



March 19, 2024

Project No.: 305811-002

Report No.: 24-3-26

Attention: Jason McIlhaney  
Ventura Unified School District  
359 South Victoria Avenue  
Ventura, CA 93003

Project: Ventura High School Softball Field Renovations  
2 North Catalina Street  
Ventura, California

Subject: Evaluation of Liquefaction Potential

References: 1. Earth Systems Pacific, November 21, 2023, Geotechnical Engineering Report for Proposed Renovations to the Ventura High School Softball Field, 2 North Catalina Street, Ventura, California.  
2. Earth Systems Southern California, January 24, 2002, Geotechnical Engineering Report for 2170 East Main Street, Ventura, California (Project No. VT-22586-01).

## Introduction

The Division of the State Architect requested a liquefaction analysis for the proposed improvements to the softball field at Ventura High School. Liquefaction is typically analyzed to a depth of 51 feet below the ground surface. Reference 1 included two borings. The deepest (Boring B-1) was only advanced to a depth of 31.5 feet because a geohazard report was not expected to be required per DSA IR-A-4. However, Earth Systems was also the geotechnical engineer of record for a project directly across Main Street from the softball field (see Reference 2). The geotechnical study for 2170 E. Main Street included a 50-foot deep boring and multiple Cone Penetrometer Test (CPT) soundings that were 50 feet or deeper. The points of exploration for the Main Street project were approximately 350 to 400 feet from the proposed dugout area of the softball field.

A comparison of Boring B-1 for the softball field project and Boring B-2 and CPT-2 for the 2170 E. Main Street project are very similar in both stratigraphy and blow counts as would be expected for the proximity of the three. (The logs of each of these are attached to this report). As a result, we have utilized a combination of the data from the three exploratory points: blow counts and stratigraphy from the upper 31.5 feet of Boring B-1 on-site, blow counts and stratigraphy from the lower 18.5 feet of Boring B-2 of the Main Street project, and  $I_c$  values from CPT-2 of the Main Street project to evaluate whether the clays and silts are potentially liquefiable.

## Liquefaction Analysis

Earthquake-induced vibrations can be the cause of several significant phenomena, including liquefaction in fine sands and silty sands. Liquefaction results in a loss of strength and can cause



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structures to settle or even overturn if it occurs in the bearing zone. Liquefaction is typically limited to the upper 50 feet of soils underlying a site.

Fine sands and silty sands that are poorly graded and lie below the groundwater table are the soils most susceptible to liquefaction. Soils that have  $I_c$  values greater than 2.6, sufficiently dense soils, soils that have plasticity indices greater than 7, and/or soils located above the groundwater table are not generally susceptible to liquefaction.

An examination of the conditions existing at the site, in relation to the criteria listed above, indicates the following:

1. Groundwater was not encountered in Boring B-1 but was encountered at a depth of 30.5 feet in Boring B-2 at 2170 E. Main Street in 2001. Mapping of historically high groundwater levels by the California Geological Survey (CGS, 2003a) indicates that groundwater has risen to within about 30 feet below the ground surface near the subject site (see attached Historical High Groundwater Map). Thus, a depth of 30 feet has been assumed for this analysis.
2. Interpretations of the CPT data indicate that nearly all soil layers logged as silts or clays in the upper 50 feet have  $I_c$  values greater than 2.6, which is considered the boundary between soils prone and not prone to liquefaction (see attached CPT-2 Log and Interpretations).
3. Standard penetration tests conducted in the borings indicate that soils within the tested depth are in a (loose) (dense) state.

Based on the above, a cyclic mobility analysis was undertaken to analyze the liquefaction potentials of the various soil layers. The analysis was performed in general accordance with the methods proposed by NCEER (1997). In the analysis, the design earthquake was considered to be a 7.12 moment magnitude event, and a peak ground acceleration of 0.957 g was assumed, as per the discussion in the "Seismicity and Seismic Design" section of Reference 1.

The analysis indicated that all soil layers below the groundwater level had factors of safety that exceeded 1.3 or had  $I_c$  values greater than 2.6. Zones with factors of safety less than 1.3 or  $I_c$  values below 2.6 are considered potentially liquefiable (C.G.S., 2008, and SCEC, 1999). Based on our analysis, it is the opinion of this firm that liquefaction does not pose a hazard to the proposed improvements. However, there is a potential for approximately 0.83 inches of seismic induced settlement of dry sands in the soils above the water table (see attached calculations and curves).



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#### Downdrag Forces and Mitigation Measures

As discussed above, there is a potential for approximately 0.83 inch of seismic induced settlement of dry sands above the water table. If the soils adjacent to the drilled pier foundations undergo relative movement sufficient enough to mobilize full negative skin friction, downdrag forces will be imposed on the piers.

It should be noted that 0.43 inch of the 0.83 inch of the estimated seismic-induced dry sand settlement was predicted within the upper 4.5 feet of the soil profile. Between the depths of 4.5 and 14 feet, 0.09 inch of seismic-induced dry sand settlement was predicted. Based on the anticipated depth of the drilled piers (i.e., 15 feet or less), it does not appear that the amount of seismic-induced settlement would be significant enough to develop negative skin friction on the drilled piers.

Therefore, a negative skin friction value of 0.3 kips/foot of pier perimeter should be used for drilled piers that extend through the upper 4.5 feet of artificial fill. The downdrag force can be determined by multiplying the circumference/perimeter of the drilled pier (in feet) by the negative skin friction value given above.

As downdrag occurs, the soils undergoing downdrag will not provide downward capacity for support of the structure. The project Structural Engineer should neglect the downward axial capacity for the zones where the soil is pulling downward on the pile. In the referenced report, it was already stated that no vertical load carrying capacity is provided for the portions of the piers in artificial fill soil.

Alternatively, the upper 4.5 feet can be replaced as engineered fill to eliminate the development of negative skin friction within this zone and provide axial capacity for support of the proposed scoreboard. If selected, soils should be overexcavated to a depth of 4 feet below finished subgrade elevation at the location of the scoreboard. The overexcavation should extend throughout the footprint of the scoreboard and to a distance of 3 feet beyond the footprint of the scoreboard on all sides. The resulting surface should then be scarified an additional 6 inches, moisture conditioned, and recompact to at least 90 percent of the maximum dry density.

By replacing the upper 4.5 feet of artificial fill as compacted engineered fill, the newly compacted fill adjacent to the piers can be relied on for both vertical and lateral capacity. The portion of the piers in the newly compacted fill may be proportioned using an allowable skin friction (adhesion) value of 215 pounds per square foot (psf). An equivalent fluid weight (EFW) of 350 psf per foot of penetration in the newly compacted fill may be used for lateral load design. This resisting pressure provided is an ultimate value.



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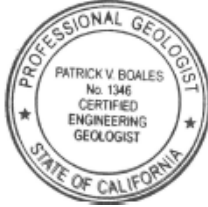
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Please call if you have any questions, or if we can be of further service.

Respectfully submitted,

**EARTH SYSTEMS PACIFIC**

Patrick V. Boales  
Engineering Geologist



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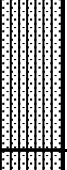
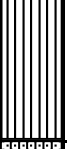
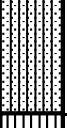
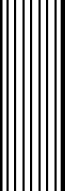
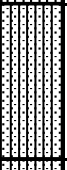
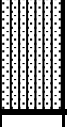
Anthony P. Mazzei  
Geotechnical Engineer



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Attach:      Log of Boring B-1 from VHS Softball Field  
                 Log of Boring B-2 from 2170 E. Main Street  
                 Log and Interpretations of CPT-2 from 2170 E. Main Street  
                 Historical High Groundwater Map  
                 Liquefaction Analysis Calculations  
                 Liquefaction Analysis Curves

Copies:      1 - Jason McIlhaney at Ventura USD  
                 1 - Todd Jespersen at KBZ Architects  
                 1 - Project File

| <b>BORING NO: B-1</b><br>PROJECT NAME: Ventura HS Softball Field Improvements<br>PROJECT NUMBER: 305811-002<br>BORING LOCATION: Per Plan |                                                                                   |     |             |                                  |                                                                                     |            |                    |                      | DRILLING DATE: October 10, 2023<br>DRILL RIG: CME 75<br>DRILLING METHOD: 8" Hollow Stem Auger<br>LOGGED BY: V. Wallace |
|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----|-------------|----------------------------------|-------------------------------------------------------------------------------------|------------|--------------------|----------------------|------------------------------------------------------------------------------------------------------------------------|
| Vertical Depth                                                                                                                           | Sample Type                                                                       |     |             | PENETRATION RESISTANCE (BLOWS/6" | SYMBOL                                                                              | USCS CLASS | UNIT DRY WT. (pcf) | MOISTURE CONTENT (%) | DESCRIPTION OF UNITS                                                                                                   |
|                                                                                                                                          | Bulk                                                                              | SPT | Mod. Calif. |                                  |                                                                                     |            |                    |                      |                                                                                                                        |
| 0                                                                                                                                        |  |     |             |                                  |                                                                                     |            |                    |                      |                                                                                                                        |
|                                                                                                                                          |                                                                                   |     |             | 3/3/5                            |    | SM         | 103.8              | 10.0                 | <b>ARTIFICIAL FILL:</b> Yellowish brown silty fine sand, trace clay, loose, moist                                      |
| 5                                                                                                                                        |                                                                                   |     |             | 7/9/11                           |    | SM         | 108.5              | 10.5                 | <b>ARTIFICIAL FILL:</b> Olive brown silty fine sand, medium dense, moist                                               |
|                                                                                                                                          |                                                                                   |     |             | 7/9/12                           |    | SM         | 103.7              | 14.2                 |                                                                                                                        |
| 10                                                                                                                                       |                                                                                   |     |             | 4/5/7                            |    | ML         | 92.6               | 21.7                 | <b>ALLUVIUM:</b> Dark yellowish brown sandy silt, little clay, stiff, moist                                            |
| 15                                                                                                                                       |                                                                                   |     |             | 7/9/12                           |   | SM         | 115.0              | 7.8                  | <b>ALLUVIUM:</b> Olive brown sand, few silt, trace gravel, medium dense, moist                                         |
| 20                                                                                                                                       |                                                                                   |     |             | 5/5/7                            |  | ML         | 96.5               | 7.9                  | <b>ALLUVIUM:</b> Olive brown sandy silt, stiff, moist                                                                  |
| 25                                                                                                                                       |                                                                                   |     |             | 3/7/9                            |  | SM         | 112.3              | 13.6                 | <b>ALLUVIUM:</b> Dark yellowish brown silty sand, medium dense, moist                                                  |
| 30                                                                                                                                       |                                                                                   |     |             | 6/13/19                          |  | SM         | 113.2              | 12.7                 | <b>ALLUVIUM:</b> Yellowish brown silty sand, medium dense, moist                                                       |
| 35                                                                                                                                       |                                                                                   |     |             |                                  |                                                                                     |            |                    |                      | <b>Total Depth 31.5 Feet</b><br><b>No Groundwater Encountered</b>                                                      |

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

**BORING NO:** 2

**PROJECT NAME:** 2170 E. Main St.

**PROJECT NUMBER:** 22586-01

**BORING LOCATION:** Per Plan

**DRILLING DATE:** 11/26/01

**DRILLING METHOD:** 6 " Hollow Stem

**DRILL:** Mobile B-80

**LOGGED BY:** KG

| VERTICAL<br>DEPTH (feet) | SAMPLE<br>TYPE |     |             | PENETRATION<br>RESISTANCE<br>(BLOWS/6") | SYMBOL | USCS CLASS | UNIT DRY WT.<br>(pcf) | MOISTURE<br>CONTENT (%) | DESCRIPTION OF UNITS                                                                                                                     |
|--------------------------|----------------|-----|-------------|-----------------------------------------|--------|------------|-----------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|                          | Bulk           | SPT | Mod. Calif. |                                         |        |            |                       |                         |                                                                                                                                          |
| 0                        |                |     |             |                                         |        |            |                       |                         | FILL                                                                                                                                     |
| 1                        |                |     |             | 6/8/8                                   |        | ML         | 99                    | 12                      | Moderate to dark yellow brown, fine sandy silt.                                                                                          |
| 2                        |                |     |             | 4/6/7                                   |        | ML         | --                    | 12                      | Same as above.                                                                                                                           |
| 3                        |                |     |             | 4/5/6                                   |        | ML         | 81                    | 19                      | Same as above.                                                                                                                           |
| 4                        |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 5                        |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 6                        |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 7                        |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 8                        |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 9                        |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 10                       |                |     |             | 4/5/5                                   |        | ML         | 110                   | 12                      | ALLUVIUM<br>Dark brown, silty fine sand to sandy silty, with trace clay.                                                                 |
| 11                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 12                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 13                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 14                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 15                       |                |     |             | 4/6/9                                   |        | ML         | 95                    | 24                      | Same as above, more clay.                                                                                                                |
| 16                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 17                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 18                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 19                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 20                       |                |     |             | 7/9/14                                  |        | SM         | 103                   | 10                      | Tan, fine to medium sand, with trace of silt.                                                                                            |
| 21                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 22                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 23                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 24                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 25                       |                |     |             | 4/9/19                                  |        | CL         | 104                   | 18                      | Moderate olive brown, fine sandy clay with some silt, trace caliche, some interbeds of silty fine sand with trace clay.                  |
| 26                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 27                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 28                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 29                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 30                       |                |     |             | 5/7/11                                  |        | SM         | --                    | 24                      | Dark tan, fine to medium sand, with trace of silt.  |
| 31                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 32                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 33                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 34                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 35                       |                |     |             | 3/3/4                                   |        | CL         | --                    | 28                      | Same as above.                                                                                                                           |
| 36                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 37                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 38                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 39                       |                |     |             |                                         |        |            |                       |                         |                                                                                                                                          |
| 40                       |                |     |             | 3/3/6                                   |        | SC         | --                    | 18                      | Moderate yellow brown, medium to coarse sand with clay.                                                                                  |

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradual.

BORING NO: 2 cont.

PROJECT NAME: 2170 E. Main St.

PROJECT NUMBER: 22586-01

BORING LOCATION: Per Plan

DRILLING DATE: 11/26/01

DRILLING METHOD: 6" Hollow Stem

DRILL: Mobile B-80

LOGGED BY: KG

[illegible]

Total Depth = 51 feet

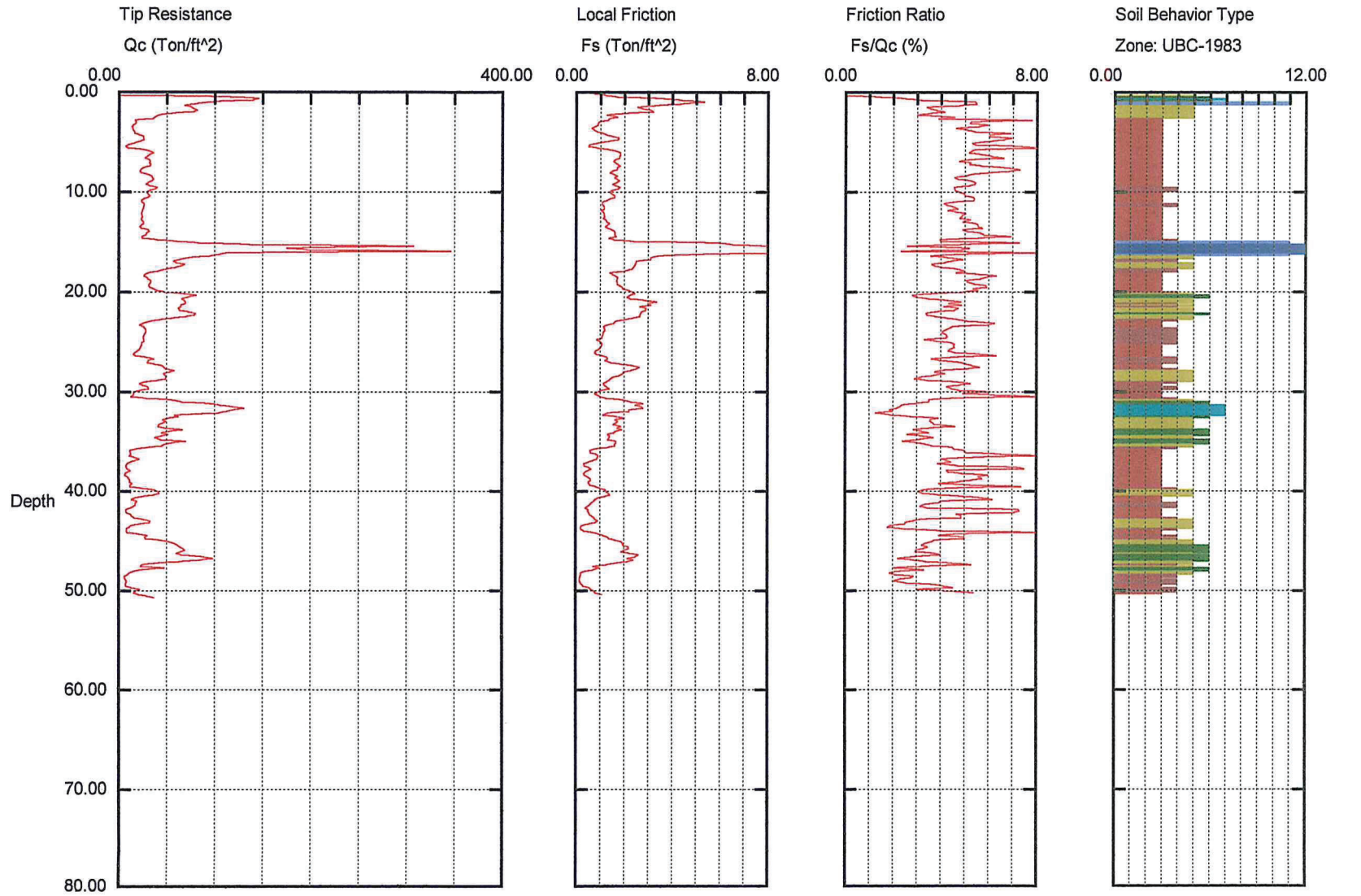
Groundwater Encountered at 10 feet

Note: The stratification lines shown represent the approximate boundary between soil and/or rock types and the transition may be gradual.

# EarthSystems S. California

Operator: 2170 E MAIN ST  
Sounding: SDF237  
Cone Used: 705 R#1 GO-JH

CPT Date/Time: 11-19-01 10:55  
Location: CPT-02  
Job Number: VT-22586-01

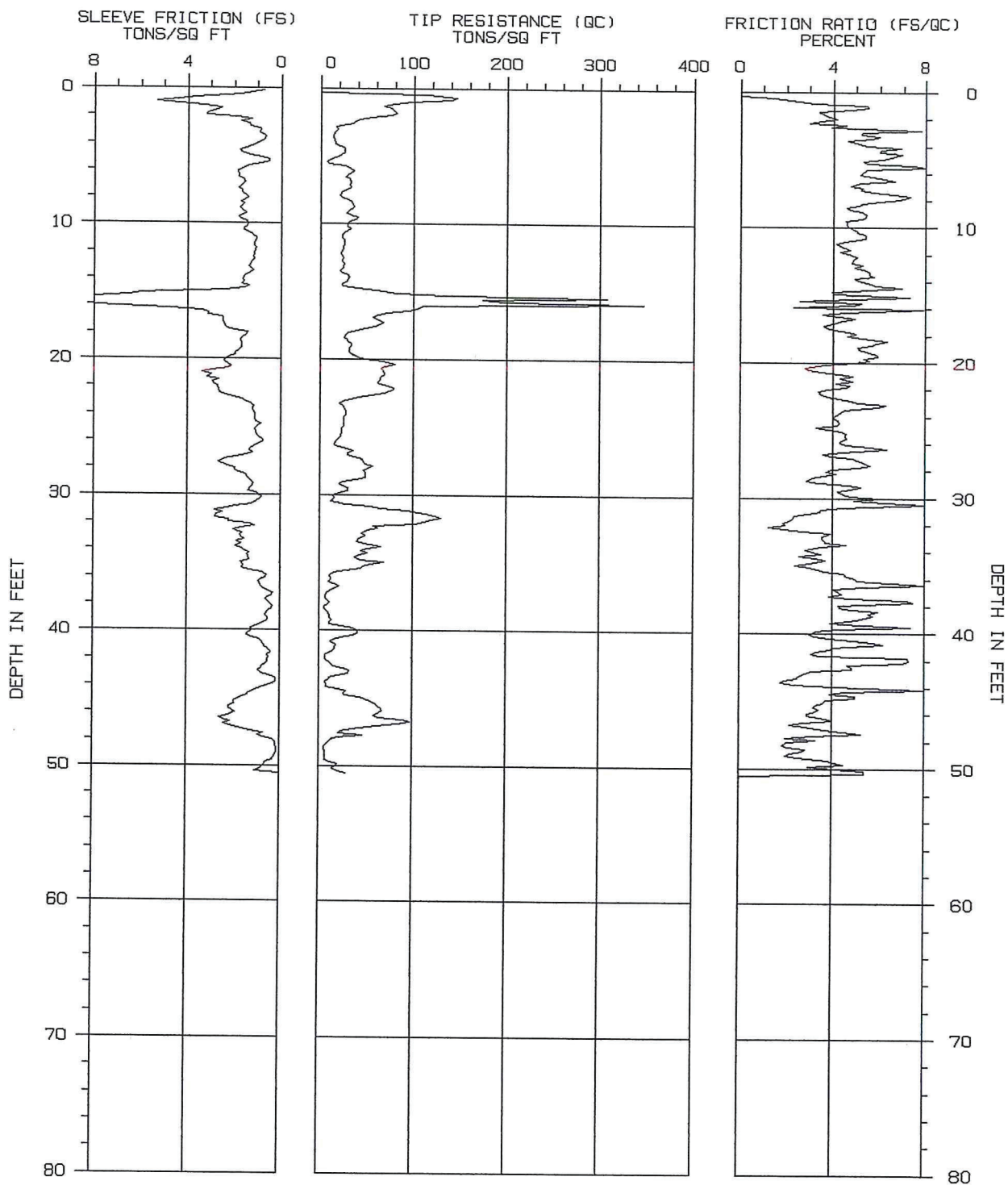


1 sensitive fine grained  
2 organic material  
3 clay

4 silty clay to clay  
5 clayey silt to silty clay  
6 sandy silt to clayey silt

7 silty sand to sandy silt  
8 sand to silty sand  
9 sand

10 gravelly sand to sand  
11 very stiff fine grained (\*)  
12 sand to clayey sand (\*)



TIP RESISTANCE NOT CORRECTED FOR END AREA EFFECT

CONE PENETRATION TEST

SOUNDING NUMBER: CPT-02

PROJECT NAME : 2170 E MAIN ST

CONE/RIG : 705 R#1 G0-JH

PROJECT NUMBER : VT-22586-01

DATE/TIME: 11-19-01 10:55



H  
F  
A

\*\*\*\*\*  
 \*  
 \* CPT INTERPRETATIONS \*  
 \*  
 \* SOUNDING : CPT-02 PROJECT No.: VT-22586-01 \*  
 \* PROJECT : 2170 E MAIN ST CONE/RIG : 705 R#1 GO-JH \*  
 \* DATE/TIME: 11-19-01 10:55 \*  
 \*  
 \*\*\*\*\*

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| DEPTH | DEPTH | TIP                 | FRICTION     | SOIL BEHAVIOR TYPE        | N(60) | N1(60) | Dr  | Su    | PHI       |
|-------|-------|---------------------|--------------|---------------------------|-------|--------|-----|-------|-----------|
| (m)   | (ft)  | RESISTANCE<br>(tsf) | RATIO<br>(%) |                           |       |        | (%) | (tsf) | (Degrees) |
| .150  | .49   | 115.57              | 1.48         | SAND to SILTY SAND        | 29    | 46     | 80  |       |           |
| .300  | .98   | 98.45               | 5.41         | *VERY STIFF FINE GRAINED  | 98    | 100    |     |       |           |
| .450  | 1.48  | 75.25               | 3.40         | SANDY SILT to CLAYEY SILT | 30    | 48     |     | 4.4   |           |
| .600  | 1.97  | 77.46               | 4.14         | CLAYEY SILT to SILTY CLAY | 39    | 62     |     | 4.5   |           |
| .750  | 2.46  | 37.58               | 4.55         | CLAY to SILTY CLAY        | 25    | 40     |     | 2.2   |           |
| .900  | 2.95  | 17.89               | 5.25         | CLAY                      | 18    | 29     |     | 1.2   |           |
| 1.050 | 3.44  | 13.79               | 5.58         | CLAY                      | 14    | 22     |     | .9    |           |
| 1.200 | 3.94  | 16.42               | 5.42         | CLAY                      | 16    | 26     |     | 1.1   |           |
| 1.350 | 4.43  | 25.49               | 6.00         | CLAY                      | 25    | 41     |     | 1.5   |           |
| 1.500 | 4.92  | 22.05               | 6.08         | CLAY                      | 22    | 35     |     | 1.3   |           |
| 1.650 | 5.41  | 7.03                | 7.40         | CLAY                      | 7     | 11     |     | .4    |           |
| 1.800 | 5.91  | 32.08               | 5.27         | CLAY                      | 32    | 51     |     | 1.9   |           |
| 1.950 | 6.40  | 29.23               | 6.16         | CLAY                      | 29    | 47     |     | 1.7   |           |
| 2.100 | 6.89  | 32.70               | 4.77         | CLAY                      | 33    | 52     |     | 1.9   |           |
| 2.250 | 7.38  | 31.85               | 5.71         | CLAY                      | 32    | 49     |     | 1.8   |           |
| 2.400 | 7.87  | 21.90               | 6.85         | CLAY                      | 22    | 33     |     | 1.3   |           |
| 2.550 | 8.37  | 33.86               | 5.05         | CLAY                      | 34    | 49     |     | 2.0   |           |
| 2.700 | 8.86  | 34.23               | 5.23         | CLAY                      | 34    | 48     |     | 2.0   |           |
| 2.850 | 9.35  | 32.23               | 5.18         | CLAY                      | 32    | 44     |     | 1.9   |           |
| 3.000 | 9.84  | 32.04               | 4.59         | CLAY to SILTY CLAY        | 21    | 28     |     | 1.9   |           |
| 3.150 | 10.33 | 32.08               | 5.02         | CLAY                      | 32    | 42     |     | 1.9   |           |
| 3.300 | 10.83 | 23.31               | 5.36         | CLAY                      | 23    | 30     |     | 1.3   |           |
| 3.450 | 11.32 | 26.24               | 4.27         | CLAY to SILTY CLAY        | 17    | 22     |     | 1.7   |           |
| 3.600 | 11.81 | 24.45               | 4.29         | CLAY to SILTY CLAY        | 16    | 20     |     | 1.6   |           |
| 3.750 | 12.30 | 23.94               | 4.89         | CLAY                      | 24    | 28     |     | 1.4   |           |
| 3.900 | 12.80 | 23.33               | 5.23         | CLAY                      | 23    | 27     |     | 1.3   |           |
| 4.050 | 13.29 | 23.28               | 5.54         | CLAY                      | 23    | 27     |     | 1.3   |           |
| 4.200 | 13.78 | 30.25               | 4.93         | CLAY                      | 30    | 34     |     | 1.7   |           |
| 4.350 | 14.27 | 27.62               | 5.79         | CLAY                      | 28    | 30     |     | 1.6   |           |
| 4.500 | 14.76 | 39.81               | 3.97         | CLAYEY SILT to SILTY CLAY | 20    | 22     |     | 2.3   |           |
| 4.650 | 15.26 | 135.71              | 4.81         | *VERY STIFF FINE GRAINED  | 100   | 100    |     |       |           |
| 4.800 | 15.75 | 196.13              | 4.88         | *VERY STIFF FINE GRAINED  | 100   | 100    |     |       |           |
| 4.950 | 16.24 | 104.33              | 4.54         | *VERY STIFF FINE GRAINED  | 100   | 100    |     |       |           |
| 5.100 | 16.73 | 62.91               | 4.93         | CLAY to SILTY CLAY        | 42    | 43     |     | 3.6   |           |
| 5.250 | 17.22 | 68.45               | 3.61         | CLAYEY SILT to SILTY CLAY | 34    | 34     |     | 4.0   |           |
| 5.400 | 17.72 | 49.39               | 4.68         | CLAY to SILTY CLAY        | 33    | 33     |     | 2.8   |           |
| 5.550 | 18.21 | 27.21               | 5.59         | CLAY                      | 27    | 27     |     | 1.5   |           |
| 5.700 | 18.70 | 30.30               | 5.64         | CLAY                      | 30    | 29     |     | 1.7   |           |
| 5.850 | 19.19 | 31.46               | 5.40         | CLAY                      | 31    | 30     |     | 1.8   |           |
| 6.000 | 19.69 | 36.31               | 5.34         | CLAY                      | 36    | 34     |     | 2.1   |           |
| 6.150 | 20.18 | 68.07               | 3.60         | CLAYEY SILT to SILTY CLAY | 34    | 32     |     | 3.9   |           |

\*INDICATES OVERCONSOLIDATED OR CEMENTED MATERIAL  
 ASSUMED TOTAL UNIT WT = 115 pcf  
 ASSUMED DEPTH OF WATER TABLE = 30.0 ft  
 N(60) = EQUIVALENT SPT VALUE (60% Energy)  
 N1(60) = OVERBURDEN NORMALIZED EQUIVALENT SPT VALUE (60% Energy)  
 Dr = OVERBURDEN NORMALIZED EQUIVALENT RELATIVE DENSITY  
 Su = OVERBURDEN NORMALIZED UNDRAINED SHEAR STRENGTH  
 PHI = OVERBURDEN NORMALIZED EQUIVALENT FRICTION ANGLE

HOLGUIN, FAHAN & ASSOCIATES, INC.

Interpretations based on: Robertson and Campanella, 1989.

## SOUNDING : CPT-02

| DEPTH<br>(m) | DEPTH<br>(ft) | TIP<br>RESISTANCE<br>(tsf) | FRICTION<br>RATIO<br>(%) | SOIL BEHAVIOR TYPE        | N(60) | N1(60) | Dr<br>(%) | Su<br>(tsf) | PHI<br>(Degrees) |
|--------------|---------------|----------------------------|--------------------------|---------------------------|-------|--------|-----------|-------------|------------------|
| 6.300        | 20.67         | 65.46                      | 3.48                     | CLAYEY SILT to SILTY CLAY | 33    | 30     |           | 3.8         |                  |
| 6.450        | 21.16         | 68.96                      | 4.32                     | CLAYEY SILT to SILTY CLAY | 34    | 31     |           | 4.0         |                  |
| 6.600        | 21.65         | 61.99                      | 4.73                     | CLAY to SILTY CLAY        | 41    | 37     |           | 3.6         |                  |
| 6.750        | 22.15         | 79.58                      | 3.38                     | SANDY SILT to CLAYEY SILT | 32    | 28     |           | 4.6         |                  |
| 6.900        | 22.64         | 54.90                      | 4.26                     | CLAYEY SILT to SILTY CLAY | 27    | 24     |           | 3.2         |                  |
| 7.050        | 23.13         | 24.98                      | 6.24                     | CLAY                      | 25    | 22     |           | 1.4         |                  |
| 7.200        | 23.62         | 27.09                      | 4.36                     | CLAY to SILTY CLAY        | 18    | 15     |           | 1.5         |                  |
| 7.350        | 24.11         | 27.62                      | 4.06                     | CLAY to SILTY CLAY        | 18    | 16     |           | 1.7         |                  |
| 7.500        | 24.61         | 25.45                      | 4.20                     | CLAY to SILTY CLAY        | 17    | 14     |           | 1.6         |                  |
| 7.650        | 25.10         | 23.99                      | 4.42                     | CLAY to SILTY CLAY        | 16    | 13     |           | 1.5         |                  |
| 7.800        | 25.59         | 22.14                      | 4.56                     | CLAY                      | 22    | 18     |           | 1.4         |                  |
| 7.950        | 26.08         | 16.78                      | 4.59                     | CLAY                      | 17    | 14     |           | 1.0         |                  |
| 8.100        | 26.57         | 29.38                      | 4.39                     | CLAY to SILTY CLAY        | 20    | 16     |           | 1.6         |                  |
| 8.250        | 27.07         | 29.85                      | 4.86                     | CLAY                      | 30    | 24     |           | 1.7         |                  |
| 8.400        | 27.56         | 47.29                      | 5.60                     | CLAY                      | 47    | 38     |           | 2.7         |                  |
| 8.550        | 28.05         | 52.67                      | 3.74                     | CLAYEY SILT to SILTY CLAY | 26    | 21     |           | 3.0         |                  |
| 8.700        | 28.54         | 48.76                      | 3.12                     | CLAYEY SILT to SILTY CLAY | 24    | 19     |           | 3.1         |                  |
| 8.850        | 29.04         | 26.34                      | 4.71                     | CLAY                      | 26    | 20     |           | 1.5         |                  |
| 9.000        | 29.53         | 29.89                      | 4.25                     | CLAY to SILTY CLAY        | 20    | 15     |           | 1.7         |                  |
| 9.150        | 30.02         | 15.02                      | 6.06                     | CLAY                      | 15    | 11     |           | .9          |                  |
| 9.300        | 30.51         | 12.70                      | 8.19                     | CLAY                      | 13    | 10     |           | .7          |                  |
| 9.450        | 31.00         | 65.52                      | 3.50                     | CLAYEY SILT to SILTY CLAY | 33    | 25     |           | 3.7         |                  |
| 9.600        | 31.50         | 118.61                     | 2.30                     | SILTY SAND to SANDY SILT  | 40    | 30     | 64        |             | 38.5             |
| 9.750        | 31.99         | 111.90                     | 1.97                     | SILTY SAND to SANDY SILT  | 37    | 28     | 62        |             | 38.0             |
| 9.900        | 32.48         | 62.03                      | 2.72                     | SANDY SILT to CLAYEY SILT | 25    | 19     |           | 4.0         |                  |
| 10.050       | 32.97         | 48.91                      | 3.56                     | CLAYEY SILT to SILTY CLAY | 24    | 18     |           | 2.8         |                  |
| 10.200       | 33.46         | 40.58                      | 4.58                     | CLAY to SILTY CLAY        | 27    | 20     |           | 2.3         |                  |
| 10.350       | 33.96         | 51.88                      | 3.18                     | CLAYEY SILT to SILTY CLAY | 26    | 19     |           | 3.3         |                  |
| 10.500       | 34.45         | 43.34                      | 3.25                     | CLAYEY SILT to SILTY CLAY | 22    | 16     |           | 2.8         |                  |
| 10.650       | 34.94         | 69.47                      | 2.40                     | SANDY SILT to CLAYEY SILT | 28    | 20     |           | 4.5         |                  |
| 10.800       | 35.43         | 44.57                      | 3.63                     | CLAYEY SILT to SILTY CLAY | 22    | 16     |           | 2.5         |                  |
| 10.950       | 35.93         | 11.43                      | 4.99                     | CLAY                      | 11    | 8      |           | .6          |                  |
| 11.100       | 36.42         | 10.94                      | 8.41                     | CLAY                      | 11    | 8      |           | .6          |                  |
| 11.250       | 36.91         | 16.21                      | 4.26                     | CLAY                      | 16    | 12     |           | .9          |                  |
| 11.400       | 37.40         | 7.22                       | 4.71                     | CLAY                      | 7     | 5      |           | .3          |                  |
| 11.550       | 37.89         | 11.75                      | 4.26                     | CLAY                      | 12    | 8      |           | .6          |                  |
| 11.700       | 38.39         | 6.05                       | 5.95                     | CLAY                      | 6     | 4      |           | .3          |                  |
| 11.850       | 38.88         | 11.43                      | 5.25                     | CLAY                      | 11    | 8      |           | .6          |                  |
| 12.000       | 39.37         | 11.49                      | 5.22                     | CLAY                      | 11    | 8      |           | .6          |                  |
| 12.150       | 39.86         | 37.03                      | 3.29                     | CLAYEY SILT to SILTY CLAY | 19    | 13     |           | 2.3         |                  |
| 12.300       | 40.35         | 35.97                      | 3.89                     | CLAYEY SILT to SILTY CLAY | 18    | 13     |           | 2.0         |                  |
| 12.450       | 40.85         | 12.83                      | 6.16                     | CLAY                      | 13    | 9      |           | .7          |                  |
| 12.600       | 41.34         | 16.78                      | 3.28                     | CLAY to SILTY CLAY        | 11    | 8      |           | 1.0         |                  |
| 12.750       | 41.83         | 7.05                       | 7.23                     | CLAY                      | 7     | 5      |           | .3          |                  |
| 12.900       | 42.32         | 11.79                      | 4.66                     | CLAY                      | 12    | 8      |           | .6          |                  |
| 13.050       | 42.81         | 25.77                      | 3.10                     | CLAYEY SILT to SILTY CLAY | 13    | 9      |           | 1.6         |                  |
| 13.200       | 43.31         | 20.03                      | 2.50                     | CLAYEY SILT to SILTY CLAY | 10    | 7      |           | 1.2         |                  |
| 13.350       | 43.80         | 7.56                       | 2.38                     | CLAY to SILTY CLAY        | 5     | 3      |           | .4          |                  |
| 13.500       | 44.29         | 20.88                      | 4.55                     | CLAY                      | 21    | 14     |           | 1.2         |                  |
| 13.650       | 44.78         | 27.89                      | 4.98                     | CLAY                      | 28    | 19     |           | 1.5         |                  |

\*INDICATES OVERCONSOLIDATED OR CEMENTED MATERIAL

ASSUMED TOTAL UNIT WT = 115 pcf

ASSUMED DEPTH OF WATER TABLE = 30.0 ft

N(60) = EQUIVALENT SPT VALUE (60% Energy)

N1(60) = OVERBURDEN NORMALIZED EQUIVALENT SPT VALUE (60% Energy)

Dr = OVERBURDEN NORMALIZED EQUIVALENT RELATIVE DENSITY

Su = OVERBURDEN NORMALIZED UNDRAINED SHEAR STRENGTH

PHI = OVERBURDEN NORMALIZED EQUIVALENT FRICTION ANGLE

HOLGUIN, FAHAN & ASSOCIATES, INC.

Interpretations based on: Robertson and Campanella, 1989.

## SOUNDING : CPT-02

| DEPTH<br>(m) | DEPTH<br>(ft) | TIP<br>RESISTANCE<br>(tsf) | FRICTION<br>RATIO<br>(%) | SOIL BEHAVIOR TYPE        | N(60) | N1(60) | Dr<br>(%) | Su<br>(tsf) | PHI<br>(Degrees) |
|--------------|---------------|----------------------------|--------------------------|---------------------------|-------|--------|-----------|-------------|------------------|
| 13.800       | 45.28         | 58.47                      | 3.32                     | CLAYEY SILT to SILTY CLAY | 29    | 20     |           | 3.3         |                  |
| 13.950       | 45.77         | 66.81                      | 3.28                     | SANDY SILT to CLAYEY SILT | 27    | 18     |           | 3.8         |                  |
| 14.100       | 46.26         | 59.63                      | 3.74                     | CLAYEY SILT to SILTY CLAY | 30    | 20     |           | 3.4         |                  |
| 14.250       | 46.75         | 97.49                      | 2.21                     | SILTY SAND to SANDY SILT  | 32    | 22     | 55        |             | 37.0             |
| 14.400       | 47.24         | 36.16                      | 4.45                     | CLAY to SILTY CLAY        | 24    | 16     |           | 2.0         |                  |
| 14.550       | 47.74         | 47.04                      | 2.02                     | SANDY SILT to CLAYEY SILT | 19    | 13     |           | 3.0         |                  |
| 14.700       | 48.23         | 10.20                      | 1.86                     | CLAYEY SILT to SILTY CLAY | 5     | 3      |           | .6          |                  |
| 14.850       | 48.72         | 5.50                       | 2.73                     | CLAY                      | 6     | 4      |           | .2          |                  |
| 15.000       | 49.21         | 7.05                       | 2.55                     | CLAY to SILTY CLAY        | 5     | 3      |           | .3          |                  |
| 15.150       | 49.70         | 12.43                      | 4.51                     | CLAY                      | 12    | 8      |           | .6          |                  |
| 15.300       | 50.20         | 15.25                      | 5.38                     | CLAY                      | 15    | 10     |           | .8          |                  |

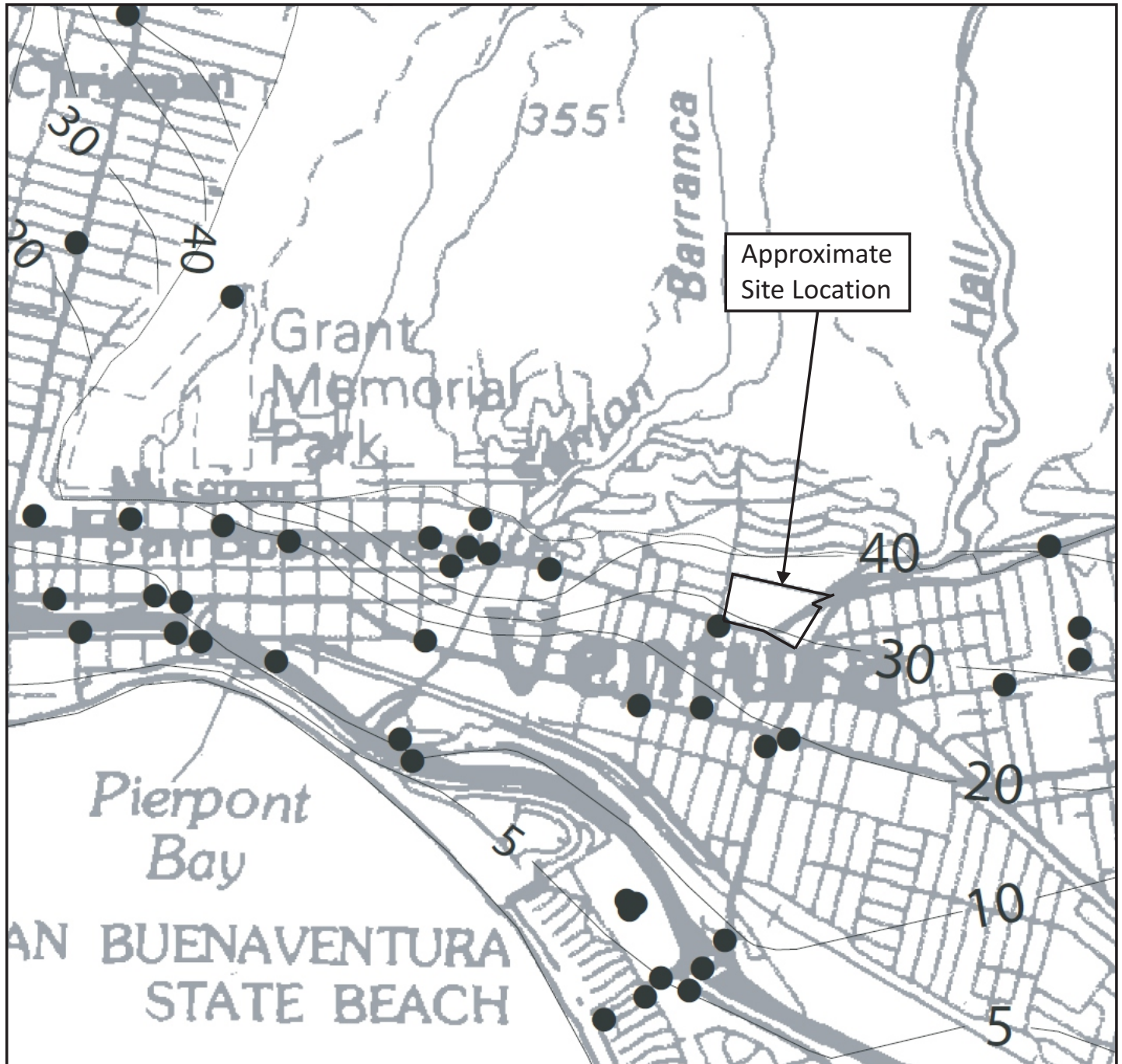
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\*INDICATES OVERCONSOLIDATED OR CEMENTED MATERIAL  
 ASSUMED TOTAL UNIT WT = 115 pcf  
 ASSUMED DEPTH OF WATER TABLE = 30.0 ft  
 N(60) = EQUIVALENT SPT VALUE (60% Energy)  
 N1(60) = OVERBURDEN NORMALIZED EQUIVALENT SPT VALUE (60% Energy)  
 Dr = OVERBURDEN NORMALIZED EQUIVALENT RELATIVE DENSITY  
 Su = OVERBURDEN NORMALIZED UNDRAINED SHEAR STRENGTH  
 PHI = OVERBURDEN NORMALIZED EQUIVALENT FRICTION ANGLE

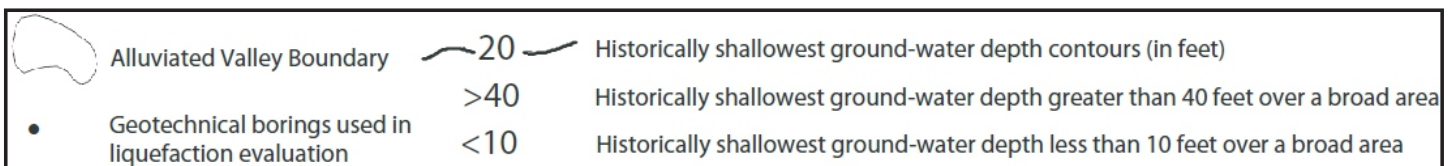
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HOLGUIN, FAHAN & ASSOCIATES, INC.

Interpretations based on: Robertson and Campanella, 1989.



\*Taken from CGS, Seismic Hazard Zone Report For The 7.5-Minute Quadrangle, Ventura County, California, 2003.



Approximate Scale: 1" = 2,000'

0 2,000' 4,000'



## HISTORICAL HIGH GROUNDWATER MAP

Ventura High School, 2 North Catalina Street  
Ventura, California



**Earth Systems**

November 2023

305811-002

LIQUEFY-v2dot45.XLS - A SPREADSHEET FOR EMPIRICAL ANALYSIS OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

Coryright & Developed 2007 by Shelton L. Stringer, PE, GE, PG , EG - Earth Systems Southwest  
(Modified by R. Beard to use 2/3's PGAm for Seismic Induced Settlement of Dry Sands)

Project: **Ventura HS Softball Field Improvements**  
Job No: **305811-002**  
Date: **3/11/2024**  
Boring: **B1**

Data Set: **1**

Methods:  
Journal of Geotechnical and Enviromental Engineering (JGEE), October 2001, Vol 127, No. 10, ASCE  
Settlement Analysis from Tokimatsu and Seed (1987), JGEE,Vol 113, No.8, ASCE  
Modified by Pradel, JGEE, Vol 124, No. 4, ASCE

Total (ft)  
Liquefied  
Thickness  
0.0

Total (in.)  
Induced  
Subsidence  
0.8  
upper 50 ft

EARTHQUAKE INFORMATION:

Magnitude: **7.12** 7.5  
PGA, g: **0.96** 0.84  
MSF: 1.14  
GWT: **30.0** feet  
Calc GWT: **30.0** feet  
Remediate to: **0.0** feet

SPT N VALUE CORRECTIONS:

Energy Correction to N60 (C<sub>E</sub>): **1.33** Automatic Hammer  
Drive Rod Corr. (C<sub>R</sub>): **1** Default  
Rod Length above ground (feet): **3.0**  
Borehole Dia. Corr. (C<sub>B</sub>): **1.00**  
Sampler Liner Correction for SPT?: **1.0** Yes  
Cal Mod/ SPT Ratio: **0.63**

Required SF: **1.30**

Threshold Acceler., g: **#N/A** Minimum Calculated SF: **#N/A**

| Base   | Cal | Liquef. |          | Total    | Fines   | Depth  | Rod    | Tot.Stress |           |      | Eff.Stress     |                |                | Rel.               |        |                     | Trigger              |                | Equiv.    |         | M = 7.5  |                     | M =7.5               |      | Liquefac.  | Post |  | Volumetric |  | Induced |
|--------|-----|---------|----------|----------|---------|--------|--------|------------|-----------|------|----------------|----------------|----------------|--------------------|--------|---------------------|----------------------|----------------|-----------|---------|----------|---------------------|----------------------|------|------------|------|--|------------|--|---------|
| Depth  | Mod | SPT     | Suscept. | Unit Wt. | Content | of SPT | Length | at SPT     | at SPT    | rd   | C <sub>N</sub> | C <sub>R</sub> | C <sub>S</sub> | N <sub>1(60)</sub> | Dens.  | FC Adj.             | Sand                 | K <sub>σ</sub> | Available | Induced | Safety   | FC Adj.             | Strain               |      | Subsidence |      |  |            |  |         |
| (feet) | N   | N       | (0 or 1) | (pcf)    | (%)     | (feet) | (feet) | po (tsf)   | p'o (tsf) |      |                |                |                |                    | Dr (%) | ΔN <sub>1(60)</sub> | N <sub>1(60)CS</sub> |                | CRR       | CSR*    | Factor   | ΔN <sub>1(60)</sub> | N <sub>1(60)CS</sub> | (%)  | (in.)      |      |  |            |  |         |
| 4.5    | 8   | 5       | 1        | 125      | 20      | 2.5    | 5.5    | 0.156      | 0.156     | 1.00 | 1.70           | 0.75           | 1.00           | 8.5                | 35     | 4.3                 | 12.8                 | 1.00           | 0.139     | 0.543   | Non-Liq. | 4.3                 | 12.8                 | 0.80 | 0.43       |      |  |            |  |         |
| 7.0    | 20  | 13      | 1        | 125      | 20      | 5.0    | 8.0    | 0.313      | 0.313     | 0.99 | 1.70           | 0.75           | 1.00           | 21.4               | 55     | 5.3                 | 26.7                 | 1.00           | 0.313     | 0.539   | Non-Liq. | 5.3                 | 26.7                 | 0.12 | 0.04       |      |  |            |  |         |
| 9.5    | 21  | 13      | 1        | 125      | 20      | 7.5    | 10.5   | 0.469      | 0.469     | 0.98 | 1.50           | 0.75           | 1.00           | 19.8               | 53     | 5.2                 | 25.0                 | 1.00           | 0.283     | 0.536   | Non-Liq. | 5.2                 | 25.0                 | 0.15 | 0.05       |      |  |            |  |         |
| 14.0   | 12  | 8       |          | 125      | 80      | 10.0   | 13.0   | 0.625      | 0.625     | 0.98 | 1.00           | 0.76           | 1.00           | 7.6                |        |                     |                      | 1.00           | Infin.    | 0.533   | Non-Liq. |                     | 7.6                  | 0.00 | 0.00       |      |  |            |  |         |
| 17.5   | 21  | 13      | 1        | 125      | 50      | 15.0   | 18.0   | 0.938      | 0.938     | 0.97 | 1.06           | 0.86           | 1.00           | 16.2               | 48     | 8.2                 | 24.4                 | 1.00           | 0.273     | 0.528   | Non-Liq. | 8.2                 | 24.4                 | 0.19 | 0.08       |      |  |            |  |         |
| 23.5   | 12  | 8       |          | 125      | 80      | 20.0   | 23.0   | 1.250      | 1.250     | 0.96 | 1.00           | 0.93           | 1.00           | 9.4                |        |                     |                      | 0.97           | Infin.    | 0.539   | Non-Liq. |                     | 9.4                  | 0.00 | 0.00       |      |  |            |  |         |
| 28.0   | 16  | 10      | 1        | 125      | 50      | 25.0   | 28.0   | 1.563      | 1.563     | 0.94 | 0.82           | 0.98           | 1.00           | 10.8               | 39     | 7.2                 | 18.0                 | 0.92           | 0.194     | 0.555   | Non-Liq. | 7.2                 | 18.0                 | 0.44 | 0.24       |      |  |            |  |         |
| 31.5   | 32  | 20      | 1        | 125      | 50      | 30.0   | 33.0   | 1.875      | 1.875     | 0.92 | 0.75           | 1.00           | 1.00           | 20.1               | 54     | 9.0                 | 29.2                 | 0.84           | 0.382     | 0.595   | Non-Liq. | 9.0                 | 29.2                 | 0.00 | 0.00       |      |  |            |  |         |
| 32.5   |     | 18      | 1        | 125      | 45      | 31.5   | 34.5   | 1.969      | 1.922     | 0.91 | 0.74           | 1.00           | 1.21           | 21.5               | 55     | 9.3                 | 30.9                 | 0.84           | Infin.    | 0.609   | Non-Liq. | 9.3                 | 30.9                 | 0.00 | 0.00       |      |  |            |  |         |
| 38.5   |     | 7       |          | 125      | 80      | 35.0   | 38.0   | 2.188      | 2.032     | 0.89 | 1.00           | 1.00           | 1.11           | 10.4               |        |                     |                      | 0.88           | Infin.    | 0.595   | Non-Liq. |                     | 10.4                 | 0.00 | 0.00       |      |  |            |  |         |
| 42.5   |     | 9       |          | 125      | 80      | 40.0   | 43.0   | 2.500      | 2.188     | 0.85 | 1.00           | 1.00           | 1.14           | 13.7               |        |                     |                      | 0.86           | Infin.    | 0.613   | Non-Liq. |                     | 13.7                 | 0.00 | 0.00       |      |  |            |  |         |
| 50.0   |     | 25      |          | 125      | 80      | 45.0   | 48.0   | 2.813      | 2.345     | 0.80 | 1.00           | 1.00           | 1.30           | 43.2               |        |                     |                      | 0.85           | Infin.    | 0.616   | Non-Liq. |                     | 43.2                 | 0.00 | 0.00       |      |  |            |  |         |
|        |     |         |          |          |         |        |        |            |           |      |                |                |                |                    |        |                     |                      |                |           |         |          |                     |                      |      |            |      |  |            |  |         |

# EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Ventura HS Softball Field Improvements

Project No: 305811-002

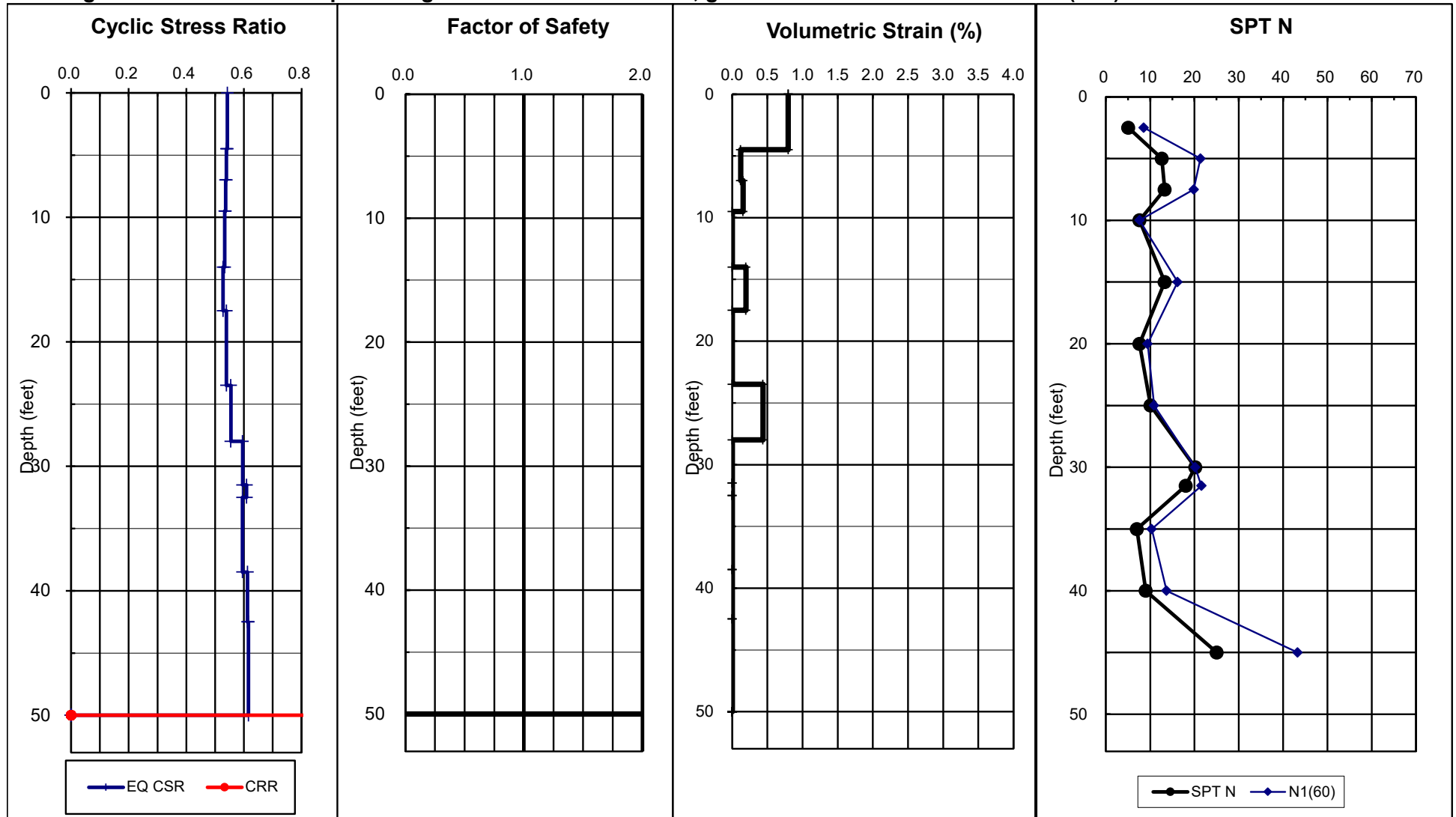
1996/1998 NCEER Method

Boring: B1

Earthquake Magnitude: 7.12

PGA, g: 0.96

Calc GWT (feet): 30



Total Thickness of Liquefiable Layers: 0.0 feet

Estimated Total Ground Subsidence: 0.8 inches