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February 28, 2002
Project No. 00-32-3662

PROJECT MEMORANDUM

To: John Foxworthy, City of Los Angeles Harbor Department
Shaun Shahrestani, City of Los Angeles Harbor Department

Copy: Robel Afewerki, City of Los Angeles Harbor Department

From: Philip Robins and Tom McNeilan

Subject: **Subsurface Conditions Underlying Pier 400 Phase 2 Terminal Surcharges, Port of Los Angeles, California**

INTRODUCTION

Overview

Fugro's evaluation of the cone penetration test (CPT) soundings, sample borings, and field observations during the rough grading of Pier 400 Phase 1 backlands contract suggested that there were areas where the accumulation of fines, within the subgrade elevation interval, produced subsurface conditions unsuitable for immediate subgrade construction. Those areas were treated prior to construction by removing the fine-grained material and replacing with coarse-grained compacted fill.

Within the Phase 2 Terminal development area, evaluation of the subsurface explorations suggests that there will be additional areas where the accumulation of fines will also produce conditions unsuitable for immediate subgrade construction. These areas may be treated with remedial work prior to construction by removing the fine-grained material and replacing with coarse-grained compacted fill. This project memorandum summarizes the evaluation of the available subsurface explorations to determine the distribution and extent of areas where the accumulation of fines also will produce conditions unsuitable for immediate subgrade construction.

Background

The ultimate objective of the Pier 400 design was to construct an engineered landfill that could be used for Port development. Unfortunately, a significant portion of the dredged materials was not desirable landfill material, which meant that the dredged materials had to be managed as a finite resource. Thus, the development of a staged dredging program that specified the sequence of dredging and the deposit of the dredged materials was a crucial component of project design.

The staged program was designed with the intent of attempting to constrain the locations of fines to areas where those fines would have minimal impact to future landfill development. Full implementation of that program during Stage 2 construction was compromised by the need to modify the dredge fill sequence "on the fly" to accommodate changing requirements relative to the timing objectives for developing the landfill. This resulted in the deposit of an abundance of fines in the western portion of Pier 400 Stage 2 landfill.

Authorization

Fugro is providing geotechnical engineering services to the Port of Los Angeles (POLA) for the development of the Pier 400 terminal via an agreement with Holmes and Narver (DMJM+HARRIS). Further to our project memorandum on the phased removal of the surcharges within the Phase 2 Terminal area (Fugro, 2001), POLA has requested that we refine our evaluation of the areas where we recommended remedial work be undertaken in advance of terminal development.

SUBSURFACE CONDITIONS

During and following construction of Pier 400 dredging and landfill project and following construction, several series of subsurface explorations have been performed to assist in the characterization of the subsurface conditions of the landfill. The subsurface explorations (including CPT soundings, borings, vibracores, and tethered mini-cone CPT soundings) performed within the Pier 400 Phase 2 Terminal area are shown on Plate 1.

Plate 2 includes the explorations that remain once the data were filtered to remove those locations where the exploration was performed when the landfill was at an elevation less than zero feet MLLW. The remaining explorations are typically land CPT soundings and borings advanced post-construction and through the surcharges. To further define the distribution of fine-grained layers underlying the Phase 2 Terminal surcharges, several cross sections were developed and are presented herein. It should be noted that there have been no additional CPT soundings advanced following the contract to install wick drains (Fugro, 2002a).

Cross section A-A' (parallel to the western boundary with Pier 400 Phase 1 terminal) is presented on Plate 3. Near the eastern limit of the Container Wharf Phase 2 construction area, cross section A-A' shows an anomalous accumulation of fine-grained material to the south of the perimeter A-Face dike (e.g. Boring 99B-15). This material was dredged from a predominantly fine-grained zone within the layered Undifferentiated Deposits (Unit 7) and during hydraulic land discharge, the fine-grained materials developed into "clay balls" that were subsequently tracked with a bulldozer. The fine-grained layer is typically present above about elevation (El.) +8 feet to about El. +12 feet.

Cross section B-B' (parallel to the B face through the southern central portion of the Phase 2 area) is presented on Plate 4. The cross section shows an area of interlayered material within the tidal zone of about El. 0 to about El. +7 feet MLLW. This interlayered zone of fine-grained and sandy material is due in part to the accumulation of fine material within an area

of stagnant flow during hydraulic filling of the eastern portion of Pier 400 Phase 2 Terminal development area.

Cross section C-C' (parallel to the temporary face of Stage 1) is presented on Plate 5. The cross section shows another accumulation of fines within the bottom of the fill along the southern Stage 2 boundary and east of the C-Face dike. This deposit was due to Stage 1 construction activity. Additional accumulations of fines are present at the base of the fill at localized areas associated with discharge weir operations during the dredging/fill activities of Pier 400 Stage 2.

Plate 6 presents cross section D-D' (parallel to the B-Face). CPT soundings directly behind the C-Face indicate a thicker-than-average layer of fines. This zone of fine-grained material extends some distance east and represents the accumulation of fines behind the Contractor's outfall weir, which was in place during the latter period of the land discharge in the western half of Stage 2.

DISTRIBUTION OF FINE-GRAINED LAYERS

Fine-grained soils were sedimented within the elevation interval El. 0 and El. +10 feet MLLW throughout much of the western Pier 400 Stage 2 fill. Within the Pier 400 Phase 2 Terminal Development area, each exploration was evaluated to estimate the quantity of fine-grained material within the following elevation intervals:

a. From El. 0 to El.+5 feet MLLW,
b. From El.+5 to El.+10 feet MLLW, and
c. From El.+10 to El.+15 feet MLLW.

These ranges were selected as a reasonable maximum depth to overexcavate material when constructing the subbase for terminal development. The rough grade elevation is anticipated to range from about El. +10 feet MLLW to about El. +15 feet MLLW, and it is unlikely that over-excavation to depths greater than 10 feet will be cost effective. The following paragraphs summarize the distribution of fine-grained material within the range of elevation intervals.

Range El. 0 and El. +5 Feet MLLW

There is a predominance of fine-grained material within the tidal zone underlying the existing surcharges, within the southern limits of the Pier 400 Phase 2 Terminal development area. The thickness of fine-grained material between El. 0 and El. +5 feet MLLW at each exploration location is presented on Plate 7. The accumulation of fine-grained material extends some distance east and represents the accumulation of fines behind the Contractor's outfall weir, which was in-place during the latter period of the land discharge in the western half of Stage 2. Because the outlet weir was maintained at the C-Face until very late during construction, the thickest accumulation of fine-grained sediments occurs in the area behind that portion of C-Face. In that area, the fine-grained fill generally is devoid of sand layers. Elsewhere in the western portion of Stage 2, the presence and thickness of the fine-grained

layers is variable, but the accumulated fine-grained layers often contain sand layers within the predominantly fine-grained sediment sequence.

Range El. +5 and El. +10 Feet MLLW

The distribution of the accumulation of fine-grained material within the emerged portion of the landfill underlying the existing surcharges is more variable. The thickness of fine-grained material between El. +5 and El. +10 feet MLLW at each exploration location is presented on Plate 8. The accumulation of fine-grained material represents the placement of material during the accumulation of fines behind the Contractor's outfall weir, which was in place during the latter period of the land discharge in the western half of Stage 2. To accelerate the consolidation of the fine-grained material within the fill at this elevation, a ground treatment program was developed using wick drains (Fugro, 2002a).

Range El. +10 and El. +15 Feet MLLW

The thickness of fine-grained material between El. +10 and El. +15 feet MLLW at each exploration location is presented on Plate 9. The distribution of the accumulation of fine-grained material within the existing surcharges is more variable. The accumulation of fine-grained material represents the placement of material during removal of material for the development of Pier 400 Phase 1 terminal development. The fine-grained material was removed from the "50 acre addition" and the region of "clay balls" adjacent to the Phase 1 wharf construction.

Summary

In summary, due to the resequencing of the dredge fill process (required to expedite completion of the eastern Stage 2 fill and Phase 1 terminal development), fine-grained soils are predominant within the elevation interval El. 0 and El. +10 feet MLLW throughout the area that is presently surcharged. Generally, except for the sand berm behind the B-Face dike, fines are present thought the Phase 2 Terminal development area and will require remediation.

CONDITION OF FINE-GRAINED LAYERS

With the exception of the area where stiff "clay balls" were deposited behind the western portion of the A-Face dike, the fine-grained soils were typically very soft when they were deposited. At the completion of filling to the planned landfill elevation of about El. +15 feet MLLW the clay soils between El. 0 and El +10 feet MLLW were compressed under the weight of the fill to a soft consistency with an undrained shear strength of several hundred pounds per square foot (psf).

The fine-grained layers have been further compressed and consolidated under the weight of the surcharge. The condition and characteristics of the fine-grained layers will vary spacially depending on the layer thickness, grain size of the fine-grained material, and the presence or absence of sand layers. Although significant variability was expected, the fine-grained layers between El. 0 and El. +10 feet MLLW were typically soft to firm with an undrained

shear strength of between 0.25 and 0.7 kips per square foot (ksf) at the time measurements were taken. It is likely that these values have increased with time.

RECOMMENDATIONS FOR REMEDIAL WORK

We recommend that remedial work be undertaken in several of the worst areas during the phased removal of the surcharges within the Phase 2 Terminal area. We recommend that near surface fine-grained layers be removed and replaced with "imported" sandy material using conventional earthmoving equipment. The sand should be placed in lifts not exceeding 12 inches and compacted to in excess of 90 percent of the maximum dry density (determined by ASTM D1557) using the earthmoving equipment prior to construction.

The volume of "poor" subgrade material to be removed and replaced within the Phase 2 Terminal area may be estimated once additional CPT soundings (and borings) have been advanced as described in our proposal dated January 9, (Fugro, 2002b).

RECOMMENDATIONS FOR PHASED SURCHARGE REMOVAL

We recommended (Fugro, 2001) the following procedure be adopted when moving the surcharge materials on Pier 400. First, every effort should be made to isolate and segregate the fine to medium "Gaspur" sand, and to reduce the amount of silt and clay that is mixed with those coarser materials. If the grain size of the fine to medium sand is not modified by the inclusion of fines, then the Gaspur sands can be subsequently used for subgrade construction (and reduce the thickness of or improve the performance of the overlying pavement section). Secondly, we recommended that the fine sands with variable silt and clay content be blended with any fine-grained materials produced by the subgrade remedial work. This should produce a sandy clay to clayey sand that is easily compacted.

CLOSURE

With proper design and careful execution, including a proactive approach to surcharge removal/placement and overexcavation and replacement with "good sand," suitable subgrade conditions may be created in advance of the Phase 2 Terminal area development. We trust that this memorandum addresses your current requirements for the Pier 400 Phase 2 Terminal Construction as discussed on February 14, 2002, following a Channel Deepening Project design coordination meeting. We look forward to continuing our association with the Port of Los Angeles in this and other projects. We would be pleased to discuss any of the conclusions and recommendations with you.

LIMITATIONS

This project memorandum has been prepared for the City of Los Angeles Harbor Department solely for the planning and design of the Phase 2 Terminal area of the Port of Los Angeles Pier 400 Project. Applicability of the data within this project memorandum is specifically limited to current conditions and considerations for the proposed project. Use of this project memorandum is not intended for any other purpose.

In performing our professional services, we have used that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers currently practicing in this or similar localities. No other warranty, express or implied, is made as to the professional advice included in this project memorandum. Fugro West, Inc., makes no claim or representation concerning any activity or conditions falling outside its specified purposes to which this report is directed.

The interpretation of general subsurface conditions is based on subsurface conditions observed at exploration locations only. The information interpreted from those explorations has been used as a basis for our interpretations. Conditions may vary at locations not investigated by our explorations. Subsurface conditions also may change with time due to either natural phenomena or people's activities. We note that any statements, or absence of statements, in this project memorandum regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous/toxic assessment.

REFERENCES

Fugro West, Inc. (2001), "Recommended Phased Surcharge Removal in Advance of Pier 400 Phase 2 Terminal Construction, Port of Los Angeles," project memorandum to the Port of Los Angeles, FWI Project No. 00-32-3662, December 17.

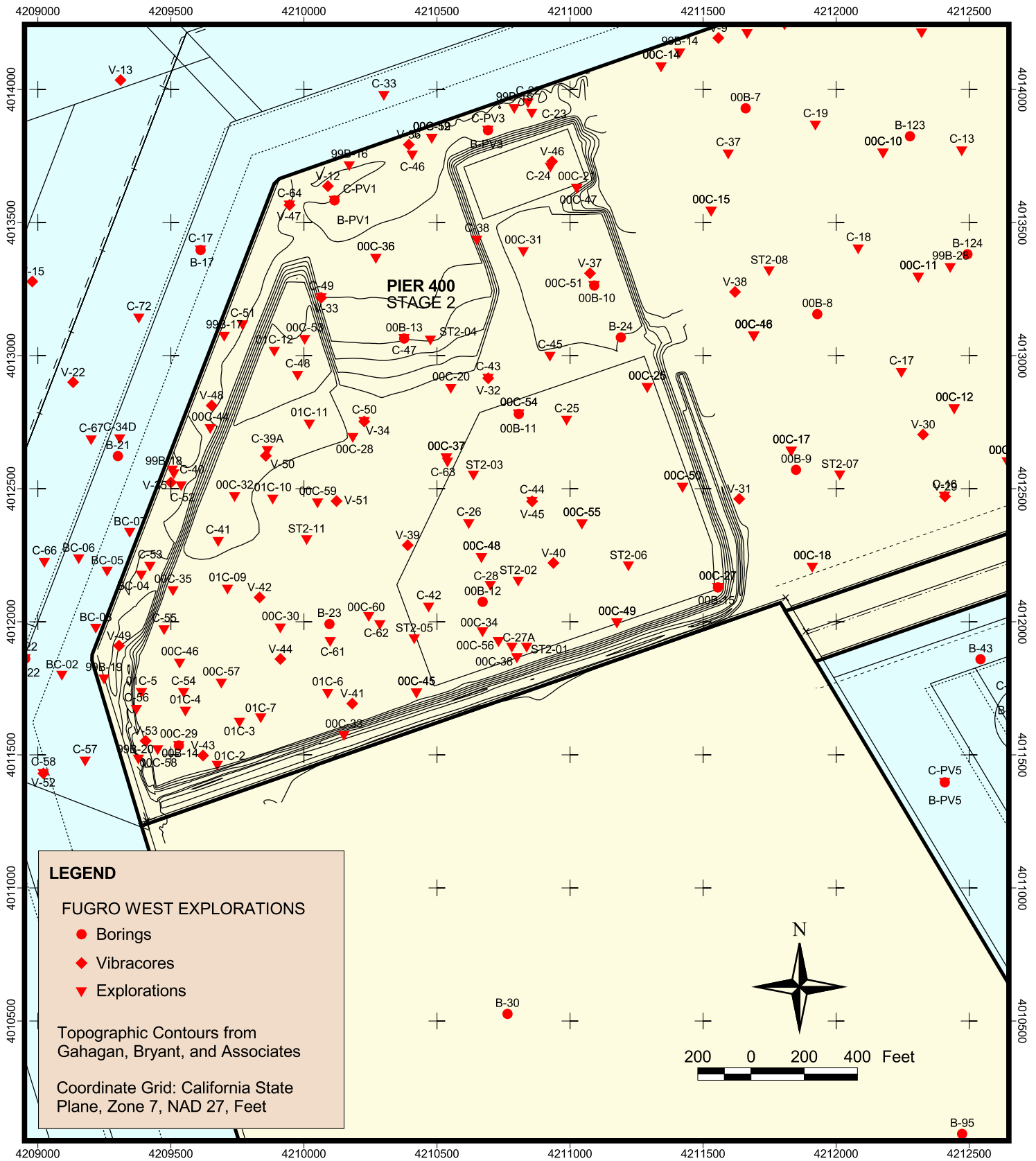
_____ (2002a), "Instrumentation Results and Installation of Settlement Plates Following Wick Drain Installation, Pier 400 Phase 2 Terminal, Port of Los Angeles," project memorandum to the Port of Los Angeles, FWI Project No. 00-32-3662, January 8.

_____ (2002b), "Proposal for CPT Soundings (and Optional Auger Borings), Surcharge Material Characterization, Pier 400 Port of Los Angeles," letter to the Port of Los Angeles, FWI Project No. 00-32-3663, January 9.

Robertson, P. K., and Campanella, R. G., (1988), Guidelines for Geotechnical Design Using PCPT and PCPTU, The University of British Columbia, Soil Mechanics Series No. 120, Vancouver, B.C., Canada.

ATTACHMENTS

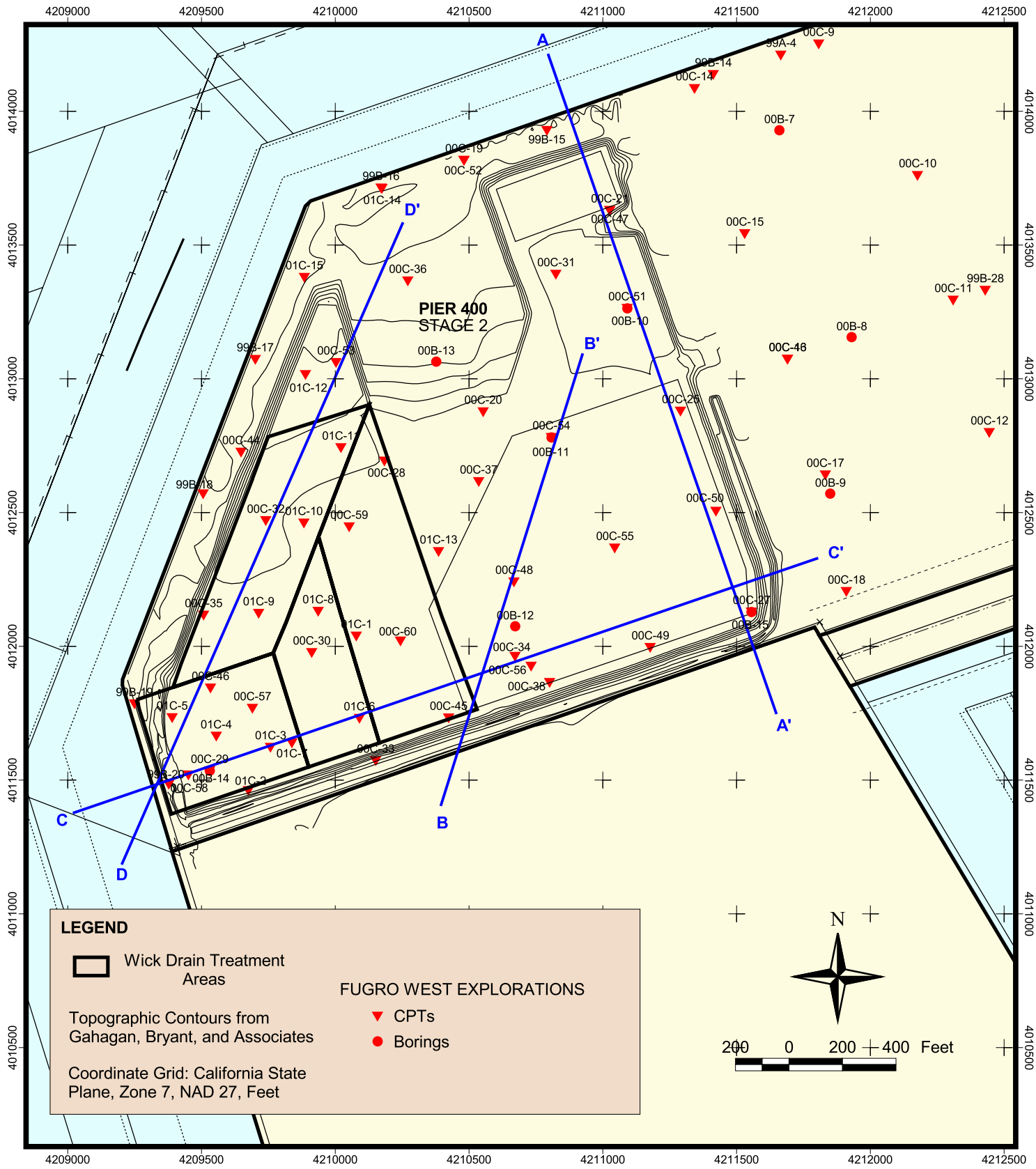
Plate 1 - Subsurface Exploration Locations
Plate 2 - Cross Section Location Map
Plate 3 - Subsurface Cross Section A-A'
Plate 4 - Subsurface Cross Section B-B'
Plate 5 - Subsurface Cross Section C-C'
Plate 6 - Subsurface Cross Section D-D'
Plate 7 - Thickness of Fine-Grained Material Between 0 and +5 feet
Plate 8 - Thickness of Fine-Grained Material Between +5 and +10 feet
Plate 9 - Thickness of Fine-Grained Material Between +10 and +15 feet
Plate 10 - Key to Cross Sections



SUBSURFACE EXPLORATION LOCATIONS

Pier 400, Phase 2 Terminal
Port of Los Angeles, California

PLATE 1



CROSS SECTION LOCATION MAP
Pier 400, Phase 2 Terminal
Port of Los Angeles, California

PLATE 2

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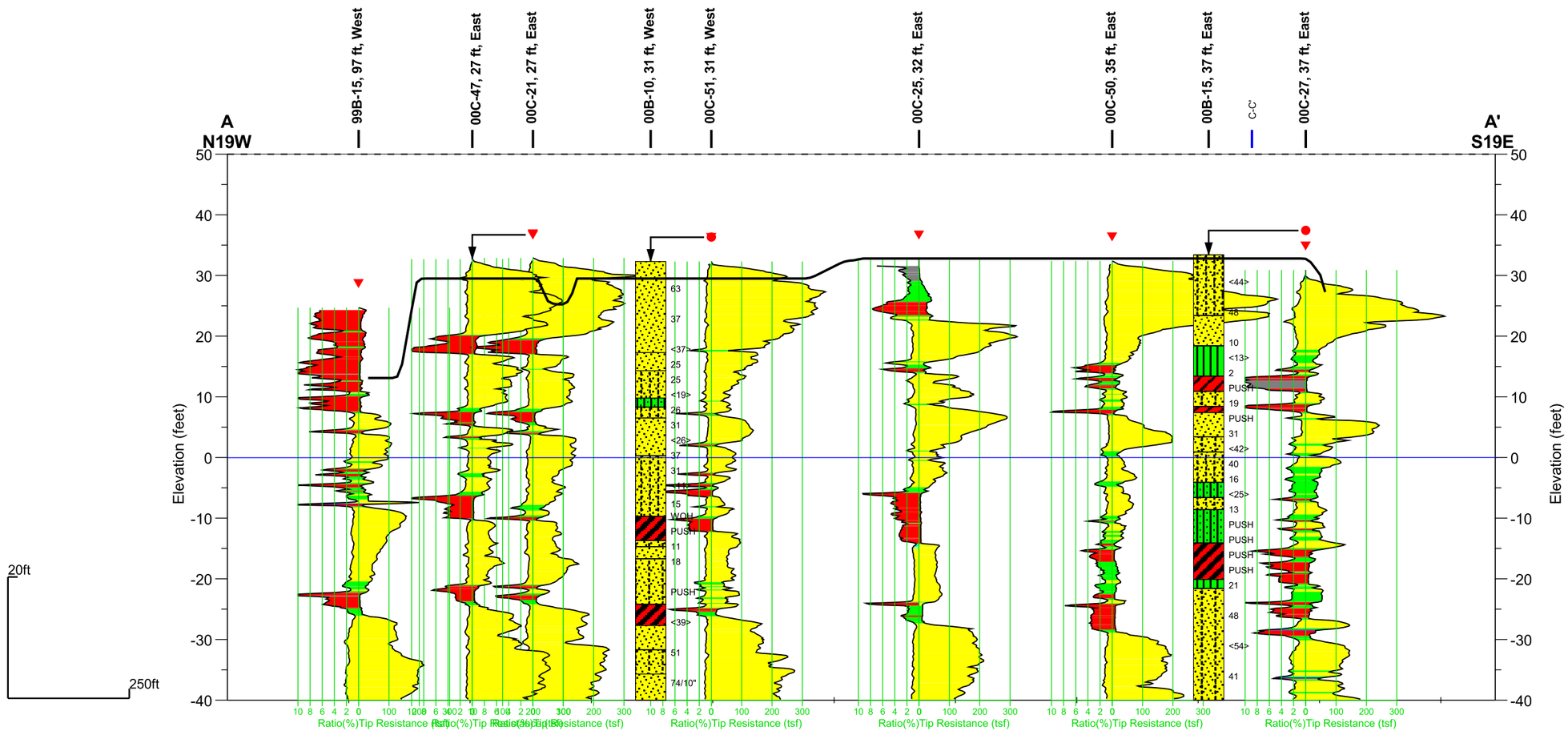


GENERAL NOTES:

1) Data concerning subsurface conditions were obtained at boring and CPT locations only. Strata breaks were interpreted from geophysical records and were interpolated between exploration locations. Actual conditions between exploration points may differ from the generalized profile shown here.

2) Exploration logs were projected onto the section line. Therefore stratigraphic contacts may not exactly correspond to the contact indications (lithology, shear strength, etc.) in the logs.

3) Indicated blow counts are SPT and equivalent SPT blow counts estimated from Modified California Sampler blow counts.

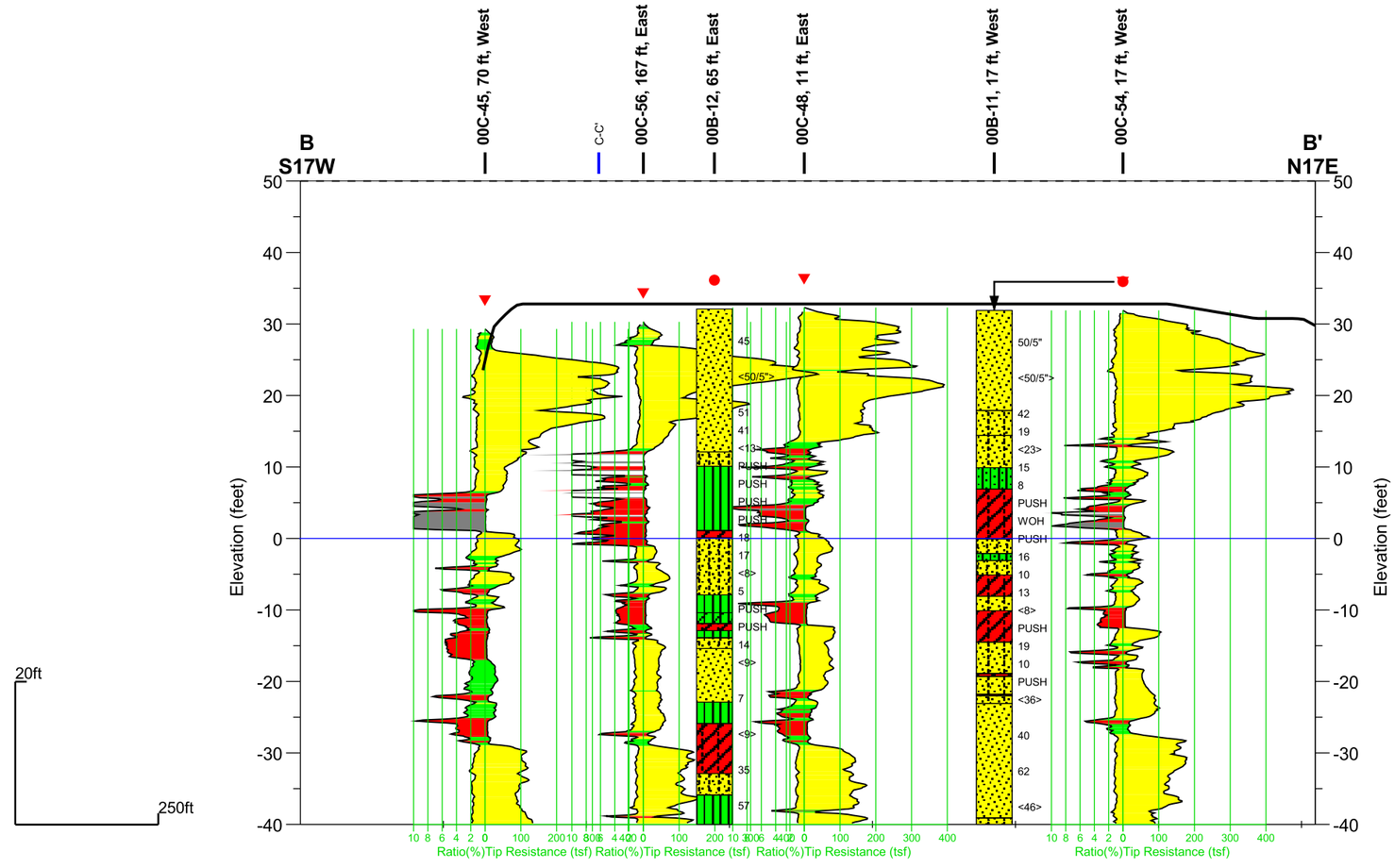
4) CPT tip resistance and blow counts are uncorrected for overburden.

5) Elevation relative to MLLW.

6) Refer to Key to Cross Sections for descriptions of boring and CPT data shown above.

7) Topography from Gahagan & Bryant Associates, Inc.

SUBSURFACE CROSS SECTION A-A'
Pier 400, Phase 2 Terminal
Port of Los Angeles, California



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5) Elevation relative to MLLW.

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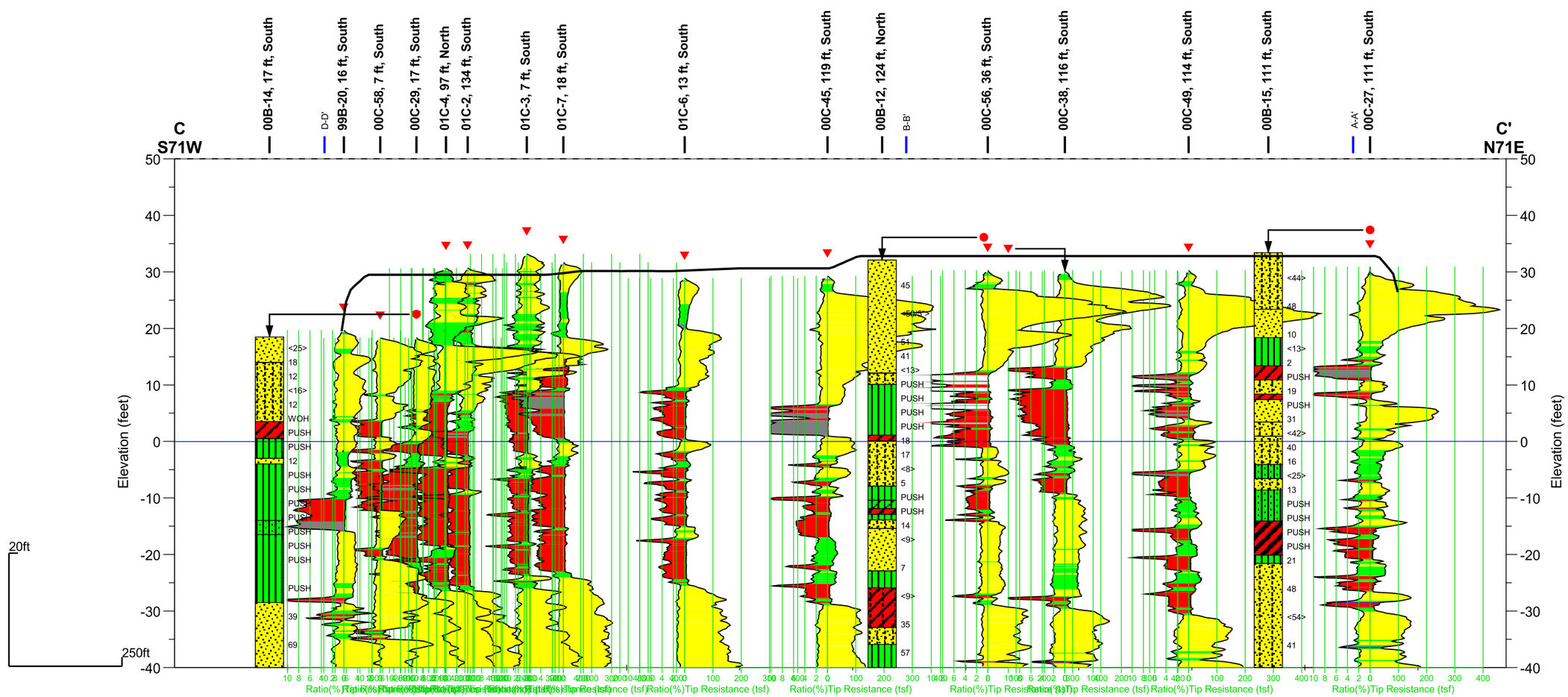
SUBSURFACE CROSS SECTION B-B'
Pier 400, Phase 2 Terminal
Port of Los Angeles, California



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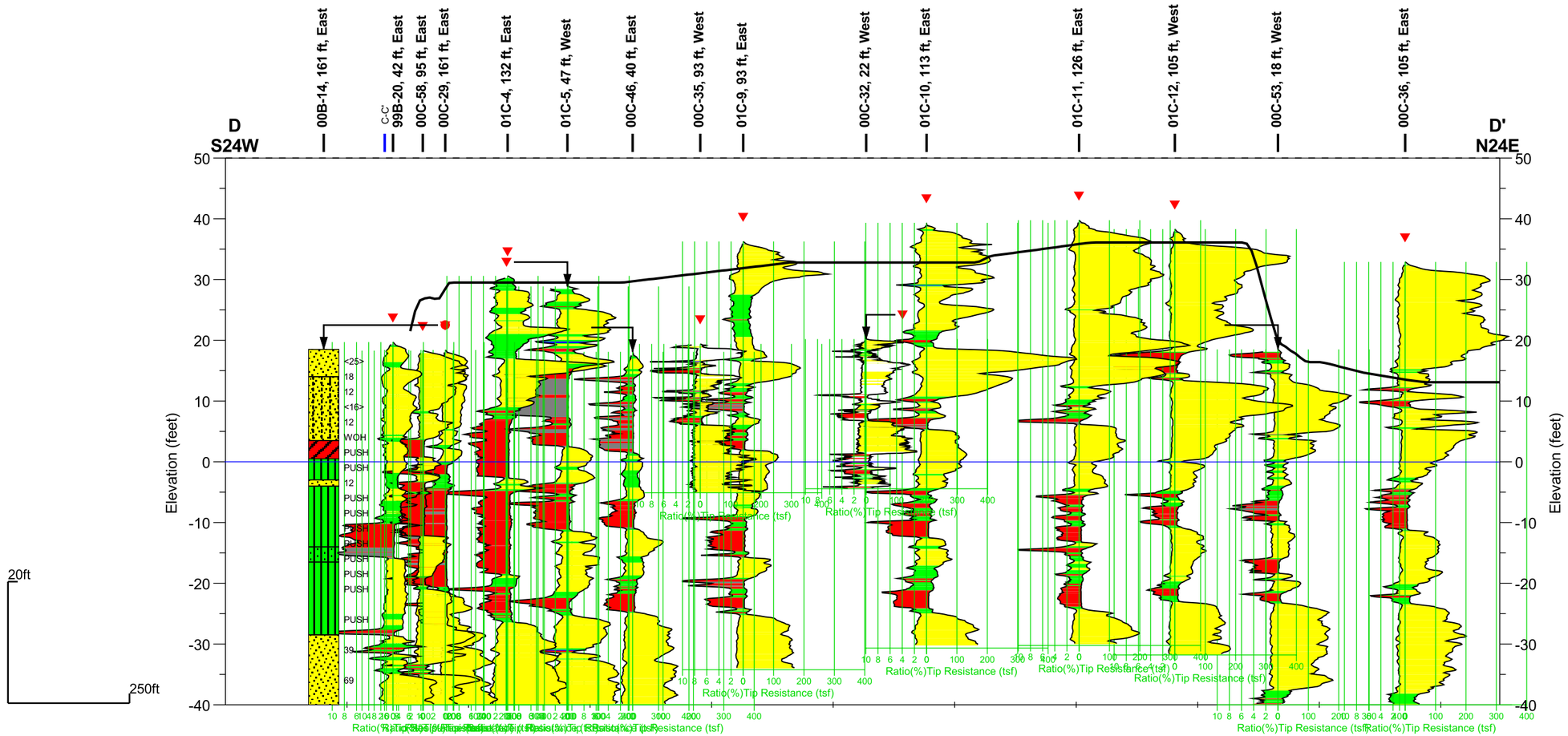
5) Elevation relative to MLLW.

6) Refer to Key to Cross Sections for descriptions of boring and CPT data shown above.

7) Topography from Gahagan & Bryant Associates, Inc.

SUBSURFACE CROSS SECTION C-C'
Pier 400, Phase 2 Terminal
Port of Los Angeles, California

PLATE 5



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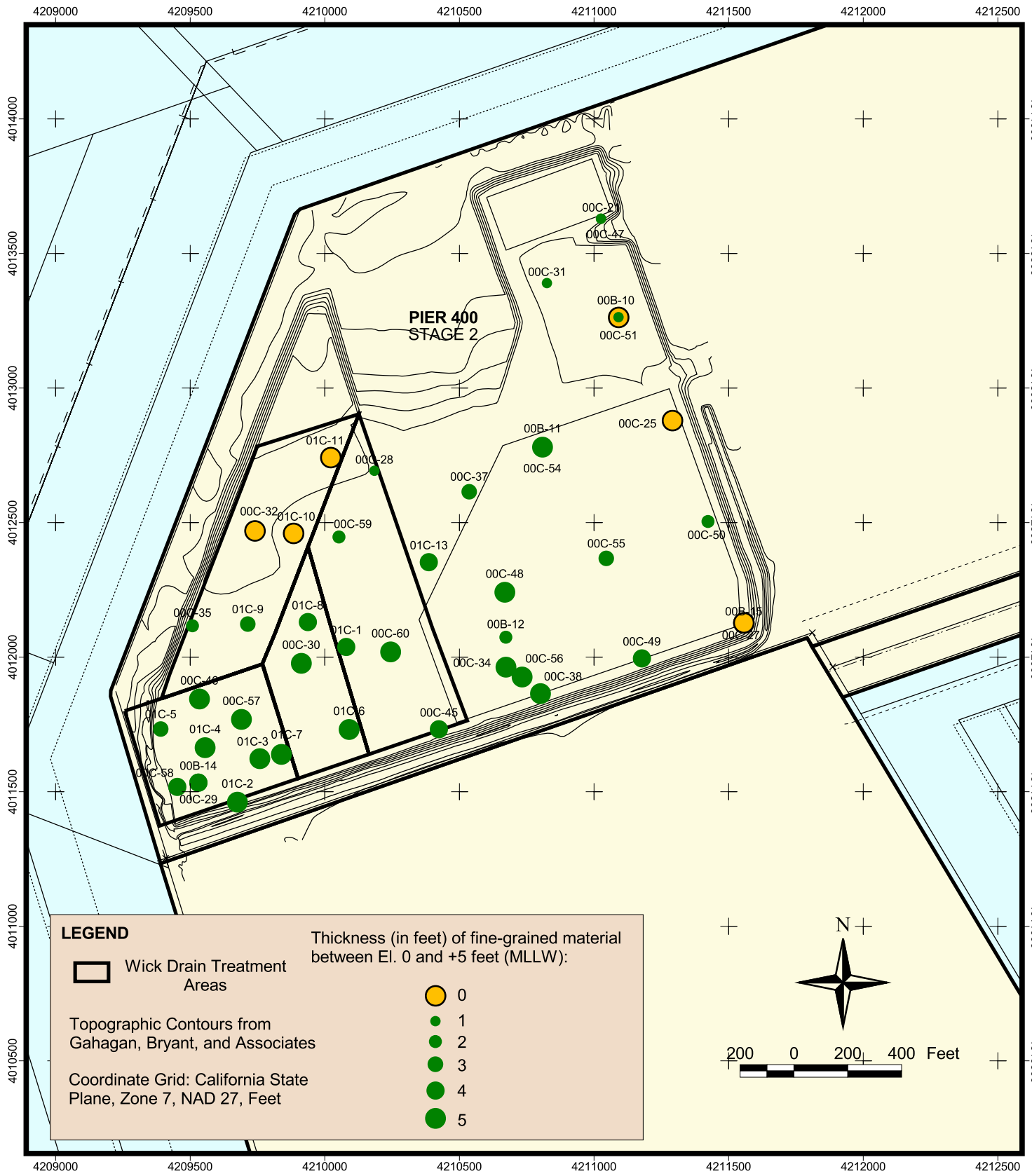
SUBSURFACE CROSS SECTION D-D'
Pier 400, Phase 2 Terminal
Port of Los Angeles, California

PLATE 6



THICKNESS OF FINE-GRAINED MATERIAL BETWEEN 0 AND +5 FEET
Pier 400, Phase 2 Terminal
Port of Los Angeles, California

PLATE 7

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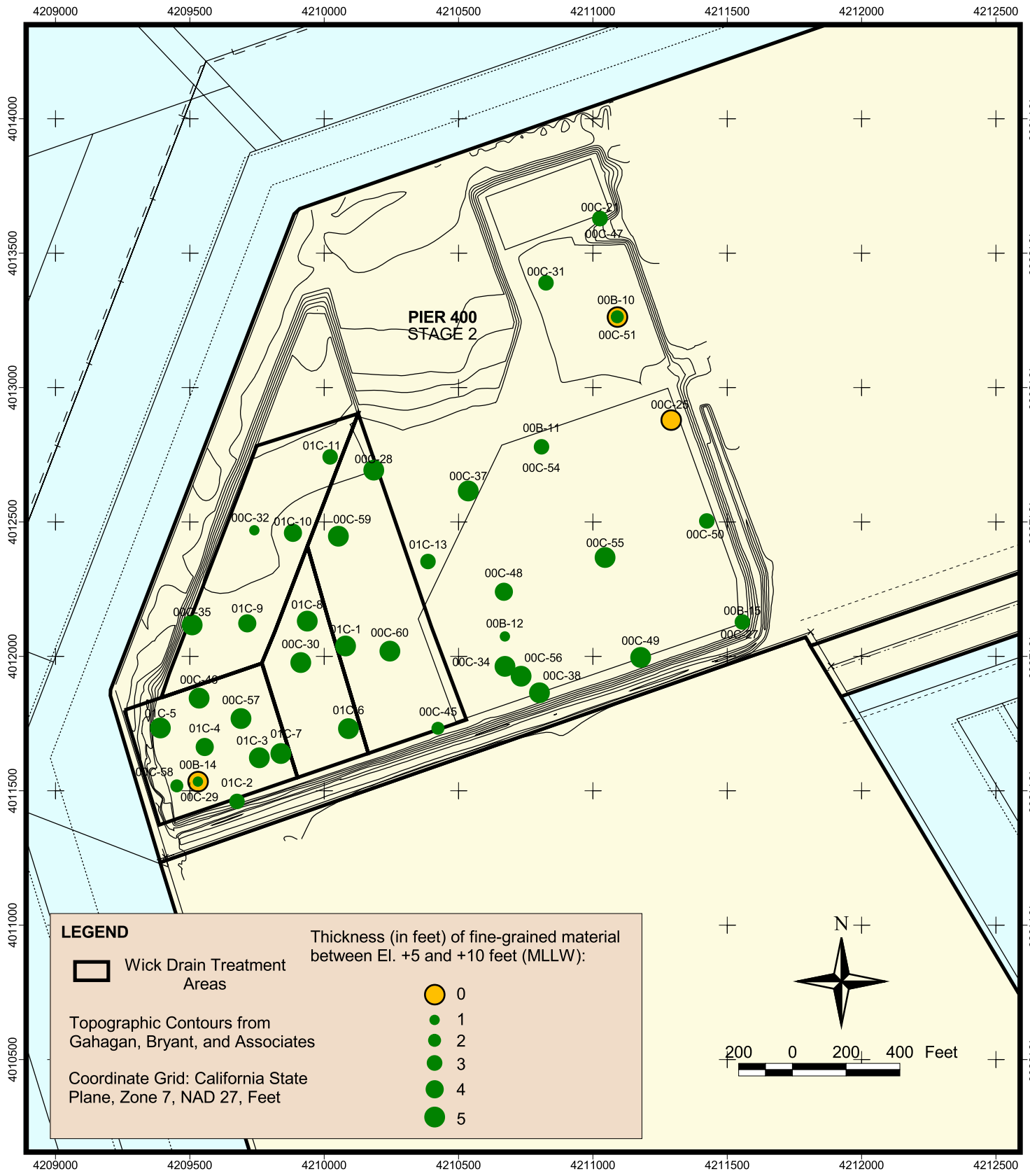

THICKNESS OF FINE-GRAINED MATERIAL BETWEEN +5 AND +10 FEET
Pier 400, Phase 2 Terminal
Port of Los Angeles, California

PLATE 8

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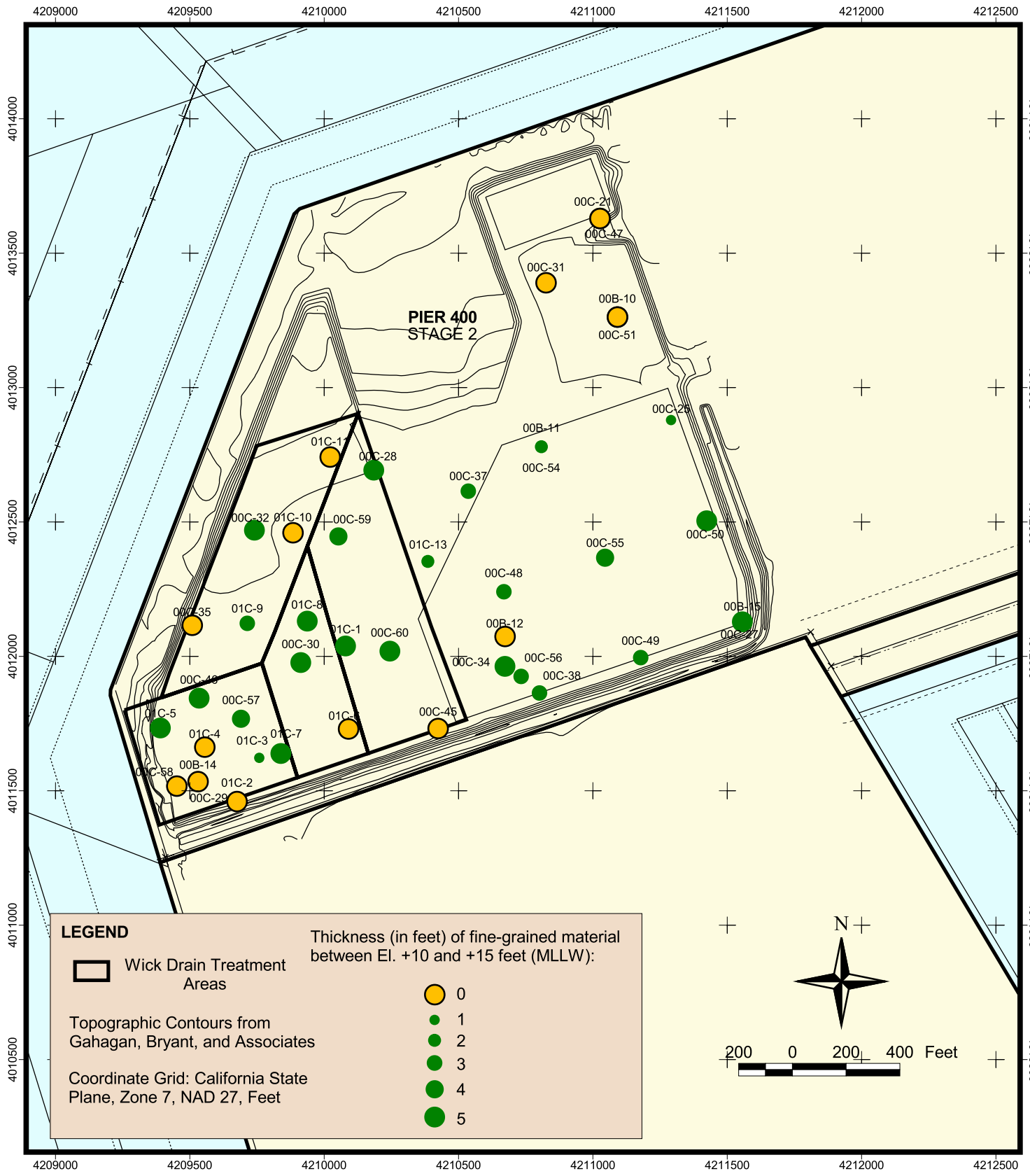

THICKNESS OF FINE-GRAINED MATERIAL BETWEEN +10 AND +15 FEET
Pier 400, Phase 2 Terminal
Port of Los Angeles, California

PLATE 9

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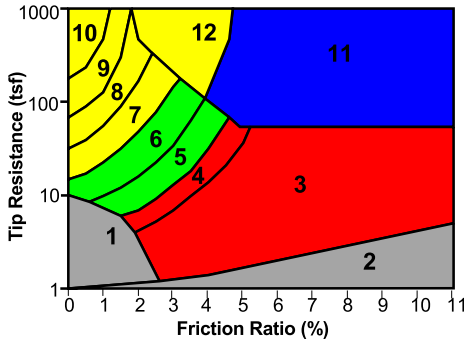
SOIL TYPES

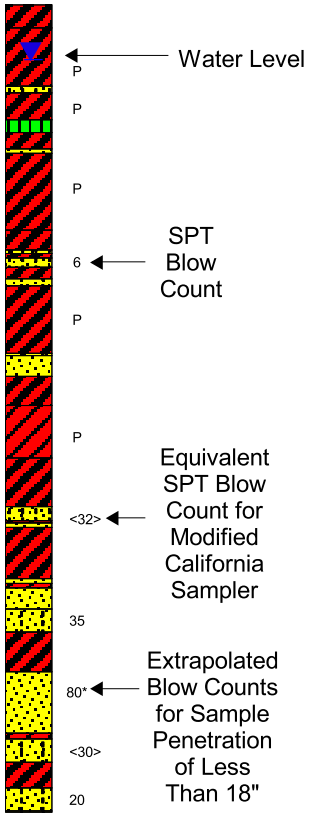
- Well graded GRAVEL (GW)
- Poorly graded GRAVEL (GP)
- GRAVEL with sand (GP or GW)
- GRAVEL with clay (GP or GW)
- Clayey GRAVEL (GC)
- GRAVEL with silt (GP or GW)
- Silty GRAVEL (GM)
- Well graded SAND (SW)
- Poorly graded SAND (SP)
- SAND with gravel (SP or SW)
- SAND with clay (SP-SC)
- Clayey SAND (SC)
- Silty SAND (SM)
- SAND with silt (SP-SM)
- Fat CLAY (CH)
- Sandy Fat CLAY (CH)
- Lean CLAY (CL)
- Sandy Lean CLAY (CL)
- Silty CLAY (CL-ML)
- Elastic SILT (MH)
- SILT (ML)
- Sandy SILT (ML)
- Clayey SILT (ML/CL)
- Highly plastic ORGANICS (OH)
- Low plasticity ORGANICS (OL)
- SANDSTONE (Rx)
- SILTSTONE (Rx)
- CLAYSTONE (Rx)
- Interbedded Rock Strata (Rx)
- CONGLOMERATE (Rx)
- PAVEMENT



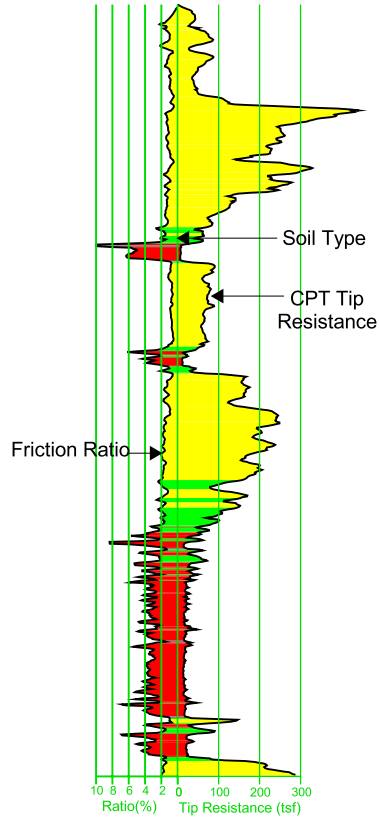
Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART (Robertson and Campanella, 1988)



SOIL BORING LITHOLOGY



CPT SOUNDING WITH INTERPRETED LITHOLOGY

KEY TO CROSS SECTIONS
Pier 400, Phase 2 Terminal
Port of Los Angeles, California