# GEOTECHNICAL INVESTIGATION
# SDG&E TL23071 UNDEGROUND
# SYCAMORE CANYON SUBSTATION
# TO PENASQUITOS SUBSTATION
# SAN DIEGO, CALIFORNIA

ENVIRONMENTAL
GEOTECHNICAL / CONSTRUCTION MATERIALS TESTING
INFRASTRUCTURE ENGINEERING
ASSET MANAGEMENT / CERTIFICATION
MUNICIPAL SERVICES

**January 10, 2017**

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*A NV5 Company – Offices Nationwide*

# Geotechnical Investigation

**SDG&E TL23071 Underground**
**Sycamore Canyon Substation to Penasquitos Substation**
**San Diego, California**

**Prepared for:**

**NV5 Infrastructure**
**15092 Avenue of Science, Suite 200**
**San Diego, California 92118**

**Attention: Mr.  Dan Klausenstock**

**Project No.: Project No.: SDB090102.01 Phase 01 Task 13**

**January 10, 2017**

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NV5

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January 10, 2017
Project No.: SDB090102.01 Phase 01 Task 13

Attention: **Mr. Dan Klausenstock**

Subject: Geotechnical Investigation

Project: SDG&E TL23071 Underground
Sycamore Canyon Substation to Penasquitos Substation
San Diego County, California

Dear Mr. Klausenstock:

This report presents the results of the geotechnical investigation for the proposed underground construction for San Diego Gas & Electric's (SDG&E's) Transmission Line (TL) 23701 in San Diego County, California. Specifically, recommendations and geotechnical parameters are presented herein to be used for the design and construction of the proposed underground utility line conduit banks and vaults. The entire segment is approximately 11.4 miles in length.

The attached report includes the subsurface soil conditions observed during our study, a review of available relevant geotechnical documents, and geotechnical engineering analyses. It is our opinion that the proposed construction is feasible from a geotechnical standpoint, provided recommendations and parameters contained in this report are incorporated during the design and construction of the project.

It is recommended that the forthcoming project plans and specifications, be reviewed by NV5 for consistency with our report prior to the bid process in order to avoid possible conflicts, misinterpretations, inadvertent omissions, etc. It should also be noted that the applicability and final evaluation of recommendations presented herein are contingent upon construction phase field monitoring by NV5 in light of the widely acknowledged importance of geotechnical consultant continuity through the various planning, design and construction stages of a project.

NV5 appreciates the opportunity to provide this geotechnical engineering service for this project. If you have any comments or questions, please do not hesitate to contact our office at 858.715.5800.

Respectfully submitted,
**NV5 West, Incorporated**

**Gene Custenborder, CEG 1319**
Senior Engineering Geologist

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Senior Vice President

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## APPENDICES

## 1.0 INTRODUCTION

This report provides the results of the geotechnical investigation conducted for the proposed underground utility line elements associated with SDG&E's TL23701 project. The location of the subject project in relation to surrounding streets and landmarks is presented on *Figure 1, Vicinity Map*. The purpose of this study was to evaluate the subsurface conditions along the alignment and to provide geotechnical recommendations and parameters for the design and construction of the proposed underground transmission conduit banks and vaults. This report summarizes the data collected and presents our findings, conclusions and geotechnical design recommendations.

This report has been prepared for the exclusive use of the client and their consultants in the design of the proposed underground transmission line project. In particular, it should be noted that this report should be considered by prospective construction bidders only as a source of general information, subject to interpretation and refinement by their own expertise and experience; particularly with regard to construction feasibility. Contract requirements set forth by the project plans and specifications will supersede any general observations and specific recommendations presented in this report.

## 2.0 SCOPE OF SERVICES

Our scope of services for this project included the following tasks:

- Review of readily available background data, including published and in-house geotechnical data, in-house geotechnical reports, geologic map, seismic hazard maps and literature relevant to the subject site.
- Performing site reconnaissance to observe the general surficial site conditions, check for accessibility, and to select the locations for seismic refraction traverses.
- Notification and coordinating with various entities involved with the field exploration activities including NV5 Infrastructure and the traffic control subcontractor.
- Conducted a subsurface investigation which included acquiring data from 12 seismic refraction traverses.
- Performing an assessment of general seismic conditions and geotechnical hazards affecting the area and their possible impact on the subject project.
- Engineering evaluation of the data collected to develop geotechnical design parameters and recommendations for the proposed construction.
- Preparation of this report including reference maps and graphics, presenting our findings, conclusions and geotechnical design recommendations specifically addressing the following items:
    - Evaluation of general subsurface conditions and description of types, distribution, and engineering characteristics of subsurface materials.
    - Recommendations including site earthwork and geotechnical parameters to be used for the design of the project.
    - General construction considerations for the underground transmission line.

## 3.0 SITE AND PROJECT DESCRIPTION

The project consists of construction of a 230 kV underground transmission line as part of SDG&E's TL23071 Sycamore Canyon Substation to Penasquitos Substation project. TL23071 is approximately 11.4 miles in total length and is located within various streets' right-of-way in the city of San Diego California. The proposed project includes construction of thirty-six underground vaults along the alignment. The alignment passes through the commercial/industrial area of Carroll Canyon and Miramar west of Interstate 15, and after crossing the interstate, continues through the residential community of Scripps Ranch.

The terrain along the alignments is generally flat to gently sloping. Elevations for the project range from a low of approximately 146 feet above mean sea level (MSL) at approximate station 16+00 near the western end of the alignment just north of Carroll Canyon Road, to a high of approximately 918 feet MSL at approximate station 607+00 on Pomerado Road near at the intersection of Vista Elevada. Local geographic information for the project alignment is presented on *Figure 1, Vicinity Map*.

## 4.0 FIELD EXPLORATION PROGRAM

Before starting our field exploration program, a field reconnaissance was conducted to observe site conditions and mark the location of our planned explorations. On August 9, 10 and 20, 2016, twelve seismic refraction traverses were performed at selected locations along the alignment. NV5 subcontracted the services of Southwest Geophysics, Inc. to use a 24-channel Geometrics Geode seismograph and data processing. The locations of the seismic refraction traverses were selected by NV5 geologists. The approximate locations of the traverses are shown on *Figure 2, Geotechnical Map*. A detailed report describing the seismic refraction procedure and summarizing the findings of the seismic refraction exploration is included in Appendix A. A summary of anticipated geotechnical conditions and excavatability characteristics is presented in Appendix B.

## 5.0 GEOLOGIC CONDITIONS

An NV5 geologist performed geologic reconnaissance mapping along the alignment. Based on our site reconnaissance, field mapping. review of a published geologic map (Kennedy, M.P. and Tan, S.S., 2005) and groundwater data, the site is underlain by the following geologic units and groundwater conditions.

### 5.1 Fill

Fill soils, apparently placed during development of the areas within and adjacent to the alignment, are present along major portions of the alignment. Fill soils are anticipated to consist of locally-derived sands, clayey sands and sandy clays with locally abundant gravel and cobble.

### 5.2 Very Old Paralic Deposits (map symbol Qvop)

Early to middle Pleistocene-aged, reddish brown, mostly interfingered, siltstone, sandstone and gravel and cobble conglomerate underlie the line alignment where it crosses the relatively level mesa in the Miramar area. Based on published regional geologic mapping, these rocks have been classified as very old paralic deposits. The dense formational materials typically exhibit favorable bearing characteristics for proposed structural loads. Cemented zones are known to occur and can present excavation difficulties. In addition, occasional boulders are present and can be difficult to excavate.

### 5.3 Poway Group Sedimentary Strata (map symbols Tmv, Tst, Tsc and Tt)

Eocene-aged mudstone, sandstone and gravel and cobble conglomerate underlies the western portion of the alignment in the Carroll Canyon area and in the eastern portion of the alignment east of Interstate 15. Based on published regional geologic mapping, these rocks have been classified as the Mission Valley Formation (Tmv), Stadium Conglomerate (Tst), Scripps Formation (Tsc) and Torrey Sandstone (Tt). The dense formational materials typically exhibit favorable bearing characteristics for proposed structural loads. Cemented zones are known to occur and can present excavation difficulties. In addition, occasional boulders are present and can be difficult to excavate.

### 5.4 Groundwater

A static near-surface groundwater table is not expected along the alignment. Based on review of the Water Data Library (California Department of Water Resources, 2014), the regional groundwater table near the western portion of the alignment along Carroll Canyon Road is expected at an approximate elevation of 80 to 85 feet above MSL. At this depth the regional groundwater level would be in excess of 50 feet below the alignment.

Groundwater is expected to be shallower where the alignment crosses Carroll Canyon near El Camino Memorial Park and the Sorrento Canyon Golf Center driving range. At that location, ground water is expected to be perched in the alluvium below the Carroll Canyon Road fill prism. However, at that location, groundwater is well below the depth of the planned construction and not expected to be an impact. As the alignment reaches the mesa top in the Miramar area and beyond to the east, regional groundwater levels are expected to be greater 150 feet below the existing ground surface.

Groundwater is not anticipated to be a major constraint to construction. However, minor seepage due to perched water at the interface between layers of differing permeability can be expected (such as fill/natural contacts, etc.). Groundwater conditions can also be expected to vary due to seasonal precipitation, irrigation, and other factors.

# 6.0 SEISMIC AND OHER GEOTECHNICAL HAZARDS

The findings of our seismic and geotechnical hazards evaluation for the proposed underground utility line segments are summarized in the sections below.

## 6.1 Faults

The project site is not located within an Earthquake Fault Zone delineated by the State of California for the hazard of fault surface rupture (Bryant, W.A., and Hart, E.W., 2007). The surface traces of known active or potentially active faults are not known to pass directly through, or to project toward the site. Therefore, the potential for damage due to surface rupture of faults at the project site is considered low during the design life of the proposed structures.

The nearest known active faults are the Rose Canyon fault located approximately 4.1 miles southwest of the site, the Coronado Bank fault located 17.6 miles southwest of the site, the Elsinore fault located approximately 26.5 miles northeast of the site and the San Jacinto fault located approximately 47.3 miles northeast of the site. The San Andreas fault is located approximately 72 miles northeasterly of the site. Figure 3, *Regional Fault Map,* shows the location of the project in relation to known faults in the region (Jennings, 2002) and (U.S. Department of the Interior, U.S. Geological Survey and California Geological Survey, 2006).

## 6.2 Ground Shaking

Although the site could be subjected to strong ground shaking in the event of an earthquake, this hazard is common in Southern California and the effects of ground shaking can be mitigated if the improvements are designed and constructed in conformance with current building codes and engineering practices (see *Section 7.8, Seismic Design*).

## 6.3 Liquefaction and Dynamic Settlement

Liquefaction and dynamic settlement of soils can be caused by ground shaking during earthquakes. Research and historical data indicate that loose, relatively clean granular soils are susceptible to liquefaction and dynamic settlement, whereas the stability of the majority of clayey silts, silty clays and clays is not adversely affected by ground shaking. Liquefaction is generally known to occur in saturated loose cohesionless soils at depths shallower than approximately 50 feet. Dynamic settlement due to earthquake shaking can occur in both dry and saturated sands. The potential for liquefaction or seismically-induced ground settlement due to an earthquake is considered low because of the stiff to very dense nature of the sedimentary formational units underlying the site at depth.

### 6.4 Slope Stability and Landslides

Based on the results of this study, there appears to be no indications of landslides or deep-seated instability in any of the sloping areas along the alignment. The dense formational materials along the alignment are not generally prone to slope instability in properly-engineered slopes.

### 6.5 Tsunami and Seiches

The site is located approximately 3 miles inland from the Pacific Ocean and generally above an elevation of 150 feet above mean sea level. Therefore, tsunamis (seismic sea waves) are not considered a hazard at the site. The site is not located near to or downslope of, any large body of water that could affect the site in the event of an earthquake-induced failure or seiche (oscillation in a body of water due to earthquake shaking).

### 6.6 Expansive Soils

The project site is underlain by predominantly silty and clayey sands with locally abundant gravel and cobble conglomerate. The clayey soils are similar to clayey soils in the vicinity generally found to have medium to high expansion indices when tested. If highly expansive soils are encountered during excavation, they may not be suitable for use as trench backfill above the conduit.

## 7.0 DESIGN RECOMMENDATIONS

### 7.1 General

Based on the results of the field exploration and engineering analyses, it is NV5's opinion that construction of the proposed underground transmission line and associated vaults is feasible from a geotechnical standpoint, provided the recommendations in this report are incorporated into the design plans and implemented during construction. The following sections present detailed recommendations and parameters pertaining to the geotechnical engineering design for this project.

### 7.2 Excavatability

It is anticipated that excavations for underground utility line trenches and vaults will be on the order of 5 to 10 feet and 14 to 16 feet in depth, respectively, below the existing surface grades. It appears that the majority of the alignment is underlain by locally derived fill soils and sedimentary units consisting of silty to clayey sand and gravel and cobble conglomerate. Excavations in these in the fill materials can likely be accomplished by conventional heavy-duty excavating equipment in good operating condition. For the most part, excavations in the formational sedimentary rock units can also likely be accomplished by conventional heavy-duty excavating equipment in good operating condition. However, the sedimentary units are known to have locally cemented zones that can present excavation difficulties. Heavy ripping, jackhammering, rock splitting or other methods may be necessary to facilitate excavation of cemented zones. Occasional boulders may also be encountered and can be difficult to excavate.

A summary of the expected earth materials and excavatability characteristics anticipated to be encountered along the alignment and at each of the vaults and cable poles is provided in Appendix C.

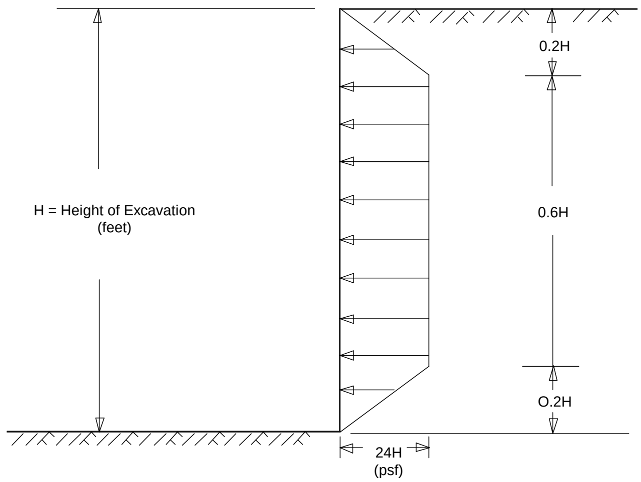
The clayey mudstone units are probably not suitable for use as trench backfill above the conduit. Excavations of sedimentary rock units may likely produce oversized cobble materials that are unsuitable for use in backfill and structural fills, although the sandy sedimentary materials are generally considered suitable for use as trench backfill. Recommendations for backfill are presented in Section 7.5 of this report.

### 7.3 Temporary Excavations

Temporary, shallow excavations with vertical side slopes less than 4 feet high will generally be stable, although there is a potential for localized sloughing; in these soil types vertical excavations greater than 4 feet high should not be attempted without proper shoring to prevent local instabilities. Shoring may be accomplished with hydraulic shores and trench plates, and/or trench boxes, soldier piles and lagging. The actual method of a shoring system should be provided and by a contractor experienced in installing temporary shoring under similar soil conditions and designed by an experienced licensed professional. If soldier piles and lagging are to be used, we should be contacted for additional recommendations.

All trench excavations should be shored in accordance with CalOSHA regulations. For your planning purposes, the native soil materials may be considered a Type C, as defined the current CalOSHA soil classification; steeper back-cut inclinations within rock should be evaluated on a case-by-case basis during construction.

Braced excavations should be designed to resist a trapezoidal distribution of lateral earth pressure. The recommended pressure distribution, for the case where the grade is level behind the shoring, is illustrated in the following diagram with the maximum pressure equal to 24H in psf, where H is the height of the excavation in feet.




Any surcharge (live, including traffic, or dead load) located within a 1(H): 1 (V) plane drawn upward from the base of the shored excavation should be added to the lateral earth pressures. The lateral load contribution of a uniform surcharge load located across the 1(H): 1(V) zone behind the excavation walls may be calculated by using *Figure 4, Lateral Surcharge Loads*. Lateral load contributions of surcharges can be provided once the load configurations and layouts are known. As a minimum, a 2-foot equivalent soil surcharge is recommended to account for nominal construction loads.

Stockpiled (excavated) materials should be placed no closer to the edge of a trench excavation than a distance defined by a line drawn upward from the bottom of the trench at an inclination of 1:1, but no closer than 4 feet. All trench excavations should be made in accordance with CalOSHA requirements.

### 7.4 Groundwater

Groundwater is not anticipated to be a major constraint to the proposed construction. Groundwater conditions can be expected to vary due to seasonal precipitation, irrigation, and other factors, and therefore, groundwater conditions may be different during construction. If water accumulates in the excavations, it should be pumped out prior to placing concrete.

### 7.5 Trench Backfill

It is understood that all conduits will be encased in cement-sand slurry in accordance with SDG&E standard specifications. If overlying trench backfill is soil and not slurry, the moisture content of the backfill should be maintained within 2% of optimum moisture content during compaction, and backfill should be placed in loose horizontal lifts not more than 8 inches in loose thickness and compacted to at least 90 percent of the maximum dry density as evaluated by the latest version of ASTM D1557. Backfill should be mechanically compacted. Flooding or jetting is not recommended.

The on-site cobbly materials may not be suitable for trench backfill unless they are screened of materials larger than 3 inches in diameter. The on-site sandy soils may be used for backfill provided they are free of any contaminated soil, debris, organic matter, or other deleterious materials. Any rock or other soil fragments greater than 3 inches in size should not be used in fills. All imported fill, if any, should consist of granular, non-expansive soil with an Expansion Index of 20 or less. Import material should be evaluated by NV5 prior to transport to the site and not contain any contaminated soil, expansive soil, debris, organic matter, or other deleterious materials.

### 7.6 Conduit Design

The conduit should be designed in accordance with the SDG&E guidelines and approved plans. Where a special design is required, it is recommended that the parameters presented in the following tables be used for the evaluation of the vertical dead load pressure in connection with the structural integrity of the conduit.

**Table 1: Design Vertical Pressures (soil)**(1)

| Depth of Cover (feet) | D (psf) |
|---|---|
| 0-5 | 650 |
| 6-10 | 1,300 |

(1) Dead load vertical pressure from soil prism considering load coefficients for cohesionless backfill.

**Table 2: Design Vertical Pressures (Dynamic Loads)**(1)

| Depth of Cover (feet) | D (psf) |
|---|---|
| 2 | 3,200 |
| 4 | 1,150 |
| 6 | 600 |
| 8 | 360 |
| 10 | 240 |

(1) Dead load vertical pressure equivalent based on a dynamic load from a truck with a contact pressure of 100 psi.

NV5 can provide additional design vertical pressure values if requested.

### 7.8 Seismic Design

Preliminary seismic design parameters along the alignment were also developed as per the guidelines outlined in the 2012 IBC (2013 CBC) with 2008 USGS hazard data and ASCE 7 10 Standard. **NV5 should be contacted with latitude/longitude coordinates for site specific improvements requiring seismic parameters, if needed.** The seismic design parameters for Site

Class "A" (very hard rock) were developed using a JAVA ™ application, Java Ground Motion Parameter Calculator–Version 5.0.9 available on the USGS website (http://earthquake.usgs.gov/designmaps). The preliminary seismic design parameters for the project site are presented in the following *Table 4*.

**Table 4: 2012 IBC Seismic Design Parameters**
**And ASCE 7-10 Standard**

| Site Class Definition | D |
|---|---|
| Mapped Spectral Accelerations for short periods, $S_S$ | 0.917g |
| Mapped Spectral Accelerations for 1-sec period, $S_1$ | 0.356g |
| Site Coefficient, $F_a$ | 1.133 |
| Site Coefficient, $F_v$ | 1.687 |
| Maximum considered earthquake spectral response acceleration for short periods, $S_{MS}$ adjusted for Site Class | 1.039g |
| Maximum considered earthquake spectral response acceleration at 1-sec period, $S_{M1}$ adjusted for Site Class | 0.601g |
| Five-percent damped design spectral response acceleration at short periods, $S_{DS}$ | 0.693g |
| Five-percent damped design spectral response acceleration at 1-sec period, $S_{D1}$ | 0.401g |

## 8.0 DESIGN REVIEW AND CONSTRUCTION MONITORING

Geotechnical review of plans and specifications is of paramount importance in engineering practice. The poor performance of many structures has been attributed to inadequate geotechnical review of construction documents. Additionally, observation and testing of the subgrade will be important to the performance of the proposed improvements. The following sections present our recommendations relative to the review of construction documents and the monitoring of construction activities.

### 8.1 Plans and Specifications

The design plans and specifications should be reviewed and approved by NV5 prior to bidding and construction, as the geotechnical recommendations may need to be reevaluated in the light of the actual design configuration. This review is necessary to evaluate whether the recommendations contained in this report and future reports have been properly incorporated into the project plans and specifications.

### 8.2 Construction Monitoring

Site preparation, removal of unsuitable soils, assessment of imported fill materials, fill placement, and other earthwork operations should be observed and tested. The substrata exposed during the construction may differ from that encountered in the test borings. Continuous observation by a representative of NV5 during construction allows for evaluation of the soil/rock conditions as they are encountered, and allows the opportunity to recommend appropriate revisions where necessary.

## 9.0 LIMITATIONS

The recommendations and opinions expressed in this report are based on NV5's review of background documents and on information developed during this study. It should be noted that this study did not evaluate the possible presence of hazardous materials on any portion of the site. More detailed limitations of the supplemental geotechnical study are presented in the ASFE's information bulletin in *Appendix D*.

Due to the limited nature of our field explorations, conditions not observed and described in this report may be present on the site. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation and laboratory testing can be performed upon request. It should be understood that conditions different from those anticipated in this report may be encountered during the proposed structure construction operations.

Site conditions, including ground-water level, can change with time as a result of natural processes or the activities of man at the subject site or at nearby sites. Changes to the applicable laws, regulations, codes, and standards of practice may occur as a result of government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which NV5 has no control.

NV5's recommendations for this site are, to a high degree, dependent upon appropriate quality control of subgrade preparation, fill/backfill placement, and foundation construction. Accordingly, the recommendations are made contingent upon the opportunity for NV5 to observe grading operations and foundation excavations for the proposed construction. If parties other than NV5 are engaged to provide such services, such parties must be notified that they will be required to assume complete responsibility as the geotechnical engineer of record for the geotechnical phase of the project by concurring with the recommendations in this report and/or by providing alternative recommendations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. NV5 should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

NV5 has endeavored to perform this study using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar soil/rock conditions. No other warranty, either expressed or implied, is made as to the conclusions and recommendations contained in this study.

## 10.0 SELECTED REFERENCES

1. Bryant, William A., and Hart Earl W., 2007, Special Publication 42, Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zone Maps (and supplement dated September 21, 2012): California Department of Conservation, California Geological Survey, 2007;

2. California Department of Water Resources, 2014, Water Data Library, website located at http://www.water.ca.gov/waterdatalibrary/ , last updated August 13, 2014;

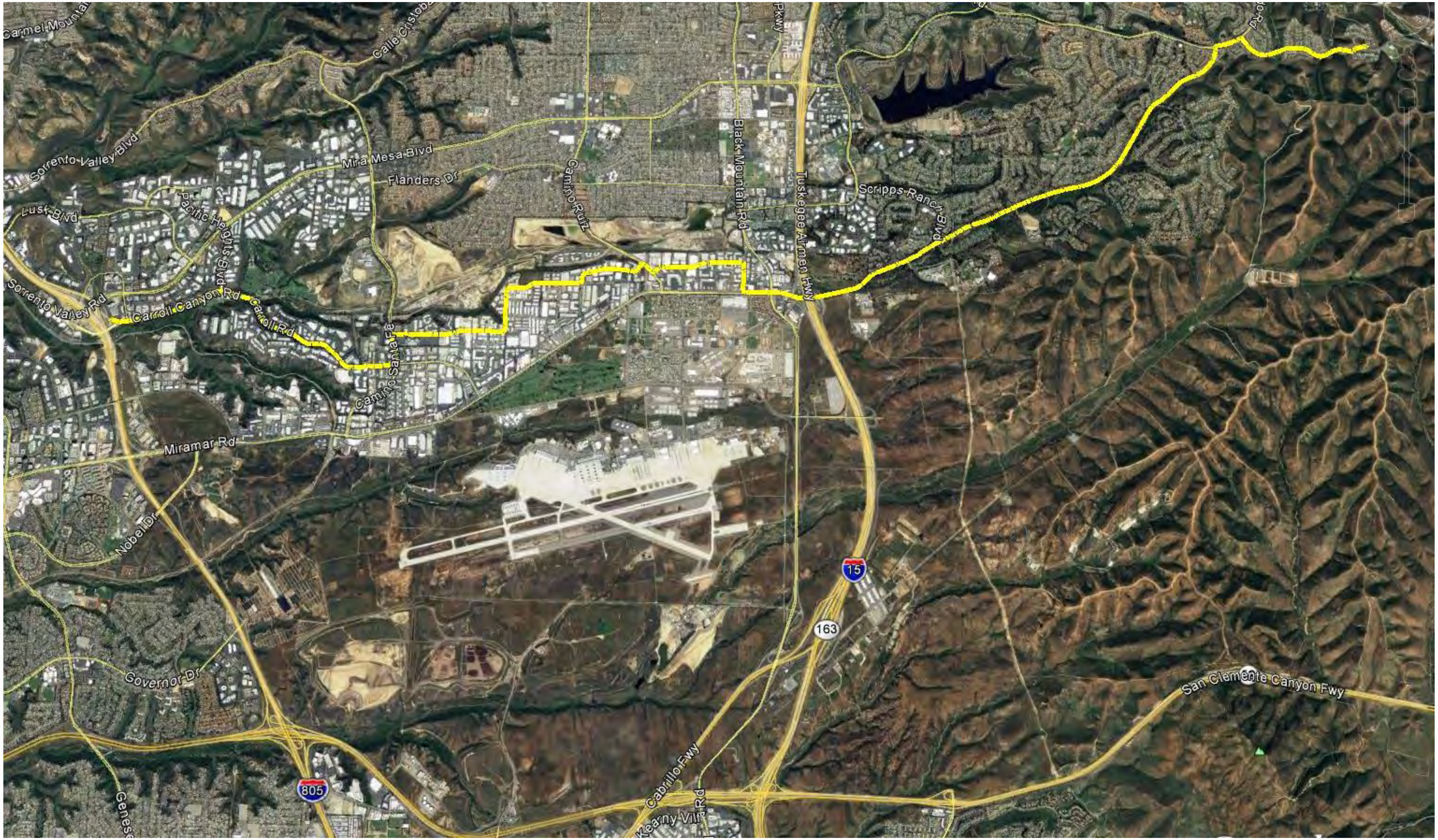
3. Jennings, C.W., 2002, Simplified Fault Activity Map of California: California Department of Conservation, California Geological Survey, Map Sheet 54, scale 1: 2,500,000;

4. Kennedy, Michael P., and Tan, Siang S., Geologic Map of the San Diego 30' X 60' Quadrangle California: United States Geological Survey, 2005;

5. U.S. Department of the Interior, U.S. Geological Survey, 2016, U.S. Seismic Design Maps, a webtool located at http://earthquake.usgs.gov/designmaps/us/application.php?, last modified December 1, 2016.

6. U.S. Department of the Interior, U.S. Geological Survey and California Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed September 16, 2016, from USGS web site: https://earthquake.usgs.gov/hazards/qfaults/.

# Figures




*Reference: Google Earth Pro 2016*

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Sycamore Canyon Substation to
Penasquitos Substation
230kV Underground Segment

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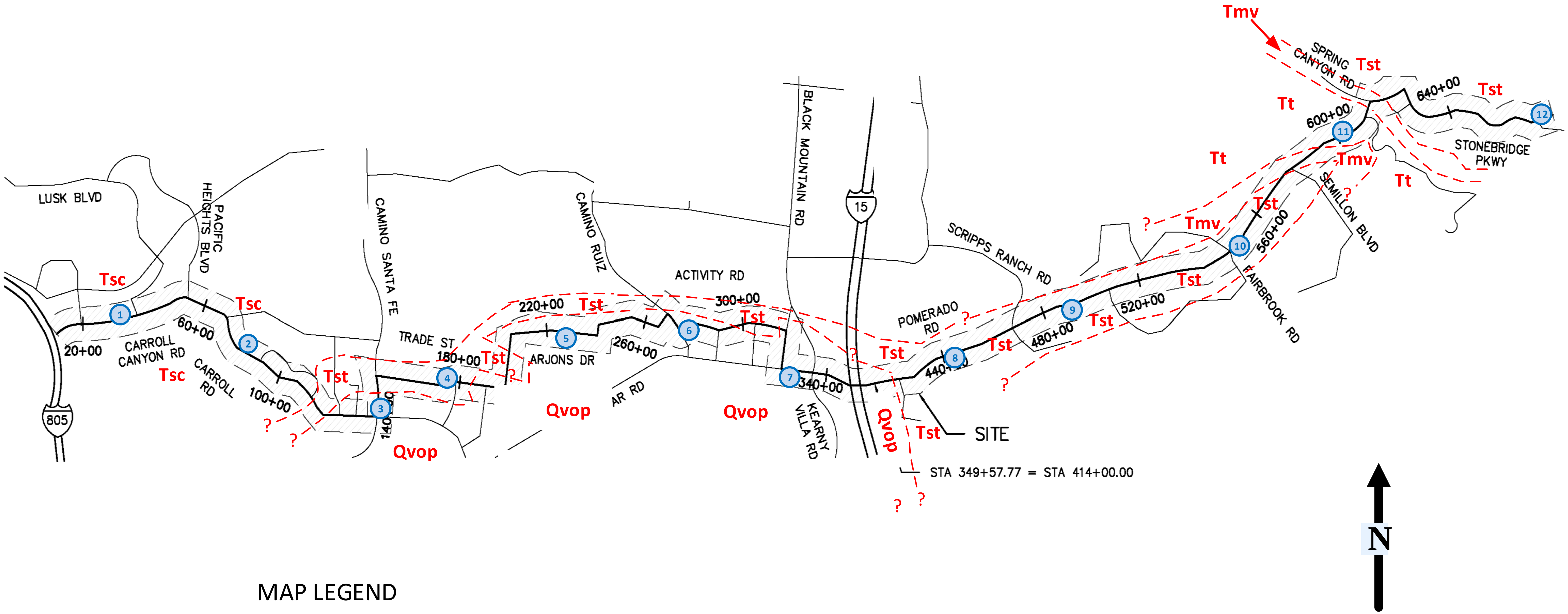
Project No: **SDB090102.01**
Drawn: **SR**
Date: **September 2016**

**Vicinity Map**
**TL23071**
**230 kV Underground Segment**
**San Diego, California**

**Figure No. 1**




MAP LEGEND

| | |
|---|---|
| 12 | Approximate locations of seismic refraction traverses |
| Qvop | Very Old Paralic Deposits |
| Tsc | Scripps Formation (undivided) |
| Tst | Stadium Conglomerate |
| Tmv | Mission Valley Formation |
| Tt | Torrey Sandstone |
| — - — | Approximate location of interpreted geologic contact |

Not to scale.
Not a construction drawing.

Base Map: Adapted from a preliminary plans titled, " TL23071, Sycamore Canyon Substation to Penaquitos Substation, 230kV Underground Segment", Sheet 1, prepared by NV5, dated July 28, 2016.

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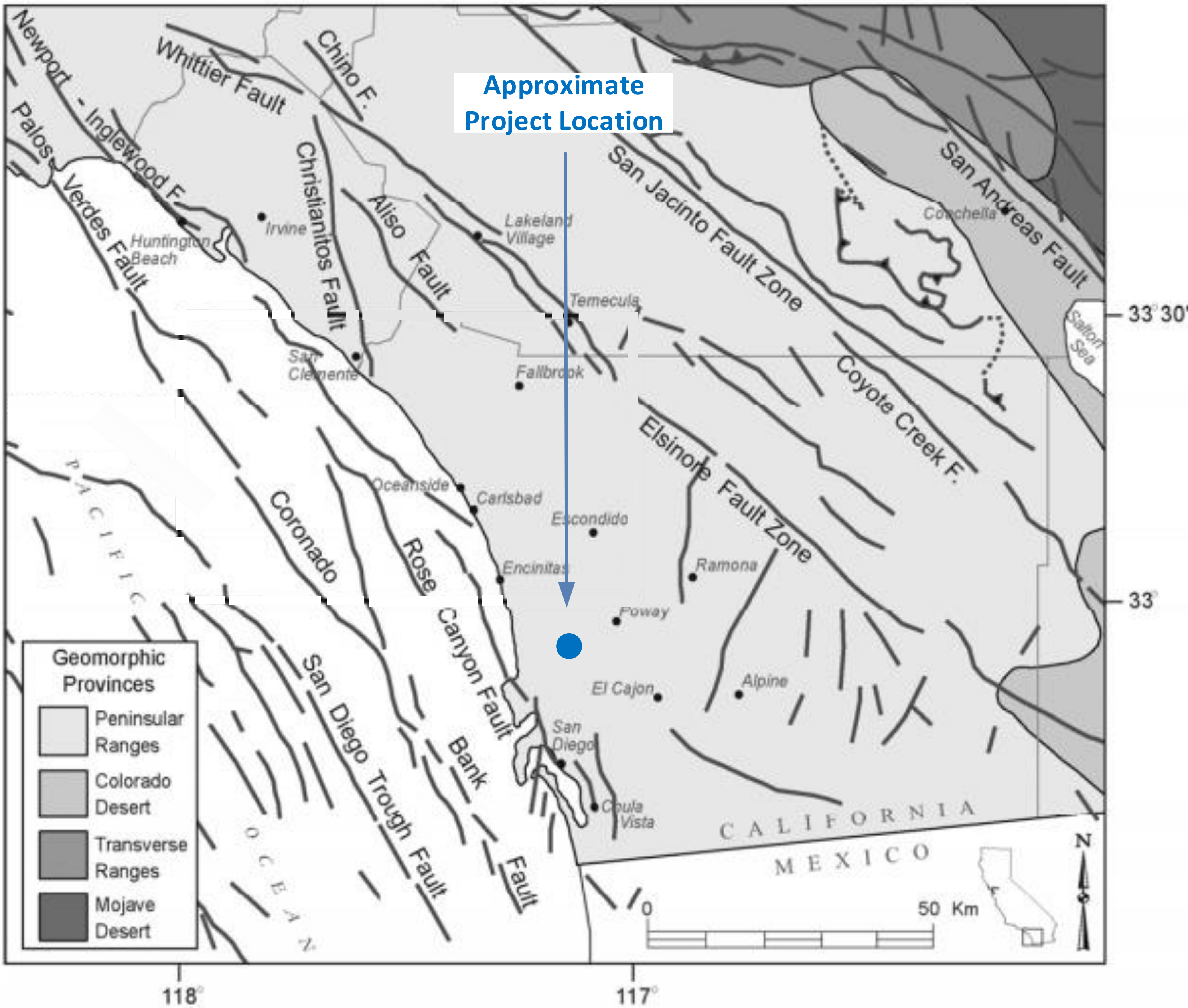
**Geotechnical Map**
**TL23071**
**230 kV Underground Segment**
**San Diego, California**

Figure No. 2




Index map showing location of major cities, faults and geomorphic provinces of southwestern California.

Reference: Jennings, C.W., and Saucedo, G.J., 2002, Simplified fault activity map of California: California Geological Survey Map Sheet 54, scale 1:2,500,000.

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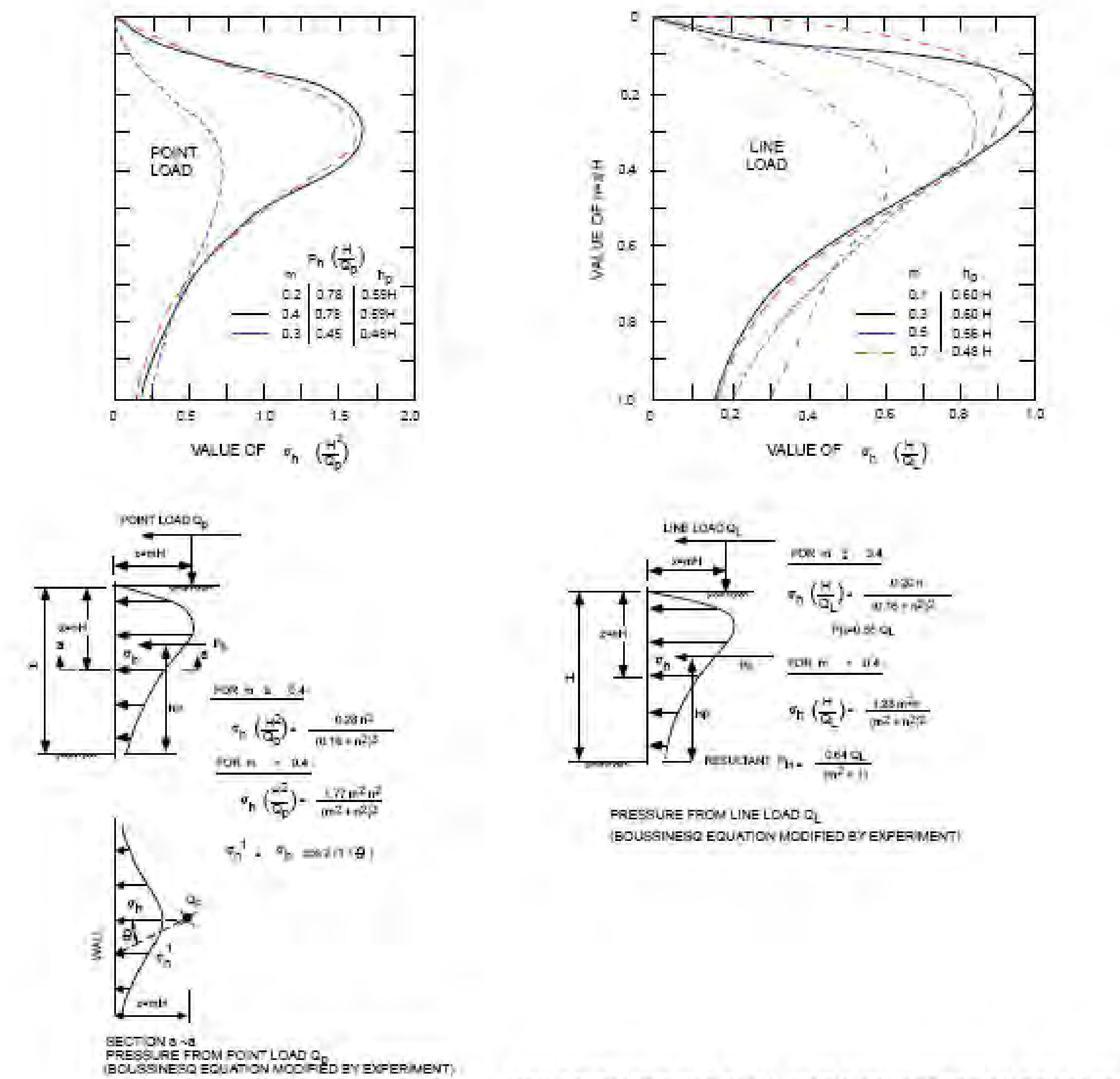
**Regional Fault Map**
**TL23071**
**230kV Underground Segment**
**San Diego, California**

**Figure No. 4**

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Project No: **SDB090102.01**
Drawn: **GC**
Date: **September 2016**

Title: **Lateral Surcharge Loads**
Project: **TL 23071**
**San Diego, California**

**Figure No. 5**

# Appendix A

Results of Seismic Refraction Study

# APPENDIX A

## Summary of Seismic Refraction Exploration
## TL 23071 Sycamore Canyon Substation to Penasquitos Substation
## San Diego, California

Introduction and Purpose

As requested, NV5 West, Inc. (NV5) is pleased to submit the results of our seismic refraction investigation along a portion of San Diego Gas and Electric's TL 23071 underground transmission project San Diego, California (refer to Figure 1 - *Site Location Map*). The purpose of the investigation was to evaluate the excavatability characteristics of the materials along the alignment by measuring the seismic velocity of the materials at selected locations. For this study, NV5 subcontracted the services of Southwest Geophysics, Inc. to use a 24-channel Geometrics Geode seismograph and data processing. This report presents the results of the investigation.

Data Acquisition Parameters

Data was acquired from, a total of 12 seismic refraction traverses during this investigation. The traverses were performed on August 9, 10 and 20, 2016. Seismic refraction traverse locations were selected by NV5 geologists. In general, each traverse employed 24 active geophone stations spaced at 5-foot intervals for a total length of approximately 125 feet each. Signal generation locations (shot points) were conducted along the lines at the ends, midpoint and intermediate points between the ends and the midpoint. The approximate locations of the seismic traverses are indicated on *Figure 2* of the accompanying geotechnical investigation report and on *Figures A-1 through A-12* of this *Appendix A*. *Figures A-1 through A-12* provide a more accurate location of the traverses using Google Earth aerial photographs as base maps.

Method, Instrumentation and Software

The seismic refraction method measures the velocity at which a seismic wave propagates through a soil or rock medium. In the case of this investigation, the first-arrival times of the refracted primary (p-wave) or compressional seismic wave was measured. Higher seismic p-wave velocities (measured in feet per second, ft/s) indicate material of higher density, thus quantifying the competency, or strength of the soil or rock medium and providing an estimation of the rippability and/or excavatability of the sub-surface materials. Seismic P-waves are generated at the surface, using a 12-lb. sledge hammer striking a steel plate. The waves are refracted at boundaries separating materials of contrasting velocities. These refracted seismic waves are then detected by a series of surface vertical component 14Hz geophones and recorded with a 24-channel seismograph. The travel times of the seismic P-waves are used in conjunction with the shot-to-geophone distances to obtain thickness and velocity information on the subsurface materials.

The collected data were processed on a data reduction and plotting workstation using SIPwin (Rimrock Geophysics, 2003), a seismic interpretation program, and analyzed using SeisOpt Pro (Optim, 2008). SeisOpt Pro uses first arrival picks and elevation data to produce subsurface velocity models through a nonlinear optimization technique called adaptive simulated annealing. The resulting velocity model provides a tomography image of the estimated geologic conditions. A color-coded seismic velocity cross-section of the subsurface has been generated for each seismic refraction line, where cool colors (blues) indicate lower seismic velocities and warm colors (reds) indicate higher velocities. Color scaling of these seismic velocity sections is based on the range of seismic velocity values calculated. Scaling has been normalized for all of the seismic refraction sections. Both vertical and lateral velocity information is contained in the tomography model. Changes in layer velocity are revealed as gradients rather than discrete contacts, which typically are more representative of actual conditions. The tomography models for each of the 12 traverses are presented in on *Figures AT-1 through AT-12* in this appendix.

<u>Rippability/Excavatability</u>

The seismic refraction survey was conducted along the proposed project alignment to evaluate the underlying subsurface material conditions. In general, seismic wave velocities can be correlated to material densities and/or rock hardness. The relationship between rippability/excavatability and seismic velocity is empirical and assumes a homogeneous mass. Localized areas of differing composition, texture, and/or structure may affect both the measured data and the actual rippability of the mass.

Henceforth in this report, the term rippability refers to excavatability and is dependent on the physical condition of the rock masses to be excavated. In addition to rock type and degree of weathering, structural features in the rock such as bedding planes, cleavage planes, joints, fractures, consolidation and shear zones also influence rippability. Rock masses tend to be more easily ripped if they have well defined, closely spaced fractures, joints, or other planes of weakness. Massive rock bodies which lack discontinuities may allow for slow and difficult ripping or refusal, even where partially weathered, and may require blasting to break the rock for efficient removal.

Seismic p-wave velocities are related to both rock hardness and fracture density. Rippability has been empirically correlated to refraction seismic velocities by Caterpillar Inc., as presented on *Figure A-13* for a CAT D10R (Caterpillar Performance Handbook, Edition 32, October 2001). According to this chart, sedimentary rock (sandstone and conglomerate) becomes marginally rippable near 8,500 ft/s; and non-rippable at about 10,500 ft/s for a D10R dozer. These estimations are based on the lowest values for sedimentary rocks on the CAT chart; however, site geology and topography may cause some variations of these values.

The Caterpillar Chart of Ripper Performance should be considered as being only one indicator of rippability. Ripper tooth penetration is the key to successful ripping, regardless of seismic velocity. This is particularly true in finer-grained, homogeneous materials and in tightly cemented formations. Ripping success may ultimately be determined by a skilled operator finding the proper combination of factors, such as: number of shanks used, length and depth of shank, tooth angle, direction of travel, and use of throttle. Although low seismic velocities in any rock type indicate probable rippability; if the fractures, bedding and/or joints do not allow tooth penetration, the material still may not be ripped efficiently. In some cases, drilling and blasting may be required to induce sufficient fracturing to allow for excavation.

The association between the seismic velocity of any given earth material and its rippability varies greatly from one type of earth-moving equipment to another. For example, a large track dozer with a single ripper tooth can sometimes rip material with seismic velocities in excess of 10,000 ft/s., however, NV5 has experienced a limiting (refusal) velocity for large excavators to range from 3,500 ft/s to 4,500 ft/s, and a standard backhoe may meet refusal at seismic velocities as low as 2,000 ft/s. Ultimately, the relationship between seismic velocity and rippability is dependent on site conditions, equipment and operator ability. NV5 provides the following table to be used as a basis for preliminary evaluations of excavatability when utilizing the seismic refraction data presented herein). The rippability of the rock is classified on a scale of "Easy" to "Blasting/Breaking Generally Required".

**Rippability Classification**

| Seismic P-wave Velocity | Rippability |
|---|---|
| **0 to 2,000 ft/sec** | **Easy** |
| **2,000 to 3,500 ft/sec** | **Moderate** |
| **3,500 to 5,000 ft/sec(1)** | **Difficult, Possible Local Breaking/Blasting** |
| **5,000 to 7,000 ft/sec(1)** | **Very Difficult, General Breaking/Blasting Required** |
| **Greater than 7,000 ft/sec(1)** | **Blasting/Breaking Generally Required** |

(1) Note: In lieu of blasting, a combination of air percussive drilling and rock breaking may be utilized.

Findings

The results of this refraction seismic investigation are summarized in on the tomographic models presented on Figures AT-1 through AT-12 in this appendix. These seismic velocity sections, which were created through the inversion process, have very low error and provide a high degree of lateral definition of the seismic velocity horizons found beneath each line. The seismic velocity sections have been scaled from 1,000 ft/s to over 10,000 ft/s for the velocity window. This appendix also includes figures which depict the locations of the seismic traverses.

It is anticipated that excavations for underground utility line trenches and vaults will be on the order of 5 to10 feet and 14 to 16 feet in depth, respectively, below the existing surface grades. Dense sedimentary rocks (sandstone and conglomerate outcrop at the surface in some areas of the site and underlie the entire site at depth. Cemented zones are known to occur in the formational units and can present excavation difficulties. In addition, occasional boulders are present and can be difficult to excavate. Based on our subsurface seismic refraction investigation exploration, it is anticipated that excavation of the near-surface, fill soils and the majority of the sedimentary rock can be mostly accomplished by skilled operators using heavy duty excavators in good operating condition. However, excavations in hard cemented sandstone and conglomerate materials may be locally difficult and may require heavy ripping, hydraulic hammering, blasting, rock-splitting, and/or other methods to facilitate excavation. Occasional large cobbles and boulders may also be encountered during excavation that are considered oversize materials that are unsuitable for use in backfill and structural fills.

Summary

This refraction seismic investigation revealed a high degree of variation in the calculated seismic velocities of the subsurface materials, with maximum seismic velocity values greater than 10,000 ft/s found in localized areas. The low to moderate velocity material encountered in the near surface material suggests moderately weathered rock and soil and/or fill.

Since it is assumed that a large track type excavator will be used for excavation on this project, which generally meets refusal at a seismic velocity around 4,000 ft/s ±, it should be anticipated that in some areas, excavation will encounter slower progress and possibly refusal before reaching the maximum depth of the excavation. Depending on the degree of weathering and/or fracturing of the rock, some locations of the planned alignment may require a hydraulic hammer or blasting to efficiently break the rock for excavation. A general guide to expected excavatability conditions along the alignment based on the seismic traverses and our field reconnaissance mapping is presented on a table in Appendix B. Note that the data in the table is based on widely spaced seismic traverse data without the benefit of actual subsurface excavations, and is therefore, considered a guide and provided for informational purposes only.

Limitations

Due to the limited nature of our field explorations, conditions not observed and described in this report may be present on the site. Site conditions can cause some variations of the calculated seismic velocities. Refraction seismic velocities assume that velocities increase with depth; therefore, a lower seismic velocity layer beneath a higher seismic velocity layer will not be resolved.

Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation and laboratory testing can be performed upon request. Site conditions, including ground-water level, can change with time as a result of natural processes or the activities of man at the subject site or at nearby sites. Therefore, it should be understood that conditions different from those anticipated in this report may be encountered during the proposed structure construction operations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. NV5 should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

NV5 has endeavored to perform this study using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar soil/rock conditions. No other warranty, either expressed or implied, is made as to the performance of services or information presented in this study.


**SEISMIC LINE LOCATION MAP**
**(SL-1)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

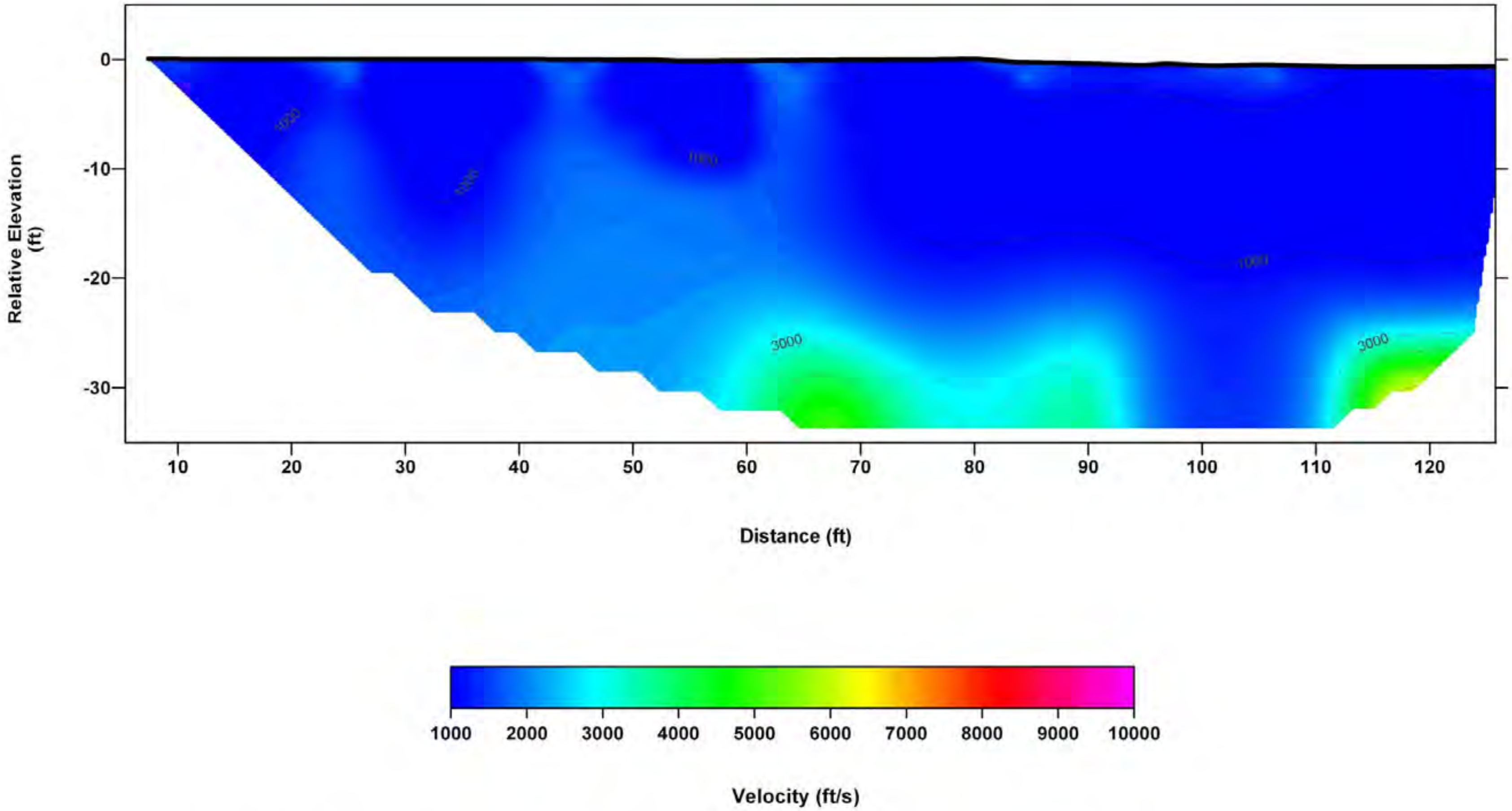
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-1

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| **SEISMIC PROFILE SL-1** | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-1 |
|---|---|---|

**Note: Contour Interval = 1,000 feet per second**


**SEISMIC LINE LOCATION MAP**
**(SL-2)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

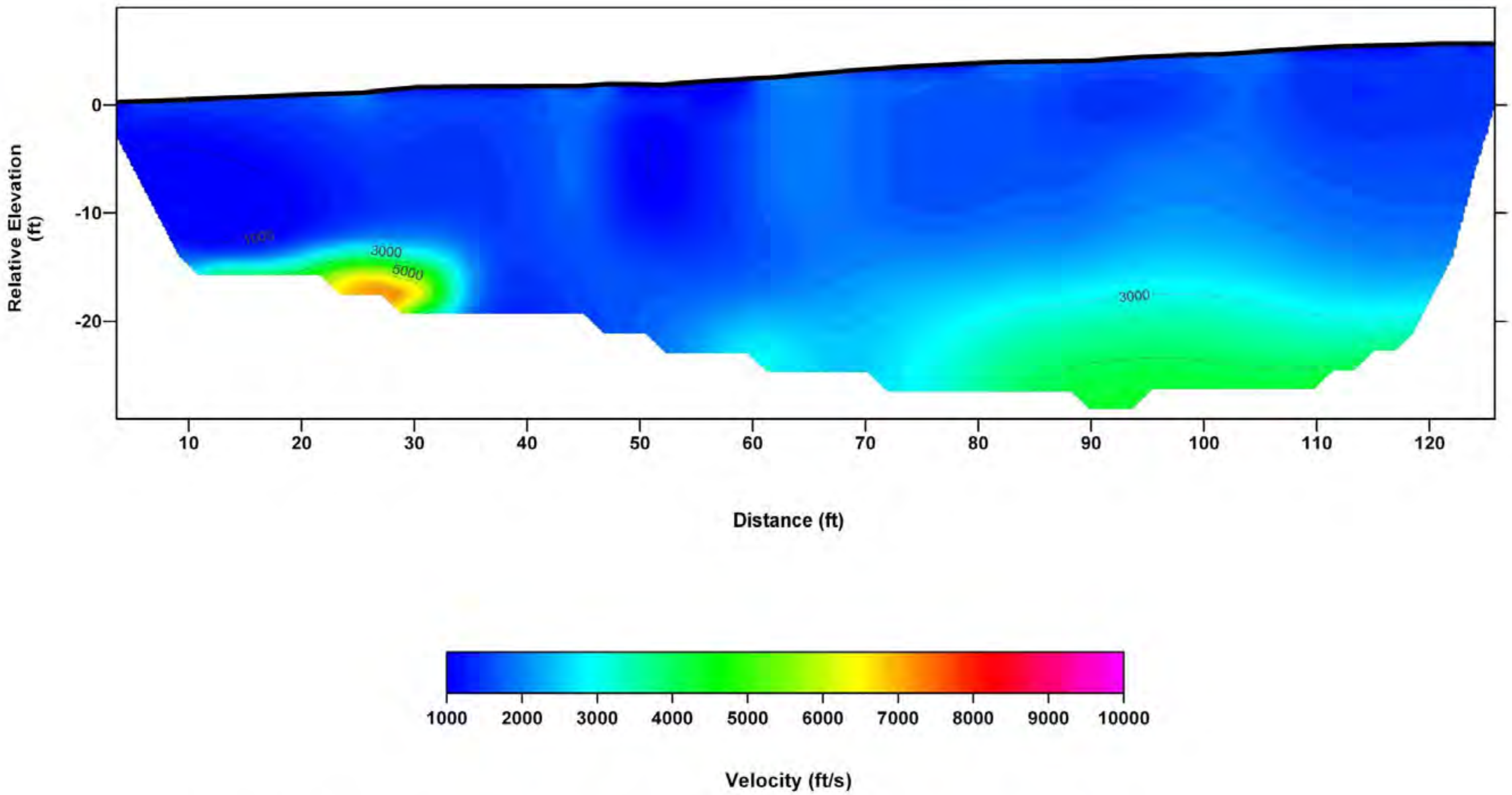
Project No.: 116343
Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-2

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| SEISMIC PROFILE SL-2 | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 — Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-2 |
|---|---|---|

Note: Contour Interval = 1,000 feet per second


**SEISMIC LINE LOCATION MAP**
**(SL-3)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

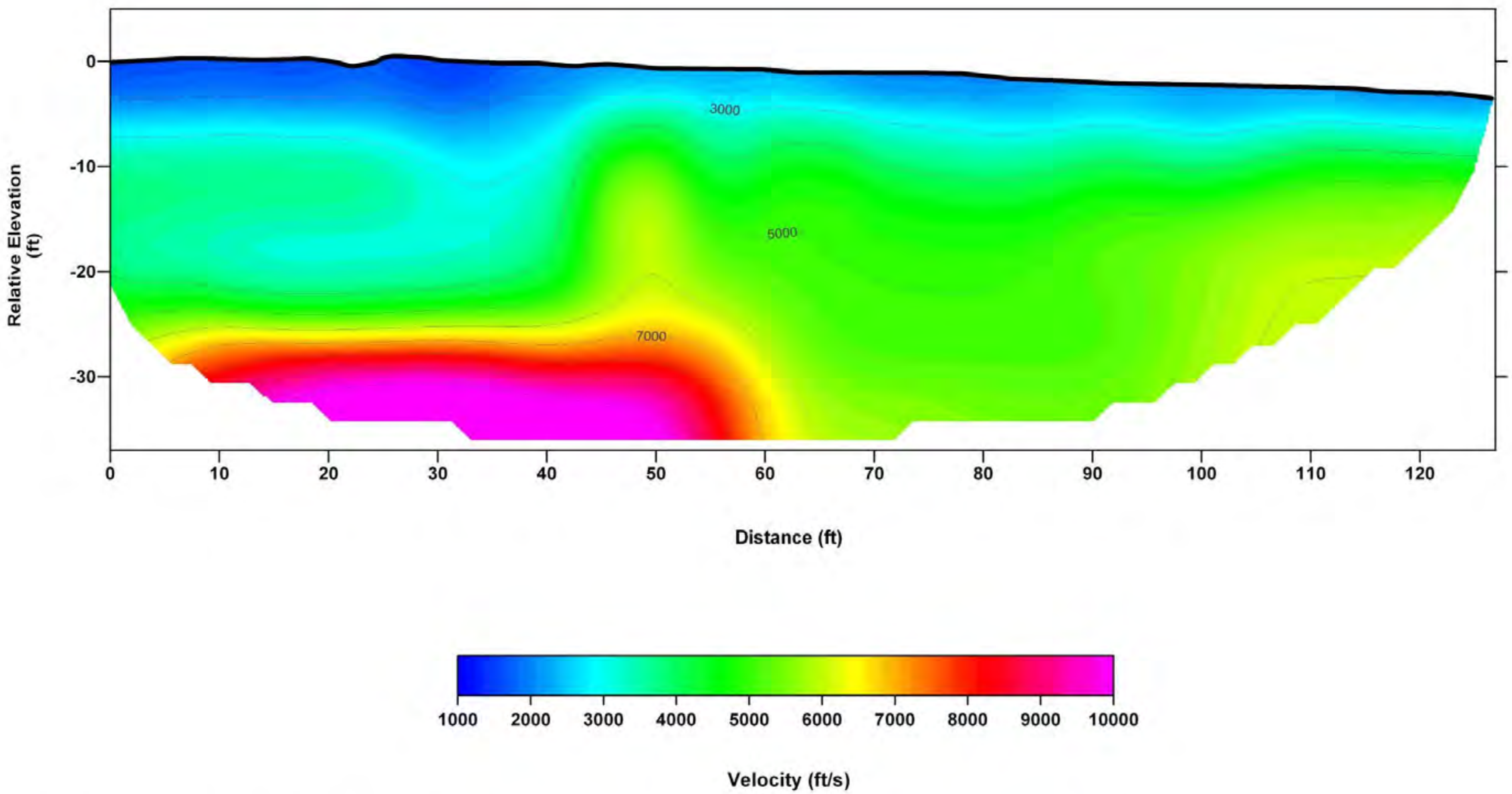
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-3

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-3** | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 — Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-3 | **Note: Contour Interval = 1,000 feet per second** |


**SEISMIC LINE LOCATION MAP**
**(SL-4)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

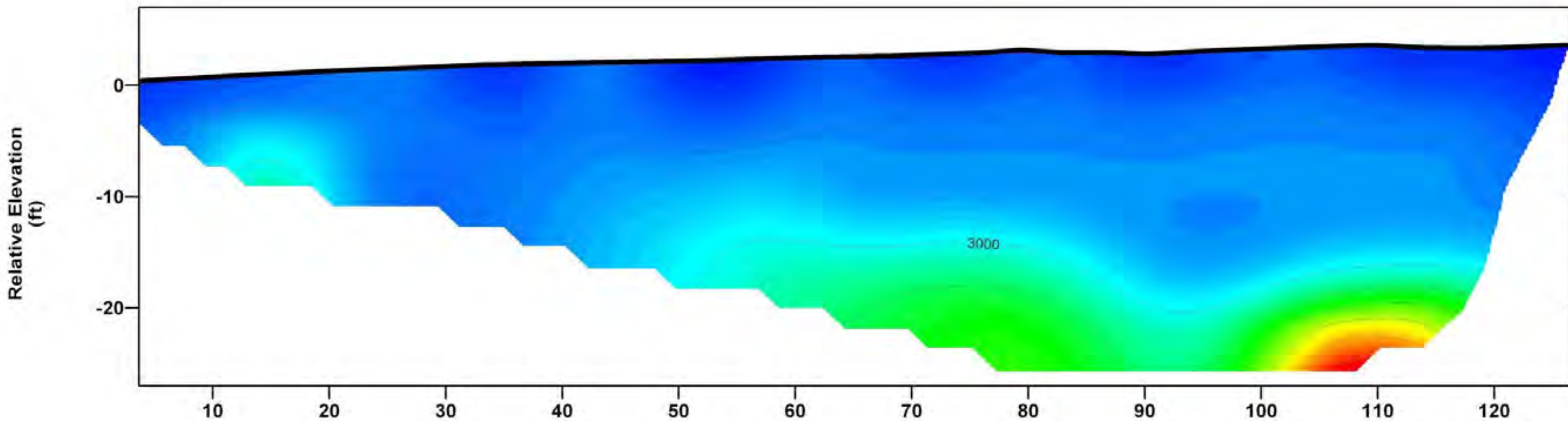
Project No.: 116343 | Date: 09/16

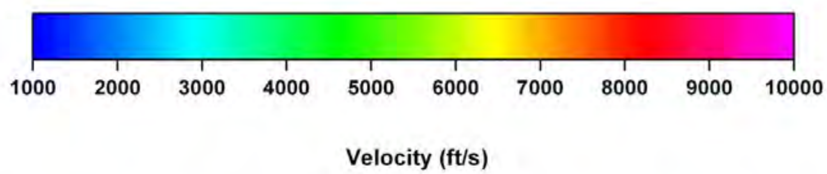
SOUTHWEST GEOPHYSICS INC.

Figure A-4

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| | | | |
|---|---|---|---|
| **SEISMIC PROFILE SL-4** | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-4 | **Note: Contour Interval = 1,000 feet per second** |


**SEISMIC LINE LOCATION MAP (SL-5)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

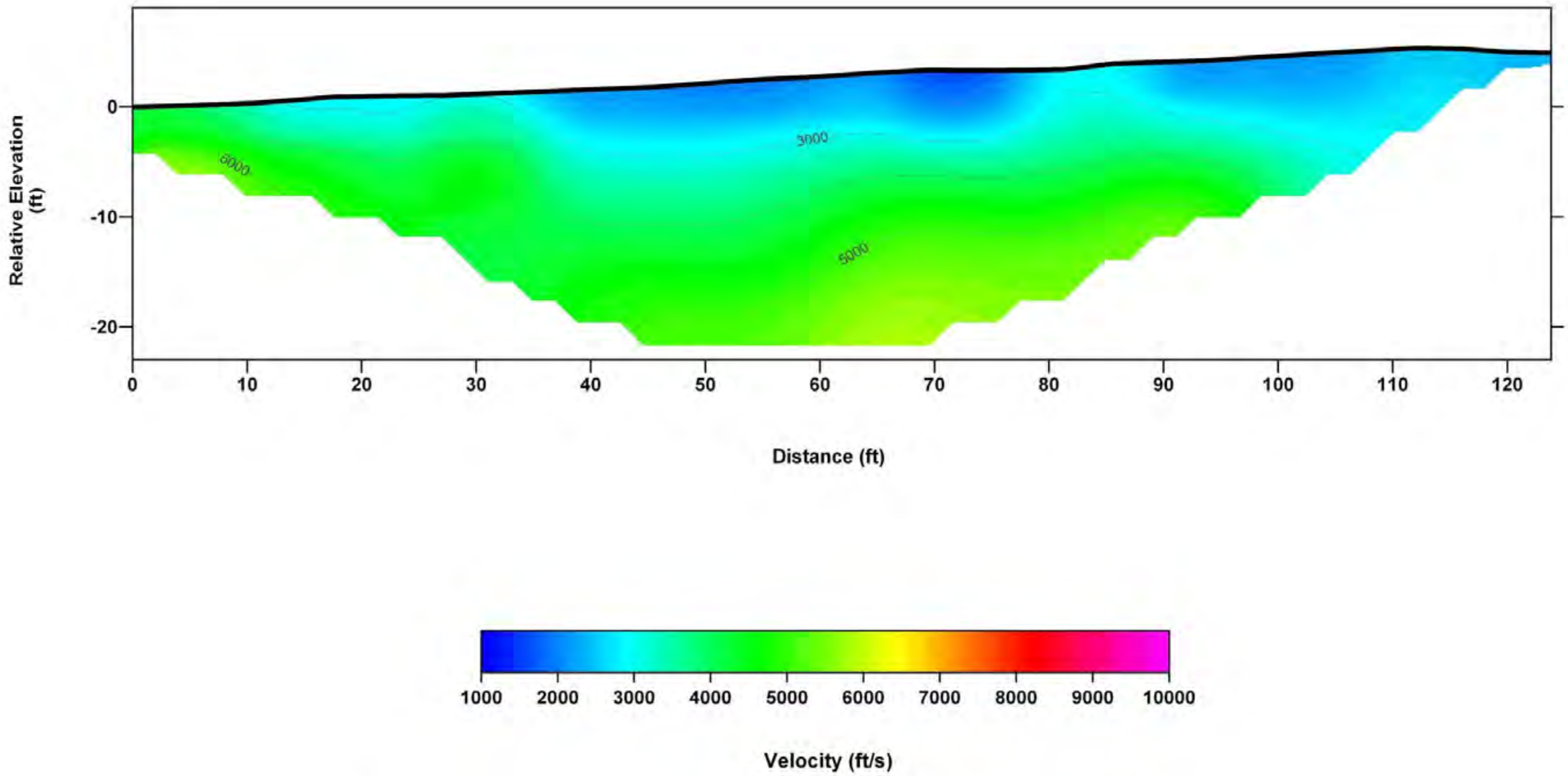
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-5

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| SEISMIC PROFILE SL-5 | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-5 |
|---|---|---|
| | Project No.: 116343 / Date: 09/16 | |

**Note: Contour Interval = 1,000 feet per second**


**SEISMIC LINE LOCATION MAP**
**(SL-6)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

Project No.: 116343

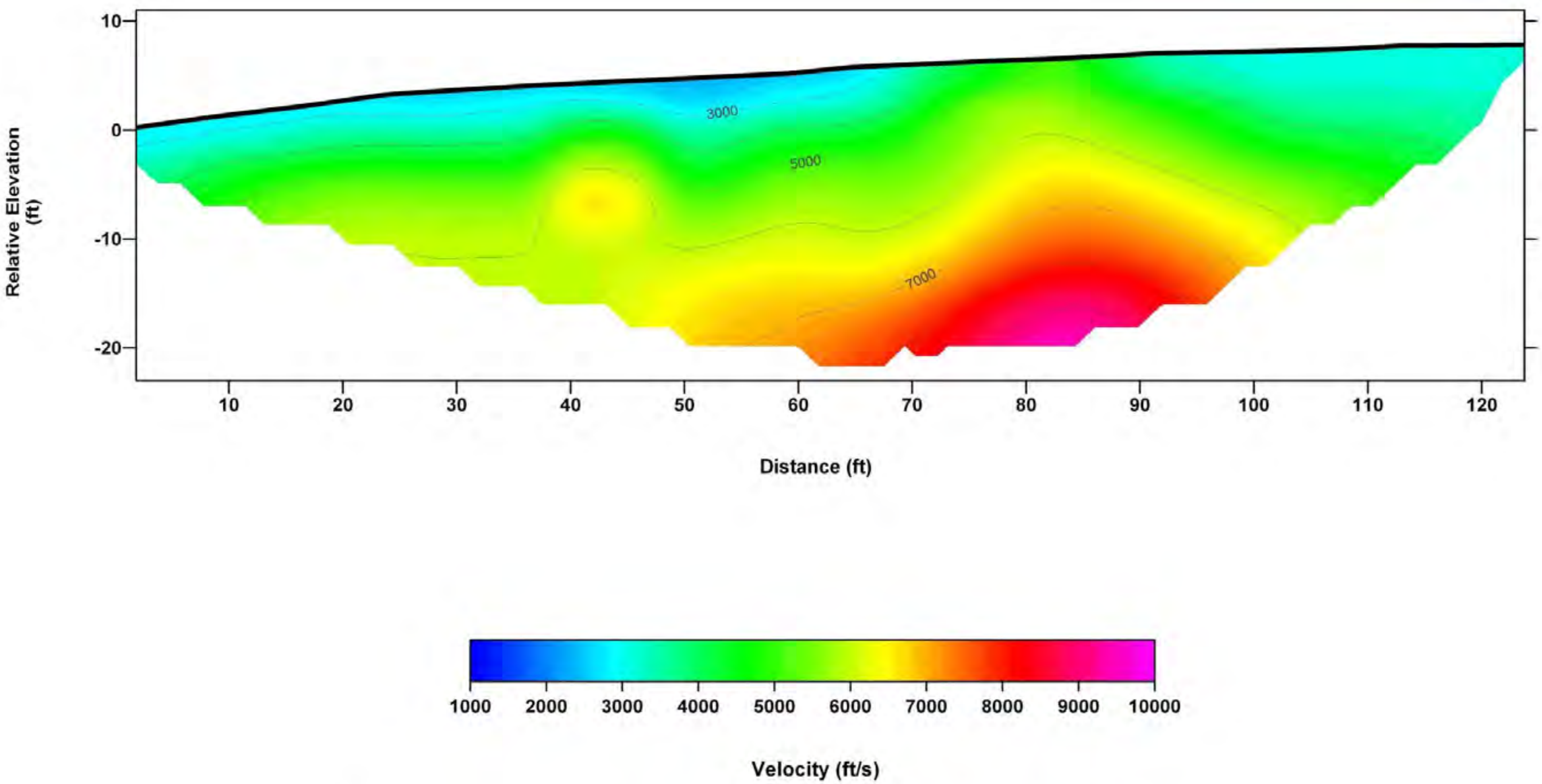
Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-6

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| | | |
|---|---|---|
| **SEISMIC PROFILE SL-6** | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-6 |

**Note: Contour Interval = 1,000 feet per second**


**SEISMIC LINE LOCATION MAP**
(SL-7)

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

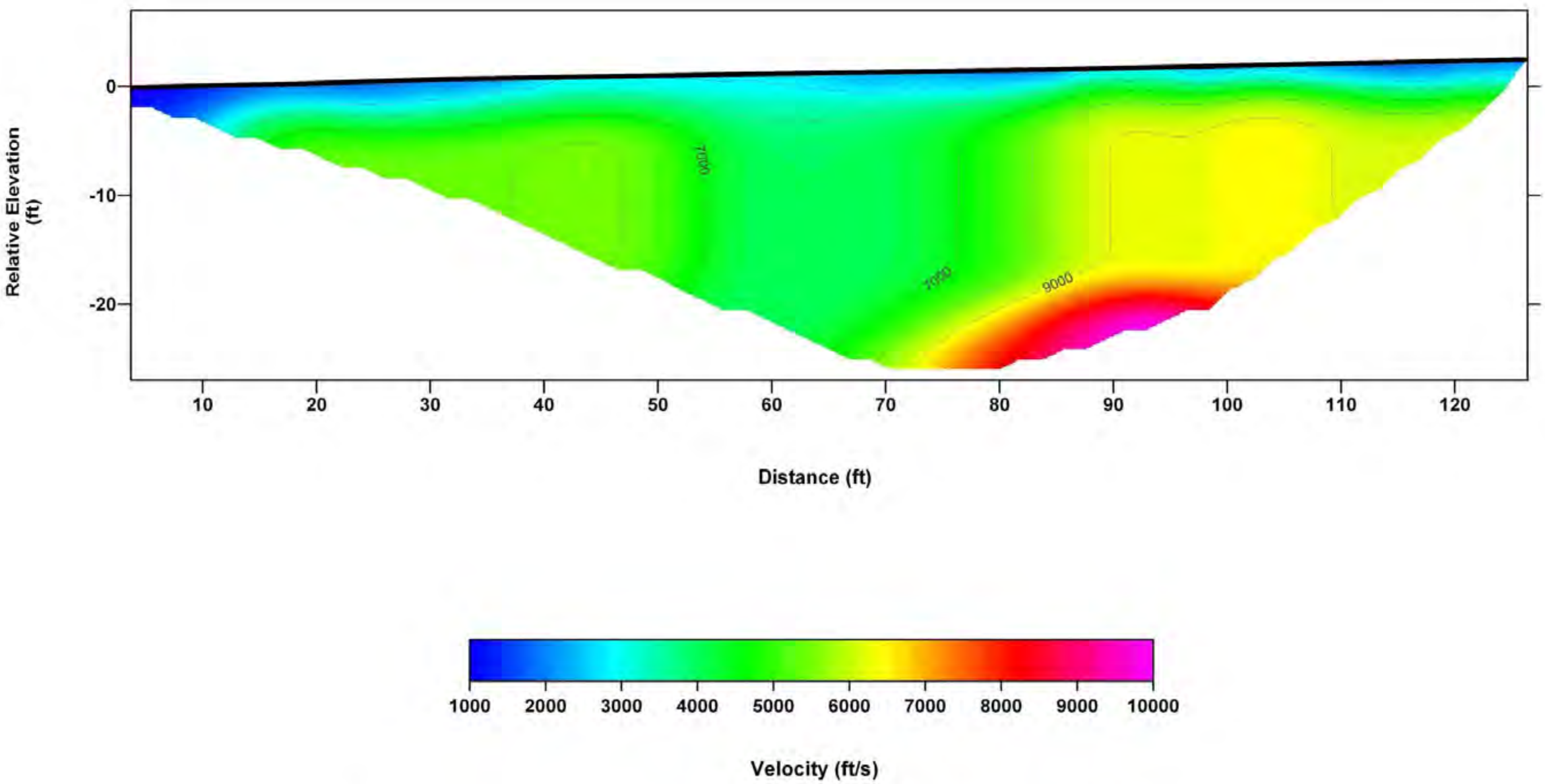
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-7

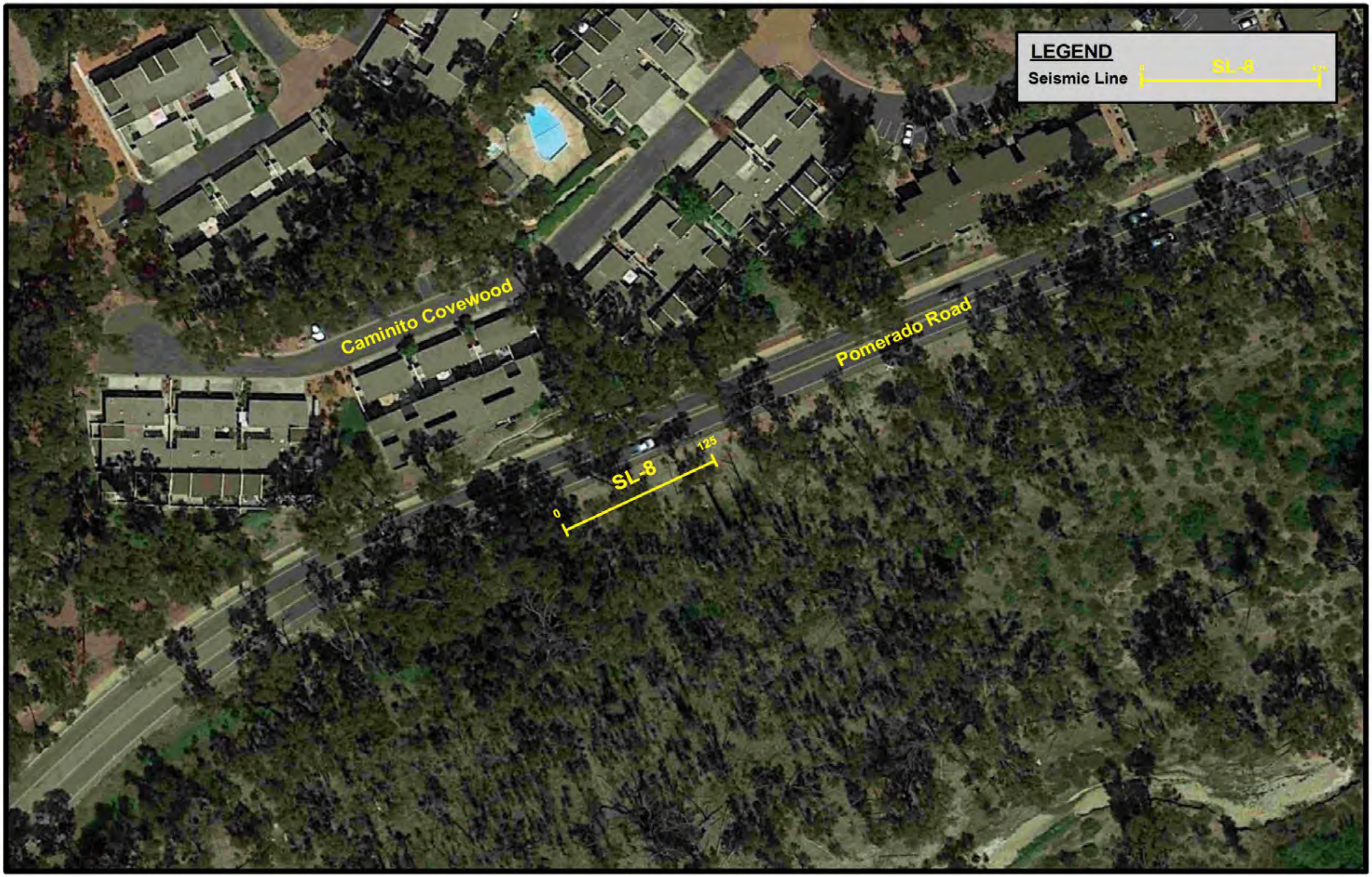
0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| SEISMIC PROFILE SL-7 | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 — Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-7 |
|---|---|---|

**Note: Contour Interval = 1,000 feet per second**




**SEISMIC LINE LOCATION MAP**
**(SL-8)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

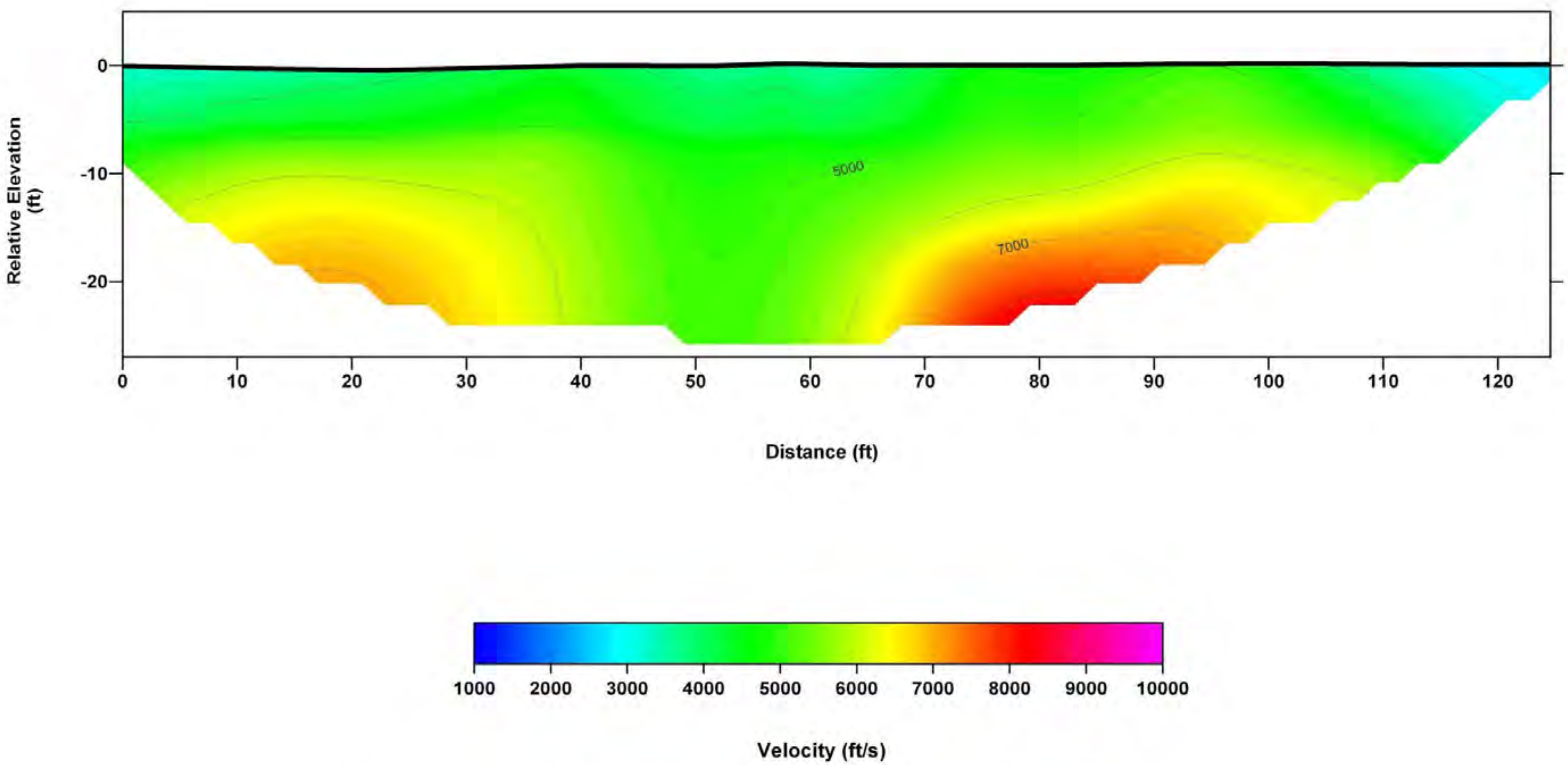
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-8

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL




| | | |
|---|---|---|
| **SEISMIC PROFILE SL-8** | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-8 |

**Note: Contour Interval = 1,000 feet per second**


**SEISMIC LINE LOCATION MAP**
**(SL-9)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

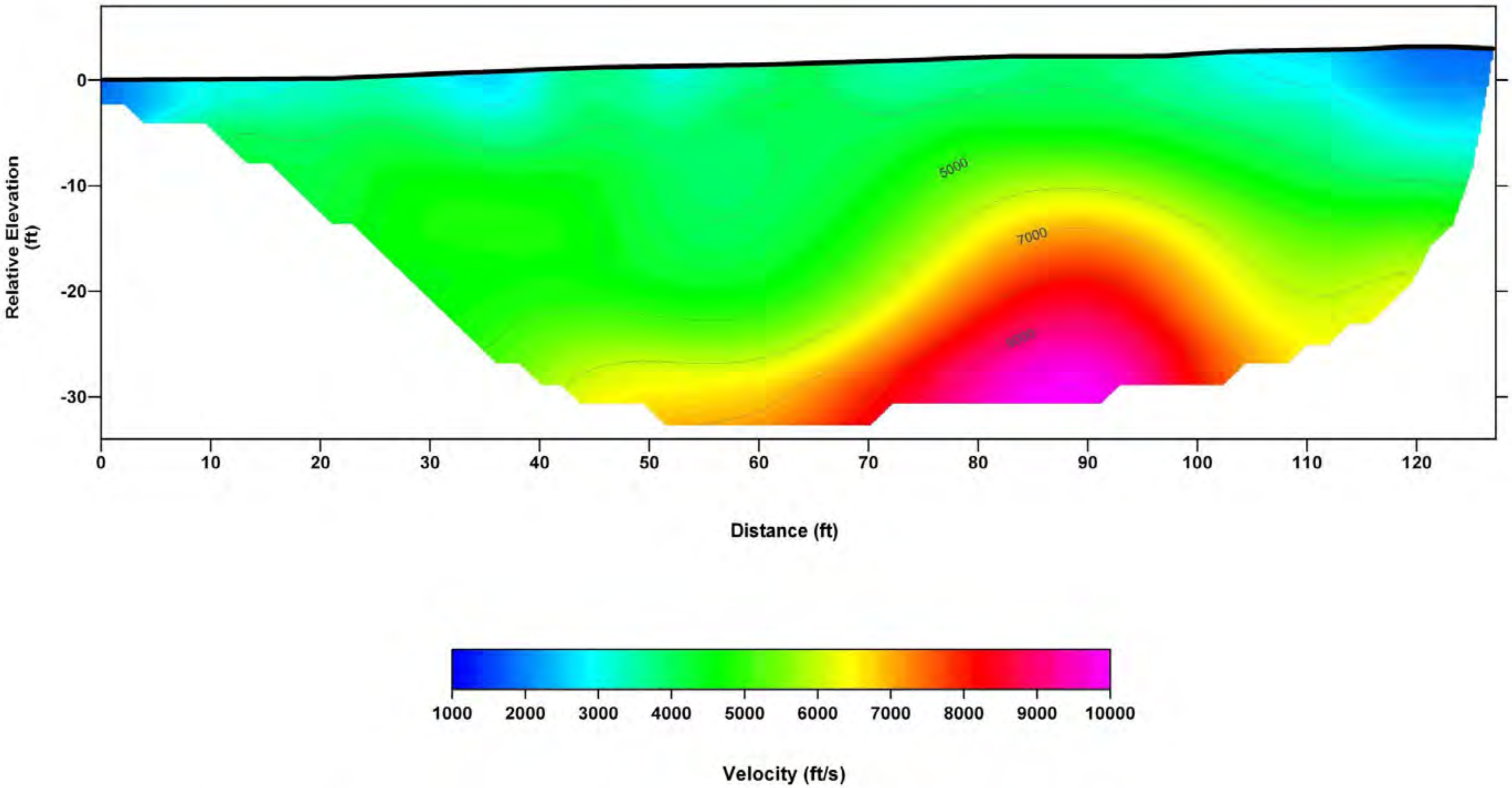
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-9

0 100 200
**approximate scale in feet**

# TOMOGRAPHY MODEL




| SEISMIC PROFILE SL-9 | TL23071 Sycamore Canyon-Penesquitos Substations San Diego, California | | SOUTHWEST GEOPHYSICS INC. Figure AT-9 |
|---|---|---|---|
| | Project No.: 116343 | Date: 09/16 | |

**Note: Contour Interval = 1,000 feet per second**


**SEISMIC LINE LOCATION MAP**
(SL-10)

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

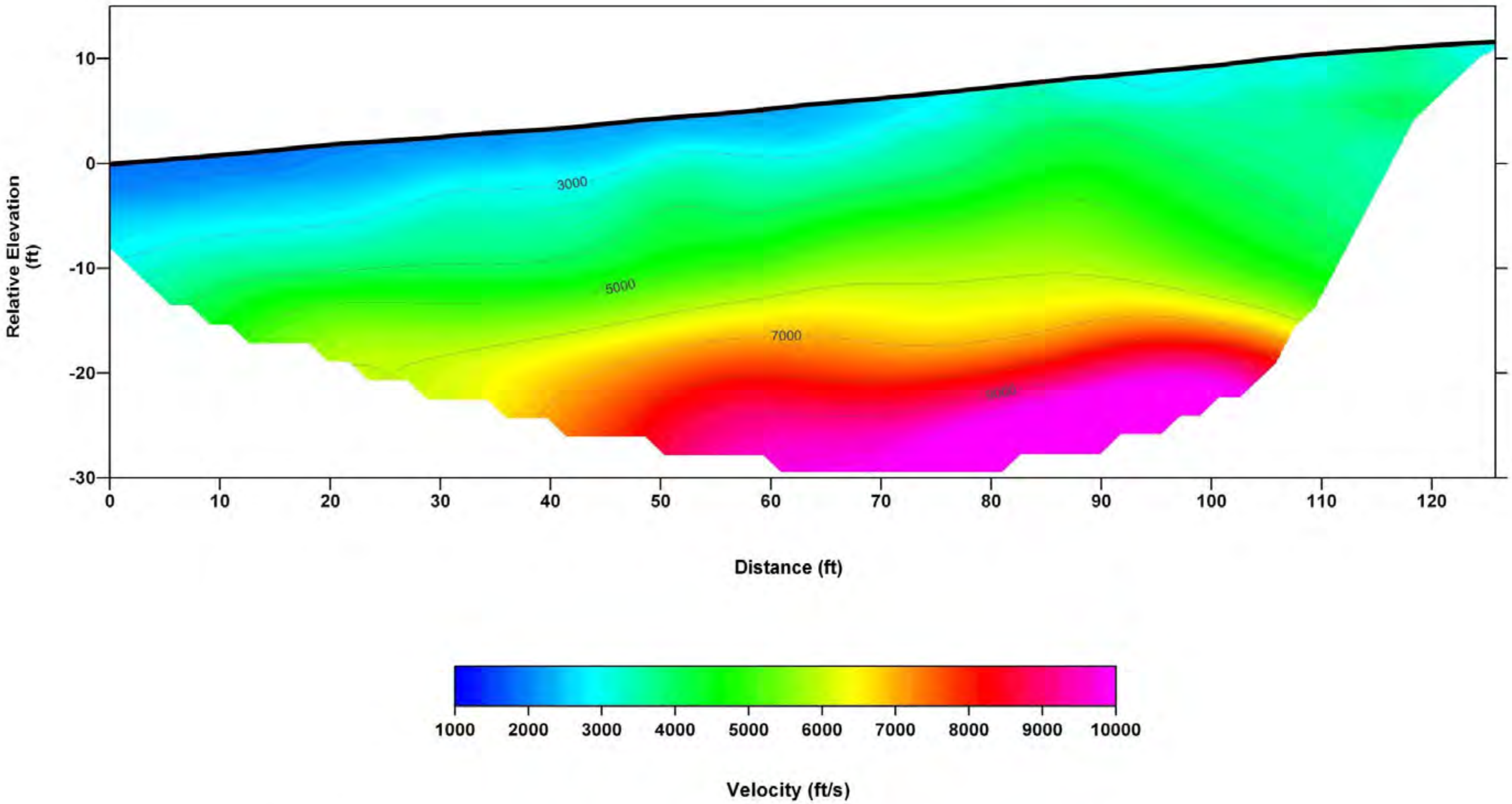
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-10

0 100 200
approximate scale in feet

# TOMOGRAPHY MODEL

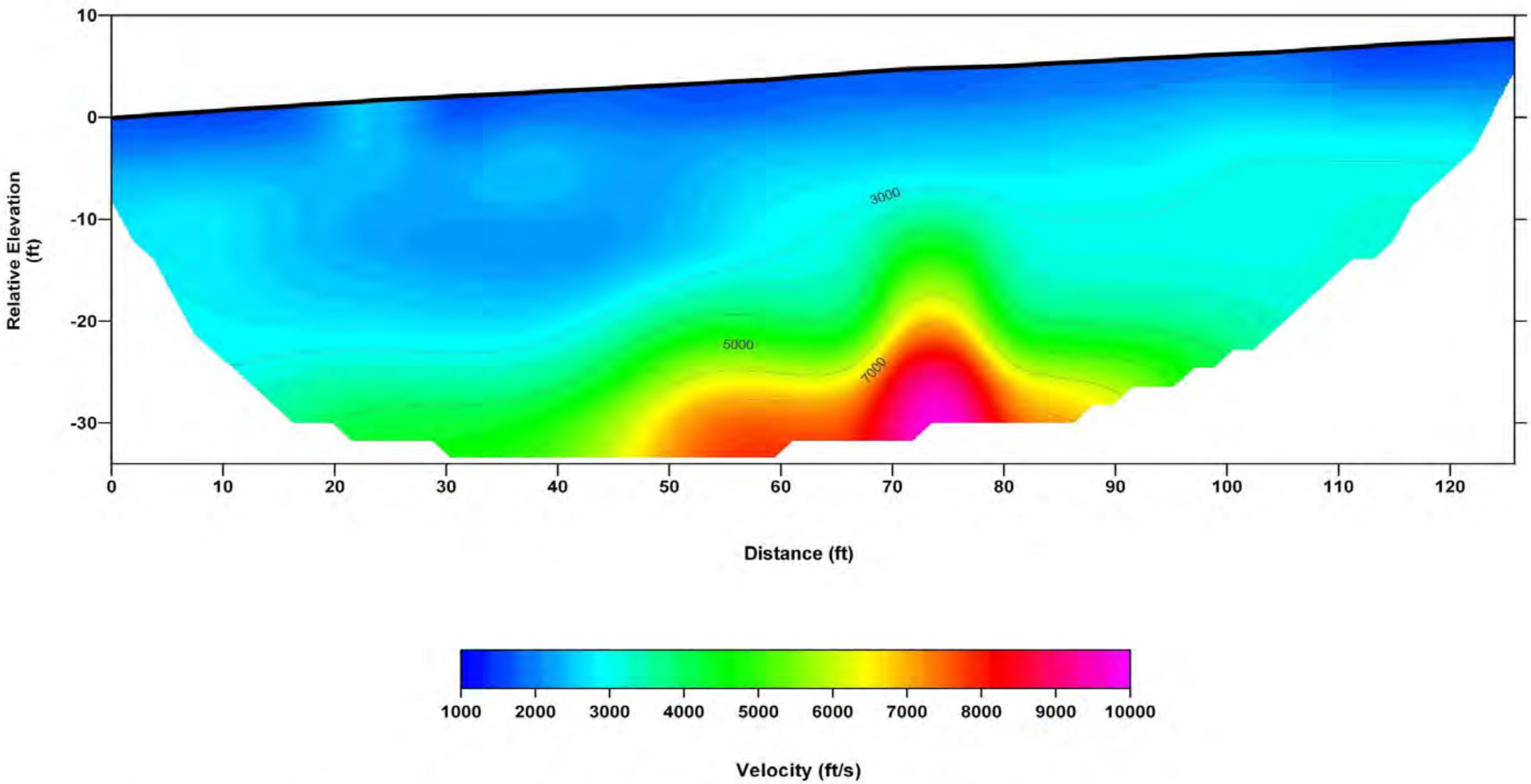



| SEISMIC PROFILE SL-10 | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California | SOUTHWEST GEOPHYSICS INC. |
|---|---|---|
| | Project No.: 116343 / Date: 09/16 | Figure AT-10 |

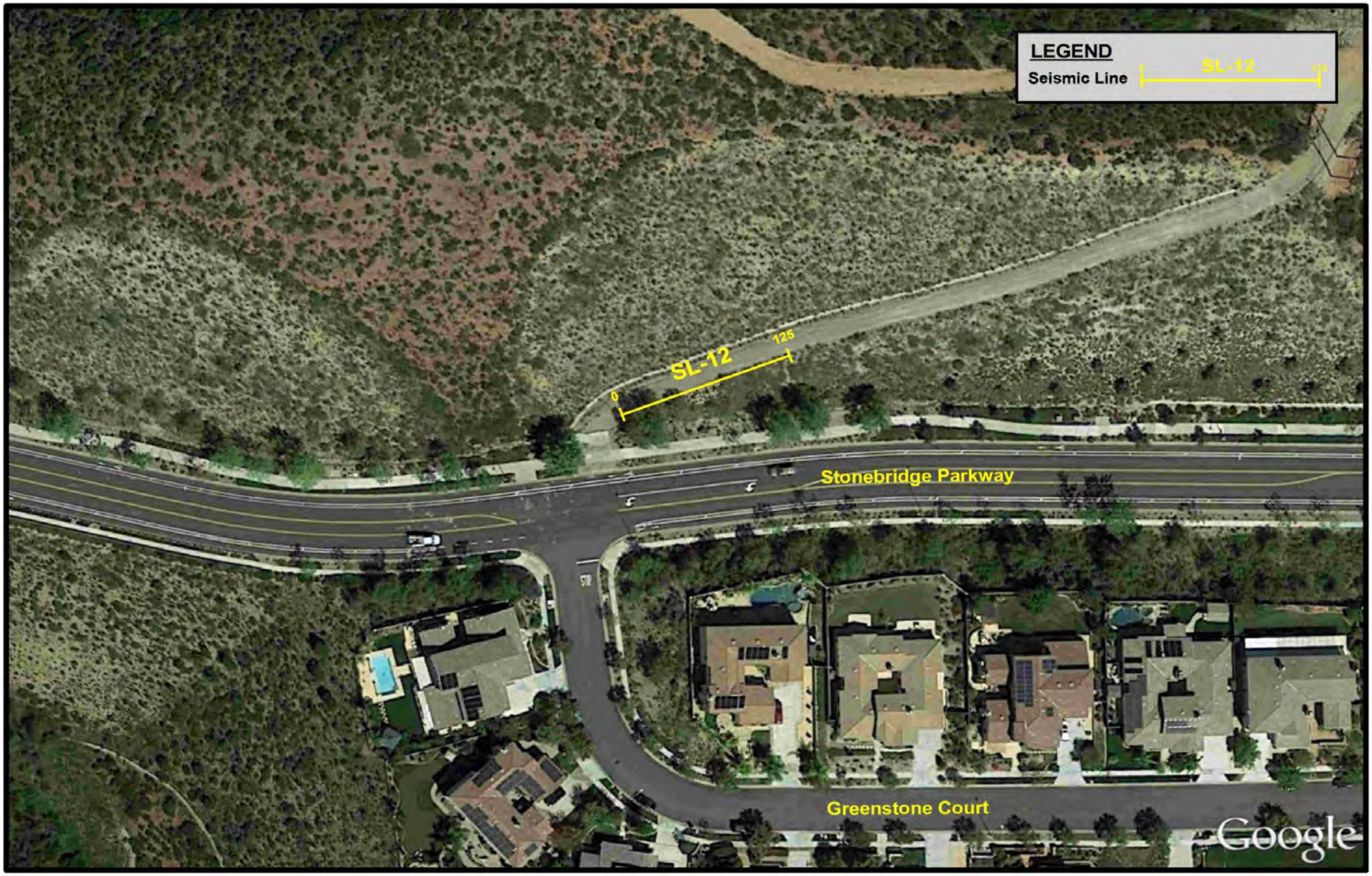
**Note: Contour Interval = 1,000 feet per second**


| SEISMIC LINE LOCATION MAP (SL-11) | N | TL23071<br>Sycamore Canyon - Penasquitos Substations<br>San Diego, California<br>Project No.: 116343 Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure A-11 | 0 100 200<br>approximate scale in feet |
|---|---|---|---|---|

# TOMOGRAPHY MODEL




| SEISMIC PROFILE SL-11 | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 — Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-11 | Note: Contour Interval = 1,000 feet per second |
|---|---|---|---|




**SEISMIC LINE LOCATION MAP**
**(SL-12)**

N

TL23071
Sycamore Canyon - Penasquitos Substations
San Diego, California

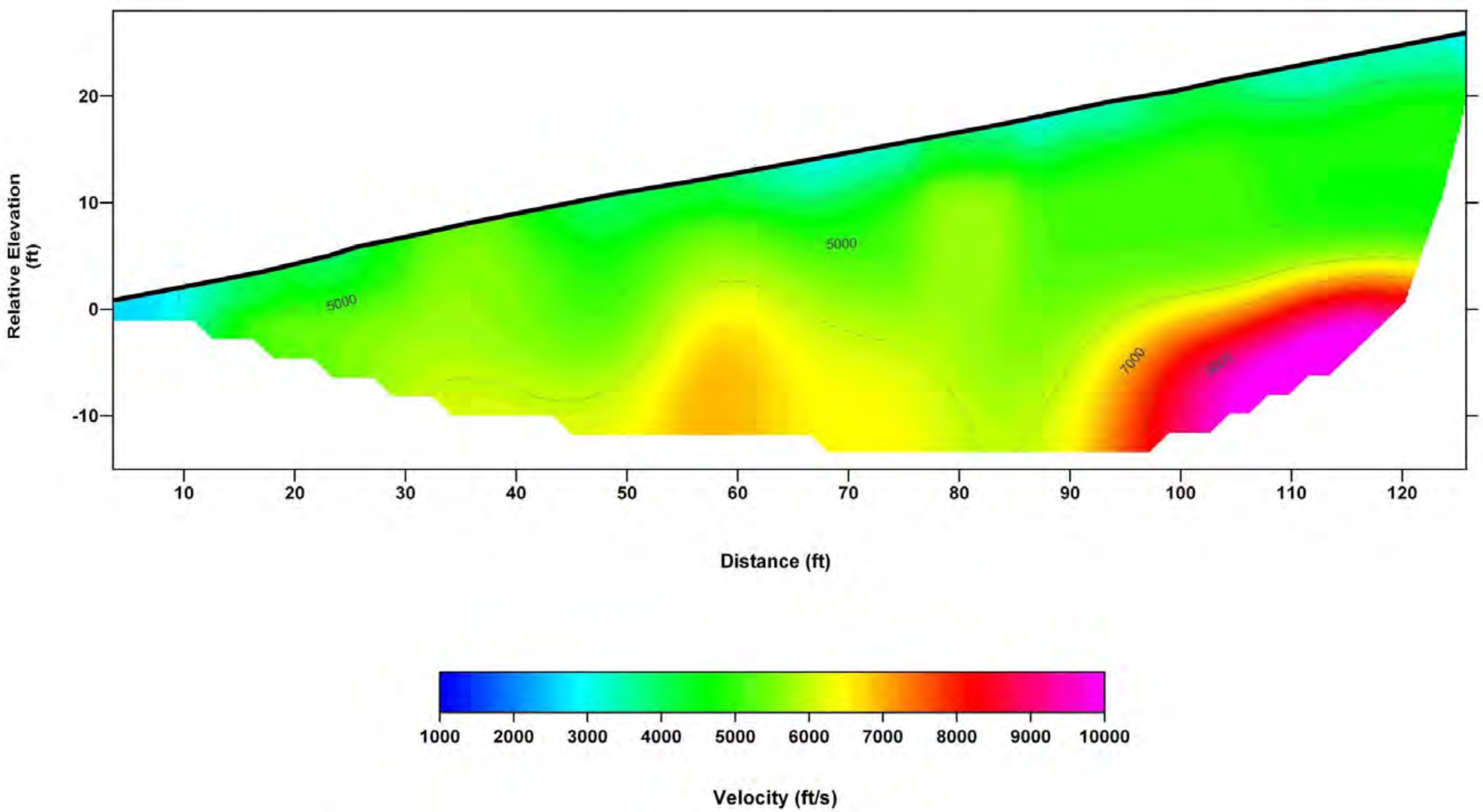
Project No.: 116343 | Date: 09/16

SOUTHWEST GEOPHYSICS INC.

Figure A-12

0 100 200
approximate scale in feet

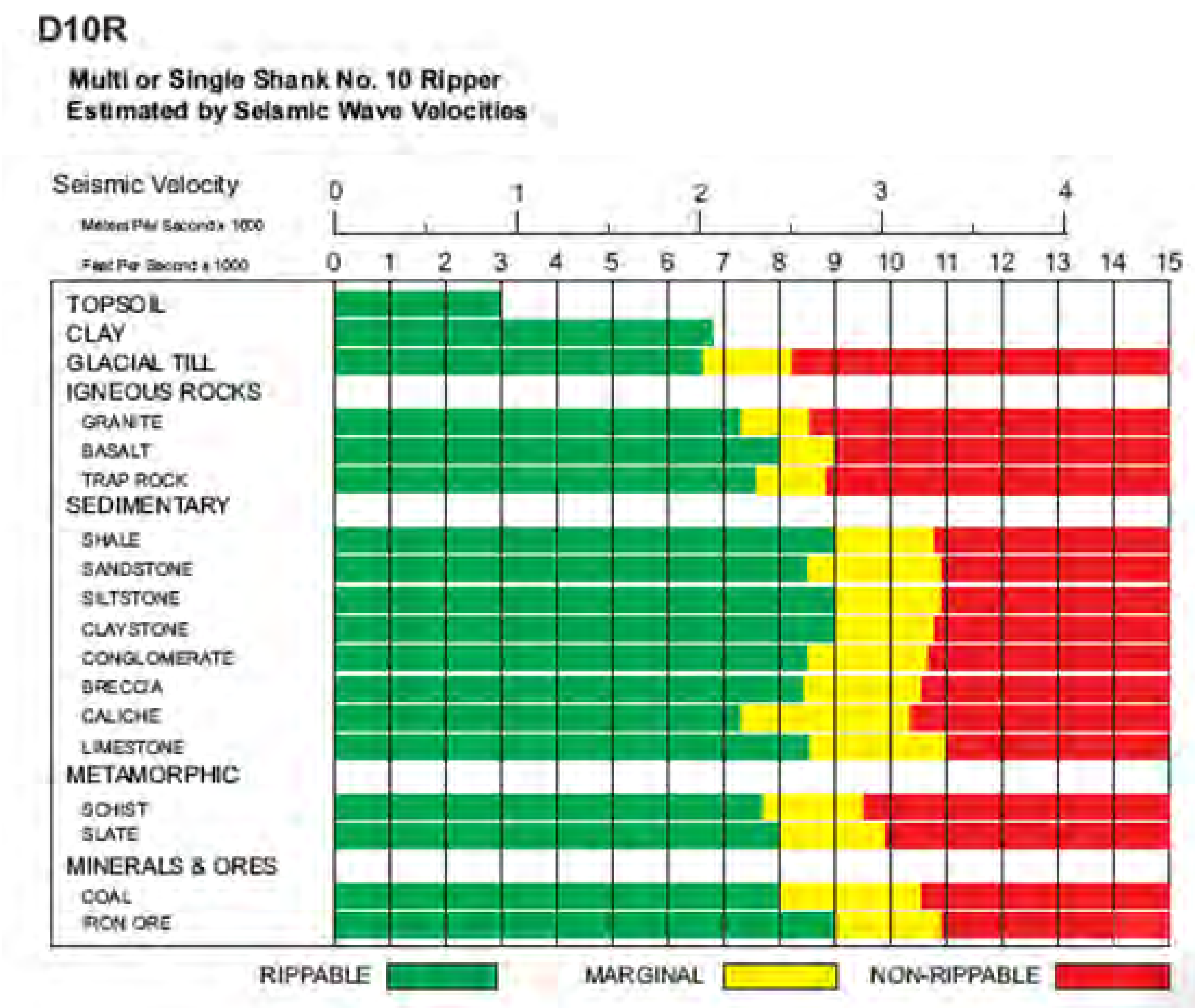
# TOMOGRAPHY MODEL




| | | |
|---|---|---|
| **SEISMIC PROFILE SL-12** | TL23071<br>Sycamore Canyon-Penesquitos Substations<br>San Diego, California<br>Project No.: 116343 / Date: 09/16 | SOUTHWEST GEOPHYSICS INC.<br>Figure AT-12 |

**Note: Contour Interval = 1,000 feet per second**

# Caterpillar D10R Ripper Performance Chart*




* Based on the Caterpillar Performance Handbook Edition 32 - October, 2001

| | Project No: SDB090102.01<br>Drawn: GC<br>Date: September 2016 | **Caterpillar Rippability Data**<br>**SDG&E TL 23071 Underground**<br>**San Diego, California**<br>**Figure No. A-13** |
|---|---|---|
| NV5 | | |

# Appendix B

Summary of Geotechnical Conditions and Excavatability Characteristics

NV5

# APPENDIX B

## T.L. 23071 UNDERGOUND
## SUMMARY OF GEOTECHNICAL CONDITIONS ALONG ALIGNMENT

| Approximate Station No. | Location | Seismic Line Number Reference | Summary of Geotechnical Conditions | Anticipated Excavatability Characteristics |
|---|---|---|---|---|
| 13+00 to 80+00 | Carroll Canyon Rd. | S-1 | Predominantly compacted fill soils | Can be excavated with heavy-duty excavators in good operating condition. |
| 80+00 to 130+00 | Carroll Rd. | S-2 | Predominantly compacted fill soils with locally formational sand and gravel and cobble conglomerate | Can be excavated with heavy-duty excavators in good operating condition. |
| 130+00 to 150+00 | Carroll Rd and Camino Santa Fe | S-3 | Fill and natural deposits consisting of sandstone and gravel and cobble conglomerate. Some localized cemented zones may be present. | Can be excavated with heavy-duty excavators in good operating condition. Localized very difficult excavation and/or heavy ripping, may be necessary below approximately 10 feet. |
| 150+00 to 175+00 | Trade St. | S-4 | Predominately fill and some natural deposits | Can be excavated with heavy-duty excavators in good operating condition. |
| 175+00 to 190+00 | Trade St. | N/A | Predominately natural deposits consisting of sandstone and gravel and cobble conglomerate. Some localized cemented zones may be present. Localized compacted fill present. | Can be excavated with heavy-duty excavators in good operating condition. Localized very difficult excavation and/or heavy ripping, may be necessary. |
| 190+00 to 210+00 | Trade Pl. | N/A | Predominately fill and some natural deposits | Can be excavated with heavy-duty excavators in good operating condition. |
| 210+00 to 420+00 | Arjons Rd., Miralani Dr., Camino Ruiz, Activity Rd., Black Mountain Rd., Miramar Rd. | S-5, S-6 & S-7 | Predominately natural deposits consisting of sandstone and gravel and cobble conglomerate. Some localized cemented zones may be present. Localized compacted fill present especially related to I-15/Miramar Rd. interchange. | Can be excavated with heavy-duty excavators in good operating condition. Localized very difficult excavation and/or heavy ripping, may be necessary. |
| 420+00 to 670+00 | Pomerado Rd., Stonebridge Pkwy., | S-8, S-9, S-10, S-11 & S-12 | Some fill and some natural deposits consisting of sandstone and gravel and cobble conglomerate. Some localized cemented zones and boulders may be present. | Can be excavated with heavy-duty excavators in good operating condition. Localized very difficult excavation and/or heavy ripping, may be necessary. |

# Appendix C

ASFE Important Information about Your Geotechnical Engineering Report

# Important Information about This

# Geotechnical-Engineering Report

**Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.**

**While you cannot eliminate all such risks, you can manage them. The following information is provided to help.**

## Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

## Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

## Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

## Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

## Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

## A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

## A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

## Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

## Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

## Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

## Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

## Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

## Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GBC GEOTECHNICAL BUSINESS COUNCIL
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