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Fremont State Street Center, LLC
c/o SummerHill Homes LLC
3000 Executive Parkway, Suite 450
San Ramon, CA 94583

August 19, 2016

Alameda County Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502
Attention: Mr. Mark Detterman, PG, CEG

Basis for Site Remedy
39155 and 39183 State Street Center, Fremont, CA

Dear Mr. Detterman:

Submitted herewith for your review is the Basis for Site Remedy regarding 39155 and 39183 State Street Center in Fremont, California prepared by PES Environmental, Inc.

I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document are true and correct to the best of my knowledge.

Very truly yours,

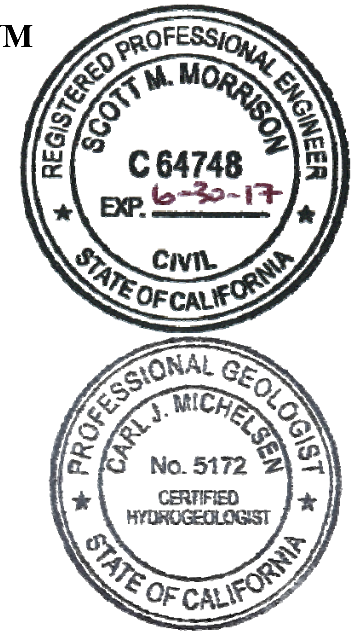
Katia Kamangar

Katia Kamangar
Executive Vice President
SummerHill Homes LLC

Cc: Carl Michelsen, PES Environmental, Inc.

PES Environmental, Inc.
Engineering & Environmental Services

MEMORANDUM



To:	Ms. Denise Cunningham Fremont State Street Center, LLC
From:	Scott Morrison, P.E. Carl J. Michelsen, P.G., C.HG. PES Environmental, Inc.
Date:	August 19, 2016
Subject:	Basis for Site Remedy 39155 and 39183 State Street, Fremont, California
Project No.:	**220.003.03.003**

At a meeting on July 21, 2016 with Alameda County Environmental Health (ACEH) a request was made to summarize the work to-date and to provide the basis for the selected remedy for the site, to allow ACEH approvals to begin site construction which is planned for no later than August 29, 2016. This memorandum summarizes the case, provides the basis for the selected remedy, and addresses specific concerns raised by ACEH staff at the meeting.

Case Overview

In July 2014 PES prepared a Phase I Environmental Site Assessment (ESA) for the subject property and identified two ASTM Recognized Environmental Conditions (RECs):

- **Former Goodyear automotive service center** located at 39090 Fremont Boulevard, directly southwest of the subject property (upgradient). Although the service center is no longer in business and there are no further listings on the EDR report or on GeoTracker/Envirostor, the proximity of the service center to the subject property, the absence of detailed information on past operations and waste handling practices, and the environmentally invasive nature of chlorinated solvents which may have been used in automotive servicing operations, a "material threat of release" exists. Therefore, the former Goodyear facility constitutes a REC for the subject site; and

- **Former Fremont Plaza Norge Cleaners** was a dry cleaner facility located at 39067 State Street, west of the northwest corner of the subject property and operated at least between 1982 and 2008. Although the dry cleaner is no longer present and the site is not a case listed on Geotracker/Envirostor, based on proximity of the cleaners to the subject property, the potential for historical use of PCE as a dry-cleaning solvent if an on-site plant was present at the cleaners, the absence of detailed information on past operations and waste handling practices, and the environmentally invasive nature of chlorinated solvents, a "material threat of release" exists. Therefore, the former Fremont Plaza Norge Cleaners site constitutes a REC for the subject site[1].

Because of the possibility of contamination at the site due to these two sites, a Phase II investigation was initiated and was undertaken with the oversight of the Alameda County Water District (ACWD). The investigation followed workplans approved by ACWD and was conducted in September and December 2014 and January 2014[2]. Soil and soil vapor samples were collected from 40 borings located throughout the site and within State Street. The objective of the investigation was to evaluate the chemical characteristics of the soil and soil vapor beneath the site in advance of proposed redevelopment to assess if the site was impacted by prior site usage or potential off-site sources of contamination. Deep borings (e.g., to depths of 45 feet below ground surface [bgs]) were advanced as deep as possible using the available direct push equipment in an attempt to sample groundwater. No groundwater was encountered during the drilling program. Subsequent review of all soil data obtained did not indicate an on-site source at concentrations that could impact groundwater. Therefore, due to the minimum 45-foot depth of the vadose zone and soil sampling results, additional attempts to conduct groundwater investigation was deemed not to be necessary.

As described in PES' February 2015 memorandum, soil vapor sampling within the State Street right of way adjacent to and northeast of the site, and on a limited area on the northeastern portion of the site has identified the presence of a tetrachloroethylene (PCE) soil vapor plume. The soil vapor appears to be the result of discharges of PCE into the sanitary sewer and/or storm drain by a prior dry cleaning establishment, Norge Cleaners, located at 39067 State Street. In addition, benzene was detected in soil vapor at boring B4 that exceeded the site-specific soil vapor screening level on the southern portion of the site. Testing in the vicinity of this location was unable to identify a source area or widespread contamination.

In April 2015, PES prepared a memorandum documenting that Norge Cleaners was the likely source of PCE in soil vapor at the site and within State Street[3]. This conclusion was supported by the ACWD in their May 2015 letter, as discussed further below. PES concluded that:

- Norge cleaners operated a dry cleaning business for 27 years and used and stored PCE on-site. In the past it was common practice to dispose of PCE-containing wastewater to the sewer. The sewer lateral at the former Norge cleaners drains to State Street;

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[1] PES, 2014. *Phase I Environmental Site Assessment, 39155 and 39183 State Street, Fremont, California*. July 15.

[2] PES, 2015. *Report of Results, Subsurface Investigation, 39155 and 39183 State Street, Fremont, California*. February 12.

[3] PES, 2015. *Source of VOCs in Soil Vapor, 39155 and 39183 State Street, Fremont, California*. April 17.

- The sewer line within State Street has tree roots in pipe joints and apparent sag at the location where elevated PCE concentrations were found in soil vapor samples collected within State Street. These defects represent preferential pathways for PCE laden wastewaters to have migrated from the sewer pipe at some point in the past into the sewer backfill and surrounding native soils. Disposal of PCE-containing wastewater at Norge Cleaners, leakage from the sewer pipes, and lateral migration of PCE soil vapors explains the presence of elevated PCE concentrations in soil vapor samples collected within State Street and on the subject property. Past releases from the storm drain may also have contributed to elevated soil vapor concentrations, particularly the detection of PCE near the storm drain lateral that serviced the rear parking lot of the former Norge Cleaners;

- Furthermore, there is no evidence that a dry cleaner occupied any of the buildings at the 39155/39183 State Street location based on documentation reviewed in the Phase I ESA; and

- Consequently, the subject property is not the source of PCE detections in soil vapor that impinge onto the site. No further action is warranted, other than to appropriately incorporate vapor mitigation measures into the design of future buildings to be constructed at the site.

Based on the planned redevelopment of the subject property, and a May 13, 2015 letter from ACWD[4], additional investigation was conducted under ACEH oversight: (1) to further evaluate the chemical characteristics of the soil and soil vapor in the vicinity of boring B4; and (2) to confirm that shallow soils are oxygenated and conducive to benzene degradation. ACEH became the lead oversight agency for the project when vapor mitigation was proposed for the subject property.

The May 2015 ACWD letter concluded that …"*the source of PCE does not appear to be emanating from the properties located at 39155 and 39183 State Street*". In a subsequent letter, ACEH conditionally approved the workplan for this additional investigation.[5] ACEH concluded that "*…it appears that an offsite source is responsible for the PCE soil vapor concentrations. It appears that, either a set of onsite underground storm drain lines that collected storm drainage from the subject site, or the lateral migration of soil vapors from the utility lines in State Street, have resulted in an area of elevated onsite PCE vapor concentrations along the northeastern property boundary with State Street.*"

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[4] Alameda County Water District (ACWD), 2015. *Contamination Detected at 39155 and 39183 State Street, Fremont (ACWD Site #690)*. May 13.

[5] ACEH, 2015. *Conditional Work Plan Approval; Site Cleanup Program Case No. RO0003176 and Geotracker Global ID T10000007102, Fremont Plaza Shopping Center, 39155 and 39183 State Street, Fremont, CA 94538.* August 11.

The additional investigation was conducted in September 2015 and involved the collection of soil and/or soil vapor samples from 10 borings[6]. Samples were collected in the vicinity of the benzene occurrence at boring B4, at the Nation's Giant Hamburgers building (which was acquired by the applicant and added to the subject property) and at deeper intervals in the northern part of the site.

A supplemental soil vapor investigation was conducted under ACEH oversight in February 2016.[7] The purpose of this investigation was to: (1) further evaluate the temporal changes, if any, in soil vapor concentrations in the vicinity of the sewer line that runs down the center of State Street and along the northeastern property boundary; (2) collect soil vapor data from within the planned footprints of elevators in the two commercial retail/residential buildings; and (3) establish baseline conditions prior to development. Soil vapor samples were collected from 10 borings located within State Street and along the northeastern property boundary and beneath future elevator shaft locations.

In summary, the site was characterized under ACEH oversight via the collection of soil and/or soil vapor samples, during five phases of investigation, from 60 borings on the site and adjacent State Street. Although samples were collected from across the site, sample collection focused on:

- The footprints of future buildings;
- The area where PCE was detected in soil vapor on-site and within State Street;
- The southern portion of the site where benzene and motor oil were detected in soil and/or soil vapor samples;
- Establishing temporal conditions at the areas of highest PCE detections in soil vapor, separated by nearly a year; and
- Collection of deeper soil vapor samples at key areas, such as the proposed elevator shafts.

Finally, as requested in the July 21, 2016 meeting with ACEH, a Human Health Risk Evaluation of Subsurface Data was completed by Apex to provide screening concentrations for chemicals detected at the site. This report is attached as Appendix A.

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[6] PES, 2015. *Report of Results, Subsurface Investigation, 39155 and 39183 State Street, Fremont, California.* October 30.

[7] PES, 2016. *Report of Results, Supplemental Soil Vapor Investigation, 39155 and 39183 State Street, Fremont, California.* March 15. The workplan for this investigation was approved by ACEH on January 4, 2016.

The findings of the Human Health Risk Evaluation of Subsurface Data are that:

- No metals, pesticides, VOCs, or TPH were detected at concentrations above the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) soil Environmental Screening Levels (ESLs) for all receptors. Therefore, no adverse effects on human health are expected to occur from exposure to any residuals in soil.

- Near the northeast boundary of the Site adjacent to State Street, PCE was detected at concentrations above the residential Site-specific screening level (SL) of 960 $\mu g/m^3$ at four soil vapor sample locations (B21, B30, B55, and B56). PCE was detected at concentrations above the commercial Site-specific SL of 8,400 $\mu g/m^3$ at only one soil vapor sample location (B21). However, subsequent soil vapor sampling near this location at soil vapor location B56 only detected PCE at 1,300 $\mu g/m^3$. Based on offsite soil vapor investigation data, the PCE concentrations detected in the northern portion of the Site are associated with an offsite source. Isoconcentration contour maps for PCE (PES, 2016c) indicate the soil vapor concentrations decrease as the offsite PCE plume migrates onto the northern portion of the Site (PES, 2016c). PCE is not detected in soil vapor in the central and southern portions of the Site.

- In the southern portion of the Site, near the former Nation's Giant Hamburgers building, benzene was detected at concentrations above the residential Site-specific SL at two soil vapor sample locations (B4 and B47). Benzene concentrations in soil vapor are localized in the area immediately adjacent to soil vapor sample B4. Benzene was not detected above the commercial Site-specific SL in any soil vapor sample.

- In the evaluation of soil vapor beneath the planned elevator shafts, only chloroform was detected at a concentration above the residential Site-specific SL. Chloroform was only detected at one soil vapor sample (B59), located in the footprint of the planned elevator shaft at Building A in the northwestern portion of the Site. Chloroform was detected in sample B59 and duplicate sample at concentrations of 190 $\mu g/m^3$ and 180 $\mu g/m^3$, respectively. These concentrations are equal to or slightly above the Site-specific SL of 180 $\mu g/m^3$, and well below the commercial Site-specific SL of 1,600 $\mu g/m^3$. Although an elevator shaft may represent a preferential pathway for vapors, exposure parameters in an elevator exposure scenario (e.g., 0.5 hours per day for 26 years) would be significantly less than exposure parameters assumed in the development of the Site-specific SLs for a long-term receptor (8 hours per day for 25 years for commercial worker receptor and 24 hours per day for 26 years for resident receptor). Regardless of the inherent conservativeness in assuming a long-term residential exposure for the elevator shaft scenario, using a soil vapor concentration of 190 $\mu g/m^3$ and an assumed soil vapor sampling depth below grade of 152 centimeters bgs (5 feet bgs), the resulting HQ estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is equal to 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4}. Therefore, chloroform in soil vapor volatilizing into indoor air within an elevator shaft does not pose a potential risk to human health at the Site.

- Planned redevelopment of the Site, includes limited open areas that will be covered with a paver system; therefore, inhalation of VOCs in outdoor air for the future onsite resident and commercial worker receptors at the Site was considered for these open areas. Without a regulatory-approved model for this scenario, this outdoor air evaluation conservatively assumes that the future onsite receptors are located directly above maximum detected VOC concentrations in soil vapor without any barrier on the ground surface (i.e. pavers). Additionally, although the VOCs impacts at the Site are not co-located, this model assumes the VOCs are co-located beneath the future onsite receptor. Regardless of the inherent conservativeness of this evaluation, the resulting HI estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is below 1 x 10^{-6}, which is the most stringent end of CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4}. Therefore, VOCs in soil vapor volatilizing into outdoor air do not pose a potential risk to human health at the Site.

Rationale for Selected Remedy or Mitigation

In summary, the comprehensive investigation identified the presence of PCE, benzene, and other VOCs in soil vapor. Based on the Apex risk evaluation, the concentrations of chemicals detected in site soil are all below calculated and SFRWQCB ESL screening levels for human health protection. As such, soil detections are not considered drivers for remedy selection. While Freon 11 and Freon 12 were frequently detected over a large portion of the site, a specific source was not identified, but may be related to the former grocery store that was present onsite and the likely use of Freon compounds in refrigeration. Because the concentrations of Freon 11 and Freon 12 measured were consistent across the Site and orders of magnitude below screening levels for unrestricted residential sites, Freon 11 and Freon 12 were not considered for inclusion in site remediation design.

To prepare the site for the proposed construction, the presence of PCE and benzene in soil vapor requires mitigation and was addressed as follows:

- At locations where PCE was detected above regulatory screening levels, a Geo-Seal vapor barrier membrane combined with a passive subslab collection pipe and venting system is being installed at the on-grade townhomes and a Geo-Seal membrane is being installed at the elevator shafts at Building A. The Vapor Mitigation System (VMS) plans and specifications for the on-grade townhomes dated August 18, 2016 are included in Appendix B. The Geo-Seal elevator pit detail for Building A is included in Appendix C;

- The benzene/hydrocarbon occurrence in the southern portion of the site has been addressed via soil excavation under an ACEH-approved workplan. Although motor oil had been detected in this area prior to excavation, none of the motor oil detections in soil were at concentrations of human health concern. In addition, the February 2016 (Revison 3) SFRWQCB ESLs do not list an ESL for motor oil for protection of leaching to groundwater (Table S-2). In other words, the presence of motor oil in soil is not a driver for protection of groundwater resources. During excavation of the benzene and hydrocarbon area, no visual or other evidence of contamination was identified. Confirmation samples collected from the base and sidewalls of the excavation detected low concentrations of chemicals of concern, below residential screening levels. The verification samples confirm that all of the hydrocarbon and benzene contaminated soil was removed from the boring B4 area. The report describing the excavation is in preparation and will be provided to ACEH for review and approval; and

The attached plates depict the current distribution of PCE (Plate 1), Freon 11 (Plate 2), Freon 12 (Plate 3), and benzene and motor oil (pre-excavation; Plate 4). Concentrations of motor oil in soil are shown on the benzene plate because they are assumed to provide a basis for removal of soil creating benzene vapors. Each plate shows the selected remedy or mitigation (excavation in the case of benzene/motor oil) and installation of vapor mitigation in the case of PCE in soil vapor. Included on each plate is the location of each structure to be constructed. Key utilities to be installed at the site and the location of porous pavement (permeable unit paving areas) and landscaping areas are also shown.

The plates show that:

1) Mitigation for PCE vapors is being conducted at all locations where PCE was detected. In addition, out of an abundance of caution, mitigation is being applied at Building 7 where PCE was not detected, but is located adjacent to Buildings 8, 9, 10 and 11. A trench plug will also be installed at locations where utilities (including sanitary sewer, storm drain, and water) enter and exit the site from State Street.

2) Detections of Freon in soil vapor are two to three orders of magnitude below residential screening levels and consistent across the entire site, indicating no residual on-going source. Consequently, no mitigation of Freon is necessary at the site.

3) As noted above, benzene and motor oil contaminated soil has been removed from the southern portion of the site. The results of the soil excavation will be reported separately.

Benzene soil vapor concentrations collected outside of the excavation area were all non-detect (detection limits were below residential ESL) except for boring B6. In the case of the one detection of benzene in boring B6, risk calculations by Apex and their updated Site-specific SLs indicate that the benzene concentration at this location is below the health-based residential screening criteria. As such, other that the excavation area which has been addressed, no other areas on site have benzene detections in soil vapor at concentrations of concern for the proposed residential and commercial development.

In summary:

1) The site has been thoroughly characterized under the oversight of ACEH.

2) The potential for temporal changes in VOC concentrations in soil vapor has been evaluated via collection of soil vapor samples at areas with the highest PCE detections in soil vapor. The temporal samples do not show an increase in concentration.

3) A human health risk evaluation has been prepared for the site by a qualified risk assessor and site-specific, risk based screening levels have been established.

4) The presence of PCE and benzene in soil vapor requires mitigation to eliminate potential human health concerns.

5) Benzene in soil vapor has been addressed via soil excavation at the one area where it was detected at concentrations of concern.

6) PCE in soil vapor is the result of releases from a former nearby dry cleaner and has migrated onto the property.

7) PCE in soil vapor is being mitigated by: (1) installation of vapor barriers and passive venting systems at residential areas where PCE is present; (2) installation of vapor barriers at elevator shafts at Building A; and (3) installation of trench dams at key utility locations to minimize any future migration of VOCs from State Street, the offsite locus of the VOC contamination.

8) A soil management contingency plan was included in the ACEH-approved workplan for the soil excavation[8]. In the event that previously unknown suspect soil conditions or subsurface features are identified during site redevelopment, the plan specifies the procedures to be undertaken to properly manage the occurrence.

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[8] PES, 2016. *Work Plan for Soil Excavation and Well Destruction, 39155 and 39183 State Street, Fremont, California. January 29*. Approved by ACEH on March 14, 2016;

9) Deed notifications describing the PCE occurrence and vapor mitigation systems will be recorded with the County and subject to ACEH approval.

Additional Questions Raised by ACEH

Deeper Soil Vapor Pattern

- In the vicinity of Borings B60, B32, and B48, PCE concentrations in soil vapor show a small increase with depth from 5 to 25 feet bgs. All of the measured concentrations were below residential screening criteria. The most likely explanation for this pattern is the presence of a subsurface storm drain in this area that acted as a preferential pathway for the lateral migration of PCE from State Street onto the subject property. The location of the former storm drain is shown on Plate 3 of the April 2015 PES memorandum[9]. The storm drain lateral that services the parking lot behind the former Norge Cleaners is also suspected to have contributed to the presence of PCE in deeper soil vapor sample collected at 13 feet bgs from boring B27. Note also that PCE was not detected in the 10 feet bgs sample collected from boring B23. No storm drains were formerly present in this area as depicted on Plate 3 of the April 2015 PES memorandum; and

- The deeper concentrations of PCE measured were all below residential screening levels and an order of magnitude below commercial screening levels, which are used by both DTSC and the SFRWQCB for soil vapor below parking podiums. Nevertheless, the presence of PCE in soil vapor is being mitigated via installation of a vapor barrier system at elevator shafts.

Sampling Events

- Initial soil and soil vapor samples were collected in October 2014. Further definition of the soil vapor conditions was accomplished in response to ACWD or ACEH requests for assessment of the plume in December 2014, January and September 2015, and February 2016. Soil vapor samples were collected twice from the most heavily impacted locations on the subject property and within State Street. As noted in the March 2016 PES report, the concentrations of PCE in soil vapor in the vicinity of the sewer line that runs down the center of State Street and along the northeastern property boundary were either approximately the same or less than prior sample results, collected about 1 year earlier. These results establish a baseline condition prior to development and indicate that concentrations of PCE remained approximately the same or decreased over time.

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[9] PES, 2015. *Source of VOCs in Soil Vapor, 39155 and 39183 State Street, Fremont, California*. April 17.

- Soil vapor concentrations are influenced by moisture content, barometric pressure, soil type and other factors which are expected to be generally similar across the site for a particular time interval. As such, a similar soil vapor temporal pattern (i.e., the same or lower concentrations) is likely for the locations that had substantially lower concentrations, but were not tested for temporal variability. Consequently, no additional soil vapor sampling is warranted.

Outdoor Vapor Intrusion Concerns

As requested by ACEH in the July 21, 2016 meeting, Apex calculated the risk of exposure to outdoor air in the area where permeable pavers will be installed. As indicated their report (Appendix A): "*Based on the maximum detected soil vapor concentrations onsite, the HI estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is below 1 x 10^{-6}, which is the most stringent end of CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4}. Generally, an excess cancer risk below 1 x 10^{-6} is acceptable for unrestricted or residential land use. Therefore, VOCs in soil vapor volatilizing into outdoor air do not pose a potential risk to human health at the Site.*"

Irrigation Well

A former water well was identified by ACWD as being located on the site in their letter dated October 6, 2014. As reported by PES, attempts were made to locate the well, but were unsuccessful[10]. In addition, no evidence of a former water well was found during removal of asphalt and concrete pavements over the entire site. Fremont State Street Center, LLC has committed to ACWD that should a well be found during construction activities, the well will be properly abandoned under permit with ACWD. ACWD will also inspect the site following final site grading in an attempt to locate the well prior to building construction.

Utilities and Preferential Pathways

A trench plug will be installed at locations where utilities enter and exit the site from State Street to limit the potential migration of soil vapor from State Street onto the site through preferential pathways along utility lines. The trench plug will consist of a 12-inch wide trench installed along the gutter at the site border along State Street and filled with a concrete slurry mix. A trench plug plan is included in Appendix D.

[10] PES, 2016. *Report of Results, Supplemental Soil Vapor Investigation, 39155 and 39183 State Street, Fremont, California*. March 15.

Additional Soils Considerations

- As noted above, both Freon 11 and 12 were widely detected in soil vapor samples. While the pattern of occurrence appears to indicate that Freons may have been released on site, no Freons were detected in any of the soil samples. Most likely this is due the high vapor pressure of Freon compounds and the low degree of adsorption of Freons by soil;

- Similarly, PCE and other VOCs detected in soil vapor were not detected in soil samples;

- The distribution of VOCs in soil vapor indicates that a soil vapor plume has migrated from State Street onto the property. Preferential migration through former utilities, such as storm drains and sanitary sewers, has helped to distribute the VOCs in soil vapor far from their off-site source within State Street; and

- Motor oil was detected in soil at concentrations below ESLs and screening levels provided by Apex. The source of motor oil and the co-located occurrence of benzene in the boring B4 vicinity is unclear. However, motor oil has no leaching-based ESL, likely because of the insolubility and low migration potential of motor oil. The maximum concentration of TPH as diesel detected onsite was 190 mg/kg, which is below the SFRWQCB residential ESL for both human health and leaching to groundwater. As such, the presence of hydrocarbons in soil does not represent a potential leaching to groundwater concern at this site and the selected soil excavation remedy is sufficient to protect human health and the environment.

Site-Specific Screening Levels (SLs)

Site-specific SLs for soil and soil vapor were provided by Apex in their Human Health Risk Evaluation of Subsurface Data (Appendix A).

Attachments: Plate 1 – PCE Concentrations in Shallow Soil Vapor
Plate 2 – Freon 11 Concentrations in Shallow Soil Vapor
Plate 3 – Freon 12 Concentrations in Shallow Soil Vapor
Plate 4 – Benzene Concentrations in Shallow Soil Vapor and TPH Motor Oil Concentrations in Soil

Appendix A – Human Health Risk Evaluation of Subsurface Data
Appendix B – Vapor Mitigation System (VMS) Drawings (August 18, 2016)
Appendix C – Elevator Pit Geo-Seal Detail
Appendix D – Trench Plug Plan

PLATES

Explanation

	Approximate Property Boundary
	Proposed Development Plan
	Approximate Former Building Location
B17	Soil Vapor Sampling Location (PES, 2014-2015)
B6	Soil Vapor and Soil Sampling Location (PES, 2014-2015)
B13	Soil Sampling Location (PES, 2014-2015)
B53	Soil Vapor Sample Location (PES, 2016)
B57	Soil Vapor Sample Location within planned elevator pit (PES, 2016)
SS	Sanitary Sewer Line
	Storm Drain Line
	Water Line
	Area of Excavation
106	PCE Concentrations in Shallow Soil Vapor Concentrations in micrograms per cubic meter (µg/m³)
480	PCE Isoconcentration contour in µg/m³ (Dashed where inferred; queried where uncertain)
ND(100)	Not detected at or above the indicated laboratory reporting limit
	Vapor Mitigation Areas for Slab-On-Grade Townhomes
	Vapor Mitigation Areas for Below Grade Parking Elevator Pits
	Landscape Planting Areas
	Permeable Unit Paving Area
	Trench Plug

0 80
SCALE IN FEET
N

Aerial Photo: October 30, 2015 (Google 2016)

PES Environmental, Inc.
Engineering & Environmental Services

PCE Concentrations in Shallow Soil Vapor
State Street Center
Fremont, California

PLATE
1

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
220.003.04.007	22000303003_ACEH_1-4	SM	8/16

Explanation

- Approximate Property Boundary
- Proposed Development Plan
- Approximate Former Building Location
- B17 — Soil Vapor Sampling Location (PES, 2014-2015)
- B6 — Soil Vapor and Soil Sampling Location (PES, 2014-2015)
- B13 — Soil Sampling Location (PES, 2014-2015)
- B53 — Soil Vapor Sample Location (PES, 2016)
- B57 — Soil Vapor Sample Location within planned elevator pit (PES, 2016)
- SS — Sanitary Sewer Line
- Storm Drain Line
- Water Line
- Area of Excavation
- 690 — Freon 11 Concentrations in Shallow Soil Vapor Concentrations in micrograms per cubic meter (µg/m^3)
- 500 — Freon 11 Isoconcentration contour in µg/m^3 (Dashed where inferred; queried where uncertain)
- ND(100) — Not detected at or above the indicated laboratory reporting limit
- Vapor Mitigation Areas for Slab-On-Grade Townhomes
- Vapor Mitigation Areas for Below Grade Parking Elevator Pits
- Landscape Planting Areas
- Permeable Unit Paving Area
- Trench Plug

0 — 80
SCALE IN FEET
N

Aerial Photo: October 30, 2015 (Google 2016)

PES Environmental, Inc.
Engineering & Environmental Services

Freon 11 Concentrations in Shallow Soil Vapor
State Street Center
Fremont, California

PLATE
2

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
220.003.04.007	22000303003_ACEH_1-4	SM	8/16

Explanation

- Approximate Property Boundary
- Proposed Development Plan
- Approximate Former Building Location
- B17 — Soil Vapor Sampling Location (PES, 2014-2015)
- B6 — Soil Vapor and Soil Sampling Location (PES, 2014-2015)
- B13 — Soil Sampling Location (PES, 2014-2015)
- B53 — Soil Vapor Sample Location (PES, 2016)
- B57 — Soil Vapor Sample Location within planned elevator pit (PES, 2016)
- SS — Sanitary Sewer Line
- Storm Drain Line
- Water Line
- Area of Excavation
- 690 — Freon 12 Concentrations in Shallow Soil Vapor Concentrations in micrograms per cubic meter (µg/m^3)
- 500 — Freon 12 Isoconcentration contour in µg/m^3 (Dashed where inferred; queried where uncertain)
- ND(100) — Not detected at or above the indicated laboratory reporting limit
- Vapor Mitigation Areas for Slab-On-Grade Townhomes
- Vapor Mitigation Areas for Below Grade Parking Elevator Pits
- Landscape Planting Areas
- Permeable Unit Paving Area
- Trench Plug

0 — 80 SCALE IN FEET N

Aerial Photo: October 30, 2015 (Google 2016)

PES Environmental, Inc.
Engineering & Environmental Services

Freon 12 Concentrations in Shallow Soil Vapor
State Street Center
Fremont, California

PLATE 3

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
220.003.04.007	22000303003_ACEH_1-4	SM	8/16

Explanation

- Approximate Property Boundary
- Proposed Development Plan
- Approximate Former Building Location
- B17 Soil Vapor Sampling Location (PES, 2014-2015)
- B6 Soil Vapor and Soil Sampling Location (PES, 2014-2015)
- B13 Soil Sampling Location (PES, 2014-2015)
- B53 Soil Vapor Sample Location (PES, 2016)
- B57 Soil Vapor Sample Location within planned elevator pit (PES, 2016)
- Sanitary Sewer Line
- Storm Drain Line
- Water Line
- Area of Excavation
- 1,400 TPH Motor Oil Concentrations in Shallow Soil Concentrations in micrograms per kilograms (mg/kg)
- 140 TPH Motor Oil Concentrations in Deeper Soil Concentrations in micrograms per kilograms (mg/kg)
- 88 Benzene Concentrations in Shallow Soil Vapor Concentrations in micrograms per cubic meter ($\mu g/m^3$)
- 100 Motor Oil Soil Isoconcentration contour in mg/kg for 1.0 to 2.5 feet bgs depth interval
- 100 Motor Oil Soil Isoconcentration contour in mg/kg for 3.0 to 4.5 feet bgs depth interval
- 97 Benzene Isoconcentration contour in $\mu g/m^3$ (Dashed where inferred; queried where uncertain)
- ND(49) Not detected at or above the indicated laboratory reporting limit
- Vapor Mitigation Areas for Slab-On-Grade Townhomes
- Vapor Mitigation Areas for Below Grade Parking Elevator Pits
- Landscape Planting Areas
- Permeable Unit Paving Area
- Trench Plug

0 80 SCALE IN FEET N

Aerial Photo: October 30, 2015 (Google 2016)

PES Environmental, Inc.
Engineering & Environmental Services

Benzene Concentrations in Shallow Soil Vapor and TPH Motor Oil Concentrations in Soil
State Street Center
Fremont, California

PLATE 4

JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE
220.003.04.007	22000303003_ACEH_1-4	SM	8/16

APPENDIX A

HUMAN HEALTH RISK EVALUATION OF SUBSURFACE DATA

Apex Companies, LLC
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August 12, 2016

Ms. Denise Cunningham
SummerHill Homes
3000 Executive Pkwy, Suite 450
San Ramon, CA 94583

Subject: Human Health Risk Evaluation of Subsurface Data
39155 and 39183 State Street, Fremont, California

Dear Ms. Cunningham:

The Source Group, Inc. (SGI), a division of Apex Companies, LLC, has reviewed the data collected during previous site investigations for the property at 39155 and 39183 State Street in Fremont, California (the Site). The data was reviewed with a focus on aspects of the investigations that may influence human health. Apex's review included the following reports prepared by PES Environmental, Inc. (PES) and previously submitted to Alameda County Environmental Health (ACEH):

- *Report of Results, Subsurface Investigation, 39155 and 39183 State Street, Fremont, California*, dated February 12, 2015 (PES, 2015);
- *Vapor Mitigation System, Basis of Design Report, State Street Center, Fremont, California*, dated March 24, 2016 (PES, 2016b); and
- *Addendum – Contour Maps, Vapor Mitigation System Design Drawings and Specifications, State Street Center, Fremont, California*, dated July 7, 2016 (PES, 2016c).

SITE LAND USE

The Site is approximately 6 acres in size and was formerly occupied by a Nob Hill grocery store and Payless drug store building. This building was demolished in 2001. The southern corner of the Site formerly included a building (Nation's Giant Hamburgers) with associated parking and landscape areas, which were removed in 2016. Currently, the Site is vacant and all pavements have been removed. The planned redevelopment of the Site includes grading and soil excavation for utilities and construction of a mixed use residential and retail project with 157 residential dwelling units and approximately 21,000 square feet of retail area. As described by PES (2016b), approximately 50 percent of the residences will be on-grade townhomes, the rest are podium townhomes and flats. The northwestern portion of the Site will include subgrade parking lots beneath the commercial retail/residential buildings. The two commercial retail/residential buildings (Building A and Building B) will include elevator shafts that extend into the subsurface. The surrounding area will contain roadways with associated landscaping.

DATA EVALUATION

As discussed in the above referenced reports prepared by PES, soil and soil vapor data were collected during previous investigations. Soil samples were analyzed for organochlorine pesticides, lead, arsenic, and volatile organic compounds (VOCs) and/or total petroleum hydrocarbons (TPH). Soil vapor samples were analyzed for VOCs. During previous investigations, PES attempted to collect groundwater samples by advancing soil borings until the drill rig hit refusal at approximately 45 feet below ground surface (bgs). Consequently, no groundwater samples were collected at the Site.

The results from the soil and soil vapor investigations were compared with San Francisco Bay Regional Water Quality Control Board Environmental Screening Levels (ESLs; SFRWQCB, 2016). These ESLs represent conservative screening values below which adverse effects on human health are not expected to occur. The ESLs are currently available for resident and commercial/industrial worker receptors potentially exposed to chemicals via inhalation of vapor in indoor air exposure pathways, and for the resident, commercial/industrial worker, and construction worker receptors potentially exposed to chemicals via direct contact exposure pathways (i.e., ingestion, dermal contact, and inhalation of dust/vapor in outdoor air). The risk-based ESLs correspond to an excess cancer risk of 1 x 10^{-6} or a hazard quotient of 1, based on standardized equations (SFRWQCB, 2016) that combine exposure assumptions with agency-derived toxicity data.

Soil ESLs

The SFRWQCB soil ESLs include a broad scope of screening levels. The SFRWQCB Tier 1 soil ESLs represent the lowest value of the risk-based and non-risk-based screening levels. The non-risk-based soil ESLs address the following environmental protection goals:

- Protection against leaching to groundwater;
- Protection of gross contamination; and
- Protection against adverse nuisance conditions (i.e., taste and odor thresholds).

The soil ESLs for protection against leaching to groundwater are not appropriate for use at the Site. The potential for chemicals to leach from soil depends on the physical and chemical properties of the chemicals, the chemical concentration, soil type, pH (for metals), and other Site-specific conditions. For example, chemicals with high water solubilities tend to leach more readily than chemicals with lower solubilities. In addition, a chemical's Koc is important for assessing the degree of chemical sorption to soil particles; chemicals with a high sorption potential do not tend to leach as readily (i.e., metals and pesticides). Site-specific conditions are also important for assessing whether leaching may occur, such as soil type (leaching occurs more readily in sandy soils than in clayey or silty soils), amount of rainfall, gradient, etc. Based on the boring logs provided in the Geotechnical Investigation prepared by Rockridge Geotechnical (Rockridge, 2015), the soil type in the vadose zone to 30 feet bgs is predominately silts and clays (Attachment A). In addition, other competing migration pathways can affect the tendency of a chemical to leach. Based on the following reasons the leaching of contaminants in the vadose zone into groundwater was not considered a significant exposure pathway:

- Metals and pesticides in soil are expected to adsorb to soil particles (especially clay), become immobile, and not leach;
- Limited VOC concentrations detected in soil within the vadose zone of the onsite area. Acetone was the only VOC detected in near surface soil at 1 to 2 feet bgs; and

- Groundwater was not encountered at recently investigated depths of 45 feet bgs (PES, 2015). Based on boring logs the upper 30 feet of vadose zone beneath the Site is predominately silts and clays, which will limit the leaching potential of any constituents detected on-site.

Therefore, the soil ESLs for protection against leaching to groundwater were not considered in the selection of appropriate soil ESLs for the Site.

In general, gross contamination levels and nuisance levels are greater than the risk-based levels and are not expected to drive any risk management decisions. However, protection against adverse nuisance conditions (i.e., taste and odor) was considered in the selection of appropriate soil ESLs.

Unlike most compounds, the soil screening levels for arsenic and lead are not derived from typical standardized equations. At many sites, the presence of arsenic in soil is due to naturally occurring background concentrations. Therefore, a regional background level of 11 milligrams per kilogram (mg/kg; Duvergé, 2011) is used as the appropriate soil screening level for arsenic. The soil screening level for lead is based on a blood lead model developed by the Office of Health Hazard Assessment (OEHHA) and the Department of Toxic Substances Control (DTSC) leadspread model (SFRWQCB, 2016; DTSC, 2016). The residential soil screening level for lead is 80 µ/kg, based on exposure to a child resident. The commercial soil screening level for lead is 320 mg/kg, based on exposure to a pregnant adult worker.

SFRWQCB soil ESLs for the construction worker receptor are included in the event any construction or redevelopment occurs at the Site. The following table summarizes the appropriate SFRWQCB soil ESLs for chemicals detected at the Site:

Chemical	**SFRWQCB Soil ESL**		
	Residential	**Commercial**	**Construction**
Arsenic	11 mg/kg		
Lead	80 mg/kg	320 mg/kg	160 mg/kg
Endrin	2,700 µg/kg	2,700 µg/kg	2,700 µg/kg
Dichlorodiphenyldichloroethane (DDD)	2,700 µg/kg	12,000 µg/kg	81,000 µg/kg
Dichlorodiphenyldichloroethene (DDE)	1,900 µg/kg	8,500 µg/kg	57,000 µg/kg
Dichlorodiphenyltrichloroethane (DDT)	1,900 µg/kg	4,300 µg/kg	4,300 µg/kg
Dieldrin	38 µg/kg	170 µg/kg	1,100 µg/kg
Heptachlor Epoxide	67 µg/kg	300 µg/kg	1,900 µg/kg
Alpha-Chlordane	480 µg/kg	2,200 µg/kg	14,000 µg/kg
Acetone	500,000 µg/kg	1,000,000 µg/kg	1,000,000 µg/kg
TPH as diesel (TPH-d)	230 mg/kg	1,000 mg/kg	880 mg/kg
TPH as motor oil (TPH-mo)	5,100 mg/kg	5,100 mg/kg	5,100 mg/kg

mg/kg = milligram per kilogram
µg/kg = microgram per kilogram

Soil Vapor ESLs

The default SFRWQCB Tier 1 soil vapor ESLs are calculated by dividing the indoor air screening level by the DTSC default attenuation factors of 0.002 and 0.001 for existing residential and commercial building type, respectively (SFRWQCB, 2016; DTSC, 2011). Since, this project involves new residential and commercial/retail buildings, the

DTSC default attenuation factors of 0.001 for future residential building type and 0.0005 for future commercial building type are more appropriate (DTSC, 2011). As presented in the table below, the SFRWQCB soil vapor ESLs were modified and estimated by dividing the indoor air ESL for residential and commercial land use by the DTSC default attenuation factors of 0.001 and 0.0005, respectively.

Soil Vapor Site-Specific Screening Levels (SLs)

Although the DTSC default attenuation factors are designated for use with future building scenarios, these attenuation factors do not specifically take into account subsurface soil conditions and may be conservative for sites with less permeable vadose zone conditions (i.e., silts and clays). Most of the onsite soil vapor samples were collected at approximately 5 feet bgs, with the exception of four soil vapor samples collected at 25 feet bgs (approximate depth of future elevator shafts). Nine offsite soil vapor samples were collected at 9 feet bgs (approximate depth of existing sewer lateral in State Street). Based on the geotechnical investigation conducted by Rockridge (2015), soil within the vadose zone is generally silts and clays (Attachment A). Rockridge (2015) describes the subsurface conditions as:

> …the Site is blanketed by stiff to hard clay with varying sand content that extends to depths ranging from approximately 5 to 11-1/2 feet bgs…Beneath the surficial clay layer are heterogeneous alluvial deposits consisting of loose to very dense silty sand, medium dense to very dense sand with varying gravel content, medium dense clayey sand, stiff to very stiff, non-plastic sandy silt, and stiff to very stiff clay with varying sand content.

With Site conditions more reflective of less permeable silts and clays, the SFRWQCB soil vapor ESLs based on DTSC default attenuation factors (based on coarser grained soils) likely further overestimate the migration and transport from soil vapor to indoor air for this Site (i.e., DTSC default attenuation factors result in higher estimated indoor air concentrations than indoor air concentrations based on site-specific attenuation factors that reflect less permeable soils). Therefore, the DTSC modified version of the Johnson and Ettinger (1991; J/E) model (DTSC, 2014) was used to estimate Site-specific screening levels (SLs) that take into account Site-specific geotechnical data. Tables 1 and 2 present the Site-specific SLs for residential and commercial exposure scenarios, respectively. The methods used to develop the Site-specific SLs are described in Attachment B. The following table summarizes the appropriate SFRWQCB soil vapor ESLs and Site-specific SLs for VOCs detected at the Site:

Chemical	**SFRWQCB Modified Soil Vapor ESL**		**Site-Specific Screening Levels***	
	Residential (µg/m^3)	**Commercial** (µg/m^3)	**Residential** (µg/m^3)	**Commercial** (µg/m^3)
Tetrachloroethene (PCE)	480	4,200	960	8,400
Benzene	97	840	130	1,100
Toluene	310,000	2,600,000	460,000	3,800,000
Ethylbenzene	1,100	9,800	1,800	16,000
m,p-Xylene	100,000	880,000	170,000	1,400,000
o-Xylene	100,000	880,000	170,000	1,400,000
Trichlorofluoromethane (Freon 11)	Not available	Not available	1,200,000	10,000,000
Dichlorodifluoromethane (Freon 12)	Not available	Not available	150,000	1,300,000
Chloroform	120	1,060	180	1,600

µg/m^3 = microgram per cubic meter
* = Site-specific screening levels represent rounded values to two significant figures, consistent with SFRWQCB ESLs.

SCREENING LEVEL RISK EVALUATION

The screening level risk evaluation is based on the soil and soil vapor data from previous Site investigations as summarized by PES in the *Vapor Mitigation System, Basis of Design Report, State Street Center, Fremont, California*, dated March 24, 2016 (PES, 2016b).

Soil

Arsenic and lead were detected in 10 of 10 soil samples collected at approximately 1 to 2 feet bgs. The maximum detected arsenic concentration of 8.2 mg/kg in soil sample B6-1.0-2.0 is below the San Francisco Bay regional background value of 11 mg/kg (Duvergé, 2011). Therefore, arsenic does not pose a potential risk to human health beyond background levels. The maximum detected lead concentration of 13 mg/kg is below the SFRWQCB soil ESLs for all receptors; therefore, lead does not pose a potential risk to human health at the Site.

Organochlorine pesticides were detected in 10 of 16 soil samples collected at approximately 1 to 2 feet bgs or 3 to 4 feet bgs. The maximum detected concentrations of the seven pesticides detected in soil were below their respective SFRWQCB soil ESLs for all receptors; therefore, pesticides do not pose a potential risk to human health at the Site.

Acetone was the only VOC detected in soil. It was detected in 2 of 21 soil samples collected at approximately 1 to 2 feet bgs or 3 to 4 feet bgs. No VOCs were detected in the deep soil sample (B50) collected at approximately 9 to 10 feet bgs. The maximum detected acetone concentration of 130 µg/kg is below the SFRWQCB soil ESLs for all receptors; therefore, acetone does not pose a potential risk to human health at the Site.

TPH as diesel (TPH-d) and TPH as motor oil (TPH-mo) were analyzed by the laboratory with and without silica gel cleanup (SGC). In accordance with SFRWQCB (2016) guidance, the results from the extractable TPH analyses without SGC were compared with the SFRWQCB ESL. The maximum detected concentrations of TPH-d (190 mg/kg) and TPH-mo (1,400 mg/kg) are below their respective SFRWQCB soil ESLs for all receptors; therefore, TPH does not pose a potential risk to human health at the Site.

Soil Vapor

During previous onsite soil vapor investigations, nine VOCs were detected in soil vapor collected at approximately 5 feet bgs. Of these nine VOCs, only PCE and benzene were detected at concentrations above their respective Site-specific SL. PCE was detected at concentrations above the residential Site-specific SL of 960 µg/m^3 at four soil vapor sample locations (B21, B30, B55, and B56), which were located in the northeast portion of the Site adjacent to State Street. Soil vapor sample B21 was collected in December 2014, sample B30 was collected in January 2015, and samples B55 and B56 were collected in February 2016 immediately adjacent to locations of B21 and B30. Benzene was detected at concentrations above the residential Site-specific SL at only two soil vapor sample locations (B4 and B47), which were located in the southern portion of the Site. Soil vapor sample B4 was collected in October 2014 and sample B47 was collected in September 2015 near the locations of B4. Only PCE was detected at concentrations above the commercial Site-specific SL of 8,400 µg/m^3 at only one soil vapor sample location (B21). However, subsequent soil vapor sampling near this location at soil vapor location B56 only detected PCE at 1,300 µg/m^3.

During the February 2016 investigation (PES, 2016b), soil vapor borings B57 through B60 were advanced within the footprint of the planned elevator shafts in Buildings A and B. Soil vapor samples B57 through B60 were collected at approximately 25 feet bgs, which is approximately 5 feet below the proposed future elevator sump bottom. Currently available vapor intrusion models do not allow for the evaluation of multi-story building or elevator exposure scenarios. Therefore, this HHRA conservatively assumes that the future onsite resident and commercial worker receptors are located 5 feet above any detected VOC concentrations. No VOCs were detected at concentrations above the commercial Site-specific SLs. Only chloroform was detected at a concentration above the residential Site-specific SL at only one soil vapor sample location (B59), which is located in the northern portion of the Site. Chloroform was detected at a concentration of 190 μg/m^3, which is only slightly above the Site-specific SL of 180 μg/m^3 and well below the commercial Site-specific SL of 1,600 μg/m^3. In the duplicate sample, chloroform was detected at 180 μg/m^3, which is equal to the Site-specific SL. Using the same DTSC modified version of the J/E model (DTSC, 2014) that was used to estimate the Site-specific SLs (as described in Attachment C) for a residential exposure scenario (24 hours per day and 350 days per year for 26 years), with a soil vapor concentration of 190 μg/m^3 and an assumed soil vapor sampling depth below grade of 152 centimeters bgs (5 feet bgs), the hazard quotient (HQ) estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is equal to 1 x 10^{-6}, which is the most stringent end of CalEPA's risk management range of 1 x 10^{-6} to 1 x 10^{-4} (Attachment D). Generally, an excess cancer risk equal to or below 1 x 10^{-6} is acceptable for unrestricted or residential land use. Although an elevator shaft may represent a preferential pathway for vapors, exposure parameters in an elevator exposure scenario (e.g., 0.5 hours per day for 26 years) would be significantly less than the exposure parameters assumed for a long-term receptor (8 hours per day for 25 years for commercial worker receptor and 24 hours per day for 26 years for resident receptor). Therefore, chloroform in soil vapor volatilizing into indoor air within an elevator shaft does not pose a potential risk to human health at the Site.

During previous offsite soil vapor investigations, samples were collected along the existing sewer lateral in State Street. The offsite soil vapor samples were collected from approximately 9 feet bgs (approximate depth of sewer lateral). No structures are anticipated over the offsite soil vapor sample locations, since they are located within State Street and the sidewalk between the Site and State Street. However, for discussion purposes, the detected VOC concentrations were compared with Site-specific SLs. Only PCE was detected at concentrations above the residential Site-specific SL of 960 μg/m^3 at six offsite soil vapor sample locations. PCE was detected at concentrations above the commercial Site-specific SL of 8,400 μg/m^3 at two offsite soil vapor sample locations. The highest PCE concentrations were detected in the offsite soil vapor samples; however, PCE concentrations in soil vapor decrease as the offsite PCE plume migrates onto the northern portion of the Site (PES, 2016c).

EVALUATION OF POTENTIAL VAPOR IMPACTS IN OUTDOOR AIR

Inhalation of VOCs in outdoor air is generally negligible due to dispersion; therefore, inhalation of VOCs in outdoor air is generally not considered a significant exposure pathway. However, the planned redevelopment of the Site includes a limited open area that will be covered with a paver system. The planned paver system will be approximately 5,000 square feet and is adjacent to the PCE plume in soil vapor (See Plate 1 of PES memorandum). At the request of ACEH, inhalation of VOCs in outdoor air for the future onsite resident and commercial worker receptors at the Site was evaluated for the open area covered with a paver system. Currently available fate and transport models do not allow for the evaluation of vapor emissions through a paver system. Therefore, this outdoor air evaluation conservatively assumes that the future onsite receptors are located directly above maximum detected VOC concentrations detected onsite without any barrier on the ground surface. The methodology for fate and transport modeling used to estimate exposure point concentrations (EPCs) in outdoor air resulting from volatilization of VOCs from subsurface sources is provided in Attachment C. The model-derived outdoor air EPCs were used to estimate noncancer adverse health effects and excess cancer risks from assumed exposure to VOCs migrating from soil vapor to outdoor air. The outdoor air EPCs are presented in Table C1 of Attachment C. Although the proposed development may also include commercial/retail workers, the estimated risks for these occupational receptors would be even less than the estimated risks for a resident receptor. Consequently, this evaluation was conducted to estimate potential human health risks from VOCs in outdoor air for future onsite resident receptor.

Consistent with U.S. Environmental Protection Agency (USEPA, 1989; 1991) guidelines, the following general equations were used to estimate excess cancer risks and noncancer adverse health effects (expressed as a HQ):

For carcinogens: $$Risk = \frac{EPC_{outdoor\ air} x EF x ED x ET x IUR}{AT_c}$$

For noncarcinogens: $$HQ = \frac{EPC_{outdoor\ air} x EF x ED x ET x \frac{1}{RfC}}{AT_n}$$

Where:

$EPC_{outdoor\ air}$	=	*Chemical concentration in outdoor air ($EPC_{outdoor\ air}$; µg/m^3).*
EF	=	*Exposure frequency (350 days/year).*
ED	=	*Exposure duration (26 years).*
ET	=	*Exposure time (24 hours/day).*
AT	=	*Averaging time (hours).* *For noncarcinogenic effects (hours), AT = ED x 365 days/year x 24 hours/day.* *For carcinogenic effects, AT (hours) = 70 years x 365 days/year x 24 hours/day.*
IUR	=	*Inhalation unit risk for carcinogenic chemicals (µg/m^3)$^{-1}$.*
RfC	=	*Inhalation reference concentration for noncarcinogenic chemicals (µg/m^3).*

The noncancer hazard quotient (HQ) and excess cancer risk for VOCs in outdoor air were estimated by using the exposure factors presented above and toxicity values presented in Table 3 in the equations above. Exposure to multiple chemicals were evaluated by summing the HQs and excess cancer risks for each chemical, resulting in a hazard index (HI) and total excess cancer risk, respectively. Risk characterization of inhalation of VOCs volatilizing from soil vapor into outdoor air for the future onsite resident receptor is presented in Table 4. The spreadsheet containing the results of the fate and transport emission rate and box model is presented in Table C1 of Attachment C.

USEPA guidance on risk and exposure levels considered protective of human health is presented to provide context for interpretation of the HI and excess cancer risk estimates presented below. Hazard indices are compared to the USEPA and California Environmental Protection Agency (CalEPA) recommended target HI of one (USEPA, 1989). Excess cancer risks are compared to the CalEPA's risk management range of one-in-one-million (1 x 10^{-6}) to one-in-ten thousand (1 x 10^{-4}). The CalEPA threshold value of 1 x 10^{-6} represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors. The USEPA target excess cancer risk represent the incremental probability of an individual developing cancer over a lifetime as a result of chemical exposure. This probability is considered an excess cancer risk because the incidence of cancer from all sources other than chemicals associated with a site (i.e., background) are substantial.

Resident Exposure Pathway	HI	Excess Cancer Risk
Inhalation of VOCs Volatilizing from Soil Vapor into Outdoor Air	0.0007	3 x 10^{-8}

Site data indicate that the maximum detected VOC concentrations were located in different areas of the Site. However, this evaluation assumes the future onsite resident receptor resides over co-located maximum detected VOC concentrations in soil vapor. Therefore, the results of this evaluation overestimate actual risk.

Based on the maximum detected soil vapor concentrations onsite, the HI estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is below 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4}. Generally, an excess cancer risk equal to or below 1×10^{-6} is acceptable for unrestricted or residential land use. Therefore, VOCs in soil vapor volatilizing into outdoor air do not pose a potential risk to human health at the Site.

SUMMARY AND CONCLUSIONS

The following summarizes the results of the human health risk evaluation for the Site:

- No metals, pesticides, VOCs, or TPH were detected at concentrations above the SFRWQCB soil ESLs for all receptors. Therefore, no adverse effects on human health are expected to occur from exposure to any residual impacts in soil.
- Near the northeast boundary of the Site adjacent to State Street, PCE was detected at concentrations above the residential Site-specific SL of 960 µg/m^3 at four soil vapor sample locations (B21, B30, B55, and B56). PCE was detected at concentrations above the commercial Site-specific SL of 8,400 µg/m^3 at only one soil vapor sample location (B21). However, subsequent soil vapor sampling near this location at soil vapor location B56 only detected PCE at 1,300 µg/m^3. Based on offsite soil vapor investigation data, the PCE concentrations detected in the northern portion of the Site are associated with an offsite source. Isoconcentration contour maps for PCE (PES, 2016c) indicate the soil vapor concentrations decrease as the offsite PCE plume migrates onto the northern portion of the Site (PES, 2016c). PCE is not detected in soil vapor in the central and southern portions of the Site.
- In the southern portion of the Site, near the former Nation's Giant Hamburgers building, benzene was detected at concentrations above the residential Site-specific SL at two soil vapor sample locations (B4 and B47). Benzene concentrations in soil vapor are localized in the area immediately adjacent to soil vapor sample B4. Benzene was not detected above the commercial Site-specific SL in any soil vapor sample.
- In the evaluation of soil vapor beneath the planned elevator shafts, only chloroform was detected at a concentration above the residential Site-specific SL. Chloroform was only detected at one soil vapor sample (B59), located in footprint of the planned elevator shaft in the northwestern portion of the Site. Chloroform was detected in sample B59 and duplicate sample at concentrations of 190 µg/m^3 and 180 µg/m^3, respectively. These concentrations are equal to or slightly above the Site-specific SL of 180 µg/m^3, and well below the commercial Site-specific SL of 1,600 µg/m^3. Although an elevator shaft may represent a preferential pathway for vapors, exposure parameters in an elevator exposure scenario (e.g., 0.5 hours per day for 26 years) would be significantly less than exposure parameters assumed in the development of the Site-specific SLs for a long-term receptor (8 hours per day for 25 years for commercial worker receptor and 24 hours per day for 26 years for resident receptor). Regardless of the inherent conservativeness in assuming a long-term residential exposure for the elevator shaft scenario, using a soil vapor concentration of 190 µg/m^3 and an assumed soil vapor sampling depth below grade of 152 centimeters bgs (5 feet bgs), the resulting HQ estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is equal to 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4}. Therefore, chloroform in soil vapor volatilizing into indoor air within an elevator shaft does not pose a potential risk to human health at the Site.

- Planned redevelopment of the Site, includes limited open area that will be covered with a paver system; therefore, inhalation of VOCs in outdoor air for the future onsite resident and commercial worker receptors at the Site was considered for these open areas. Without a regulatory-approved model for this scenario, this outdoor air evaluation conservatively assumes that the future onsite receptors are located directly above maximum detected VOC concentrations in soil vapor without any barrier on the ground surface (i.e. pavers). Additionally, although the VOCs impacts at the Site are not co-located, this model assumes the VOCs are co-located beneath the future onsite receptor. Regardless of the inherent conservativeness of this evaluation, the resulting HI estimate is below the USEPA and CalEPA target level of one and the excess cancer risk estimate is below 1×10^{-6}, which is the most stringent end of CalEPA's risk management range of 1×10^{-6} to 1×10^{-4}. Therefore, VOCs in soil vapor volatilizing into outdoor air do not pose a potential risk to human health at the Site.

The site remedy for the PCE, benzene, and chloroform impacted areas of the Site have been proposed to ACEH (PES, 2016a,b) to further reduce any potential risks to future onsite resident and commercial receptors.

Sincerely,
The Source Group, Inc.

ivy inouye

Ivy Inouye
Senior Toxicologist

cc: Mr. Tom Graf, GrafCon
Mr. Carl J. Michelsen, PES Environmental, Inc.

Tables

Table 1 – Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Residential Exposure Scenario
Table 2 – Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Commercial Exposure Scenario
Table 3 – Inhalation Toxicity Values
Table 4 – Risk Characterization for the Future Onsite Resident Receptor, Inhalation of Volatile Organic Compounds Volatilizing from Soil Vapor into Outdoor Air

Attachments

Attachment A – Soil Geotechnical Data
Attachment B – Site-Specific Screening Levels for Soil Vapor
Attachment C – Fate and Transport for Vapor Emissions from Soil Vapor into Outdoor Air

Table C1 – Estimation of Outdoor Air Concentrations from Volatile Organic Compounds Volatilizing from Soil Vapor
Attachment C1 - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Residential Exposure Scenario
Attachment C2 - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Commercial Exposure Scenario

Attachment D – Fate and Transport for Vapor Emissions of Chloroform from Soil Vapor into Indoor Air (Elevator Shaft Scenario) - DTSC J/E Model for Subsurface Vapor Intrusion into Buildings for the Residential Exposure Scenario

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TABLES

Table 1
Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Residential Exposure Scenario
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	Soil Vapor	Indoor Air[2]				Site-Specific Screening Level (SL)		
	$EPC_{soil\ vapor}$[1] (μg/m³)	Soil Vapor to Indoor Air Attenuation Factor (unitless)	$EPC_{indoor\ air}$ (μg/m³)	Cancer Risk (unitless)	Noncancer Hazard Index (unitless)	Soil Vapor SL Based on Carcinogenic Effects[3] (μg/m³)	Soil Vapor SL Based on Nonarcinogenic Effects[4] (μg/m³)	Lowest Soil Vapor SL[5] (μg/m³)
Tetrachloroethene	8,500	4.9E-04	4.20E+00	8.8E-06	1.2E-01	963	73,824	963
Benzene	710	7.6E-04	5.39E-01	5.6E-06	1.7E-01	128	4,122	128
Toluene	1,500	6.9E-04	1.03E+00	NA	3.3E-03	NA	455,126	455,126
Ethylbenzene	280	6.3E-04	1.75E-01	1.6E-07	1.7E-04	1,794	1,666,207	1,794
m,p-Xylene	1,100	6.3E-04	6.88E-01	NA	6.6E-03	NA	166,800	166,800
o-Xylene	350	6.3E-04	2.20E-01	NA	2.1E-03	NA	165,796	165,796
Freon 11	2,300	6.0E-04	1.39E+00	NA	1.9E-03	NA	1,207,772	1,207,772
Freon 12	6,400	6.8E-04	4.33E+00	NA	4.1E-02	NA	154,272	154,272
Chloroform	160	6.8E-04	1.09E-01	8.9E-07	1.1E-03	179	149,896	179

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
μg/m³ = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs. Note: All maximum detected concentrations were detected at 5 feet bgs.
[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with vapor intrusion model to estimate attenuation factors, EPCs in indoor air, cancer risk, and noncancer hazard index for residential scenario.
[3] Represents the Site-specfic SL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1×10^{-6}).
Soil Vapor SL (Carcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Cancer Risk of 1×10^{-6} / Cancer $Risk_i$
[4] Represents the Site-specific SL for noncarcinogenic effects, based on a target hazard quotient of one (1).
Soil Vapor SL (Noncarcinogenic Effects) for compound i = Soil Vapor EPC_i x Target Noncancer Hazard Index of 1 / Noncancer Hazard $Index_i$
[5] Represents the lower of the Site-specific SLs based on noncarcinogenic or carcinogenic effects.

Table 2
Exposure Point Concentrations and Site-Specific Screening Levels for Volatile Organic Compounds in Soil Vapor and Indoor Air for Future Onsite Commercial Exposure Scenario
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	Soil Vapor	Indoor Air[2]				Site-Specific Screening Level (SL)		
	$EPC_{soil\ vapor}$[1] (µg/m³)	Soil Vapor to Indoor Air Attenuation Factor (unitless)	$EPC_{indoor\ air}$ (µg/m³)	Cancer Risk (unitless)	Noncancer Hazard Index (unitless)	Soil Vapor SL Based on Carcinogenic Effects[3] (µg/m³)	Soil Vapor SL Based on Nonarcinogenic Effects[4] (µg/m³)	Lowest Soil Vapor SL[5] (µg/m³)
Tetrachloroethene	8,500	2.5E-04	2.10E+00	1.0E-06	1.4E-02	8,408	620,122	8,408
Benzene	710	3.8E-04	2.69E-01	6.4E-07	2.1E-02	1,114	34,621	1,114
Toluene	1,500	3.4E-04	5.16E-01	NA	3.9E-04	NA	3,823,062	3,823,062
Ethylbenzene	280	3.1E-04	8.76E-02	1.8E-08	2.0E-05	15,676	13,996,141	15,676
m,p-Xylene	1,100	3.1E-04	3.44E-01	NA	7.9E-04	NA	1,401,117	1,401,117
o-Xylene	350	3.1E-04	1.10E-01	NA	2.5E-04	NA	1,392,683	1,392,683
Freon 11	2,300	3.0E-04	6.95E-01	NA	2.3E-04	NA	10,145,282	10,145,282
Freon 12	6,400	3.4E-04	2.16E+00	NA	4.9E-03	NA	1,295,883	1,295,883
Chloroform	160	3.4E-04	5.45E-02	1.0E-07	1.3E-04	1,564	1,259,125	1,564

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
µg/m³ = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs. Note: All maximum detected concentrations were detected at 5 feet bgs.

[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with vapor intrusion model to estimate attenuation factors, EPCs in indoor air, cancer risk, and noncancer hazard index for commercial scenario.

[3] Represents the Site-specfic SL for carcinogenic effects, based on a target excess cancer risk of one-in-one million (1×10^{-6}).
Soil Vapor SL (Carcinogenic Effects) for compound *i* = Soil Vapor EPC_i x Target Cancer Risk of 1×10^{-6} / Cancer $Risk_i$

[4] Represents the Site-specific SL for noncarcinogenic effects, based on a target hazard quotient of one (1).
Soil Vapor SL (Noncarcinogenic Effects) for compound *i* = Soil Vapor EPC_i x Target Noncancer Hazard Index of 1 / Noncancer Hazard $Index_i$

[5] Represents the lower of the Site-specific SLs based on noncarcinogenic or carcinogenic effects.

Table 3
Inhalation Toxicity Values
39155 and 39183 State Street
Fremont, California

Chemical	Inhalation Reference Concentration (RfCi)[1] (μg/m^3)		Inhalation Unit Risk Factor (IUR)[2] (μg/m^3)$^{-1}$	
	Value	Source	Value	Source
Benzene	3.00E+00	DTSC, 2016	2.90E-05	DTSC, 2016
Chloroform	9.80E+01	ATSDR, 2016	2.30E-05	USEPA, 2016b
Ethylbenzene	1.00E+03	USEPA, 2016b	2.50E-06	OEHHA, 2016
Freon 11	7.00E+02	USEPA, 1997	- -	- -
Freon 12	1.00E+02	USEPA, 2016a	- -	- -
Tetrachloroethene	3.50E+01	DTSC, 2016	5.90E-06	DTSC, 2016
Toluene	3.00E+02	DTSC, 2016	- -	- -
m,p-Xylene	1.00E+02	USEPA, 2016b	- -	- -
o-Xylene	1.00E+02	USEPA, 2016b	- -	- -

Notes:

μg/m^3 = Micograms per cubic meter.

"- -" = value was not available from the sources listed below or not applicable for this exposure route.

[1] Inhalation reference concentrations were obtained from the following sources of information: DTSC, 2016; OEHHA, 2016; USEPA, 2016a,b; ATSDR, 2015; USEPA, 1997.

[2] Inhalation unit risk factors were obtained from the following sources of information: DTSC, 2016; OEHHA, 2016; USEPA, 2016a,b.

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USEPA. 2016b. Integrated Risk Information System (IRIS). On-line computer database. Last accessed August.

Table 4
Risk Characterization for the Future Onsite Resident Receptor
Inhalation of Volatile Organic Compounds Volatilizing from Soil Vapor into Outdoor Air
39155 and 39183 State Street
Fremont, California

Volatile Organic Compounds (VOCs) Detected in Soil Vapor	**Soil Vapor**	**Outdoor Air**	**Noncarcinogenic Effects**		**Carcinogenic Effects**	
	$EPC_{soil\ vapor}$[1] (µg/m³)	**$EPC_{outdoor\ air}$**[2] (µg/m³)	**Inhalation Reference Concentration (cRfCi)** (µg/m³)	**Hazard Quotient (HQ)** (unitless)	**Inhalation Unit Risk Factor (URF)** $(\mu g/m^3)^{-1}$	**Excess Cancer Risk** (unitless)
Tetrachloroethene	8.50E+03	7.82E-03	3.50E+01	2 E-04	5.90E-06	2 E-08
Benzene	7.10E+02	1.16E-03	3.00E+00	4 E-04	2.90E-05	1 E-08
Toluene	1.50E+03	2.13E-03	3.00E+02	7 E-06	- -	- -
Ethylbenzene	2.80E+02	3.49E-04	1.00E+03	3 E-07	2.50E-06	3 E-10
m,p-Xylene	1.10E+03	1.37E-03	1.00E+02	1 E-05	- -	- -
o-Xylene	3.50E+02	4.40E-04	1.00E+02	4 E-06	- -	- -
Freon 11	2.30E+03	2.74E-03	7.00E+02	4 E-06	- -	- -
Freon 12	6.40E+03	8.87E-03	1.00E+02	9 E-05	- -	- -
Chloroform	1.60E+02	2.24E-04	9.80E+01	2 E-06	2.30E-05	2 E-09
			Hazard Index =	**7 E-04**	**Cancer Risk =**	**3 E-08**

Notes:
bgs = below ground surface.
EPC = exposure point concentration.
SL = screening level.
µg/m³ = micrograms per cubic meter.

[1] Represents the maximum detected concentration for onsite soil vapor samples (3 purge volumes) collected from 0 to 10 feet bgs.
Note: All maximum detected concentrations were detected at 5 feet bgs.
[2] EPCs in soil vapor ($EPC_{soil\ vapor}$) were coupled with fate and transport emission rate and box models to estimate EPCs in outdoor air.

ATTACHMENT A

SOIL GEOTECHNICAL DATA

ROCKRIDGE GEOTECHNICAL

Prepared for **SummerHill Homes LLC**

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
STATE STREET AND CAPITOL AVENUE
FREMONT, CALIFORNIA

August 30, 2015
Project No. 15-905

270 Grand Avenue
Oakland, CA 94610

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ROCKRIDGE GEOTECHNICAL

August 30, 2015
Project No. 15-905

Ms. Denise Cunningham
SummerHill Homes LLC
3000 Executive Parkway, Suite 450
San Ramon, California 94583

Subject: Final Report
Geotechnical Investigation
Proposed Residential Development
State Street and Capitol Avenue
Fremont, California

Dear Ms. Cunningham,

We are pleased to present the results of our geotechnical investigation for the proposed residential development to be constructed at the intersection of State Street and Capitol Avenue in Fremont, California. Our geotechnical study was performed in accordance with our proposal, dated May 5, 2015, and our Professional Service Agreement with SummerHill Homes LLC, dated August 3, 2015.

The subject property consists of two relatively level, contiguous parcels (Parcel A and Parcel B) encompassing an area of about 176,400 square feet. It is bordered by one- to two-story commercial buildings and asphalt-concrete parking lots to the northwest, southwest and southeast, and State Street to the northeast. Although the site is currently vacant, it was previously occupied by a commercial structure with an adjacent asphalt-concrete parking lot. The structure has been demolished and removed, leaving the asphalt-concrete parking area and mature trees in place. There is currently construction near the site to extend Capitol Avenue through to Fremont Boulevard.

Plans are to construct eleven at-grade, three-story townhomes buildings on the eastern two-thirds of the site and two mixed-use buildings on the western one-third of the site. The mixed-use buildings will each have one level of below-grade parking and a one-story concrete podium above the garage that will contain both retail space and parking. Three stories of residential flats and townhomes will be constructed above the podium level. Other improvements include new streets along the eastern and southern edges of the site, as well as “B” Street, which will run through the middle of the site.

On the basis of the results of our geotechnical study, we conclude the proposed residential development can be constructed as planned, provided the recommendations presented in this report are incorporated into the project plans and specifications and properly implemented during construction. The primary geotechnical concerns at the site are: 1) the presence of moderately expansive near-surface soil, and 2) the potential for up to one inch of seismically induced differential settlement over a horizontal distance of 30 feet. We conclude the proposed townhomes should be supported on either conventionally reinforced mat foundations or post-tensioned slabs-on-grade underlain by at least two feet of properly moisture-conditioned on-site soil. We conclude the mixed-use buildings should either be supported on a mat foundation or spread footings bottomed on soil improved using Rapid Impaction Compaction (RIC).

The recommendations contained in our report are based on a limited subsurface investigation. Consequently, variations between expected and actual subsurface conditions may be found in localized areas during construction. Therefore, we should be engaged to observe grading, fill placement, and foundations installation, during which time we may make changes in our recommendations, if deemed necessary.

We appreciate the opportunity to provide our services to you on this project. If you have any questions, please call.

Sincerely yours,
ROCKRIDGE GEOTECHNICAL, INC.

REGISTERED PROFESSIONAL ENGINEER
CRAIG S. SHIELDS
GE2116
3/31/17
GEOTECHNICAL
STATE OF CALIFORNIA

Craig S. Shields, P.E., G.E.
Principal Geotechnical Engineer

Enclosure

ROCKRIDGE GEOTECHNICAL

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APPENDIX B

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
STATE STREET AND CAPITOL AVENUE
Fremont, California

1.0 INTRODUCTION

This report presents the results of the geotechnical investigation performed by Rockridge Geotechnical, Inc. for the proposed residential development to be constructed near the intersection of State Street and Capitol Avenue in Fremont, California. The site is on the southwestern side of State Street between Capitol and Beacon avenues, as shown on the Site Location Map, Figure 1.

The subject property consists of two relatively level, contiguous parcels (Parcel A and Parcel B) encompassing an area of about 176,400 square feet. It is bordered by one- to two-story commercial buildings and asphalt-concrete parking lots to the northwest, southwest and southeast, and State Street to the northeast. Although the site is currently vacant, it was previously occupied by a commercial structure with an adjacent asphalt-concrete parking lot. The structure has been demolished and removed, leaving the asphalt-concrete parking area and mature trees in place. There is currently construction near the site to extend Capitol Avenue through to Fremont Boulevard.

Plans are to construct 11 at-grade, three-story townhomes buildings on the eastern two-thirds of the site and two mixed-use buildings on the western one-third of the site. The mixed-use buildings will each have one level of below-grade parking and a one-story concrete podium above the garage that will contain both retail space and parking. Three stories of residential flats and townhomes will be constructed above the podium level. Other improvements include new streets along the eastern and southern edges of the site, as well as “B” Street, which will run through the middle of the site.

2.0 SCOPE OF WORK

Our investigation was performed in accordance with our proposal dated May 5, 2015 and our Professional Service Agreement, dated August 3, 2015, with SummerHill Homes LLC. Our scope of work consisted of exploring subsurface conditions at the site by drilling test borings, performing cone penetration tests (CPTs), and performing laboratory testing on selected soil samples. We used the data from our field investigation to perform engineering analyses to develop conclusions and recommendations regarding:

- site seismicity and seismic hazards, including the potential for liquefaction and liquefaction-induced ground failure
- the most appropriate foundation type(s) for the proposed structures
- design criteria for the recommended foundation type(s), including vertical and lateral capacities
- estimates of foundation settlement
- lateral earth pressures for basement wall design
- subgrade preparation for slab-on-grade floors and exterior flatwork
- site grading and excavation, including criteria for the fill quality and compaction
- 2013 California Building Code (CBC) site class and design spectral response acceleration parameters
- soil corrosivity
- construction considerations.

3.0 FIELD INVESTIGATION AND LABORATORY TESTING

Our field investigation consisted of drilling seven test borings, performing seven CPTs, and performing laboratory testing on selected soil samples. Prior to advancing the test borings, we obtained a drilling permit from Alameda County Water District (ACWD) and contacted Underground Service Alert (USA) to notify them of our work, as required by law. Details of the field investigation and laboratory testing are described below.

3.1 Test Borings

Our field investigation included drilling seven test borings, designated as Borings B-1 through B-7, at the approximate locations shown on Figure 2. The borings were drilled to depths ranging from 26-1/2 to 40 feet below the existing ground surface (bgs) using a truck-mounted drill rig equipped with hollow-stem augers. During drilling, our field engineer logged the soil encountered and obtained representative samples for visual classification and laboratory testing. The logs of the borings are presented on Figures A-1 through A-7 in Appendix A. The soil encountered in the borings was classified in accordance with the classification charts shown on Figures A-8.

Soil samples were obtained using the following samplers:

- Sprague and Henwood (S&H) split-barrel sampler with a 3.0-inch outside diameter and 2.5-inch inside diameter, lined with 2.43-inch inside diameter brass or stainless steel tubes.
- Standard Penetration Test (SPT) split-barrel sampler with a 2.0-inch outside and 1.5-inch inside diameter, without liners.

The type of sampler used was selected based on soil type and the desired sample quality for laboratory testing. In general, the S&H sampler was used to obtain samples in medium stiff to very stiff cohesive soil and the SPT sampler was used to evaluate the relative density of cohesionless soil.

The SPT and S&H samplers were driven with a 140-pound, downhole, wireline hammer falling about 30 inches per drop. The samplers were driven up to 18 inches and the hammer blows required to drive the samplers were recorded every six inches and are presented on the boring logs. A “blow count” is defined as the number of hammer blows per six inches of penetration or 50 blows for six inches or less of penetration. The blow counts required to drive the S&H and SPT samplers were converted to approximate SPT N-values using factors of 0.7 and 1.2, respectively, to account for sampler type and approximate hammer energy. The blow counts used for this conversion were: (1) the last two blow counts if the sampler was driven more than 12 inches, (2) the last one blow count if the sampler was driven more than six inches but less than 12 inches, and (3) the only blow count if the sampler was driven six inches or less. The converted SPT N-values are presented on the boring logs.

Upon completion, the boreholes were backfilled with neat cement grout under the observation of a grout inspector from ACWD, the pavement was patched with quick-set concrete, and drilling spoils generated by the borings were placed in landscaped areas on site.

3.2 Laboratory Testing

We re-examined the soil samples obtained from our borings to confirm the field classifications and selected representative samples for laboratory testing. Selected soil samples were tested to measure moisture content, dry density, Atterberg limits, particle-size distribution (gradation), resistance value (R-value), and corrosivity. The results of the laboratory tests are presented on the boring logs and in Appendix B.

4.0 SUBSURFACE CONDITIONS

Regional geologic information (Figure 3) indicates the site is underlain Holocene-age alluvium (Qha). Our borings indicate the site is blanketed by stiff to hard clay with varying sand content that extends to depths ranging from approximately 5 to 11-1/2 feet bgs. Atterberg limits tests indicate the near-surface clay has low to moderate expansion potential. Beneath the surficial clay layer are heterogeneous alluvial deposits consisting of loose to very dense silty sand, medium dense to very dense sand with varying gravel content, medium dense clayey sand, stiff to very stiff, non-plastic sandy silt, and stiff to very stiff clay with varying sand content.

Groundwater was not encountered during drilling of any of the test borings, which extended to a maximum depth of 40 feet bgs. Based on a CPT pore pressure dissipation test performed at a depth of 44.8 feet bgs at the CPT-7 location, the depth to groundwater is estimated to be 40.5 feet bgs at that location at the time the test was performed.

Our borings were drilled following a long drought. The groundwater level at the site is expected to fluctuate several feet seasonally with potentially larger fluctuations annually, depending on the amount of rainfall. To further evaluate the depth to the groundwater table at the site, we reviewed information on the State of California Water Resources Control Board GeoTracker website (http://geotracker.swrcb.ca.gov). Groundwater monitoring data from January 2006 at a nearby site indicate the highest groundwater levels measured during that period was about 32-1/2 feet bgs. Based on the available information, we recommend a design groundwater of 30 feet bgs be used for the site.

5.0 SEISMIC CONSIDERATIONS

5.1 Regional Seismicity

The site is located in the Coast Ranges geomorphic province of California that is characterized by northwest-trending valleys and ridges. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon plate and North American plate and subsequent strike-slip faulting along the San Andreas Fault system. The San Andreas Fault is more than 600 miles long from Point Arena in the north to the Gulf of California in the south. The Coast Ranges province is bounded on the east by the Great Valley and on the west by the Pacific Ocean.

The major active faults in the area are the Hayward, Mount Diablo Thrust, Calaveras, and San Andreas faults. These and other faults in the region are shown on Figure 4. For these and other active faults within a 50-kilometer radius of the site, the distance from the site and estimated mean characteristic Moment magnitude[1] [2007 Working Group on California Earthquake Probabilities (WGCEP) (USGS 2008) and Cao et al. (2003)] are summarized in Table 1.

[1] Moment magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area.

TABLE 1
Regional Faults and Seismicity

Fault Segment	Approximate Distance from Site (km)	Direction from Site	Mean Characteristic Moment Magnitude
Total Hayward	2	Northeast	7.0
Total Hayward – Rodgers Creek	2	Northeast	7.3
Total Calaveras	11	East	7.0
Mount Diablo Thrust	25	Northeast	6.7
Monte Vista - Shannon	25	Southwest	6.5
N. San Andreas - Peninsula	28	Southwest	7.2
N. San Andreas (1906 Event)	28	Southwest	8.0
Greenville Connected	32	Northeast	7.0
Green Valley Connected	39	North	6.8
N. San Andreas – Santa Cruz	42	South	7.1
San Gregorio Connected	44	West	7.5
Great Valley 7	46	East	6.9

Since 1800, four major earthquakes have been recorded on the San Andreas Fault. In 1836, an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale occurred east of Monterey Bay on the San Andreas Fault (Toppozada and Borchardt 1998). The estimated Moment magnitude, M_w, for this earthquake is about 6.25. In 1838, an earthquake occurred with an estimated intensity of about VIII-IX (MM), corresponding to an M_w of about 7.5. The San Francisco Earthquake of 1906 caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. This earthquake created a surface rupture along the San Andreas Fault from Shelter Cove to San Juan Bautista approximately 470 kilometers in length. It had a maximum intensity of XI (MM), an M_w of about 7.9, and was felt

560 kilometers away in Oregon, Nevada, and Los Angeles. The most recent earthquake to affect the Bay Area was the Loma Prieta Earthquake of 17 October 1989 with an M_w of 6.9. This earthquake occurred in the Santa Cruz Mountains about 58 kilometers southwest of the site.

In 1868, an earthquake with an estimated maximum intensity of X on the MM scale occurred on the southern segment (between San Leandro and Fremont) of the Hayward Fault. The estimated M_w for the earthquake is 7.0. In 1861, an earthquake of unknown magnitude (probably an M_w of about 6.5) was reported on the Calaveras Fault. The most recent significant earthquake on this fault was the 1984 Morgan Hill earthquake ($M_w = 6.2$).

The U.S. Geological Survey's (USGS) 2007 WGCEP has compiled the earthquake fault research for the San Francisco Bay area in order to estimate the probability of fault segment rupture. They have determined that the overall probability of moment magnitude 6.7 or greater earthquake occurring in the San Francisco Bay Region during the next thirty years is 63 percent. The highest probabilities are assigned to the Hayward/Rodgers Creek Fault and the northern segment of the San Andreas Fault; these probabilities are 31 and 21 percent, respectively (USGS 2008). The probabilities assigned to Calaveras, Concord-Green Valley, and Mount Diablo Thrust faults are 7, 3, and 1 percent, respectively (USGS 2008).

5.2 Geologic Hazards

Because the project site is in a seismically active region, we evaluated the potential for earthquake-induced geologic hazards, including ground shaking, ground surface rupture, liquefaction,[2] lateral spreading,[3] and cyclic densification[4]. We used the results of our field investigation to evaluate the potential of these phenomena occurring at the project site.

5.2.1 Ground Shaking

The seismicity of the site is governed by the activity of the Hayward and Calaveras faults, although ground shaking from future earthquakes on other faults, including the Mount Diablo Thrust and San Andreas faults, will also be felt at the site. The intensity of earthquake ground motion at the site will depend upon the characteristics of the generating fault, distance to the earthquake epicenter, and magnitude and duration of the earthquake. We judge that strong to very strong ground shaking could occur at the site during a large earthquake on one of the nearby faults.

5.2.2 Ground Surface Rupture

Historically, ground surface displacements closely follow the trace of geologically young faults. The site is not within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act, and no known active or potentially active faults exist on the site. We therefore conclude the risk of fault offset at the site from a known active fault is very low. In a seismically active area, the remote possibility exists for future faulting in areas where no faults previously existed; however, we conclude the risk of surface faulting and consequent secondary ground failure from previously unknown faults is also very low.

---

2 Liquefaction is a phenomenon where loose, saturated, cohesionless soil experiences temporary reduction in strength during cyclic loading such as that produced by earthquakes.

3 Lateral spreading is a phenomenon in which surficial soil displaces along a shear zone that has formed within an underlying liquefied layer. Upon reaching mobilization, the surficial blocks are transported downslope or in the direction of a free face by earthquake and gravitational forces.

4 Cyclic densification is a phenomenon in which non-saturated, cohesionless soil is compacted by earthquake vibrations, causing ground-surface settlement.

5.2.3 Liquefaction and Associated Hazards

When a saturated, cohesionless soil liquefies, it experiences a temporary loss of shear strength created by a transient rise in excess pore pressure generated by strong ground motion. Soil susceptible to liquefaction includes loose to medium dense sand and gravel, low-plasticity silt, and some low-plasticity clay deposits. Flow failure, lateral spreading, differential settlement, loss of bearing strength, ground fissures and sand boils are evidence of excess pore pressure generation and liquefaction. The site is **not** located within a zone of liquefaction potential as shown on the map titled *State of California Seismic Hazard Zones, Nile Quadrangle, Official Map*, prepared by the California Geological Survey (CGS), dated October 19, 2004 (see Figure 5).

We evaluated the liquefaction potential of soil encountered at the site using data collected from our CPTs and borings. Our liquefaction analyses were performed using the methodology proposed by P.K. Robertson (2009). We also used the relationship proposed by Zhang, Robertson, and Brachman (2002) to estimate post-liquefaction volumetric strains and corresponding ground surface settlement; a relationship that is an extension of the work by Ishihara and Yoshimine (1992).

Our analyses were performed using the approximate in-situ groundwater depths measured in our CPTs and a "during earthquake" groundwater depth of 30 feet bgs. In accordance with the 2013 CBC, we used a peak ground acceleration of 0.83 times gravity (g) in our liquefaction evaluation; this peak ground acceleration is consistent with the Maximum Considered Earthquake Geometric Mean (MCE_G) peak ground acceleration adjusted for site effects (PGA_M). We also used a moment magnitude 7.33 earthquake, which is consistent with the mean characteristic moment magnitude for the Hayward Fault, as presented in Table 1.

Our analyses indicate there are thin layers of cohesive soil between depths of approximately 30 and 44 feet bgs that are susceptible to cyclic softening as a result of pore pressure build-up during a major earthquake. We estimate total and differential ground settlement resulting from post-earthquake reconsolidation of these layers following a MCE event with PGA_M of 0.83g will be on the order of 1/2 inch and 1/4 inch across a horizontal distance of 30 feet, respectively.

Lateral spreading occurs when a continuous layer of soil liquefies at depth and the soil layers above move toward an unsupported face, such as a shoreline slope, or in the direction of a regional slope or gradient. Based on the lack of controlling boundary conditions and the cohesive nature of the soil that may experience cyclic softening, we conclude the potential for lateral spreading to occur at the project site is very low.

5.2.4 Cyclic Densification

Cyclic densification (also referred to as differential compaction) of non-saturated sand (sand above groundwater table) can occur during an earthquake, resulting in settlement of the ground surface and overlying improvements. The site is underlain by areas of loose to medium dense sand above the groundwater table that is susceptible to cyclic densification. We estimate ground settlement as a result of cyclic densification during a major earthquake could be up to one inch and differential settlement could be up to about 3/4 inch over a horizontal distance of 30 feet.

6.0 DISCUSSION AND CONCLUSIONS

From a geotechnical standpoint, we conclude the proposed residential development can be constructed as planned, provided the recommendations presented in this report are incorporated into the project plans and specifications and implemented during construction. The primary geotechnical concerns at the site are: 1) the presence of moderately expansive near-surface soil, and 2) the potential for up to one inch of seismically induced differential settlement over a horizontal distance of 30 feet. This and other geotechnical issues as they pertain to the proposed development are discussed in this section.

6.1 Foundations

Considering the presence of moderately expansive near-surface soil and the potential for up to one inch of seismically induced differential settlement, we conclude the proposed townhomes should be supported on either conventionally reinforced mat foundations or post-tensioned slabs-on-grade underlain by at least two feet of properly moisture-conditioned on-site soil. If it is not practical to excavate, moisture-condition and recompact the upper two feet of soil beneath the townhomes due to rainy weather, the upper 18 inches of the townhome building pads may be treated in place with lime.

The excavation for the proposed below-grade levels beneath the mixed-use buildings will remove the moderately expansive near-surface soil and expose low-plasticity soil, which may consist of materials, such as sandy silt, silty sand, and clayey sand, which have moderate strength and are moderately compressible. We estimate settlement of footings bottomed on the native soil will be approximately one inch under static conditions and differential settlement will be about 3/4 inch over a horizontal distance of 30 feet. As discussed above, an additional one inch of seismically induced differential settlement may occur during a major earthquake from a combination of liquefaction and cyclic densification. The estimated differential settlement of 1-1/2 inches under a combination of static and seismic loading is larger than can be accommodated by a conventional spread footing foundation. Therefore, we conclude the mixed-use buildings should either be supported on a mat foundation or spread footings bottomed on improved soil. We believe the most economical ground improvement method for this site consists of using a Rapid Impact Compactor (RIC) to densify the upper 15 feet of soil (measured below footings for below-grade level). The RIC is a track-mounted machine that imparts energy by dropping an approximately 7.5-ton weight from a controlled height of about three feet onto a patented foot. The energy is delivered at a rate of 40 to 60 blows per minute. Drop height, number of blows, and penetration per blow are monitored and/or controlled by an on-board data acquisition system. Compaction points are performed on a geometric grid, the spacing of which is determined based on the properties of the soil to be densified.

If RIC is performed, we conclude conventional spread footings could be used to support the mixed-use buildings. We estimate total settlement of the buildings would be less than 3/4 inch under static conditions and differential settlement would be less than 1/2 inch of over a horizontal distance of 30 feet. We estimate seismically induced differential settlement would be less than 1/4 inch over a horizontal distance of 30 feet.

The soil that will be exposed at the base of the excavation for the below-grade parking levels is susceptible to softening and disturbance if exposed to rain. Therefore, if construction will occur during the rainy season, measures should be taken to protect the subgrade. These measures could include in-place cement treatment of the soil or placement of a six-inch-thick layer of compacted aggregate base over the subgrade. Footing excavations may be protected from rain by placing a 1- to 2-inch-thick layer of concrete ("mud slab") on the footing excavation bottoms after they are inspected by our firm.

6.2 Excavation Support

We anticipate the finished floor of the below-grade parking garages for the mixed-use buildings will be about 10 feet bgs. Therefore, we estimate construction of the below-grade level and foundations will require excavations up to about 12 feet in depth. Where there is adequate space, the sides of the excavation for the below-grade parking garage can be sloped. Excavations that will be deeper than 5 feet and will be entered by workers should be shored or sloped in accordance with the Occupational Safety and Health Administration (OSHA) standards (29 CFR Part 1926). The shoring designer should be responsible for the shoring design. The contractor should be responsible for the construction and safety of temporary slopes and shoring.

Where there is inadequate space to slope the sides of the excavation, shoring should be installed. We judge that a soldier pile-and-lagging shoring system is most appropriate for support of the proposed excavations for this project. A soldier pile-and-lagging system usually consists of steel H-beams and concrete placed in predrilled holes extending below the bottom of the excavation. The steel H-beams can also be installed with a vibratory hammer provided there are no vibration-sensitive improvements within 25 feet of the soldier piles. Wood lagging is placed between the piles as the excavation proceeds from the top down. Where the required cut is less than about 12 feet, a soldier pile and lagging system can typically provide economical shoring without tiebacks, and therefore will not encroach beyond the property line. Where cuts exceed about 12 feet in height, soldier pile-and-lagging systems are typically more economical if they include tieback anchors.

A structural/civil engineer knowledgeable in this type of construction should be retained to design the shoring. The shoring designer should design the shoring system for lateral deformation of less than 1/2 inch at any location on the shoring where there is an adjacent structure within a horizontal distance equal to twice the retained soil height and one inch where there are no structures within that horizontal distance. We should review the final shoring plans and calculations to check that they are consistent with the recommendations presented in this report.

6.3 Soil Corrosivity

Laboratory testing was performed by Sunland Analytical to evaluate the corrosivity of soil samples from Boring B-2 at a depth of 3 feet bgs and from Boring B-7 at a depth of 12 feet bgs. The results of the tests are presented in Appendix B. Based on the results of the resistivity tests performed on the samples, we conclude the soil is corrosive to buried metal. Accordingly, all buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric-coated steel or iron should be protected against corrosion depending upon the critical nature of the structure. If it is necessary to have metal in contact with soil, a corrosion engineer should be consulted to provide recommendations for corrosion protection. The results indicate that sulfate ion concentrations are insufficient to damage reinforced concrete structures below ground, and the pH and chloride concentration of the soil do not present a problem with reinforcing steel in buried concrete structures.

6.4 Construction Considerations

The soil to be excavated for the below-grade garage, foundations for the at-grade building, and utilities is expected to consist of clay above a depth of five feet bgs and interbedded soil (clay, silt and sand) below a depth of five feet bgs. If site grading is performed during the rainy season, the near-surface clay will likely be wet and will have to be dried before compaction can be achieved. Heavy rubber-tired equipment could cause excessive deflection (pumping) of the wet clay and, therefore, should be avoided. If construction occurs during the winter, it may be necessary to winterize the site by lime treating the upper 18 inches of clay for the at-grade buildings and cement treating the upper 12 inches of the subgrade for the below-grade garages.

7.0 RECOMMENDATIONS

Our recommendations for site preparation and grading, temporary cut slopes and shoring, foundation and basement wall design, and other geotechnical aspects of the project are presented in this section.

7.1 Site Preparation and Grading

Site demolition should include the removal of existing pavements, foundations, and underground utilities. In general, abandoned underground utilities should be removed to the property line or service connections and properly capped or plugged with concrete. Where existing utility lines are outside of the proposed building footprints and will not interfere with the proposed construction, they may be abandoned in-place provided the lines are filled with lean concrete or cement grout to the property line. Voids resulting from demolition activities should be properly backfilled with compacted fill following the recommendations provided later in this section. Removed asphalt concrete should be taken to an asphalt recycling facility.

In areas that will receive pavements or exterior concrete flatwork, the soil subgrade exposed following stripping and clearing should be scarified to a depth of at least 12 inches, moisture-conditioned to at least three percent above optimum moisture content, and compacted to at least 90 percent relative compaction[5]. In the proposed building pad areas, the soil beneath the pads should be excavated to a depth of 12 inches below finished pad grade. The excavations should

[5] Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same material, as determined by the ASTM D1557 laboratory compaction procedure.

extend at least five feet outside the proposed building footprints. The excavation subgrade should then be scarified to a depth of at least 12 inches, moisture-conditioned to at least three percent above optimum moisture content, and compacted to at least 90 percent relative compaction. If the existing moisture content of the soil is already at least three percent above optimum moisture content, it is not necessary to scarify the soil prior to compaction. After compaction of the excavation subgrade, the excavated soil should be placed in lifts not exceeding eight inches in loose thickness, moisture-conditioned to at least three percent above optimum moisture content, and compacted to at least 90 percent. The building pad subgrade should be protected against drying by either wetting the subgrade or by using imported Class 2 aggregate base as fill for the upper four inches of the building pads. If construction will occur during the rainy season, then lime treatment of the upper 18 inches of the building pads may be performed in lieu of the overexcavation and recompaction described above.

Fill may consist of on-site soil that is free of organic matter and rocks or lumps larger than four inches in greatest dimension. If it is necessary to import soil (select fill), the material should be free of organic matter, contains no rocks or lumps larger than four inches in greatest dimension, has a liquid limit of less than 40 and a plasticity index lower than 12, and is approved by the Geotechnical Engineer. Samples of proposed imported fill material should be submitted to the Geotechnical Engineer at least three business days prior to use at the site. The grading contractor should provide analytical test results or other suitable environmental documentation indicating the imported fill is free of hazardous materials at least three days before use at the site. If this data is not available, up to two weeks should be allowed to perform analytical testing on the proposed imported material.

Fill should be placed in horizontal lifts not exceeding eight inches in uncompacted thickness, moisture-conditioned to at least three percent optimum moisture content and compacted to at least 90 percent relative compaction. If low-plasticity on-site or imported soil, such as silty sand or sand, will be used as fill, it should be moisture-conditioned to above optimum moisture content, and compacted to at least 90 percent relative compaction. Low-plasticity fill should be compacted to at least 95 percent relative compaction where the fill is: (1) placed below foundations; (2) greater than five feet in thickness; or (3) consists of clean sand or gravel, defined as soil with less than 10 percent fines by weight. The upper one foot of pavement subgrade should also be compacted to at least 95 percent relative compaction, and be non-yielding.

7.1.1 Exterior Flatwork Subgrade Preparation

We recommend a minimum of six inches of Class 2 aggregate base (AB) be placed below exterior concrete flatwork, such as patios and sidewalks. The subgrade and Class 2 AB should be moisture-conditioned and compacted to at least 90 percent relative compaction. The prepared subgrade should be kept moist until it is covered with the Class 2 AB.

7.1.2 Utility Trench Backfill

Excavations for utility trenches can be readily made with a backhoe. All trenches should conform to the current CAL-OSHA requirements. To provide uniform support, pipes or conduits should be bedded on a minimum of four inches of sand or fine gravel. After the pipes and conduits are tested, inspected (if required) and approved, they should be covered to a depth of six inches with sand or fine gravel, which should be mechanically tamped.

Backfill for utility trenches and other excavations is also considered fill, and should be placed and compacted as according to the recommendations previously presented. If imported clean sand or gravel (defined as soil with less than 10 percent fines) is used as backfill, it should be compacted to at least 95 percent relative compaction. Jetting of trench backfill should not be permitted. Special care should be taken when backfilling utility trenches in pavement areas. Poor compaction may cause excessive settlements, resulting in damage to the pavement section.

Where utility trenches enter the at-grade building pads, an impermeable plug consisting of lean concrete or sand-cement slurry, at least three feet in length, should be installed where the trenches enter the building footprint. Furthermore, where sand- or gravel-backfilled trenches cross planter areas and pass below asphalt or concrete pavements, a similar plug should be placed at the edge of the pavement. The purpose of these recommendations is to reduce the potential for water to become trapped in trenches beneath the buildings or pavements. This trapped water can cause heaving of soils beneath slabs and softening of subgrade soil beneath pavements.

7.1.3 Lime-Treated Soil

Lime treatment of fine-grained soils generally includes site preparation, application of lime, mixing, compaction, and curing of the lime treated soil. Field quality control measures should include checking the depth of lime treatment, degree of pulverization, lime spread rate measurement, lime content measurement, and moisture content and density measurements, and mixing efficiency. Quality control may also include laboratory tests for unconfined compressive strength tests on representative samples.

The lime treatment process should be designed by a contractor specializing in its use and who is experienced in the application of lime in similar soil conditions. Based on our experience with lime treatment, we judge that the specialty contractor should be able to treat the moderately to highly expansive on-site material to produce a non-expansive fill for the building pad subgrades and, if desired, for exterior flatwork and pavement subgrades. For planning purposes, we recommend assuming the lime treatment will consist of at least four percent of Quicklime by dry weight of soil. An average dry unit weight of 110 pounds per cubic foot (pcf) should be assumed for design purposes. The specialty contractor should confirm this amount is suitable and prepare a treatment specification for our review prior to construction.

7.1.4 Drainage and Landscaping

Positive surface drainage should be provided around the buildings to direct surface water away from the foundations. To reduce the potential for water ponding adjacent to the building, we recommend the ground surface within a horizontal distance of five feet from the buildings slope down away from the buildings with a surface gradient of at least two percent in unpaved areas and one percent in paved areas. In addition, roof downspouts should be discharged into controlled drainage facilities to keep the water away from the foundations. The use of water-intensive landscaping around the perimeter of the buildings should be avoided to reduce the amount of water introduced to the moderately expansive clay subgrade.

Care should be taken to minimize the potential for subsurface water to collect beneath flatwork and pavements. Where landscape beds and tree wells are immediately adjacent to pavements and flatwork that are not designed as permeable systems, we recommend vertical cutoff barriers be incorporated into the design to prevent irrigation water from saturating the subgrade and AB. These barriers may consist of either flexible impermeable membranes or deepened concrete curbs.

7.2 Foundation Support and Settlement

We recommend the at-grade townhouses be supported on either conventional mat foundations or P-T slabs. We recommend the mixed-use buildings be supported on either a conventional mat foundation or on spread footings underlain by soil improved using RIC or other methods. Recommendations for each foundation type are presented in the following sections.

7.2.1 Mat Foundations

We recommend conventional mat foundations be at least 12 inches thick. For the at-grade buildings, the edges of the mat should be thickened such that the mat edge is bottomed at least 12 inches below the adjacent exterior grade. The minimum edge embedment depth may be decreased to 6 inches if the upper 18 inches of soil on the building pads is treated with lime. Where a mat foundation is constructed near a bioswale or other stormwater treatment area, the edge of the slab should be founded below an imaginary line extending up at an inclination of 1.5:1 (horizontal:vertical) from the base of the bioswale/treatment area. Conventional mat foundations should be designed using an allowable bearing capacity of 3,000 pounds per square foot (psf) for dead-plus-live loads. This value may be increased by one-third for total design loads, which includes wind or seismic forces. To evaluate the pressure distribution beneath the mat foundation, we recommend a modulus of vertical subgrade reaction (K_S) of 25 pounds per cubic inch (pci) be used. This value has been corrected to take into account the mat width and may be increased by one-third percent for total load conditions. To check the mat stiffness to resist the estimated seismically induced differential settlement, the mat foundations should be designed to distribute the superimposed structural loads assuming an area of reduced support measuring 15 by 15 feet at any location within the interior of the mat and 5 by 15 feet around the perimeter of the mat, where the 15-foot dimension is measured parallel to the edge of the mat. The subgrade modulus in the areas of reduced support should be taken as 5 pci. Once the structural engineer estimates the distribution of bearing stress on the bottom of the mat, we should review the distribution and revise the modulus of subgrade reaction, if appropriate.

Lateral loads may be resisted by a combination of friction along the base of the mat and passive resistance against the vertical faces of the mat foundation. To compute lateral resistance, we recommend using an equivalent fluid weight of 260 pounds per cubic foot (pcf); the upper foot of soil should be ignored unless confined by a slab or pavement. Frictional resistance should be computed using a base friction coefficient of 0.30 where the mat is in contact with the soil. Where a vapor retarder is placed beneath the mat, a base friction coefficient of 0.20 should be used. The passive pressure and frictional resistance values include a factor of safety of at least 1.5.

To reduce water vapor transmission through the mat foundations, we recommend a vapor retarder be placed between the bottom of the mat and the underlying subgrade soil. The vapor retarder should be at least 15 mils thick and meet the requirements for Class B vapor retarders stated in ASTM E1745. The vapor retarder should be placed in accordance with the requirements of ASTM E1643. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder. A vapor retarder is not required beneath the mat foundation in the parking garage; however, it should be placed beneath the mat in areas that will be used for storage and enclosed rooms, such as mechanical and electrical rooms.

The mat subgrade should be free of loose, weak, or disturbed material. The mat subgrade should be prepared as recommended in Section 7.1. We should check the mat subgrade prior to placement of the vapor retarder and/or reinforcing steel.

7.2.2 Post-Tensioned Slabs-on-Grade

We recommend P-T slabs be at least 10 inches thick. The edges of the foundation should be thickened such that the foundation edge is bottomed at least 12 inches below the adjacent exterior grade. The minimum edge embedment depth may be decreased to 6 inches if the upper 18 inches of soil on the building pads is treated with lime. Where a P-T slab is constructed near a bioswale or other stormwater treatment area, the edge of the slab should be founded below an imaginary line extending up at an inclination of 1.5:1 (horizontal:vertical) from the base of the bioswale/treatment area. The maximum bearing pressure beneath the P-T slab should not exceed 3,000 psf under dead-plus-live-load conditions and 4,000 psf under total load conditions. For design of P-T slabs, we recommend using the parameters presented below in Table 2. To check the P-T slab stiffness to resist seismically induced differential settlement, the P-T slabs should be designed to distribute the superimposed structural loads assuming an area of reduced support measuring 15 by 15 feet at any location within the interior of the P-T slab and 5 by 15 feet around the perimeter of the foundation, where the 15-foot dimension is measured parallel to the edge of the P-T slab. The subgrade modulus in the areas of reduced support should be taken as 5 pci.

TABLE 2
P-T Slab Design Parameters

Parameter	Value
Thornwaite Moisture Index	20
Edge moisture variation distance edge lift center lift	 4.9 feet 9.0 feet
Percentage fines	92%
Percentage of clay	35%
Liquid limit	38%
Plasticity Index	20%
Suction Variance at Ground	1.5 pF
Soil differential movement edge lift center lift	 1.5 inches 0.7 inches

Lateral loads can be resisted by a combination of passive pressure on the vertical faces of the foundation and friction along the bottom of the mat or P-T slab. Passive resistance may be computed using an equivalent fluid weight of 260 pounds per cubic foot (pcf). The upper one foot of soil should be ignored unless it is confined by slabs or pavement. Frictional resistance should be computed using a base friction coefficient of 0.30 where the slab is in contact with native soil and 0.20 where the slab is in underlain by a vapor retarder. These values include a factor of safety of at least 1.5 and may be used in combination without reduction.

To reduce water vapor transmission through the P-T slabs, we recommend a vapor retarder be placed between the bottom of the P-T slab and the underlying subgrade soil. The vapor retarder should be at least 15 mils thick and meet the requirements for Class B vapor retarders stated in ASTM E1745. The vapor retarder should be placed in accordance with the requirements of

ASTM E1643. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder.

Concrete can be placed directly on the vapor retarder provided the water/cement (w/c) ratio of the concrete does not exceed 0.45 and water is not added in the field. If necessary, workability may be increased by adding plasticizers. In addition, the slab should be properly cured. Before floor coverings are placed over P-T slab foundations, the contractor should check that the concrete surface and the moisture emission levels (if emission testing is required) meet the manufacturer’s requirements.

The subgrade for the P-T slabs should be free of standing water, debris, and disturbed materials prior to placing concrete. The bottoms and sides of the excavations should be wetted following excavation and maintained in a moist condition until concrete is placed. We should check the foundation subgrade prior to placement of reinforcing steel.

7.2.3 Spread Footings

Spread footings may be used to support the mixed-use buildings provided ground improvement is performed to strengthen the upper 15 feet of soil beneath the footings. Continuous footings should be at least 18 inches wide and isolated spread footings should be at least 24 inches wide. Footings should be bottomed at least 24 inches below the bottom of the floor slab. Footings on improved soil may be designed using an allowable bearing pressure of 5,000 pounds per square foot (psf) for dead-plus-live loads; this value may be increased by one-third for total design loads, which includes wind or seismic forces.

Lateral loads may be resisted by a combination of passive pressure on the vertical faces of the footings and friction between the bottoms of the footings and the underlying soil. To compute lateral resistance for footings, we recommend using an equivalent fluid weight of 300 pcf. The upper foot of soil should be ignored for passive resistance unless confined by a slab or pavement. Frictional resistance should be computed using a base friction coefficient of 0.35. The passive pressure and frictional resistance values include a factor of safety of at least 1.5 and may be used in combination without reduction.

Footing excavations should bottom in firm soil and be free of standing water, debris, and weak and disturbed materials prior to placing concrete. The bottoms and sides of the footing excavations should be maintained in a moist condition until concrete is placed. We should check footing excavations prior to placement of reinforcing steel.

7.3 Ground Improvement

As discussed previously, ground improvement should be performed beneath the footprint of the proposed mixed-use buildings if spread footing foundations will be used. Based on our experience, we conclude the most economical type of ground improvement for the site conditions consists of dynamic compaction using the RIC. The sequence of compaction using the RIC in a 20- by 20-foot-square area consists of performing compaction at either 9 or 13 points, with more compaction points for looser soil. We recommend a 13-point grid be used to densify the soil within the proposed building footprint. The RIC should be performed at the base of the excavation for the below-grade garage and should extend at least five feet outside the building footprint where space permits. RIC should be performed no closer than 25 feet horizontally from off-site storm drain/sanitary sewer lines and no closer than 10 feet horizontally from the edge of public sidewalks.

We recommend the upper 15 feet of soil, measured below the bottom of the proposed spread footings be improved to achieve minimum equivalent SPT N-values (uncorrected for overburden) of 25 for sand, 22 for silty sand, and 18 for non-plastic sandy silt. We should drill 3 to 4 post-treatment borings to check the desired improvement has been achieved. The bid should provide a unit price (on a square-foot basis) to retreat areas; however, the base bid should assume no recompaction is required.

Treatment with the RIC results in craters that are about 24 to 30 inches deep on the subgrade. Therefore, recompaction of the upper two feet of soil at the base of the excavation should be performed after completion of the ground improvement.

7.4 Basement Walls

Basement walls should be designed to resist lateral earth pressure imposed by the retained soil, as well as a surcharge pressure from nearby vehicles and foundations, where appropriate. Where basement walls will be restrained from movement at the top by the building floor slab, they should be designed for at-rest conditions. We recommend basement walls at the site be designed using an at-rest equivalent fluid weight of 56 pcf. To evaluate the basement walls for seismic loading, we recommend using an active equivalent fluid weight of 37 pcf plus a seismic increment of 33 pcf (triangular distribution). Site retaining walls that are free to rotate may be designed using an equivalent fluid weight of 37 pcf. For seismic evaluation of site retaining walls that are free to rotate, we recommend using an active equivalent fluid weight of 37 pcf plus a seismic increment of 13 pcf (triangular distribution).

Where traffic loads are expected within 10 feet of the walls, an additional design load of 100 psf should be applied to the upper ten feet of the wall. Basement walls adjacent to existing buildings should be designed for surcharge pressures if the foundations supporting the adjacent buildings are founded above the zone-of-influence for the basement walls. This zone is defined as an imaginary line extending up from the bottom of the wall at an inclination of 1.5:1. The influence on a wall from a foundation that is founded within this zone of influence should be analyzed on an individual basis after the geometry has been determined.

The lateral earth pressures recommended are applicable to walls that are backdrained above the water table to prevent the buildup of hydrostatic pressure. One acceptable method for backdraining the walls is to place a prefabricated drainage panel (Miradrain 6000 or equivalent) against the shoring or the back of the walls. The drainage panel should extend down to a four-inch-diameter perforated PVC collector pipe at the base of the walls. The pipe should be surrounded on all sides by at least four inches of Caltrans Class 2 permeable material (see

Caltrans Standard Specifications Section 68-1.025) or 3/4-inch drain rock wrapped in filter fabric (Mirafi 140NC or equivalent). The collector pipe should outlet into the storm drain system outside the garage, if possible. Where shoring is installed and there is insufficient room to install a perforated pipe between the shoring and the back of the basement wall, the drainage panel should extend down to a proprietary, prefabricated collector drain system, such as Tremdrain Total Drain or Hydroduct Coil, designed to work in conjunction with the drainage panel. The pipe should be connected to a suitable discharge point inside or outside the basement. We should check the manufacturer's specifications regarding the proposed prefabricated drainage panel material to verify it is appropriate for its intended use. To protect against moisture migration into the below-grade parking levels, we recommend that the below-grade walls be water-proofed and water stops be installed at all construction joints.

If backfill is required behind basement walls, the walls should be braced, or hand compaction equipment used, to prevent unacceptable surcharges on walls (as determined by the Structural Engineer).

7.5 Concrete Slab-on-Grade Floor

The floor slab for the below-grade parking garages should be at least five inches thick and reinforced with No. 4 bars at 18 inches on center. The finished floor for the below-grade parking levels will be well above the design groundwater level. A capillary moisture break and vapor retarder are generally not required below parking slabs-on-grade because there is sufficient air circulation to limit condensation of moisture on the slab surface; however, we recommend a capillary break and vapor retarder be placed in areas where there is a floor covering, areas used for storage, and any enclosed rooms. Where a capillary moisture break/vapor retarder is not used, we recommend six inches of Class 2 aggregate base compacted to at least 95 percent relative compaction be placed beneath the parking garage slab and and ramp.

A capillary moisture break consists of at least four inches of clean, free-draining gravel or crushed rock. The vapor retarder should meet the requirements for Class B vapor retarders stated in ASTM E1745. The vapor retarder should be placed in accordance with the requirements of

ASTM E1643. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder.

If required by the structural engineer, the vapor retarder may be covered with two inches of sand to aid in curing the concrete and to protect the vapor retarder during slab construction. The sand overlying the vapor retarder should be moist at the time concrete is placed. However, excess water trapped in the sand could eventually be transmitted as vapor through the slab. Therefore, if rain is forecast prior to pouring the slab, the sand should be covered with plastic sheeting to avoid wetting. If the sand becomes wet, concrete should not be placed until the sand has been dried or replaced. The particle size of the capillary break material and sand (if used) should meet the gradation requirements presented in Table 3.

TABLE 3
Gradation Requirements for Capillary Moisture Break

Sieve Size	Percentage Passing Sieve
Gravel or Crushed Rock	
1 inch	90 – 100
¾ inch	30 – 100
½ inch	5 – 25
3/8 inch	0 – 6
Sand	
No. 4	100
No. 200	0 – 5

Concrete mixes with high water/cement (w/c) ratios result in excess water in the concrete, which increases the cure time and results in excessive vapor transmission through the slab. Therefore, concrete for the floor slab should have a low w/c ratio - less than 0.50. If necessary, workability should be increased by adding plasticizers. In addition, the slab should be properly cured. Before the floor covering is placed, the contractor should check that the concrete surface and the moisture emission levels (if emission testing is required) meet the manufacturer’s requirements.

7.6 Temporary Cut Slopes and Shoring

The safety of workers and equipment in or near the excavation is the responsibility of the contractor. The selection, design, construction, and performance of the shoring system should be the responsibility of the contractor. A structural engineer/civil engineer knowledgeable in this type of construction should design the shoring. We should review the geotechnical aspects of the proposed shoring system to ensure that it meets our requirements. During construction, we should observe the installation of the shoring system and check the condition of the soil encountered during excavation.

We judge that temporary cuts in on-site soil which are less than 20 feet high, above groundwater, and inclined in accordance to OSHA guidelines for Type B soil will be stable provided that they are not surcharged by equipment or building material. Temporary shoring will be required where temporary slopes are not possible because of space constraints.

7.6.1 Cantilevered Soldier Pile and Lagging Shoring System

A cantilevered soldier pile and lagging system should be designed using an active equivalent fluid weight of 37 pcf for level backfill conditions, provided there are no building foundations within a horizontal distance equal to 1.5 times the retained soil height. If there are foundations within that horizontal distance, then the shoring should be designed using an at-rest pressure of 56 pcf plus the surcharge load imposed by the building foundation. Where traffic loads are expected within 10 feet of the shoring walls, an additional design load of 100 psf should be applied to the upper 10 feet of the wall. Shoring should be designed for surcharge loads where there will be construction equipment and/or stockpiled soil within a horizontal distance of 1.5 times the excavation height from the edge of excavation; and from adjacent foundations located above an imaginary line that extends at an inclination of 1.5:1 (horizontal: vertical), projected upward from the bottom edge of the proposed excavation that are not underpinned. We can provide recommendations for surcharge pressures once surcharge loads are known.

Passive resistance at the toe of the soldier pile should be computed using an equivalent fluid weights of 260 pcf with a maximum passive earth pressure of 2,500 psf, respectively. The upper foot of soil should be ignored when computing passive resistance. Passive pressure can be assumed to act over an area of three soldier pile widths assuming the toe of the soldier pile is filled with structural concrete. If lean concrete is placed in the soldier pile shaft, the passive pressure can be assumed to act over two pile diameters. These passive pressure values include a factor of safety of at least 1.5.

7.7 Flexible and Rigid Pavement Design

Design recommendations for asphalt concrete and Portland cement concrete pavements are presented in the following sections.

7.7.1 Rigid (Portland Cement Concrete) Pavement

For concrete pavement that will experience only passenger car and light truck traffic, we recommend the concrete be at least five inches thick over six inches of Class 2 aggregate base (AB). The thickness of concrete pavement that may be subject to traffic from heavier vehicles, such as garbage and/or delivery trucks, will depend on the weight of the trucks and the amount of truck traffic. Assuming a maximum single-axle load of 20,000 pounds and a maximum tandem axle of 32,000 pounds, the recommended rigid pavement section for these axle loads is 6-1/2 inches of Portland cement concrete over six inches of Class 2 aggregate base compacted to at least 95 percent relative compaction. Prior to placement of the aggregate base, we should confirm by proof rolling that the native soil subgrade is firm and non-yielding. If the subgrade deflects excessively during proof rolling, it should be scarified, aerated, and recompacted as discussed in Section 7.1 of this report.

The modulus of rupture of the concrete should be at least 500 psi at 28 days. Contraction joints should be constructed at 15-foot spacing. Where the outer edge of a concrete pavement meets asphalt pavement, the concrete slab should be thickened by 50 percent at a taper not to exceed a slope of 1 in 10. Concrete slabs subject to vehicular traffic should be reinforced with a minimum of No. 4 bars spaced at 16 inches in both directions.

7.7.2 Flexible (Asphalt Concrete) Pavement Design

The State of California flexible pavement design method was used to develop the recommended asphalt concrete (AC) pavement sections. Based on the laboratory R-value test results, we used an R-value of 21 for pavement design. Table 4 presents our pavement section recommendations for traffic indices (TIs) of 4.5 through 7.0 and a 30-year pavement design life. Actual TIs should be determined through a traffic engineer's analysis of expected automobile and truck traffic at the site.

TABLE 4
Recommended Asphalt Pavement Sections
30-Year Design Life

TI	Asphaltic Concrete (inches)	Class 2 Aggregate Base R = 78 (inches)
4.5	3.0	7.0
5.0	3.0	9.0
5.5	3.5	9.5
6.0	4.0	10.0
6.5	4.0	12.0
7.0	4.5	12.5
7.5	5.0	13.0
8.0	5.0	15.0

The soil subgrade beneath AC pavements should be prepared and compacted in accordance with the recommendations presented in Section 7.1. In addition, the subgrade should be a firm and non-yielding surface. The subgrade should be proof-rolled to confirm it is non-yielding prior to placing the aggregate base. The Class 2 aggregate base should be moisture-conditioned to near optimum moisture content and compacted to at least 95 percent relative compaction.

7.8 Seismic Design

For design in accordance with the 2013 CBC, we recommend Site Class D be used. The latitude and longitude of the site are 37.5494° and -121.9848°, respectively. Hence, in accordance with the 2013 CBC, we recommend the following:

- S_S = 2.172g, S_1 = 0.896g
- S_{MS} = 2.172g, S_{M1} = 1.344g
- S_{DS} = 1.448g, S_{D1} = 0.896g
- Seismic Design Category E for Risk Categories I, II, and III.

8.0 ADDITIONAL GEOTECHNICAL SERVICES

Prior to construction, Rockridge Geotechnical should review the project plans and specifications to verify that they conform to the intent of our recommendations. During construction, our field engineer should provide on-site observation and testing during site preparation, placement and compaction of fill, and installation of shoring and building foundations. These observations will allow us to compare actual with anticipated subsurface conditions and to verify that the contractor's work conforms to the geotechnical aspects of the plans and specifications.

9.0 LIMITATIONS

This geotechnical investigation has been conducted in accordance with the standard of care commonly used as state-of-practice in the profession. No other warranties are either expressed or implied. The recommendations made in this report are based on the assumption that the subsurface conditions do not deviate appreciably from those disclosed in the exploratory borings and CPTs. If any variations or undesirable conditions are encountered during construction, we should be notified so that additional recommendations can be made. The foundation recommendations presented in this report are developed exclusively for the proposed development described in this report and are not valid for other locations and construction in the project vicinity.

REFERENCES

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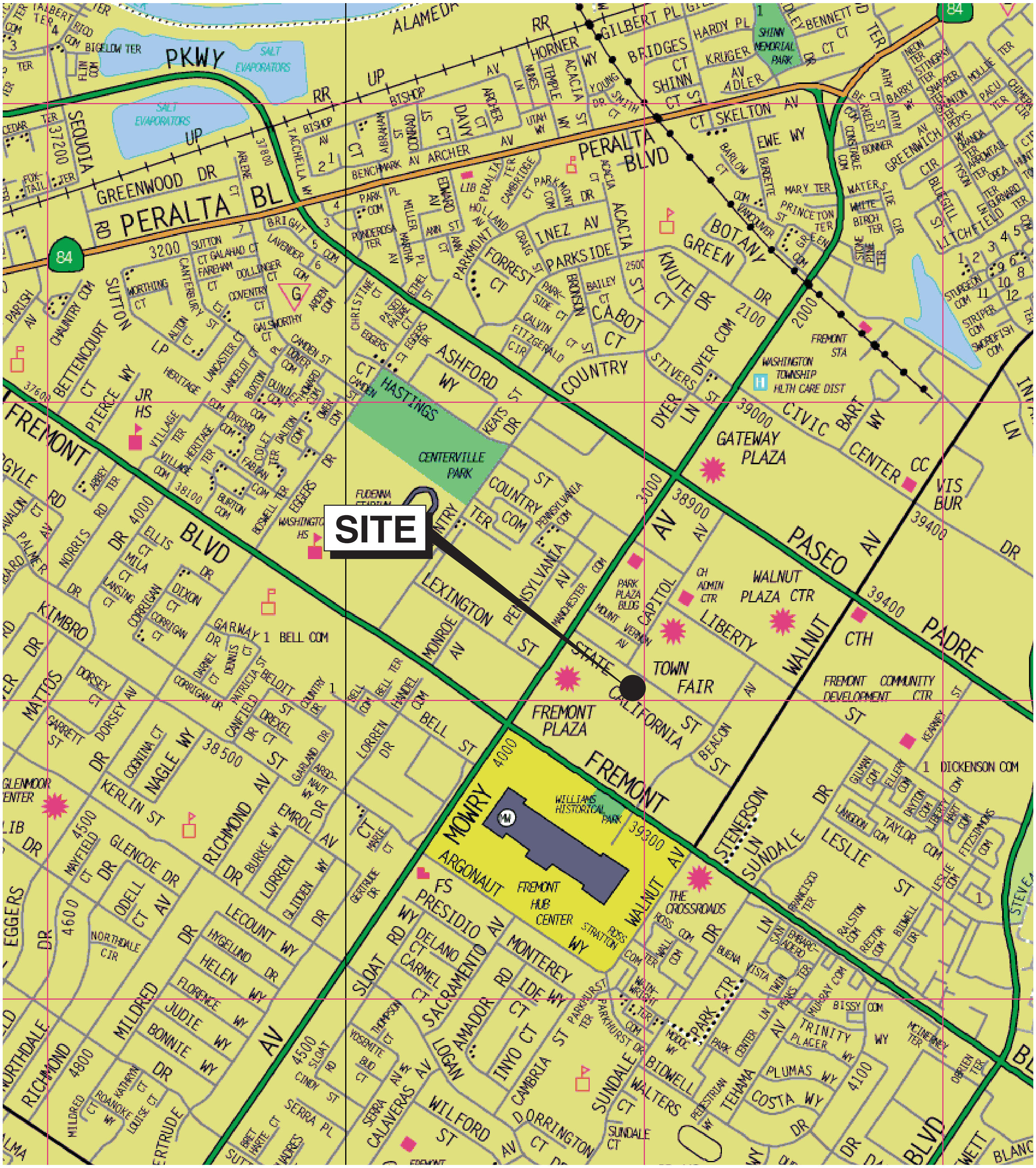
ROCKRIDGE GEOTECHNICAL

FIGURES



Base map: The Thomas Guide
Alameda County
2002

0 1/4 1/2 Mile

Approximate scale

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

SITE LOCATION MAP

Date 06/28/15	Project No. 15-905	Figure 1

EXPLANATION

CPT-1 — Approximate location of cone penetration test by Rockridge Geotechnical, Inc., June 2015

B-1 — Approximate location of boring by Rockridge Geotechnical, Inc., June 2015

Project limits

STATE STREET AND CAPITOL AVENUE
Fremont, California

SITE PLAN

Date 07/09/15 | Project No. 15-905 | Figure 2

ROCKRIDGE GEOTECHNICAL

Reference: Base map from a drawing titled "Conceptual Site Plan", by KTGY Group, Inc, dated August 11, 2014.

Base map: Goolge Earth with U.S. Geological Survey (USGS), Alameda County, 2015.

EXPLANATION

Qha	**Alluvium (Holocene)**
Qpa	**Alluvium (Pleistocene)**

Geologic contact: dashed where approximate and dotted where concealed, queried where uncertin

N

0 1500 3000 Feet

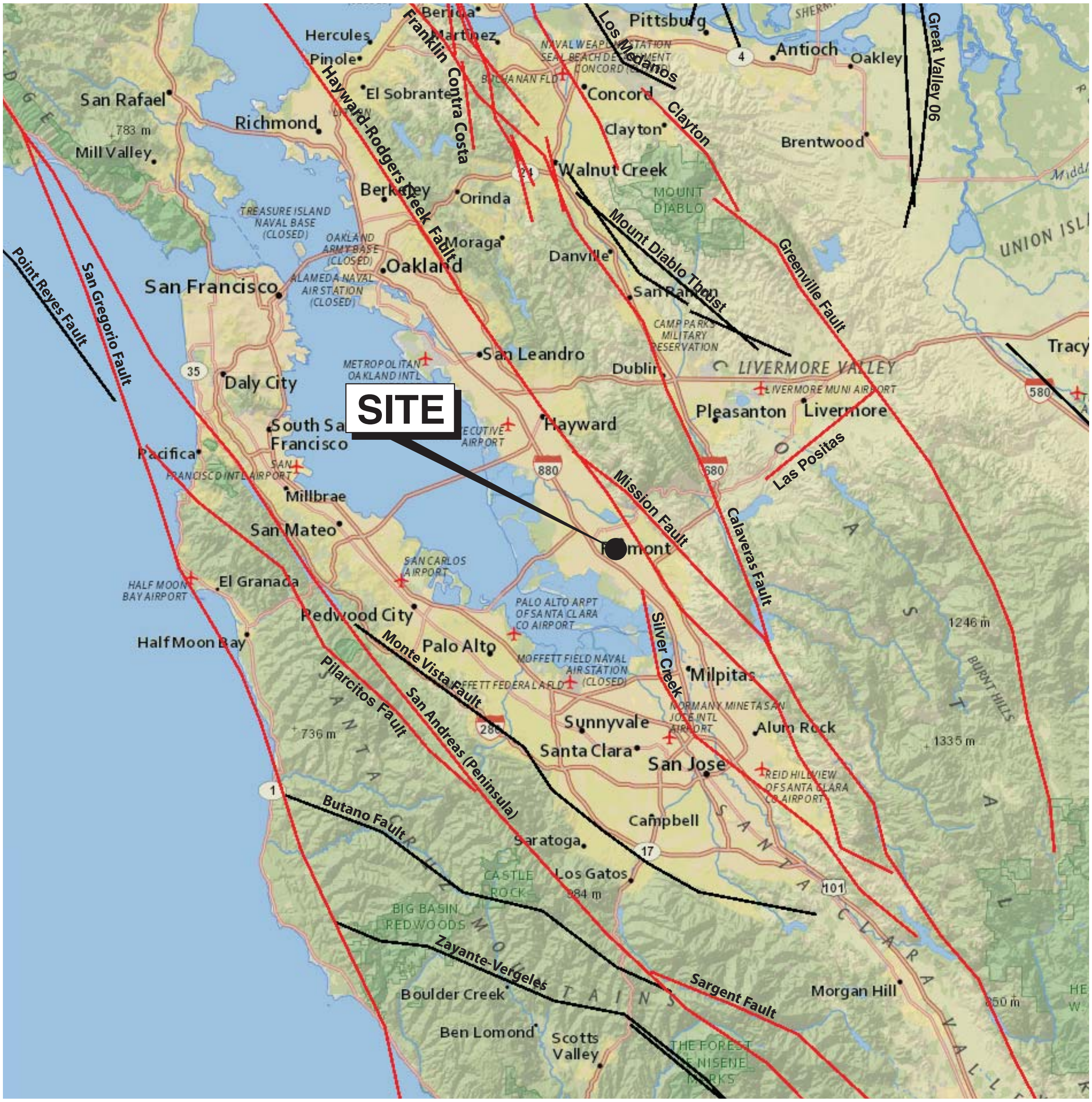
Approximate Scale

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

REGIONAL GEOLOGIC MAP

Date 06/28/15	Project No. 15-905	Figure 3



Base Map: U.S. Geological Survey, National Seismic Hazards Maps - Fault Sources, 2014.

EXPLANATION

Strike slip

Thrust (Reverse)

Normal

0 5 10 Miles

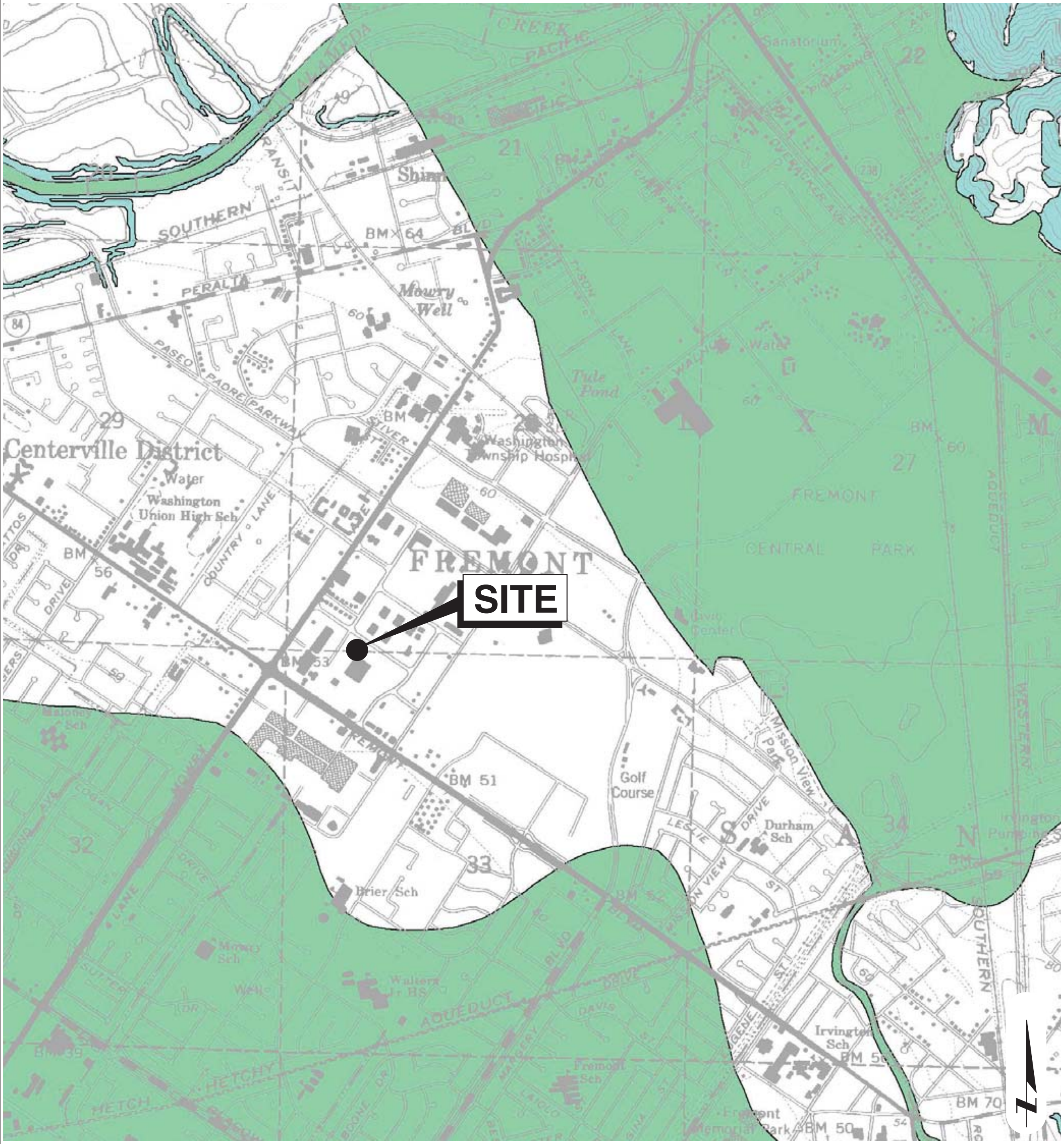
Approximate scale

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

REGIONAL FAULT MAP

Date 06/28/15	Project No. 15-905	Figure 4



EXPLANATION

Liquefaction; Areas where historic occurence of liquefaction, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements.

Earthquake-Induced Landslides; Areas where previous occurence of landslide movement, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements.

0 1,500 3,000 Feet

Approximate scale

Reference:
State of California "Seismic Hazard Zones"
Niles Quadrangle
Released on October 19, 2004

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

REGIONAL SEISMIC HAZARDS MAP

Date 06/28/15 | Project No. 15-905 | Figure 5

ROCKRIDGE GEOTECHNICAL

APPENDIX A

Logs of Test Borings and Cone Penetration Tests

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-1

Boring location: See Site Plan, Figure 2
Date started: 6/17/15 Date finished: 6/17/15
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches Hammer type: Downhole
Sampler: Sprague & Henwood (S&H)
Logged by: K. Samlik

LABORATORY TEST DATA

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0						3 inches Asphalt						
1					SP	GRAVELLY SAND (SP) brown, medium dense, moist						
2	S&H		8 8 17	18		CLAY with SAND (CL) black, very stiff, moist						
4	S&H		12 16 18	24	CL	dark brown						
5						light brown, increased sand content LL = 34, PL = 16, PI = 18	TxUU	500	2,400		15.6	111
6	S&H		8 9 12	15			TxUU	550	2,880		17.9	112
7					CL	SANDY CLAY (CL) light brown, stiff, moist, fine-grained sand						
8	S&H		5 6 7	9	SM	SILTY SAND (SM) light brown, loose, moist, fine gravel				38		
10						SANDY CLAY (CL) olive-brown, stiff, moist, fine-grained sand						
11	S&H		5 7 12	13	CL							
15						SANDY SILT (ML) light brown, very stiff, moist, fine-grained sand						
16	S&H		9 11 14	18						62		
21	S&H		9 10 12	15	ML							
26	S&H		7 12 20	22								
30												

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905
Figure: A-1

PROJECT:	STATE STREET AND CAPITOL AVENUE Fremont, California	Log of Boring B-2 PAGE 1 OF 1

Boring location: See Site Plan, Figure 2
Date started: 6/17/15 — Date finished: 6/17/15
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches — Hammer type: Downhole
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)
Logged by: K. Samlik

LABORATORY TEST DATA

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–1				SP	3 inches Asphalt GRAVELLY SAND (SP) brown, medium dense, moist						
2	S&H	13, 14, 21	25	CL	CLAY with SAND (CL) black, very stiff, moist LL = 32, PL = 18, PI = 14					15.7	118
4	S&H	16, 19, 32	36	CL	dark brown, hard						
6	S&H	14, 16, 18	24	CL	very stiff						
8	S&H	9, 10, 12	15	CL	CLAY with SAND (CL) brown, very stiff, moist, fine-grained sand						
11	S&H	5, 7, 12	13	ML	SANDY SILT (ML) light brown, stiff, moist, fine-grained sand				81		
16	S&H	10, 11, 13	17	ML	very stiff						
21	S&H	9, 11, 12	16	ML							
24	S&H	30, 26, 20	32	SW	GRAVELLY SAND (SW) brown, dense, moist						
26	SPT	24, 31, 36	80	SW	very dense						

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905 — Figure: A-2

PROJECT:	STATE STREET AND CAPITOL AVENUE Fremont, California	**Log of Boring B-3** PAGE 1 OF 1

Boring location:	See Site Plan, Figure 2
Date started:	6/17/15
Date finished:	6/17/15
Drilling method:	Hollow Stem Auger
Hammer weight/drop:	140 lbs./30 inches
Hammer type:	Downhole
Sampler:	Sprague & Henwood (S&H), Standard Penetration Test (SPT)
Logged by:	K. Samlik

DEPTH (feet)	SAMPLES: Sampler Type	SAMPLES: Blows/ 6"	SAMPLES: SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	LABORATORY TEST DATA: Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					2- 3 inches Asphalt						
				CL	SANDY CLAY (CL) brown, stiff, moist						
2	S&H	9 8 12	14	CL	CLAY with SAND (CL) black, stiff, moist LL = 30, PL = 17, PI = 13					18.0	114
4	S&H	11 23 27	35		dark brown, hard hard						
6	S&H	7 9 10	13		brown, stiff						
7				SM	SILTY SAND (SM) light brown, medium dense, moist, fine-grained sand						
8	S&H	6 8 9	12						44		
11	SPT	4 5 5	12								
16	SPT	5 6 9	18								
21	S&H	9 11 16	19								
26	SPT	17 20 28	58		very dense						
26				SP	SAND with GRAVEL (SP) dark brown, very dense, moist						

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905

Figure: A-3

Log of Boring B-4

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Boring location:	See Site Plan, Figure 2
Date started:	6/17/15
Date finished:	6/17/15
Drilling method:	Hollow Stem Auger
Hammer weight/drop:	140 lbs./30 inches
Hammer type:	Downhole
Sampler:	Sprague & Henwood (S&H), Standard Penetration Test (SPT)
Logged by:	K. Samlik

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–0.25					3 inches Asphalt						
0.25–1.5				SC	CLAYEY SAND with GRAVEL (SC) brown, medium dense, moist						
1.5–5				CL	CLAY with SAND (CL) brown, very stiff, moist, trace gravel						
2	S&H	8 13 25	27								
5–6				CL	CLAY with SAND (CL) brown, hard, moist						
6	S&H	12 24 32	39								
6–20				SM	SILTY SAND (SM) light brown, medium dense, moist, fine-grained sand						
11	S&H	13 16 21	26								
13	S&H	12 15 20	25						38		
16	S&H	10 11 14	18								
20–25				SP	SAND with GRAVEL (SP) brown, dense, moist, trace fines						
21	SPT	9 11 16	32								
25–30				SP	GRAVELLY SAND (SP) brown, dense, moist						
26	SPT	13 16 19	42								

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905 | Figure: A-4a

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-4

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31	SPT		17 18 20	46	SP	GRAVELLY SAND (SP) (continued)						
32												
33												
34												
35												
36	S&H		13 7 8	11	CL	CLAY (CL) olive-brown, stiff, moist						
37												
38												
39												
40												
41												
42												
43												
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												

Boring terminated at a depth of 36.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905

Figure: A-4b

ROCKRIDGE 15-905.GPJ TR.GDT 8/31/15

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-5

Boring location: See Site Plan, Figure 2
Logged by: K. Samlik
Date started: 6/17/15 Date finished: 6/17/15
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30 inches Hammer type: Downhole
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–3	S&H	11, 23, 30	37	CL	CLAY (CL) brown, hard, moist						
3–6.5	S&H	12, 22, 28	35	SC	CLAYEY SAND (SC) dark brown with mottled brown, dense, moist LL = 33, PL = 15, PI = 18				50	15.2	117
	S&H	13, 15, 19	22		dark brown, medium dense						
6.5–7				CL	SANDY CLAY (CL) brown, very stiff, moist						
7–10	S&H	9, 12, 15	19	SC	CLAYEY SAND (SC) brown, medium dense, moist						
10–24	S&H	5, 7, 11	13	ML	SANDY SILT (ML) light brown, stiff, moist, fine-grained sand				86		
	S&H	17, 9, 11	14								
	S&H	7, 8, 10	13								
24–25.5				CL	CLAY (CL) brown, hard, moist						
25.5–26	S&H	7, 23, 42	46	SP	SAND (SP) brown, dense, moist						
26–26.5				GP	SANDY GRAVEL (GP) brown, dense, moist						

Boring terminated at a depth of 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905 Figure: A-5

PROJECT:	**STATE STREET AND CAPITOL AVENUE** Fremont, California

Log of Boring B-6

Boring location:	See Site Plan, Figure 2	Logged by:	K. Samlik
Date started:	6/17/15	Date finished:	6/17/15
Drilling method:	Hollow Stem Auger		
Hammer weight/drop:	140 lbs./30 inches	Hammer type:	Downhole
Sampler:	Sprague & Henwood (S&H), Standard Penetration Test (SPT)		

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					3 inches Asphalt						
				SP	SAND with GRAVEL (SP) light brown, medium dense, moist						
1–2.5	S&H	13 12 19	22	CL	CLAY (CL) dark brown, very stiff, moist						
5–6.5	S&H	5 7 8	11	SM	SILTY SAND (SM) brown, medium dense, moist, fine-grained				43		
10–11.5	S&H	5 7 10	12	CL	CLAY with SAND (CL) light brown, stiff, moist						
12–13.5	S&H	8 9 11	14	SP	SAND (SP) brown, medium dense, moist				5		
15–16.5	SPT	9 7 8	18	SP							
20–21.5	SPT	9 7 3	12	SP	trace fines gravel present						
25–26.5	SPT	9 11 14	30	SP	medium dense to dense, gravel present						
30											

LABORATORY TEST DATA

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-6

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31	SPT		6 12 15	32	SC	CLAYEY SAND (SC) olive brown, dense, moist						
32												
33												
34												
35					CL	CLAY (CL) olive brown, stiff, moist						
36	S&H		7 9 10	13								
37												
38												
39	S&H		10 12 13	19		very stiff						
40												
41												
42												
43												
44												
45												
46												
47												
48												
49												
50												
51												
52												
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56												
57												
58												
59												
60												

Boring terminated at a depth of 40 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905

Figure: A-6b

Log of Boring B-7

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Boring location:	See Site Plan, Figure 2
Date started:	6/18/15
Date finished:	6/18/15
Drilling method:	Hollow Stem Auger
Hammer weight/drop:	140 lbs./30 inches
Hammer type:	Downhole
Sampler:	Sprague & Henwood (S&H), Standard Penetration Test (SPT)
Logged by:	K. Samlik

LABORATORY TEST DATA

DEPTH (feet)	Sampler Type	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0				CL	3 inches Asphalt SANDY CLAY with GRAVEL (CL) brown, very stiff, moist						
1–2	S&H	12 14 16	21	CL	CLAY with SAND (CL) dark brown, very stiff, moist						
5–6	S&H	9 12 14	18	CL	brown						
10–11	S&H	7 11 13	17	CL	increased sand content LL = 27, PL = 17, PI = 10				69	16.4	114
12–13	S&H	7 9 10	13	ML	SANDY SILT (ML) light brown, stiff, moist, fine-grained sand				55		
15–16	S&H	8 10 11	15	CL	SILTY CLAY with SAND (CL) brown, stiff to very stiff, moist LL = 26, PL = 19, PI = 7	TxUU	1,300	2,630		16.2	113
20–21	SPT	7 9 10	23	SC	CLAYEY SAND (SC) brown, medium dense, moist						
25–26	SPT	8 10 11	25	SC	dark brown olive-brown						
30											

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905
Figure: A-7a

PROJECT: **STATE STREET AND CAPITOL AVENUE**
Fremont, California

Log of Boring B-7

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
31	SPT		10 8 9	20	SP	SAND with GRAVEL (SP) brown, medium dense, moist				13		
32												
33												
34	S&H		11 14 19	23	CL	SANDY CLAY (CL) olive, very stiff, moist						
35					CL	CLAY (CL) olive, very stiff, moist						
					SP	SAND (SP) brown, medium dense, moist						
36												
37												
38												
39												
40												
41												
42												
43												
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												

Boring terminated at a depth of 35 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using a factor of 0.7 and 1.2, respectively, to account for sampler type and hammer energy.

ROCKRIDGE GEOTECHNICAL

Project No.: 15-905

Figure: A-7b

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		Symbols	Typical Names
Coarse-Grained Soils (more than half of soil > no. 200 sieve size)	**Gravels** (More than half of coarse fraction > no. 4 sieve size)	**GW**	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	**SW**	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly-graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine -Grained Soils (more than half of soil < no. 200 sieve size)	**Silts and Clays** LL = < 50	**ML**	Inorganic silts and clayey silts of low plasticity, sandy silts, gravelly silts
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silt-clays of low plasticity
	Silts and Clays LL = > 50	**MH**	Inorganic silts of high plasticity
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic silts and clays of high plasticity
Highly Organic Soils		**PT**	Peat and other highly organic soils

GRAIN SIZE CHART

Classification	Range of Grain Sizes	
	U.S. Standard Sieve Size	**Grain Size in Millimeters**
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 4.76
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.075
coarse	No. 4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.075
Silt and Clay	Below No. 200	Below 0.075

Unstabilized groundwater level

Stabilized groundwater level

SAMPLE DESIGNATIONS/SYMBOLS

Sample taken with Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter. Darkened area indicates soil recovered

Classification sample taken with Standard Penetration Test sampler

Undisturbed sample taken with thin-walled tube

Disturbed sample

Sampling attempted with no recovery

Core sample

Analytical laboratory sample

Sample taken with Direct Push sampler

Sonic

SAMPLER TYPE

C — Core barrel

CA — California split-barrel sampler with 2.5-inch outside diameter and a 1.93-inch inside diameter

D&M — Dames & Moore piston sampler using 2.5-inch outside diameter, thin-walled tube

O — Osterberg piston sampler using 3.0-inch outside diameter, thin-walled Shelby tube

PT — Pitcher tube sampler using 3.0-inch outside diameter, thin-walled Shelby tube

S&H — Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter

SPT — Standard Penetration Test (SPT) split-barrel sampler with a 2.0-inch outside diameter and a 1.5-inch inside diameter

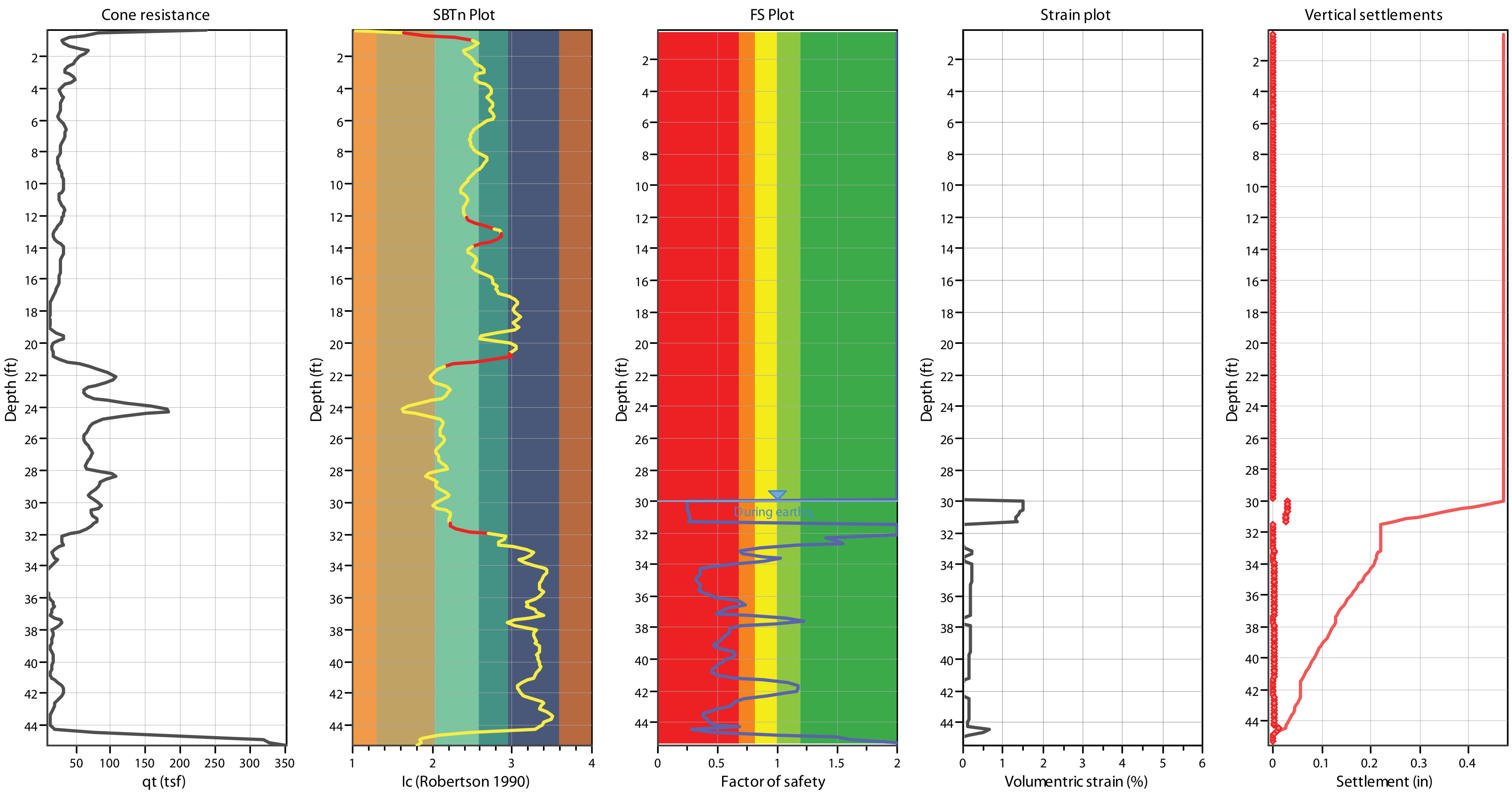
ST — Shelby Tube (3.0-inch outside diameter, thin-walled tube) advanced with hydraulic pressure

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CLASSIFICATION CHART

Date 06/28/15 | Project No. 15-905 | Figure A-8



Total depth: ____ ft, Date: ________
Measured Groundwater Depth: ___ feet
Approximate Ground Surface Elevation: ______________
Cone Operator: ______________________

SBT legend

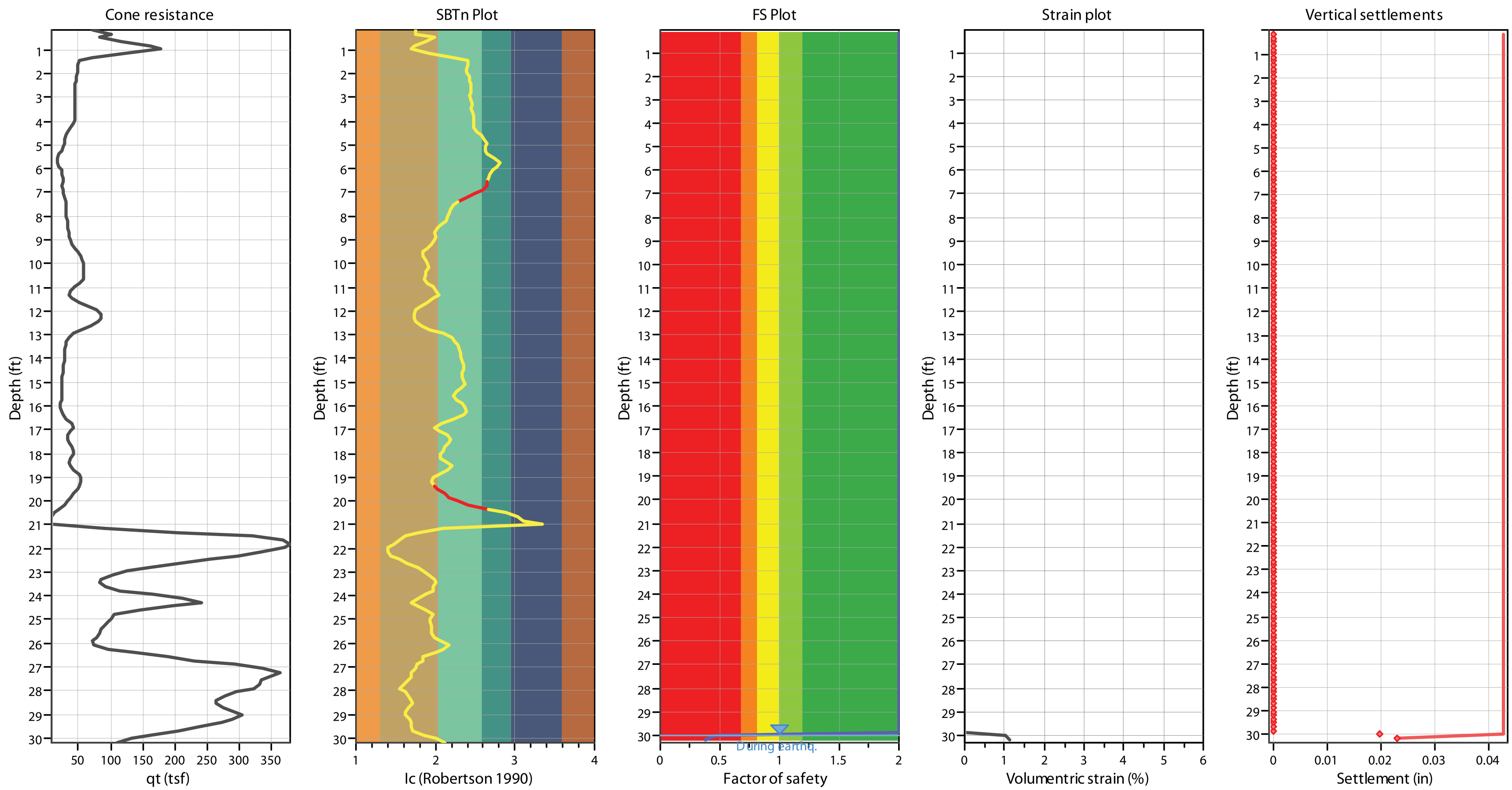
- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-1

Date 07/07/15 | Project No. 15-905 | Figure A-9



SBT legend

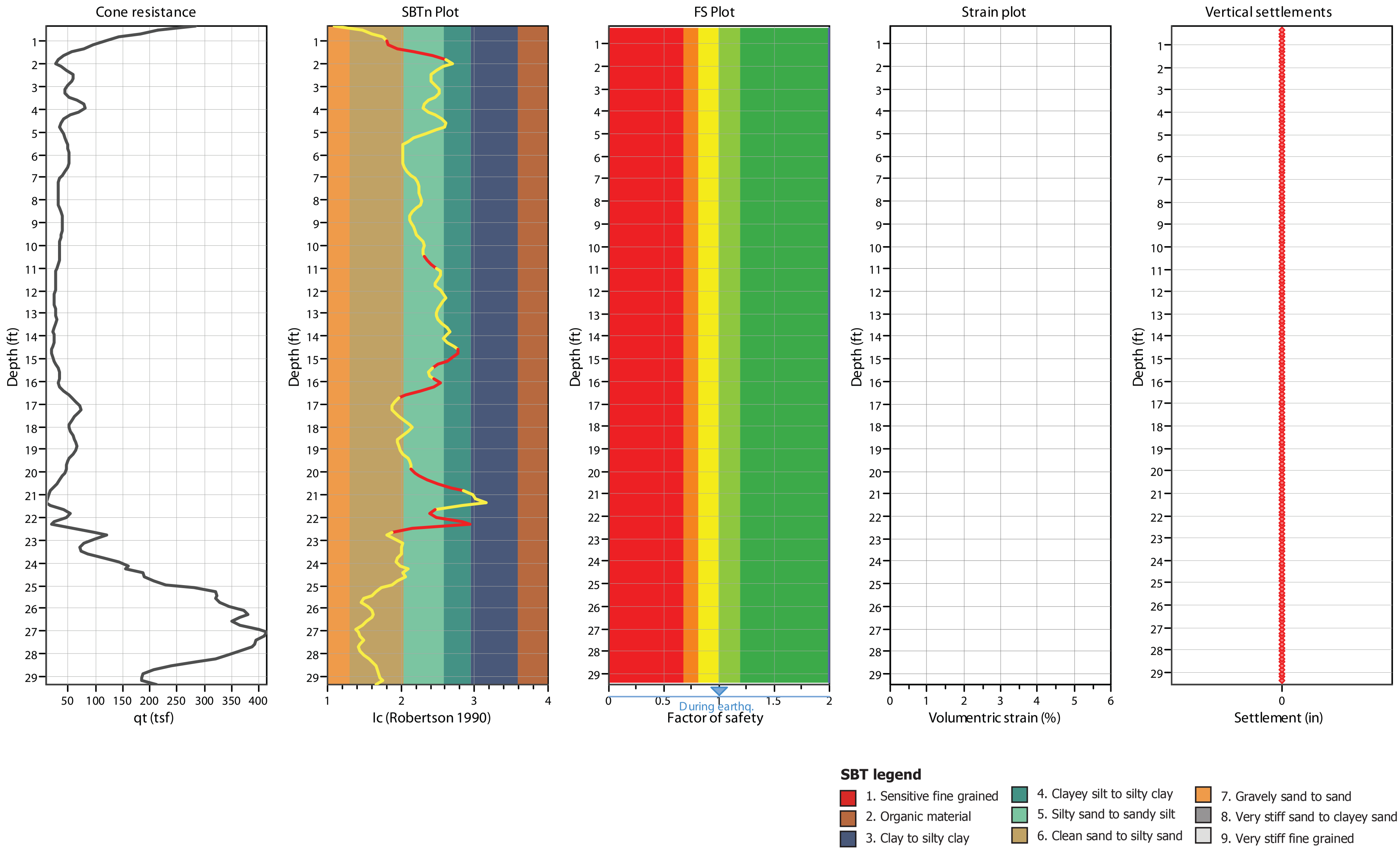
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-2

Date 07/07/15 | Project No. 15-905 | Figure A-10

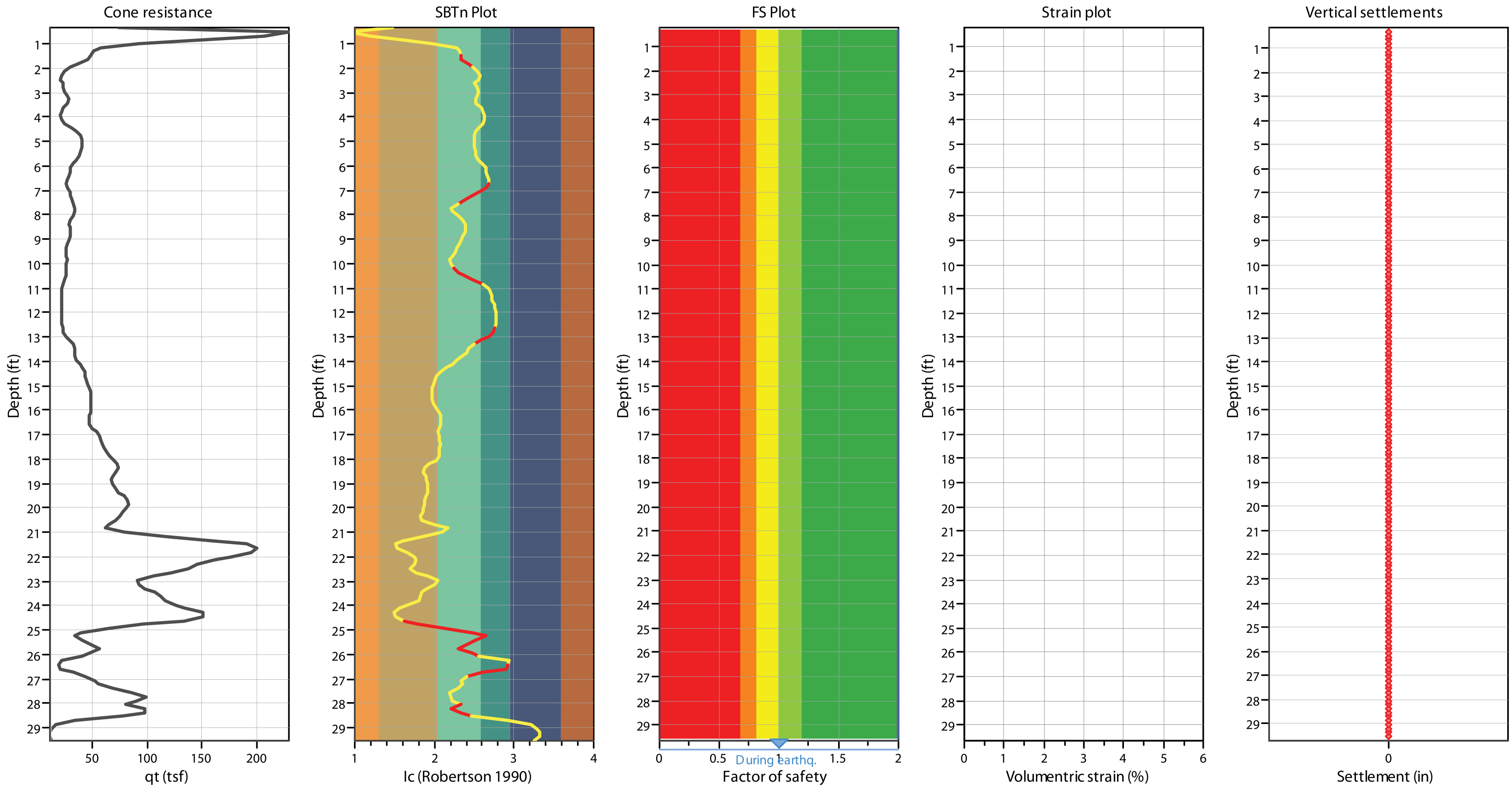


STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-3

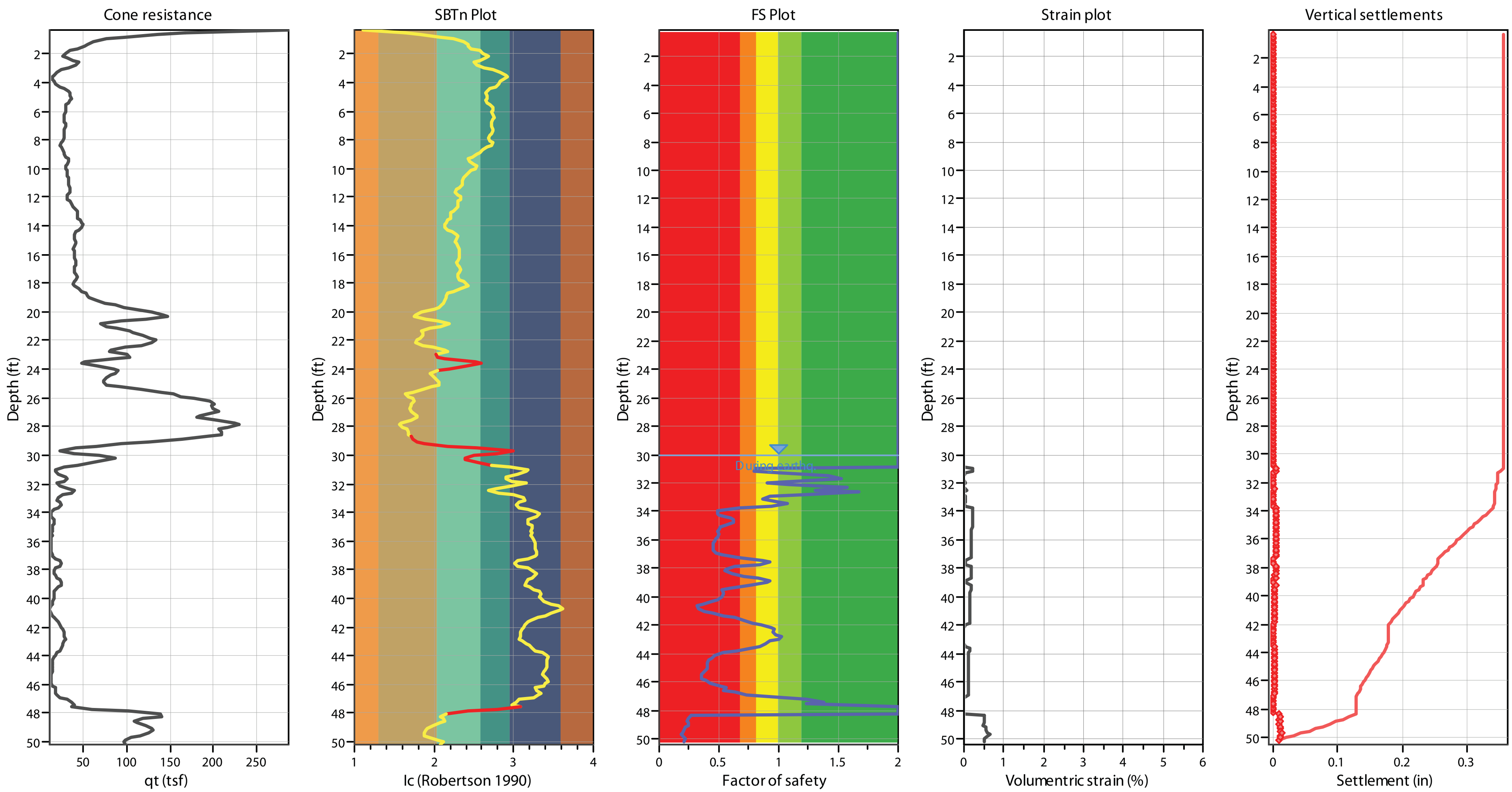
Date 07/07/15 | Project No. 15-905 | Figure A-11



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE Fremont, California	**CONE PENETRATION TEST RESULTS** **CPT-4**
ROCKRIDGE GEOTECHNICAL	Date 07/07/15 | Project No. 15-905 | Figure A-12



SBT legend

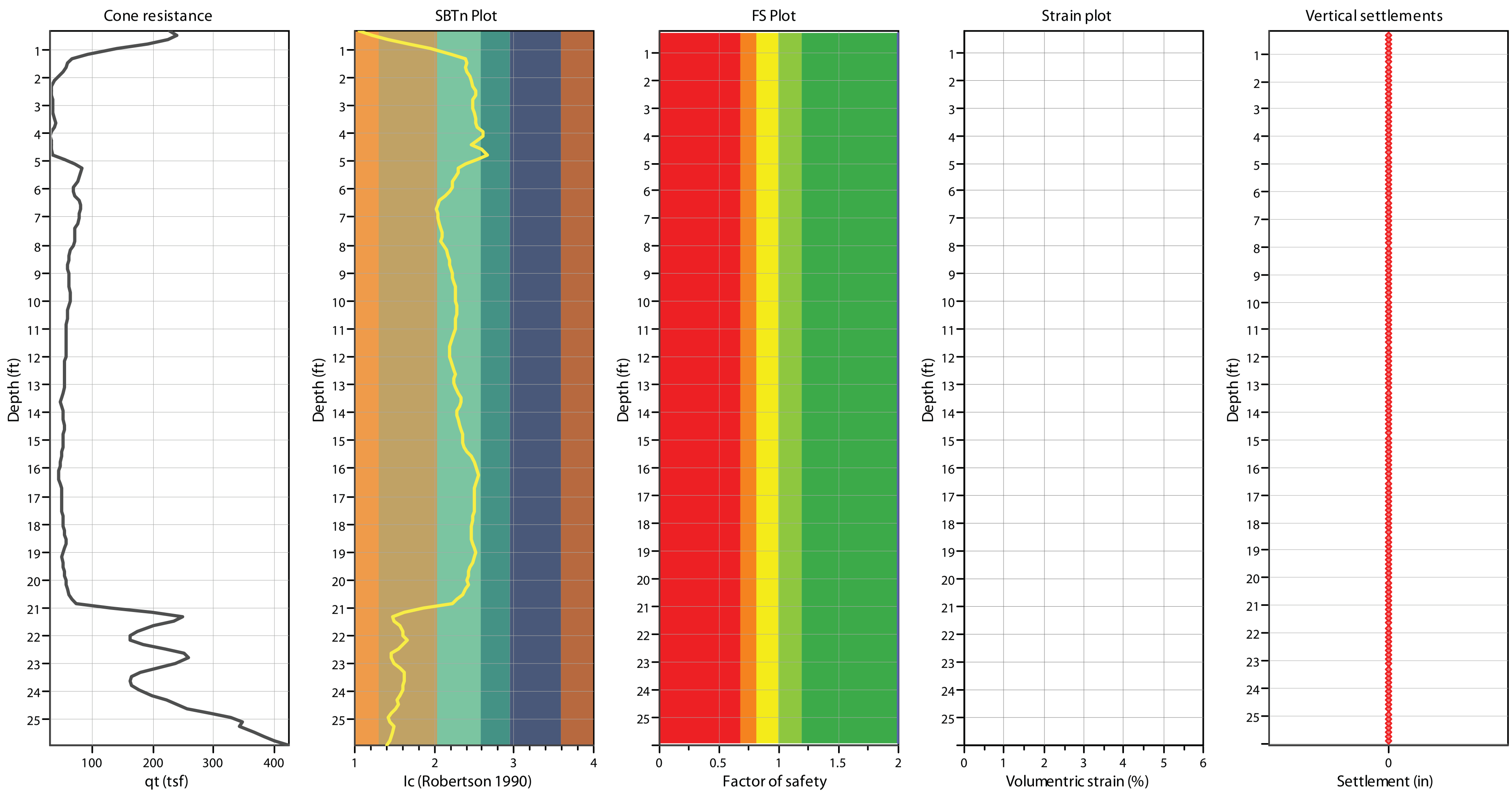
- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-5

Date 07/07/15	Project No. 15-905	Figure A-13



SBT legend

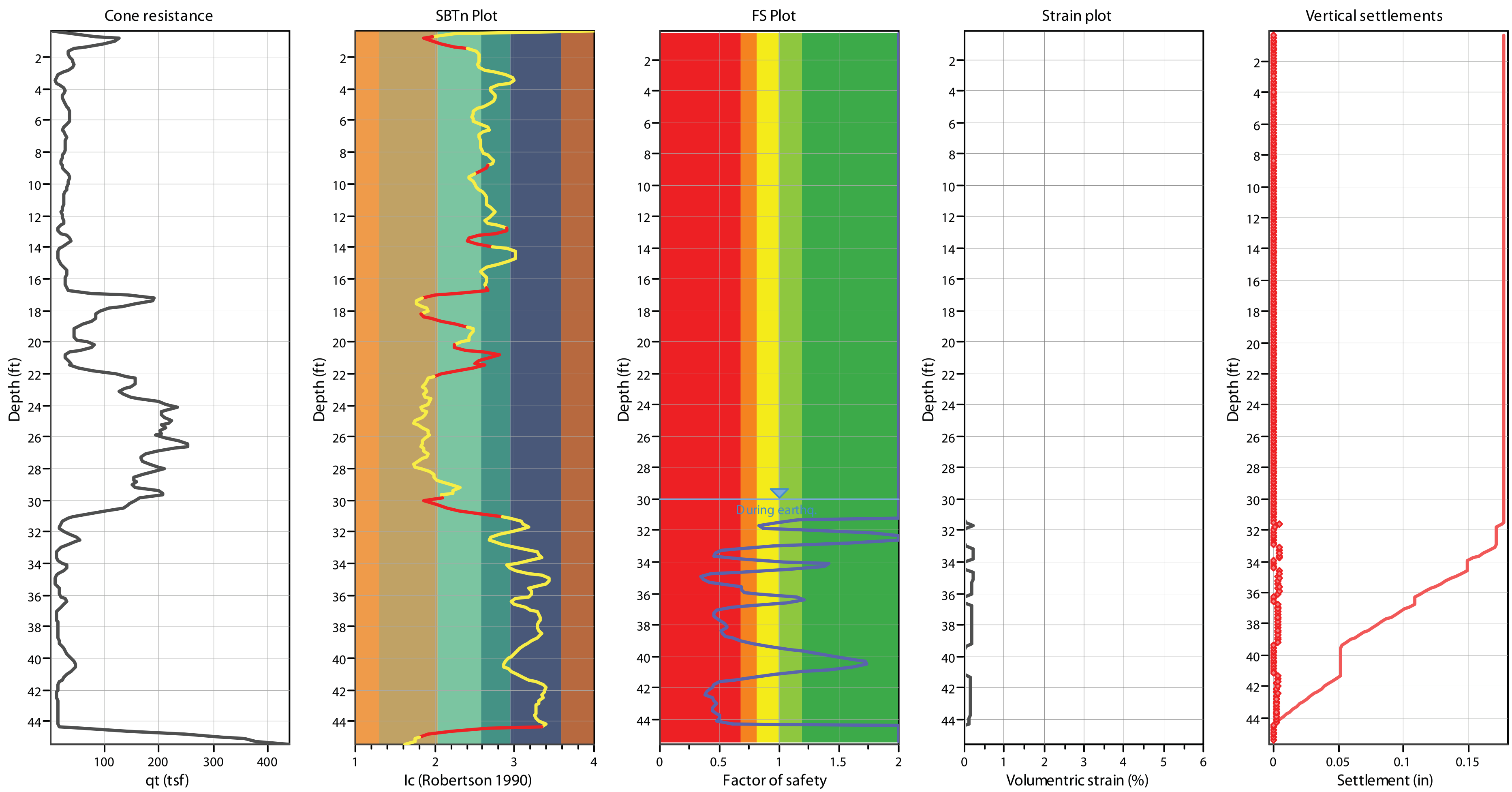
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-6

Date 07/07/15	Project No. 15-905	Figure A-14



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

STATE STREET AND CAPITOL AVENUE
Fremont, California

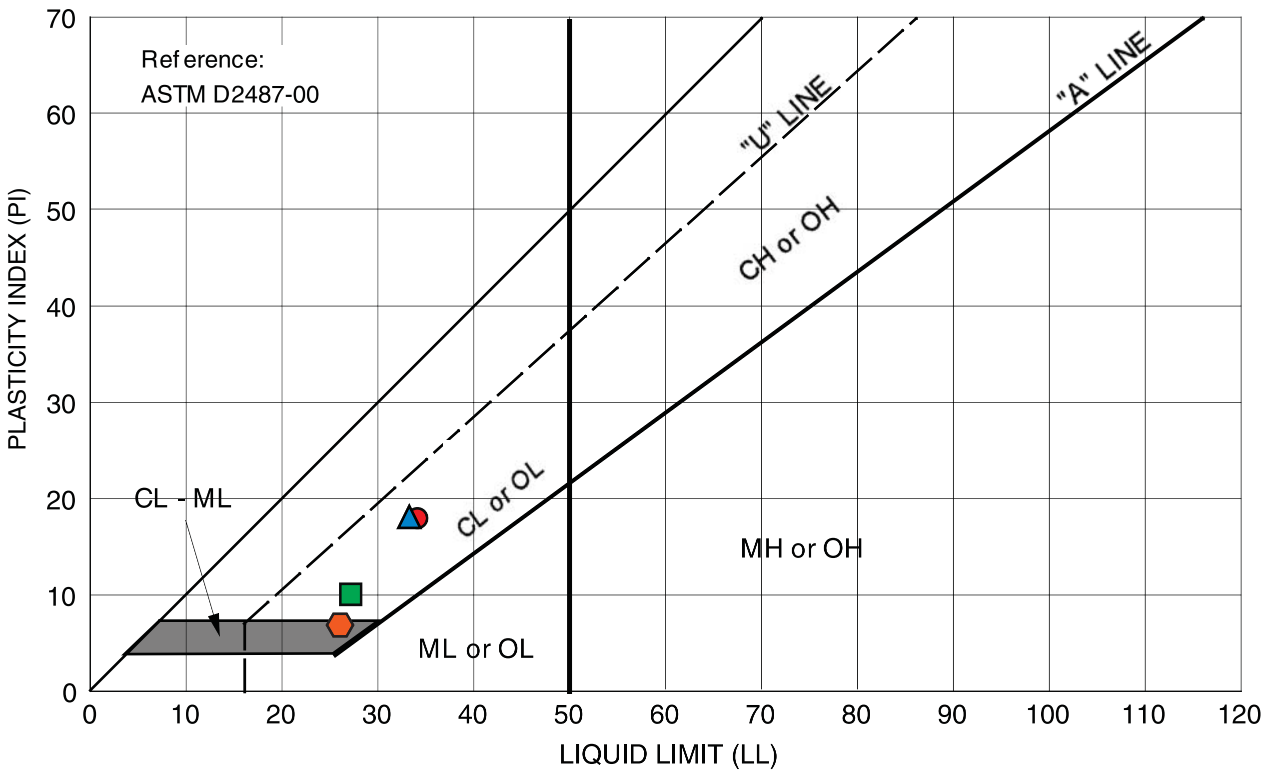
ROCKRIDGE GEOTECHNICAL

CONE PENETRATION TEST RESULTS
CPT-7

Date 07/07/15	Project No. 15-905	Figure A-15

APPENDIX B

Laboratory Test Data



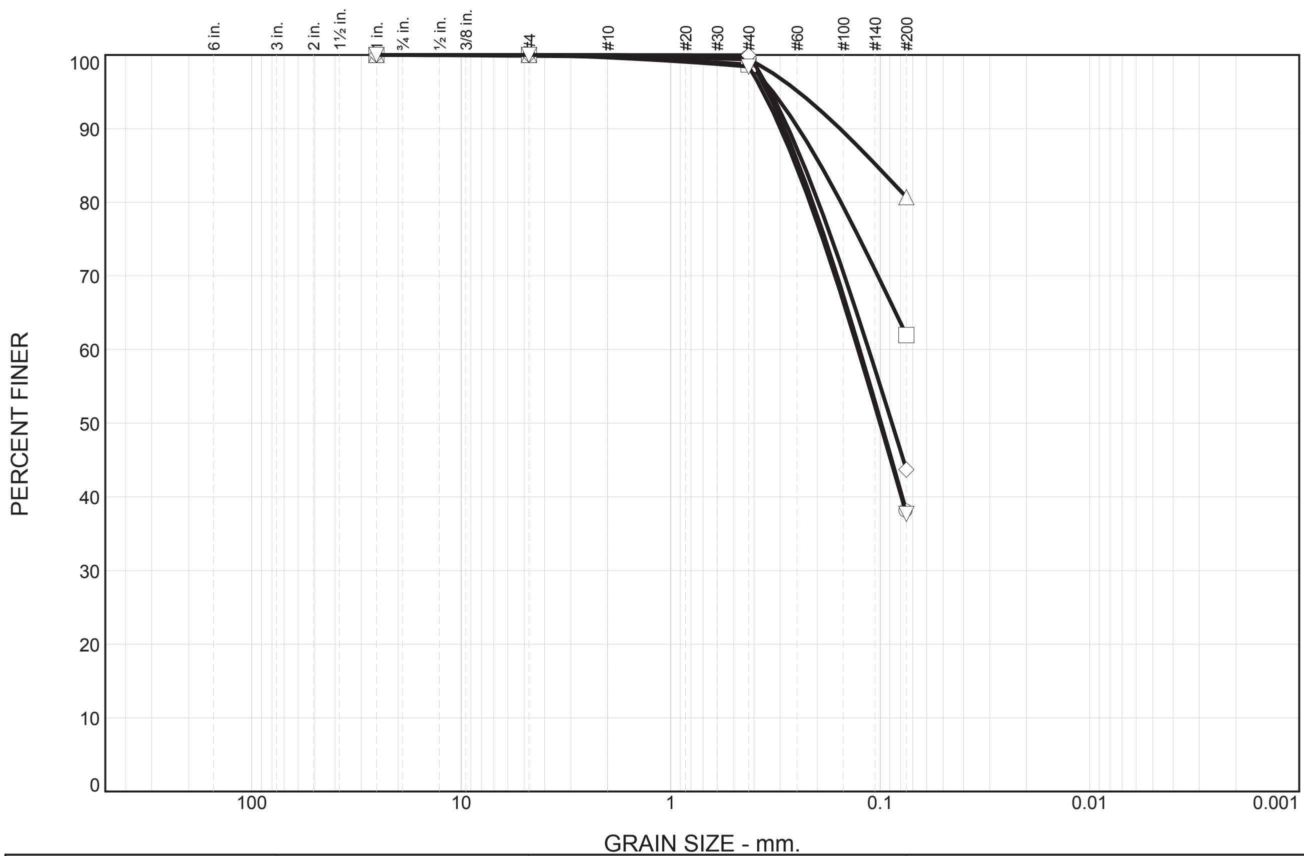
Symbol	Source	Description and Classification	Natural M.C. (%)	Liquid Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
● (red circle)	B-1 at 5.0 feet	CLAY (CL), light brown	15.6	34	18	--
▲ (blue triangle)	B-5 at 3.5 feet	CLAYEY SAND (SC), dark brown with mottled brown	15.2	33	18	50
■ (green square)	B-7 at 10.5 feet	CLAY (CL), dark brown	16.4	27	10	69
⬢ (orange hexagon)	B-7 at 15.5 feet	CLAY with SAND (CL), brown	16.2	26	7	--

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PLASTICITY CHART

Date 07/07/15 | Project No. 15-905 | Figure B-1



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

MATERIAL DATA

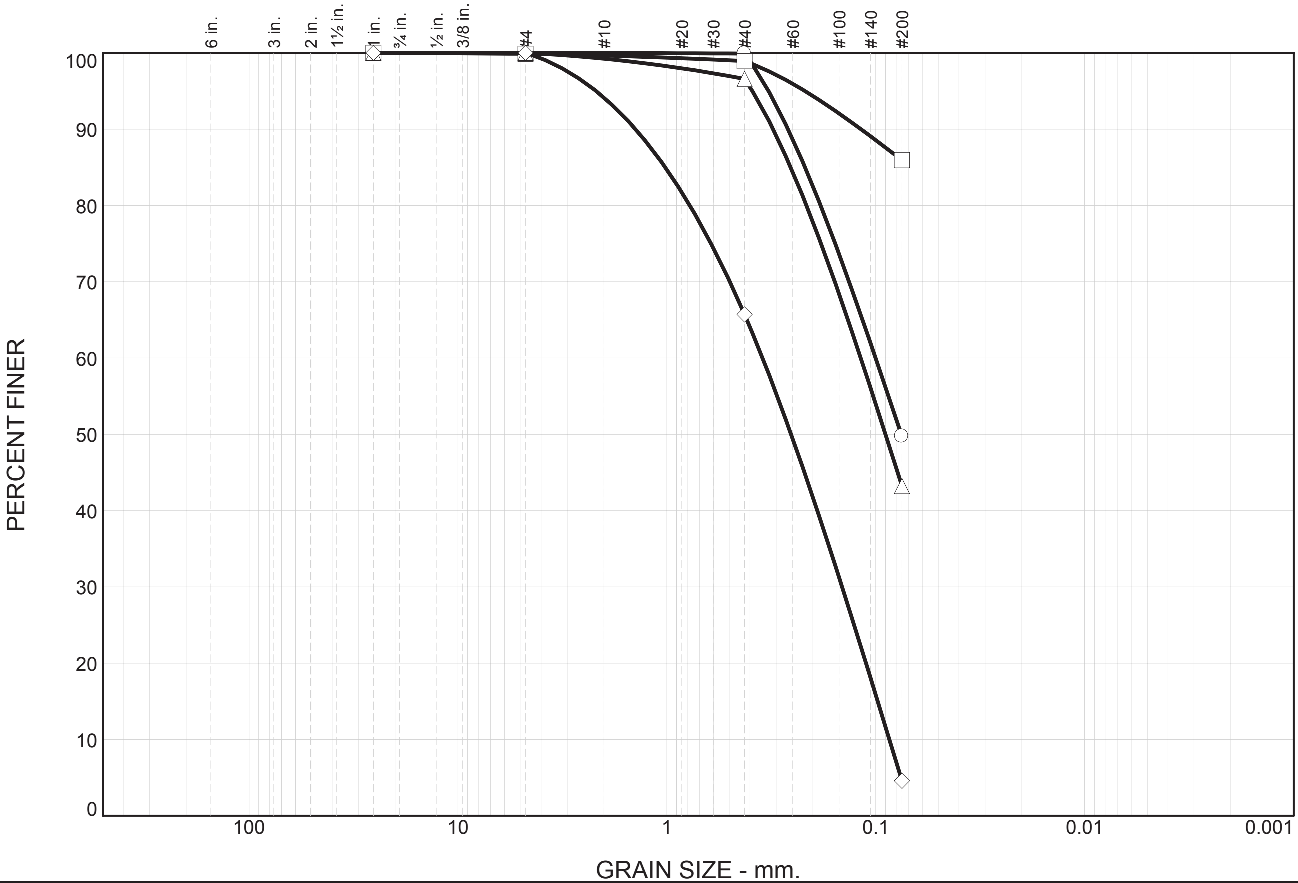
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-1	7	8.0'	SILTY SAND, light brown	SM
□	B-1	11	15.5'	SANDY CLAY, olive-brown	SM
△	B-2	10	10.5'	SANDY SILT, light brown	ML
◇	B-3	7	7.5'	SILTY SAND, light brown	SM
▽	B-4	7	12.5'	SILTY SAND, light brown	SM

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION REPORT

Date 07/07/15 | Project No. 15-905 | Figure B-2



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

MATERIAL DATA

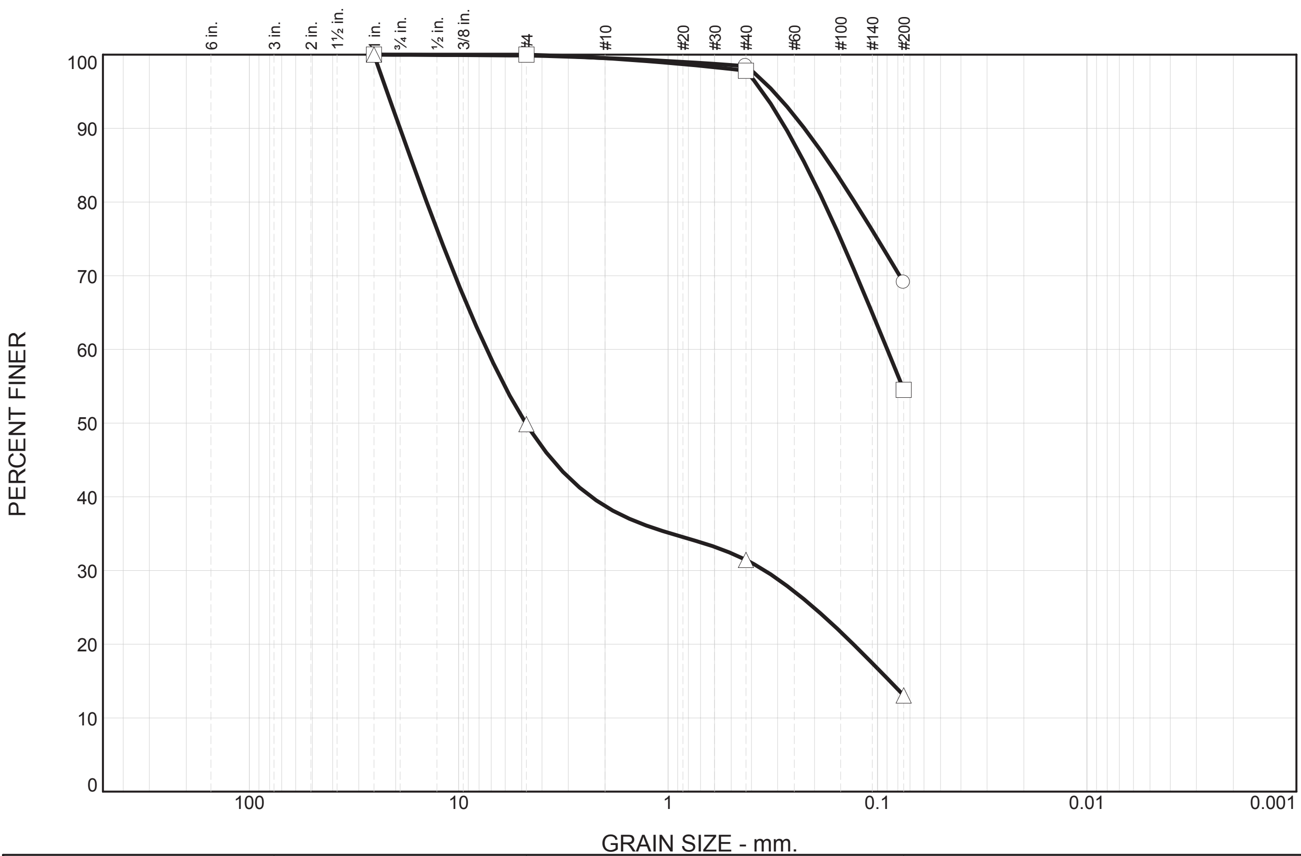
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-5	4	3.5'	SILTY SAND, dark brown with mottled brown	SC
□	B-5	9	11.0'	CLAYEY SAND, brown	ML
△	B-6	4	6.0'	SILTY SAND, brown	SM
◇	B-6	7	12.0'	SAND, brown	SP

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION REPORT

Date 07/07/15 | Project No. 15-905 | Figure B-3



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

MATERIAL DATA

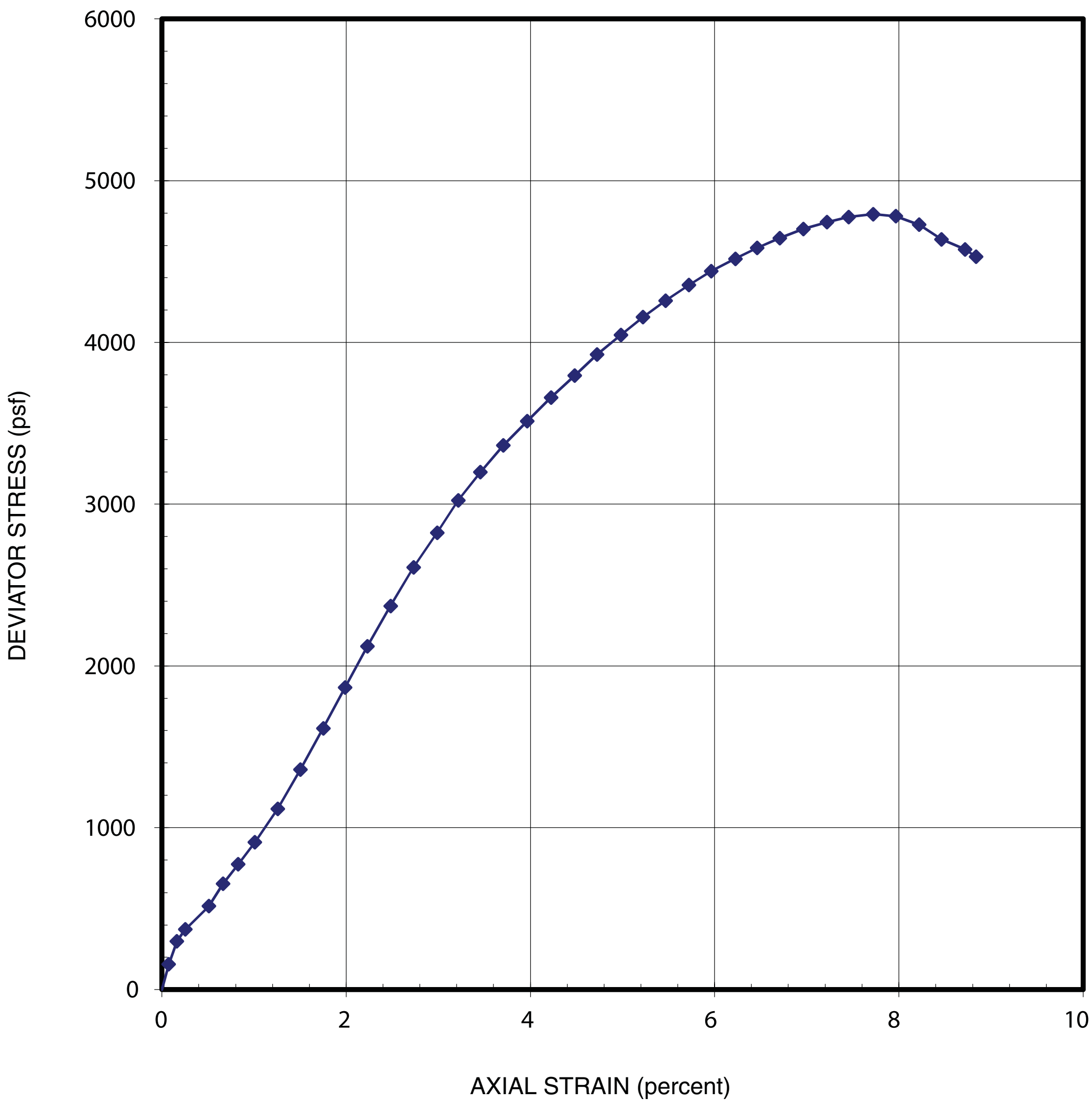
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-7	6	10.5'	CLAY, brown	CL
□	B-7	8	12.5'	SANDY SILT	ML
△	B-7	14	30.0'	SAND with GRAVEL, brown	SP

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

PARTICLE SIZE DISTRIBUTION REPORT

Date 07/07/15 | Project No. 15-905 | Figure B-4



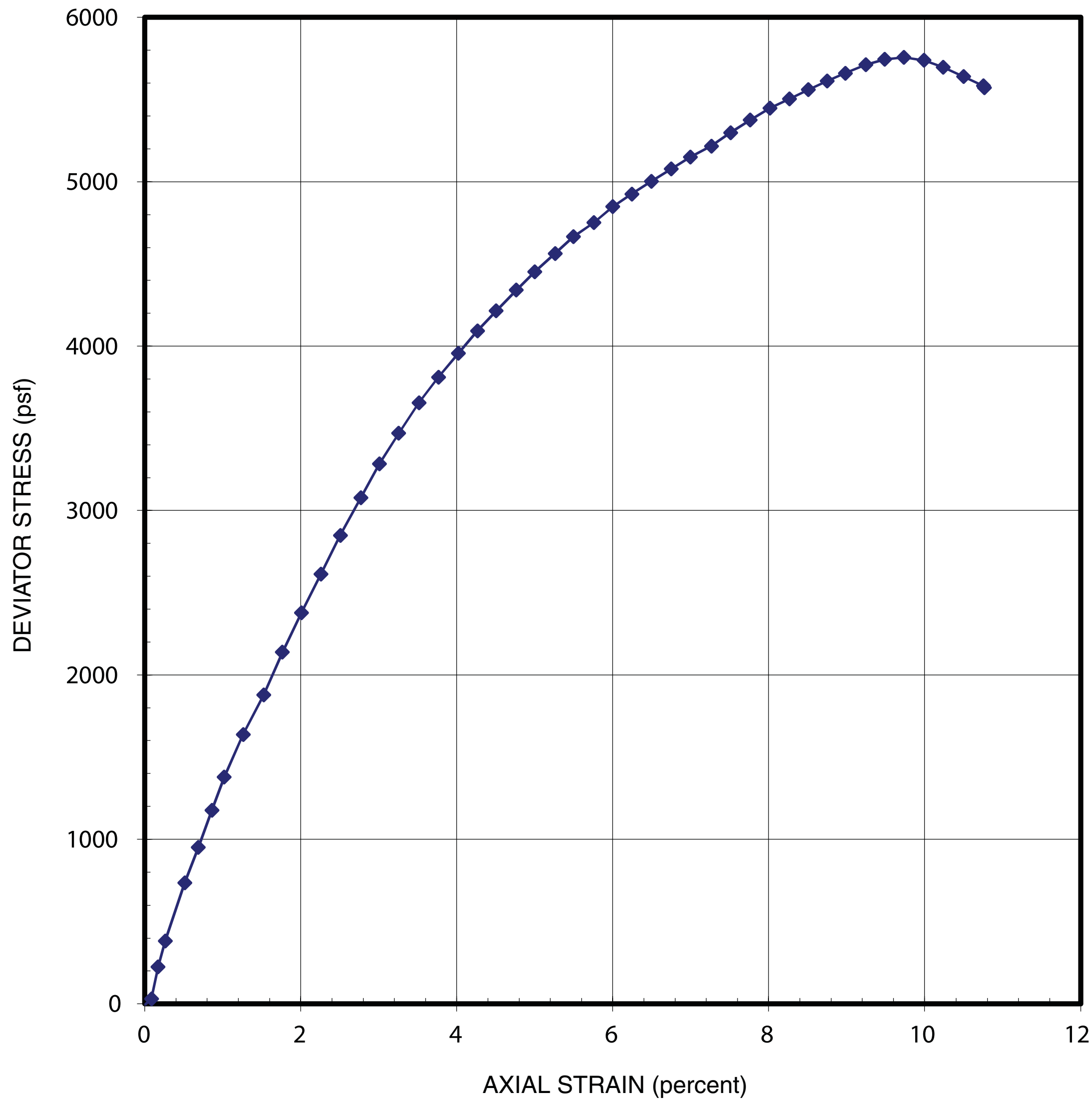
SAMPLER TYPE	Sprague and Henwood	SHEAR STRENGTH	2,400 psf
DIAMETER (in.) 2.40	HEIGHT (in.) 5.17	STRAIN AT FAILURE	7.7 %
MOISTURE CONTENT	16 %	CONFINING PRESSURE	500 psf
DRY DENSITY	111 pcf	STRAIN RATE	1 % / min.
DESCRIPTION	CLAY with SAND (CL), light brown	SOURCE	B-1 at 5.0 feet

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 08/31/15 | Project No. 15-905 | Figure B-5



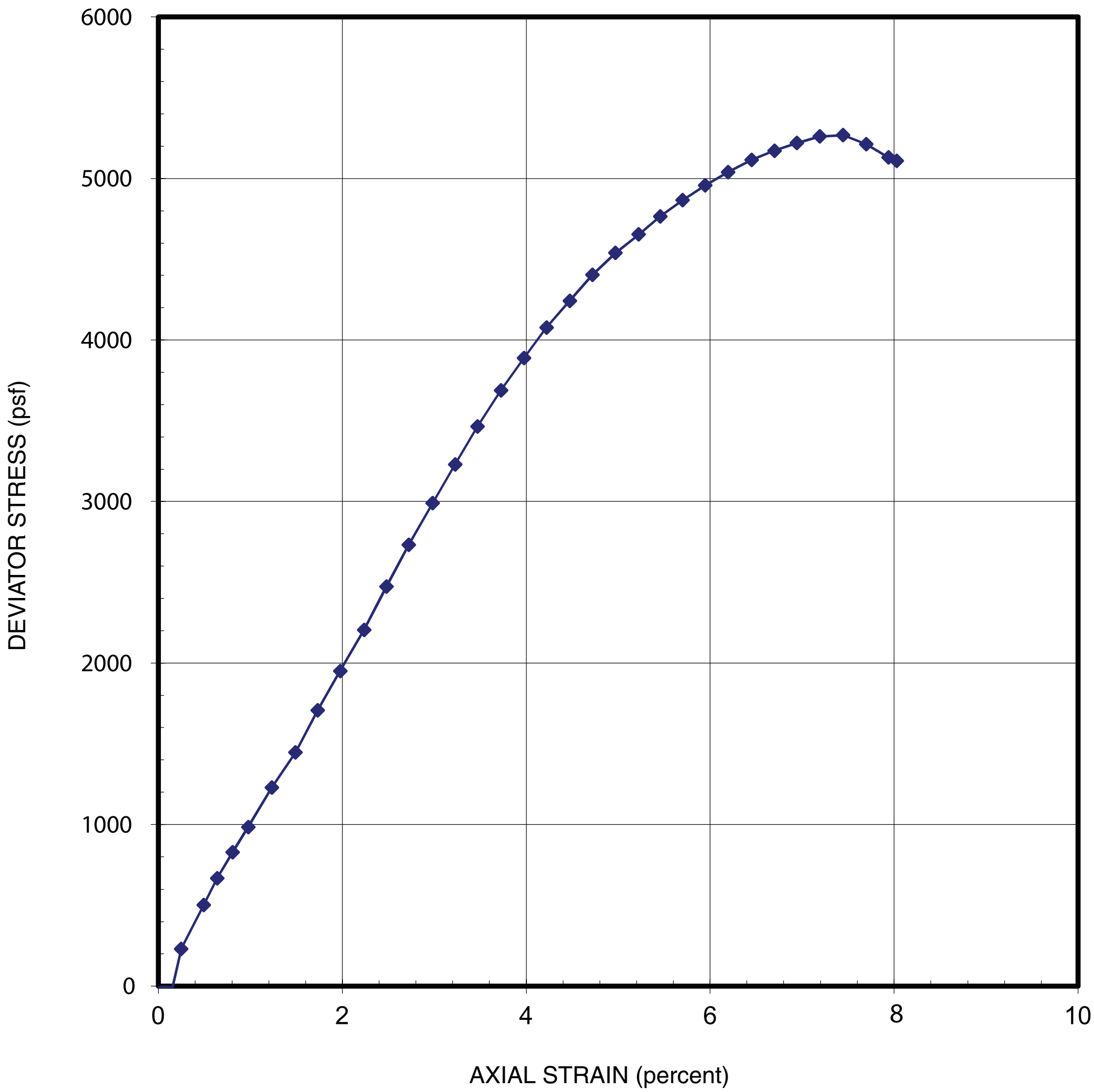
SAMPLER TYPE	Sprague and Henwood	SHEAR STRENGTH	2,880 psf
DIAMETER (in.) 2.39	HEIGHT (in.) 5.56	STRAIN AT FAILURE	9.7 %
MOISTURE CONTENT	18 %	CONFINING PRESSURE	550 psf
DRY DENSITY	112 pcf	STRAIN RATE	1 % / min.
DESCRIPTION	CLAY with SAND (CL), light brown	SOURCE	B-1 at 5.5 feet

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 08/31/15 | Project No. 15-905 | Figure B-6



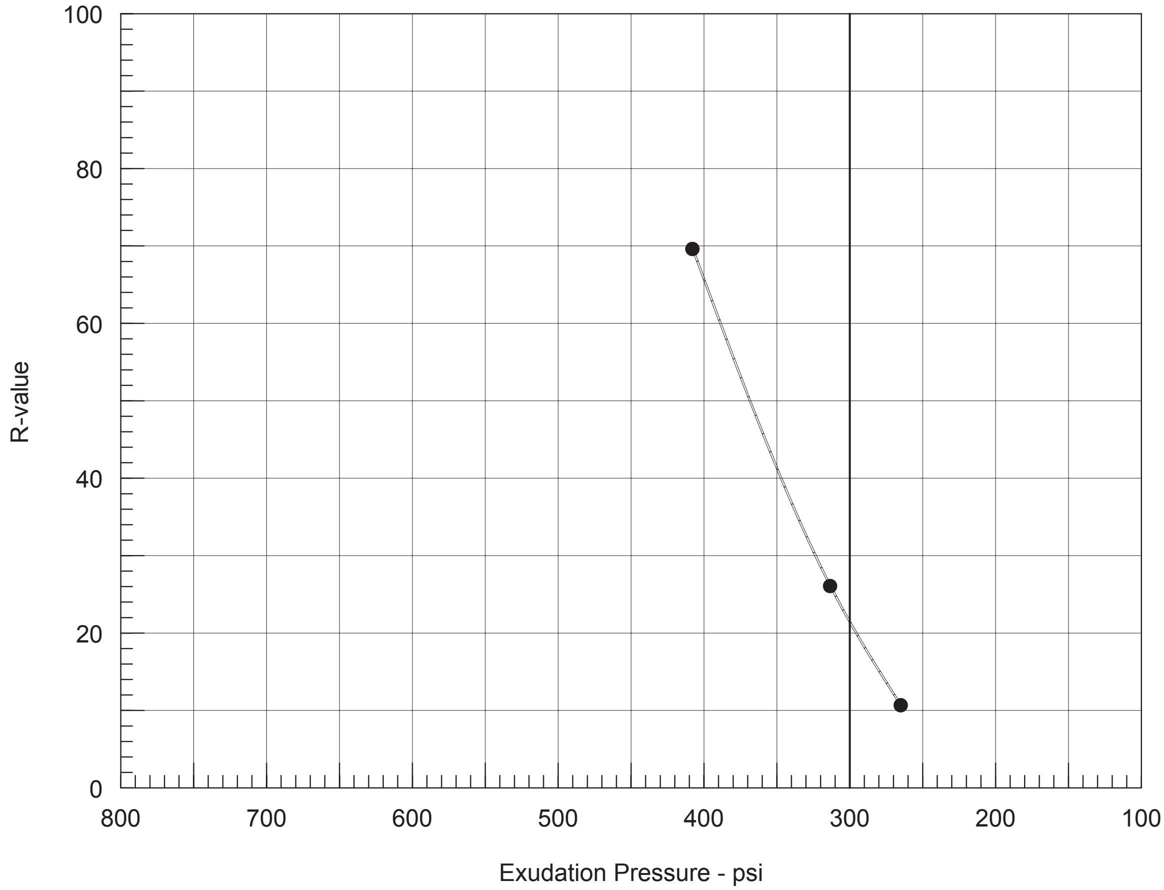
SAMPLER TYPE Sprague and Henwood		SHEAR STRENGTH	2,630 psf
DIAMETER (in.) 2.40	HEIGHT (in.) 5.99	STRAIN AT FAILURE	7.5 %
MOISTURE CONTENT	16 %	CONFINING PRESSURE	1,300 psf
DRY DENSITY	112 pcf	STRAIN RATE	1 % / min.
DESCRIPTION SILTY CLAY with SAND (CL), brown			SOURCE B-7 at 15.5 feet

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Date 08/31/15 | Project No. 15-905 | Figure B-7



Resistance R-Value and Expansion Pressure - Cal Test 301

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	85	233.2	7.1	0.00	130	2.56	265	10.2	10.6
2	250	139.3	3.8	0.00	40	2.48	407	69.5	69.5
3	210	132.7	5.0	0.00	103	2.53	313	26.0	26.0

Test Results	Material Description
R-Value at 300 psi exudation pressure = 21.5	CLAY with SAND (CL), black
	Sample Source: Onsite Depth: 0'-3' Sample Number: 1

STATE STREET AND CAPITOL AVENUE
Fremont, California

ROCKRIDGE GEOTECHNICAL

R-VALUE TEST REPORT

Date 08/31/15 | Project No. 15-905 | Figure B-8

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 15-905 STATE+CAPITOL Site ID : B-7-7 @ 12 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145416.

EVALUATION FOR SOIL CORROSION

Soil pH	7.71			
Moisture	11.9	%		
Minimum Resistivity	1.19	ohm-cm (x1000)		
Chloride	36.7	ppm	00.00367	%
Sulfate	49.2	ppm	00.00492	%
Redox Potential	(+) 178	mv		
Sulfides	Presence - TRACE			

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422
Redox Potential ASTM G-200, Sulfides AWWA C105/A25.5

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 15-905 STATE+CAPITOL Site ID : B-7-7 @ 12 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145417.

Extractable Sulfide Analysis

TYPE OF TEST	RESULTS	UNITS
Sulfide	0.10	mg/kg

DETECTION LIMITS
Sulfide 0.05

Method 9031m, ND = Below Detection Limits

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 15-905 STATE+CAPITOL Site ID : B-2-3 @ 3 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145418.

EVALUATION FOR SOIL CORROSION

Soil pH	7.22		
Moisture	12.3 %		
Minimum Resistivity	1.35 ohm-cm (x1000)		
Chloride	19.8 ppm	00.00198	%
Sulfate	75.7 ppm	00.00757	%
Redox Potential	(-) 86 mv		
Sulfides	Presence - POSITIVE		

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422
Redox Potential ASTM G-200, Sulfides AWWA C105/A25.5

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 07/01/2015
Date Submitted 06/24/2015

To: Katie Dickinson
Rockridge Geotechnical, Inc.
270 Grand Ave
Oakland, CA 94610

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 15-905 STATE+CAPITOL Site ID : B-2-3 @ 3 FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 69809-145419.

Extractable Sulfide Analysis

TYPE OF TEST	RESULTS	UNITS
Sulfide	0.48	mg/kg

DETECTION LIMITS
Sulfide 0.05

Method 9031m, ND = Below Detection Limits

ATTACHMENT B

SITE-SPECIFIC SCREENING LEVELS FOR SOIL VAPOR

SITE-SPECIFIC SCREENING LEVELS FOR SOIL VAPOR

This section describes the methods used to estimate Site-specific screening levels (SLs) for soil vapor for future onsite resident and commercial worker receptors for the property at 39155 and 39183 State Street in Fremont, California (the Site). The San Francisco Regional Water Quality Control Board (SFRWQCB) soil vapor Environmental Screening Levels (ESLs) are based on Department of Toxic Substances Control (DTSC) default attenuation factors that likely overestimate the attenuation from soil vapor to indoor air for this Site because Site conditions are more reflective of less permeable silts and clays. Therefore, the DTSC modified version of the Johnson and Ettinger (1991; J/E) model (DTSC, 2014) was used to estimate Site-specific SLs that take into account Site-specific geotechnical data. The conceptual approach to vapor intrusion modeling and model input parameters used in the development of the Site-specific SLs is presented in Attachment C.

The DTSC J/E model (2014) was used to evaluate volatilization of chemicals from soil vapor, migration of vapors to the ground surface, and mixing with indoor air for the future onsite receptors. This model estimates vapor concentrations in indoor air directly from source vapor concentrations, accounting for advection and diffusion in the vadose zone and building foundation and mixing in the building interior. Vapor emissions were modeled for the Site using source concentrations from soil vapor ($EPC_{soil\ vapor}$). The following table summarizes the Site-specific and chemical-specific properties input into the DTSC J/E model (DTSC, 2014) for vapor migration from soil vapor to indoor air.

Model Variables – Vapor Migration from Soil Vapor to Indoor Air		
Properties	**Symbol**	**Assumed Value**
Depth Below Grade to Bottom of Enclosed Space Floor (default)	L_F	15 centimeters
Soil Vapor Sampling Depth Below Grade (5 feet)	L_S	152 centimeters
Average Soil Temperature (default)	T_s	24°C
Vadose Zone SCS Soil Type (Site-specific)	- -	Sandy Clay Loam (SCL)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.63 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.384
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.146
Average Vapor Flow Rate into Building (default)	Q_{soil}	0.238
Residential Exposure Scenario		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	26 years
Exposure Duration	ED	26 years
Exposure Frequency	EF	350 days/year
Exposure Time	ET	24 hours/day
Air Exchange Rate	ACH	0.5 hour^{-1}
Commercial Exposure Scenario		
Averaging Time for Carcinogens	AT_C	70 years
Averaging Time for Noncarcinogens	AT_{NC}	25 years
Exposure Duration	ED	25 years
Exposure Frequency	EF	250 days/year
Exposure Time	ET	8 hours/day
Air Exchange Rate	ACH	1 hour^{-1}

g/cm^3 = gram per cubic centimeter

The spreadsheets containing the input parameters and results of the DTSC J/E model (DTSC, 2014) for subsurface vapor intrusion into buildings for the residential and commercial exposure scenarios are provided in Attachments C1 and C2 of Attachment C, respectively.

Toxicity Assessment

Toxicity values are combined with exposure factors to estimate adverse noncancer health effects and excess cancer risks. Toxicity values include inhalation reference concentrations (RfCs) and inhalation unit risk factors (IURs). As presented on Table 3 of the *Human Health Risk Evaluation of Subsurface Data* letter report, toxicity values supplied by the DTSC J/E model (2014) were used.

Risk Characterization

The risk characterization process incorporates data from the exposure and toxicity assessments to estimate noncancer adverse health effects and excess cancer risks. To estimate noncancer effects, the chronic daily intake is divided by the RfC. The resulting value is referred to as a hazard quotient (HQ). A HQ less than or equal to 1 indicates that no adverse noncancer health effects are expected to occur (USEPA, 1989). Consistent with USEPA (1989) risk assessment guidelines, carcinogenic effects are typically evaluated by multiplying the IUR by the chronic daily intake averaged over 70 years to estimate lifetime excess cancer risk. The resulting values are referred to as excess cancer risks. These potential excess cancer risks are compared to the CalEPA risk management range of one-in-one-million (1×10^{-6}) to one-in-ten thousand (1×10^{-4}).

Consistent with USEPA (1989; 1991) guidelines, the following general equations were used to estimate excess cancer risks and noncancer adverse health effects (expressed as a HQ):

For carcinogens: $$Risk = \frac{EPC_{indoor\ air} x EF x ED x ET x IUR}{AT_c}$$

For noncarcinogens: $$HQ = \frac{EPC_{indoor\ air} x EF x ED x ET x \frac{1}{RfC}}{AT_n}$$

Where:

$EPC_{indoor\ air}$	=	*Exposure point concentration in indoor air ($EPC_{indoor\ air}$; micrograms per cubic meter [µg/m^3]).*
EF	=	*Exposure frequency (days/year).*
ED	=	*Exposure duration (years).*
ET	=	*Exposure time (hours/day).*
AT	=	*Averaging time (days).* *For noncarcinogenic effects (hours), AT = ED x 365 days/year x 24 hours/day.* *For carcinogenic effects, AT (hours) = 70 years x 365 days/year x 24 hours/day.*
IUR	=	*Inhalation unit risk for carcinogenic chemicals (µg/m^3)$^{-1}$.*
RfC	=	*Inhalation reference concentration for noncarcinogenic chemicals (µg/m^3).*

The HQ and excess cancer risk for VOCs in soil vapor were estimated by using the exposure factors presented in the table above and toxicity values supplied by the DTSC J/E model in the equations above. Risk characterization of inhalation of VOCs volatilizing from soil vapor into indoor air for the future onsite resident and commercial worker receptors are presented in Tables 1 and 2, respectively, of the *Human Health Risk Evaluation of Subsurface Data* letter report.

Site-Specific Screening Levels

The development of Site-specific SLs was based on the methods presented previously in this attachment. The Site-specific SLs were estimated for the following hypothetical human receptors:

- Future Onsite Resident Receptor; and
- Future Onsite Commercial Worker Receptor.

Using the HQ and excess cancer risk estimates, source EPCs, and USEPA and CalEPA target HI and target excess cancer risk, a Site-specific SL was estimated using the equations in the following sections. Site-specific SLs based on noncarcingenic effects used a target HI of one. Site-specific SLs based on carcinogenic effects used a target excess cancer risk of 1 x 10^{-6}, which represents the lower end (most stringent) of the CalEPA's risk management range and is the point of departure for risk management decisions for all receptors

Site-Specific SL – Noncarcinogenic Effects

$$Site - Specific\ SL_{nc} = \frac{HQ_T \times EPC_{i,p}}{HQ_{i,p}}$$

Where:

Site-specific SL_{nc} =Site-specific SL for noncarcinogenic effects for chemical i via pathway p (µg/m^3);
HQ_T = Target hazard quotient (1), a HQ less than or equal to 1 indicates that no adverse noncancer health effects are expected to occur (USEPA, 1989; unitless);
$EPC_{i,p}$ = Exposure point concentration for source for chemical i via pathway p (µg/m^3); and
$HQ_{i,p}$ = Hazard quotient for chemical i via pathway p (unitless).

Site-Specific SL – Carcinogenic Effects

$$Site - Specific\ SL_{c} = \frac{CR_T \times EPC_{i,p}}{CR_{i,p}}$$

Where:

Site-specific SL_c =Site-specific SL for carcinogenic effects for chemical i via pathway p (µg/m^3);
CR_T = Target excess cancer risk (1 x 10^{-6}), the upper end (most stringent) of CalEPA's risk management range of one-in-ten thousand (1 x 10^{-4}) to one-in-one-million (1 x 10^{-6});
$EPC_{i,p}$ = Exposure point concentration for source for chemical i via pathway p (µg/m^3); and
$CR_{i,p}$ = Excess cancer risk for chemical i via pathway p (unitless).

The Site-specific SLs for soil vapor for residential and commercial exposure scenarios are presented in Tables 1 and 2, respectively, of the *Human Health Risk Evaluation of Subsurface Data* letter report.

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ATTACHMENT C

FATE AND TRANSPORT FOR VAPOR EMISSIONS FROM SOIL VAPOR INTO OUTDOOR AND INDOOR AIR

FATE AND TRANSPORT FOR VAPOR EMISSIONS FROM SOIL VAPOR INTO OUTDOOR AND INDOOR AIR

In support of the development of Site-specific screening levels for soil vapor and the evaluation of exposure in outdoor and indoor air, this attachment presents the methodology for fate and transport modeling used to estimate exposure point concentrations (EPCs) in air resulting from volatilization of volatile organic compounds (VOCs) from subsurface sources at the property at 39155 and 39183 State Street in Fremont, California (the Site). According to the U.S. Environmental Protection Agency (USEPA, 2016), a compound is assumed to be volatile if it has a Henry's Law constant greater than 1×10^{-5} and a molecular weight less than 200 grams per mole (g/mole).

The fate and transport modeling incorporates Site-specific data into analytical models that simulate vapor migration of VOCs. The following analytical models were used:

- An emission rate model to estimate flux as recommended by American Society for Testing and Materials (ASTM, 1995) and a box model to convert the emission rate to a concentration in ambient air as recommended by Department of Toxic Substances Control (DTSC, 1994); and
- The Johnson and Ettinger (1991) model, recommended and provided by the Department of Toxic Substances Control (DTSC, 2014), was used to estimate vapor emissions from soil vapor into indoor air

The conceptual approach to modeling, the calculations, and the modeling results are described in the following sections.

CONCEPTUAL MODEL

Volatile compounds can be released from the subsurface into indoor and outdoor air resulting in an indirect exposure to contaminants in the subsurface. The modeling addresses chemical sources in soil vapor under future site conditions for a reasonable maximum exposure (RME) scenario. Specifically, the modeling included calculations for the following exposure pathways:

- Volatilization of chemicals from soil vapor, migration of vapors to the soil surface and mixing with outdoor air.
- Volatilization of chemicals from soil vapor, migration of vapors to the soil surface, and mixing with indoor air.

Most of the soil vapor samples were collected above the water table in the vadose zone, at approximately 5 feet below ground surface (bgs), which is consistent with the DTSC (2011) recommended sampling depth. Some soil vapor samples were collected at deeper depths to specifically evaluate exposures in the planned elevator shaft and exposures offsite associated with the sewer lateral along State Street. The soil vapor samples were analyzed for VOCs only. The soil vapor data used in this HHRA are presented in previous report prepared by PES (2015, 2016a,b). For the purposes of fate and transport modeling, all onsite soil vapor data collected from 0 to 13 feet bgs were included in the soil vapor dataset. The maximum detected concentration for each VOC was used at the soil vapor exposure point concentration ($EPC_{soil\ vapor}$). Within this soil vapor dataset, the maximum detected concentrations were all detected at 5 feet bgs.

Using the soil vapor data, the fate and transport modeling was performed and a concentration in ambient air for each VOC was estimated. Site conditions were generalized to create a simplified conceptual model to estimate vapor concentration in outdoor and indoor air. Details of the approach and assumptions used for each hypothetical source and transport mechanism are discussed below.

Sources of VOC Vapors

Vapor sources were modeled based on the following assumptions:

- VOCs are uniformly distributed in soil vapor; and
- The concentrations of VOCs remain constant over time.

These assumptions are highly conservative because the distribution of VOCs is likely more limited than was assumed, and because the mass of the source will deplete over time as natural attenuation processes occur, thereby lowering actual concentrations in the source over time.

Chemical Transport Mechanisms

The models simulate the following transport mechanisms:

- Chemical partitioning between phases;
- Vapor migration from soil vapor to the ground surface; and
- Mixing of soil vapor emissions with ambient (indoor and outdoor) air.

Chemicals are assumed to partition between soil vapor ($EPC_{soil\ vapor}$) and ambient air under equilibrium conditions.

Vapor Migration from Soil Vapor to Ground Surface

Vertical migration of chemicals in soil vapor to the soil surface was assumed to occur by steady-state diffusion induced by a chemical concentration gradient between the soil-vapor source and the soil surface. For the outdoor air pathway, an emission rate model (ASTM, 1995) was used to estimate fluxes of VOCs at the soil surface. The indoor air pathway analysis accounted for the effects of steady-state advection induced by an assumed pressure differential between the exterior and interior of the building. Chemical diffusion of soil vapor through the vadose zone and building foundations (indoor only) was characterized by effective diffusion coefficients, D_s^{eff} (vadose zone) and D_f^{eff} (building foundations). Advection of chemicals dissolved in soil moisture was assumed to be negligible. This assumption is conservative because soil moisture tends to migrate downward, decreasing the overall flux of chemical toward the surface. Chemical and biological transformations were conservatively assumed not to occur during migration to the surface.

Mixing of Soil Vapor Emissions with Ambient (Indoor and Outdoor) Air

Different methods were used to simulate dispersion and mixing of vapors in outdoor and indoor air after vapors were emitted from subsurface sources. For outdoor air, a box model (DTSC, 1994) was used to convert the emission rate at the soil surface to a concentration in outdoor air. The analysis of indoor air simulated vapor-phase advection and diffusion of chemicals near the building foundation. Vapor diffusion of chemicals upward was assumed to occur through a foundation. Advective transport through a region generated by the pressure differential between inside (lower pressure) and outside (higher pressure) of the building was simulated. Such underpressurization is generally induced by temperature differentials, wind loading, and operation of devices such as furnaces and exhaust fans. Underpressurization is highly variable over time, but was conservatively assumed to be constant in modeling. This approach is highly conservative for periods when structures are neutrally or positively pressurized, as these conditions will inhibit migration of soil vapor into the building. The mixing of vapor-phase chemicals with ambient indoor air was simulated using a building of volume (V_b) that is ventilated at a constant exchange rate (*ER*), resulting in an indoor air concentration ($C_{building}$ *or* $EPC_{indoor\ air}$).

CALCULATIONS

This section presents the equations, input parameters, and model assumptions used as inputs to calculate vapor emissions.

Vapor Migration from Soil Vapor to Outdoor Air

Vapor concentrations in outdoor air from soil vapor were estimated using an emission rate model and box model. The resulting outdoor air concentrations from soil vapor are presented in Table C1. For vapor migration from soil vapor to outdoor air, concentrations in outdoor air were estimated based on the following equations from DTSC (1994) and ASTM (1995), respectively:

$$EPC_{outdoor\ air} = \frac{E}{LS \times V \times MH}$$

where:

$EPC_{outdoor\ air}$	=	*Concentration of VOC in outdoor air (milligram per cubic meter [mg/m³]);*
E	=	*Emission rate of chemical over site (milligram per second [mg/sec]);*
LS	=	*Length of side of site, taken to be* $[Area]^{0.5}$ *(meter);*
V	=	*Average wind velocity (default = 2.25 square meters per second [m²/sec]); and*
MH	=	*Mixing height (default = 2 meters).*

$$E = \frac{C_{soil\ gas} A}{L_s} \times \left[D_{a,i} \frac{\theta_a^{10/3}}{n^2} + D_{w,i} \frac{\theta_w^{10/3}}{H' n^2} \right] \times 10^{-5} \frac{m^2}{cm^2} \times 10^2 \frac{L}{m^3} \times 10^{-4} \frac{mg}{\mu g}$$

where:

E	=	*Emission rate of chemical over site (mg/sec);*
$C_{soil\ vapor}$	=	*Measured vapor phase concentration immediately above the vapor source (microgram per liter [µg/L]);*
A	=	*Area of site (square meters [m²]);* *Value for the exposed surface area is equal to 5,000 square feet (484 m²), the approximate dimensions of area* covered with a paver system
L_s	=	*Depth to contamination (meter);*
$D_{a,I}$	=	*Diffusion coefficient of i in air (square centimeter per second [cm²/s]);*
θ_a	=	*Air-filled porosity of soil* ($liter_{air}/liter_{soil}$);
n	=	*Total porosity of soil* ($liter_{air}/liter_{soil}$);
$D_{w,I}$	=	*Diffusion coefficient of i in water (cm²/s);*
θ_w	=	*Water-filled porosity of soil* ($liter_{water}/liter_{soil}$); *and*
H'	=	*Dimensionless Henry's Law constant (unitless).*

The following sections discuss the input parameters used in the fate and transport modeling of vapor migration from soil vapor to outdoor air.

Source Concentrations

Vapor emissions were modeled for the Site using source concentrations from soil vapor ($EPC_{soil\ vapor}$; Table C1). Onsite source concentrations in soil vapor (i.e., soil vapor EPCs) represent the maximum detected concentration from soil vapor collected from 0 to 13 feet bgs. The soil vapor EPCs are presented in Table C1

Site-Specific Properties

Site-specific geotechnical analyses were conducted by Rockridge Geotechnical (Rockridge, 2015; Attachment A). Rockridge (2015) describes the subsurface conditions as:

> …the Site is blanketed by stiff to hard clay with varying sand content that extends to depths ranging from approximately 5 to 11-1/2 feet bgs…Beneath the surficial clay layer are heterogeneous alluvial deposits consisting of loose to very dense silty sand, medium dense to very dense sand with varying gravel content, medium dense clayey sand, stiff to very stiff, non-plastic sandy silt, and stiff to very stiff clay with varying sand content.

Rockridge collected 4 soil samples near the soil vapor sample depth of 5 feet bgs. Based on Rockridge's boring logs and particle size distribution analyses for the four soil samples collected from 3.5 to 8 feet bgs (B-1 at 8 feet bgs, B-3 at 7.5 feet bgs, B-5 at 3.5 feet bgs, and B-6 at 6 feet bgs), the soil ranged from 50 to 62-percent sand (coarse grain) with 38 to 50-percent silt/clay (fine grain). In accordance with the U.S. Soil Conservation Service (USCS) classification chart (Figure 3 of USEPA, 2004), the results from the particle size distribution analyses (Attachment A) were used to determine the appropriate USCS soil textural classification within the Site. Assuming the particle size distribution analysis indicates that Site soils are approximately 50-percent sand and 50-percent silts and clay, with predominantly more clay based on boring logs, the USCS soil textural classification is likely "sandy clay loam". As a result, sandy clay loam (SCL) was selected as the vadose zone input parameter for the fate and transport modeling. The DTSC (2014) default values for SCL for total porosity (0. 384), and water-filled porosity (0.146) were used as model input parameters. The Rockridge geotechnical report is provided in Attachment A.

The Site-specific and soil properties used in the fate and transport model for vapor migration from soil vapor to outdoor air are summarized in the table below.

Model Variables – Vapor Migration from Soil vapor to Outdoor Air		
Properties	**Symbol**	**Assumed Value**
Area of site Value for the exposed surface area is equal to 5,000 square feet (484 m^2), the approximate dimensions of area covered with a paver system.	A	484 m^2
Length of side of site, taken to be $[Area]^{0.5}$	LS	22 meters
Depth to contamination (5 feet bgs)	L	1.52 meters
Soil Total porosity	n	0.384
Soil Water-filled porosity	θ_w	0.146
Soil Air-filled porosity	θ_a	0.238

Chemical-Specific Properties

The values for the dimensionless Henry's Law constant and molecular diffusion coefficients in air and water ($D_{a,i}$ and $D_{w,i}$), were obtained from USEPA (2016).

The input parameters and results of the emission rate model and box model used to estimate vapor emissions from soil vapor to outdoor air are presented in Table C1.

Vapor Migration from Soil vapor to Indoor Air

Using the DTSC version of the Johnson and Ettinger (1991) model (DTSC, 2014), vapor concentrations in indoor air from soil vapor were estimated for the future onsite resident and commercial worker receptors. This model estimates vapor concentrations in indoor air directly from concentrations in soil vapor, accounting for advection and diffusion in the vadose zone and building foundation and mixing in the building interior.

As presented by USEPA (2004), for vapor migration from soil vapor to indoor air, concentrations in indoor air were estimated based on the following equations:

$$C_{building} = C_{source} \times \propto \quad \text{or} \quad EPC_{indoor\ air} = EPC_{soil\ vapor} \times \propto$$

where:

$$\alpha = \frac{\left[\left(\frac{D_T^{eff} \times A_B}{Q_{building} \times L_T}\right) \times \exp\left(\frac{Q_{soil} \times L_{crack}}{D_{crack} \times A_{crack}}\right)\right]}{\left[\exp\left(\frac{Q_{soil} \times L_{crack}}{D_{crack} \times A_{crack}}\right) + \left(\frac{D_T^{eff} \times A_B}{Q_{building} \times L_T}\right) + \left(\frac{D_T^{eff} \times A_B}{Q_{soil} \times L_T}\right) \times \left[\exp\left(\frac{Q_{soil} \times L_{crack}}{D_{crack} \times A_{crack}}\right) - 1\right]\right]}$$

where:

$C_{building}$/$EPC_{indoor\ air}$ = *EPC in indoor air (microgram per cubic meter [$\mu g/m^3$]);*
C_{source}/$EPC_{soil\ vapor}$ = *EPC in soil vapor ($\mu g/m^3$);*
α = *Steady-state attenuation coefficient (unitless);*
D_T^{ef} = *Total overall effective diffusion coefficient (cm^2/s);*
A_B = *Area of enclosed space below grade (cm^2);*
$Q_{building}$ = *Building ventilation rate (cubic centimeter per second [cm^3/s]);*
L_T = *Source-building separation (centimeter [cm]);*
Q_{soil} = *Volumetric flow rate of soil vapor into the enclosed space (cm^3/s);*
L_{crack} = *Enclosed space foundation or slab thickness (cm);*
A_{crack} = *Area of total cracks (cm^2); and*
D_{crack} = *Effective diffusion coefficient through the cracks (cm^2/s) (assumed equivalent to D_i^{eff} of soil layer (i) in contact with the floor).*

A more detailed description of the equations and input parameters used in this model are provided in the *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (USEPA, 2004).

The following sections discuss the input parameters used in the fate and transport modeling for vapor migration from soil vapor to indoor air.

Source Concentrations

Vapor emissions were modeled for the Site using source concentrations from soil vapor ($EPC_{soil\ vapor}$). Source concentrations in soil vapor represent the maximum detected concentration. Soil vapor EPCs and the resulting modeled indoor air EPCs ($EPC_{indoor\ air}$) for the residential and commercial exposure scenarios are presented in Tables 1 and 2 of the *Human Health Risk Evaluation of Subsurface Data* letter report, respectively.

Site-Specific Properties

As discussed previously, based on Site-specific soil property data and soil boring logs, the DTSC (2014) default soil properties for sandy clay loam (SCL) were used in the fate and transport model for vapor migration from soil vapor to indoor air.

Chemical-Specific Properties

The values for the dimensionless Henry's Law constant, organic carbon-water partition coefficient (K_{oc}), and molecular diffusion coefficients in air and water, D_i and D_w, for each soil vapor VOC were obtained from DTSC (2014).

The properties used in the fate and transport model (DTSC, 2014) for vapor migration from soil vapor to indoor air are summarized in the table below.

Model Variables – Vapor Migration from Soil Vapor to Indoor Air		
Properties	**Symbol**	**Assumed Value**
Depth Below Grade to Bottom of Enclosed Space Floor (default)	L_F	15 centimeters
Soil Vapor Sampling Depth Below Grade (5 feet)	L_S	152 centimeters
Average Soil Temperature (default)	T_s	24°C
Vadose Zone SCS Soil Type (Site-specific)	- -	Sandy Clay Loam (SCL)
Vadose Zone Soil Dry Bulk Density (Site-specific)	ρ_b	1.63 g/cm^3
Vadose Zone Soil Total Porosity (Site-specific)	θ_T	0.384
Vadose Zone Soil Water-Filled Porosity (Site-specific)	θ_w	0.146
Average Vapor Flow Rate into Building (default)	Q_{soil}	0.238

g/cm^3 = gram per cubic centimeter

The spreadsheets containing the input parameters and results of the Johnson and Ettinger (1991) model, for subsurface vapor intrusion into buildings (DTSC, 2014) for the residential and commercial exposure scenarios are provided in Attachments C1 and C2, respectively.

Following a discussion of uncertainties in the next section, the results are summarized, which may have influenced the estimation of vapor emission estimates and corresponding EPCs and health risks.

UNCERTAINTY ANALYSIS

The procedures used in evaluating vapor migration and estimating EPCs are subject to various degrees of uncertainty. A significant amount of conservatism has been incorporated into the fate and transport modeling process to address this uncertainty. Specifically, the Johnson and Ettinger (1991) model employs a series of simplified, analytical solutions to chemical transport, often resulting in overestimation of EPCs. The conservatism inherent to the formulation of these models is supplemented by additional conservatism associated with selection of model input data and conceptualization of site conditions imposed by model users. As a result of this multilevel conservatism, actual EPCs and corresponding health risks are likely to be significantly lower than were estimated for the inhalation exposure pathway. These conservative aspects of the fate and transport modeling process are further discussed below.

Model Formulation

The conservative aspects of the vapor migration models include simplified representation or complete omission of the following processes that affect transport, for example:

- Loss mechanisms - The absence of loss mechanisms such as biodegradation and vapor-phase adsorption result in overestimation of vapor emissions to outdoor and indoor air, yielding higher EPCs.
- Depleting contaminant source - The use of a nondepleting, constant source results in an unlimited supply of contaminated vapor and an overestimation of vapor emissions to outdoor and indoor air, yielding higher EPCs.
- Water movement - The assumed absence of water (and dissolved chemical) movement through unsaturated soil results in an overestimation of chemical mass in vapor-phase available for transport to outdoor and indoor air, yielding higher EPCs.
- Neutral or positive pressurization - The assumption of continuously under-pressurized buildings neglects significant periods where neutral or positive pressurized conditions exist, thereby over-estimating advective transport of contaminated vapors to indoor air, yielding higher EPCs.
- One-dimensional transport - The assumption of vapor transport under a single (vertical) dimension ignores the potential for vapor migration in multiple directions away from the source area, resulting in an over-estimation of vapor emissions and higher EPCs.

Under actual field conditions, the combined effect of these processes typically results in significantly lower EPCs than those estimated in this assessment.

Model Input Data

As previously indicated, various model input data characterizing soil physical properties and building parameters used in this analysis correspond to conservative default values adopted by DTSC (1994 and 2014). Use of conservative default values for the above-mentioned parameters also likely results in over-estimation of vapor emissions to outdoor and indoor air, maximizing estimates of EPCs.

Conceptualization of Site Conditions

As previously indicated, site conditions were generalized to create a simplified conceptual model for simulation of vapor emissions at the Site. As a result, many components of this conceptualization are based on highly conservative assumptions, including:

- Outdoor and indoor points of exposure are assumed to directly overlie locations of maximum detected VOC concentrations in soil vapor.
- VOCs are assumed to be uniformly distributed in soil vapor, with no spatial and temporal changes in concentrations.

As a result of this conservative conceptualization, estimated vapor emissions to outdoor and indoor air are maximized, yielding higher EPCs. As stated in Hers, et al. (2003), "If there is information only on contamination depth, the range in [vapor attenuation] can vary 3-4 orders of magnitude. When information on soil properties is also available, the uncertainty…is reduced resulting in [vapor attenuation] that vary over two orders of magnitude. When good quality Site-specific data is available for both soil properties (e.g., moisture content) and building properties (e.g., ventilation rate, mixing height), it may be possible to reduce the uncertainty…to approximately one order of magnitude."

RESULTS

The soil vapor EPCs and their respective outdoor and indoor air concentrations were used to estimate noncancer adverse health effects and excess cancer risks from assumed exposure to VOCs migrating from soil vapor to ambient air. The soil vapor and indoor air EPCs for the residential and commercial exposure scenarios are presented in Tables 1 and 2 of the *Human Health Risk Evaluation of Subsurface Data* letter report, respectively. The results of the emission rate model and box model used to estimate vapor emissions from soil vapor to outdoor air are presented in Table C1 and Table 3 of the *Human Health Risk Evaluation of Subsurface Data* letter report.

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TABLE C1

ESTIMATION OF OUTDOOR AIR CONCENTRATIONS FROM VOLATILE ORGANIC COMPOUNDS VOLATILIZING FROM SOIL VAPOR

Table C1
Estimation of Outdoor Air Concentrations from Volatile Organic Compounds Volatilizing from Soil Vapor
39155 and 39183 State Street
Fremont, California

Emission Rate of Volatile Organic Compound (VOC)[1]

$$E = \frac{C_{v,i} \times A}{d} \times \left(D_{a,i} \times \frac{\theta_a^{10/3}}{\theta_t^2} + D_{w,i} \times \frac{\theta_w^{10/3}}{H'\theta_t^2} \right) \times 10^{-4} \frac{m^2}{cm^2} \times 10^3 \frac{L}{m^3} \times 10^{-3} \frac{mg}{\mu g}$$

Concentration in Outdoor Air via Box Model[2]

$$EPC_{outdoor\ air} = \frac{E}{LS \times V \times MH}$$

Parameter		Units	Benzene	Chloroform	Ethylbenzene	Freon 11	Freon 12	Tetrachloroethene	Toluene	m,p-Xylene	o-Xylene
Vapor Phase Concentration Above Source $EPC_{soil\ vapor}$	$C_{v,i}$	(µg/L)	7.10E-01	1.60E-01	2.80E-01	2.30E+00	6.40E+00	8.50E+00	1.50E+00	1.10E+00	3.50E-01
Area of Site[3]	A	(m^2)	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02	4.84E+02
Depth to Contamination[4]	d	(m)	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00
Total Soil Porosity[5]	n	(L_{pore}/L_{soil})	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01	3.84E-01
Water-Filled Soil Porosity[5]	θ_w	(L_{water}/L_{soil})	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01
Air-Filled Soil Porosity[6]	θ_a	(L_{air}/L_{soil})	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01	2.38E-01
Diffusivity in Air[7]	$D_{a,i}$	(cm^2/s)	8.95E-02	7.69E-02	6.85E-02	6.54E-02	7.60E-02	5.05E-02	7.78E-02	6.84E-02	6.89E-02
Diffusivity in Water[7]	$D_{w,i}$	(cm^2/s)	1.03E-05	1.09E-05	8.46E-06	1.00E-05	1.08E-05	9.46E-06	9.20E-06	8.44E-06	8.53E-06
Dimensionless Henry's Law Constant[7]	H'	(unitless)	2.27E-01	1.50E-01	3.22E-01	3.97E+00	1.40E+01	7.24E-01	2.71E-01	2.94E-01	2.12E-01
Emission Rate over Entire Site	E	(mg/sec)	1.15E-04	2.22E-05	3.46E-05	2.71E-04	8.78E-04	7.74E-04	2.11E-04	1.36E-04	4.35E-05
Length of Side of Site (taken as $Area^{0.5}$) [8]	LS	(m)	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01	2.20E+01
Average Wind Velocity[8]	V	(m/sec)	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00	2.25E+00
Mixing Height[8]	MH	(m)	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00
Concentration in Outdoor Air ($EPC_{outdoor\ air}$)		**(mg/m^3)**	**1.16E-06**	**2.24E-07**	**3.49E-07**	**2.74E-06**	**8.87E-06**	**7.82E-06**	**2.13E-06**	**1.37E-06**	**4.40E-07**

Notes:

µg/L = micrograms per liter.
m^2 = square meter.
m = meter
L = liter
cm^2/s = square centimeter per second.
mg/sec = milligrams per second.
m^2/sec = square meters per second.
mg/m^3 = milligrams per cubic meter.

1 Equations for the emission rate (flux from subsurface vapor source) are from ASTM (1995).
2 Equations for the box model are from DTSC (1994).
3 The value for the planned paver system area is approximately 5,000 square feet (484 m^2).
4 Vapor phase concentrations estimated from soil gas concentrations. Depth to soil vapor is approximately 5 feet below ground surface or 1.52 meters.
5 Values for total and water-filled porosity are default values for a "sandy clay loam" (DTSC, 2014).
6 Air-filled porosity is equal to total soil porosity minus water-filled porosity.
7 Chemical-specific properties were obtained from USEPA (2016).
8 Default value from DTSC (1994).
9 Attenuation factor is the concentration in outdoor air divided by the concentration in soil gas.

Reference:

ASTM. 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. American Society for Testing and Materials, Designation E1739-95. November.
DTSC. 1994. Preliminary Endangerment Assessment Guidance Manual. California Environmental Protection Agency. January.
DTSC. 2014. DTSC Screening-Level Model for Soil Gas Contamination. California Environmental Protection Agency. Last Modified December.
USEPA. 2016. Regional Screening Levels for Chemical Contaminants at Superfund Sites. USEPA Region 3, Region 6, and Region 9. May.

ATTACHMENT C1

DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS

FOR THE RESIDENTIAL EXPOSURE SCENARIO

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Tetrachloroethylene**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
8.50E+03	4.9E-04	4.2E+00	8.8E-06	1.2E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Benzene

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
7.10E+02	7.6E-04	5.4E-01	5.6E-06	1.7E-01

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
71432	7.10E+02			Benzene

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: Residential
Chemical: Toluene

DATA ENTRY SHEET

Results Summary				
Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
1.50E+03	6.9E-04	1.0E+00	NA	3.3E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108883	1.50E+03			Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **Ethylbenzene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
2.80E+02	6.3E-04	1.8E-01	1.6E-07	1.7E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
100414	2.80E+02			Ethylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **m-Xylene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.10E+03	6.3E-04	6.9E-01	NA	6.6E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108383	1.10E+03			m-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **o-Xylene**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
3.50E+02	6.3E-04	2.2E-01	NA	2.1E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
95476	3.50E+02			o-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: **Residential**
Chemical: **Trichlorofluoromethane**

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
2.30E+03	6.0E-04	1.4E+00	NA	1.9E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75694	2.30E+03			Trichlorofluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Residential**
Chemical: **Dichlorodifluoromethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
6.40E+03	6.8E-04	4.3E+00	NA	4.1E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75718	6.40E+03			Dichlorodifluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Chloroform

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.60E+02	6.8E-04	1.1E-01	8.9E-07	1.1E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.60E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

END

ATTACHMENT C2

DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FOR THE COMMERCIAL EXPOSURE SCENARIO

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Tetrachloroethylene**

Results Summary				
Soil Gas Conc. (μg/m^3)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m^3)	Cancer Risk	Noncancer Hazard
8.50E+03	**2.5E-04**	**2.1E+00**	**1.0E-06**	**1.4E-02**

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m^3)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
127184	8.50E+03			**Tetrachloroethylene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Benzene**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
7.10E+02	3.8E-04	2.7E-01	6.4E-07	2.1E-02

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
71432	7.10E+02			Benzene

MESSAGE: See VLOOKUP table comments on chemical properties and/or toxicity criteria for this chemical.

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

Scenario: Commercial
Chemical: Toluene

DATA ENTRY SHEET

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.50E+03	3.4E-04	5.2E-01	NA	3.9E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108883	1.50E+03			Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Ethylbenzene**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
2.80E+02	**3.1E-04**	**8.8E-02**	**1.8E-08**	**2.0E-05**

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
100414	2.80E+02			**Ethylbenzene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **m-Xylene**

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.10E+03	**3.1E-04**	**3.4E-01**	**NA**	**7.9E-04**

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
108383	1.10E+03			**m-Xylene**

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **o-Xylene**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
3.50E+02	3.1E-04	1.1E-01	NA	2.5E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
95476	3.50E+02			o-Xylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Trichlorofluoromethane**

Results Summary

Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
2.30E+03	3.0E-04	7.0E-01	NA	2.3E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75694	2.30E+03			Trichlorofluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (^oC)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

Lookup Soil Parameters

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: **Commercial**
Chemical: **Dichlorodifluoromethane**

Results Summary				
Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
6.40E+03	3.4E-04	2.2E+00	NA	4.9E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
75718	6.40E+03			Dichlorodifluoromethane

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)⁻¹
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Commercial
Chemical: Chloroform

Results Summary

Soil Gas Conc. (μg/m³)	Attenuation Factor (unitless)	Indoor Air Conc. (μg/m³)	Cancer Risk	Noncancer Hazard
1.60E+02	3.4E-04	5.5E-02	1.0E-07	1.3E-04

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g (μg/m³)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.60E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm²)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm³)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm³/cm³)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH (hour)$^{-1}$
NEW=> Commercial	70	25	25	250	8	1
					(NEW)	(NEW)

END

ATTACHMENT D

FATE AND TRANSPORT FOR VAPOR EMISSIONS OF CHLOROFORM FROM SOIL VAPOR INTO INDOOR AIR (ELEVATOR SHAFT SCENARIO) - DTSC J/E MODEL FOR SUBSURFACE VAPOR INTRUSION INTO BUILDINGS FOR THE RESIDENTIAL EXPOSURE SCENARIO

USEPA SG-SCREEN
Version 2.0, 04/2003

DTSC Modification
December 2014

Department of Toxic Substances Control
Vapor Intrusion Screening Model - Soil Gas

DATA ENTRY SHEET

Scenario: Residential
Chemical: Chloroform

Results Summary				
Soil Gas Conc. ($\mu g/m^3$)	Attenuation Factor (unitless)	Indoor Air Conc. ($\mu g/m^3$)	Cancer Risk	Noncancer Hazard
1.90E+02	6.8E-04	1.3E-01	1.1E-06	1.3E-03

Reset to Defaults

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
67663	1.90E+02			Chloroform

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	152	24	SCL		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
SCL	1.63	0.384	0.146	5

MORE ↓

Lookup Receptor Parameters

	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Exposure Time ET (hrs/day)	ENTER Air Exchange Rate ACH $(hour)^{-1}$
NEW=> Residential	70	26	26	350	24	0.5
					(NEW)	(NEW)

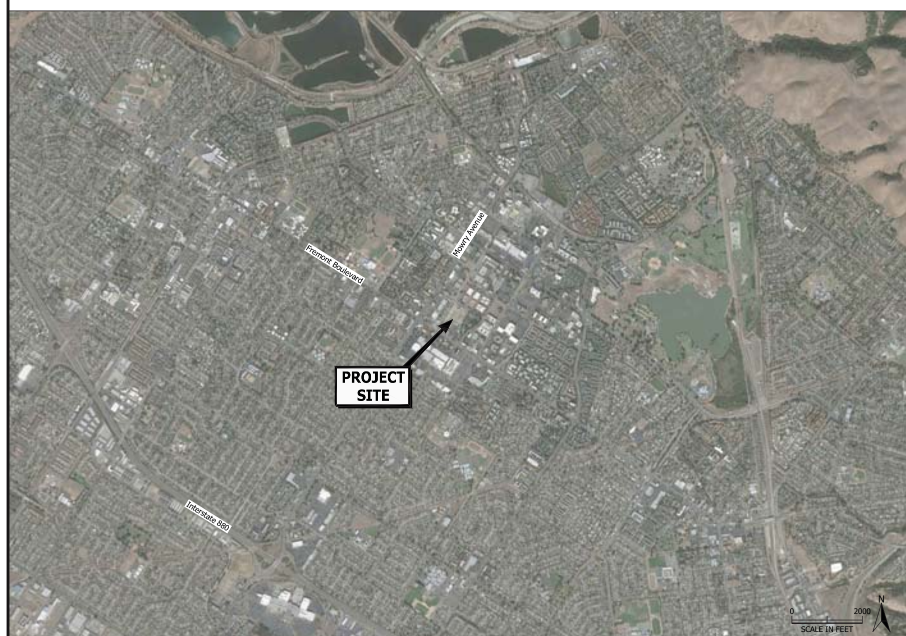
END

APPENDIX B

VAPOR MITIGATION SYSTEM (VMS) DRAWINGS (AUGUST 18, 2016)

VAPOR MITIGATION SYSTEM (VMS)
LOCALE @ STATE STREET
ON-GRADE TOWNHOMES
FREMONT, CALIFORNIA

Site Location



Site Plan

Project Information

Prepared For:
Fremont State Street Center, LLC
3000 Executive Parkway, Suite 450
San Ramon, California 94583

Prepared By:
PES Environmental, Inc
1682 Novato Boulevard, Suite 100
Novato, California 94947

Architect:
KTGY Group, Inc.
580 Second Street, Suite 200
Oakland, California 94607

Sheet Index

PES Environmental, Inc.
Engineering & Environmental Services

A Project for:

LOCALE @ STATE STREET
ON-GRADE TOWNHOMES
FREMONT, CALIFORNIA

Client:
Fremont State Street Center, LLC
3000 Executive Parkway, Suite 450
San Ramon, California, 94583

Revisions:

No.	Description	Date
	VMS Report Update	6/15/2016
	City Submittal	7/13/2016
3	3rd Plan Check Response	8/18/2016

Project No.:	220.003.03.002
Drawn By:	BP
Reviewed By:	SM
Scale:	AS NOTED
Date:	8/18/2016
Filename:	22000303002_VB_r3_1-4

Seal: REGISTERED PROFESSIONAL ENGINEER SCOTT M. MORRISON C 64748 CIVIL STATE OF CALIFORNIA

Sheet Title: TITLE SHEET

Sheet #: VM-1.0

GENERAL NOTES & SPECIFICATIONS

I. GENERAL NOTES

A. Applicability

1. The subslab vapor mitigation system details presented in these plans and specifications shall be utilized in the construction of buildings as shown on this plan set.
2. The owner of this project is Fremont State Street Center, LLC (FSSC).
3. The Project Engineer for construction of this vapor mitigation system is PES Environmental, Inc. (PES).
4. The regulatory agency for this project is Alameda County Environmental Health (ACEH).

B. Quality Assurance

1. The Vapor Barrier Contractor/Applicator shall be trained and approved by the Vapor Barrier Manufacturer (e.g., Land Science Technologies for Geo-Seal). The Contractor/Applicator shall provide the Project Engineer with a letter from the manufacturer that: (a) confirms that the Contractor/Applicator is certified by the manufacturer for installation of the product; and (b) warranties its product to be free of defects when that product is installed by the Contractor/Applicator.
2. A pre-installation conference shall be held at the project site prior to the installation of the vent system and application of the vapor barrier to assure proper subgrade, conditions and installation procedures. Construction of slab depressions, as applicable, shall be discussed to ensure that the vent piping and vapor barrier will be protected in these areas. The Vapor Barrier Contractor/Applicator, site superintendent for the General Contractor, the foundation subcontractor, and the Project Engineer shall be present at this meeting.
3. The installation of the vent system and vapor barrier shall be observed by the Project Engineer, or a designated representative. Inspections shall typically be performed prior to, during, and subsequent to the application of the system.
4. All surfaces to receive the vapor barrier shall be inspected and approved by the Contractor/Applicator and the Project Engineer prior to commencing work.
5. Materials (excluding bulk aggregates) are to be delivered to the project site in their original unbroken packages bearing the manufacturers label showing brand, weight, volume and batch number, where applicable. Materials are to be stored at the project site in strict compliance with the manufacturer's instructions. Do not allow materials to freeze in containers.

C. Submittals

1. The Vapor Barrier Contractor/Applicator shall submit any updates or revisions to the manufacturers product data and recommended installation procedures to the Project Engineer for review and approval at least two weeks prior to the construction of the vapor barrier.
2. The Vapor Barrier Contractor/Applicator and the foundation subcontractor shall submit representative samples and manufacturer's cut-sheets of the following to the Project Engineer for approval:
   - Base layer beneath the vapor barrier membrane;
   - Vapor barrier membrane material;
   - Protection layer below and above the vapor barrier membrane; and
   - Low profile vent piping.
3. At the completion of the installation, the Contractor/Applicator shall submit a letter to the Owner and Project Engineer certifying that installation was completed in accordance with the project plans and specifications as well as the procedures recommended by the manufacturer.

D. Job Conditions

1. All plumbing, electrical, mechanical and structural items that are located beneath, or that pass through (if any), the vapor barrier membrane shall be positively secured in their proper positions and appropriately protected prior to application of the membrane.
2. It shall be the responsibility of the General Contractor to prepare the subgrade to the desired condition and appropriate elevation prior to the arrival of the Vapor Barrier Contractor/Applicator.
3. The areas adjacent to the vapor barrier are to be protected by the Vapor Barrier Contractor/Applicator during the installation process. Where necessary, masking or other protective measures shall be applied to prevent staining of surfaces beyond the limits of the application.
4. Work is to be performed only when existing and forecasted weather conditions are within the manufacturers recommendations for the material and product used. The application of the vapor barrier membrane compounds shall be suspended if the ambient temperature falls below 45°F, or during periods of precipitation. Allow longer curing time in high humidity conditions. Take precautions not to overspray into unprotected areas during windy conditions.
5. Minimum clearance required for application of this product is 2 feet.
6. The vapor barrier membrane shall be installed before placement of reinforcing steel. If reinforcing steel is present at the time of application, all exposed reinforcement shall be masked prior to membrane application to ensure that the steel surface remains free of the product.

II. PASSIVE VENT SYSTEM

The subslab vent system shall be installed beneath the vapor barrier and concrete floor slab of the buildings shown on Sheet VM-2.0 of this plan set. The passive vent system shall consist of perforated horizontal vent lines installed in a gravel layer under the vapor barrier and vent risers. General specifications for this system are as follows:

A. General

1. Subslab horizontal vent lines shall be placed such that no portion of the foundation is more than 25 feet from the vent lines.
2. Where solid piping transitions through building footings, the penetration shall be accomplished in compliance with the International Building Code and with the approval of the Project Structural Engineer and the Building Official.
3. Vent risers may be located within the building walls, furred pilasters, or shall be similarly protected from physical damage. Vent risers shall not be located within fire walls.

B. Materials

1. The gravel layer shall be ¾-inch or less with rounded edges and shall contain minimal fines. The gravel layer must be compacted and rolled flat.
2. Subslab horizontal vent lines (low profile) shall be Vapor-Vent manufactured by Land Science Technologies, or an equivalent product approved by the Project Engineer. Connector fittings that connect the low profile vent lines to solid vent piping shall be from the same manufacturer as the low profile vent lines.
3. Solid subslab vent piping shall be 3-inch diameter Sch. 40 PVC. Subslab vent piping shall transition to 3-inch diameter vent risers within the building interior.

C. Installation

1. Low profile vent piping shall be placed in conjunction with the gravel venting layer. Install the low profile vent piping at the top of the gravel layer.
2. At points of intersection, cut away vent piping geotextile to produce rectangular flaps. Interlock exposed dimple boards and fold flaps of geotextile in a manner so that the dimple boards are covered completely. Secure geotextile folds with fiber reinforced tape so that the geotextile is completely impermeable to the gravel.
3. Subgrade low profile vent pipes that cross interior footings shall be connected to solid vent pipe embedded in the concrete slab footings/grade beams when poured. Alternatively, and only if necessary and with approval of the Project Engineer, existing concrete footings can be cored and solid venting pipe no less than 3-inch diameter may be placed through the footing.
4. Subgrade low profile vent pipes shall be connected to the solid vent pipe using manufacturer end outlets. Solid vent pipe shall not be less than 3-inch diameter and shall be constructed of materials that comply with the Uniform Plumbing and International Mechanical Codes. All joints shall be tightly sealed.
5. Where it passes through concrete footing, solid vent pipe shall be continuously wrapped with foam pipe wrap tape in accordance with the Uniform Plumbing Code.
6. Vent risers shall be constructed using 3-inch diameter pipe approved by the Project Engineer and Building Official in compliance with the Uniform Plumbing Code. Risers shall terminate at an approved outlet in accordance with this plan set and the Uniform Plumbing Code.
7. Horizontal vent riser piping shall be set at an incline, with a slope of no less than 2%, in order to allow any enclosed moisture or condensate to run back down the vertical vent riser sections to the subgrade.
8. Vent risers shall be located as follows:
   - 10 feet above grade;
   - 10 feet away from any window, door, roof hatch, opening or air intake into the building;
   - 3 feet above the highest point of roof within a 10 foot radius of outlet;
   - 3 feet away from any parapet;
   - 5 feet from any electrical device; and
   - 4 feet away from the property line.

10. Venting pipe shall be clearly marked with warning labels. This may be accomplished through stencils, labels, or other permanent labeling method. Pipes shall be clearly and permanently labeled in ½-inch high (minimum) letters, near the vent piping outlets and at 10-foot (minimum) intervals along the remainder of the venting pipe. This includes sections encased within walls or other enclosures.

III. VAPOR BARRIER

The vapor barrier shall be installed beneath the concrete floor slab of the buildings shown on Sheet VM-2.0 of this plan set. General specifications for this system are as follows:

A. General

1. The vapor barrier membrane shall have a minimum cured (dry) thickness of 60 mils (0.060 inches).
2. The vapor barrier shall be placed between the bottom of the floor slab and the subgrade gravel venting layer, and fastened to footings and foundations, in accordance with this plan set. The vapor barrier shall be placed directly below the bottom of the floor slab, except where the barrier may attach to deepened interior or perimeter footings.
3. The upper surface of the vapor barrier membrane shall be protected by a protection layer, placed directly above the membrane as specified on this plan set.
4. Prior to placing the protection layer material over the vapor barrier membrane, the Project Engineer shall inspect and test the membrane, observe smoke tests by Vapor Barrier Contractor/Applicator, and approve the vapor barrier in accordance with these plans and specifications. Construction of the floor slab shall not proceed without written certification of the successful installation of the vapor barrier system by the Vapor Barrier Contractor/Applicator and the approval of the Project Engineer.
5. Where piping, electrical conduits, etc. penetrate the membrane, a collar shall be provided to create a gas-tight seal around the penetration.
6. All piping associated with the subslab vent system shall be installed below the vapor barrier membrane, or shall be sealed using approved seals or boots in accordance with these plans, where they penetrate the membrane.
7. Reinforcing steel, piping, forms, etc. shall not be supported directly on the vapor barrier membrane or protective layer covering. Flat-bottomed dobie blocks, rebar chair, or similar non-puncturing materials shall be used to support reinforcing steel atop the protection layer.
8. Equipment shall not be driven over the vapor barrier membrane or its protective covering.
9. Notification of the presence of a subslab vapor barrier system shall be permanently stamped or affixed to the slab or wall in accordance with this plan set.

B. Materials

1. The vapor barrier system shall be Geo-Seal manufactured by Land Science Technologies, or an equivalent product approved by the Project Engineer.
2. The Geo-Seal system shall consist of the following:
   - Geo-Seal Base for the base layer beneath the spray-applied membrane;
   - Geo-Seal Core for the spray-applied membrane material; and
   - Geo-Seal Bond for the protection layer above the membrane.

C. Installation

1. Concrete surfaces at the interface with the vapor barrier shall be light broom finished or smoother, free of any dirt, debris, loose material, release agents or curing compounds. All voids more than ¼-inch in depth and ¼-inch in width shall be properly filled. Masonry joints shall be struck smooth with a metal trowel. Minimum ¾-inch cant of trowel or brush applied membrane, or other suitable material, shall be applied at all horizontal to vertical transitions and other inside corners of 120° or less. The material shall be allowed to cure overnight before application of the spray-applied membrane. All cracks and cold joints greater than 1/16th-inch must be completely grouted with non-shrink grout as approved by the Project Engineer. Install Hardcast reinforcing tape over all cold joints, cracks and form tie holes (after holes and cracks are grouted). Expansion joints must be filled with a conventional waterproof expansion joint material.
2. The finished surface of the underlying venting layer shall be rolled flat and be free of debris and any protruding sharp edges. The walls of footing or utility trenches shall be smooth and free of roots or protruding rocks. Final subgrade inspection shall not precede the membrane application by more than 72 hours.
3. All penetrations shall be prepared in accordance with manufacturers specifications. Any form stakes that penetrate the membrane shall be solid plastic stakes such as the VaporStake (www.vaporstake.com) or equivalent approved by the Project Engineer. The plastic stakes shall be left in the slab and may be cut flush with the top of the concrete slab as necessary. If rebar is required to penetrate the membrane, reinforcing steel penetrations should be cleaned to remove rust to insure proper adherence of the membrane. Once sealed, reinforcing rebar shall not be removed and shall be bent over and left in the slab when poured.
4. Trenches shall be cut oversize as necessary to accommodate the membrane. Any open utility, footing, or other trench present at the time of application shall be lined with the base layer extending at least six inches onto the adjoining subgrade. The base layer shall be in integral contact with the subgrade at all interior corners. Secure all overlapped seams of the base layer in accordance with this plan set.
5. The base layer shall be sealed in integral contact with interior foundations as shown in this plan set.
6. Spray apply membrane to a 60 mil (0.060inches) minimum dry thickness except in the vicinity of elevator pits, where the membrane layer shall be applied to a minimum cured dry thickness of 80 mils (0.080 inches). If a second coat is required, remove any standing water from the membrane prior to proceeding with installation. Prepare vapor barrier membrane materials according to manufacturers recommendations.
7. The upper surface of the membrane shall be protected by the protection layer, placed directly above the membrane as specified on these plans. Prior to placing the protective layer material over the membrane, the Project Engineer shall inspect and test the vapor membrane, observe smoke tests by the Vapor Barrier Contractor/Applicator, and approve the vapor barrier in accordance with these plans and specifications. Construction of the floor slab shall not proceed without written certification of the successful installation of the vapor barrier membrane system by the Contractor/Applicator.
8. Appropriate care shall be exercised to protect the membrane and prevent penetrations subsequent to its application. The membrane shall be kept free of dirt, debris and traffic until the concrete slab is in place. It shall be the responsibility of the General Contractor to ensure that the membrane is not penetrated after the placement of the protective layer.
9. If penetrations are required during subsequent tenant improvements, the procedures are detailed in this plan set.
10. If exposed to precipitation prior to placement of the slab, the vapor barrier will trap water above its surface. Appropriate care shall be taken to prevent ponding of water atop the vapor barrier prior to placement of the slab.

D. Sealing Penetrations

1. All penetrations shall be securely in place prior to installation of the membrane. Seal all pipes and conduits that penetrate the vapor barrier as shown in this plan set..
2. All penetrations shall be cleaned, as necessary, to provide a gas tight seal. All metal penetrations shall be cleaned with a mild non-chlorinated solvent to remove factory oils and then sanded clean with emery cloth.
3. Cut base layer and protection layers around penetrations so that they lay flat on the gravel venting layer. Lay base layer and protection layers tight at all inside corners.
4. Penetration should be treated in a 6-inch radius around the penetration and 3 inches onto penetrating object. The application shall be allowed to cure completely before proceeding.
5. The penetration shall be wrapped with a cable tie at a point two inches above the base of the penetration. The cable tie shall be tightened firmly so as to squeeze the cured membrane collar.
6. Conduits penetrating the barrier shall be sealed on their interior using either electrical "Y" seals (EYS fittings) or, in conformance with electrical code, by creating an internal vapor seal at a conduit termination by placing expandable polyurethane foam (EPF). The EPF seals shall have a length at least 6 times the inside diameter of the conduit.

E. Inspections and Testing

1. Field Quality Control is a very important part of all subslab vapor system applications. The Contractor/Applicator shall check his own work for coverage, thickness, and all around good workmanship, before calling for inspections.
2. Gravel layer thickness shall be checked once per every 1,000 square feet of application. Thickness checks shall be performed prior to placement of the first protection or base layer.
3. The membrane must be cured at least overnight before inspecting for dry thickness, holes, and shadow shrinkage, and any other membrane damage.
4. Membrane coupon samples to be inspected shall be cut by the Project Engineer or its designee from the spray-applied membrane and base layer composite. One coupon sample shall be cut for each 500 square feet of vapor barrier application. Each coupon shall be square and have maximum area of 2 square inches (per manufacturers specifications). The thickness of the composite layer shall be measured on all sides with a digital caliper having a resolution of 1 mil or better. The thickness of the plain base layer (as determined from uncoated samples) shall be deducted from the composite thickness in order to determine the thickness of the spray-applied membrane. The test areas shall be marked for repair by the Project Engineer.
5. Voids left by sampling shall be patched by the Vapor Membrane Barrier Contractor/Applicator with the base layer overlapping the void by a minimum of two inches and the vapor barrier membrane shall be applied to a 60 mil minimum dry thickness, extending at least three inches beyond the base layer patch.
6. On concrete footings, the vapor barrier membrane shall be checked for coverage with a depth gauge. Four readings shall be taken over a one square inch area for every 500 lineal feet of membrane application along the footings. The minimum reading shall be recorded and the test area shall be marked for repair by the Project Engineer. Test areas at concrete footings shall be patched with to a 60 mil (0.060 inch) minimum dry thickness, extending a minimum of one inch beyond the test perimeter.
7. Each completed membrane shall be smoke tested at the completion of the installation to confirm the integrity of the membrane system. Smoke testing shall be performed by the Contractor/Applicator in the presence the Project Engineer. Several smoke tests shall be performed using the coupon sample holes and vent piping stub-outs to test the entire membrane area. Smoke shall be pumped beneath the membrane at a pressure of approximately 2 to 5 inches of water column pressure. The test area of each smoke test will be determined by visible rise in the membrane surface. Any leaks which are identified shall be repaired, the membrane allowed to cure for a minimum of 1 hour, and the membrane re-tested, until all leaks/perforations are eliminated. The number and duration of smoke tests shall be determined at the time of smoke testing by the Project Engineer. The protective layer shall not be placed over the membrane until the Contractor/Applicator has certified the successful installation of the vapor barrier membrane, and only upon the approval of the Project Engineer.

3 IV. SUBSEQUENT VAPOR BARRIER PENETRATIONS

No penetrations shall be made in the foundation slab without prior approval from the Structural Engineer.

A. Preserving and Repairing the Vapor Barrier:

1. To maintain the integrity of the vapor barrier, the completed slab shall not be penetrated without notification to, and approval by, the Project Engineer. However, it is recognized that tenant improvements may require building improvements that could include penetrating the concrete slab and underlying vapor barrier. If the slab is penetrated the barrier shall be preserved and repaired in accordance with these specifications.
2. Sheet VM-4.0 presents procedures for preserving and repairing the vapor barrier when penetrations are necessary. It is critical that a shallow sawcut equal to at least one inch less than the slab thickness be performed around the perimeter of the area, and the perimeter concrete be chipped away by hand in order to preserve the underlying vapor barrier. Steps 1, 2 and 4, including sawcutting, concrete breaking and concrete patching may be performed by others. It is recommended that this work be coordinated with the Project Engineer and Contractor/Applicator to ensure the remaining vapor barrier flaps are sufficient to perform the vapor barrier repairs. Step 3, the vapor barrier repairs, must be performed by the Certified Contractor/Applicator in order to maintain the original warranty.
3. Vapor barrier repairs shall be inspected and documented by the Project Engineer or their designee. Testing shall be performed as appropriate at the discretion of the Project Engineer.

VI. "AS-BUILT" DOCUMENTATION

A. The inspection of all vapor control measures constructed per these specifications shall be performed by a California licensed Professional Engineer (i.e. the Project Engineer) or his or her designee. "As-Built" Certification of installation of the vapor control measures shown in these plans shall be provided to the Project Engineer at the completion of construction.

B. Addenda to the "As-Built" documentation shall be prepared, as necessary, to document future vapor barrier repairs necessitated by tenant improvements that penetrate the vapor barrier.

PES Environmental, Inc.
Engineering & Environmental Services

A Project for:

LOCALE @ STATE STREET
ON-GRADE TOWNHOMES
FREMONT, CALIFORNIA

Client:

Fremont State Street Center, LLC

3000 Executive Parkway, Suite 450
San Ramon, California, 94583

Revisions:

No.	Description	Date
	VMS Report Update	6/15/2016
	City Submittal	7/13/2016
3	3rd Plan Check Response	8/18/2016

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Filename:	22000303002_VB_r3_1-4

Seal:

REGISTERED PROFESSIONAL ENGINEER
SCOTT M. MORRISON
C64748
CIVIL
STATE OF CALIFORNIA

Sheet Title:

GENERAL NOTES & SPECIFICATIONS

Sheet #:

VM-1.1

Explanation

Building where Vapor Mitigation Measures to be Installed for PCE (and PCE degradation products)

PES Environmental, Inc.
Engineering & Environmental Services

A Project for:

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Seal:

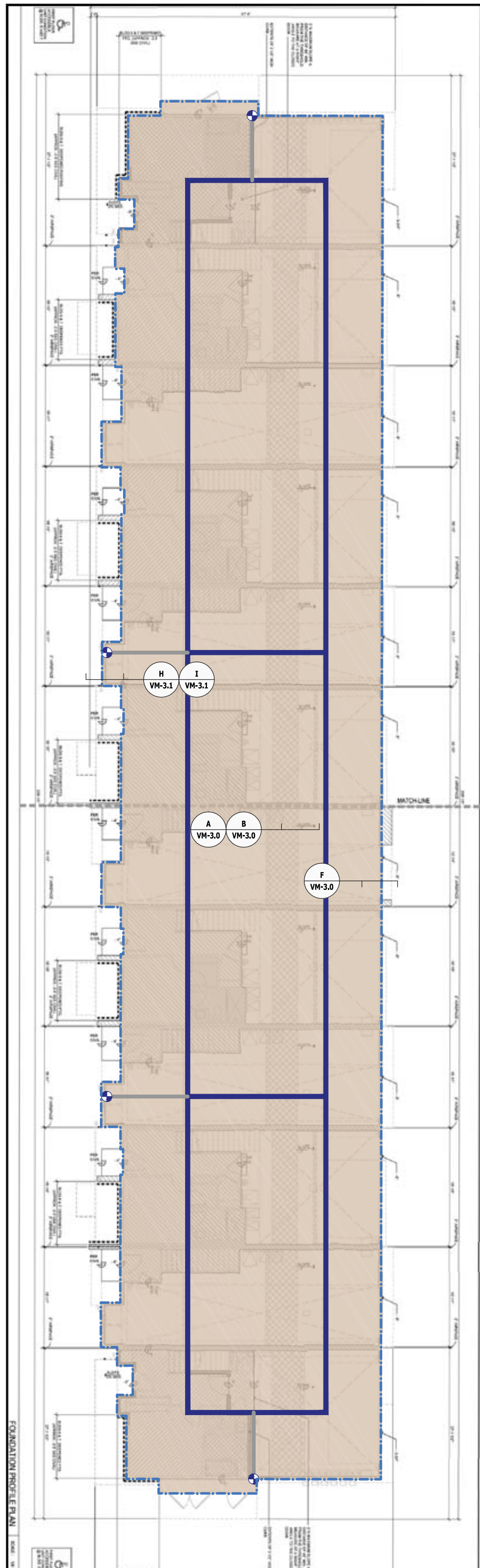
REGISTERED PROFESSIONAL ENGINEER SCOTT M. MORRISON C 64748 CIVIL STATE OF CALIFORNIA

Sheet Title:

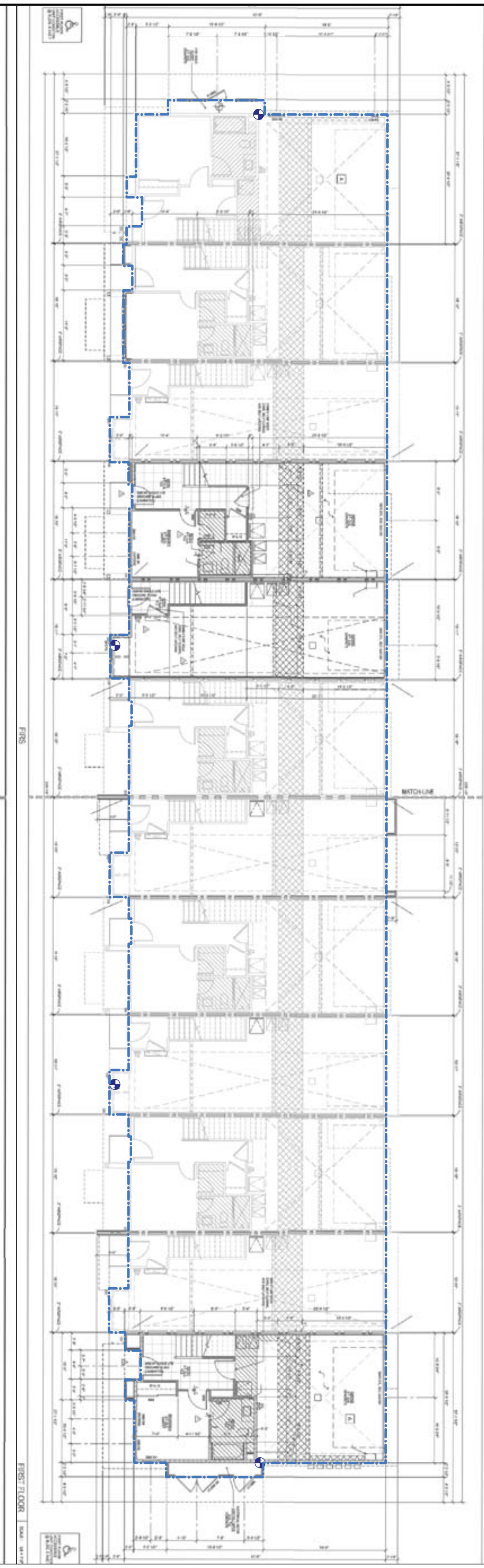
SITE PLAN

Sheet #:

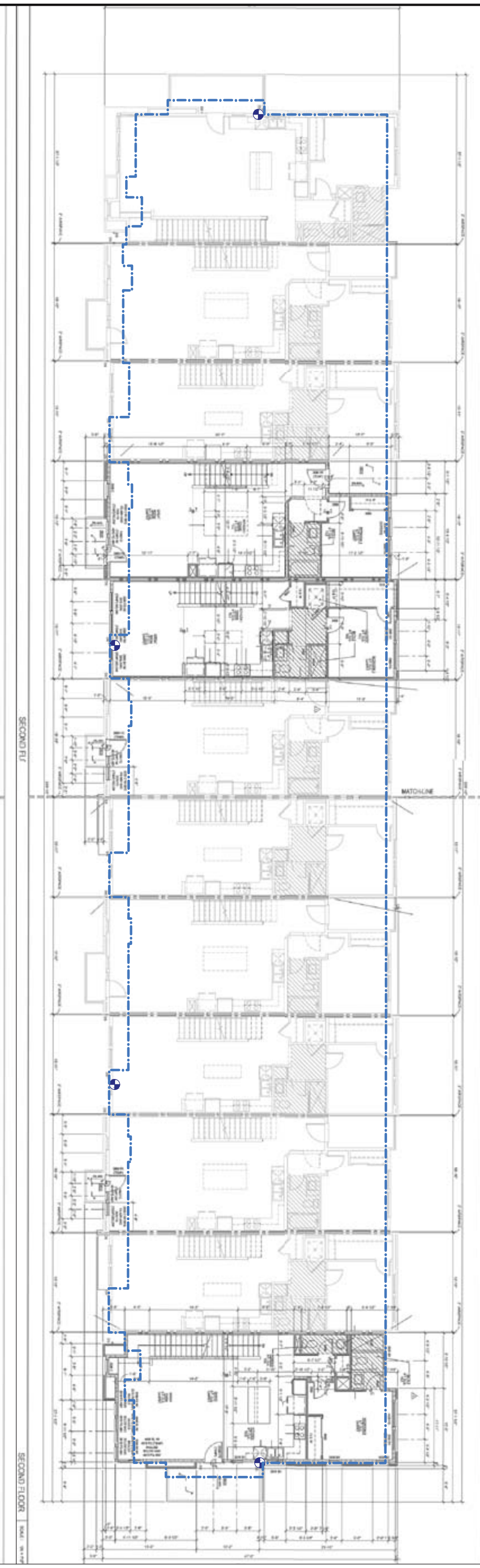
VM-2.0



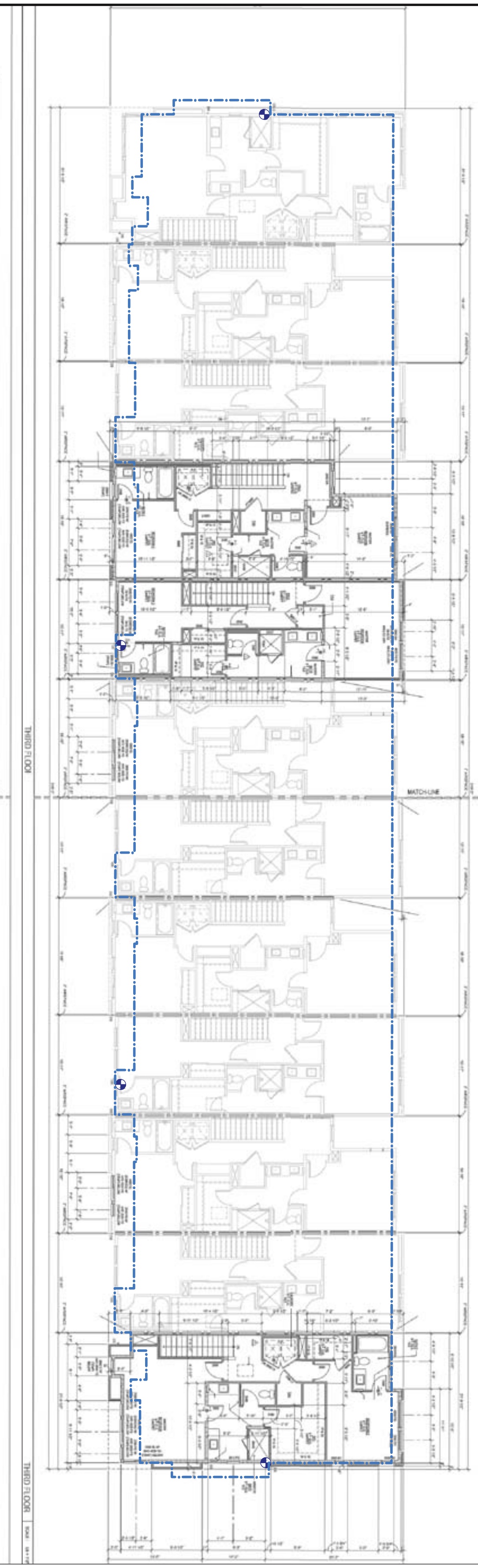
Foundation Plan
Type C.1 - Building 7



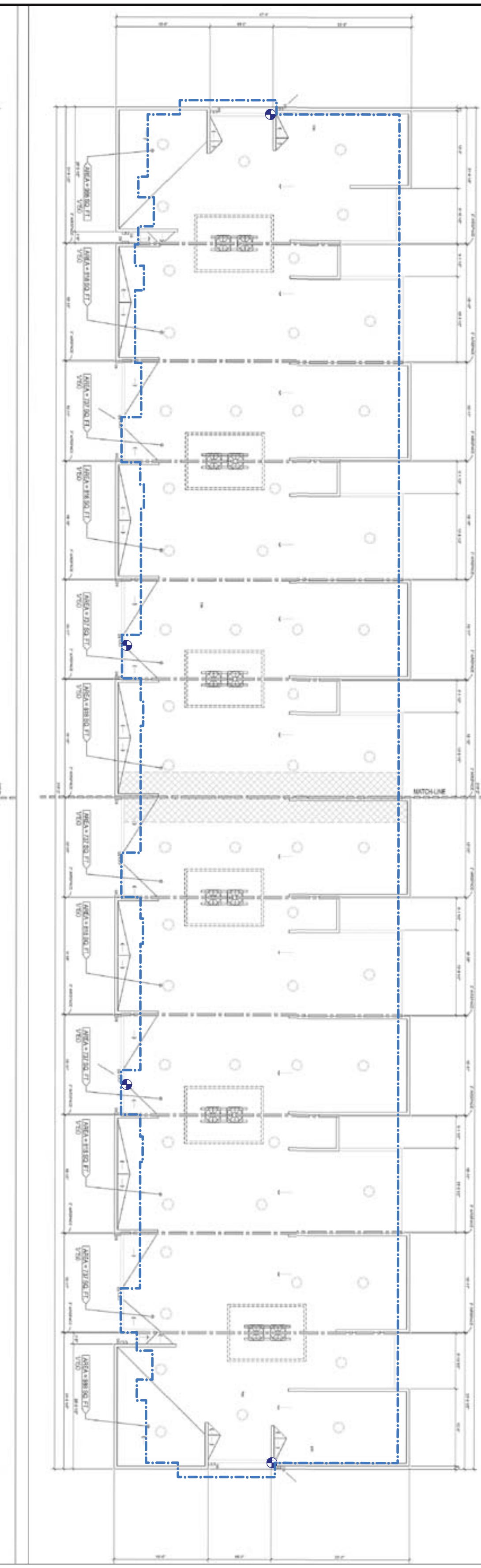
First Floor Plan
Type C.1 - Building 7



Second Floor Plan
Type C.1 - Building 7



Third Floor Plan
Type C.1 - Building 7



Roof Plan
Type C.1 - Building 7

Explanation

- Areal Extent of Subslab Vapor Barrier Membrane
- Low Profile Vent Piping
- Solid Vent Piping (3-inch diameter)
- VR1 Proposed Vent Riser Location

N

0 10
SCALE IN FEET

PES Environmental, Inc.
Engineering & Environmental Services

A Project for:

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Seal:

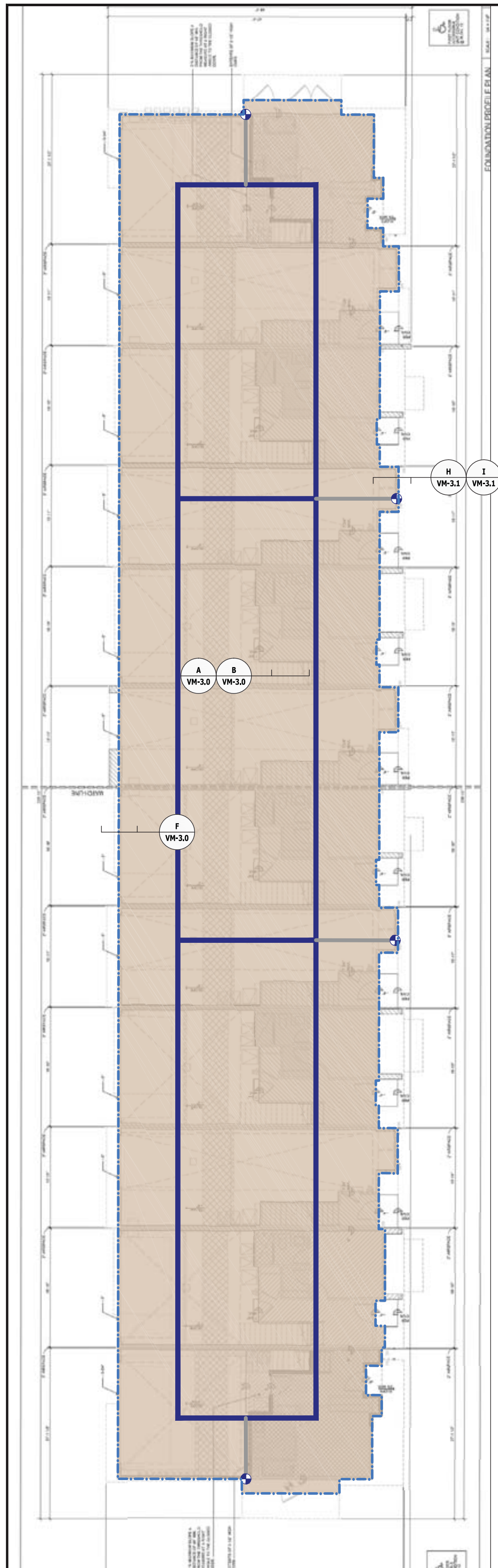
REGISTERED PROFESSIONAL ENGINEER
SCOTT M. MORRISON
C 64748
EXP.
CIVIL
STATE OF CALIFORNIA

Sheet Title:

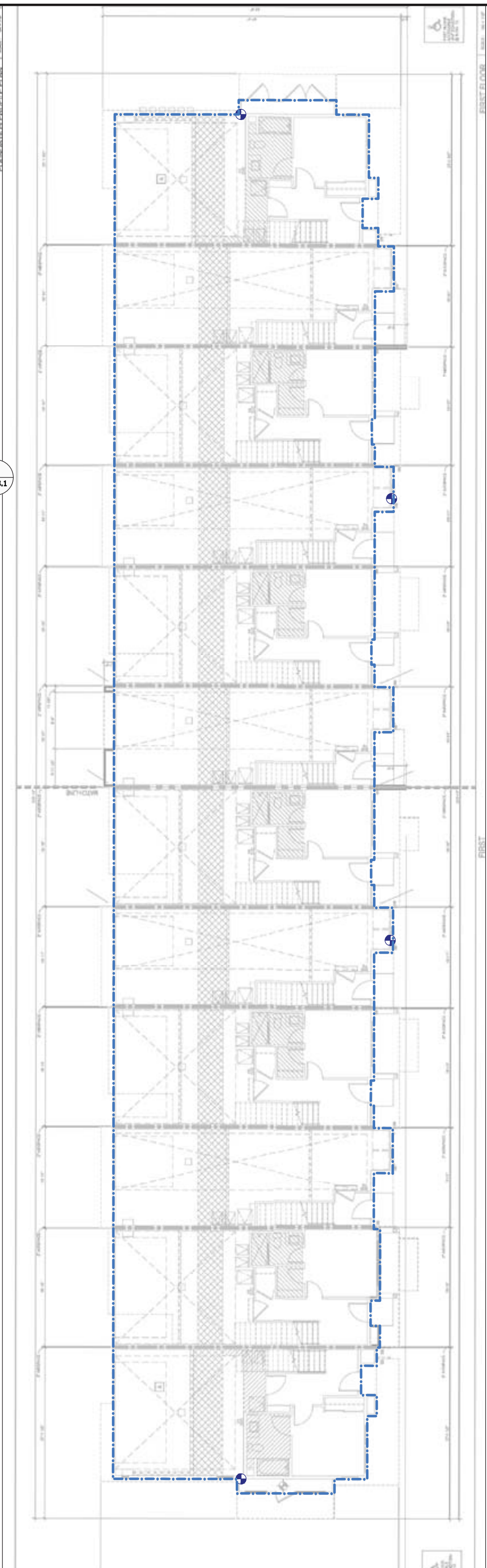
SYSTEM
CONFIGURATION
BUILDING TYPE C.1
(BUILDING #7)

Sheet #:

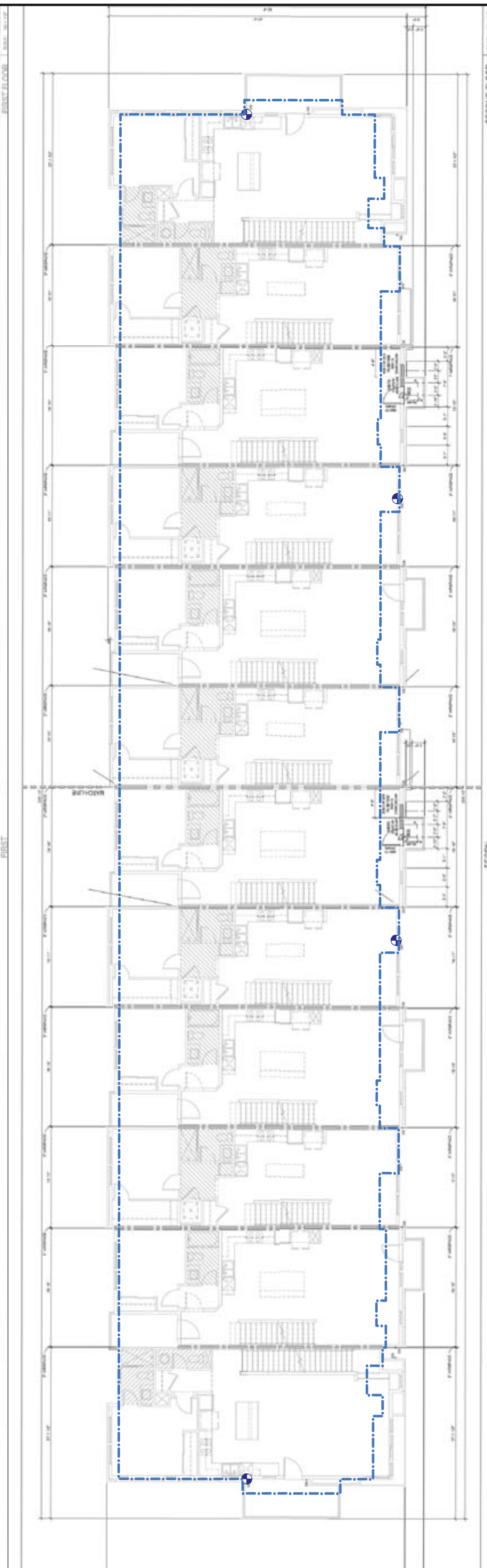
VM-2.1



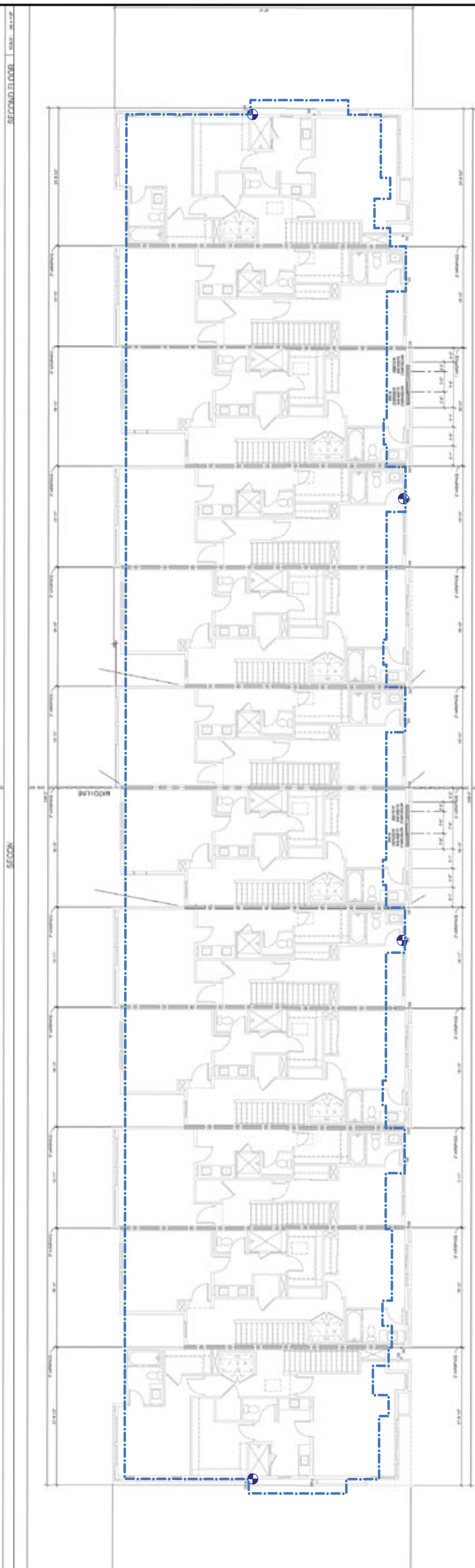
Foundation Plan
Type C.3 - Building 12



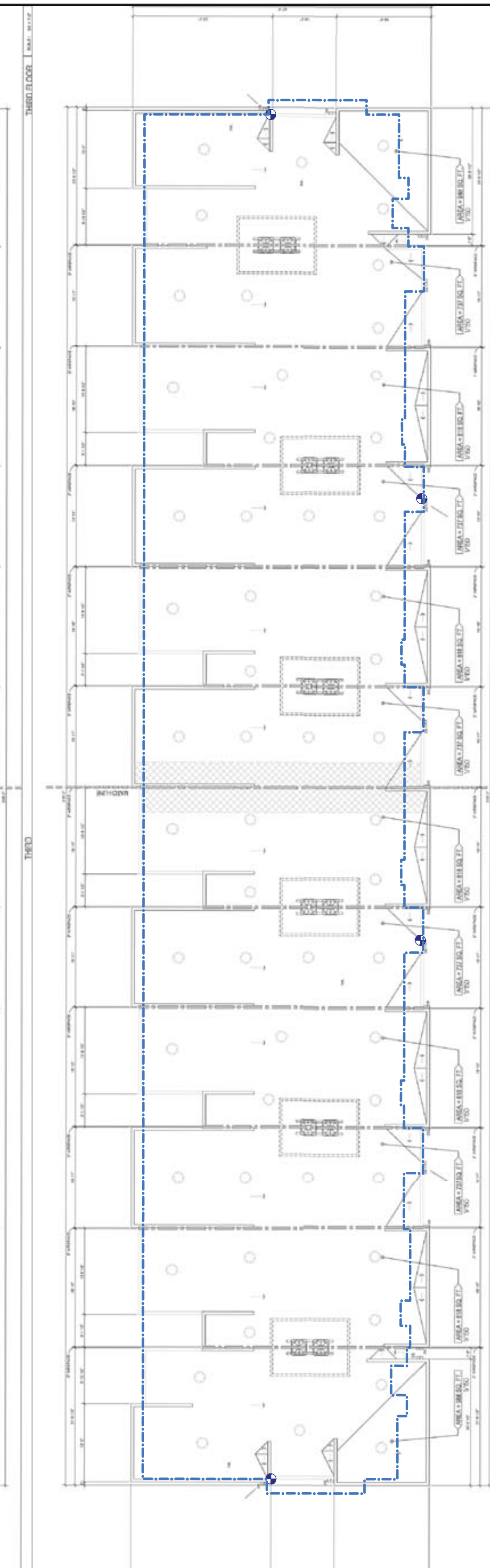
First Floor Plan
Type C.3 - Building 12



Second Floor Plan
Type C.3 - Building 12



Third Floor Plan
Type C.3 - Building 12



Roof Plan
Type C.3 - Building 12

Explanation

- Areal Extent of Subslab Vapor Barrier Membrane
- Low Profile Vent Piping
- Solid Vent Piping (3-inch diameter)
- VR1 Proposed Vent Riser Location

N

0 10
SCALE IN FEET

PES Environmental, Inc.
Engineering & Environmental Services

A Project for:

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Seal:

REGISTERED PROFESSIONAL ENGINEER
SCOTT M. MORRISON
C 64748
Exp.
CIVIL
STATE OF CALIFORNIA

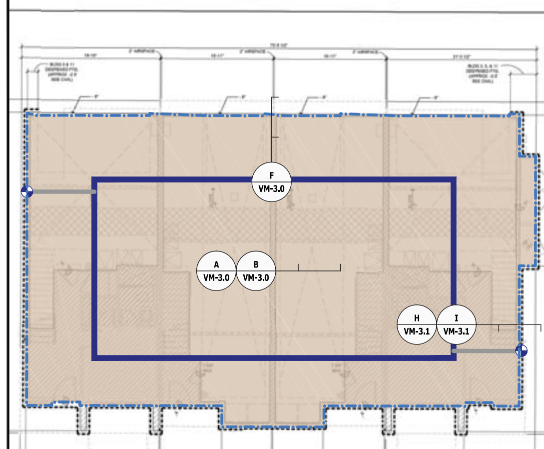
Sheet Title:

SYSTEM CONFIGURATION BUILDING TYPE C.3 (BUILDING #12)

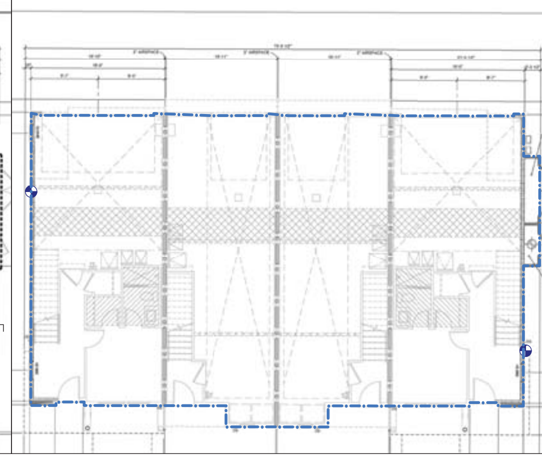
Sheet #:

VM-2.2

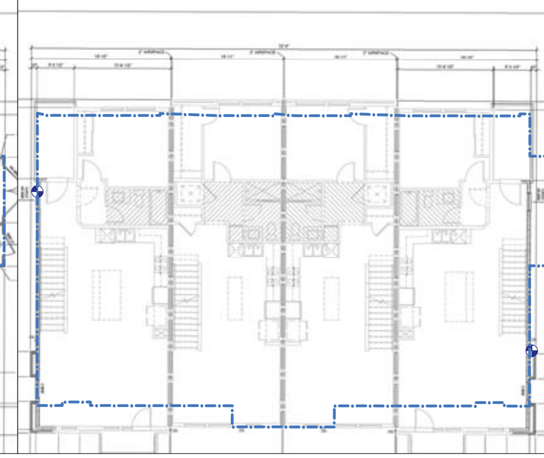
Building D



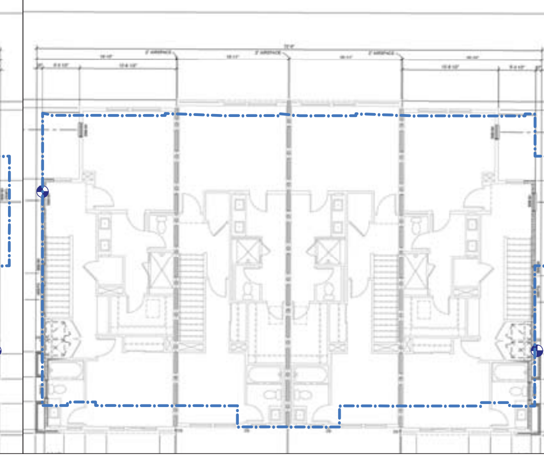
Foundation Plan
Type D - Buildings 9 and 11



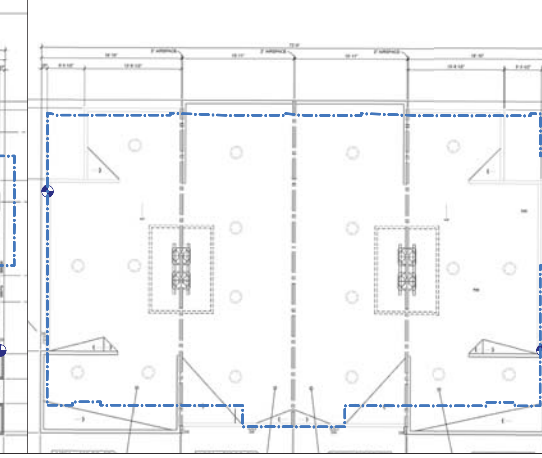
First Floor Plan
Type D - Buildings 9 and 11



Second Floor Plan
Type D - Buildings 9 and 11

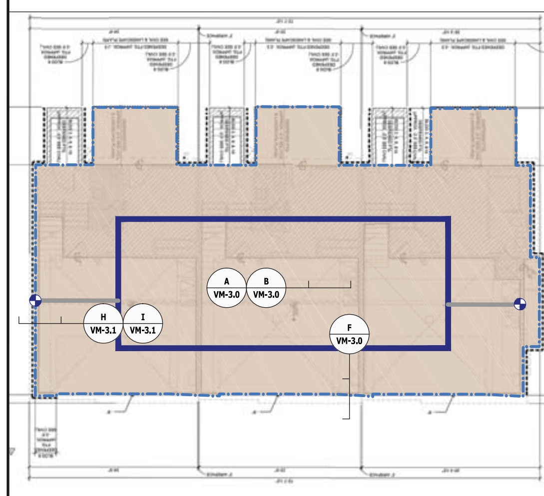


Third Floor Plan
Type D - Buildings 9 and 11

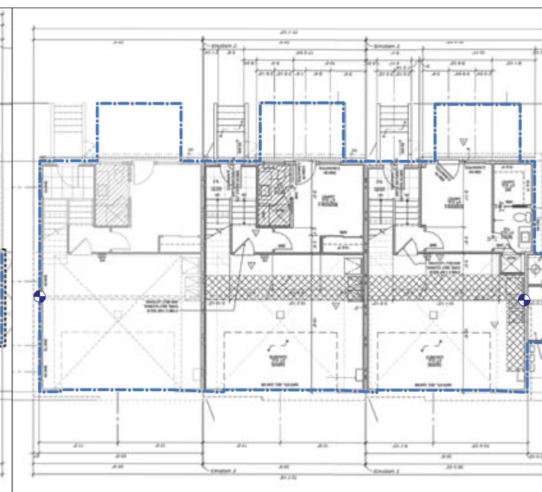


Roof Plan
Type D - Buildings 9 and 11

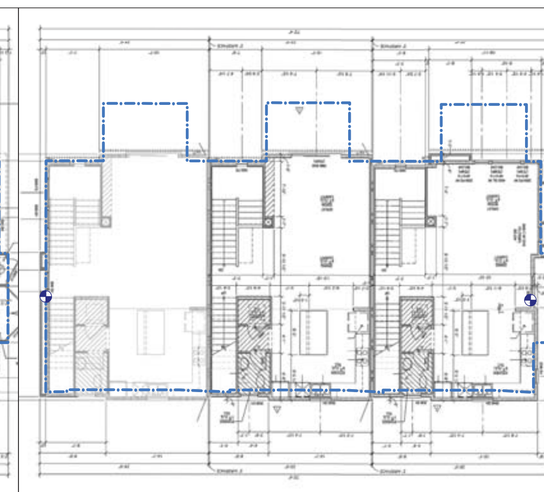
Building E



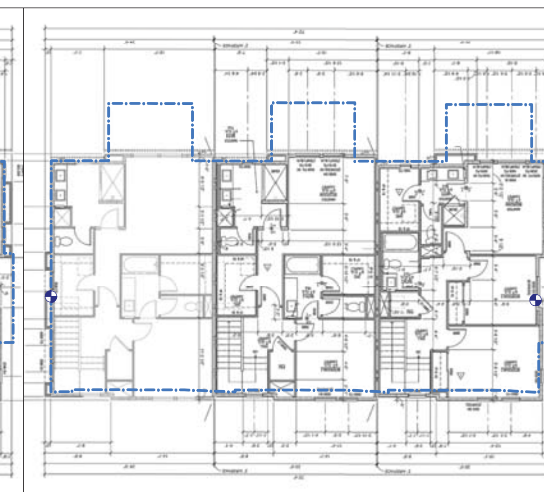
Foundation Plan
Type E - Buildings 8 and 10



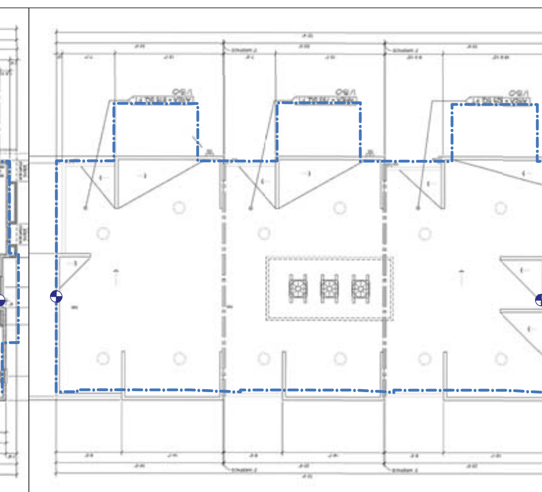
First Floor Plan
Type E - Buildings 8 and 10



Second Floor Plan
Type E - Buildings 8 and 10



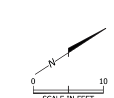
Third Floor Plan
Type E - Buildings 8 and 10



Roof Plan
Type E - Buildings 8 and 10

Explanation

- Areal Extent of Subslab Vapor Barrier Membrane
- Low Profile Vent Piping
- Solid Vent Piping (3-inch diameter)
- VR1 Proposed Vent Riser Location



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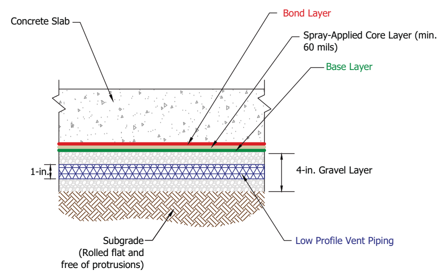
Seal: REGISTERED PROFESSIONAL ENGINEER SCOTT M. MORRISON C64748 CIVIL STATE OF CALIFORNIA

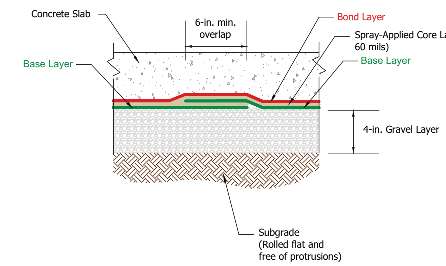
Sheet Title:
SYSTEM CONFIGURATION BUILDING TYPES D & E (BUILDINGS #8, 9, 10, AND 11)

Sheet #:
VM-2.3



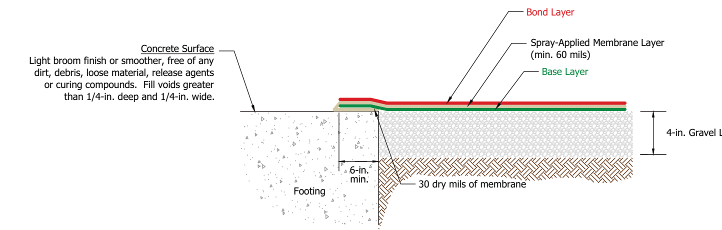
A Detail A - Typical Membrane and Vent Piping Configuration

(Not to Scale)



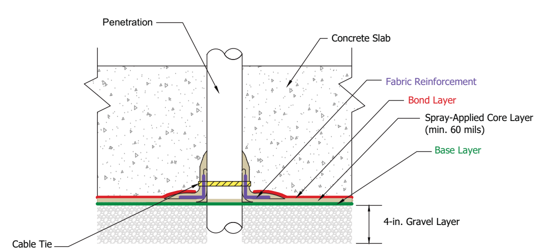
B Detail B - Typical Membrane Lap Joint

(Not to Scale)



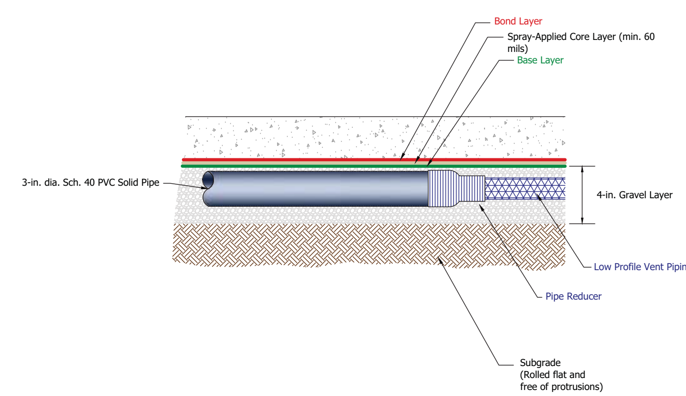
C Detail C - Typical Membrane Termination Configuration

(Not to Scale)



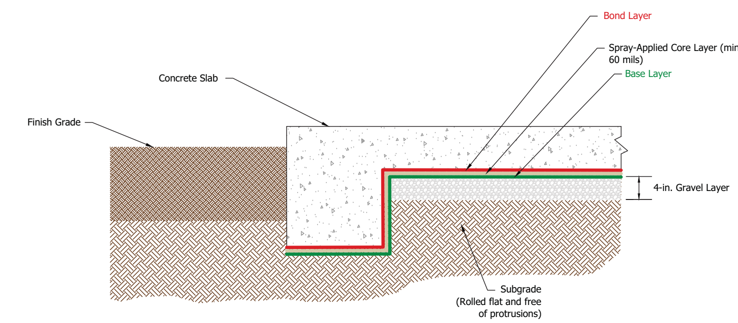
D Detail D - Vertical Penetration Detail

(Not to Scale)



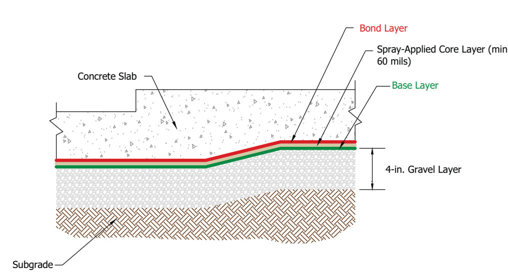
E Detail E - Vent Pipe To PVC Transition

(Not to Scale)



F Detail F - Typical Edge of Slab Condition Detail

(Not to Scale)



G Detail G - Membrane at Small Slab Step (less than 12-inches)

(Not to Scale)

Explanation

- Bond Layer = Geo-Seal BOND
- Spray-Applied Core Layer = Geo-Seal CORE
- Base Layer = Geo-Seal BASE
- Low Profile Vent Piping = Vapor-Vent
- Gravel Layer = 3/8-in Pea Gravel

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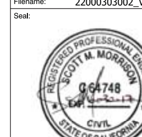
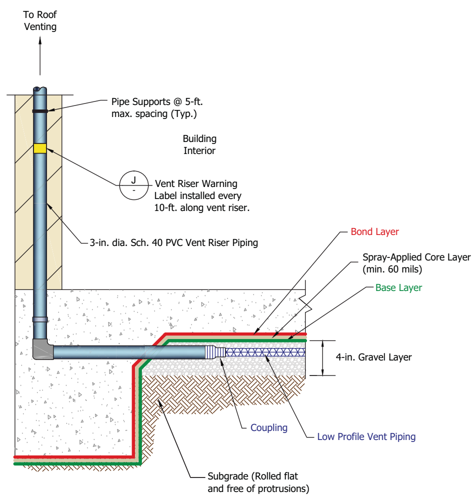


Sheet Title:

VAPOR BARRIER AND VENT PIPE DETAILS

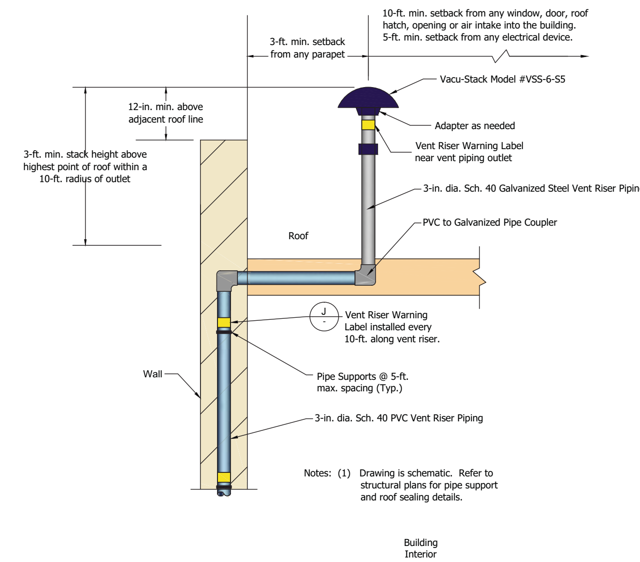
Sheet #:

VM-3.0



H / - Detail H - Vent Pipe to Vent Riser Transition

(Not to Scale)



I / - Detail I - Vent Riser to Roof

(Not to Scale)

CAUTION

SUBSLAB VENT PIPE

IMMEDIATELY NOTIFY BUILDING OWNER IF DAMAGED

3-in. x 4-in. wide

All labels with adhesive backing

Large letters: 1/2-in. (min.) height

Small letters: 1/4-in. (min.) height

Red letter on white or yellow background

3 min. required per vent riser

These labels are to be placed near each vent piping inlet and outlet and every 10-ft. (min.) along the vent riser piping

J / - Detail J - Vent Riser Warning Label

(Not to Scale)

WARNING

THIS BUILDING IS PROTECTED WITH A SUBSLAB VAPOR CONTROL BARRIER. ANY PROPOSED PENETRATION OR ALTERATION OF FLOOR SLAB REQUIRES NOTIFICATION OF THE BUILDING OFFICIAL AND INSPECTION BY A QUALIFIED ENGINEER

This notification is to be permanently stamped or etched in the surface of the garage slab at the time it is poured or a plate with this notification is to be affixed to the slab or room wall after construction.

All letters 1/2-in. min. in height

At least 1 Warning Placard is required in each garage.

K / - Detail K - Warning Placard

(Not to Scale)

Explanation

- Bond Layer = Geo-Seal BOND
- Spray-Applied Core Layer = Geo-Seal CORE
- Base Layer = Geo-Seal BASE
- Low Profile Vent Piping = Vapor-Vent
- Gravel Layer = 3/8-in Pea Gravel

PES Environmental, Inc.
Engineering & Environmental Services

A Project for:

LOCALE @ STATE STREET
ON-GRADE TOWNHOMES
FREMONT, CALIFORNIA

Client:

Fremont State Street Center, LLC

3000 Executive Parkway, Suite 450
San Ramon, California, 94583

Revisions:

No.	Description	Date
	VMS Report Update	6/15/2016
	City Submittal	7/13/2016
3	3rd Plan Check Response	8/18/2016

Project No.:	220.003.03.002
Drawn By:	BP
Reviewed By:	SM
Scale:	AS NOTED
Date:	8/18/2016
Filename:	22000303002_VB_r3_1-4

Seal:

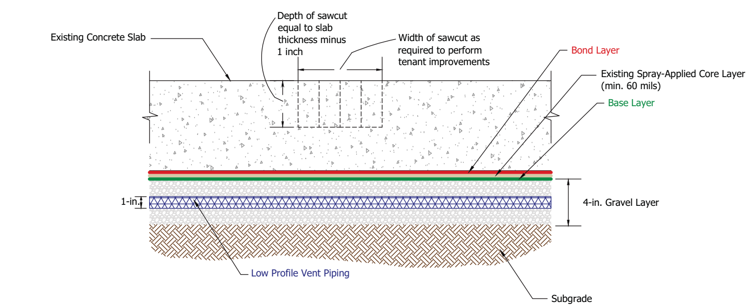
Sheet Title:

VAPOR BARRIER AND VENT PIPE DETAILS

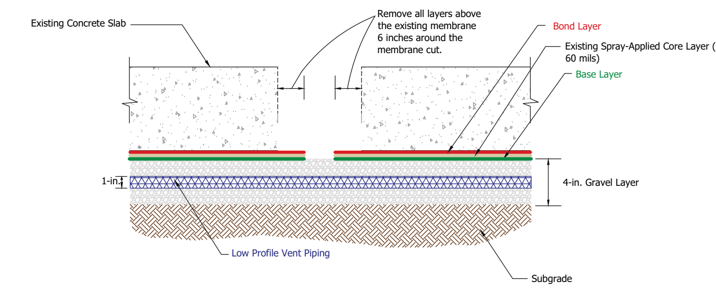
Sheet #:

VM-3.1

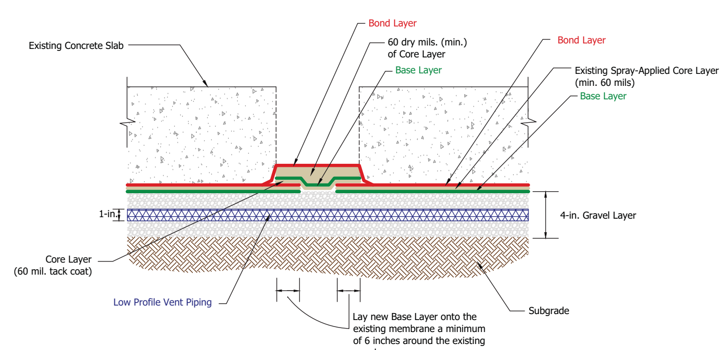
NOTE: NO PENETRATIONS SHALL BE MADE IN THE FOUNDATION SLAB WITHOUT PRIOR APPROVAL FROM THE STRUCTURAL ENGINEER.



Step 1 - Perform a shallow sawcut to facilitate removal of concrete.

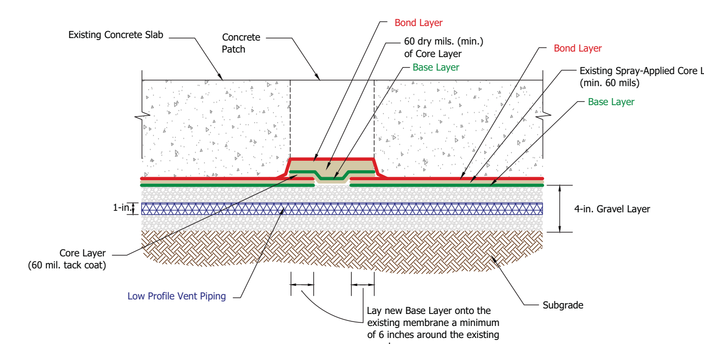


Step 2 - Gently break out concrete along edges of sawcut. Cut vapor barrier in center of sawcut area and pull back to expose gravel layer or subgrade. Remove all layers above the existing vapor barrier membrane, 6 inches around the membrane cut. Check gravel layer for presence of vent piping. Leave vent piping in place if present. Perform subgrade work.



Step 3 - Contract original approved vapor barrier installer to repair vapor barrier. Repair to include:

1. **Restoration of gravel layer.**
2. **Clean the exposed membrane area with water and a soft brush.**
3. **Wipe the exposed membrane with a mild non-chlorinated solvent and allow the solvent to evaporate completely before proceeding to the next step.**
4. **Apply a thin (60-mil) tack coat to the exposed membrane and allow to tack.**
5. **Lay new base layer onto the existing membrane referenced above a minimum 6 inches around the existing membrane cut.**
6. **Patch over base layer with vapor barrier membrane to the specified thickness and extending a minimum 6 inches onto the existing membrane.**
7. **After membrane has cured and been checked for proper thickness and flaws, install protection layer pursuant to manufacturer's instructions.**



Step 4 - Backfill sawcut area with concrete and finish to match existing concrete.

Procedures for Preserving and Repairing Vapor Barrier if Future Penetrations Required

(Not to Scale)

Notes on Repair

1. Steps 1 and 2 to be performed by others prior to vapor barrier installer arrival.
2. It is the General Contractor's responsibility to observe and supervise preparations for repair, and to ensure sufficient vapor barrier flaps remain around entire perimeter of sawcut area. If not, the vapor barrier installer may require additional shallow sawcutting and removal of concrete from the perimeter, in order to expose sufficient vapor barrier flaps for adherence of the patch.
3. All due care must be used to ensure hand-chipping of concrete from perimeter of sawcut does not penetrate or damage in-place liner.
4. Step 3 to be performed by vapor barrier installer.
5. Pouring and finishing of concrete patch to be performed by others.

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Seal:

REGISTERED PROFESSIONAL ENGINEER
SCOTT M. MORRISON
C64748
CIVIL
STATE OF CALIFORNIA

Sheet Title:

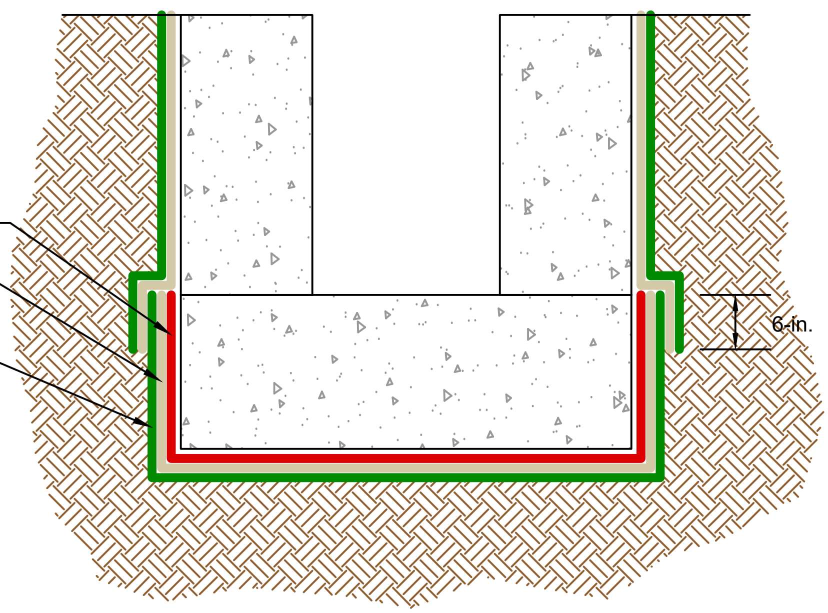
VAPOR BARRIER
REPAIR DETAILS

Sheet #:

VM-4.0

APPENDIX C

ELEVATOR PIT GEO-SEAL DETAIL



Explanation

Bond Layer = Geo-Seal BOND

Spray-Applied Core Layer = Geo-Seal CORE

Base Layer = Geo-Seal BASE

PES Environmental, Inc.
Engineering & Environmental Services

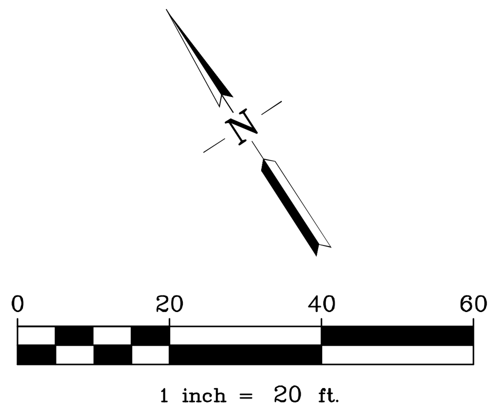
Geo-Seal Elevator Pit Detail
State Street Center
Fremont, California

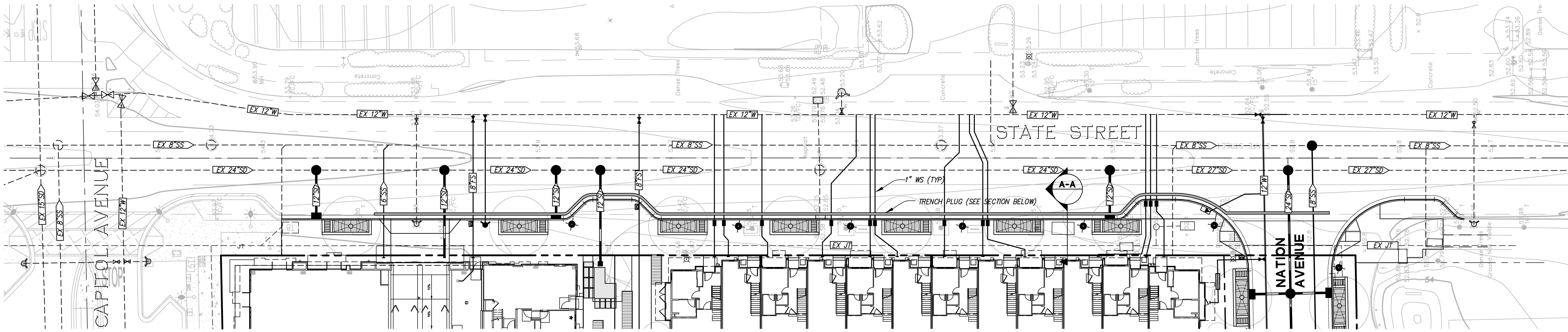
PLATE
1

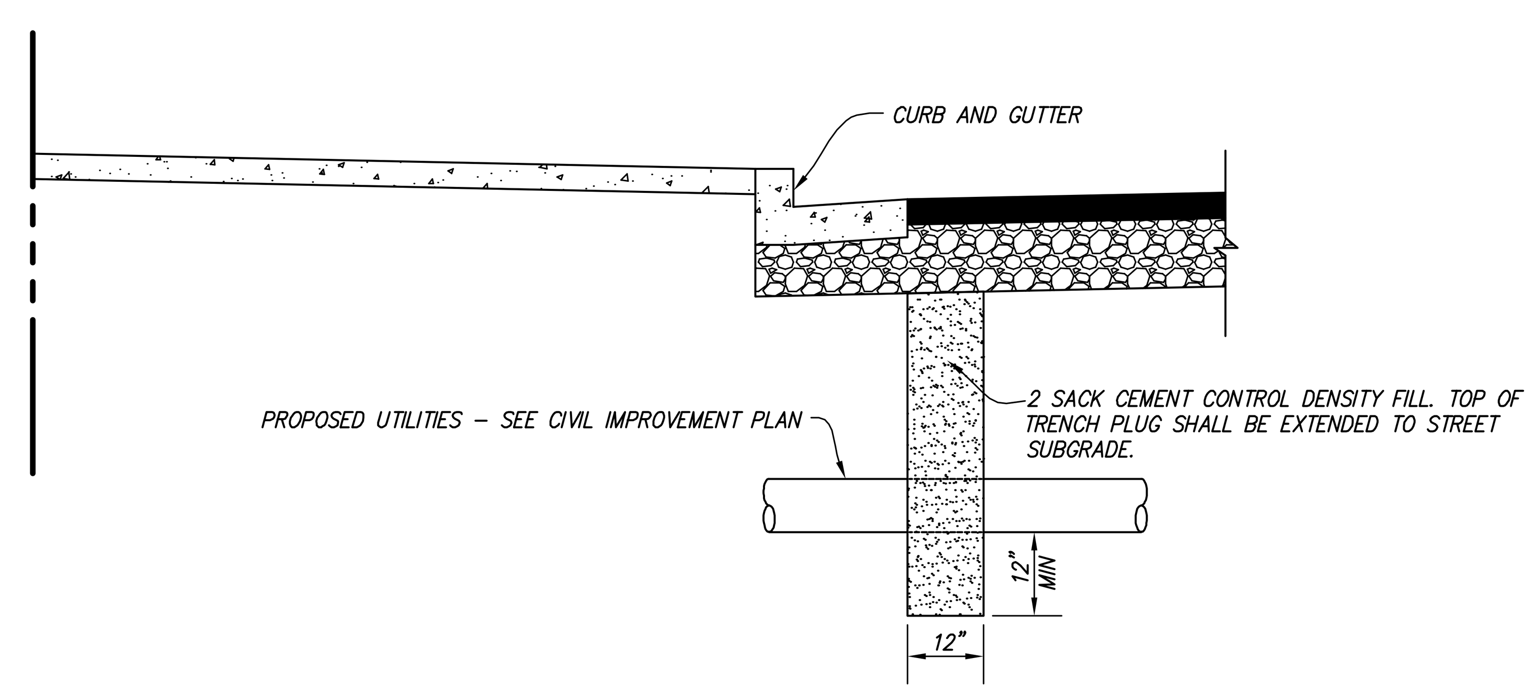
220.003.03.002	22000303002_VB_Det1	SM	6/16
JOB NUMBER	DRAWING NUMBER	REVIEWED BY	DATE

APPENDIX D

TRENCH PLUG PLAN







SECTION A-A TYPICALTRENCH PLUG SECTION

NOT TO SCALE

TRENCH PLUG PLAN

STATE STREET CENTER

CITY OF FREMONT, ALAMEDA COUNTY, CALIFORNIA

FOR: FREMONT STATE STREET CENTER, LLC.

RJA

RUGGERI-JENSEN-AZAR

ENGINEERS ▪ PLANNERS ▪ SURVEYORS

4690 CHABOT DRIVE, SUITE 200 PLEASANTON, CA 94588

PHONE: (925) 227-9100 FAX: (925) 227-9300

DATE: AUGUST 18, 2016 JOB NO. 151070 SHEET 1 OF 1

G:\JOB2015\151070\CAD FILES\00-EXHIBITS\TRENCH PLUG EXHIBIT.DWG 8/18/2016 2:03:46 PM ROGER FONG