

# TRANS PACIFIC GEOTECHNICAL CONSULTANTS, INC.

445 GRANT AVENUE, SUITE 403, SAN FRANCISCO, CALIFORNIA 94108-3249  
TELEPHONE: (415) 788-8627 FAX: (415) 788-3121

REPORT  
GEOTECHNICAL CONSULTATION  
PROPOSED YARD FACILITY  
PIER 94  
SAN FRANCISCO, CALIFORNIA

RECEIVED  
JUL 12 2000

OUR JOB NO. 1227-006

JUNE 28, 2000

# TRANS PACIFIC GEOTECHNICAL CONSULTANTS, INC.

445 GRANT AVENUE, SUITE 403, SAN FRANCISCO, CALIFORNIA 94108-3249  
TELEPHONE: (415) 788-8627 FAX: (415) 788-3121

June 28, 2000

Our Job No. 1227-006

Structus, Inc.  
982 Mission Street, Suite A  
San Francisco, California 94103

Attention: Mr. Fu-Lien (Henry) Chang

Ladies and Gentlemen:

Report  
Geotechnical Consultation  
Proposed Yard Facility  
Pier 94  
San Francisco, California

This report presents the results of our geotechnical consultation for the proposed yard facility at Pier 94 in San Francisco, California.

An existing topographic survey of the site, prepared by the Port of San Francisco, is shown on the Site Plan, Plate 1.

We were provided with the following drawings entitled, "Pier 94 East," prepared by the Port of San Francisco, Department of Engineering.

<u>Sheet</u>	<u>Title</u>	<u>Date</u>	<u>Revision</u>
1 of 8	Dredging Plan for Sand Dike	March 19, 1973	March 3, 1975
2 of 8	Sections of Sand Dike	March 19, 1973	May 13, 1974
4 of 8	Typ. Sections & Details-Conc. Deck	March 19, 1973	March 27, 1974
C-1 of 5	Paving & Drainage, General Plan	May 22, 1975	

We were also provided with the following drawings entitled, "Pier 94-96 Gabion Wall Completion," prepared by the Port of San Francisco, Department of Engineering.

<u>Sheet</u>	<u>Title</u>	<u>Date</u>
1 of 4	Site Plan	July 1988
2 of 4	Typical Section	July 1988
3 of 4	Sections & Details	July 1988
4 of 4	North End Existing Tiebacks	July 1988

The following reports prepared by other geotechnical consultants in the previous development site were made available for our use.

- 1) "Soil Engineering Services, Proposed Pier 94, Between India Basin and Islais Creek, San Francisco, California," prepared by Harding, Miller, Lawson and Associates, dated September 22, 1972, (HML&A Job No. 604,010.04).
- 2) "Soil Engineering Consultation, Proposed Pier 94 East and North, San Francisco, California," prepared by Harding-Lawson Associates, dated April 10, 1973, (HLA Job No. 604,012.04).
- 3) "Slide Investigation, A Line Stations 14 to 18, Pier 94 East, San Francisco, California," prepared by Harding Lawson Associates, dated February 8, 1974 (HLA Job No. 604,012.04).
- 4) "Modified Design Scheme, North of A Line Station 18, Pier 94 East, San Francisco, California," prepared by Harding Lawson Associates, dated May 17, 1974, (HLA Job No. 604,012.04).
- 5) "Geotechnical Investigation, Deck Settlement at Pier 94 East, San Francisco, California," prepared by Harding Lawson Associates, dated May 7, 1982, (HLA Job No. 604,012.04).
- 6) "Geotechnical Services for Preliminary Engineering Design and Cost Estimating, Berths 90 and 92 Phase I Development, San Francisco, California," prepared by Harding Lawson Associates, dated January 26, 1983, (HLA Job No. 604,013.04).
- 7) "Pier 94 Design for Subsidence Correction, City and County of San Francisco, San Francisco Port Commission, Volume 1, Summary," prepared by Parsons Brinckerhoff, dated December 9, 1983.
- 8) "Pier 94 Design for Subsidence Correction, City and County of San Francisco, San Francisco Port Commission, Volume 2, Engineering Report," prepared by Parsons Brinckerhoff, dated December 9, 1983.
- 9) "Pier 94 Design for Subsidence Correction, City and County of San Francisco, San Francisco Port Commission, Volume 3, Geotechnical Report," prepared by Geotechnical Consultants, Inc. for Parsons Brinckerhoff, dated December 9, 1983.
- 10) "Geotechnical Investigation, Intermodal Container Transfer Facility, Port of San Francisco, for Sverdrup & Parcel and Associates, Inc.," prepared by Allstate Geotechnical Services, dated February 1986 and revised May 1986.

#### PROPOSED CONSTRUCTION

Present plans call for utilizing the existing pier facility to stockpile aggregate materials which will be delivered by cargo ship. It is planned to offload the aggregate material from the cargo ship via a conveyor belt and place the material in piles up to 70 feet in height on the landside portion of the pier facility.

## PURPOSE AND SCOPE OF SERVICES

The purpose of the geotechnical consultation was to perform engineering analyses, specifically, slope stability analyses, of the adequacy of the existing pier facilities to support the anticipated loading conditions of an aggregate materials yard. No borings were planned or performed for this consultation. The analyses were performed based solely on subsurface information from reports for previous investigations for the site.

## SITE CONDITIONS

### HISTORIC DEVELOPMENT

The site, which was originally part of San Francisco Bay, was reclaimed by the placement of artificial fill. The area west of Pier 94 was filled when a debris dike was constructed in the early 1960's to contain the dredged bay mud spoil from the Army Street Terminal Project. Prior to the construction of Pier 94, sand and gravel fill was placed over the young bay mud, dredged spoil and debris dike.

Several failures occurred at the northeast portion of the site during the construction of the debris dike. During the excavation of the keyway trench for the construction of Pier 94, three landslides occurred at the northern end of the proposed pier. Subsequently, the proposed Pier 94 was shortened from the original design to avoid the area affected by the landslides; however, debris from the landslides is believed to be present in the northern portion of the bottom of the keyway trench for Pier 94.

The site investigation for the development of Pier 94 was performed by Harding, Miller, Lawson Associates. Settlement on the order of several feet was measured at the site after construction. Subsequently, Parsons Brinckerhoff performed a site investigation and presented several remedial measures. Based on drawings on file at the San Francisco Port Commission, it appears that the recommended remedial measures as presented in Parsons Brinckerhoff's report were not carried out other than the installation of a gabion wall below the pier deck in the late 1980's.

Details of the development of the site are presented in the geotechnical investigation reports prepared by Harding, Miller, Lawson Associates and Parsons Brinckerhoff.

### SURFACE CONDITIONS

The site is currently used by several different organizations. During a recent site visit, San Francisco Municipal Railway (MUNI) buses were observed parked along the fence at the northern portion of the site. The San Francisco Police Department was using the southern portion of the site as a driver training facility. Cargo containers were observed stacked at the western portion of the site. The waterside portion of the site is occupied by a floating drydock.

The waterside portion of the site is a pile-supported concrete deck. The landside portion of the site is paved with asphalt concrete.

SUBSURFACE CONDITIONS

The site is underlain by artificial fill overlying young bay mud, overlying old bay clay. A typical cross-section of the pier is presented on Plate 2, Typical Cross-Section.

**DISCUSSION AND RECOMMENDATIONS**

Based on our recent site visit, review of the previous reports for the site, and engineering analysis, it is our opinion, from a geotechnical engineering standpoint, that the proposed aggregate storage yard may be developed with certain limitations.

SLOPE STABILITY ANALYSESSlope Configuration

Slope stability analyses were performed to evaluate the stability of the pier and the adjoining landside area, i. e. along the shoreline, for both static and pseudo-static (seismic) conditions for the loading conditions being considered. The slope configuration analyzed was modeled after the soil profile determined to be the most critical by Geotechnical Consultants, Inc. in their geotechnical investigation report<sup>1</sup> for Pier 94 in 1983, as presented on Plate 3, Cross-Section A-A.

Slope stability analyses were also performed for another shoreline condition in the northwesterly landside area, as presented on Plate 4, Cross-Section B-B. The slope configuration and subsurface soil information were inferred based on borings from the previous geotechnical investigations performed at the site and from waterside soundings performed by the Port of San Francisco.

Parameters

Strength parameters for the soil layers were derived from reports for previous geotechnical investigations performed at the site. Due to the lack of strength information for the dredge spoil, debris fill, and landslide debris the strength parameters for these materials were assumed based on the available boring information. We recommend that additional borings be drilled to verify the assumed subsurface information, considering that the previous borings were drilled more than 17 years ago, there is limited information on the strength characteristics of the dredge fill material, and consolidation of the young bay mud since the previous borings were drilled. Strength parameters used in the analyses is presented in the following table.

---

<sup>1</sup>Pier 94 Design For Subsidence Correction, City and County of San Francisco, San Francisco Port Commission, Volume 3, Geotechnical Report, prepared by Geotechnical Consultants, Inc. for Parsons Brinckerhoff, dated December 9, 1983.

Soil	Unit Weight (pounds per cubic foot)	Cohesion (pounds per square foot)	Friction Angle (degrees)
Fill	130	0	34
Bay Mud	90	800	0
Landslide Debris	90	600	0
Silty Sand	115	0	38
Old Bay Clay	105	1200	0

The parameters for the properties and configuration of the stockpiles of aggregate were provided by Mr. Edward Byrne of the Port Commission. The stockpiles of aggregate were modeled with an angle of repose of 38 degrees and a unit weight of 125 pounds per cubic foot.

#### Static Analysis

The static stability analyses of the existing slope beneath the pier, cross-section A-A, and parallel to the pier, cross-section B-B, were performed using the computer program TSTAB - Slope Stability Analysis, Circular Surface Search Routine, version 2.52. Bishop's simplified method was implemented to search for the critical slip circle.

For cross-section A-A, static slope stability analysis was performed for distances of 200 feet to 450 feet from the outboard edge of the pier deck to the center of the proposed aggregate pile. The height of the aggregate pile was also varied from a maximum height of 70 feet to a minimum height of 10 feet.

For cross-section B-B, static slope stability analysis was performed for a minimum distance of 25 feet from the existing chainlink fence to the edge of the proposed aggregate stockpiles and setback 350 feet from the outboard edge of the pier deck. The height of the aggregate pile was varied from a minimum height of 5 feet to a maximum height of 70 feet.

Locations of the cross-sections are presented on the Site Plan, Plate 1.

#### Pseudo-Static (Seismic) Analysis

Pseudo-static stability of the slope was analyzed by applying a lateral acceleration of 0.1g and 0.15g to the slope.

#### Results of Slope Stability Analyses

The results of the slope stability analyses are presented in the following tables.

**Cross-Section A-A**

Setback Distance* (feet)	Height of Aggregate Pile (feet)	Static Factor of Safety	Pseudo-Static Factor of Safety (0.1g)	Pseudo-Static Factor of Safety (0.15g)
200	10	1.1		
200	70	0.5		
300	20	1.3	0.8	
300	30	1.3		
300	40	1.3		
300	50	1.2		
300	60	0.9		
300	70	0.8		
350	50	1.3	0.8	
350	60	1.3		
350	70	1.2		
400	60	1.4		
400	70	1.2		
450	70	1.6	1.1	1.0

\* Setback distance is measured from the outboard edge of the pier deck.

**Cross-Section B-B**

Setback Distance* (feet)	Height of Aggregate Pile (feet)	Static Factor of Safety
25	5	1.5
25	10	0.3
25	70	0.0
100	10	0.3
100	20	0.0
240	70	1.5

\* Setback distance is measured from the chainlink fence.

Typical critical slip circles for the safe loading configuration are presented on Plate 5, Slip Circle at 450 Feet Setback For a 70-Foot High Pile at Cross-Section A-A, and Plate 6, Slip Circle at 25 Feet Setback For a 5-Foot High Pile and 240 Feet Setback For a 70-Foot High Pile at Cross-Section B-B.

#### CONCLUSION

Based on the results of the slope stability analyses for cross-section A-A, we recommend that the piles of aggregate be set back from the outer edge of the pile-supported pier deck by at least 450 feet for a 70-foot high pile of aggregate. A plot of static factor of safety versus setback distance for a 70-foot high aggregate pile is presented on Plate 7, Factor of Safety vs. Setback Distance For 70-Foot High Aggregate Pile - Cross-Section A-A.

Based on the results of the slope stability analyses for cross-section B-B, we recommend that piles of aggregate located between 25 feet to 240 feet of the chainlink fence be limited to 5 feet in height. Aggregate should not be stockpiled within 25 feet of the fence. The height of the aggregate pile may be increased to the maximum height of 70 feet at a distance greater than 240 feet to the edge of the pile from the fence.

We recommend that additional borings be drilled to verify the assumed subsurface soil conditions, considering that the previous borings were drilled more than 17 years ago, and there is limited information on the strength characteristics of the dredge fill material. In addition, we anticipate there could be substantial strength gain, since the previous borings were drilled, in the young bay mud, resulting from consolidation of the young bay mud due to the imposed fill loads.

#### CLOSURE

Our services have been performed with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended.

The conclusions and recommendations presented in this report are professional opinions based on project criteria and data described in this report, and are intended only for the purpose, site location and project indicated. If there is a significant change in the project, or if different soils are encountered from those indicated, Trans Pacific Geotechnical Consultants, Inc. should be notified for evaluation and supplemental recommendations as necessary or appropriate.

Trans Pacific Geotechnical Consultants, Inc. cannot be responsible for interpretations made by others with regard to foundation support or other recommendations presented in this report.



Structus, Inc.

June 28, 2000

If you have any questions regarding this report, please contact us. The following plates are attached and complete this report.

Plate 1	Site Plan
Plate 2	Typical Cross-Section
Plate 3	Cross-Section A-A
Plate 4	Cross-Section B-B
Plate 5	Slip Circle at 450 Feet Setback For a 70-Foot High Pile at Cross-Section A-A
Plate 6	Slip Circle at 25 Feet Setback For a 5-Foot High Pile and 240 Feet Setback For a 70-Foot High Pile at Cross-Section B-B
Plate 7	Factor of Safety vs. Setback Distance For 70-Foot High Aggregate Pile - Cross-Section A-A



Yours Very Truly,  
Trans Pacific Geotechnical Consultants, Inc.

Handwritten signature of Eddy T. Lau in black ink.

Eddy T. Lau, P.E.  
Reg. Civil Engineer 019897  
Reg. Geotechnical Engineer 506  
Expiration 9/30/2001

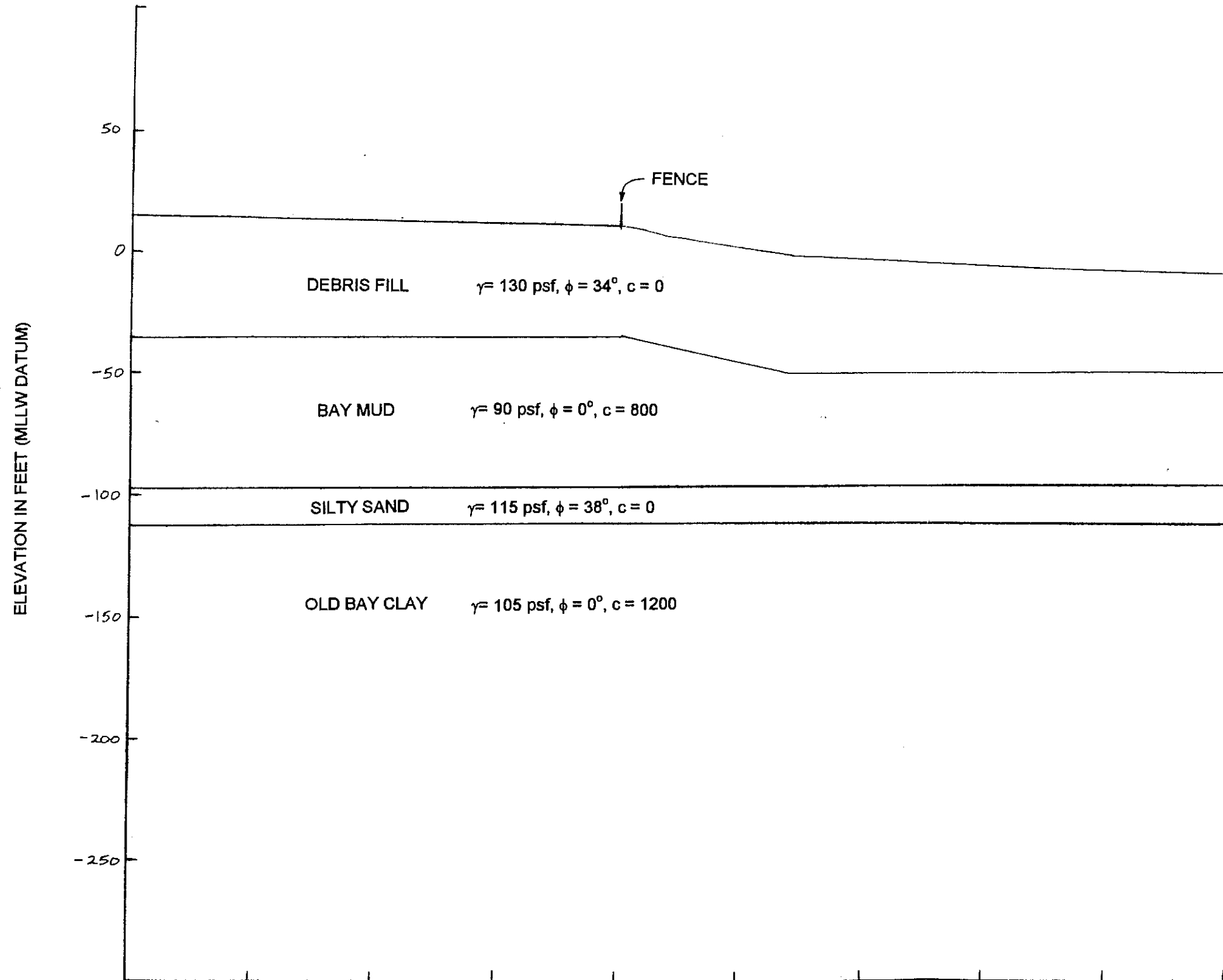
Handwritten signature of Marlene Wong in black ink.

Marlene Wong  
Project Engineer

(Three copies submitted)

cc: San Francisco Port Commission (6)  
Ferry Building, Suite 3100  
San Francisco, California 94111  
Attention: Mr. Edward Byrne

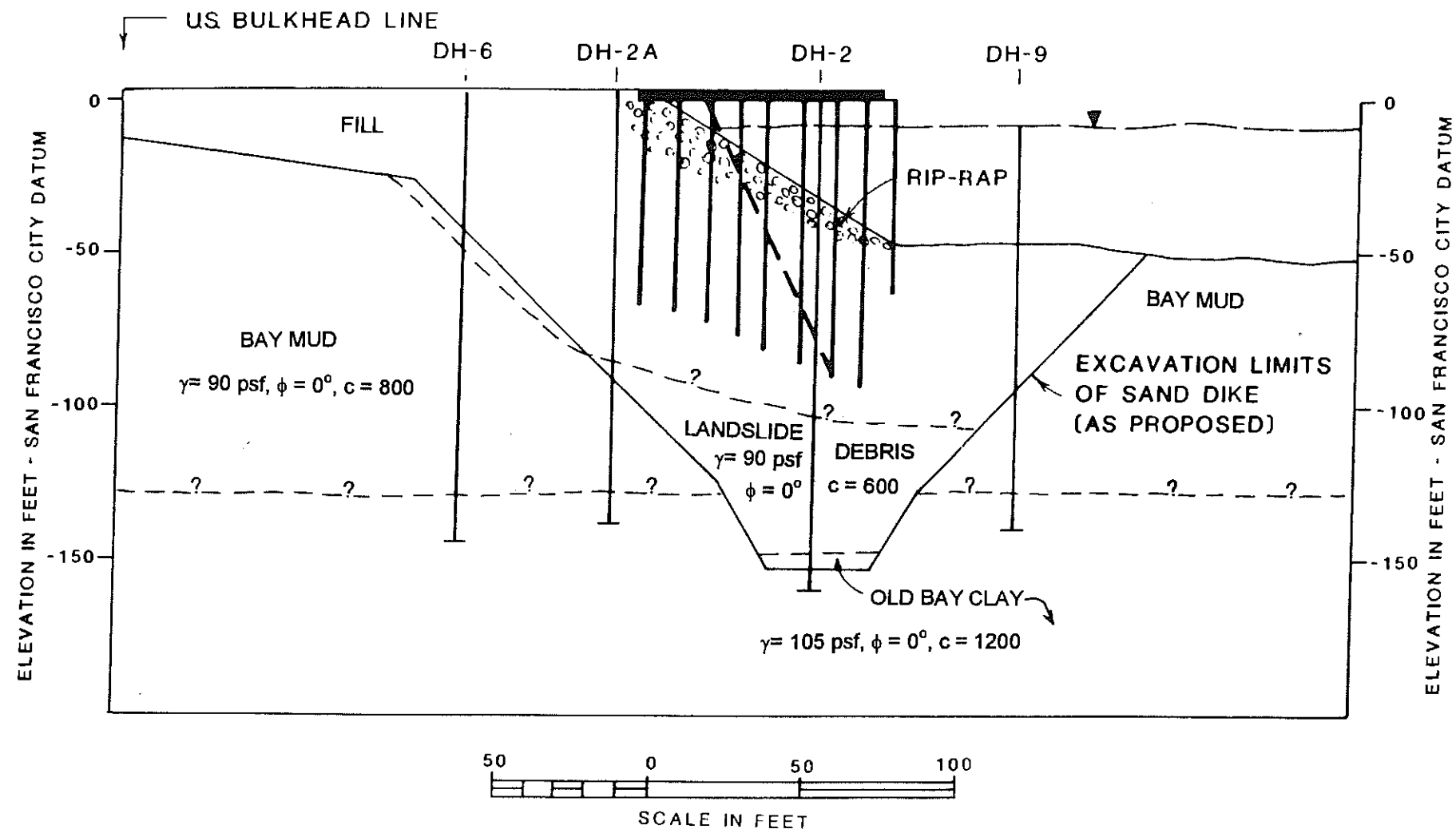
WPP:1227006.REP



# CROSS-SECTION B-B

TRANS PACIFIC GEOTECHNICAL CONSULTANTS, INC.

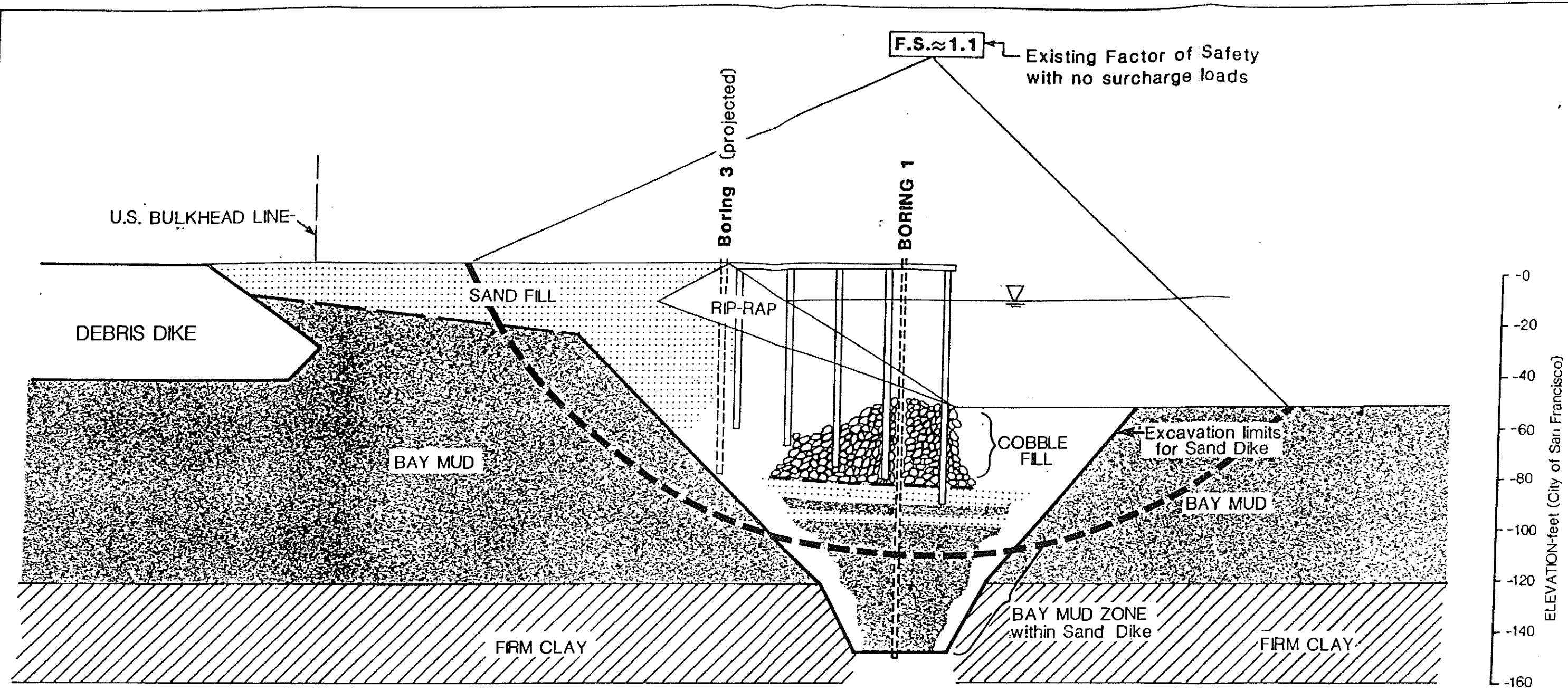
PLATE 4



Source: "Geotechnical Investigation, Pier 94, San Francisco, California, by Geotechnical Consultants, Inc. for Parsons, Brinckerhoff, Quade & Douglas, Inc.," dated December 1983.

# CROSS-SECTION A-A

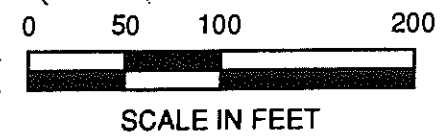
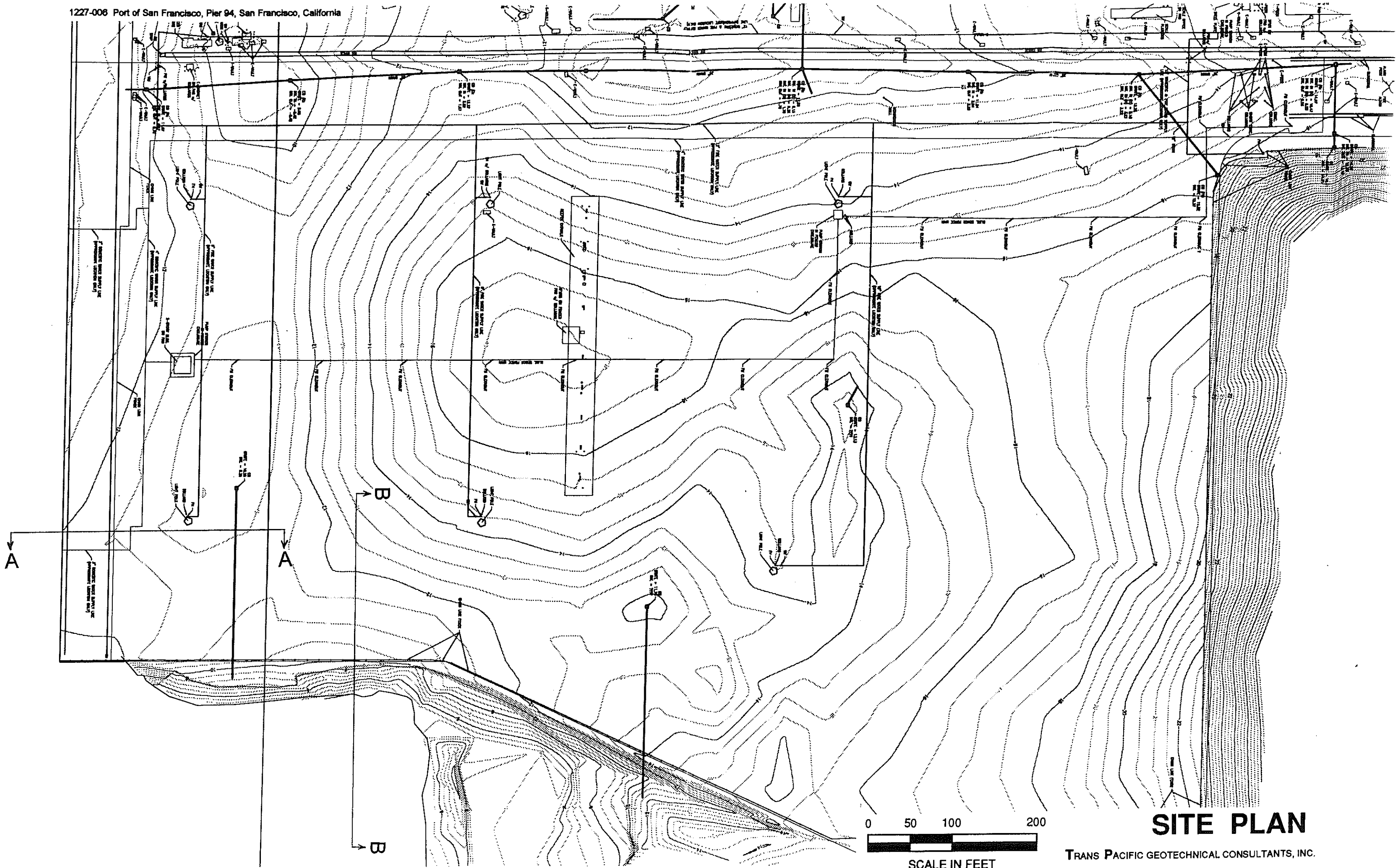
TRANS PACIFIC GEOTECHNICAL CONSULTANTS, INC.



## TYPICAL CROSS-SECTION

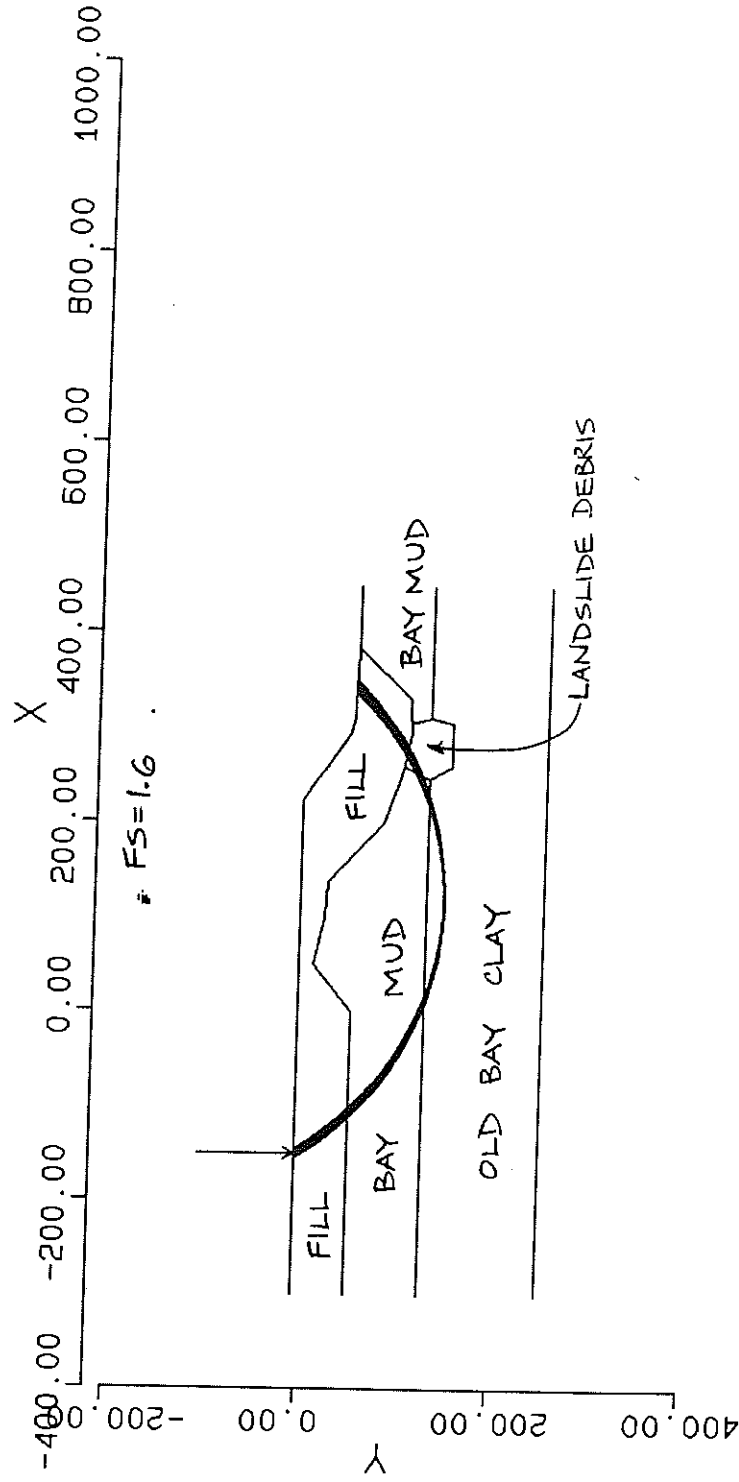
TRANS PACIFIC GEOTECHNICAL CONSULTANTS, INC.

Source: "Geotechnical Investigation, Deck Settlement At Pier 94 East, San Francisco, California,"  
by Harding Lawson Associates, dated May 7, 1982.



# SITE PLAN

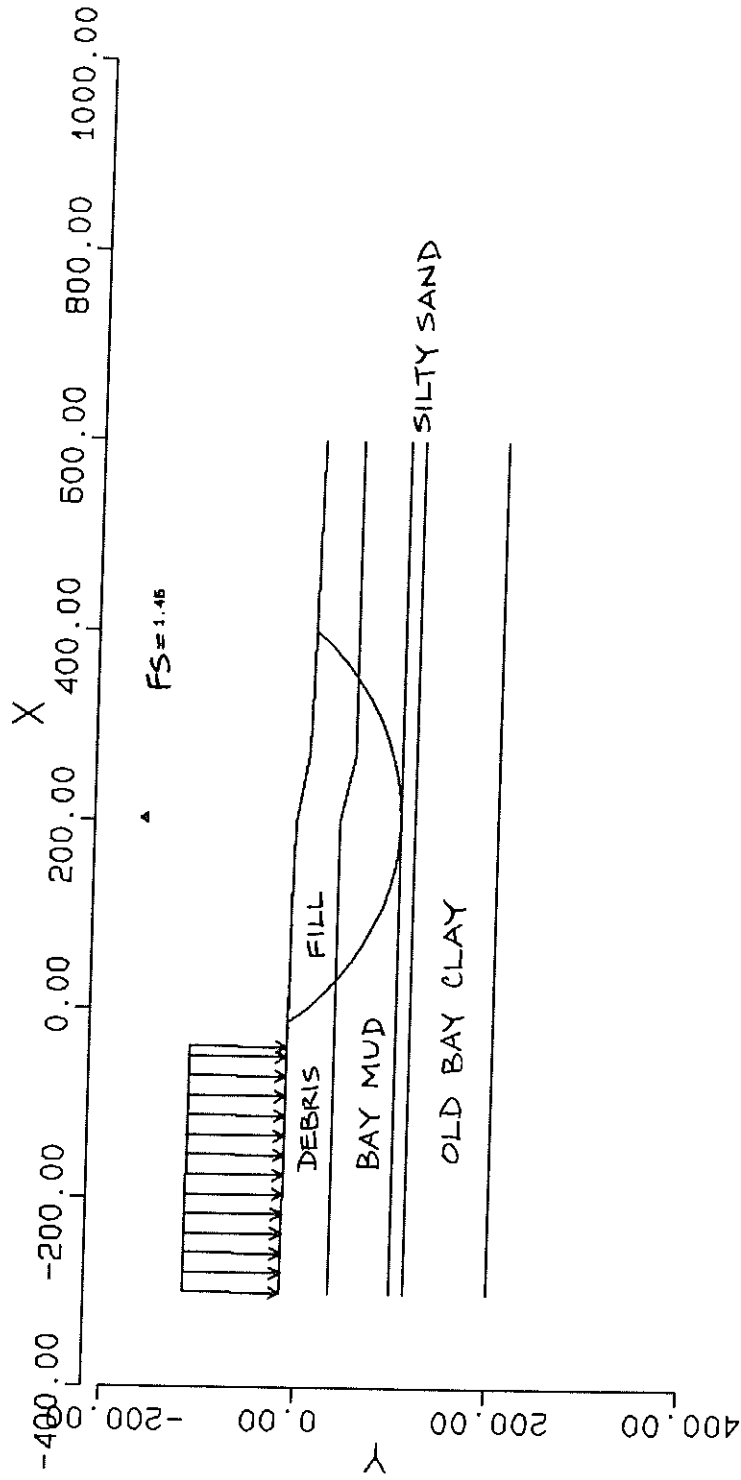
TRANS PACIFIC GEOTECHNICAL CONSULTANTS, INC.



Pier 94

# SLIP CIRCLE AT 450 FEET SETBACK FOR A 70-FOOT HIGH PILE AT CROSS-SECTION A-A

TRANS PACIFIC GEOTECHNICAL CONSULTANTS, INC.



Pier 94

SLIP CIRCLE AT 25 FEET SETBACK FOR A 5-FOOT HIGH PILE AND 240 FEET SETBACK FOR A 70-FOOT HIGH PILE AT CROSS-SECTION B-B

### Factor of Safety vs. Setback Distance for 70-Foot High Aggregate Pile Cross-Section A-A

