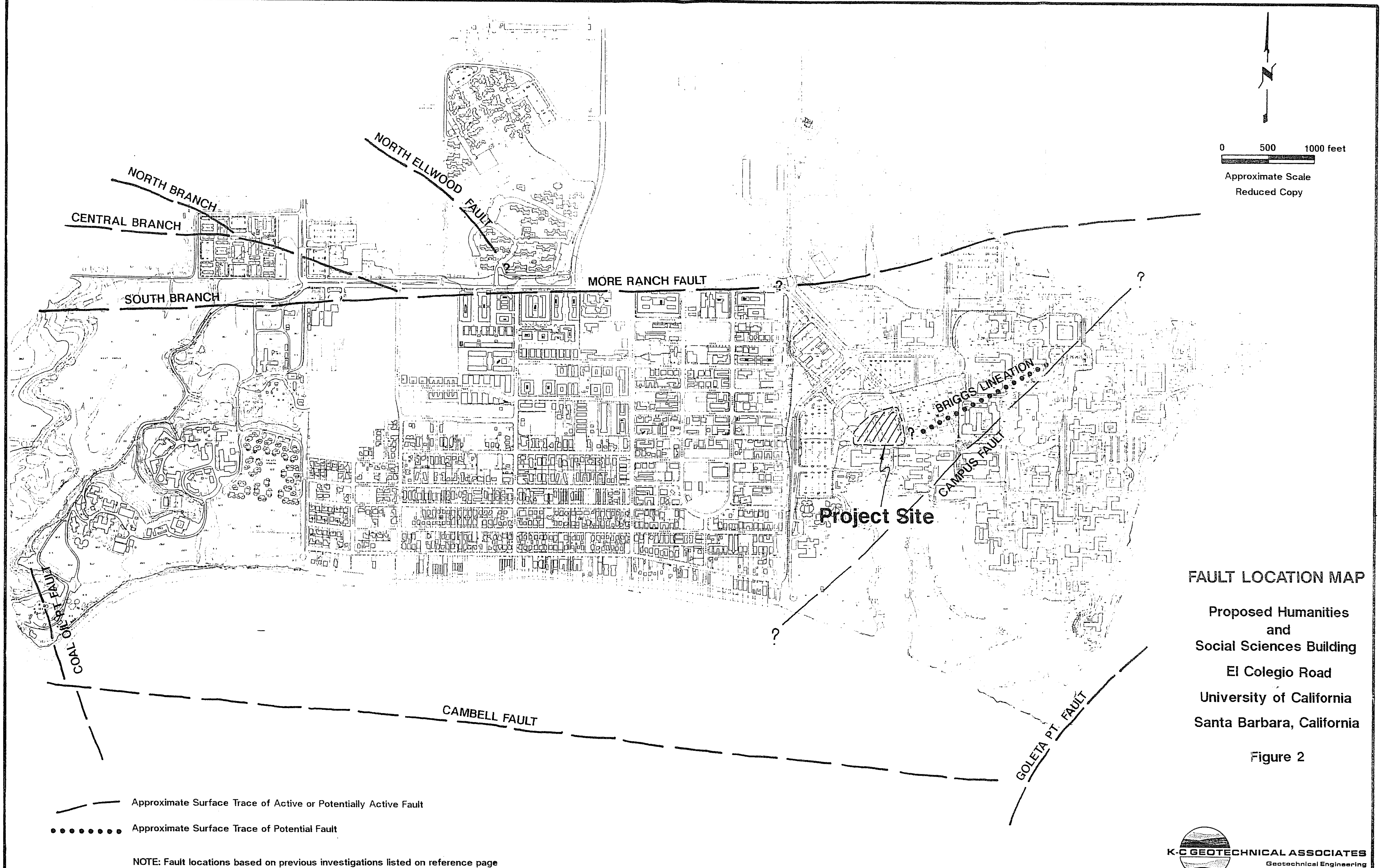
**Santa Barbara, California**

"Reproduced with permission granted by Thomas Brothers Maps"

**K-C GEOTECHNICAL ASSOCIATES**
Geotechnical Engineering
Engineering Geology

Figure 1

File ______ By ______ Date ______




**FAULT LOCATION MAP**

Proposed Humanities
and
Social Sciences Building

El Colegio Road

University of California

Santa Barbara, California

Figure 2

K-C GEOTECHNICAL ASSOCIATES
Geotechnical Engineering

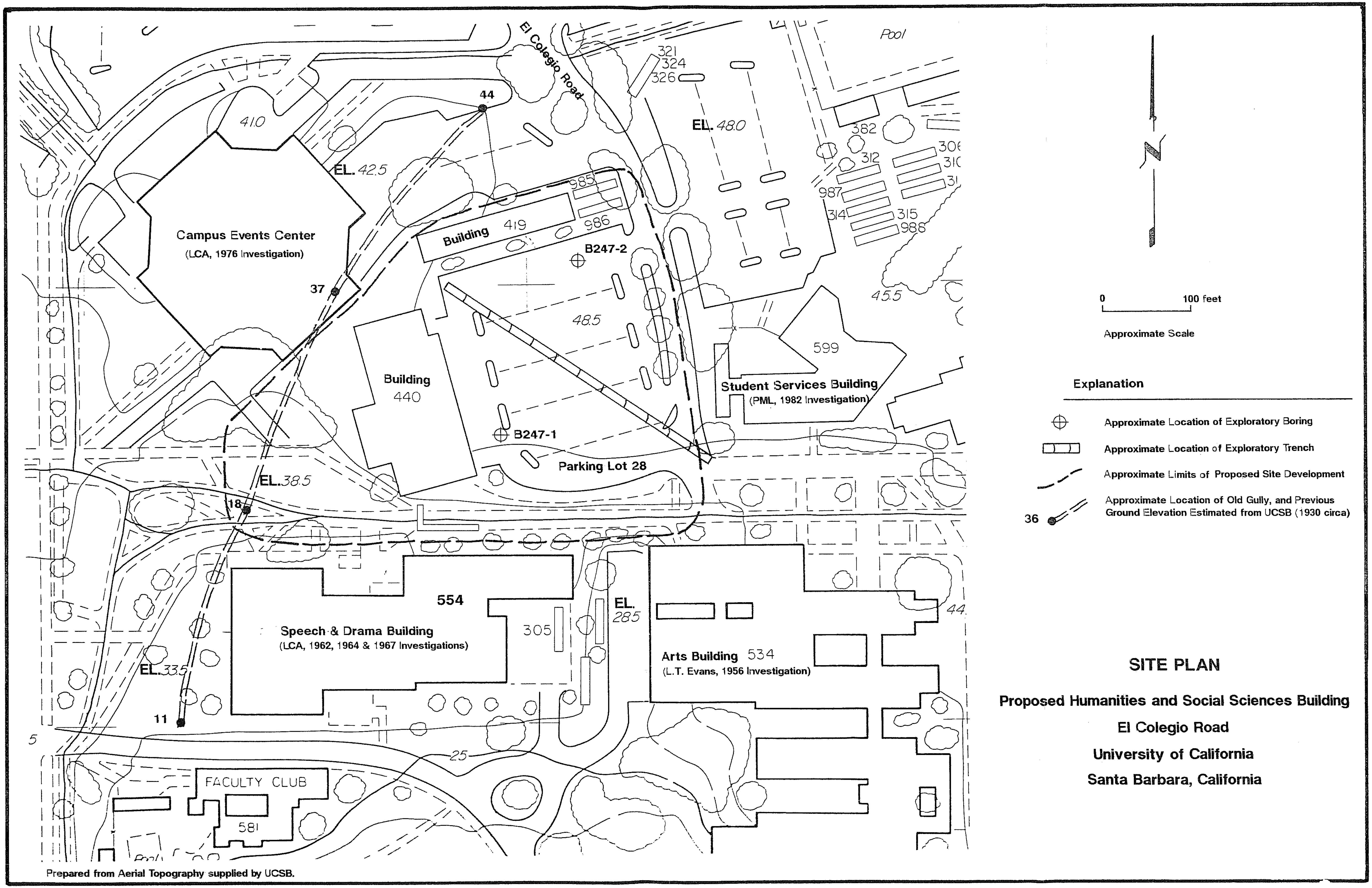

El Colegio Road
Pool
321
324
326
44
41.0
EL. 48.0
382
312
306
310
987
314
315
988
EL. 42.5
985
419
986
Building
Campus Events Center
(LCA, 1976 Investigation)
B247-2
37
48.5
45.5
599
Building
440
Student Services Building
(PML, 1982 Investigation)
B247-1
Parking Lot 28
EL. 38.5
18
554
Speech & Drama Building
(LCA, 1962, 1964 & 1967 Investigations)
305
EL. 28.5
Arts Building 534
(L.T. Evans, 1956 Investigation)
EL. 33.5
11
5
25
FACULTY CLUB
581
Pool
N
0
100 feet
Approximate Scale
Explanation
Approximate Location of Exploratory Boring
Approximate Location of Exploratory Trench
Approximate Limits of Proposed Site Development
36
Approximate Location of Old Gully, and Previous Ground Elevation Estimated from UCSB (1930 circa)
SITE PLAN
Proposed Humanities and Social Sciences Building
El Colegio Road
University of California
Santa Barbara, California
Prepared from Aerial Topography supplied by UCSB.

Figure 3

## APPENDIX A

### FIELD EXPLORATION

#### A.1 General

The field exploration for this Preliminary Geotechnical Engineering Report consisted of excavating two exploratory borings on March 26, 1990, and excavating one exploratory trench during the period March 28 through April 2, 1990. This exploration program was conducted in accordance with the scope of services given in the K-C proposal dated January 19, 1990.

#### A.2 Borings

The drilling subcontractor on the project, Valley Well Drilling of Ventura, California, used a truck-mounted Georex T-500 drill rig with a hollow stem auger to advance the borings. The drilling was performed under the observation of a staff engineer of K-C, who prepared logs of the soil conditions and obtained soil samples for laboratory observation and testing. The soils were classified in the field in accordance with the Unified Soil Classification System (see Figure A-2). Two 8-inch-diameter borings were drilled to depths ranging from approximately 42 to 53 feet below the existing ground surface. The approximate locations of the exploratory borings are shown on Figure 2. Boring locations were assessed approximately in the field by taping and sighting from existing topographic features.

Drive samples were obtained from the exploratory borings using a modified California sampler and/or a Standard Penetration Sampler. The modified California sampler has a 3-inch outside diameter and a 2.37-inch inside diameter; it contains 1-inch-high fiber liners. The sampler was generally driven 12 inches into the material at the bottom of the hole by dropping a 140-pound hammer 30 inches. The number of blows needed to drive the sampler into the soils a measured depth was recorded, as shown on the Log of Borings. Recovered samples were sealed in transport containers and returned to the laboratory for further classification and testing. The borings were backfilled with excavated cuttings and were not compacted.

Standard Penetration Tests (split spoon) were performed to obtain an indication of the density of the soil and to allow visual observation of at least a portion of the soil column. Soil samples obtained with the split spoon sampler were retained for further observation and testing. The split spoon samples were driven approximately 18 inches by dropping a

140-pound hammer 30 inches. The number of blows required to drive the split spoon to three 6-inch increments was recorded on the field boring log. The number of blows per foot (Standard Penetration N Value) is equal to the sum of the last two 6-inch increments.

Bulk samples were collected from cuttings obtained from the borings. The bulk samples were selected for classification and testing purposes and may represent a mixture of soils within the noted depths. Recovered samples were placed in transport containers and returned to the laboratory for further classification and testing.

Logs of the borings, showing the depths and descriptions of soils encountered, geologic structure where applicable, vertical locations of drive samples, penetration resistances, and results of density and moisture content tests, are presented in the Appendix. A legend of symbols typically used on the Log of Boring are given in Figure A-1. The logs represent the interpretation of field logs and tests, the interpolation of soil conditions between samples, and the results of laboratory observations and tests. The noted stratification lines represent approximate boundaries between soil types; the transitions can be gradual.

## A.3 Exploratory Trench

The excavation subcontractor on the project, Tierra Construction of Goleta, California, used a track-mounted excavator to excavate the exploratory trench. The trenching was performed under the observation of a staff geologist and senior geologist, who prepared a log of the soil conditions and geologic features (Figure A-8 and A-9). The soils were classified in the field in accordance with the Unified Soil Classification System. One, 30-inch wide trench was dug to depths ranging from approximately 7 to 14 feet below the existing ground surface. The length of the trench was approximately 365 feet, and the approximate location is shown on the Site Plan, Figure 3. The trench was backfilled with the excavated soils and compacted using vibratory compactors. The backfilled trench was subsequently patched with asphalt by Kelly Construction of Santa Barbara, California.

# LEGEND FOR SYMBOLS
# COMMONLY USED ON BORING LOGS

- 3-Inch O.D. Modified California Split-Barrel Sampler

- Standard Penetration Test (SPT)

- Loose Bulk Sample

- Water Level First Encountered

- Water Level After Drilling

NR - No Recovery

ROTARY AND CORE BORING LOGS

DATA ON THESE LOGS IS APPROXIMATE BECAUSE OF POSSIBLE DEVIATION FROM THE INTENDED DIRECTION OF DRILLING, INCOMPLETE RECOVERY OF DRILL CORE, AND THE LIMITED AND POSSIBLY DISTURBED SAMPLE PROVIDED BY A SMALL DIAMETER HOLE.

THESE LOGS INDICATE CONDITIONS ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES.

BORINGS WERE LOGGED IN SUCH A WAY AS TO PRIMARILY PROVIDE DATA FOR DESIGN PURPOSES AND NOT NECESSARILY FOR PURPOSES OF SPECIFIC CONSTRUCTORS.

SOIL CLASSIFICATIONS SHOWN ON THE LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THE TRANSITIONS MAY BE GRADUAL.

| | | |
|---|---|---|
| FILE NO.: KC-1405-06 | **LEGEND FOR SYMBOLS** | FIGURE A-1 |

K-C GEOTECHNICAL ASSOCIATES

| Major Divisions | | | Graphic Symbol | Letter Symbol | Typical Descriptions |
|---|---|---|---|---|---|
| Coarse-Grained Soils | Gravel and Gravelly Soils | Clean Gravels | | GW | Well-graded gravels, gravel-sand mixtures, little or no fines |
| | | (Little or no fines) | | GP | Poorly-graded gravels, gravel-sand mixtures, little or no fines |
| | More than 50% of coarse fraction retained on No. 4 seive | Gravels with Fines | | GM | Silty gravels, gravel-sand-silt mixtures |
| | | (Appreciable amount of fines) | | GC | Clayey gravels, gravel-sand-clay mixtures |
| More than 50% of material retained on No. 200 sieve | Sand and Sandy Soils | Clean Sands | | SW | Well-graded sands, gravelly sands, little or no fines |
| | | (Little or no fines) | | SP | Poorly-graded sands, gravelly sands, little or no fines |
| | 50% or more of coarse fraction passing No. 4 seive | Sands with Fines | | SM | Silty sands, sand-silt mixtures |
| | | (Appreciable amount of fines) | | SC | Clayey sands, sand-clay mixtures |
| Fine-Grained Soils | Silts and Clays | Liquid limit less than 50 | | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity |
| | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | | | | OL | Organic silts and organic silty clays of low plasticity |
| 50% or more of material passing No. 200 sieve | Silts and Clays | Liquid limit 50 or more | | MH | Inorganic siltys, micaceous or diatomaceous fine sand or silty soils |
| | | | | CH | Inorganic clays of high plasticity, fat clays |
| | | | | OH | Organic clays of medium to high plasticity, organic silts |
| Highly Organic Soils | | | | PT | Peat, humus, swamp soils with high organic contents |

NOTE: Dual symbols are used to indicate borderline soil classifications.

| FILE NO.: KC-1405-06 | **UNIFIED SOIL CLASSIFICATION SYSTEM** | FIGURE A-2 |
|---|---|---|

PROJECT: UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara LOGGED BY:J. Blanchard
DRILLING METHOD: Hollow Stem Auger DRILLED BY: Valley Well Drilling

DRILLING DATE: March 26, 1990
SURFACE EL.: 45-1/2 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENE-TROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | 10 in. asphalt pavement | | | | | | |
| | | | | | SM | Silty SAND, dark brown, moist | | | | | | -- |
| | | 1-1 | 10 | | SM | Silty SAND, loose, gray-brown, moist (poor recovery) medium dense, (wet at 3.5 feet/ Perched water) - Fill - | -- | 10.1 | -- | -- | | |
| | | 1A | | | | | | | | | | |
| | | 1-2 | 23 | | | | 106.8 | 16.5 | -- | -- | | 4.25 |
| 5 | | 1-3 | 42 | | SM | Silty SAND, medium dense, gray to tan, moist, thin clay infilled fractures - Terrace Deposit - | 109.1 | 15.7 | -- | -- | | -- |
| 10 | | 1-4 | 7 | | MH | "Elastic SILT", firm, gray, moist, interbedded with yellow brown silty sand, siltstone - Sisquoc Formation - | -- | 51.5 | 73 | 23 | | 2.0 |
| 15 | | 1-5 | 14 | | MH | "Elastic SILT", hard, gray, moist, massive, fine fractures, siltstone - Sisquoc Formation - | -- | 44.6 | 65 | 21 | | 3.0 |
| 20 | | 1-6 | 18 | | | | -- | 37.9 | -- | -- | | 2.5 |
| 25 | | 1-7 | 26 | | MH | "Elastic SILT", very hard, dark green-gray, silt stone - Sisquoc Formation - | -- | 31.3 | -- | -- | | 4.25 |

GROUNDWATER DATA:
Groundwater not encountered
Seepage at 3.5 feet

**LOG OF BORING**
BORING NO. 247-1

FILE NO.: KC-1405-06
FIGURE A-3

K-C GEOTECHNICAL ASSOCIATES

PROJECT:UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara
LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger
DRILLED BY: Valley Well Drilling
DRILLING DATE: March 26, 1990
SURFACE EL.: 45-1/2 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | | | | | | | | | | | | |
| 30 | | 1-8 | 40 | | MH | Very hard, laminated | -- | 33.2 | -- | -- | | 4.5+ |
| 35 | | 1-9 | 38 | | | - Sisquoc Formation - | -- | 38.6 | -- | -- | | 4.5+ |
| 40 | | 1-10 | 55 | | | | -- | 46.6 | 68 | 6 | | 4.5+ |
| | | | | | | Boring Terminated at 41.5 feet. | | | | | | |
| 45 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered

## LOG OF BORING
BORING NO. 247-1

FILE NO.: KC-1405-06

FIGURE A-4

K-C GEOTECHNICAL ASSOCIATES

PROJECT: UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara
LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger
DRILLED BY: Valley Well Drilling
DRILLING DATE: March 26, 1990
SURFACE EL.: 47 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | 0.2 feet Asphalt pavement | | | | | | |
| | | | SM | 0.5 feet, silty SAND, yellow brown | | | | | | -- |
| | 2-1 | 20 | SM | Silty SAND, gray-brown, medium dense, moist - Fill - | 97.4 | 5.9 | -- | -- | | -- |
| | 2-2 | 36 | SC | Clayey SAND, medium dense, yellow brown, moist - Terrace Deposit - | 106.9 | 19.2 | 39 | 16 | | 2.5 |
| 5 | 2-3 | 50 | SM | Silty SAND, dense, yellow brown, moist, pockets of white silty sand; interbedded layers of clayey sand - Terrace Deposit - | 107.0 | 14.1 | -- | -- | | -- |
| 10 | 2-4 | 18 | ML | "SILT" , hard, brown-gray, moist, interbedded with yellow brown silty sand, weathered, siltstone - Sisquoc Formation - | -- | 14.5 | -- | NP | | -- |
| 15 | 2-5 | 17 | | Yellow-brown to gray, siltstone | -- | 40.8 | -- | -- | | 2.5 |
| 20 | 2-6 | 32 | MH | "Elastic SILT" , very hard, dark gray-green, laminated - Sisquoc Formation - | -- | 37.5 | -- | -- | | 4.5+ |
| 25 | 2-7 | 36 | | | -- | 36.7 | 55 | 12 | | 4.5+ |

GROUNDWATER DATA:
Groundwater not encountered

# LOG OF BORING
BORING NO. 247-2

FILE NO.: KC-1405-06
FIGURE A-5

K-C GEOTECHNICAL ASSOCIATES

PROJECT: UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara
LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger
DRILLED BY: Valley Well Drilling
DRILLING DATE: March 26, 1990
SURFACE EL.: 47 feet
DATUM: UCSB Topo Plan

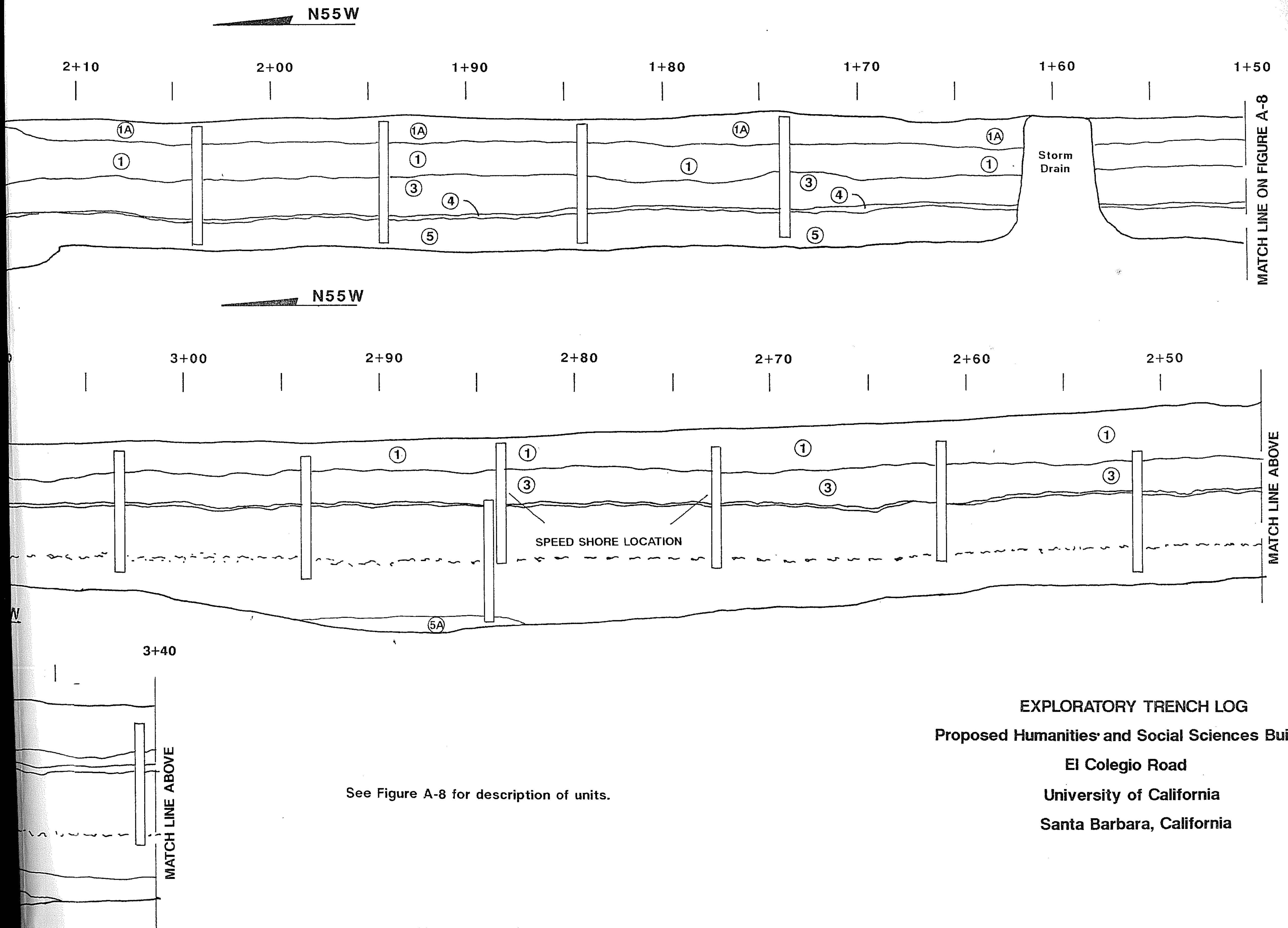
| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | | | | | MH | "Elastic SILT", very hard, dark gray-green, laminated | | | | | | |
| 30 | | 2-8 | 35 | | | | -- | 39.1 | -- | -- | | 4.5+ |
| | | | | | | - Sisquoc Formation - | | | | | | |
| | | | | | | | | | | | | 4.5+ |
| 35 | | 2-9 | 40 | | | | -- | 41.0 | -- | -- | | |
| | | | | | | | | | | | | 4.5+ |
| 40 | | 2-10 | 20 | | | | -- | 43.9 | -- | -- | | |
| 45 | | | | | | | | | | | | |
| 50 | | 2-11 | 43 | | | Occasional thin lenses of black sand | -- | 50.4 | -- | -- | | 4.5+ |

GROUNDWATER DATA:
Groundwater not encountered

**LOG OF BORING**
BORING NO. 247-2 (con't)

FILE NO.: KC-1405-06
FIGURE A-6

K-C GEOTECHNICAL ASSOCIATES




See Figure A-8 for description of units.

Approximate Horizontal and Vertical Scale: 1 inch = 5 feet

EXPLORATORY TRENCH LOG

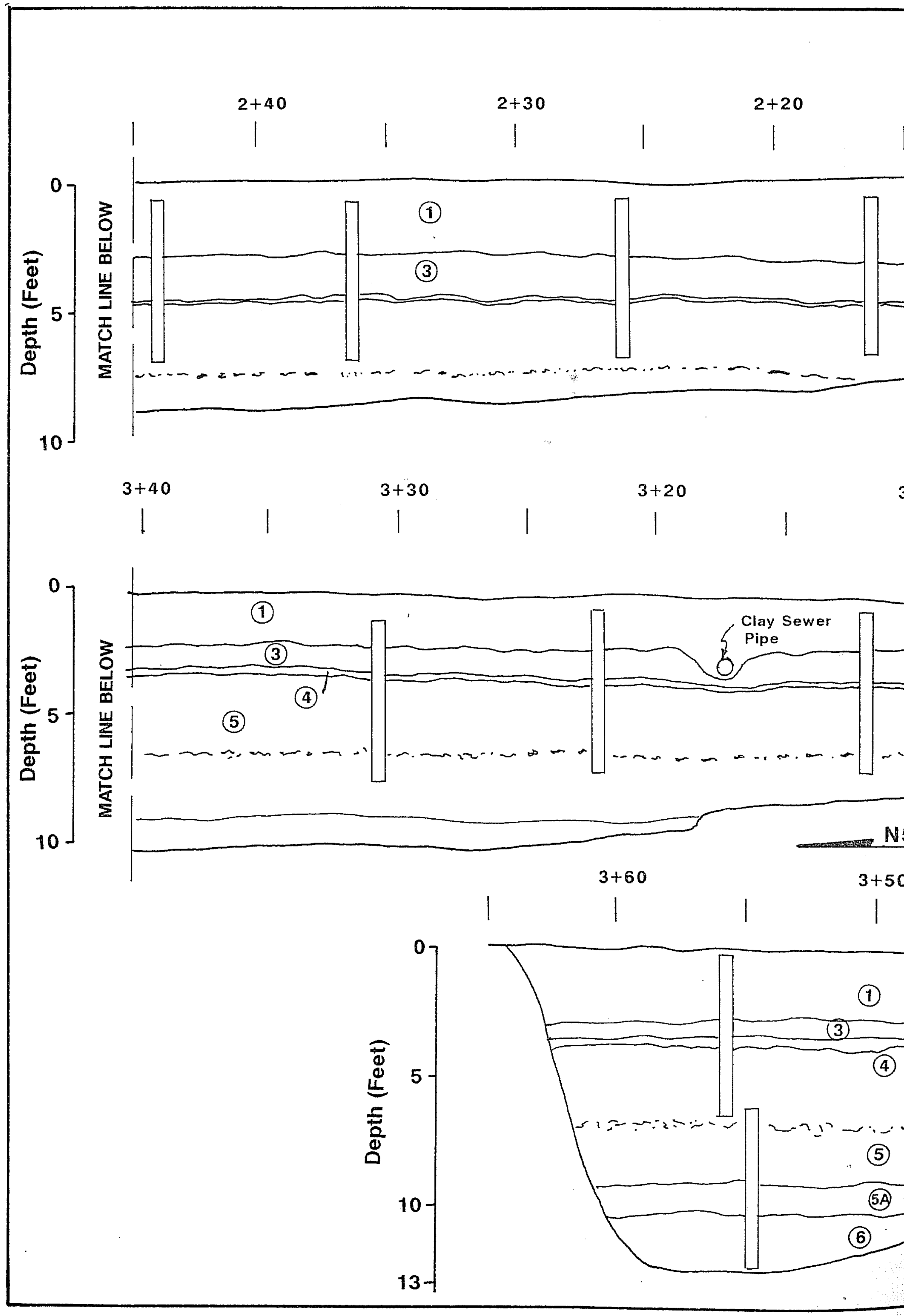
Proposed Humanities and Social Sciences Building

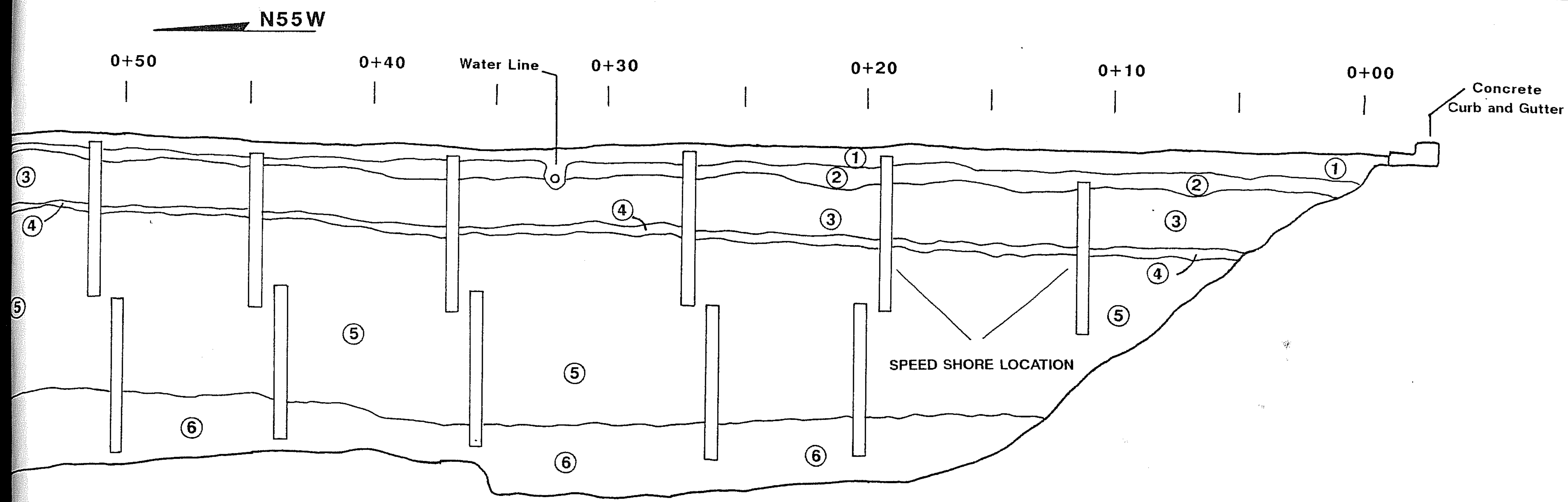
El Colegio Road

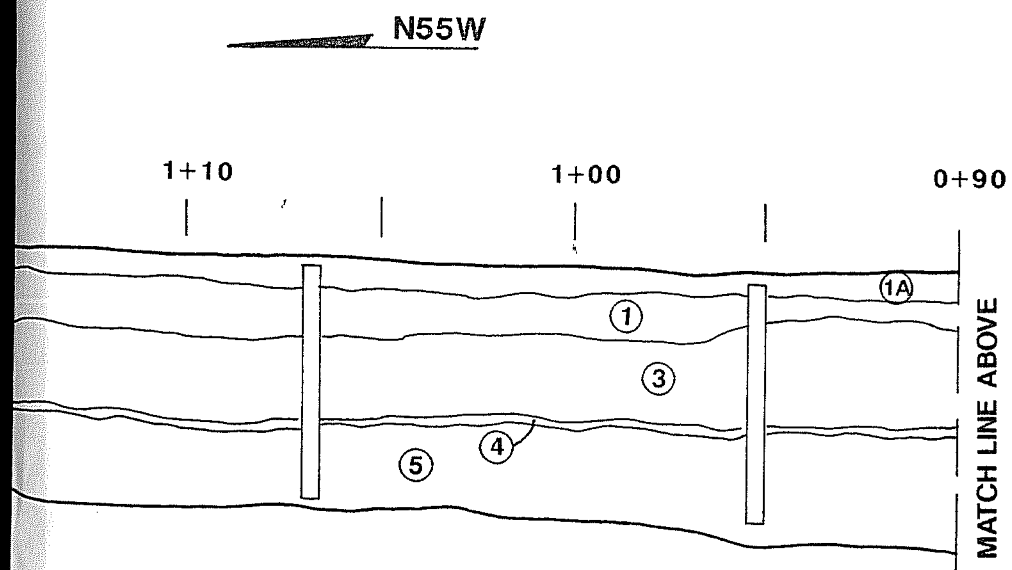
University of California

Santa Barbara, California

Figure A-9


2+40
2+30
2+20
0
5
10
Depth (Feet)
MATCH LINE BELOW
①
③
3+40
3+30
3+20
Clay Sewer Pipe
④
⑤
3+60
3+50
13
5A
⑥




## Description

(1) Silty SAND (SM),dark brown, dry (FILL)

(1A) Poorly graded SAND to silty SAND and silty CLAY (SP-SM, CL-ML), yellow, moist (FILL)

(2) Poorly graded SAND (SP),medium to light gray brown, dry (FILL)

(3) Poorly graded SAND (SP), medium brown, moist, with abundant organics and rootlets (TERRACE DEPOSIT)

(4) Poorly graded SAND (SP), dark brown, moist (TERRACE DEPOSIT - PALEOSOL)

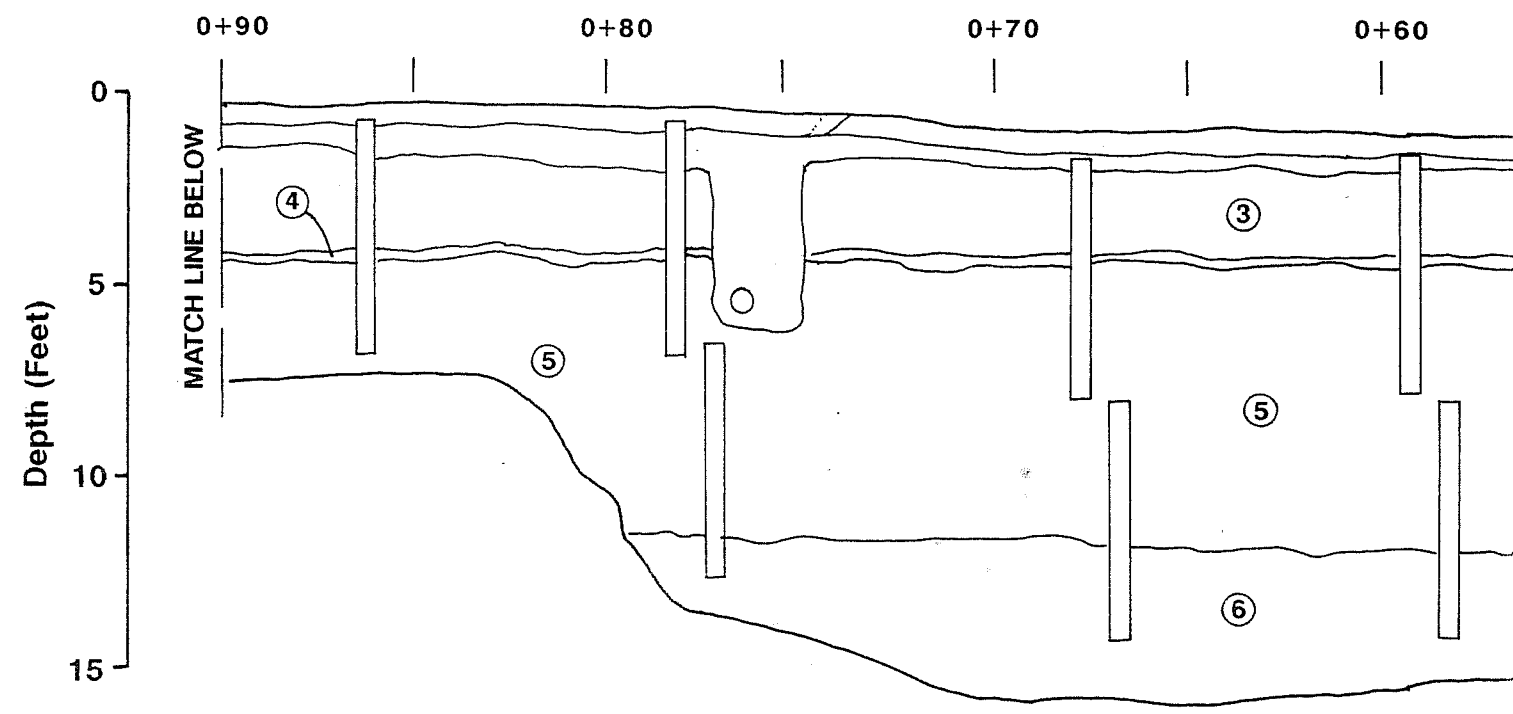
(5) Silty SAND to SILT (SM, ML), mottled yellow to gray and orange brown, moist, with common rip-up clasts of Sisquoc Fm at base **(TERRACE DEPOSIT)**

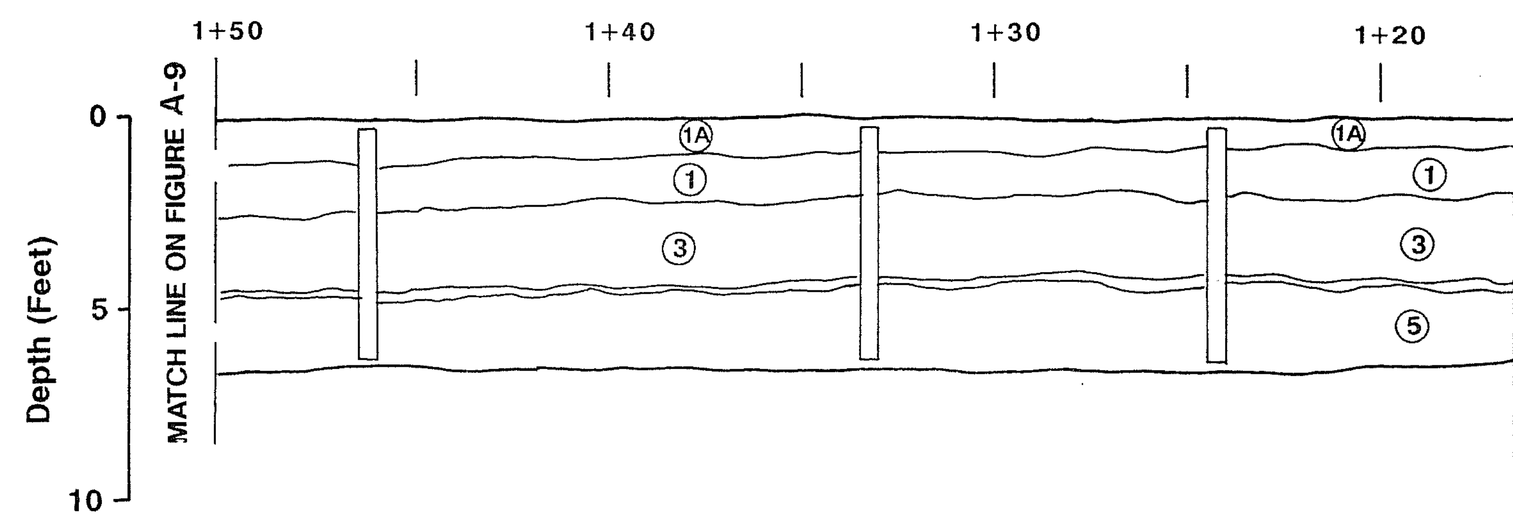
(5A) Poorly graded SAND to SILT (SP, SM), gray green, moist, with abundant fossil fragments (pectin, turitella)**(TERRACE DEPOSIT)**

(6) "Elastic SILT" (MH), gray green, moist, blocky fractures (SISQUOC FORMATION)

**EXPLORATORY TRENCH LOG**

**Proposed Humanities and Social Sciences Building**
**El Colegio Road**
**University of California**
**Santa Barbara, California**




Approximate Horizontal and Vertical Scale: 1 inch = 5 feet

PROJECT: UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara
LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger
DRILLED BY: Valley Well Drilling
DRILLING DATE: March 26, 1990
SURFACE EL.: 47 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | | | | | MH | "Elastic SILT", very hard, dark gray-green, moist, siltstone | | | | | | |
| 50 | | 2-11 | 43 | | | - Sisquoc Formation - | -- | 50.4 | | | | |
| | | 2-12 | 54 | | | | -- | 51.6 | -- | -- | | |
| | | | | | | Boring Terminated at 53 feet. | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered

# LOG OF BORING
BORING NO.247-2 (con't)

FILE NO.: KC-1405-06
FIGURE A-7

K-C GEOTECHNICAL ASSOCIATES

## APPENDIX B

## LABORATORY TESTING

### B.1 General

This appendix discusses the results of the laboratory test program performed for this Preliminary Geotechnical Engineering Report. Laboratory tests were performed on selected samples obtained from the field to help classify the soils and estimate some of their engineering properties. The program was carried out employing, wherever practical, currently accepted test procedures of the American Society for Testing and Materials (ASTM).

Driven-ring and bulk samples used in the laboratory testing program were obtained from various locations during the course of the field exploration, as discussed in Appendix A. Each sample is identified by sample number and depth. The various laboratory tests performed are described below.

### B.2 Index Properties Testing

The method of identifying and classifying soils according to their engineering properties used in this study is ASTM Test Method D2487-83, based on the Unified Soil Classification System. The index properties tests discussed in this report are for water content and dry density, and grain-size distribution (mechanical and hydrometer), and plasticity indices.

Tests for water content and dry density of the soils were performed, often in conjunction with other tests, on selected drive samples. The samples were trimmed to obtain a smooth, flat face, measured to obtain volume and wet weight, extruded, and visually classified. The samples were dried for approximately twelve hours in an oven maintained at 110 degrees Celsius. After drying, each sample was weighed, and the moisture content and dry density were calculated. The water content and dry density results are summarized on Table B-1 and are given on the boring log data in Appendix A.

The gradation characteristics of selected samples were estimated by hydrometer and sieve analysis procedures. Samples were soaked in water until individual soil particles were separated, then washed on the No. 200 mesh sieve, oven dried, weighed to assess the percent passing the No. 200 sieve, and mechanically sieved. Additionally, hydrometer analyses were performed to assess the distribution of the minus No. 200

mesh material of selected samples. The hydrometer test was run using sodium hexametaphosphate as a dispersing agent. The grain size distribution tests are presented on Figures B-1 and B-2.

Tests for liquid limit, plastic limit, and plasticity index were conducted on selected samples in accordance with ASTM Test Method D4318. The liquid limit of soils is the water content at the boundary between the liquid and plastic states of the soil. The plastic limit is the water content between the plastic and semisolid states. The plasticity index is the range of water content where the soil is plastic. The boundary conditions are arbitrarily defined by the test methods. These tests allow a comparison to be made between the natural water content and the laboratory standard. The test results are an important correlation with the engineering properties and engineering behavior of fine-grained soils. Results of the tests are presented on Figure B-3.

## B.3 Engineering Properties Testing

The engineering properties testing consisted of tests for direct shear analysis and swell.

The direct shear tests were performed on selected driven-ring and remolded samples. The samples were pre-loaded with a confining pressure and flooded with water for at least twenty-four hours. The samples were sheared horizontally at a controlled strain rate, allowing partial drainage. The shear stress on the samples was recorded at regular strain intervals. The results of the direct shear tests are tabulated on Table B-1.

Swell tests were performed on selected driven-ring soil samples. The samples were surcharged under 100 psf load and allowed to air dry to a moisture content approximately near or below the shrinkage limit. Samples were then submerged with water, and the amount of swell was recorded with a dial indicator. The results of the swell tests are presented on Table B-2.

# TABLE B-1

## Summary of Moisture, Density & Direct Shear Testing

| Sample Number | Depth Feet | In-Place Conditions: Dry Density pcf | In-Place Conditions: Moisture Content % Dry Wt. | Direct Shear Testing: Angle of Internal Friction | Direct Shear Testing: Unit Cohesion psf |
|---|---|---|---|---|---|
| 1-1 | 1 | -- | 10.1 | | |
| 1-2 | 3 | 106.8 | 16.5 | | |
| 1-3 | 5 | 126.3 | 15.7 | | |
| 1-4 | 10 | -- | 51.5 | | |
| 1-5 | 15 | -- | 44.6 | | |
| 1-6 | 20 | -- | 37.9 | | |
| 1-7 | 25 | -- | 31.3 | | |
| 1-8 | 30 | -- | 33.2 | | |
| 1-9 | 35 | -- | 38.6 | | |
| 1-10 | 40 | -- | 46.6 | | |
| 2-1 | 1 | 97.4 | 5.9 | | |
| 2-2 | 3 | 106.9 | 19.2 | 12° | 1800 |
| 2-3 | 5 | 107.0 | 14.1 | | |
| 2-4 | 10 | -- | 14.5 | | |
| 2-5 | 15 | -- | 40.8 | | |
| 2-6 | 20 | -- | 37.5 | | |
| 2-7 | 25 | -- | 36.7 | | |
| 2-8 | 30 | -- | 39.1 | | |
| 2-9 | 35 | -- | 41.0 | | |
| 2-10 | 40 | -- | 43.9 | | |
| 2-11 | 50 | -- | 50.4 | | |
| 2-12 | 51.5 | -- | 51.6 | | |

**TABLE B-2**

Summary of Swell Testing

| | | | |
|---|---|---|---|
| Sample No. | : | 1-3 | 2-2 |
| Location, Boring | : | 1 | 2 |
| Depth, Feet | : | 5 | 3 |
| Swell % @ 100 psf | : | 3.4 | 7.2 |
| Initial Moisture, % | : | 8.9 | 17.8 |
| Initial Density, pcf | : | 107.5 | 102.3 |
| Final Moisture, % | : | 20.7 | 26.5 |

Description:

1-3: Silty SAND (SM), gray to tan, thin clay filled fractures

2-2: Clayey SAND (SC), yellow-brown,

File No. KC-1405-06

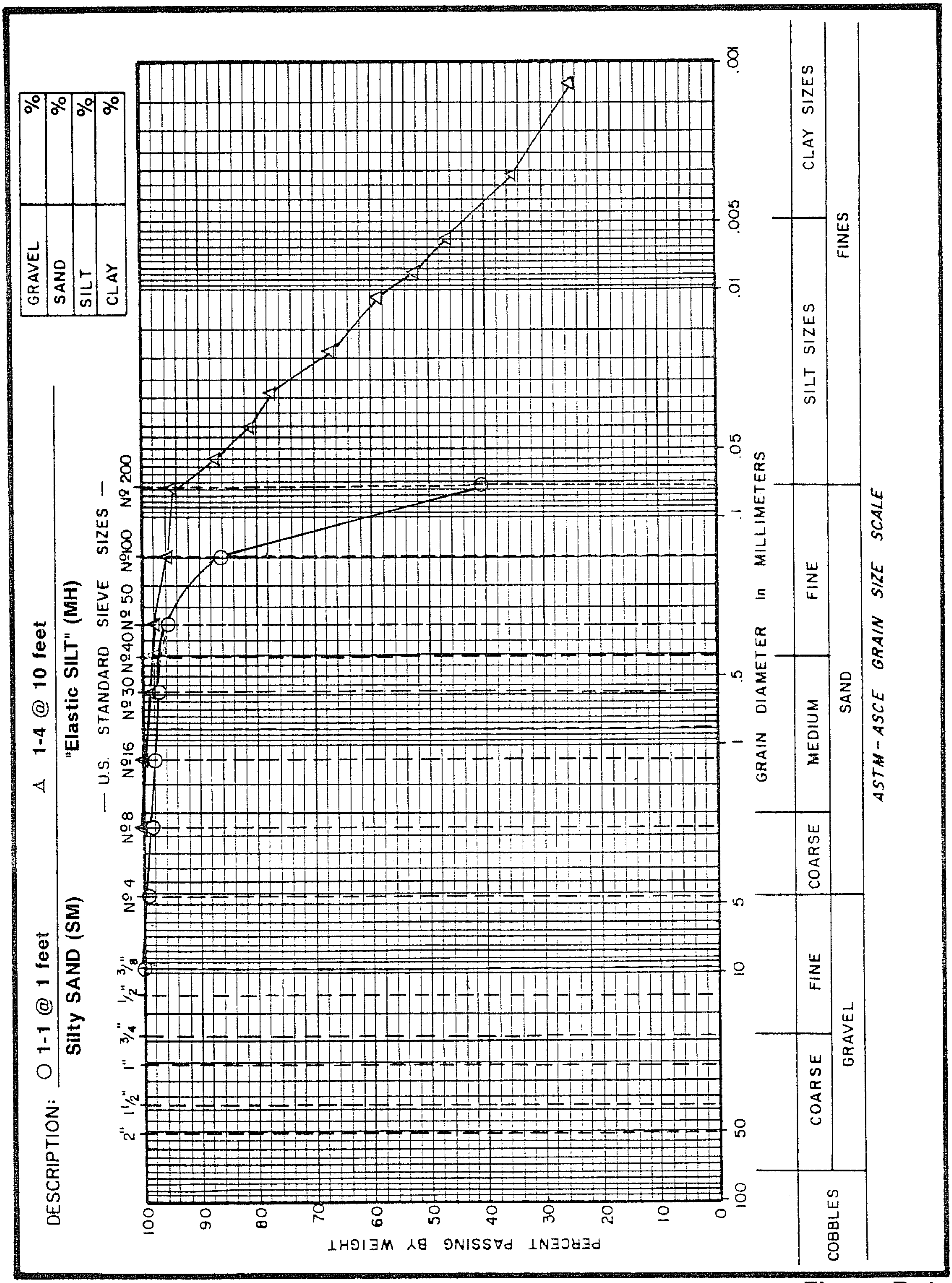



Figure B-1

File No. KC-1405-06

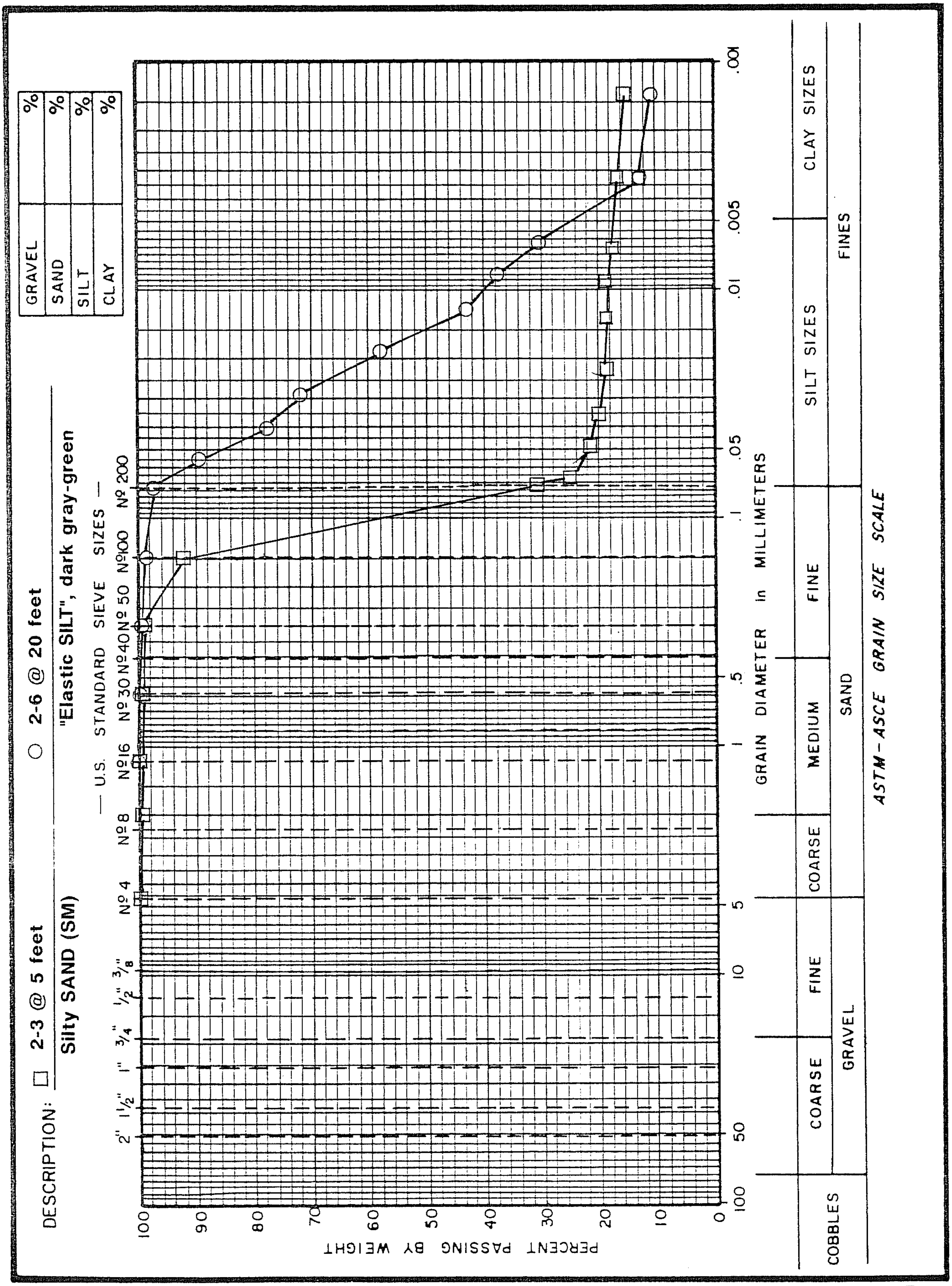
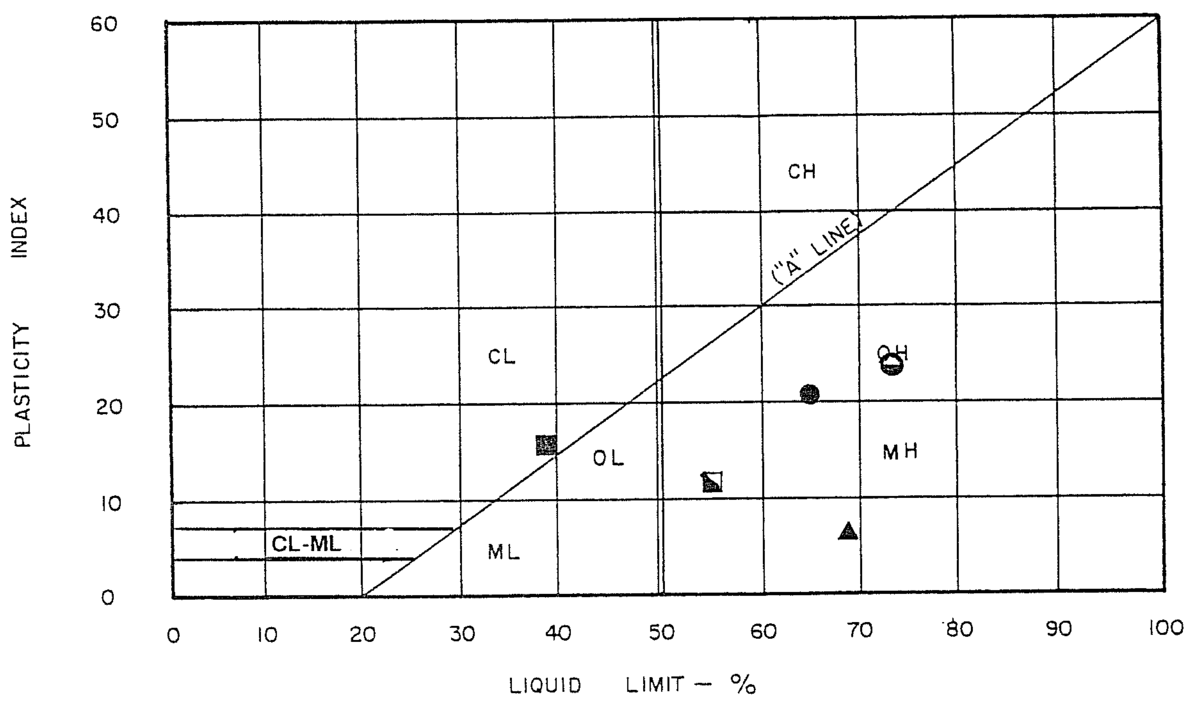



Figure B-2

## PLASTICITY CHART




| Sample Number | | Depth (ft.) | Description | Atterberg Limits: Liquid Limit % | Atterberg Limits: Plasticity Index |
|---|---|---|---|---|---|
| ◒ | 1-4 | 10 | "Elastic SILT" (MH), gray | 73 | 23 |
| ● | 1-5 | 15 | "Elastic SILT" (MH), gray | 65 | 21 |
| ▲ | 1-10 | 40 | "Elastic SILT" (MH), dark green-gray | 68 | 6 |
| ■ | 2-2 | 3 | Clayey SAND (SC), yellow-brown | 39 | 16 |
| | 2-4 | 10 | "SILT" (ML), brown-gray | Non-plastic | |
| ◪ | 2-7 | 25 | "Elastic SILT" (MH), dark gray-green | 55 | 12 |

Humanities and Social Sciences Building
University of California
Santa Barbara, California
# GEOTECHNICAL ENGINEERING REPORT

File No. KC-1610-01
April 27, 1992

Mr. Bill Hanna
Facilities Management, Building 439
University of California
Santa Barbara, California 93106

Subject: Humanities and Socials Sciences Building
University of California
Santa Barbara, California
**GEOTECHNICAL ENGINEERING REPORT**

Dear Mr. Hanna:

K-C Geotechnical Associates (K-C) is pleased to present this Geotechnical Engineering Report for the proposed Humanities and Socials Sciences Building project at the University of California, Santa Barbara. This report completes our assignment according to our proposal of January 17, 1992, as authorized by the University of California Authorization No. 123/91-92 dated February 19, 1992.

The report summarizes our field and laboratory testing data compiled in this evaluation. We have provided recommendations for the design of foundations, and for site preparation and grading. The conclusions and recommendations presented are based upon the generally accepted standards of our profession at the location and time the report was prepared.

Please contact the undersigned if there are any questions concerning the report.

Very truly yours,
K-C Geotechnical Associates
a California Corporation

Jonathan D. Blanchard
Project Engineer, CE 47071

Ross A. Morrison
Principal Engineer, GE 621

Copies: 8 - Addressee
1 - Mr. Steve Karzen, UCSB

JB:kd(203047)

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# GEOTECHNICAL ENGINEERING REPORT

# FOR

# HUMANITIES AND SOCIALS SCIENCES BUILDING

# UNIVERSITY OF CALIFORNIA

# SANTA BARBARA, CALIFORNIA

## 1. INTRODUCTION

K-C Geotechnical Associates (K-C) is pleased to present this Geotechnical Engineering Report for the proposed Humanities and Socials Sciences Building project at the University of California, Santa Barbara (UCSB). This report completes our assignment according to our proposal of January 17, 1992, as authorized by the University of California Authorization No. 123/91-92 dated February 19, 1992.

### 1.1 Purpose and Scope

The purpose of our geotechnical engineering investigation was to explore and evaluate the soil conditions at the site. We have provided geotechnical recommendations for the design of the proposed building based on the results of our investigation. Our understanding of the proposed project and the general scope of geotechnical services is based on discussions with Mr. Bill Hanna of the Facilities Management Department of UCSB, on discussions and correspondence with Mr. Bruce Gibbons and Ms. Katherine Wells of Ove Arup & Partners (Structural Engineers), and on discussions with Mr. Dave Rundle of Penfield & Smith Engineers (Civil Engineer). Information from our discussions and meetings, and from our field exploration, laboratory testing, literature review, and engineering evaluation has been used in preparing this report.

Our scope of services was presented in our January 17, 1992 proposal. A summary of the completed work presented in this report is the following:

- Exploring the soil conditions at the site by excavating and sampling seven borings;

- Laboratory testing of selected soil samples obtained from the exploratory borings;

- Evaluating field and laboratory tests, assessing and organizing data, and reviewing the project objectives with UCSB and Ove Arup & Partners; and

- Preparing this written report, with graphics and data obtained from the exploration and testing programs. The report presents the results of laboratory tests, boring logs of the subsoil strata, and a discussion of the general soil characteristics with respect to the planned project. We have provided our geotechnical opinions and recommendations regarding:

    - Soil and groundwater conditions encountered at the site;

    - Shallow foundation systems for support of structures, soil bearing pressures, foundation embedment depths, foundation design, and estimated settlement;

    - Drilled pier foundations for support of structures, belled and straight shaft piers, end bearing and frictional capacities, foundation embedment depths, foundation design, and estimated settlement;

    - Resistance to lateral loads, passive pressures and friction coefficients for shallow foundation design, and lateral load capacities for drilled pier foundations;

    - Lateral earth pressures, backfill, compaction, and drainage for design of retaining walls;

    - Soil material and backfill requirements for site preparation and grading;

    - Slab-on-grade and asphalt pavements;

    - Soil corrosivity, groundwater considerations, drainage, and soil expansion potential; and

    - Liquefaction potential and slope stability.

## 1.2 General Conditions

K-C prepared the conclusions and professional opinions presented in this report according to generally accepted geotechnical engineering principles and practices at the time and location this report was prepared. This statement is in lieu of all warranties, expressed or implied.

This report has been prepared for use by the University of California, Santa Barbara and their authorized agents only. It may not contain sufficient information for other parties or other uses. If any changes are made in the project as described in this report, the conclusions and recommendations contained in this report should not be considered valid. K-C should review any changes in the project and modify and approve in writing the conclusions and recommendations of this report. This report and the drawings contained in this report are intended for design-input purposes; they are not intended to act as construction drawings or specifications.

Soil and rock deposits may vary in type, strength, and other geotechnical properties between points of observations and exploration. Additionally, groundwater and soil moisture conditions also can vary seasonally or for other reasons. Therefore, we do not and cannot have a complete knowledge of the subsurface conditions underlying the site. The criteria presented in this report are based upon the findings at the points of exploration and on interpolation and extrapolation of information obtained at the points of observation.

## 2. LOCATION AND DESCRIPTION OF SITE

The project site is on the Main Campus of the University of California, Santa Barbara, California. The site is on the west side of El Colegio Road, near its intersection with the Pardall Corridor. The location of the site relative to nearby streets and local landmarks is shown on the Vicinity Map, Figure 1. The site is presently occupied by existing parking lots (Lots 26 and 28), two single-story wood-framed structures (Buildings 440 and 419), and two mobile trailer units occupied by Military Sciences. Site elevations range from approximately elevation 45 near the north end of the site to approximately elevation 40 feet at the west side of Building 440.

## 3. PLANNED DEVELOPMENT

The general layout of the Humanities and Social Sciences Building is shown on the Boring Location Plan, Figure 2. As planned, the Humanities and Social Sciences building will consist of four connected structure elements. The elements will generally consist of a single-story theater and dance studio; two four-story elements composed of space for anthropology and classrooms, and academic offices; and a six-story element accommodating academic and administrative support. The buildings will generally be constructed with reinforced concrete frames, with perimeter shear walls, and concrete floor slabs. Floor to floor heights are 14 feet at the first floor, 10 feet at intermediate floors, and 11 feet from the top floors to the roof.

As planned, the single-story element has a finished floor elevation of 42 feet. Based on the preliminary grading and drainage plan (Penfield & Smith Engineers 1992), the building pad for the single-story element will be constructed with approximately 4 feet of cut and 3 feet of fill. The schematic design phase (Zimmer Gunsul Frasca Partnership 1991) shows the single-story element supported by conventional spread footing foundations bearing on compacted fill. Based on preliminary information provided to K-C by Ove Arup & Partners, the single-story element would have column loads on the order of 42 kips (dead plus live load), and wall loads on the order of 3 to 6 kips (dead plus live load).

As indicated in our Preliminary Geotechnical Engineering Report (K-C 1990), the west end of the building footprint for the single-story element is over a gully that was reportedly filled with uncompacted fill materials (UCSB 1930 circa, UCSB 1950, LeRoy Crandall & Associates 1962 and 1967). A comparison of the UCSB (1930 circa and 1950) topographic plans with the Garner Land Surveying (1990) topographic plans indicate that the existing fill could be up to approximately 20 feet thick in the site vicinity.

The four- and six-story elements will be constructed with a ground floor elevation of approximately 46 feet. The ground floor elevation for the elements will be constructed within approximately 1 to 2 feet of existing site grades. A basement will be constructed below the six-story element. The basement floor elevation is approximately 12 feet below existing site grades. The schematic design phase shows the four- and six-story elements supported by drilled and belled cast-in-place piers. Based on preliminary information provided to K-C by Ove Arup & Partners, the four-story element would have column loads on the order of 190 to 390 kips (dead plus live load). The six-story element would have column loads on the order of 675 kips (dead plus live load)

## 4. GENERAL SUMMARY OF SITE CONDITIONS

The geotechnical engineering investigation for this project consisted of a program of field exploration, laboratory testing, engineering evaluation, and review of geotechnical engineering reports and geologic information for the site vicinity. This investigation was used to supplement our previous field exploration and laboratory testing program performed for our preliminary geotechnical investigation (K-C 1990). The present field exploration consisted of the excavation and sampling of seven exploratory borings to depths ranging between approximately 20 and 40 feet below the ground surface. Laboratory testing was conducted on selected soil samples obtained from the borings to characterize general geotechnical engineering properties of the soils. The approximate location of the borings is shown on the Boring Location Plan, Figure 2. The field and laboratory data for this study and the preliminary study are presented in the Appendices. Field data is presented in Appendix A, and laboratory testing data is presented in Appendix B.

## 4.1 Geologic Setting

The project site is located on the southern portion of an elevated mesa that is bound by the Pacific Ocean to the south, Goleta slough to the north and east, and Devereaux slough to the west. The mesa is a gently undulatory surface, but is generally a flat lying marine terrace elevated 20 to 45 feet above the sea level. Tectonic uplift during the Pleistocene is believed to have been the cause of the elevated feature (Dibblee 1966). Stream erosion dissected the marine terrace to produce the present isolated mesa.

As encountered in the exploratory borings, the project site is underlain by miscellaneous man-made fills, terrace deposits (older alluvium), and Sisquoc Formation. Terrace deposits blanket a majority of the Main Campus to depths of up to approximately 15 feet. The Sisquoc Formation typically underlies the terrace deposits in the Main Campus area. The Sisquoc Formation is generally composed of massive to thin-bedded siltstone. A description of the materials encountered in our borings is presented in Section 4.3.

## 4.2 Fault Setting

We performed exploratory trenching and a fault evaluation at the site during our preliminary geotechnical investigation (K-C 1990). Faults located in the general vicinity of the UCSB campus are the More Ranch fault zone, the Campus fault and the offshore Goleta Point and Coal Oil Point faults. Faults within the More Ranch fault zone are the closest significant mapped faults to the project site. The South Branch of the More Ranch fault is mapped approximately 2,000 feet north of the site (Dibblee 1987), and the Campus fault is mapped approximately 600 feet east of the project site. Based on our preliminary investigation and review of geologic information for the site vicinity, it is our opinion that active or potentially active faults do not underlie the project site.

## 4.3 Soil Conditions

The description of soil conditions is based on visual classification of samples obtained from our March 1992 and from our previous March 1990 (K-C 1990) field explorations. Information from previous investigations performed for adjacent sites (LeRoy Crandall Associates 1962, 1964, 1967, 1976a, and 1976b) and site topography UCSB (1930 circa and 1950) were used to help characterize the depth and limits of the soils encountered. Relative densities and consistency of the soil were estimated from penetration resistances recorded in the borings. The soils encountered at the site generally consist of existing fill material and terrace deposits overlying Sisquoc Formation siltstone.

Existing fill material consisting of a mixture of sand, silt and clay was encountered to depths of approximately 2 to 6 feet over most of the building area, and to depths of approximately 10 to 13 feet along the west end of the site. The existing fill was not encountered in Borings 247B-3 and 247B-4, and likely pinches out near the eastern end of the site. The data that we reviewed indicates that the existing fill materials encountered at the west end of the site were likely placed in a gully that previously occupied this area (see Figure 2). Based on our comparison of UCSB (1930 circa and 1950) with Garner Land Surveying (1990) topography, we estimate that the existing fill could be up to approximately 20 feet deep near the center of the old gully. Laboratory test results for samples of the existing fill had dry densities ranging from approximately 83 to 123 pounds per cubic foot, and moisture contents ranging from approximately 3 to 37 percent. Existing fill materials were typically underlain by terrace deposits, with the exception of Boring 247B-7 where the existing fill was underlain by the Sisquoc Formation.

Terrace deposits were typically encountered below the existing fill materials. The depth to the terrace deposits ranged from just below the existing pavements at the east end of the site (Borings 247B-3 and 247B-4), to depths of approximately 13 feet at the west end of the site (Boring 247B-6). The base of the terrace deposits was typically encountered at depths of approximately 8 to 11 feet below the ground surface over most of the building area. The terrace deposits generally consist of medium to very dense silty to clayey sand and hard to very hard sandy silt. Laboratory tests performed on samples of the terrace deposits had dry densities ranging from approximately 93 to 116 pounds per cubic foot, and moisture contents ranging from approximately 3 to 19 percent. The terrace deposits were typically underlain by Sisquoc Formation.

Sisquoc Formation consisting of siltstone (classified predominantly as "elastic silt") was encountered below the existing fill and terrace deposits. The Sisquoc Formation extended to the maximum depth explored, approximately 53 feet below the ground surface in Boring 247-2 (K-C 1990). The Sisquoc Formation consists of a layer of firm to very hard weathered siltstone overlying very hard siltstone. The weathered siltstone typically has a light brown to gray color, and also is characterized as having higher compressibility and lower unconfined compressive strength than the underlying very hard siltstone. Atterberg limits tests performed on samples of the Sisquoc Formation had liquid limits ranging from 55 to 88 percent and a plasticity index ranging from 6 to 32 percent. Laboratory tests results for samples of the Sisquoc Formation had dry densities ranging from approximately 62 to 108 pounds per cubic foot, and moisture contents ranging from approximately 15 to 60 percent.

The borings for our 1990 and 1992 field exploration programs were performed using two different drill rigs. The drill rig used for our March 1992 program used an automatic trip hammer calibrated for a 30-inch drop to perform standard penetration tests (SPT) and to obtain drive samples. The automatic trip hammer operated above ground and delivered blows to the top of the drill rods. The drill rig used for our March 1990 program used a down-hole type hammer operating on a wire-line system to perform SPT and to obtain drive samples. At depth, the down-hole hammer typically delivered blows directly behind the sampler. We observed differences in the blow counts for samples taken at similar elevations between the 1990 and 1992 borings. The differences in the blow counts are likely attributed to the differences in the hammer systems, the length of drill rod used during sampling, and variations in the soil conditions between points of exploration.

### 4.4 Groundwater Conditions

Except for zones of seepage groundwater was generally not encountered in our borings. Groundwater seepage was encountered during our March 1990 field exploration at depths of approximately 3 to 4 feet in Boring 247-1 and in the exploratory trench. The observed seepage likely occurred as a result of groundwater perching on the contact between the existing fill and the underlying terrace deposits. Some sloughing of the trench sidewalls occurred in the exploratory trench, and was likely aggravated by areas of wet soils and/or seepage.

Previous explorations performed for the Speech and Drama Building (LeRoy Crandall & Associates 1962 and 1967) and for the Campus Events Center (LeRoy Crandall & Associates 1976) indicate that relatively "minor" seepage was encountered along seams within the Sisquoc Formation. The seepage occurred at depths ranging from 9 and 35 feet below the ground surface. An investigation performed for the Arts Building (L.T. Evans 1956), reported that groundwater was not encountered in borings.

Variations in the groundwater level and rate of seepage can occur as a result of variations in irrigation schedules, rainfall, and runoff.

### 4.5 Liquefaction Conditions

We have reviewed the liquefaction potential of the soils encountered during this evaluation. In general, potentially liquefiable soils typically consist of relatively loose to medium dense, saturated sandy soils. Our review is based on the results of our field exploration program, laboratory tests performed on selected samples, and the local and regional geologic settings. We have characterized the site as containing three units. These units are existing fill, terrace deposits, and Sisquoc Formation. In general the units consist of variable existing fills, medium dense to very dense terrace deposits, and hard to very hard Sisquoc Formation. We have recommended that the existing fill materials be removed and replaced with compacted fill during site grading. In our opinion the compacted fill would generally have a low potential for liquefaction. Based on our characterization of terrace deposits and Sisquoc Formation, and based on the relatively deep depth to groundwater expected for the site (greater than 50 feet), in our opinion these soil units also have a low potential for liquefaction.

### 4.6 Slope Stability

Our evaluation of slope stability is based on our review of the site geology and proximity of the site relative to mapped landslides and to relatively steep slopes. In general, the site contains relatively flat grades ranging from elevation 45 feet at the north end of the site to elevation 40 feet at the south end of the site. To our knowledge the site is not in an area of mapped landslides or of known slope instability. Based on our review of the existing site grades and the geologic conditions at the site, in our opinion there is generally a low potential for landsliding within the proposed building areas. Our recommendations for temporary and graded slopes are presented in Section 5.

## 5. CONCLUSIONS AND RECOMMENDATIONS

Our conclusions and recommendations are based on the exploration and testing programs, and on our understanding of the project. Our recommendations for site preparation and grading, and for foundation support for the building are presented below.

## 5.1 Site Development and Grading - General

Fill placement and grading operations should be performed according to the grading recommendations of this report. Temporary slopes should be braced or sloped according to the requirements of (Cal) OSHA. The contractor should be responsible for job site safety, and for the design of temporary slopes or shoring. As guidance for design, we recommend that temporary construction slopes be constructed at 1:1 or flatter. Finish cut or fill slopes should be constructed at 2:1 or flatter. We recommend that, unless otherwise noted, the fill and backfill materials be compacted to at least 95 percent relative compaction as determined by ASTM Test Method D1557.

### *5.1.1 Clearing and Grubbing*

Existing fills, soil containing debris, organics, pavement, or other unsuitable materials should be excavated and removed prior to commencing grading operations. Demolition areas should be cleared of old foundations, slabs, abandoned utilities, and soils disturbed during the demolition process. Depressions or disturbed areas left from the removal of such material should be replaced with compacted fill. We performed an exploratory trench as part of our K-C (1990) exploration program (see Figure 2). We recommend that the trench backfill be removed and be replaced with sand cement slurry where the trench crosses building area. The trench was excavated to depths of approximately 7 to 14 feet using a backhoe with a 30-inch wide bucket. The limits of the slurry used to replace trench backfill should extend at least 5 feet outside the building area.

We expect that within the general building areas existing fill materials will typically be encountered to depths of approximately 2 to 6 feet. Existing fill materials are expected to be encountered to depths of up to approximately 20 feet in a gully that was filled near the west end of the single-story element (See Section 4.3 for discussion). Based on our review of topographic plans, we expect that the depth of the existing fill likely ranges from approximately 4 to 6 feet over most of the building area to approximately 20 feet near the west end of the proposed single-story element. The project specifications should provide for variations in the actual thickness and areal extent of the existing fill materials. The limits and depths for removal of existing fill materials should be evaluated during grading.

### *5.1.2 Materials*

Materials to be used as fill in building or pavement areas should consist of on-site soils having a low to medium potential for expansion or imported sandy material. Based on our review of the site conditions, the terrace deposits generally have a low to medium potential for expansion within the expected depths of grading. During grading operations, the soils should be checked for organic content and expansion potential. We expect that the excavated terrace deposits and existing fills, free of organic and other deleterious materials, can be used as compacted fill in the proposed building and pavement areas. The Sisquoc Formation encountered below the terrace deposits generally consists of siltstone (elastic silt). We expect that the siltstone will be encountered within the drilled pier and basement excavations. We recommend that the siltstone not be used as compacted fill in building or pavement areas, or as backfill material for retaining walls.

Backfill material for retaining walls should consist of sandy soils having a sand equivalent (SE) of at least 20. We do not expect that the excavated on-site soils (existing fill, terrace deposits, or Sisquoc Formation) will have the minimum recommended sand equivalent for retaining wall backfill.

Imported material, if used, should be reviewed before being brought to the site. Imported soils should consist of sandy material having a low potential for expansion (less than 3 percent swell under a surcharge of 100 pounds per square foot).

### *5.1.3 Fill Placement*

Fill and backfill materials should be placed in layers that can be compacted with the equipment being used. Each layer should be spread evenly and should be thoroughly blade-mixed during the spreading to provide relative uniformity of material within each layer.

When the moisture content of the fill material is below that sufficient to achieve the recommended compaction, water should be added to the fill. While water is being added, the soil should be bladed and mixed to provide a relatively uniform moisture content throughout the material. When the moisture content of the fill material is excessive, the fill material should be aerated by blading or other methods. Fill placed in pavement areas should be compacted at a moisture content near the optimum. Fill to be placed in building areas should be compacted at approximately 2 percent above the optimum moisture content. After each layer has been conditioned and placed, it should be spread in lifts no thicker than approximately 8 inches and compacted.

## 5.2 Pavement Areas

We understand that asphalt pavements are planned for the parking lot as part of the site improvements. The pavements will generally be used to provide parking for campus students and personnel (passenger cars and pick-up truck sized vehicles).

### *5.2.1 Grading for Pavement Areas*

We recommend that in areas to receive pavement that the existing soils be removed to a depth of at least 12 inches below the existing ground surface, or 6 inches below the bottom of the pavement section, whichever is deeper. The bottom of the excavation should then be cross-scarified and bladed to a depth of at least 6 inches, and compacted in-place to at least 95 percent relative compaction. Compacted fill can then be placed to finished grade according to Section 5.1. The upper 1 foot of the subgrade material in pavement areas should be compacted to at least 95 percent relative compaction.

### *5.2.2 Pavement Sections*

Our pavement section recommendations are based on an assumed R-value of at least 20 for the soil conditions encountered, and on a traffic index (TI) of 4.0. We recommend that the pavement consist of a minimum section of 0.25 feet of asphalt concrete over 0.35 feet of aggregate base. The pavement section should be placed on a subgrade prepared in accordance with Section 5.2.1. Our pavement section recommendations are based on Caltrans pavement design procedures. Pavement materials should conform to Sections 26 and 39 of the Caltrans Standard Specifications (or equivalent) for aggregate base and asphalt concrete, respectively.

We recommend that the subgrade materials be reviewed at the time of construction with regard to the as-graded conditions. Based on our observations and tests, we can provide additional pavement section recommendations at that time, if needed. Where lower R-value material or wet soils are encountered in subgrade areas, thicker pavement sections may be needed. The project specifications should provide for variations in the subgrade conditions, and resulting increased thickness in the pavement section.

## 5.3 Grading for Building Areas

In our opinion the single-story element can be supported on shallow foundations. To provide relatively uniform support, we recommend that shallow foundations and floor slabs be supported on a mat of compacted fill. Prior to commencing grading for building areas, clearing and grubbing should be performed according to Section 5.1.1. As recommended in Section 5.1.1, where structures are to be supported on shallow foundations, existing fill materials should be removed and replaced with compacted fill.

We recommend that in building areas the existing soils be excavated to a depth of at least at least 4 feet below the existing ground surface, or 1 foot below the bottom of floor slabs, whichever is deeper. Where shallow foundations are used for support of structures, the excavation should also extend at least 3 feet below the bottom of footing. We recommend that the excavation extend over the entire building footprint (including areas containing slab-on-grade) and at least 5 feet beyond the building footprint. The bottom of the excavations should then be scarified to a depth of at least 6 inches and compacted in-place to at least 95 percent relative compaction. Fill should then be placed in accordance with Section 5.1 to complete the building pads.

Existing fill materials were encountered below our recommended minimum depths of removal at the west end of the proposed single-story element. The excavation in this portion of the building area should be deepened to remove the existing fill materials. In areas where the deeper excavation is needed, the existing fills should be removed to at least 5 feet beyond the building footprint, or beyond a 1:2 (horizontal to vertical) line projected downward from the building footprint, whichever results in the wider excavation. We expect that the excavation will result in differences in fill thickness across the single-story building area. As a result of the differences in fill thickness, we estimate that some differential settlement of the fill could occur. To provide a relatively uniform transition between the east and west ends of the fill, we recommend that the bottom of the excavation be sloped to 2:1 or flatter between the areas having a differential fill thickness. To reduce the potential for post-construction settlement, we recommend that fill placed in building areas be compacted approximately 2 percent above the optimum moisture content. A summary of our grading recommendations for differential fill conditions in the single story element area is given in Figure 3.

## 5.4 Shallow Foundations

In our opinion the single-story element can be supported on conventional spread footings bearing on compacted fill. Spread footings should be designed to bear on a minimum of 3 feet of compacted fill prepared in accordance with Section 5.3.

### *5.4.1 Spread Footings*

We recommend that for foundations founded in compacted fill a maximum allowable bearing pressure of 2,000 pounds per square foot be used for continuous strip footing and isolated pad footing design. Footings should be embedded at least 2 feet below the lowest adjacent grade or finished slab elevation, whichever is deeper. Where foundations are to be constructed adjacent to other footings or existing retaining walls, footings should be embedded below a 1:1 line projected upward from the edge of adjacent footings or the base of the retaining wall. Continuous footings should be designed with a width of at least 12 inches. Isolated pad footings should be designed with a least dimension of 24 inches. The maximum allowable bearing pressure can be increased by one-third when considering short-term wind or seismic loads.

We estimate that foundation settlements under static loading conditions, when placed as recommended, should generally be on the order of 1 to 1-1/2 inch total, and 3/4 inch differential between pad footings or along continuous footing elements.

The Structural Engineer responsible for foundation design should design the reinforcing of foundations based on loading conditions. Based on the expected soil conditions, we recommend that as a minimum at least two Number 5 reinforcing bars be placed in continuous footings, one near the top and one near the bottom. Soils should be tested for expansion potential at the time of grading. If the soils are more expansive than anticipated, additional reinforcement may be needed.

### *5.4.2 Resistance to Lateral Loads*

Resistance to lateral loading can be provided by sliding friction acting on the base of spread footings combined with passive pressure acting on the sides of foundations. We recommend a coefficient of friction of 0.3 for resistance to lateral forces bearing in compacted fill. For resistance to lateral load, we recommend using a value of 220 pounds per cubic foot, equivalent fluid weight, for passive resistance acting on the sides of foundation stems, with concrete placed neat against compacted materials. Passive resistance should not be used for the upper one foot of soil that is not constrained at the ground surface by slab-on-grade or pavement. A one-third increase in the passive value can be used when considering short-term wind or seismic loads.

## 5.5 Drilled Cast-in-Place Piers

In our opinion the four- and six-story elements of the building can be supported on drilled cast-in-place pier foundations. The piers can be designed as straight shafted friction piers, end bearing piers, or as combined friction and end bearing piers.

We recommend that drilled piers have a minimum embedment of at least 20 feet into relatively hard siltstone. As guidance for estimating the depth of drilled piers, the top of the relatively hard siltstone can be assumed to be at elevation 36 feet. The actual depth of the piers should be evaluated during excavation for the piers.

We recommend that piers be designed with a spacing of at least 3 pier diameters. If needed, we can provide additional recommendations for piers spaced closer than 3 diameters.

### *5.5.1 Friction Piers*

We recommend that friction piers be designed with a minimum diameter of 2 feet. We recommend using a maximum allowable frictional resistance of 1,000 pounds per foot square foot for drilled cast-in-place piers founded in relatively hard Sisquoc Formation. In our opinion drilled piers can likely be excavated without the use of drilling fluids. If the drilling fluids are used, we should review the allowable frictional resistance and provide additional recommendations, if needed. No frictional resistance should be used for portions of the pier above the siltstone, for the top five feet of the pier, or for the bottom one diameter of the pier (see Figure 4). A one-third increase in the frictional resistance can be used when considering short-term wind or seismic loads. The uplift capacity of drilled cast-in-place piers can be estimated as one-half of the frictional resistance plus the dead weight of the pier.

We estimate that foundation settlements, when placed as recommended, will generally be on the order of 1/2 inch total, and 1/4 inch differential between piers.

### *5.5.2 End Bearing Piers*

We recommend that end bearing piers be designed using a minimum diameter of four feet to provide room for cleaning the bottom of the pier and downhole observation, if needed. Drilled piers can be designed for combined friction and end bearing provided the bottom of the piers are cleaned prior to placing concrete. The base of the pier can be expanded to form a belled pier to provide additional end bearing capacity. If belled piers are designed for combined friction and end bearing, the bottom one diameter of the pier stem above the bell should not be included for providing friction resistance (see Figure 4).

We recommend using a maximum allowable end bearing pressure of 8,000 pounds per foot square foot for drilled piers founded in relatively hard Sisquoc Formation siltstone. A one-third increase in the end bearing pressure can be used when considering short-term wind or seismic loads. The uplift capacity of belled piers can be estimated as one-half the frictional resistance plus the dead weight of the pier.

We estimate that foundation settlements, when placed as recommended, will generally be on the order of 1/2 inch total, and 1/4 inch differential between piers.

### *5.5.3 Resistance to Lateral Loads*

We estimated the lateral load capacity of drilled cast-in-place piers using the computer program PILED/G to analyze a soil resistance-pile deflection model (p-y analysis). Our analysis used a minimum 28-day compressive strength for concrete of 2,000 pounds per square inch. We have estimated the piles lateral load capacity and maximum moment for an equivalent 1/4-inch horizontal movement. Our estimates are based on pile deflections at the ground line. No factor of safety has been applied to the estimated loads. The depth of fixity was estimated as the depth corresponding to approximately zero lateral deflection. Our estimated lateral capacities, maximum moment, and depth of fixity for drilled cast-in-place piers of various diameters are as follows:

| Pier Diameter | Head Conditions | Estimated Maximum Lateral Load (kips) | Estimated Maximum Moment (kip-feet) | Estimated Depth of Fixity (feet) |
|---|---|---|---|---|
| 24-inch | Free-Head | 7 | 39 | 13 |
| | Fixed-Head | 20 | 114 | 15 |
| 30-inch | Free-Head | 12 | 75 | 14 |
| | Fixed Head | 34 | 219 | 17 |
| 36-inch | Free-Head | 18 | 124 | 16 |
| | Fixed-Head | 52 | 370 | 19 |

| | | | | |
|---|---|---|---|---|
| 42-inch | Free-Head | 24 | 179 | 17 |
| | Fixed-Head | 72 | 556 | 21* |
| 48-inch | Free-Head | 32 | 258 | 19* |
| | Fixed-Head | 92 | 771 | 22* |

* Point of Inflection

Resistance to lateral loads can also be provided by passive pressure acting on the sides of the basement walls, piers caps or grade beams. Passive resistance can be provided according to our recommendations presented in Section 5.4.2.

*5.5.4 Pier Construction*

Prior to placing concrete, loose and disturbed materials should removed from the bottom of pier excavations. In general, the bottoms of friction piers can typically be prepared using augering equipment. End bearing piers can be used to provide additional capacity, and should be cleaned more carefully, perhaps using hand excavation techniques or "special" cleaning augers or buckets. We expect that at least the upper approximately 10 to 12 feet of the pier excavations will need to be cased to support the excavation through the existing fill and terrace deposits. The project specifications should provide for shoring or casing as needed to allow for cleaning and observation of the excavations, and for the placement of concrete.

Concrete should be poured neat against relatively undisturbed soil or siltstone. The concrete for piers should be placed through down-hole funnels, or similar provisions and in such a manner that the concrete does not strike the side of the pier shaft. Concrete should be placed the day the drilling is completed. A pier excavation should not be allowed to stand open overnight. In general, a minimum of 24 hours should be allowed between placing concrete in one pier shaft and the drilling of nearby piers shafts within four piers diameters, center to center, or within three bell diameters, edge to edge.

A representative of K-C should be on-site during pier construction to observe that the pier excavation extends at least 20 feet into relatively hard siltstone, and to review the bearing materials. All applicable safety requirements, including the use of casing if necessary, is the contractors responsibility. The project specifications should provide for variations in the depth of the pier excavations, and for expected variations in the depth of the Sisquoc Formation siltstone.

## 5.6 Slab-on-Grade Construction

Concrete slab-on-grade in building areas should be supported on compacted fill prepared in accordance with Section 5.3. Outside of building and pavement areas, the upper 12 inches of the subgrade in areas to receive concrete slab-on-grade should be compacted to at least 90 percent relative compaction. We recommend that concrete slabs without vehicular traffic be at least 4 inches thick. Based on the expected soil conditions, we recommend that building slabs be reinforced with at least Number 3 reinforcing bars placed 24 inches on center both ways, at mid-depth of concrete slabs. Additional reinforcing should be provided as recommended by the Structural Engineer.

Samples of the subgrade soils in slab-on-grade areas should be evaluated for expansion potential at the time of grading. This will allow for the soil conditions to be reviewed at that time. Additional reinforcement of the slab can then be provided, if needed.

We recommend that in the interior of buildings a vapor barrier be placed below concrete slabs-on-grade not subjected to vehicular traffic. The vapor barrier should consist of 2 inches of clean, well-graded sand, overlain by a visqueen membrane and an additional 2 inches of sand. We recommend that basement floor slabs be underlain by at least 12 inches of permeable material. Permeable material can consist of Class 2 permeable as specified in Section 68 of the Caltrans specifications. Drainage should be provided within the permeable layer to remove infiltrating water and to reduce the potential for uplift forces acting on the base of the slab.

Based on relatively light traffic loading conditions (passenger cars and pick-up trucks), we recommend that concrete pavements subject to vehicle traffic be designed with a minimum thickness of 6 inches. Portland cement concrete used for pavements should have a compressive strength of at least 4,000 pounds per square inch at 28 days. Concrete pavements should be cast on a subgrade prepared in accordance with Grading for Pavements Areas, Section 5.2.1, and should be underlain with at least 4 inches of Class 2 Aggregate Base (Caltrans) compacted to at least 95 percent relative compaction.

## 5.7 Retaining Walls

Retaining wall backfill material placed inside the building footprint should be compacted to at least 95 percent relative compaction. In areas where the backfill will not support foundations, floor slabs, or pavements, the backfill material should be compacted to at least 90 percent relative compaction. Equivalent fluid weights presented below are for conditions with the backfill material placed level behind retaining walls. Backfill material for retaining walls should consist of sandy soils having a sand equivalent of at least 20. We recommend the following lateral earth pressures (equivalent fluid weights) be used for the design of retaining walls:

| Wall Loading Condition | Lateral Earth Pressure Condition | Equivalent Fluid Pressure (pcf) |
|---|---|---|
| Free Standing | Active | 40 |
| Constrained | At-rest | 65 |

For considering seismic loads, the increase in the lateral force can be approximated as 3/4 of the peak horizontal ground acceleration times the lateral earth pressure. The seismic increase in force should be considered to act 0.6 times the height of the wall. We understand that ground motion data is being provided for this project by another firm.

The tabulated values are based on a soil unit weight of 125 pounds per cubic foot (pcf). The values do not provide for hydrostatic forces (for example, standing water in the backfill materials), and do not provide for surcharge conditions resulting from vehicle traffic or heavy compaction equipment. Foundation loads should bear behind a 1:1 line projected upward from the base of the wall. To help reduce the potential for water accumulating in the backfill, we recommend that drainage be provided behind retaining walls. If conditions such as surcharge resulting from footings, or hydrostatic forces, are to be expected, K-C should be advised so that we can provide additional recommendations as they are needed.

Permeable filter materials for drainage behind walls should consist of prefabricated drainage panels, such as Miradrain, or Class 2 permeable material, as specified in Section 68 of the California Standard Specifications (or equivalent). As an alternative, Class I permeable or open graded gravel can be used, if the materials are encased in a needle-punched, nonwoven geotextile with an apparent opening size of no more than 0.2 millimeters (or the U.S. Number 70 Standard Sieve opening).

## 5.8 Seismic Considerations

Based on the latest edition of the Uniform Building Code (ICBO 1988) with State of California 1989 amendments, the site is located within Seismic Zone 4. Structures should be designed to the minimum standards for Seismic Zone 4. For use with the equivalent static force method, we recommend that the proposed structures be designed using a site coefficient of 1.2 for stiff soil conditions (Type $S_2$).

## 5.9 Corrosion

The results of pH, soluble chloride, soluble sulfate, and resistivity tests are presented in Appendix B. The design of subsurface utilities and concrete structures should consider the results of corrosivity tests as they apply to the proposed construction.

## 5.10 Utility Trenches

Excavation of utility trenches can likely be accomplished with a backhoe. Trenches over 5 feet in depth should be braced or sloped in accordance with the requirements of (Cal) OSHA. Utility trench backfill should be governed by the provisions of this report relating to minimum compaction recommendations. In general, backfill for service lines extending inside of the property should be compacted to at least 90 percent relative compaction. Where utility trench backfill is placed in pavement or building areas, backfill should be compacted to at least 95 percent relative compaction.

## 5.11 Drainage Control

Site grading should be such that positive drainage away from the structure and pavements is provided, and so that water will not pond near the structures or run over slopes. We recommend that roof gutters or drainage systems be installed to collect roof water and to carry them away from the foundations. Surface drainage swales should be positioned to allow for rapid removal of rain and irrigation water away from the foundations.

## 5.12 Additional Services

The design and construction phases of the project involve a continuation of the geotechnical evaluation and the observations of site conditions described in this report. The responsible geotechnical engineer must, in order to provide this continued service, render interpretations, respond to additional information and observe the contractor's implementation of design.

### *5.12.1 Plan Review*

We recommend that K-C provide a general review of the grading, improvement, and foundation plans. The purpose of this review is to assess general compliance with the earthwork and foundation recommendations of this report, and to confirm that the recommendations given in this report are incorporated in the project design plans and specifications.

### *5.12.2 Observation and Testing*

We further recommend that K-C provide services during the grading, excavation, and foundation phases of the work. Foundation and drilled pier excavations should be checked at the time of construction. The purpose of these services is to observe compliance with the initial development concept, the specifications, and the geotechnical recommendations. The observation and testing services will allow for changes in the recommendations in the event that subsurface conditions differ from those anticipated prior to construction.

END OF TEXT

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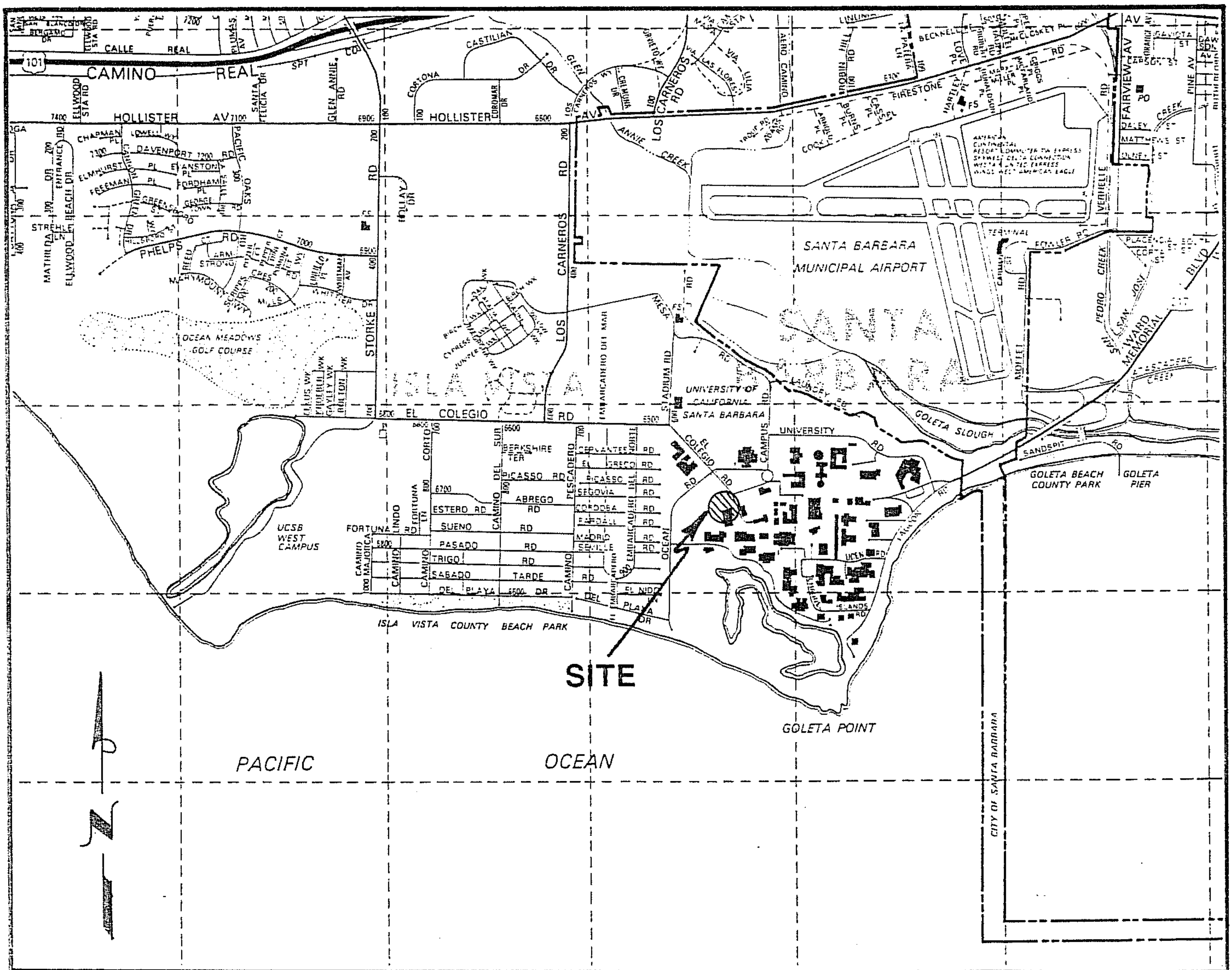


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# VICINITY MAP

Humanities and Social Sciences Building
University of California
Santa Barbara, California

File No. KC-1610-01

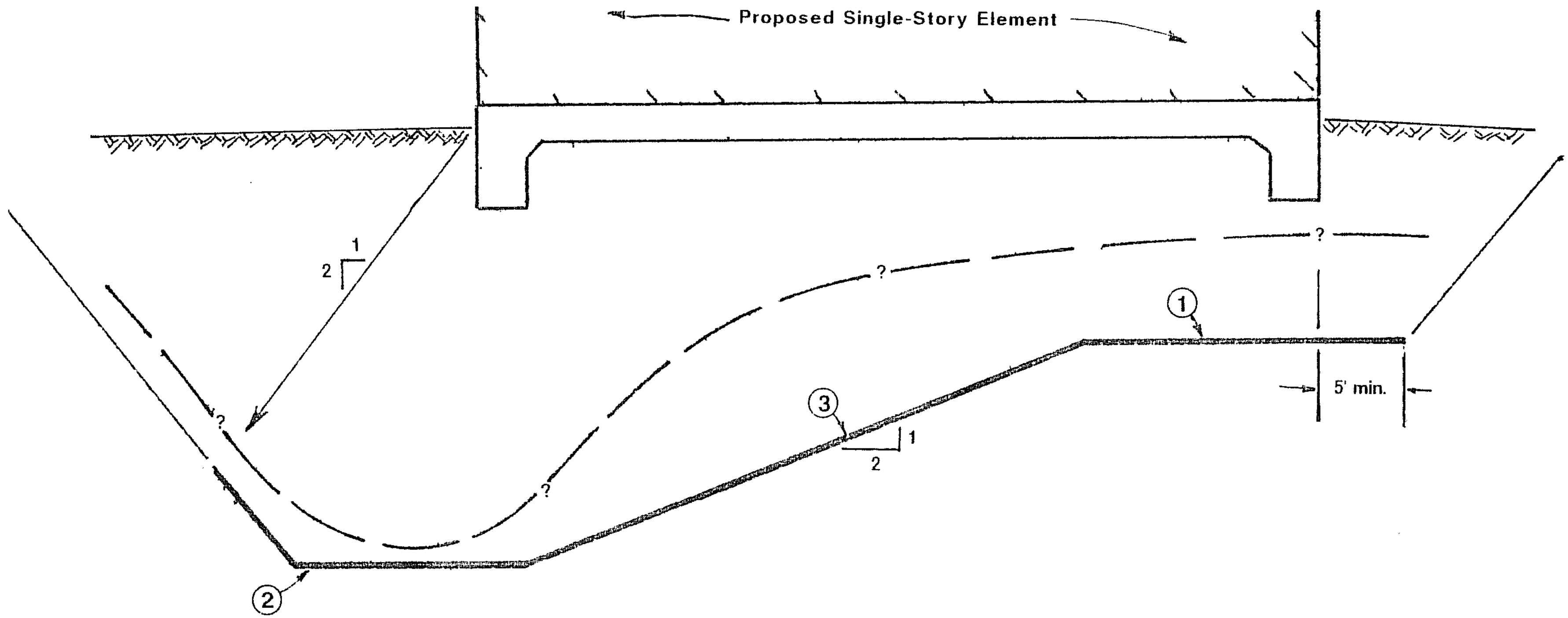
**Figure 1**

K-C GEOTECHNICAL ASSOCIATES

File 1610-01

By KJ Date 5/92

By JB Date 4/22/92 File KC-1610-01




## Notes

1. Within the building area, the building perimeter plus an additional 5 feet, remove existing soils to at least 4 feet below the existing ground surface, or to at least 3 feet below the bottom of footing, whichever is deeper.

2. Deepen excavation below minimum recommended depths to remove existing fill material within the building area, at least 5 feet byond the building footprint or beyond a 1:2 line project downward from the building perimeter, whichever results in the greater excavation.

3. Slope bottom of excavation to 2:1 or flatter between areas with differential fill thickness.

## Explanation

—?— Limits of existing fill

━━ Limits of excavation

—— Construction Slope

**Schematic Diagram**
**Drawing not to scale**

# GRADING FOR DIFFERENTIAL FILL THICKNESS

Humanities and Social Sciences Building
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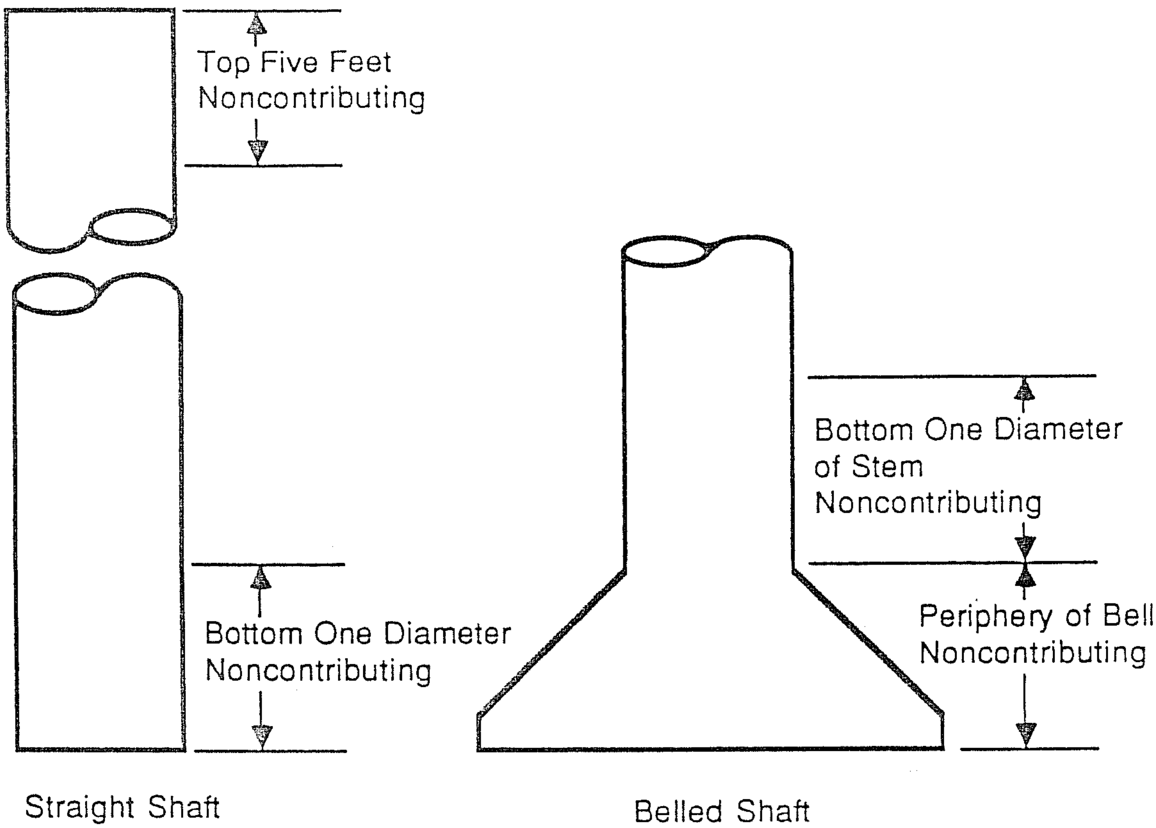
Santa Barbara, California

File No. KC-1610-01

**Figure 3**

K-C GEOTECHNICAL ASSOCIATES

File 1610-01

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**FRICTIONAL RESISTANCE FOR DRILLED PIER FOUNDATIONS**

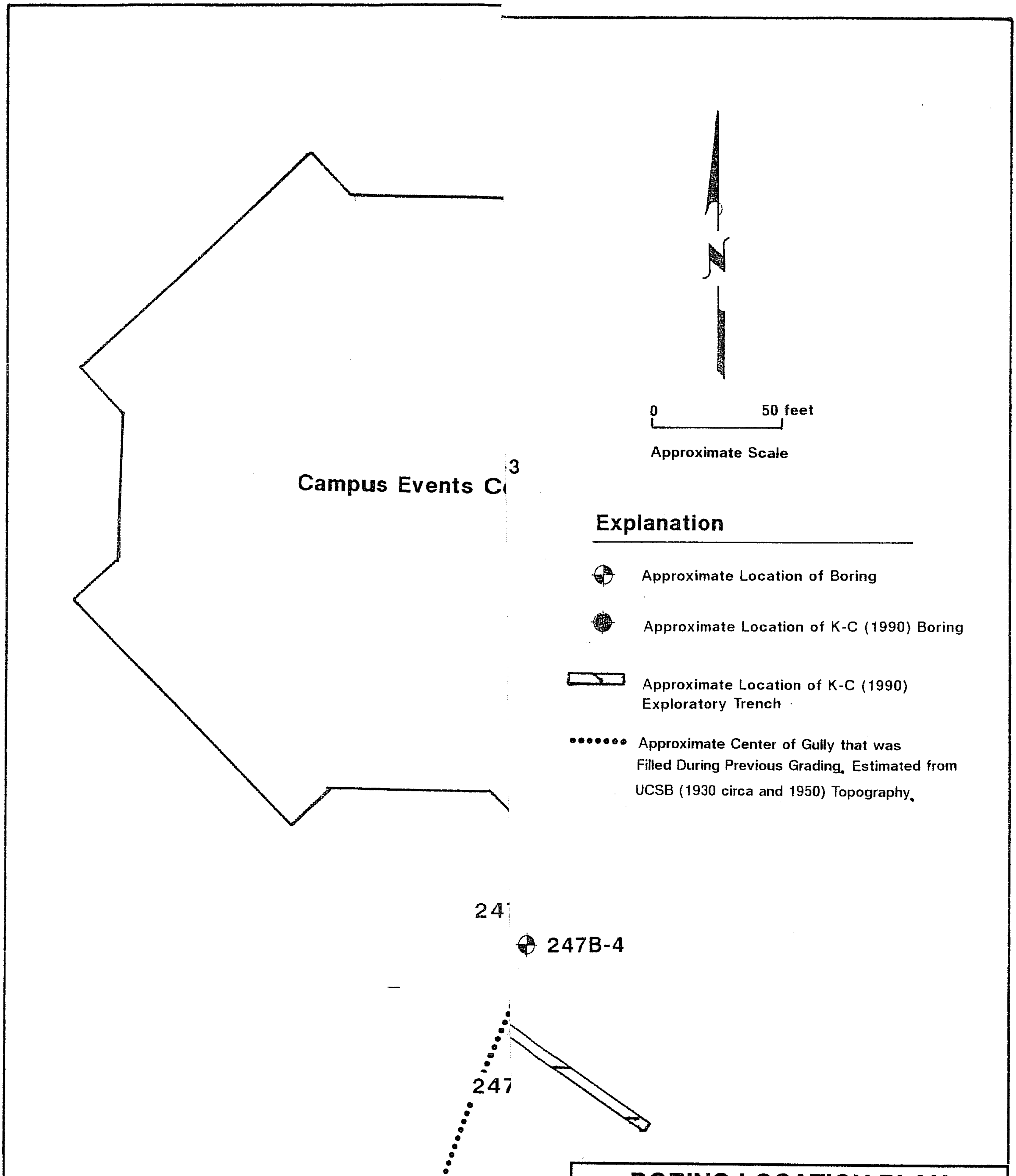
Humanities and Social Sciences Building
University of California
Santa Barbara, California

File No. KC-1610-01

**Figure 4**

K-C GEOTECHNICAL ASSOCIATES

By JB Date 4/20/92




# BORING LOCATION PLAN

Humanities and Social Sciences Building
University of California
Santa Barbara, California

File No. KC-1610-01

**Figure 2**

## APPENDIX A

## FIELD EXPLORATION

### A.1 General

The field exploration for this Geotechnical Engineering Report consisted of excavating seven exploratory borings on March 4 and 5, 1992. This field exploration program was conducted according to our proposal dated January 17, 1992. The field exploration for the Preliminary Geotechnical Engineering Report was performed in March 1990, and consisted of excavating two exploratory borings and one exploratory trench. Boring logs from the preliminary investigation (K-C 1990) are attached with this appendix.

### A.2 Borings

The drilling subcontractor on the project was S/G Testing Laboratory of Lompoc, California. The drilling subcontractor used a truck-mounted CME 75 drill rig to advance the borings. The borings were drilled using hollow stem auger, and an automatic trip hammer for sampling. The drilling was performed under the observation of a senior staff geologist of K-C. The senior staff geologist prepared logs of the soil conditions and obtained soil samples for laboratory observation and testing. Seven, 8-inch-diameter hollow stem auger borings were drilled to depths of approximately 21 feet below the existing ground surface. The soils from both sets of borings were classified in the field in accordance with the Unified Soil Classification System (see Figure A-1). The approximate locations of the exploratory borings are shown on the Boring Location Plan, Figure 2. The borings were located approximately in the field by taping from buildings and landmarks shown on the Garner Topographic Plan, dated . The borings were backfilled with the excavated cuttings. The backfill was tamped with the drill stem. The log of borings are attached as Borings 247B-1 through 247B-7.

As part of our K-C (1990) preliminary investigation, 8-inch-diameter borings were excavated at the project site. The drilling subcontractor for the preliminary investigation was Valley Well Drilling of Ventura, California. The drilling subcontractor used a truck-mounted Georex T-500 drill rig to advance the borings. The borings were drilled using hollow stem auger, and a safety hammer operated on a wire-line system for sampling. The drilling was performed under the observation of a senior staff engineer of K-C, who prepared logs of the soil conditions and obtained soil samples for laboratory observation and testing. Two, 8-inch-diameter hollow stem borings were drilled to depths ranging from approximately 42 to 53 feet below the existing ground surface. The log of borings are attached as Boring 247-1 and 247-2.

Drive samples were obtained from the borings using modified California and standard penetration split spoon samplers. The modified California sampler has a 3-inch outside diameter and a 2.37-inch inside diameter; it contains 1-inch-high fiber glass liners. The sampler was generally driven 12 to 18 inches into the material at the bottom of the hole. The sampler was driven by dropping a 140-pound hammer 30 inches. The number of blows needed to drive the sampler the last 12 inches into the soils is shown on the Log of Borings. Recovered samples were sealed in transport containers and returned to the laboratory for further classification and testing.

Standard penetration tests (SPT) were performed in the borings. The SPT provides an indication of the relative density and consistency of the soil, and a sample for visual observation. Soil samples obtained from the SPT were retained for further laboratory observation and testing. The SPT split spoon was driven approximately 18 inches by dropping a 140-pound hammer 30 inches. The number of blows required to drive the split spoon to three 6-inch increments was recorded. The number of blows per foot (SPT N Value) is equal to the sum of the last two 6-inch increments.

Bulk samples were collected from cuttings obtained from the borings. The bulk samples were selected for classification and testing purposes and may represent a mixture of soils within the noted depths. Recovered samples were placed in transport containers and returned to the laboratory for further classification and testing.

Logs of the borings, showing the depths and descriptions of soils encountered, geologic structure where applicable, vertical locations of samples, N values, and results of density and moisture content tests, are presented in this Appendix. A legend of symbols typically used on the Log of Boring is given in Figure A-2. The logs represent the interpretation of field logs and tests, interpolation between samples, and the results of laboratory observation and tests. The stratification lines are approximate boundaries between soil types; the transitions can be gradual.

| Major Divisions | | | Graphic Symbol | Letter Symbol | Typical Descriptions |
|---|---|---|---|---|---|
| Coarse Grained Soils<br><br>More than 50% of material retained on No. 200 sieve | Gravel and Gravelly Soils<br><br>More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels<br><br>(Little or no fines) | | GW | Well graded gravels, gravel-sand mixtures, little or no fines |
| | | | | GP | Poorly graded gravels, gravel-sand mixtures, little or no fines |
| | | Gravels with Fines<br><br>(Appreciable amount of fines) | | GM | Silty gravels, gravel-sand-silt mixtures |
| | | | | GC | Clayey gravels, gravel-sand-clay mixtures |
| | Sand and Sandy Soils<br><br>50% or more of coarse fraction passing No. 4 sieve | Clean Sands<br><br>(Little or no fines) | | SW | Well graded sands, gravelly sands, little or no fines |
| | | | | SP | Poorly graded sands, gravelly sands, little or no fines |
| | | Sands with Fines<br><br>(Appreciable amount of fines) | | SM | Silty sands, sand-silt mixtures |
| | | | | SC | Clayey sands, sand-clay mixtures |
| Fine Grained Soils<br><br>More than 50% of material passing No. 200 sieve | Silts and Clays | Liquid limit less than 50 | | ML | Inorganic silts, rock flour or clayey silt with low plasticity |
| | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | | | | OL | Organic silts and clayey silts of low plasticity |
| | Silts and Clays | Liquid limit greater than 50 | | MH | Inorganic plastic silts, micaceous or diatamaceous silts |
| | | | | CH | Inorganic clays of high plasticity, fat clays |
| | | | | OH | Organic clays of medium to high plasticity, organic silty clays |
| Highly Organic Soils | | | | PT | Peat, humus, swamp soils with high organic contents, fiberous |

NOTE: Dual symbols are used to indicate borderline soil classifications.

| | | |
|---|---|---|
| Humanities and Scocial Sciences Building | UNIFIED SOIL CLASSIFICATION SYSTEM | File No. KC-1610-01<br>Figure A-1 |

K-C GEOTECHNICAL ASSOCIATES

# LEGEND FOR SYMBOLS COMMONLY USED ON BORING LOGS

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS GRAPHIC LOG | SYMBOLS USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS LIQUID LIMIT (%) | ATTERBERG LIMITS PLASTIC INDEX (%) | TORVANE (TSF) | POCKET PENE-TROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-1 | -- | | | Shelby Tube Sampler Pushed into Soils Using Drill Rig Hydraulics | 101.3 | 12.4 | | | | |
| | | 1-2 | 35 | | | Modified California Sampler Driven Using a 140-pound Hammer Dropping 30 inches | 106.5 | 25.6 | 54 | 28 | | |
| 5 | | 1A | | | | Loose Bulk Sample Obtained from Soil Cuttings | | | | | | |
| | | | | | | Water Level First Encountered | | | | | | |
| | | NR | 12 | | | Standard Penetration Test (SPT) Driven Using a 140-pound Hammer Dropping 30 inches | | | | NP | | |
| 10 | | | | | | Water Level After Drilling | | | | | | |

NR — No Recovery

NP — Non-Plastic

## NOTES:

1. DATA ON THESE LOGS IS APPROXIMATE BECAUSE OF POSSIBLE DEVIATION FROM THE DIRECTION OF DRILLING, INCOMPLETE RECOVERY OF SAMPLES, AND POSSIBLE DISTURBANCE TO THE SOIL DURING SAMPLING.
2. THESE LOGS DESCRIBE CONDITIONS ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES.
3. BORINGS WERE LOGGED IN SUCH A WAY AS TO PRIMARILY PROVIDE DATA FOR DESIGN PURPOSES AND NOT NECESSARILY FOR PURPOSES OF SPECIFIC CONSTRUCTORS.
4. SOIL CLASSIFICATIONS SHOWN ON THE LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.
5. THE STRATIFICATION LINES INDICATE THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THE TRANSITIONS MAY BE GRADUAL.

| Hamanities and Social Sciences Building | LEGEND FOR BORING LOG SYMBOLS | File No. KC-1610-01<br>Figure A-2 |
|---|---|---|

K-C GEOTECHNICAL ASSOCIATES

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N7195-E4985
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 45.0
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2-1/2 inches asphalt pavement | | | | | | |
| | | | | | | 6 inches aggregate base | | | | | | |
| | | 1-1 | 34 | | CL | Sandy CLAY, hard, gray to dark brown, moist<br>- Fill - | 122.5 | 11.6 | | | | 4.5+ |
| | | 1-2<br>1A | 55 | | SM | Silty SAND, dense, gray to tan, dry | 107.9 | 7.3 | | | | |
| 5 | | | | | | - Terrace Deposit - | | | | | | |
| | | 1-3 | 92 | | | | 107.9 | 29.1 | | | | 4.5+ |
| | | | | | MH | "Elastic SILT," very hard, olive gray, moist, weathered siltstone | | | | | | |
| 10 | | | | | | - Sisquoc Formation - | | | | | | |
| | | 1-4 | 73 | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| | | | | | MH | "Elastic SILT," very hard, dark olive gray, moist, siltstone | | | | | | |
| | | 1-5 | 64 | | | - Sisquoc Formation - | 83.0 | 34.6 | | | | 4.5+ |
| 20 | | | | | | | | | | | | |
| | | 1-6 | 52 | | | | | | | | | |
| 25 | | | | | | | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 1

File No. KC-1610-01

Figure A-3

K-C GEOTECHNICAL ASSOCIATES

KCGA

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N7195-E4985
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 45.0
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-7 | 67 | | MH | "Elastic SILT," very hard, dark olive gray, moist, siltstone | 72.6 | 45.0 | | | | 4.5+ |
| 30 | | | | | | | | | | | | |
| | | | | | | - Sisquoc Formation - | | | | | | |
| | | 1-8 | 34 | | | | | | | | | |
| 35 | | | | | | | | | | | | |
| | | NR | 70/1" | | | | | | | | | |

Boring terminated at 38-1/2 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 1 Con't

File No. KC-1610-01

Figure A-4

K-C GEOTECHNICAL ASSOCIATES

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N7080-E4885
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 46.5
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENE-TROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2-1/2 inches asphalt pavement | | | | | | |
| | | | | | | 6 inches aggregate base | | | | | | |
| | | 2-1 | 21 | | SM | Silty SAND, medium dense, gray brown, moist with shale fragments - Fill - | 99.8 | 11.0 | | | | |
| 5 | | 2-2 | 17 | | CL | Clayey SAND, medium dense, to sandy lean CLAY, firm, dark brown, moist - Fill - | 110.0 | 16.6 | | | | |
| | | | | | SM | Silty SAND, medium dense, gray to tan, dry - Terrace Deposit - | | | | | | |
| 10 | | 2-3 | 67 | | MH | "Elastic SILT," very hard, light olive gray, moist, weathered siltstone - Sisquoc Formation - | 69.4 | 36.9 | 88 | 32 | | 4.5+ |
| 15 | | 2-4 | 39 | | | | | | | | | |
| | | | | | MH | "Elastic SILT", very hard, dark gray green, moist, siltstone - Sisquoc Formation - | | | | | | |
| 20 | | 2-5 | 70 | | | | 79.0 | 39.0 | | | | 4.5+ |
| 25 | | 2-6 | 42 | | | | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 2

File No. KC-1610-01
Figure A-5

K-C GEOTECHNICAL ASSOCIATES

KCGA

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N7080-E4885
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 46.5
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MH | "Elastic SILT", very hard, dark gray green, moist, siltstone | | | | | | |
| 30 | | 2-7 | 43 | | | | | 30.2 | | | | |
| | | | | | | - Sisquoc Formation - | | | | | | |
| 35 | | 2-8 | 40 | | | | | | | | | |
| 40 | | 2-9 | 90 | | | | 73.9 | 43.6 | | | | 4.5+ |

Boring terminated at 40 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 2 Con't

File No. KC-1610-01

Figure A-6

K-C GEOTECHNICAL ASSOCIATES

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N7060-E5125
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 47.0
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | LIQUID LIMIT (%) | PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | 2 inches asphalt pavement | | | | | | |
| | | | | 5 inches aggregate base | | | | | | |
| | | | SM | Silty SAND, medium dense to very dense, gray to tan, dry | | | | | | |
| | 3-1 | 55 | | - Terrace Deposit - | 113.4 | 4.0 | | | | |
| | 3-2 | 110/9" | | | 95.4 | 5.1 | | | | |
| 5 | | | | Grades to sandy SILT (ML), very hard, light brown, moist | | | | | | |
| 10 | 3-3 | 28 | | | 93.3 | 11.7 | | | | |
| | | | MH | "Elastic SILT," very hard, dark gray green, moist, siltstone | | | | | | |
| 15 | 3-4 | 62 | | | 77.9 | 36.4 | | | | 4.5+ |
| | 3B | | | - Sisquoc Formation - | | | | | | |
| 20 | 3-5 | 41 | | | | | | | | |
| 25 | 3-6 | 44 | | | | 26.6 | | | | |

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 3

File No. KC-1610-01

Figure A-7

K-C GEOTECHNICAL ASSOCIATES

KCGA

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N7060-E5125
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 47.0
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENE-TROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MH | "Elastic SILT," very hard, dark gray green, moist, siltstone | | | | | | |
| 30 | | 3-7 | 42 | | | | | | | | | |
| | | | | | | - Sisquoc Formation - | | | | | | |
| 35 | | 3-8 | 93 | | | | 89.3 | 29.2 | | | | 4.5+ |
| 40 | | 3-9 | 68 | | | | | | | | | |

Boring terminated at 40-1/2 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 3 Con't

File No. KC-1610-01

Figure A-8

K-C GEOTECHNICAL ASSOCIATES

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N6890-E5135
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 47.5
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENE-TROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2 inches asphalt pavement | | | | | | |
| | | 4-1 | 15 | | SM | 4 inches aggregate base | 102.1 | 3.2 | | | | |
| | | | | | | Silty to clayey SAND, loose, medium gray brown, dry, becoming dense at 3 feet | | | | | | |
| | | 4C | | | | | | | 31 | 12 | | |
| | | 4-2 | 83 | | | | 116.5 | 5.6 | | | | |
| 5 | | | | | | - Terrace Deposit - | | | | | | |
| | | | | | ML | Sandy SILT, very hard, light gray to tan, dry | | | | | | |
| | | 4-3 | 52 | | | | 98.4 | 8.1 | | | | |
| 10 | | | | | | - Terrace Deposit - | | | | | | |
| | | | | | MH | "Elastic SILT," very hard, medium gray green moist, weathered siltstone | | | | | | |
| | | 4-4 | 39 | | | | 83.9 | 31.5 | | | | 3.5 to 4.5 |
| 15 | | | | | | - Sisquoc Formation - | | | | | | |
| | | 4-5 | 42 | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| | | 4-6 | 76/11" | | MH | "Elastic SILT," very hard, dark gray green, moist, siltstone | 79.2 | 39.4 | 65 | 22 | | |
| 25 | | | | | | | | | | | | |
| | | | | | | - Sisquoc Formation - | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
## BORING NO. 247B- 4

File No. KC-1610-01

Figure A-9

K-C GEOTECHNICAL ASSOCIATES

KCGA

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N6890-E5135
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 47.5
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MH | "Elastic SILT," very hard, dark gray green, moist, siltstone | | | | | | |
| 30 | | 4-7 | 35 | | | | | | | | | |
| | | | | | | - Sisquoc Formation - | | | | | | |
| 35 | | NR | 60/1" | | | | | | | | | |
| 40 | | 4-8 | 40 | | | | | | | | | |

Boring terminated at 40-1/2 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 4 Con't

File No. KC-1610-01

Figure A-10

K-C GEOTECHNICAL ASSOCIATES

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N6980-E4860
DRILLING METHOD: Hollo Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 4, 1992
SURFACE EL. (feet): 45.0
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | Silty SAND, loose, medium brown, moist | | | | | | |
| | | NR | 6 | | | - Fill - | | | | | | |
| 5 | | 5-1 | 18 | | SC | Clayey SAND, medium dense, dark brown, moist | 112.4 | 16.5 | 30 | 9 | | |
| | | | | | | - Terrace Deposit - | | | | | | |
| 10 | | 5-2 | 35 | | MH | "Elastic SILT," hard to very hard, light olive gray, moist, weathered siltstone | 66.9 | 53.1 | | | | 4.5+ |
| | | | | | | - Sisquoc Formation - | | | | | | |
| 15 | | 5-3 | 27 | | | | | | | | | |
| 20 | | 5-4 | 75/11" | | | | 70.8 | 47.5 | | | | 4.5+ |

Boring terminated at 20-1/2 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 5

File No. KC-1610-01

Figure A-11

K-C GEOTECHNICAL ASSOCIATES

KCGA

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N6880-E4740 LOGGED BY: R. Slayman
DRILLING METHOD: Hollow Stem Auger DRILLED BY: S/G Testing

DRILLING DATE: March 5, 1992
SURFACE EL. (feet): 40.5
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | Silty SAND, medium dense, dark to light brown moist to dry, with pockets of clayey SAND | | | | | | |
| | | 6-1 | 21 | | | | 110.6 | 15.4 | | | | |
| | | | | | | - Fill - | | | | | | |
| 5 | | 6-2 | 37 | | | Grades to medium brown, dry | 113.7 | 3.3 | | | | |
| 10 | | 6-3 | 76 | | | | 109.4 | 4.2 | | | | |
| | | | | | | Grades to dark brown at 12 feet | | | | | | |
| | | | | | ML | Sandy SILT, hard, mottled brown to gray green | | | | | | |
| 15 | | 6-4 | 27 | | | - Terrace Deposit - | 99.0 | 17.5 | | | | 4.0 |
| | | | | | MH | "Elastic SILT," hard to very hard, mottled gray green to rust brown, moist | | | | | | |
| 20 | | 6-5 | 32 | | | - Sisquoc Formation - | | | | | | |
| 25 | | 6-6 | 82 | | | | 67.0 | 53.8 | | | | 4.5+ |
| | | | | | MH | | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
## BORING NO. 247B- 6

File No. KC-1610-01

Figure A-12

K-C GEOTECHNICAL ASSOCIATES

KCGA

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N6880-E4740
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 5, 1992
SURFACE EL. (feet): 40.5
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS GRAPHIC LOG | SYMBOLS USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS LIQUID LIMIT (%) | ATTERBERG LIMITS PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | 6-7 | 42 | | MH | "Elastic SILT," very hard, dark gray green, moist siltstone<br>- Sisquoc Formation - | | | | | | |

Boring terminated at 30-1/2 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 6 Con't

File No. KC-1610-01

Figure A-13

K-C GEOTECHNICAL ASSOCIATES

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N6815-E4750
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 5, 1992
SURFACE EL. (feet): 39.0
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | Silty SAND, loose, dark brown, moist - Fill - | | | | | | |
| | | 7-1 | 19 | | ML | SILT, firm, mottled gray brown, moist - Fill - | 105.7 | 11.6 | | | | |
| | | | | | SM | Silty SAND, loose, medium brown, moist - Fill - | 97.1 | 10.2 | | | | |
| | | 7-2 | 8 | | | | | | | | | |
| | | | | | MH | Sandy Lean CLAY, firm, mottled dark brown, moist | | | | | | |
| 5 | | 7D | | | | | | | 29 | 11 | | |
| | | 7-3 | 22 | | | - Fill - | 82.6 | 36.8 | | | | 2.75 |
| 10 | | | | | MH | "Elastic SILT," very hard, medium gray green to moist, weathered siltstone | | | | | | |
| | | 7-4 | 41 | | | - Sisquoc Formation - | 62.2 | 60.4 | | | | |
| 15 | | | | | | | | | | | | |
| | | 7-5 | 24 | | | | | | | | | |
| 20 | | | | | | Grades to medium olive gray | | | | | | |
| | | 7-6 | 47 | | | | 65.0 | 53.2 | | | | 4.5+ |
| 25 | | | | | | | | | | | | |
| | | | | | MH | | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
## BORING NO. 247B- 7

File No. KC-1610-01

Figure A-14

K-C GEOTECHNICAL ASSOCIATES

KCGA

PROJECT: Humanities and Social Sciences Building
LOCATION: Grid N6815-E4750
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: March 5, 1992
SURFACE EL. (feet): 39.0
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS GRAPHIC LOG | SYMBOLS USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS LIQUID LIMIT (%) | ATTERBERG LIMITS PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | 7-7 | 33 | | MH | "Elastic SILT," very hard, dark gray green, moist, siltstone<br>- Sisquoc Formation - | | | | | | |

Boring terminated at 30 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B- 7 Con't

File No. KC-1610-01

Figure A-15

K-C GEOTECHNICAL ASSOCIATES

# BORING LOGS FROM

# PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

## LEGEND FOR SYMBOLS COMMONLY USED ON BORING LOGS

- 3-Inch O.D. Modified California Split-Barrel Sampler

- Standard Penetration Test (SPT)

- Loose Bulk Sample

- Water Level First Encountered

- Water Level After Drilling

NR - No Recovery

ROTARY AND CORE BORING LOGS

DATA ON THESE LOGS IS APPROXIMATE BECAUSE OF POSSIBLE DEVIATION FROM THE INTENDED DIRECTION OF DRILLING, INCOMPLETE RECOVERY OF DRILL CORE, AND THE LIMITED AND POSSIBLY DISTURBED SAMPLE PROVIDED BY A SMALL DIAMETER HOLE.

THESE LOGS INDICATE CONDITIONS ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES.

BORINGS WERE LOGGED IN SUCH A WAY AS TO PRIMARILY PROVIDE DATA FOR DESIGN PURPOSES AND NOT NECESSARILY FOR PURPOSES OF SPECIFIC CONSTRUCTORS.

SOIL CLASSIFICATIONS SHOWN ON THE LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THE TRANSITIONS MAY BE GRADUAL.

| FILE NO.: KC-1405-06 | LEGEND FOR SYMBOLS | FIGURE A-1 |
|---|---|---|

K-C GEOTECHNICAL ASSOCIATES

| Major Divisions | | | Graphic Symbol | Letter Symbol | Typical Descriptions |
|---|---|---|---|---|---|
| Coarse-Grained Soils<br>More than 50% of material retained on No. 200 sieve | Gravel and Gravelly Soils<br>More than 50% of coarse fraction retained on No. 4 seive | Clean Gravels<br>(Little or no fines) | | GW | Well-graded gravels, gravel-sand mixtures, little or no fines |
| | | | | GP | Poorly-graded gravels, gravel-sand mixtures, little or no fines |
| | | Gravels with Fines<br>(Appreciable amount of fines) | | GM | Silty gravels, gravel-sand-silt mixtures |
| | | | | GC | Clayey gravels, gravel-sand-clay mixtures |
| | Sand and Sandy Soils<br>50% or more of coarse fraction passing No. 4 seive | Clean Sands<br>(Little or no fines) | | SW | Well-graded sands, gravelly sands, little or no fines |
| | | | | SP | Poorly-graded sands, gravelly sands, little or no fines |
| | | Sands with Fines<br>(Appreciable amount of fines) | | SM | Silty sands, sand-silt mixtures |
| | | | | SC | Clayey sands, sand-clay mixtures |
| Fine-Grained Soils<br>50% or more of material passing No. 200 sieve | Silts and Clays | Liquid limit less than 50 | | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity |
| | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | | | | OL | Organic silts and organic silty clays of low plasticity |
| | Silts and Clays | Liquid limit 50 or more | | MH | Inorganic siltys, micaceous or diatomaceous fine sand or silty soils |
| | | | | CH | Inorganic clays of high plasticity, fat clays |
| | | | | OH | Organic clays of medium to high plasticity, organic silts |
| Highly Organic Soils | | | | PT | Peat, humus, swamp soils with high organic contents |

NOTE: Dual symbols are used to indicate borderline soil classifications.

| FILE NO.: KC-1405-06 | **UNIFIED SOIL CLASSIFICATION SYSTEM** | FIGURE A-2 |
|---|---|---|

PROJECT: UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger DRILLED BY: Valley Well Drilling

DRILLING DATE: March 26, 1990
SURFACE EL.: 45-1/2 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | 10 in. asphalt pavement | | | | | | |
| | | | | | SM | Silty SAND, dark brown, moist | | | | | | -- |
| | | 1-1 | 10 | | SM | Silty SAND, loose, gray-brown, moist (poor recovery) medium dense, (wet at 3.5 feet/ Perched water) - Fill - | -- | 10.1 | -- | -- | | |
| | | 1A | | | | | | | | | | |
| | | 1-2 | 23 | | | | 106.8 | 16.5 | -- | -- | | 4.25 |
| 5 | | 1-3 | 42 | | SM | Silty SAND, medium dense, gray to tan, moist, thin clay infilled fractures - Terrace Deposit - | 109.1 | 15.7 | -- | -- | | -- |
| 10 | | 1-4 | 7 | | MH | "Elastic SILT", firm, gray, moist, interbedded with yellow brown silty sand, siltstone - Sisquoc Formation - | -- | 51.5 | 73 | 23 | | 2.0 |
| 15 | | 1-5 | 14 | | MH | "Elastic SILT", hard, gray, moist, massive, fine fractures, siltstone - Sisquoc Formation - | -- | 44.6 | 65 | 21 | | 3.0 |
| 20 | | 1-6 | 18 | | | | -- | 37.9 | -- | -- | | 2.5 |
| 25 | | 1-7 | 26 | | MH | "Elastic SILT", very hard, dark green-gray, silt stone - Sisquoc Formation - | -- | 31.3 | -- | -- | | 4.25 |

GROUNDWATER DATA:
Groundwater not encountered
Seepage at 3.5 feet

# LOG OF BORING

BORING NO. 247-1

FILE NO.: KC-1405-06

FIGURE A-3

K-C GEOTECHNICAL ASSOCIATES

PROJECT:UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger DRILLED BY: Valley Well Drilling

DRILLING DATE: March 26, 1990
SURFACE EL.: 45-1/2 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | | | | | | | | | | | | |
| 30 | | 1-8 | 40 | | MH | Very hard, laminated | -- | 33.2 | -- | -- | | 4.5+ |
| 35 | | 1-9 | 38 | | | | -- | 38.6 | -- | -- | | 4.5+ |
| | | | | | | - Sisquoc Formation - | | | | | | |
| 40 | | 1-10 | 55 | | | | -- | 46.6 | 68 | 6 | | 4.5+ |
| | | | | | | Boring Terminated at 41.5 feet. | | | | | | |
| 45 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered

# LOG OF BORING
BORING NO. 247-1

FILE NO.: KC-1405-06
FIGURE A-4

K-C GEOTECHNICAL ASSOCIATES

PROJECT: UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara
LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger
DRILLED BY: Valley Well Drilling
DRILLING DATE: March 26, 1990
SURFACE EL.: 47 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | 0.2 feet Asphalt pavement | | | | | | |
| | | | | | SM | 0.5 feet, silty SAND, yellow brown | | | | | | -- |
| | | 2-1 | 20 | | SM | Silty SAND, gray-brown, medium dense, moist - Fill - | 97.4 | 5.9 | -- | -- | | -- |
| | | 2-2 | 36 | | SC | Clayey SAND, medium dense, yellow brown, moist - Terrace Deposit - | 106.9 | 19.2 | 39 | 16 | | 2.5 |
| 5 | | 2-3 | 50 | | SM | Silty SAND, dense, yellow brown, moist, pockets of white silty sand; interbedded layers of clayey sand - Terrace Deposit - | 107.0 | 14.1 | -- | -- | | -- |
| 10 | | 2-4 | 18 | | ML | "SILT" , hard, brown-gray, moist, interbedded with yellow brown silty sand, weathered, siltstone - Sisquoc Formation - | -- | 14.5 | -- | NP | | -- |
| 15 | | 2-5 | 17 | | | Yellow-brown to gray, siltstone | -- | 40.8 | -- | -- | | 2.5 |
| 20 | | 2-6 | 32 | | MH | "Elastic SILT" , very hard, dark gray-green, laminated - Sisquoc Formation - | -- | 37.5 | -- | -- | | 4.5+ |
| 25 | | 2-7 | 36 | | | | -- | 36.7 | 55 | 12 | | 4.5+ |

GROUNDWATER DATA:
Groundwater not encountered

## LOG OF BORING
BORING NO. 247-2

FILE NO.: KC-1405-06
FIGURE A-5

K-C GEOTECHNICAL ASSOCIATES

PROJECT: UCSB - Humanities and Social Sciences Building

LOCATION: El Colegio Road, Santa Barbara  LOGGED BY: J. Blanchard

DRILLING METHOD: Hollow Stem Auger  DRILLED BY: Valley Well Drilling

DRILLING DATE: March 26, 1990

SURFACE EL.: 47 feet

DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | | | | | MH | "Elastic SILT", very hard, dark gray-green, laminated | | | | | | |
| | | | | | | | | | | | | 4.5+ |
| 30 | | 2-8 | 35 | | | | -- | 39.1 | -- | -- | | |
| | | | | | | - Sisquoc Formation - | | | | | | |
| | | | | | | | | | | | | 4.5+ |
| 35 | | 2-9 | 40 | | | | -- | 41.0 | -- | -- | | |
| | | | | | | | | | | | | 4.5+ |
| 40 | | 2-10 | 20 | | | | -- | 43.9 | -- | -- | | |
| 45 | | | | | | | | | | | | |
| 50 | | 2-11 | 43 | | | Occasional thin lenses of black sand | -- | 50.4 | -- | -- | | 4.5+ |

GROUNDWATER DATA:
Groundwater not encountered

## LOG OF BORING

BORING NO. 247-2 (con't)

FILE NO.: KC-1405-06

FIGURE A-6

K-C GEOTECHNICAL ASSOCIATES

PROJECT: UCSB - Humanities and Social Sciences Building
LOCATION: El Colegio Road, Santa Barbara LOGGED BY: J. Blanchard
DRILLING METHOD: Hollow Stem Auger DRILLED BY: Valley Well Drilling
DRILLING DATE: March 26, 1990
SURFACE EL.: 47 feet
DATUM: UCSB Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | | | | | MH | "Elastic SILT", very hard, dark gray-green, moist, siltstone | | | | | | |
| 50 | | 2-11 | 43 | | | - Sisquoc Formation - | -- | 50.4 | | | | |
| | | 2-12 | 54 | | | | – | 51.6 | -- | – | | |
| | | | | | | Boring Terminated at 53 feet. | | | | | | |

GROUNDWATER DATA:
Groundwater not encountered

# LOG OF BORING
BORING NO.247-2 (con't)

FILE NO.: KC-1405-06

FIGURE A-7

K-C GEOTECHNICAL ASSOCIATES

# APPENDIX B

## LABORATORY TESTING

### B.1 General

This appendix discusses the results of the laboratory test program performed for this Geotechnical Engineering Report. Laboratory tests were performed on selected samples obtained from the field to help classify the soils and estimate some of their engineering properties. The program was carried out employing, wherever practical, currently accepted test procedures of the American Society for Testing and Materials (ASTM).

Driven-ring and bulk samples used in the laboratory testing program were obtained from various locations during the course of the field exploration, as discussed in Appendix A. Each sample is identified by sample number and depth. The various laboratory tests performed are described below. Laboratory test results obtained for the preliminary geotechnical investigation (K-C 1990) are attached with this appendix.

### B.2 Index Properties Testing

The method of identifying and classifying soils according to their engineering properties used in this study is ASTM Test Method D2487, based on the Unified Soil Classification System. The index properties tests discussed in this report are for water content and dry density, grain-size distribution (mechanical), and plasticity indices.

Tests for water content and dry density of the soils were performed, often in conjunction with other tests, on selected drive samples. The samples were trimmed to obtain a smooth, flat face, measured to obtain volume and wet weight, extruded, and visually classified. The samples were dried for at least twelve hours in an oven maintained at approximately 110 degrees Celsius. After drying, each sample was weighed, and the moisture content and dry density were calculated. The water content and dry density results are summarized on Table B-1 and are included on the boring log data in Appendix A. The second Table B-1 attached to the appendix contains data obtained from our preliminary investigation of the site.

The gradation characteristics of selected samples were estimated by sieve analysis procedures. Samples were soaked in water until individual soil particles were separated, then washed on the No. 200 mesh sieve, oven dried, weighed to assess the percent passing the No. 200 sieve, and mechanically sieved. The hydrometer test was run using sodium hexametaphosphate as a dispersing agent. The grain size distribution tests are presented on Figure B-1, and on Figures B-1 and B-2 with the preliminary investigation data.

Tests for liquid limit, plastic limit, and plasticity index were conducted on selected samples in accordance with ASTM Test Method D4318. The liquid limit of soils is the water content at the boundary between the liquid and plastic states of the soil. The plastic limit is the water content between the plastic and semisolid states. The plasticity index is the range of water content where the soil is plastic. The boundary conditions are arbitrarily defined by the test methods. These tests allow a comparison to be made between the natural water content and the laboratory standard. The test results are an important correlation with the engineering properties and engineering behavior of fine-grained soils. Results of the tests are presented on Figure B-2, and on Figure B-3 with the preliminary investigation data.

## B.3 Engineering Properties Testing

The engineering properties testing consisted of tests for direct shear strength, unconfined compression, consolidation, estimation of maximum density, swell, and expansion index.

The direct shear tests were performed on selected driven-ring and remolded samples. The samples were pre-loaded with a confining pressure and flooded with water for at least twenty-four hours. The samples were sheared horizontally at a controlled strain rate, allowing partial drainage. The shear stress on the samples was recorded at regular strain intervals. The results of the direct shear tests are tabulated on Table B-1 for this phase of work, and on Table B-1 with the preliminary investigation data.

Unconfined compression tests were performed on selected driven ring samples in accordance with ASTM 2166. The tests were performed at approximately field moisture conditions. The primary purpose of this test is to obtain approximate quantitative values of the compressive strength of the foundation soils possessing sufficient cohesion to permit testing in an unconfined state. The results of the unconfined compression tests are tabulated on Table B-1 of for this phase of work.

Maximum density tests were performed to estimate the moisture-density relationship of selected soil materials. The tests were performed according to ASTM Test Method D1557. The results of the maximum density tests are presented on Table B-2 for this phase of work.

Swell tests were performed on selected driven-ring soil samples. The samples were surcharged under 100 psf load and allowed to air dry to a moisture content near or below the shrinkage limit. Samples were then submerged with water, and the amount of swell was recorded with a dial indicator. The results of the swell tests are presented on Table B-2.

Expansion index tests were performed on bulk soil samples according to the Uniform Building Code Test Method 29-A. The samples were surcharged under a 114 psf load at a moisture content near 50 percent saturation. The samples were then submerged in water, and the amount of expansion was recorded with a dial indicator. The results of the expansion index tests are presented on Table B-2.

One-dimensional consolidation tests were performed on selected driven-ring samples. The samples were typically incrementally loaded to 0.6, 1.1, 2.3, 4.6, 9.2, and 18.4 kips per square foot (ksf). The samples were allowed to consolidate under each load increment. Rebound was measured under reverse alternate loading. Samples 1-3 and 4-6 were flooded with water after unloading the sampled to 0.6 ksf, and the amount of swell was recorded. Sample 4-6 was then run through the load cycle again after being flooded with water. Compression was measured by dial gauges accurate to 0.0001 inch. Results of the consolidation tests, in the form of percent consolidation versus log of pressure curves, are presented on Figures B-4 through B-6, and Figures B-5 through B-6 with the preliminary investigation data.

## B.3 Chemical Testing

Chemical tests for resistivity, pH, soluble sulfates, and soluble chlorides were performed on a selected bulk sample by Health Sciences Associates of Los Alamitos, California. The results of the chemical tests are presented on Table B-3.

## TABLE B-1

Summary of Moisture, Density, Direct Shear, and Unconfined Compressive Strength Testing

| Sample Number | Depth Feet | Dry Density pcf | Moisture Content % Dry Wt. | Angle of Internal Friction | Unit Cohesion psf |
|---|---|---|---|---|---|
| 1-1 | 1 | 122.5 | 11.6 | | |
| 1-2 | 3 | 107.9 | 7.3 | 43° | 0[1] |
| 1-3 | 8-1/2 | 88.3 | 29.1 | 48° | 0[1] |
| 1-5 | 18-1/2 | 83.0 | 34.6 | | |
| 1-7 | 28-1/2 | 72.6 | 45.0 | -- | 5,600[2] |
| 2-1 | 1 | 99.8 | 11.0 | | |
| 2-2 | 4 | 110.0 | 16.6 | | |
| 2-3 | 9 | 69.4 | 36.9 | | |
| 2-5 | 19 | 79.0 | 39.0 | 52° | 0[1] |
| 2-7 | 29 | -- | 30.2 | | |
| 2-9 | 39 | 73.9 | 43.6 | | |
| 3-1 | 2 | 113.4 | 4.0 | 25° | 235[1] |
| 3-2 | 4 | 95.4 | 5.1 | | |
| 3-3 | 9 | 93.3 | 11.7 | | |
| 3-4 | 14 | 77.9 | 36.4 | -- | 6,000[2] |
| 3-6 | 24 | -- | 26.6 | | |
| 3-8 | 34 | 89.3 | 29.2 | -- | 9,900[2] |
| 4C | 1-5 | 107.3 | 12.0 | 23° | 185[1,3] |
| 4-1 | 1/2 | 102.1 | 3.2 | | |
| 4-2 | 4 | 116.5 | 5.6 | | |
| 4-3 | 9 | 98.4 | 8.1 | | |
| 4-4 | 14 | 83.9 | 31.5 | | |
| 4-6 | 24 | 79.2 | 39.4 | | |
| 5-1 | 4 | 112.4 | 16.5 | | |
| 5-2 | 9 | 66.9 | 53.1 | -- | 3,600[2] |
| 5-4 | 19 | 70.8 | 47.5 | | |

## TABLE B-1 (CONTINUED)

Summary of Moisture, Density & Direct Shear, and Unconfined Compressive Strength Testing

| Sample Number | Depth Feet | Dry Density pcf | Moisture Content % Dry Wt. | Angle of Internal Friction | Unit Cohesion psf |
|---|---|---|---|---|---|
| 6-1 | 1 | 110.6 | 15.4 | | |
| 6-2 | 4 | 113.7 | 3.3 | | |
| 6-3 | 9 | 109.4 | 4.2 | | |
| 6-4 | 14 | 99.0 | 17.5 | | |
| 6-6 | 24 | 67.0 | 53.8 | | |
| 7D | 5-7 | 107.4 | 11.4 | 18° | 430[1,3] |
| 7-1 | 1 | 105.7 | 11.6 | | |
| 7-2 | 2 | 97.1 | 10.2 | | |
| 7-3 | 8-1/2 | 82.6 | 36.8 | | |
| 7-4 | 13-1/2 | 62.2 | 60.4 | -- | 2,900[1] |
| 7-6 | 23-1/2 | 65.0 | 53.2 | | |

[1] Result of Direct Shear Test
[2] Result of Unconfined Compression Test
[3] Sample Remolded to approximately 90 percent relative compaction

**TABLE B-2**

Summary of Maximum Density - Optimum Moisture, Swell and Expansion Index Testing

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample No. | : | 3B | 4C | 7D | 2-2 | 4-1 | 5-1 |
| Location, Boring | : | 247B-3 | 247B-4 | 247B-7 | 247B-2 | 247B-4 | 247B-5 |
| Depth, Feet | : | 16-17 | 2-5 | 5-7 | 4 | 1/2 | 4 |
| Maximum Density, pcf | : | -- | 119.2 | 119.3 | -- | -- | -- |
| Optimum Moisture, % | : | -- | 12.0 | 11.4 | -- | -- | -- |
| | | | | | | | |
| Swell % @ 100 psf | : | -- | -- | -- | 7.4 | 0.0 | 3.4 |
| Initial Moisture, % | : | -- | -- | -- | 9.0 | 2.3 | 10.9 |
| Initial Dry Density, pcf | : | -- | -- | -- | 109.7 | 99.7 | 109.8 |
| Final Moisture, % | | -- | -- | -- | 19.3 | 17.6 | 18.0 |
| | | | | | | | |
| Expansion Index | : | 77 | 70 | -- | -- | -- | -- |
| Initial Moisture, % | : | 21.2 | 11.5 | -- | -- | -- | -- |
| Initial Dry Density, pcf | : | 79.5 | 103.8 | -- | -- | -- | -- |
| Final Moisture, % | : | 43.4 | 23.5 | -- | -- | -- | -- |

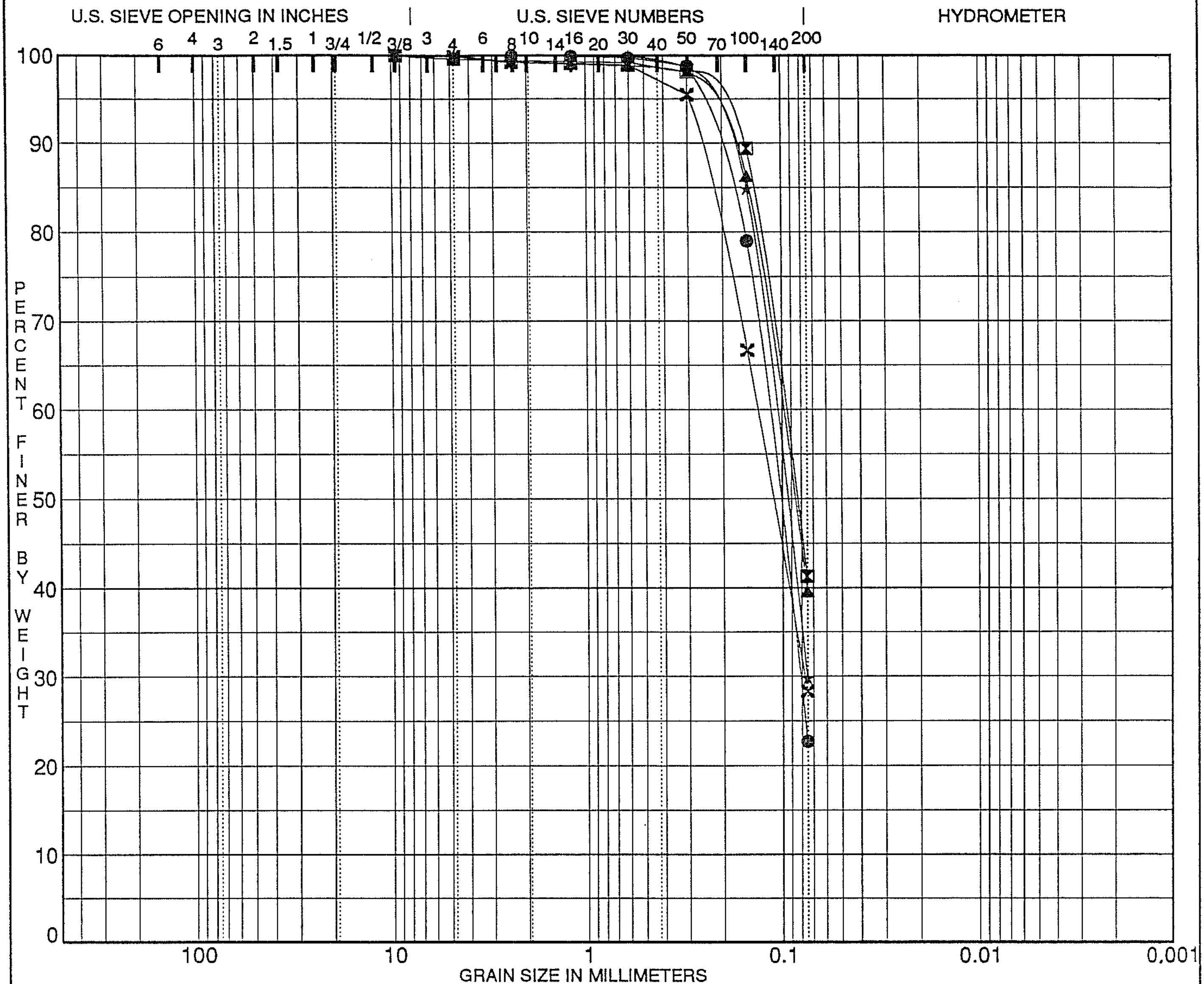
Description: 3B: Elastic SILT (MH)
4C: Clayey SAND (SC)
7D: Sandy Lean CLAY (CL)
2-2: Clayey SAND (SC)
4-1: Silty SAND (SM)
5-1: Clayey SAND (SC)

**TABLE B-3**

Summary of Chemical Analyses

| | | | |
|---|---|---|---|
| Sample No. | : | 1A | 3B |
| Location, Boring | : | 247B-1 | 247B-3 |
| Depth, Feet | : | 3-5 | 16-18 |
| Test Method | : | California 643 | |
| Resistivity, ohm-centimeters | : | 910 | 2.5 |
| pH: | : | 7.42 | 5.49 |
| Test Method | : | California 417 and 422 | |
| Soluble Sulfate, mg/kg | : | 246 | 1209 |
| Soluble Chloride, mg/kg | : | 245 | 460 |

Description: 1A, Silty SAND (SM)
5B, Elastic SILT (MH)

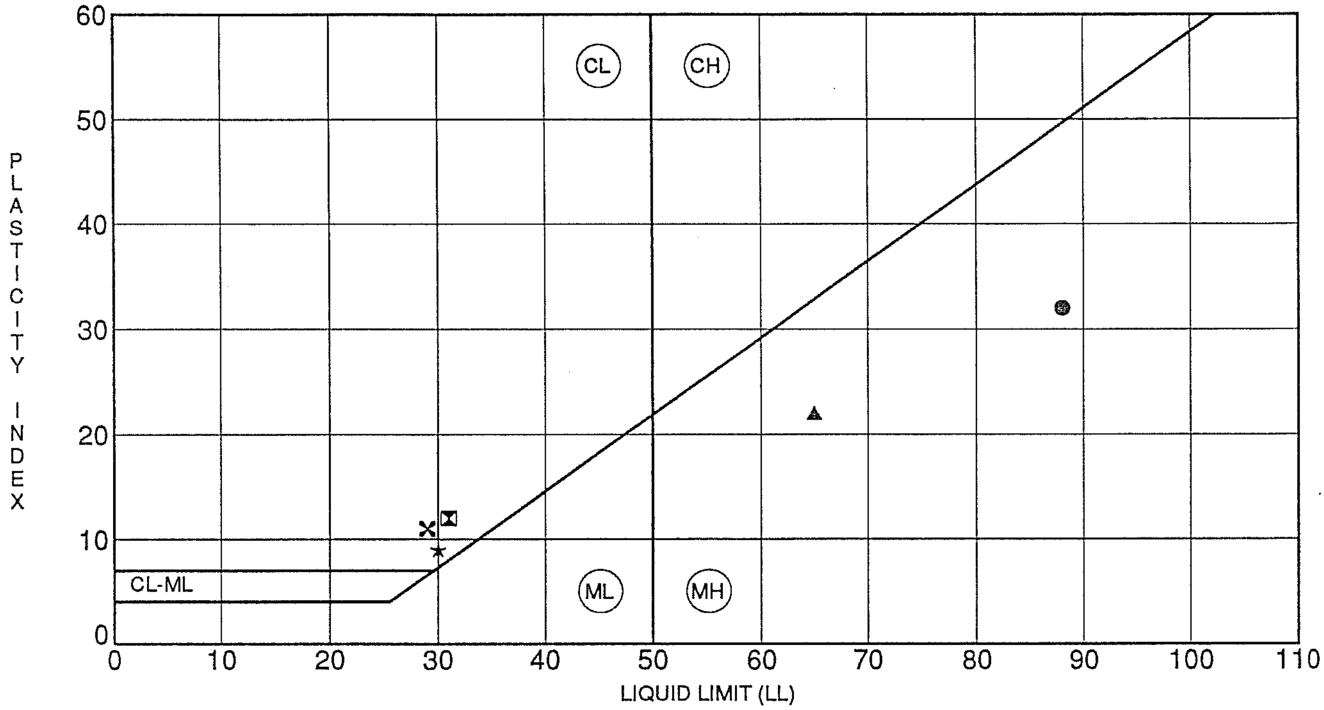



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Sample No. | | Depth | Cc | Cu | Classification |
|---|---|---|---|---|---|
| ● | 1-2 | 3.0 feet | | | SILTY SAND SM |
| ⊠ | 3-1 | 2.0 feet | | | SILTY SAND SM |
| ▲ | 4C | 2.0 feet | | | CLAYEY SAND SC |
| ★ | 5-1 | 4.0 feet | | | CLAYEY SAND SC |
| ✕ | 6-2 | 4.0 feet | | | SILTY SAND |

| Humanities and Social Sciences Building | GRADATION CURVES | File No. KC-1610-01<br>Figure B-1 |
|---|---|---|

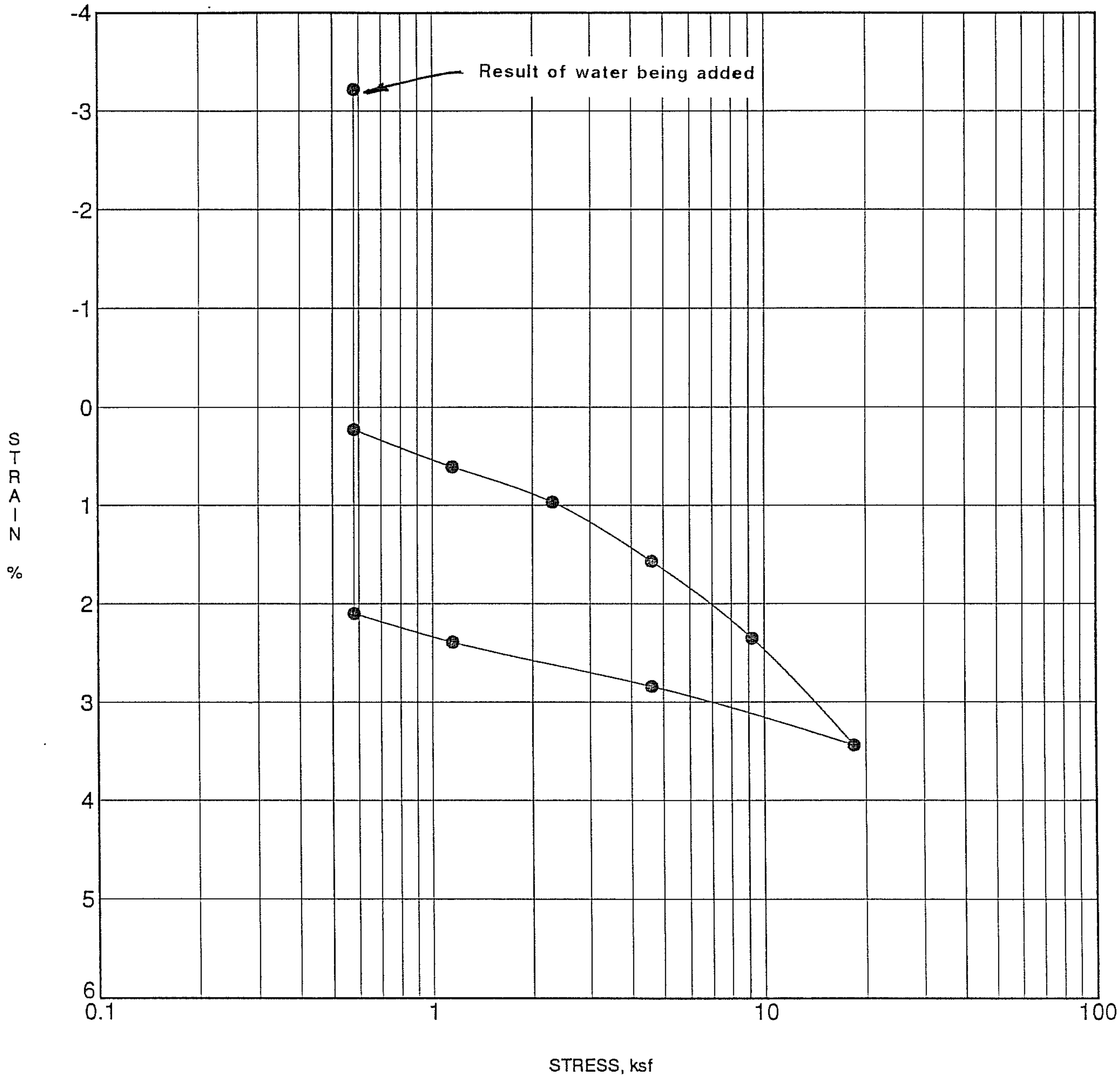
K-C GEOTECHNICAL ASSOCIATES




| Sample No. | Depth | LL | PL | PI | Classification |
|---|---|---|---|---|---|
| ● 2-3 | 9.0 feet | 88 | 56 | 32 | ELASTIC SILT MH |
| ⊠ 4C | 2.0 feet | 31 | 19 | 12 | CLAYEY SAND SC |
| ▲ 4-6 | 24.0 feet | 65 | 43 | 22 | ELASTIC SILT MH |
| ★ 5-1 | 4.0 feet | 30 | 21 | 9 | CLAYEY SAND SC |
| ✕ 7D | 5.0 feet | 29 | 18 | 11 | SANDY LEAN CLAY CL |

| Humanities and Social Sciences Building | ATTERBERG LIMITS' RESULTS | File No. KC-1610-01<br>Figure B-2 |
|---|---|---|

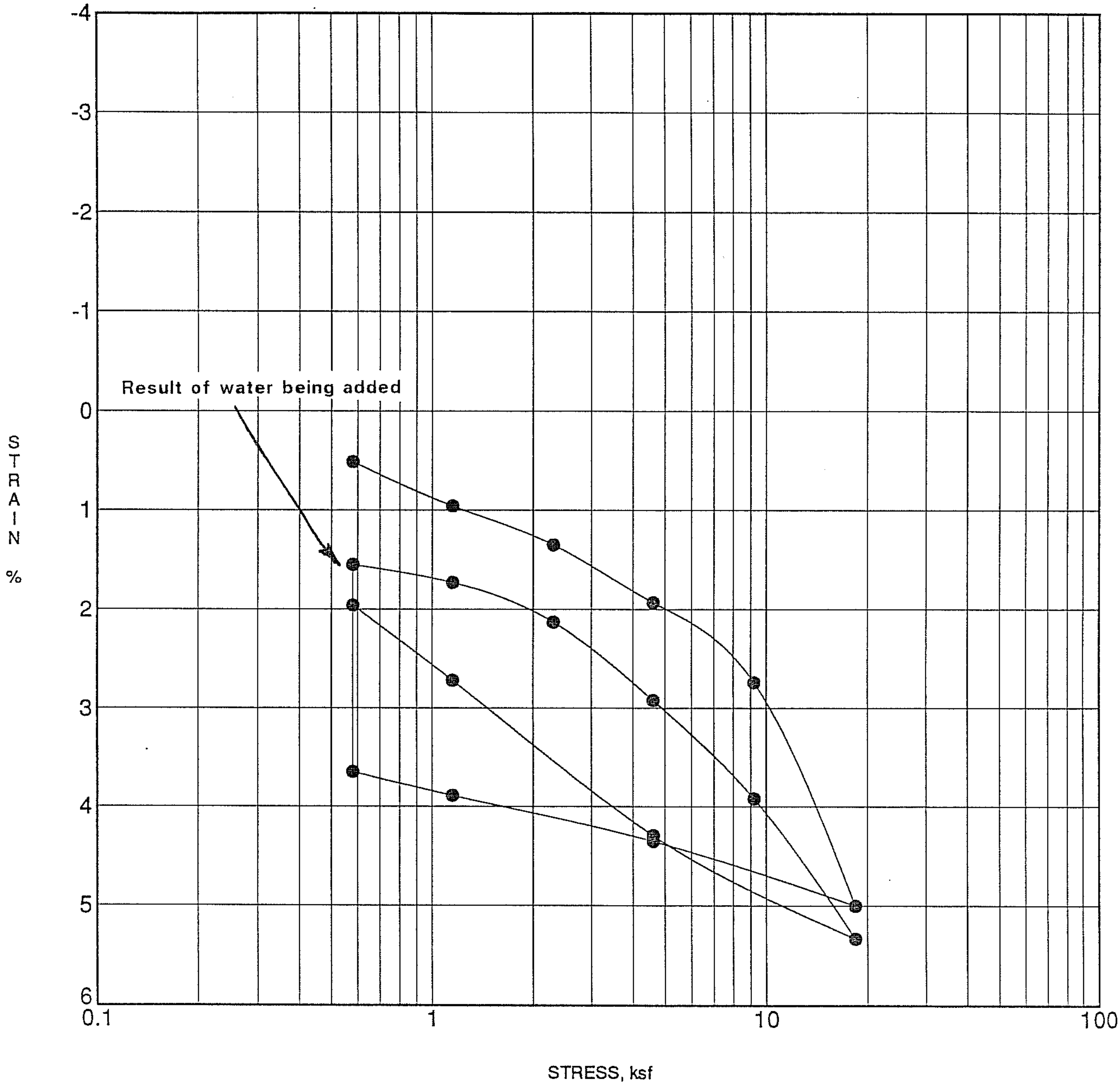
K-C GEOTECHNICAL ASSOCIATES




| Sample No. | Depth | Classification | DD, pcf | MC% |
|---|---|---|---|---|
| ● 1-3 | 8.5 feet | ELASTIC SILT MH | 77.2 | 40.3 |

| Humanities and Social Sciences Building | CONSOLIDATION TEST | File No. KC-1610-01 Figure B-3 |
|---|---|---|

K-C GEOTECHNICAL ASSOCIATES




| Sample No. | | Depth | Classification | DD, pcf | MC% |
|---|---|---|---|---|---|
| ● | 4-6 | 24.0 feet | ELASTIC SILT MH | 102.2 | 8.3 |

| Humanities and Social Sciences Building | CONSOLIDATION TEST | File No. KC-1610-01<br>Figure B-4 |
|---|---|---|

K-C GEOTECHNICAL ASSOCIATES

LAB DATA FROM

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

# TABLE B-1

## Summary of Moisture, Density & Direct Shear Testing

| | | In-Place Conditions | | Direct Shear Testing | |
|---|---|---|---|---|---|
| Sample Number | Depth Feet | Dry Density pcf | Moisture Content % Dry Wt. | Angle of Internal Friction | Unit Cohesion psf |
| 1-1 | 1 | -- | 10.1 | | |
| 1-2 | 3 | 106.8 | 16.5 | | |
| 1-3 | 5 | 126.3 | 15.7 | | |
| 1-4 | 10 | -- | 51.5 | | |
| 1-5 | 15 | -- | 44.6 | | |
| 1-6 | 20 | -- | 37.9 | | |
| 1-7 | 25 | -- | 31.3 | | |
| 1-8 | 30 | -- | 33.2 | | |
| 1-9 | 35 | -- | 38.6 | | |
| 1-10 | 40 | -- | 46.6 | | |
| 2-1 | 1 | 97.4 | 5.9 | | |
| 2-2 | 3 | 106.9 | 19.2 | 12° | 1800 |
| 2-3 | 5 | 107.0 | 14.1 | | |
| 2-4 | 10 | -- | 14.5 | | |
| 2-5 | 15 | -- | 40.8 | | |
| 2-6 | 20 | -- | 37.5 | | |
| 2-7 | 25 | -- | 36.7 | | |
| 2-8 | 30 | -- | 39.1 | | |
| 2-9 | 35 | -- | 41.0 | | |
| 2-10 | 40 | -- | 43.9 | | |
| 2-11 | 50 | -- | 50.4 | | |
| 2-12 | 51.5 | -- | 51.6 | | |

**TABLE B-2**

Summary of Swell Testing

| | | | |
|---|---|---|---|
| Sample No. | : | 1-3 | 2-2 |
| Location, Boring | : | 1 | 2 |
| Depth, Feet | : | 5 | 3 |
| Swell % @ 100 psf | : | 3.4 | 7.2 |
| Initial Moisture, % | : | 8.9 | 17.8 |
| Initial Density, pcf | : | 107.5 | 102.3 |
| Final Moisture, % | : | 20.7 | 26.5 |

Description:

1-3: Silty SAND (SM), gray to tan, thin clay filled fractures

2-2: Clayey SAND (SC), yellow-brown,

File No. KC-1405-06

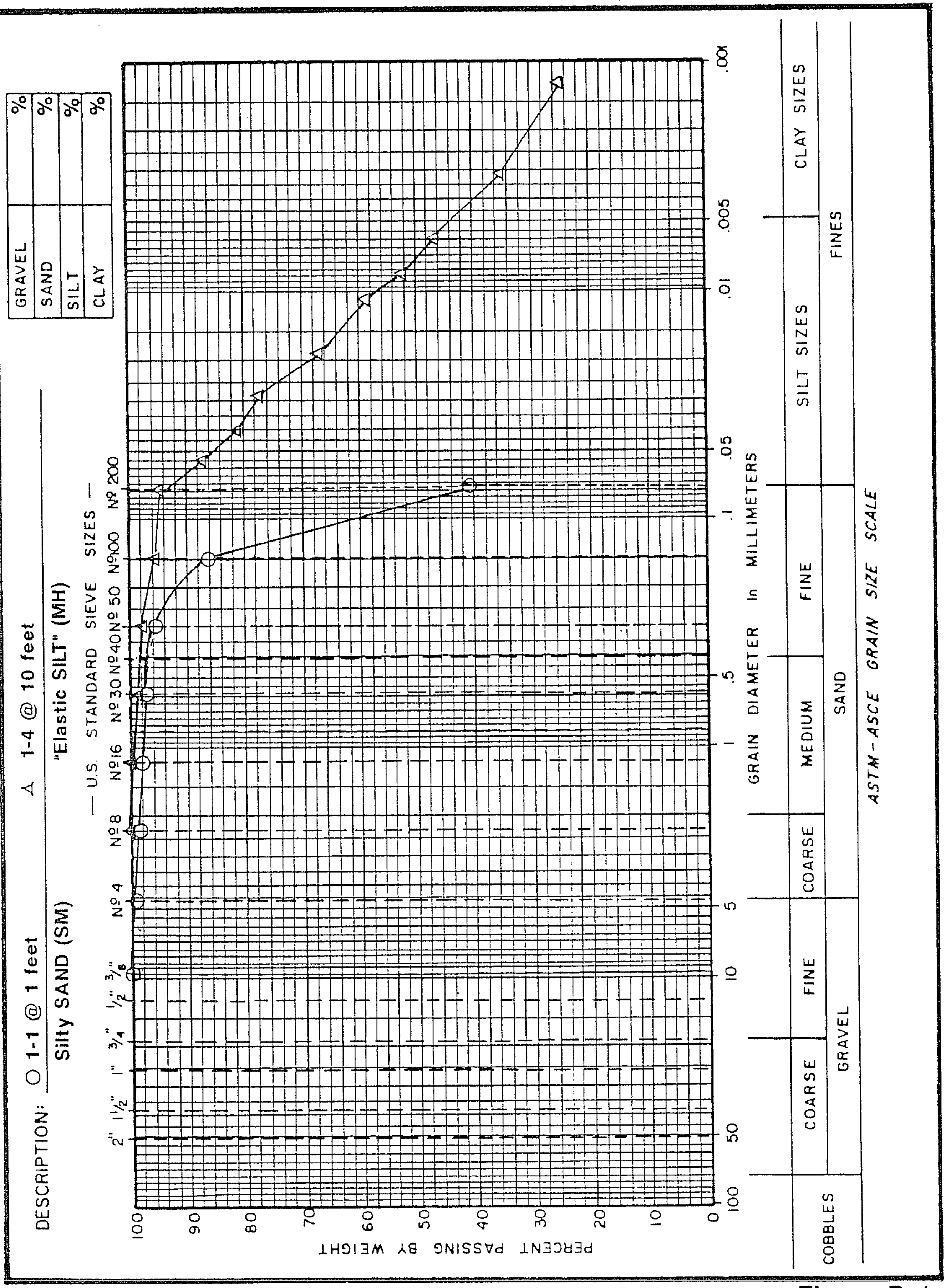



Figure B-1

File No. KC-1405-06

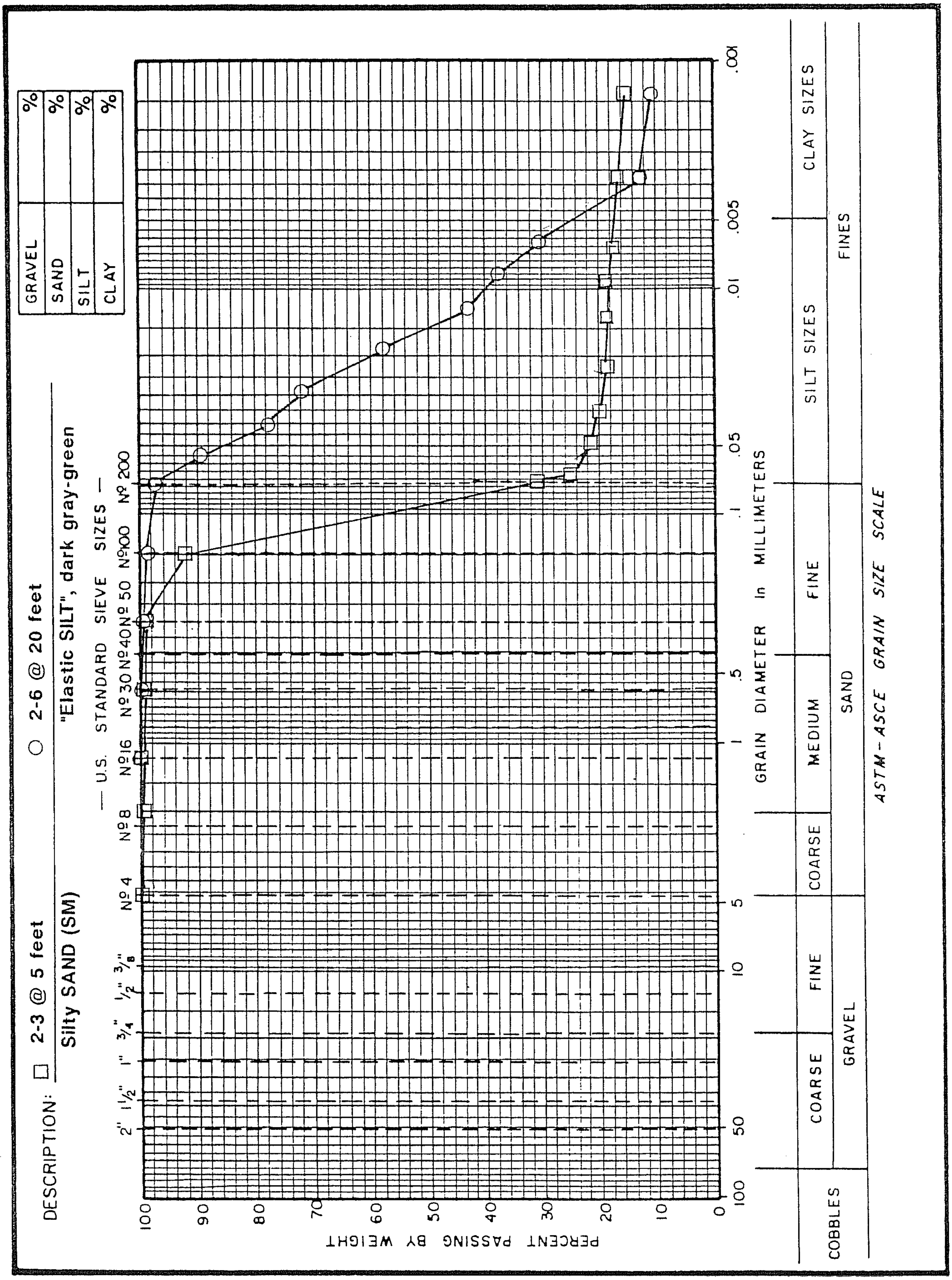
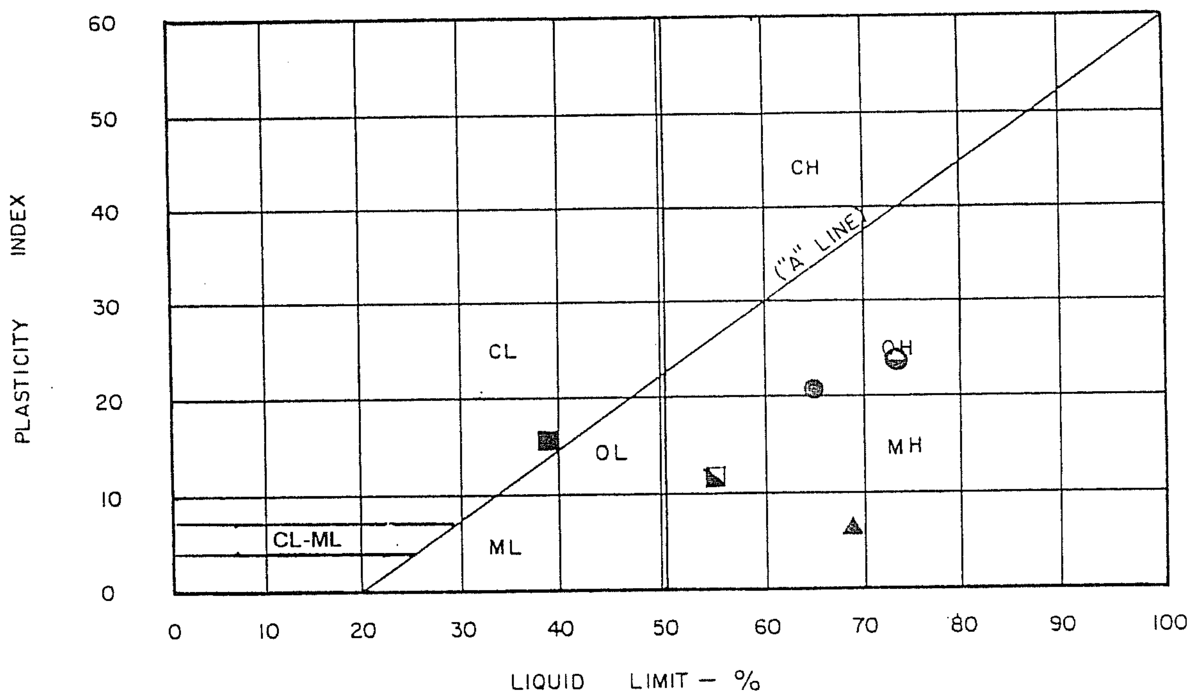



Figure B-2

PLASTICITY CHART




| | Sample Number | Depth (ft.) | Description | Atterberg Limits: Liquid Limit % | Atterberg Limits: Plasticity Index |
|---|---|---|---|---|---|
| ◒ | 1-4 | 10 | "Elastic SILT" (MH), gray | 73 | 23 |
| ● | 1-5 | 15 | "Elastic SILT" (MH), gray | 65 | 21 |
| ▲ | 1-10 | 40 | "Elastic SILT" (MH), dark green-gray | 68 | 6 |
| ■ | 2-2 | 3 | Clayey SAND (SC), yellow-brown | 39 | 16 |
| | 2-4 | 10 | "SILT" (ML), brown-gray | Non-plastic | |
| ◪ | 2-7 | 25 | "Elastic SILT" (MH), dark gray-green | 55 | 12 |

File No. KC-1610-01
September 15, 1992

Mr. Bill Hanna
Facilities Management, Building 439
University of California
Santa Barbara, California 93106

Subject: Humanities and Socials Sciences Building
University of California
Santa Barbara, California
**ADDENDUM No. 1 TO GEOTECHNICAL ENGINEERING REPORT**

Dear Mr. Hanna:

K-C Geotechnical Associates (K-C) is pleased to present this addendum to our Geotechnical Engineering Report for the Humanities and Socials Sciences Building project at the University of California, Santa Barbara. This addendum documents our recommendations given to Mr. Bruce Gibbons of Ove Arup & Partners (Structural Engineers) for site coefficients used with UBC seismic design requirements. The recommendations contained in this addendum should be attached to and made part of our Geotechnical Engineering Report dated April 27, 1992.

Ove Arup & Partners has requested that K-C review the recommended site coefficients presented in our report, with regards to buildings supported by drilled pier foundations founded in Sisquoc Formation. The recommended site coefficients were selected from the 1988 UBC, with California amendments, based on our characterization of the soil conditions at the site. Based on our review of the site data, we recommend that the four and six-story elements with drilled pier foundations founded in relatively hard siltstone (Sisquoc Formation) be designed using a site coefficient of 1.0. As recommended in the report, we recommend that the single-story element with the spread footing foundations founded in compacted fill be designed using a site coefficient of 1.2.

We trust this addendum meets your needs at this time. Please contact the undersigned if you have questions, or require additional information.

Very truly yours,
K-C Geotechnical Associates
a California Corporation

Jonathan D. Blanchard
Project Engineer, CE 47071

Ross A. Morrison
Principal Engineer, GE 621

Copies: 8 - Addressee
1 - UCSB; Attention: Mr. Steve Karzen
1 - Ove Arup & Partners: Mr. Bruce Gibbons

JB:kd(209011)

File No. KC-1610-01
March 24, 1993

Mr. Bill Hanna
Facilities Management, Building 439
University of California
Santa Barbara, California 93106

Subject: Humanities and Social Sciences Building
University of California
Santa Barbara, California
**ADDENDUM No. 2 TO GEOTECHNICAL ENGINEERING REPORT**

Dear Mr. Hanna:

K-C Geotechnical Associates (K-C) is pleased to present this addendum to our Geotechnical Engineering Report for the proposed Humanities and Social Sciences Building project at the University of California, Santa Barbara. This addendum documents our foundation, slab-on-grade, and drainage recommendations presented to Ove Arup & Partners (Structural Engineer), and Zimmer Gunsul Frasca Partnership (Architect) during the period of January 18 through March 9, 1993. The recommendations contained in this addendum should be attached to and made a part of our Geotechnical Engineering Report, dated April 27, 1992, and Addendum No. 1 to the report, dated September 15, 1992.

## 1. Foundation Design

### 1.1 Pier Spacing

The Geotechnical Engineering Report provided recommendations for the design of cast-in-place drilled pier foundations. In the report we recommended that piers be designed with a center-to-center spacing of at least 3 pier diameters. We understand from Ove Arup & Partners that selected foundations are designed with a two-pier group having a center-to-center spacing of approximately 9.5 feet. The piers have a diameter of 4 feet with an embedment of approximately 40 to 50 feet. Ove Arup & Partners has requested that K-C review the proposed foundation design, and provide recommendations for the piers spaced less than 3 diameters center-to-center spacing.

Based on our review of the foundation design, in our opinion the capacity of the two-pier groups can be designed based on the sum of the individual pier capacities using maximum allowable friction and end bearing resistances presented in the Geotechnical Engineering Report.

## 1.2 Pier Diameters

In the report we recommended that end bearing straight-shafted and belled piers be designed with a minimum diameter of 4 feet to provide room for cleaning the base of piers and downhole of observation of the piers, if needed. We understand from Ove Arup & Partners that the piers have been designed with straight shafts using combined friction and end bearing resistance to support foundation loads. For the expected foundation loading conditions the design dimensions (length and diameter) of selected piers would be based on the recommended minimum embedment into relatively hard siltstone. Ove Arup & Partners estimates that for the foundation loads considered, that a 3-foot diameter pier could be used to provide support for the foundation loads in these areas, and has requested that K-C review our recommended minimum pier diameters for these locations.

We have revised our recommendations based on information presented in the Geotechnical Engineering Report, discussions with pier drilling contractors, and review of drilled pier construction for other projects on the UCSB Campus. We recommend that straight-shafted piers designed using end bearing resistance have a pier diameter of at least 3 feet.

The bottom of end bearing piers should be "cleaned" to remove loose and disturbed material resulting from the drilling. The specifications should provide for using hand cleaning or "special" cleaning augers or buckets to prepare the bottoms of end bearing piers. We expect that downhole observation (at least initially) of the piers will be needed to evaluate whether the method used to clean the bottom of drilled piers complies with the specifications, and to confirm that the piers are bearing on relatively hard siltstone.

## 2. Drainage below Floor Slabs

The Geotechnical Engineering Report provided recommendations for the design of slab-on-grade and site drainage. Zimmer Gunsul Frasca requested that K-C clarify our recommendations with respect to providing drainage below floor slabs.

Based on the recommendations presented in Section 5.6 of our report, drainage should be provided below the basement floor slab and behind the basement walls. Floor slabs at the ground floor level should be supported on compacted fill, and underlain by a vapor barrier. In our opinion, subsurface drainage will not need to be provided at the ground floor levels to remove infiltrating groundwater.

### 3. Concrete Pavers

We understand that concrete pavers (6-inch by 12-inch by 3-1/8 inch thick precast concrete blocks) are proposed in the court yard areas. The concrete pavers will be placed in areas that will be used for fire access. Zimmer Gunsul Frasca and UCSB has requested that K-C provide recommendations for the support of the concrete pavers. In general, we recommend that the pavers be designed according to the manufacturers recommendations. Based on the "Construction of Interlocking Concrete Pavements," National Concrete Masonry Association (NCMA), the pavers should be underlain by at least 8 inches of base material for traffic conditions similar to low volume streets. We recommend that base material consist of Class 2 aggregate base (Caltrans) compacted to at least 95 percent compaction. To provide relatively uniform support for the pavers, we recommend that the upper 1-foot of subgrade material in pavement areas (as measured below the aggregate base and/or subbase material) be compacted to at least 95 percent relative compaction, in accordance with Section 5.2.1 of the report.

Please contact the undersigned if you require additional information, or have questions regarding this addendum.

Very truly yours,
K-C Geotechnical Associates
a California Corporation

Jonathan D. Blanchard
Project Engineer, CE 47071

Ross A. Morrison
Principal Engineer, GE 621

Copies:
2 - Addressee
1 - UCSB; Attention: Mr. Steve Karzen
1 - Ove Arup & Partners; Attention: Mr. Mike Ishler
1 - Zimmer Gunsul Frasca Partnership; Attention: Mr. Joe Collins
1 - Penfield & Smith Engineers; Attention: Mr. Steve Wang

JB:km(303008)

File No. KC-1610-01
March 25, 1993

Mr. Bill Hanna
Facilities Management, Building 439
University of California
Santa Barbara, California 93106

Subject: Humanities and Social Sciences Building
University of California
Santa Barbara, California
**ADDENDUM No. 3 TO GEOTECHNICAL ENGINEERING REPORT**

Dear Mr. Hanna:

K-C Geotechnical Associates (K-C) is pleased to present this addendum to our Geotechnical Engineering Report for the proposed Humanities and Social Sciences Building project at the University of California, Santa Barbara. This addendum documents recommendations presented to Ove Arup & Partners (Structural Engineer) on March 24, 1993 regarding the spacing of drilled pier foundations. The recommendations contained in this addendum should be attached to and made a part of our Geotechnical Engineering Report, dated April 27, 1992, and Addendum No. 1 and Addendum No. 2 to the report, dated September 15, 1992 and March 24, 1993, respectively.

## 1. Foundation Design

### 1.1 Pier Spacing

The Geotechnical Engineering Report provided recommendations for the design of cast-in-place drilled pier foundations. In the report we recommended that piers be designed with a center-to-center spacing of at least 3 pier diameters. We understand from Ove Arup & Partners that at the corners of the tower building the foundations are designed with a 2 by 2 four-pier group having a center-to-center spacing of approximately 9 feet. The piers have a diameter of 4 feet with an embedment of approximately 30 to 35 feet. Ove Arup & Partners has requested that K-C review the proposed foundation design, and provide recommendations for the piers spaced less than 3 diameters center-to-center spacing.

Based on our review of the foundation design, we recommended that the capacity of the four-pier groups be designed using a group efficiency of 85 percent of the sum of the individual pier capacities. The individual pier capacities can be estimated using the recommended maximum allowable frictional and end bearing resistances presented in the Geotechnical Engineering Report.

Please contact the undersigned if you require additional information, or have questions regarding this addendum.

Very truly yours,
K-C Geotechnical Associates
a California Corporation

Jonathan D. Blanchard
Project Engineer, CE 47071

Ross A. Morrison
Principal Engineer, GE 621

Copies:
2 - Addressee
1 - UCSB; Attention: Mr. Steve Karzen
1 - Ove Arup & Partners; Attention: Mr. Mike Ishler
1 - Zimmer Gunsul Frasca Partnership; Attention: Mr. Joe Collins
1 - Penfield & Smith Engineers; Attention: Mr. Steve Wang

JB:km(303029)

Under Item G (page 11), we suggest that the reference to 95 percent relative compaction refer to "building areas" as well as pavement areas.

Section 02200, 3.7 Grading, Page 12 - Under Item F, the specified compaction of the subgrade could be inconsistent with the Compaction Subsection 3.5 for pavements. We suggest that the second sentence of this paragraph be reworded as follows:

> The bottom of the excavation shall then be cross-scarified and bladed to a depth of at least 6 inches, be moisture conditioned as needed, and be compacted in-place to at least the specified relative compaction.

In the last sentence of Item F, according to the recommendations of our report, the upper 12 inches of subgrade material should be compacted to at least 95 percent relative compaction.

Under Items F and G, referenced Sections 02211-3.06 and 02110-3.03 were not found.

Section 02200 - We suggest that the words "should" and "recommend", as used through out this section, be replaced with the words "shall" and "specify" for use with the specifications.

Section 02370, 1.1 Description of Work, Page 1 - Under Item A, we believe that this section covers the requirements for both end bearing and friction drilled piers. We recommend that Section 02370 provide for minimum pier depths shown on plans and for deepening and cleaning of the piers, as recommended by the Geotechnical Engineer.

Section 02510, 3.03 Base Course, Page 3 - To be consistent with Section 02231, we recommend that base course should be graded in layers not exceeding 0.5 feet in compacted thickness.

**Comments Regarding Plans:**

Sheet A1.7, Detail 11 - We recommend that the gravel backfill at retaining wall consist of at least a 2-foot wide zone of Class 2 permeable material (Caltrans).

Sheets C3 and C4, Drainage and Construction Notes - Detail H referenced in Note 1 is shown Sheet C7.

Sheets C3 and C4, General Notes - Under Note 2, we suggest that the approximate location of the geologic trench be shown on the plans. The recommendations of our report with regards to excavating and backfilling of the trench should be incorporated into the project plans and specifications. The contractor should be responsible for locating, excavating and backfilling the trench according to the specifications. The excavation for the trench should observed by the Geotechnical Engineer for compliance with the plans and specifications.

Sheet C4, Grading Construction Notes - Under Note 4, we recommend that the upper 12 inches of the subgrade material be compacted to at least 95 percent relative compaction. We suggest that the words "native material" be replaced by "subgrade material" for use with the grading notes.

Sheet C7, Detail H - We suggest that the specified 95% compaction be shown for the bedding layer.

Sheet S1.1, Detail 9 Foundation - Under Notes 1 and 2, the design of the foundations should be based on our Geotechnical Engineering Report, dated April 27, 1992, and addendum reports dated September 15, 1992 and March 24, 1993.

Under Note 3, our recommended equivalent fluid pressure for constrained backfill conditions is 65 pounds per cubic foot.

Under Note 5, the grading recommendations of the Geotechnical Engineering Report should be incorporated into the project plans and specifications.

Sheet S1.2, Detail 7 Typical Slab On Grade - We recommend that the reference to "natural ground" be deleted; site slabs should be supported on compacted materials.

Sheet S1.2, Detail 7 Slab On Grade Control and Construction Joints - The depth of control joints would typically be 1/4 the depth of the slab (for example, 1-1/4" for a 5-inch thick slab).

Structural Engineering Foundation Plan Sheets - We take no exceptions to the general layout shown on the 90 percent submittal. At this time the plans do not show general foundation information, for example, footing embedments and widths, pier diameters and embedments. We request that K-C be provided another opportunity to review the plans once the structural sheets are completed.

File No. KC-1610-03
June 28, 1993

Mr. Bill Hanna
Facilities Management, Building 439
University of California
Santa Barbara, California 93106

Subject: Humanities and Social Sciences Building
University of California
Santa Barbara, California
**ADDENDUM No. 4 TO GEOTECHNICAL ENGINEERING REPORT**

Dear Mr. Hanna:

K-C Geotechnical Associates (K-C) is pleased to present this addendum to our Geotechnical Engineering Report for the proposed Humanities and Social Sciences Building project at the University of California, Santa Barbara. This addendum provides the results of additional field exploration performed to evaluate the thickness of existing fill materials encountered in the west end of the Dance Studio building area. This addendum should be attached to and made a part of our Geotechnical Engineering Report, dated April 27, 1992, and Addendum Reports dated September 15, 1992, March 24, 1993, March 25, 1993 and June 30, 1993.

## 1. Field Exploration

The field exploration for this addendum consisted of drilling five exploratory borings on June 21, 1993. This field exploration program was conducted according to our letter of additional services dated June 16, 1993, as authorized by the University of California Authorization No. 123/91-92 (R2), dated June 21, 1993.

The drilling subcontractor on the project was S/G Testing Laboratory of Lompoc, California. The drilling subcontractor used a truck-mounted CME 75 drill rig equipped with hollow stem auger to advance the borings. The borings were sampled using a CME continuous sampling system. The drilling was performed under the observation of a senior staff geologist of K-C. The senior staff geologist prepared logs of the soil conditions encountered in the borings. Five, 8-inch-diameter hollow stem auger borings were drilled to depths of up to approximately 19 feet below the existing ground surface. The soils were classified in the field in accordance with the Unified Soil Classification System (see Figure A-1). The approximate locations of the exploratory borings are shown on the Boring Location Plan, Figure 1. The borings locations were surveyed by Garner Land Surveyors. The campus grid coordinates of the boring locations are presented on the log of borings sheets. The borings were backfilled with the excavated cuttings. The backfill was tamped with the drill stem. The logs of borings are attached as Borings 247B-8 through 247B-12.

## 2. Soil Conditions

The description of soil conditions is based on visual classification and laboratory tests performed on samples obtained from this phase of work and from previous (K-C 1990, K-C 1992) field exploration. Generalized geotechnical cross sections of the soil conditions encountered are shown on Figure 2.

Existing fill materials consisting of sand, silt and clay were encountered in the borings to depths of approximately 2 to 14 feet below the existing ground surface. As discussed in the Geotechnical Engineering Report, the fill material at the west end of the site was likely placed in a gully that previously occupied this area. The approximate center of the gully, shown on Figure 1, was estimated by comparing 1930 circa topographic information with the Garner Land Surveying topography for the HSSB project.

Terrace deposits were encountered below the fill material in Borings 247B-6, 247B-8 and 247B-9. The terrace deposits generally consisted of silty sand. Siltstone units of the Sisquoc Formation were encountered below the fill and terrace deposits. Groundwater in the form of free water or seepage was not observed in the borings to the total depth explored.

We trust this addendum meets your needs at this time. Please contact the undersigned if you have questions, or require additional information.

Very truly yours,
K-C Geotechnical Associates
a California Corporation

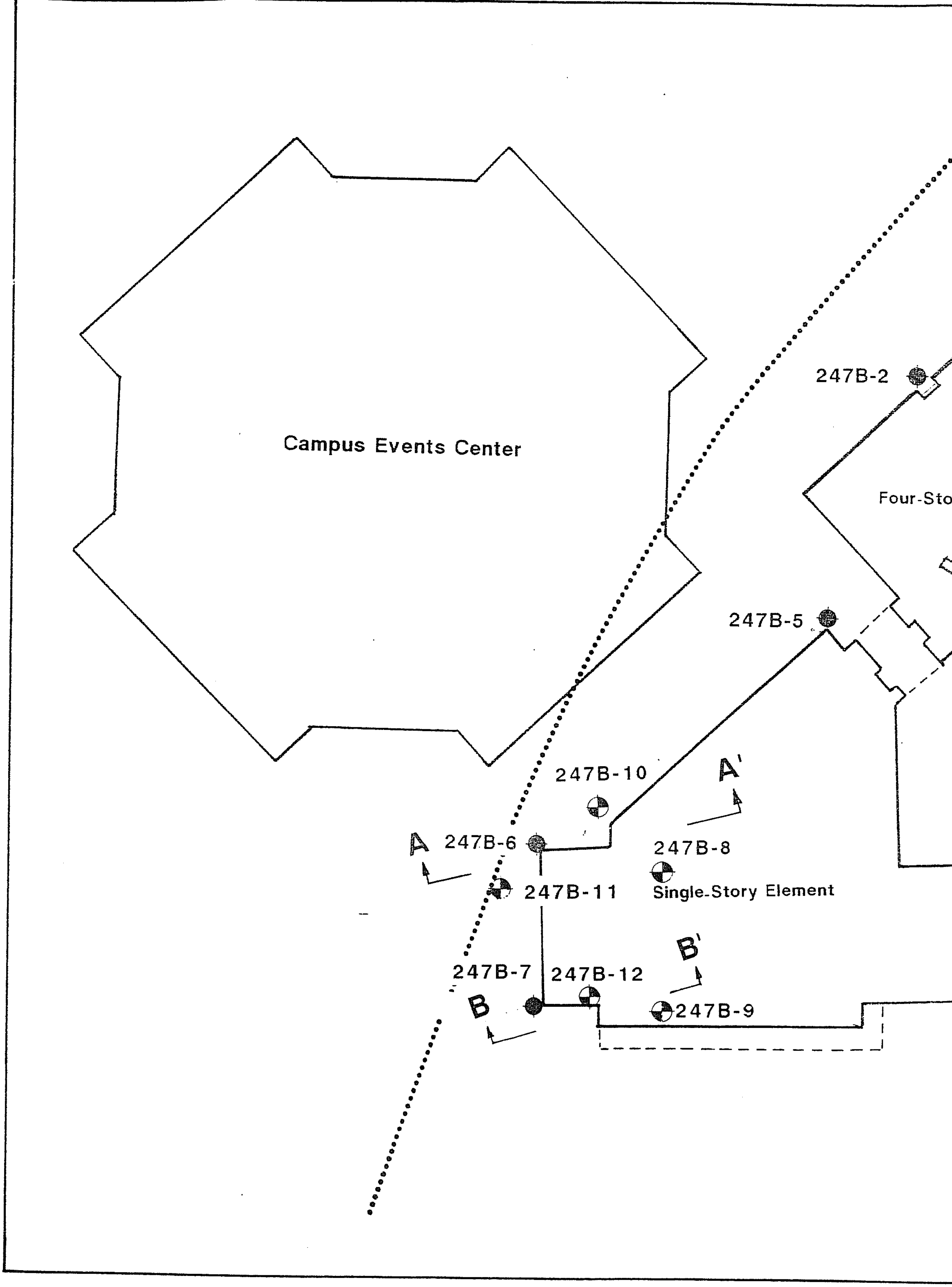
Roger C. Slayman
Senior Staff Geologist

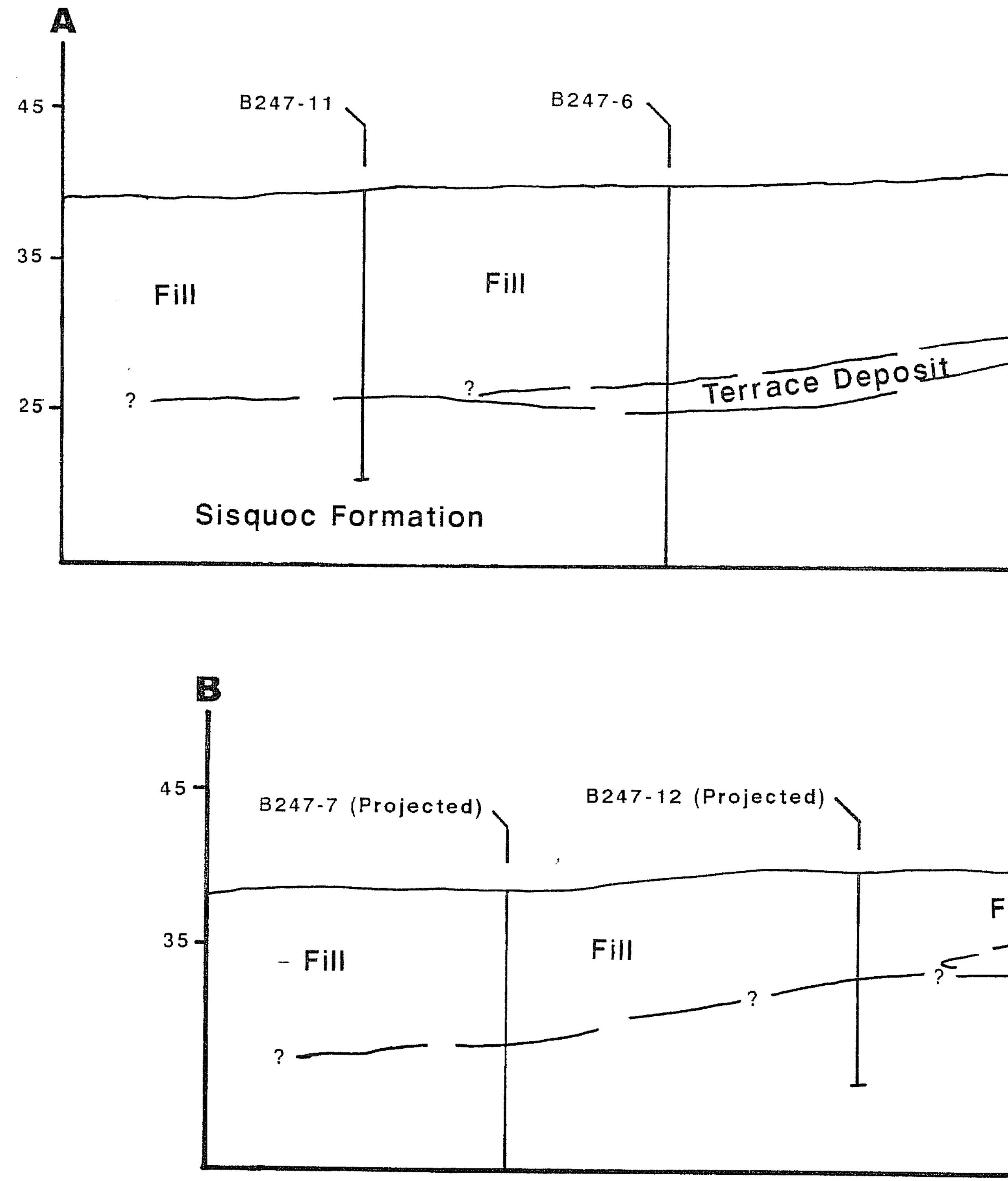
Ross A. Morrison
Principal Engineer, GE 621

Copies: 2 - Addressee

Enclosures:
Figure 1 - Boring Location Plan
Figure 2 - Generalized Geotechnical Cross Sections
Figures A-1 through A-7 - Log of Borings

RS:ns(306037)


Campus Events Center
247B-2
Four-Sto
247B-5
247B-10
A'
A
247B-6
247B-8
247B-11
Single-Story Element
B'
247B-7
247B-12
B
247B-9




Approximate Scale, Horizontal and Vertical: 1

| Major Divisions | | | Graphic Symbol | Letter Symbol | Typical Descriptions |
|---|---|---|---|---|---|
| Coarse Grained Soils | Gravel and Gravelly Soils | Clean Gravels | | GW | Well graded gravels, gravel-sand mixtures, little or no fines |
| | | (Little or no fines) | | GP | Poorly graded gravels, gravel-sand mixtures, little or no fines |
| | More than 50% of coarse fraction retained on No. 4 sieve | Gravels with Fines | | GM | Silty gravels, gravel-sand-silt mixtures |
| | | (Appreciable amount of fines) | | GC | Clayey gravels, gravel-sand-clay mixtures |
| | Sand and Sandy Soils | Clean Sands | | SW | Well graded sands, gravelly sands, little or no fines |
| More than 50% of material retained on No. 200 sieve | | (Little or no fines) | | SP | Poorly graded sands, gravelly sands, little or no fines |
| | 50% or more of coarse fraction passing No. 4 sieve | Sands with Fines | | SM | Silty sands, sand-silt mixtures |
| | | (Appreciable amount of fines) | | SC | Clayey sands, sand-clay mixtures |
| Fine Grained Soils | Silts and Clays | Liquid limit less than 50 | | ML | Inorganic silts, rock flour or clayey silt with low plasticity |
| | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |
| | | | | OL | Organic silts and clayey silts of low plasticity |
| More than 50% of material passing No. 200 sieve | Silts and Clays | Liquid limit greater than 50 | | MH | Inorganic plastic silts, micaceous or diatamaceous silts |
| | | | | CH | Inorganic clays of high plasticity, fat clays |
| | | | | OH | Organic clays of medium to high plasticity, organic silty clays |
| Highly Organic Soils | | | | PT | Peat, humus, swamp soils with high organic contents, fiberous |

NOTE: Dual symbols are used to indicate borderline soil classifications.

| Humanities and Social Sciences Building | UNIFIED SOIL CLASSIFICATION SYSTEM | File No. KC-1610-03<br>Figure A-1 |
|---|---|---|

K-C GEOTECHNICAL ASSOCIATES

FIGA1 Rev. 7-3-92

# LEGEND FOR SYMBOLS COMMONLY USED ON BORING LOGS

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USC | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTIC INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-1 | -- | | | ◄ Shelby Tube Sampler Pushed into Soils Using Drill Rig Hydraulics | 101.3 | 12.4 | | | | |
| | | 1-2 | 35 | | | ◄ Modified California Sampler Driven Using a 140-pound Hammer Dropping 30 inches | 106.5 | 25.6 | 54 | 28 | | |
| 5 | | 1A | | | | ◄ Loose Bulk Sample Obtained from Soil Cuttings | | | | | | |
| | | | | | | Water Level First Encountered ► ▽ | | | | | | |
| | | NR | 12 | | | ◄ Standard Penetration Test (SPT) Driven Using a 140-pound Hammer Dropping 30 inches | | | | NP | | |
| 10 | | | | | | Water Level After Drilling ► ▼ | | | | | | |

NR = No Recovery

NP = Non-Plastic

NOTES:

1. DATA ON THESE LOGS IS APPROXIMATE BECAUSE OF UNCERTAINTIES ASSOCIATED WITH SUBSURFACE EXPLORATION , INCOMPLETE RECOVERY OF SAMPLES, AND POSSIBLE DISTURBANCE TO THE SOIL DURING SAMPLING.
2. THESE LOGS DESCRIBE CONDITIONS ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES.
3. BORINGS WERE LOGGED IN SUCH A WAY AS TO PRIMARILY PROVIDE DATA FOR DESIGN PURPOSES AND NOT NECESSARILY FOR PURPOSES OF SPECIFIC CONSTRUCTORS.
4. SOIL CLASSIFICATIONS SHOWN ON THE LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.
5. THE STRATIFICATION LINES INDICATE THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THE TRANSITIONS MAY BE GRADUAL.

| Humanities and Social Sciences Building | LEGEND FOR BORING LOG SYMBOLS | File No. KC-1610-03<br>Figure A-2 |
|---|---|---|

K-C GEOTECHNICAL ASSOCIATES

FIGTWO Rev. 7-6-92

PROJECT: Humanities and Social Sciences Building

LOCATION: N6868.1 E4811.8
LOGGED BY: R. Slayman
DRILLING METHOD: Hollow Stem Auger
DRILLED BY: S/G Testing

DRILLING DATE: June 21, 1993
SURFACE EL. (feet): 42.7
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USCS | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ML | Sandy SILT, gray brown, moist, interbeds of clayey silt (CL-ML) and silty sand (SM) - Fill - | | | | | | |
| 5 | | | | | CL | Sandy CLAY, dark brown, moist - Fill - | | | | | | |
| | | | | | ML | Sandy SILT, mottled orange brown to gray green, moist, with shell fragments - Terrace Deposit - | | | | | | |
| | | | | | MH | "Elastic SILT", gray green, moist, siltstone - Sisquoc Formation - | | | | | | |

Boring terminated at 9 feet.

GROUNDWATER DATA:
Groundwater not encountered

# LOG OF BORING
## BORING NO. 247B- 8

File No. KC-1610-03

Figure A-3

K-C GEOTECHNICAL ASSOCIATES

KCGA Rev. 6-23-93

PROJECT: Humanities and Social Sciences Building
LOCATION: N6812.5 E4807.7
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: June 21, 1993
SURFACE EL. (feet): 42.3
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USCS | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | Silty SAND, medium brown, dry<br>- Fill - | | | | | | |
| 5 | | | | | SM | Silty SAND, gray green, moist<br>- Terrace Deposit - | | | | | | |
| | | | | | | Carbon fragments at contact | | | | | | |
| | | | | | MH | "Elastic SILT", gray green, moist, siltstone<br>- Sisquoc Formation - | | | | | | |

Boring terminated at 9 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
## BORING NO. 247B- 9

File No. KC-1610-03

Figure A-4

K-C GEOTECHNICAL ASSOCIATES

KCGA Rev. 6-23-93

PROJECT: Humanities and Social Sciences Building
LOCATION: N6894.5 E4778.2 LOGGED BY: R. Slayman
DRILLING METHOD: Hollow Stem Auger DRILLED BY: S/G Testing

DRILLING DATE: June 21, 1993
SURFACE EL. (feet): 42.5
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USCS | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | Silty SAND, gray brown, dry<br>- Fill - | | | | | | |
| 5 | | | | | CL | Sandy CLAY with gravel, dark brown, moist<br>- Fill - | | | | | | |
| | | | | | MH | "Elastic SILT", dark brown, moist<br>- Sisquoc Formation - | | | | | | |
| 10 | | | | | MH | "Elastic SILT", gray green, moist<br>- Sisquoc Formation - | | | | | | |

Boring terminated at 14 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
## BORING NO. 247B-10

File No. KC-1610-03

Figure A-5

KCGA Rev. 6-23-93

K-C GEOTECHNICAL ASSOCIATES

PROJECT: Humanities and Social Sciences Building
LOCATION: N6864.6 E4741.2
DRILLING METHOD: Hollow Stem Auger]
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: June 21, 1993
SURFACE EL. (feet): 40.2
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USCS | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | Silty SAND, gray brown, dry<br>- Fill - | | | | | | |
| | | | | | ML | Sandy SILT, dark brown, moist<br>- Fill - | | | | | | |
| 5 | | | | | SM | Silty SAND, dark brown, moist, pockets of sandy clay (CL)<br>- Fill - | | | | | | |
| 10 | | | | | | | | | | | | |
| 15 | | | | | MH | "Elastic SILT", dark brown, moist<br>Grading to gray green<br>- Sisquoc Formation - | | | | | | |

Boring terminated at 19 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
BORING NO. 247B-11

File No. KC-1610-03
Figure A-6

K-C GEOTECHNICAL ASSOCIATES

KCGA Rev. 6-23-93

PROJECT: Humanities and Social Sciences Building
LOCATION: N6835.0 E4771.2
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: R. Slayman
DRILLED BY: S/G Testing
DRILLING DATE: June 21, 1993
SURFACE EL. (feet): 40.2
DATUM: Garner (1990) Topo Plan

| DEPTH (FEET) | SAMPLE INTERVAL | SAMPLE NUMBER | BLOW COUNT (BLOWS/FOOT) | SYMBOLS: GRAPHIC LOG | SYMBOLS: USCS | DESCRIPTION AND CLASSIFICATION | DRY DENSITY | MOISTURE CONTENT (%) | ATTERBERG LIMITS: LIQUID LIMIT (%) | ATTERBERG LIMITS: PLASTICITY INDEX (%) | TORVANE (TSF) | POCKET PENETROMETER (TSF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | SM | Silty SAND, light brown, dry<br>- Fill - | | | | | | |
| | | | | | ML | Sandy SILT, gray brown, moist, with organics<br>- Fill - | | | | | | |
| 5 | | | | | SM | Silty SAND<br>- Fill - | | | | | | |
| | | | | | MH | "Elastic SILT", gray green, moist | | | | | | |
| 10 | | | | | | - Sisquoc Formation - | | | | | | |

Boring terminated at 14 feet.

GROUNDWATER DATA:
Groundwater not encountered.

# LOG OF BORING
## BORING NO. 247B-12

File No. KC-1610-03
Figure A-7

KCGA Rev. 6-23-93

K-C GEOTECHNICAL ASSOCIATES

File No. KC-1610-01
June 30, 1993

Mr. Bill Hanna
Facilities Management, Building 439
University of California
Santa Barbara, California 93106

Subject: Humanities and Socials Sciences Building
University of California
Santa Barbara, California
**ADDENDUM No. 5 TO**
**GEOTECHNICAL ENGINEERING REPORT**

Dear Mr. Hanna:

K-C Geotechnical Associates (K-C) is pleased to present this addendum to our Geotechnical Engineering Report for the Humanities and Socials Sciences Building (HSSB) project at the University of California, Santa Barbara(UCSB). This addendum documents foundation recommendations given to Ove Arup & Partners (Structural Engineers) and pavement section recommendations given to Penfield & Smith, Engineers (Civil Engineers). The recommendations contained in this addendum should be attached to and made part of our Geotechnical Engineering Report dated April 27, 1992, and addendum reports dated September 15, 1992, March 24, 1993, and March 25, 1993.

## 1. Foundation Design

The Geotechnical Engineering Report provided a recommended maximum allowable frictional resistance of 1,000 pounds per square foot to be used for the design of cast-in-place drilled piers. Ove Arup & Partners has requested that K-C review the recommended frictional resistance compared with higher recommended frictional resistances that have been provided by other consultants for projects near the HSSB site.

In our report we recommended that drilled piers should be designed using a minimum embedment of 20 feet into relatively hard siltstone of the Sisquoc Formation. The recommended maximum allowable frictional resistance is based on the estimated shear strength of the siltstone encountered to the minimum embedment depth. The Sisquoc Formation encountered at the site generally consists of approximately 10 feet of weathered and oxidized siltstone overlying less weathered and unoxidized siltstone. Although the oxidized and unoxidized materials are both relatively hard, the unoxidized siltstone typically has a shear strength at least twice that of the weathered siltstone based on the results of unconfined compression tests. The recommended frictional resistance presented in the report was essentially based on the average of the shear strength between the oxidized and unoxidized siltstone. In our opinion, the portion of a pier founded below the recommended minimum embedment depth could be designed using a higher frictional resistance estimated for the unoxidized siltstone.

Based on review of the site conditions and our recommendations, in our opinion higher frictional resistance can be used for the design of drilled piers that are deeper than the recommended minimum embedment. We have revised our recommended allowable capacity to account for the additional frictional resistance achieved with depth, as presented in the plot of maximum allowable pier capacity versus depth presented in Figure 1. The capacity of drilled piers should be estimated from the plot. The plot provides for combined frictional and end bearing resistance to estimate the capacity of 36-inch and 48-inch diameter piers, as recommended in the report and Addendum No. 2. The capacity of 24-inch diameter piers was estimated based on frictional resistance only.

## 2. Pavement Design

The Geotechnical Engineering Report provided recommendations for the design of asphalt pavements based on a traffic index (TI) of 4. The TI was selected to provide for predominantly passenger car and pick-up truck sized vehicles, and relatively light truck loading. We understand from Mr. Steve Wang of Penfield & Smith, Engineers that some of the pavements near the north end of the project will be subject to delivery truck traffic. Penfield & Smith, Engineers has requested that K-C review our pavement section recommendations with respect to the revised traffic loading conditions. We reviewed the TI for delivery truck areas with Mr. Ed Bookin of UCSB, and the UCSB Pavement Evaluation and Maintenance Study performed by the County of Santa Barbara in July 1990. Based on our review, a TI of 6 was selected for the design of pavements subject to delivery truck traffic to be consistent with other pavement designs for the campus.

Based on the TI of 6, we recommend that asphalt pavements in delivery truck areas be designed with at least 0.25 feet of asphalt concrete over 0.85 feet of aggregate base. Grading and materials for pavement areas should be provided according to the recommendations in the report.

We trust this addendum meets your needs at this time. Please contact the undersigned if you have questions, or require additional information.

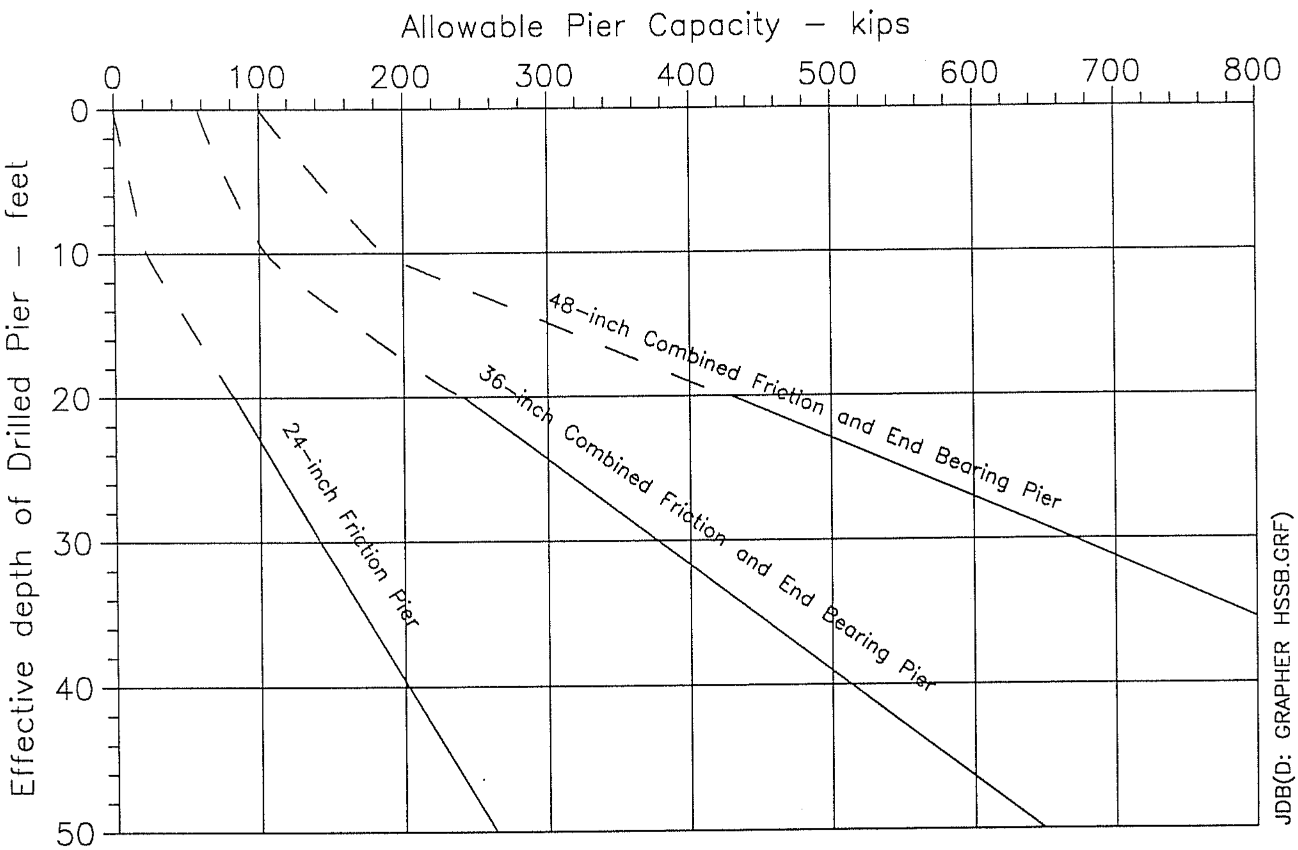
Very truly yours,
K-C Geotechnical Associates
a California Corporation

Jonathan D. Blanchard
Project Engineer, CE 47071

Ross A. Morrison
Principal Engineer, GE 621

Copies:
1 - Addressee
1 - UCSB; Attention: Mr. Steve Karzen
1 - Ove Arup & Partners: Mr. Bruce Gibbons
1 - Penfield & Smith, Engineers: Mr. Steve Wang

JB(306041)




Note: The recommended minimum embedment for drilled piers is at least 20 feet into relatively hard siltstone. The effective depth of drilled piers should be estimated as the embedment of the pier into relatively hard siltstone.

# RECOMMENDED PIER CAPACITY VERSUS DEPTH

Humanities and Social Sciences Building
University of California
Santa Barbara, California

File No. KC-1610-01

**Figure 1**

K-C GEOTECHNICAL ASSOCIATES