Appendix F
Health Risk Assessment

Human Health Risk Assessment
Construction and Incremental Operational Emissions
Proposed Stanford University Medical Center
Facilities Renewal and Replacement Project
Palo Alto, California

Prepared for:
PBS&J
San Francisco, California

Prepared by:
ENVIRON International Corporation
Emeryville/San Francisco, California

Date:
February 22, 2010

Project Number:
03-20077A

ENVIRON

Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
ARB	Air Resources Board
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAAQMD	Bay Area Air Quality Management District
BPIP	Building Profile Input Program
Cal/EPA	California Environmental Protection Agency
CC	Community Commercial
CEQA	California Environmental Quality Act
CPF	Cancer Potency Factor
DEIR	Draft Environmental Impact Report
DPM	Diesel Particulate Matter
EDMS	Emission Dispersion Modeling System
EMFAC	EMission FACtor model
FAA	Federal Aviation Administration
FIM	Frontiers in Medicine
HAP	Hazardous Air Pollutant
HC	Hydrocarbon
HEPA	High Efficiency Particulate Air
HHDT	Heavy-Heavy-Duty Trucks
HI	Hazard Index
HQ	Hazard Quotient
HHRA	Human Health Risk Assessment
HVAC	Heating, Ventilation, and Air Conditioning
ISCST3	Industrial Source Complex Short Term Model
LPCH	Lucile Packard Children's Hospital
LST	Localized Significance Thresholds
MEI	Maximally Exposed Individual
MEIR	Maximally Exposed Individual Resident
MEIW	Maximally Exposed Individual Worker
MERV	Minimum Efficiency Reporting Value
MOB	Hoover Medical Office Building
MOR	Medical Office and Medical Research
MSA	Metropolitan Statistical Area
NCP	National Contingency Plan
OEHHA	Office of Environmental Health Hazard Assessment
OSHA	Occupational Safety and Health Administration
OSHPD	Office of Statewide Health Planning and Development
PBS&J	Post, Buckley, Schuh & Jernigan
PF	Public Facilities
PM10	Particulate Matter Less than 10 μm in Diameter
PRIME	Plume Rise Model Enhancements

REL	Reference Exposure Levels
SB	Senate Bill
SCAQMD	South Coast Air Quality Management District
SHC	Stanford Hospitals and Clinics
SoM	Stanford University School of Medicine
SUMC	Stanford University Medical Center
TAC	Toxic Air Contaminant
URBEMIS	URBan EMISsions Model
USEPA	United States Environmental Protection Agency
USCB	United States Census Bureau
USGS	United States Geological Survey

List of Units

g	gram
g/s	grams per second
hr	hour
kg	kilogram
L	liter
m^3	cubic meter
m	meter
mg	milligram
s	second
µg	microgram
µm	micrometer

Executive Summary

At the request of Post, Buckley, Schuh and Jernigan (PBS&J), ENVIRON International Corporation (ENVIRON) performed a human health risk assessment (HHRA) of the incremental increase in diesel particulate matter (DPM) emissions associated with the construction and operation of the proposed Stanford University Medical Center Facilities Renewal and Replacement Project (SUMC Project) and the toxic air contaminants (TAC) emissions associated with the helipad operation at the Medical Center. This HHRA has been conducted as part the Draft Environmental Impact Report (DEIR) for the SUMC Project which is being prepared by PBS&J on behalf of the City of Palo Alto Planning and Community Environment Department. This HHRA estimates excess lifetime cancer risks and chronic noncancer hazard indices (HIs) and compares them to the Bay Area Air Quality Management District (BAAQMD or District) California Environmental Quality Act (CEQA) thresholds of significance.

Process

ENVIRON performed this HHRA using information obtained from the City of Palo Alto and PBS&J. This HHRA reflects the fact that we utilized conservative methodologies for:

1) the estimation of DPM and other TAC emissions from Project construction and operational sources,
2) the calculation of airborne DPM concentrations at both onsite and offsite receptor locations, and
3) the estimation of excess lifetime cancer risk and noncancer HIs at these receptor locations.

Emissions Estimation

Using established emission standards adopted by the California Air Resources Board (ARB) and an emission estimation model developed by ARB; ENVIRON estimated DPM emissions from emergency generators and loading docks associated with future operations at the proposed SUMC. In addition, ENVIRON estimated incremental TAC emissions for the existing and proposed helipad operation using an emission estimation model developed by the Federal Aviation Administration (FAA). PBS&J provided estimated incremental DPM emissions for the construction of the SUMC Project that were estimated using the ARB In-Use Off-Road Diesel Vehicle Rule.[1]

Air Dispersion Modeling

Consistent with BAAQMD-approved practices, DPM concentrations for estimated emissions were then conservatively estimated at receptor locations using the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) version 07026 (United States Environmental Protection Agency [USEPA] 2005) with meteorological data recorded on the Stanford University campus during 2005.

[1] ARB's In-Use Off-Road Diesel Vehicle Rule was approved on July 26, 2007 and will come into effect in 2010. The rule sets increasingly stringent fleet-average emission rates year-by-year through 2021.

Human Health Risk Assessment

This HHRA was performed to evaluate the potential health effects associated with exposures to the incremental increase in DPM emissions resulting from the proposed SUMC Project. Specifically, ENVIRON estimated the excess lifetime cancer risks and chronic noncancer HIs associated with onsite and offsite exposures to the incremental increase in DPM emitted during construction activities and on-going operations. The potential health effects associated with TAC emissions from helipad operations are not evaluated in this section because the incremental increases of TAC emissions from helipad operations are below the BAAQMD TAC Trigger Levels. According to the BAAQMD, TAC Trigger Levels represent the concentration "below which the resulting health risks are not expected to cause, or contribute significantly to, adverse health effects" (BAAQMD Regulation 2, Rule 5, Section 223).

The HHRA was performed in accordance with the June 2005 BAAQMD *Toxic Evaluation Section Staff Report* (BAAQMD 2005a) and consistent with BAAQMD's *Risk Evaluation Procedure and Risk Management Policy* (BAAQMD 2000) as well as methodologies presented in the California Environmental Protection Agency (Cal/EPA) Air Toxics Hot Spots Program Risk Assessment Guidelines, *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* (Cal/EPA 2003) and *Technical Support Document for Exposure Assessment and Stochastic Analysis* (Cal/EPA 2000).

Findings

Estimated excess lifetime cancer risks and chronic noncancer HIs associated with potential exposures to DPM from construction and operational sources related to the SUMC Project were compared to current CEQA significance thresholds defined by BAAQMD (1999). Pursuant to BAAQMD CEQA Guidelines (BAAQMD 1999), projects that expose the public to TACs in excess of the following thresholds would be considered to have a significant air quality impact:

- Probability of contracting cancer for the Maximally Exposed Individual (MEI) exceeds ten in a million (10×10^{-6} or 1×10^{-5}); and
- Ground level concentrations of non-carcinogenic toxic air contaminants would result in a HI greater than one (1) for the MEI.

DPM Exposures Related to SUMC Project Construction Sources

The estimated excess lifetime cancer risks and chronic HIs for onsite and offsite worker, offsite resident, and offsite sensitive receptor exposures to construction sources of DPM from the Project are below the BAAQMD significance thresholds. Thus, based on the results of this HHRA, the impact on air quality from the DPM emissions associated with the SUMC Project is not significant according to BAAQMD CEQA Guidelines.

DPM Exposures Related to SUMC Project Operational Sources

The results of the HHRA indicate that the estimated excess lifetime cancer risks associated with potential onsite and offsite exposures to operational sources of DPM (i.e., emergency generators and delivery vehicles servicing loading docks) are below the BAAQMD significance threshold of 10 in one million and the estimated HIs are below one (1). Thus the operational components of the SUMC Project should not have a significant impact on air quality according to BAAQMD guidelines.

DPM Exposures Related to SUMC Project Construction and Operational Sources

The results of the HHRA indicate that the estimated excess lifetime cancer risks associated with potential simultaneous exposures to construction and operational sources of DPM (i.e., emergency generators and delivery vehicles servicing loading docks) are below the BAAQMD significance threshold of 10 in one million and the estimated HIs are below one (1). Thus, simultaneous exposures to DPM from the construction and operational components of the Project should not have a significant impact on air quality according to BAAQMD guidelines.

Further, estimated cancer risks associated with DPM emissions related to the SUMC Project are below or within the target risk range of one in one million (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) generally considered protective of human health by the USEPA (40 Code of Federal Regulations [CFR] § 300).

The many conservative assumptions that have been used in this assessment regarding the estimation of emissions, ambient air concentrations, exposure assumptions, and carcinogenic potency lead to an overestimate of potential risks, the magnitude of which could likely be substantial. The USEPA (1989) explains the effect of using conservative assumptions in regulatory risk assessments as follows:

> *"These values are upper-bound estimates of excess cancer risk potentially arising from lifetime exposure to the chemical in question. A number of assumptions have been made in the derivation of these values, many of which are likely to overestimate exposure and toxicity. The actual incidence of cancer is likely to be lower than these estimates and may be zero."*

The estimated risks in this HHRA are based primarily on a series of conservative assumptions related to predicted environmental concentrations, exposure, and chemical toxicity. The use of conservative assumptions tends to produce upper-bound estimates of risk. Although it is difficult to quantify the uncertainties associated with all the assumptions made in this risk assessment, the use of conservative assumptions is likely to result in substantial overestimates of exposure, and hence, risk. BAAQMD acknowledges this uncertainty by stating: "the methods used [to estimate risk] are conservative, meaning that the real risks from the source may be lower than the calculations, but it is unlikely that they will be higher" (BAAQMD 2009).

1 Introduction

At the request of Post, Buckley, Schuh & Jernigan, Inc. (PBS&J), ENVIRON International Corporation (ENVIRON) performed a human health risk assessment (HHRA) to estimate the potential health effects associated with the incremental increase in diesel particulate matter (DPM) and other toxic air contaminant (TAC) emissions from construction sources and operational emissions associated with the Stanford University Medical Center Facilities Renewal and Replacement Project ("SUMC Project"). This HHRA serves as an appendix to the Draft Environmental Impact Report (DEIR) for the SUMC Project which is being prepared by PBS&J on behalf of the City of Palo Alto Planning and Community Environment Department. This HHRA estimates excess lifetime cancer risks and chronic noncancer hazard indices (HIs) and compares them to the Bay Area Air Quality Management District (BAAQMD or District) California Environmental Quality Act (CEQA) thresholds of significance (BAAQMD 1999).

The Stanford Hospital and Clinics (SHC), the Lucile Packard Children's Hospital (LPCH), and the Stanford University School of Medicine (SoM) are jointly proposing the SUMC Project. The SUMC Project consists of demolishing approximately 1.2 million square feet of existing buildings and replacing them with onsite structures containing approximately 2.5 million square feet of new hospital, clinic, medical office and medical research uses; adding approximately 1.3 million square feet of net new floor area. SUMC comprises the general area between Sand Hill Road, Welch Road, Quarry Road, Pasteur Drive, and includes the Hoover Pavilion Site in Palo Alto, California.

The general location and Project area boundary for the SUMC Project is shown in Figure 1.1. For the purposes of this HHRA, anything within the Project boundary is considered onsite while anything outside the Project boundary is considered offsite.

1.1 Objectives and Methodology

The purpose of this HHRA is to estimate the potential health effects associated with the incremental increase in DPM and other TAC emissions from construction sources and operational emissions of the SUMC Project, including:

- Exposure to emissions of DPM from construction equipment used for the SUMC Project,
- Incremental exposure to DPM emissions from additional onsite emergency generators at SUMC,[2]
- Incremental exposure to DPM emissions from additional trucks traveling to/from the existing and proposed loading dock at SUMC, and
- Incremental exposure to TAC emission from additional helicopter travels to/from the existing and proposed helipad at SUMC.

[2] As this is a facility renewal and replacement project, the HHRA estimates the incremental risks associated with the Project, that is, health effects related to the increased DPM emissions associated with operational use upon completion of the Projects above those associated with the current operations within the Project area boundaries.

The methodology used in this HHRA is consistent with the following California Environmental Protection Agency (Cal/EPA) and BAAQMD risk assessment guidance:

- Air Toxics Hot Spots Program Risk Assessment Guidelines: Part IV Technical Support Document for Exposure Assessment and Stochastic Analysis (Cal/EPA 2000),
- Air Toxics Hot Spots Program Risk Assessment Guidelines (Cal/EPA 2003),
- BAAQMD CEQA Guidelines: Assessing the Air Quality Impacts of Projects and Plans (BAAQMD 1999),
- BAAQMD Air Toxics Risk Evaluation Procedure and Risk Management Policy (BAAQMD 2000),
- BAAQMD Bay Area Air Quality Management District Staff Report (BAAQMD 2005a), and
- BAAQMD Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines (BAAQMD 2005b).

Potential health effects—including estimated excess lifetime cancer risks and noncancer HIs —associated with exhaust emissions from construction equipment, diesel-fueled trucks, emergency generators, and helicopters serving the hospital are evaluated for onsite workers, offsite workers, offsite residents, and offsite sensitive receptors surrounding the proposed SUMC Project (including schools, daycare centers and retirement facilities/senior centers). ENVIRON evaluated potential exposures at these locations using conservative exposure parameters consistent with BAAQMD risk screening guidance (BAAQMD 2005a, 2005b).

As part of this assessment, the estimated human health risks were compared to the thresholds for significance for TACs in the BAAQMD CEQA Guidelines for a maximally exposed individual (MEI). According to the BAAQMD CEQA Guidelines, the threshold for significance for TACs is a excess lifetime cancer risk greater than ten in one million (1×10^{-5}) and a noncancer HI of greater than 1.0 for the MEI (BAAQMD 1999).

1.2 Report Organization

This HHRA report is divided into seven sections as follows:

Section 1.0 – Introduction: describes the purpose and scope of the HHRA and outlines the report organization.

Section 2.0 – Project Description: presents a description of the proposed SUMC Project.

Section 3.0 – Estimated Air Concentrations: describes the methods used to estimate the ambient air concentrations of DPM and TACs emitted from the construction and operational activities associated with the proposed SUMC Project.

Section 4.0 – Human Health Risk Analysis: provides an overview of the methodology for conducting the HHRA.

Section 5.0 – Estimated Excess Lifetime Cancer Risks and Noncancer Hazard Indices: presents the estimated excess lifetime cancer risks and chronic noncancer HIs related to emissions from the proposed SUMC Project. This section also identifies and describes the uncertainties associated with the risk estimates and discusses how these uncertainties may affect the risk assessment conclusions.

Section 6.0 – Conclusions: summarizes the results of the HHRA and presents the report conclusions.

Section 7.0 – References: includes a listing of all references cited in this report.

The appendices include supporting information as follows:

Appendix A: Meteorological Data and Land Use Analysis. This appendix describes processing performed for meteorological and land use inputs to the air dispersion model used in the HHRA.

Appendix B: Construction Activity. This appendix provides details on emissions estimation and air dispersion modeling for SUMC Project construction activity.

Appendix C: Operational Activity. This appendix provides details on emissions estimation and air dispersion modeling for post-Project operation of emergency generators and from delivery trucks.

Appendix D: Helipad. This appendix describes the emissions estimation for post-Project operationof SUMC helipads.

2 Project Description

The SUMC consists of facilities operated by the following three entities: SHC, the LPCH, and the SoM; and comprises the general area between Sand Hill Road, Welch Road, Quarry Road, Pasteur Drive, and includes the Hoover Pavilion Site (Figure 1.1). The area is zoned Medical Office and Medical Research (MOR) and Public Facilities (PF).

As discussed previously, SHC, LPCH and SoM are jointly proposing the SUMC Project, which consists of:

- Demolition, renovation, and construction of SHC facilities, providing a net increase of approximately 824,000 square feet;
- Demolition, renovation, and construction of LPCH facilities, resulting in approximately 442,000 additional square feet;
- Demolition of four existing SoM buildings and construction of three replacement buildings, resulting in no additional square footage;
- Demolition of shops and storage space, renovation of existing Hoover Pavilion, and net addition of approximately 46,000 square feet of new medical, office, research, clinic and administrative facilities at the Hoover Pavilion Site for medical offices for community practitioners, SUMC-related medical offices, clinical facilities, and support uses;
- Demolition of existing parking and construction of 2,985 new and replacement spaces, for a net increase of 2,053 spaces to address additional demand for the SUMC Project , to be located in surface parking and above- and underground structures;
- Construction of a new road connecting Sand Hill and Welch Road, and provision of interior driveways and improved circulation connections including improvements to the existing extension of Quarry Road to Roth Way;
- Widening of Welch Road by the addition of a third lane to accommodate left turns in both directions; and
- Related on-site and off-site improvements.

The reconstruction of the Hospital is to be in compliance with Senate Bill (SB) 1953 to meet seismic safety standards. The renovation and expansion Project, which would be constructed over a 12-year time line, would result in a net increase of approximately 1.3 million square feet of floor area, including 60,000 square feet of new medical office space at the Hoover Pavilion. The Project would also include the demolition and reconstruction of the existing SoM buildings, demolition and reconstruction of parking facilities, and demolition of several buildings now housing medical office space for clinics and community health practitioners.

Figure 2.1 and 2.2 show the existing and the proposed layout for the SUMC Project, respectively. Table 2.1 lists the existing buildings associated with the SUMC as well as the buildings to be demolished or constructed as part of the proposed SUMC Project. As an example of the reconfiguration, at the SoM the Edwards, Lane, Alway, and Grant buildings would be demolished and the Foundations in Medicine (FIM) buildings 1, 2 and 3 would replace them.

Assuming SUMC Project approval in mid-2009, the SUMC Project demolition and construction would occur from 2009 through 2021. However, due to a number of factors, including the lengthy OSHPD review process, if the SUMC Project will be approved, approval will occur later than assumed in this EIR. It should be considered that the construction schedule can continue to change in numerous ways over the construction duration. The mid-2009 approval date serves as a conservative assumption to ensure that mitigation would be in place when warranted and not later. A conceptual schedule describing the number of phases, the phase schedule, and the equipment list for each phase are summarized in Table B.1 in Appendix B. This schedule was developed based on the construction emissions calculated by PBS&J.

The SUMC Project proposes the addition or modification of emergency generators, loading docks and helipads which can be sources of DPM or other TACs; therefore, the incremental impact of these operational sources will also be evaluated in this HHRA:

- The SUMC Project proposes the addition of 13 diesel-fired engines (12 standard backup generators plus an extra generator on stand-by as required by the California Health and Human Services Agency's Office of Statewide Health Planning and Development [OSHPD]) and removal of two diesel-fired engines for emergency stand-by power generation, as shown in Figure 2.3. SHC would have seven new emergency generators, LPCH would have three, and each FIM building would have its own new generator. Generators associated with the Grant building and 701 Welch Road would be removed as part of the SUMC Project.
- The SUMC Project involves the construction of one new loading dock at LPCH, as shown on Figure 2.4. The existing loading dock along Quarry Road will-be maintained as the SHC's primary loading dock. A new SHC technology dock also is proposed, and would have access off Welch Road when major equipment would be delivered and would have minimal truck trips.[3] This HHRA evaluates the potential health effects from exposure to emissions of DPM from truck movement associated with deliveries to these loading docks. As the location of emissions associated with truck travel to and from the existing and proposed loading docks will change as a result of the SUMC Project, the incremental impacts from these sources are evaluated in this HHRA.
- An additional helipad is also proposed under the SUMC Project. The location of the new helipad is within 900 feet of the existing helipad, as shown in Figure 2.5. While the new helipad could accommodate larger helicopters in the event of a large-scale disaster, the size of helicopters regularly using the helipads is not expected to change. Both helipads would be approved for day and night time use. Excess lifetime cancer risks and chronic noncancer hazard indices are not estimated for DPM emissions related to helipad operations. Instead, the incremental emissions from helicopters using both the existing and the proposed helipads are estimated and compared to the BAAQMD Toxic Air Contaminant Trigger Levels (BAAQMD 2005b).

[3] The Technology Dock, which is only used infrequently (once or twice per month) for the delivery or removal of large medical equipment (application, Tab 5, Page 7) which would represent at most 0.6% of the total deliveries to the SUMC Project. Therefore, impacts were not evaluated at the location of this loading dock.

3 Estimated Emissions and Air Concentrations

This section describes the estimation of DPM emissions from construction and operational sources. These emission estimates are used to develop exposure point concentrations of DPM in air using air dispersion modeling techniques.

Methods used to estimate TAC emissions related to helipad operations are also presented. However, as stated above, exposure point concentrations of these TACs and associated cancer risks and noncancer HIs are not estimated for helipad TACs. Instead, the emissions estimates are compared to BAAQMD Toxic Air Contaminant Trigger Levels (BAAQMD 2005b).

3.1 Emissions Estimation

This section describes the methodology used to estimate DPM emissions from construction equipment, emergency generators and truck traffic traveling to and from loading docks and TAC emissions from helicopters at the helipads.

3.1.1 Estimated Diesel Particulate Matter Emissions - Construction Activities

PBS&J provided ENVIRON the year-by-year construction DPM emissions calculated based on ARBs In-Use Off-Road Diesel Vehicle Rule. Table 3.1 presents the year-by-year emissions of DPM from building construction and demolition at the construction sites of SHC, LPCH, FIM and Hoover Pavilion.

3.1.2 Estimated Diesel Particulate Matter Emissions - Emergency Generators

This section describes the methodology proposed for estimating DPM emissions from diesel-fueled engines associated with the emergency generators. Table 3.2 provides a list of the 13 diesel-fired engines that would be added to the SUMC Project. The thirteenth proposed generator would function as a stand-by, as required by OSHPD. SHC would have seven new emergency generators, LPCH would have three new emergency generators and FIMs 1, 2 and 3 would have one new emergency generator each. The existing emergency generators located at 701 Welch Road and the Grant building are to be removed. The locations of the new and removed emergency generators were provided by the application and are presented in Figure 2.3.

Table 3.2 presents emission factors used to calculate annual emissions from the generators. As the generators would be installed after the Tier 4 final off-road compression-ignition engine standards from the ARB are required, it was assumed that all new engines would meet the Tier 4 standard. Estimated emissions are based on non-emergency operations (primarily the schedule of testing that is required for the generators) and the permitted or planned number of hours of non-emergency operations (typically weekly testing for 30 minutes for a total of 26 hours per year). A detailed description of DPM emissions estimation from emergency generators associated with the SUMC Project is presented in Appendix C.

3.1.3 Estimated Diesel Particulate Matter Emissions - Loading Docks

As discussed earlier, the SUMC Project involves the construction of one new loading dock at LPCH, as shown on Figure 2.4. The existing loading dock along Quarry Road will continue to serve the SHC. A third loading dock, the Technology Dock shown on Figure 2.4 would only be used infrequently (once or twice per month) for the delivery or removal of large medical equipment.[4] As deliveries to the Technology Dock are expected to at most be 0.6% of total SUMC Project deliveries, the impact from the DPM emissions associated with the Technology Dock are likely to be de minimis compared to that from the existing SHC and the proposed LPCH loading docks and therefore was not evaluated.

This HHRA evaluates the potential health effects from exposure to emissions of DPM from truck movement associated deliveries to the existing SHC and the proposed LPCH loading docks. As the location of emissions associated with truck travel to and from the existing and proposed loading docks would change as a result of the SUMC Project, the incremental impacts from these sources are evaluated in this HHRA.

Truck driving routes from the proposed loading docks to the interchanges of US Highway 101 and Interstate 280 were chosen for evaluation as they are the most direct truck route to the Project in accordance with the City of Palo Alto truck route ordinance.[5] Although it is possible that the trucks may choose different routes, these two routes were chosen as a representative to estimate the travel pathways. The selected truck travel routes associated with the loading dock activities are shown in Figure 3.1 and Figure 3.2.

DPM emissions from vehicles at the loading docks and their associated traffic routes were calculated using the estimated vehicle trips[6] and the emission factors for particulate matter less than 10 micrometers (μm) in diameter (PM_{10}) generated with the current version of the EMission FACtor model (EMFAC 2007) developed by ARB.[7] Though only 25% of the truck traffic is expected to be tractor-trailer type, ENVIRON conservatively assumed that all trips are generated by heavy heavy-duty trucks (HHDTs) which have the highest emission profiles for all trucks anticipated to service the Project. A summary of these emissions is presented in Table 3.3a.

Additionally, in the absence of a defined schedule, truck traffic to and from the loading docks was assumed to occur at any point during the day or night (i.e., 24 hours per day). It was stated in the SUMC Project description that the existing loading dock along Quarry Road will experience the greatest number of deliveries, while the new loading dock at LPCH will experience less deliveries. Based on this information, ENVIRON assumed that the existing

[4] Stanford University Medical Center Facility Renewal and Replacement Project application, Tab 5, page 7
[5] http://www.cityofpaloalto.org/news/displaynews.asp?NewsID=209&TargetID=57
[6] Stanford University Medical Center Facilities Renewal and Replacement Project – Demographics and Operations: http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=8833
[7] EMission FACtors (EMFAC 2007) model is distributed by ARB to calculate emission rates from all motor vehicles, such as passenger cars to heavy-duty trucks, operating on highways, freeways and local roads in California (http://www.arb.ca.gov/msei/onroad/latest_version.htm)

SHC and the proposed LPCH loading docks share the incremental daily deliveries associated with the SUMC Project as shown in Table 3.3b:[8]

As the in-use fleet characteristics, and the concomitant HHDT DPM emission rates, change over time, the average composite PM_{10} emission factors were calculated for each year evaluated. ARB's On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation[9] requires HHDT to meet specific performance requirements between 2011 and 2023, and all vehicles must have a 2010 model year engine or equivalent by January 1, 2023. Based on this regulation, ENVIRON calculated the year-by-year emission factors using the following methodology.

- 2010 – 2022: used EMFAC2007 with the most conservative vehicle age distribution (i.e. the oldest vehicle model is 45 years prior to the model year), then applied an emission abatement factor generated based on the performance requirement presented in the regulation.
- 2023 – 2040: used EMFAC2007 assuming the oldest vehicles have 2010 model year engines. No additional abatement factor was applied.
- 2040+: EMFAC2007 only contains emission factors for the model year from 1965 through 2040, the emission factors for model years beyond 2040 were assumed to be the same as emission factors in 2040. This is a conservative measure as it assumes no fleet turnover or cleaner technology with lower emissions might be incorporated after 2040.

As such, this assessment is considered conservative as it likely overestimates DPM emissions from delivery trucks traveling to and from the Project. Calculated emission factors and the detailed estimation of DPM emissions associated with the existing and proposed loading docks are presented in Appendix C.

3.1.4 Estimated Toxic Air Contaminant Emissions - Helipad

An additional helipad is proposed as part of the SUMC Project. The location of the new helipad is within 900 feet of the existing helipad. A detailed schematic of the new location of the helipad and the location of the existing helipad can be found in Figure 2.5. While the new helipad would accommodate larger helicopters in the event of emergencies, the size of the helicopters regularly using the helipads is not expected to change. Both helipads would be approved for day and night time use.

The TAC emission source associated with the helipad results from helicopter movement when transporting patients to or from the Project. Based on available information about the helipad operation, there are no other TAC or DPM emissions expected from stationary facility-based equipment. As the SUMC Project proposes to add a helipad, the increased TAC emissions

[8] The percentage of deliveries associated with the existing and the proposed loading dock is estimated based on the annual number of deliveries presented in the Project description (Demographics and Operations - Loading Zone, 05/2009).

[9] On December 12, 2008, the ARB approved a new regulation to significantly reduce emissions from existing on-road diesel vehicles operating in California.

associated with the SUMC Project above those associated with the current operations were estimated.

Speciated hydrocarbon (HC) emissions for helicopters used at the Project were estimated using the Emission Dispersion Modeling System (EDMS) developed by Federal Aviation Administration (FAA).[10] The most recent version of the software, EDMS 5.1, released in September 2008, is capable of calculating the speciated HC emission including 44 hazardous air pollutants (HAPs) and 351 non-toxic compounds. The modeled emission inventory summarized in Table 3.4 shows that both the chronic (annual) and acute (hourly) incremental emissions of TACs are below the BAAQMD trigger levels.[11] Therefore, further assessment of the helipad emissions is not required under BAAQMD Guidance (2005b) as resulting health risks from emissions at this level are "not expected to cause, or contribute significantly to, adverse health effects."[12] Details of the emission analysis are present in Appendix D, and the electronic files of EDMS inputs and outputs are also attached in Appendix D.

3.2 Air Dispersion Modeling

ENVIRON conducted air dispersion modeling to estimate the DPM concentrations associated with emissions from the SUMC Project as characterized in Section 3.1. The air dispersion analysis was performed in accordance with United States Environmental Protection Agency (USEPA), ARB and BAAQMD modeling guidelines (USEPA 2005, Cal/EPA 2003, BAAQMD 2005b). The air dispersion analysis requires the following: 1) selection of the dispersion model, 2) selection of appropriate dispersion coefficients based on land use, 3) preparation of meteorological data, 4) evaluation of potential terrain considerations, 5) selection of receptor locations, and 6) identification of the source specific release parameters, operational schedule, and averaging time periods. The following sections describe each of these steps.

Appendices A through C provide electronic files related to the air dispersion modeling analysis.

3.2.1 Air Dispersion Model Selection

ENVIRON used the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) version 07026, the USEPA recommended air dispersion model (USEPA 2004a,b). AERMOD was developed as a replacement for USEPA's Industrial Source Complex Short Term (ISCST3) air dispersion model to improve the accuracy of air dispersion model results for routine regulatory applications and to incorporate the progress in scientific knowledge of atmospheric turbulence and dispersion. This change was made in November 2005 (USEPA 2005).

---

[10] Emissions and Dispersion Modeling System (EDMS) was developed by the Federal Aviation Administration as a model designed to assess the air quality impacts of proposed airport development projects (http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model/)

[11] BAAQMD Regulation 2, Rule 5 specifies that all permit applications for new and modified sources must be screened for emissions of TACs. If the emissions from a project are less than the listed trigger-levels, it is assumed that the project does not pose a significant risk to the public and a health risk screening analysis is not required.

[12] Ibid

Air modeling dispersion factors (i.e., concentration per unit emission rate), sometimes called "chi-over-Q" ("χ/Q"), were estimated for the simulated dispersion sources (i.e., construction equipment, emergency generators, and delivery truck/vehicles) using AERMOD in conjunction with information about the locations of the sources and receptors, as well as assumptions about the nearby land use. Modeling details including AERMOD input files are presented in Appendices A through C.

The following equation was used to estimate annual average concentration from the modeled dispersion factor:

$$\text{Annual Average Concentration} = \left(Q_{annual} \times \left(\frac{\chi}{Q} \right)_{annual} \right)_i$$

Where:

Q	=	emission rate of DPM (grams per second [g/s])
$\left(\frac{\chi}{Q}\right)$	=	dispersion factor (μg/m^3)/(g/s)
I	=	source

The results of the air dispersion analysis were used in conjunction with the chemical-specific emissions rates discussed in Section 3.1 and Appendices B and C to estimate DPM concentrations.

3.2.2 Urban Heat Island Effect

As determined in the land use analysis discussed in Appendix A, the sources are located in an urban area and have been modeled with the urban boundary layer option selected in AERMOD. As the urban boundary layer is selected, published census data were used to determine the population contributing to the heat island effect, as recommended by USEPA (USEPA 2005) for input into AERMOD. USEPA guidance (USEPA 2008) recommends using published census data corresponding to the Metropolitan Statistical Area (MSA) for the model area, in this case the Palo Alto-Stanford MSA (total population 71,561; United States Census Bureau [USCB] 2008).

3.2.3 Meteorological Data

ENVIRON used 2005 meteorological data collected from a meteorological station installed at Stanford University in June 2004 and located near the Project. This location was determined to be the most representative meteorological data available for air dispersion modeling for the SUMC Project. Meteorological data for use in AERMOD were processed in accordance with the AERMOD Implementation Guidance released in January 2008. A description of meteorological data processing and processed meteorological data ready for use in AERMOD can be found in Appendix A. As discussed later in Section 3.2.6, each source type (e.g., construction equipment, emergency generators, and delivery truck/vehicles) is assumed to operate on a separate schedule based on information provided in the SUMC Project application.[13,14] Wind roses which correspond to the period modeled for each source are shown in Figures 3.3 (construction activities – 9 am to 5 pm), 3.4 (emergency generators – 6 am to 7 am) and 3.5 (delivery truck/vehicles – 24 hours per day).

3.2.4 Terrain

An important consideration in an air dispersion modeling analysis is whether the terrain in the modeling area is simple or complex (i.e., terrain above the effective height of the emission point). Complex terrain can affect the results of a dispersion analysis involving point and volume sources, but does not affect the predicted results for area sources (USEPA 2004a). Terrain elevations were obtained from United States Geological Survey (USGS) maps for the 7.5 Minute Quadrangles of Palo Alto and San Jose, and imported to sources and receptors using AERMAP, a data preprocessing module associated with AERMOD. Electronic files containing these terrain elevations are included in Appendix A. Since the modeling area for this assessment contains complex terrain, complex terrain elevations were used in the air dispersion modeling for this HHRA.

3.2.5 Receptors

DPM concentrations were estimated for three types of receptors: two-meter high grid receptors, building roof grid receptors (i.e., at air intake locations), and discrete receptors at potential sensitive receptor locations (i.e., schools, daycare centers and retirement facilities/senior centers).

3.2.5.1 Two-Meter High Grid Receptors

Three resolutions of grid spacing were used at differing distances from the SUMC Project. A fine grid with 20 meter spacing between receptors was used for areas within and up to 500 meters from the Project boundary. A medium grid receptor spacing of 50 meters was used up to one kilometer from the Project boundary, and a coarse grid spacing of 200 meters was used to cover the area bounded by US 101 (northeast), 280 (southwest), and local streets that are 2000 meters northwest and 4500 meters southeast of the Project boundary. Figure 3.6 presents an overview of the ground level grid receptor locations used in this analysis; Figure 3.7 shows an expanded view of receptor locations immediately adjacent to the SUMC Project.

As the BAAQMD has not developed a methodology for evaluating construction emissions, a receptor height of two meters was chosen following the localized significance threshold (LST) methodology developed by the South Coast Air Quality Management District (SCAQMD), as discussed later in Section 3.2.6. While this methodology was specified for construction

---

[13] Project Application – Demographics and Operations (Revised 04/2008), http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=8833

[14] Project Application – Construction Activities (Revised 04/2008), htttp://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=8839

modeling, ENVIRON also used receptors at the same height to evaluate operational emissions (vehicle and emergency generator emissions) so that impacts from both construction and operational activity could be evaluated together, if necessary.

3.2.5.2 Building Roof Receptors

Estimated concentrations at ground level receptors assume the receptors are exposed to ambient air concentrations at a height of two meters. Most of the buildings associated with the SUMC (both onsite and offsite) have air intakes located on the roofs and the buildings themselves have non-operable windows. For these buildings (both existing and proposed), ENVIRON evaluated air concentrations at building height (e.g., rooftop air intake level).

Exceptions include the Hoover Pavilion and the existing LPCH. The Hoover Pavilion has a main air intake for package units at roof level, but windows are operable and package air conditioning units exist at all levels, and are used during the summer months. This configuration would change by 2011, however, when major heating, ventilation, and air conditioning (HVAC) equipment will be installed as part of the renovation. After the HVAC equipment is installed, windows would be sealed during the construction of the Hoover Medical Office Building (MOB) and Parking Structure. Meanwhile, the existing LPCH has operable windows but they are fixed shut, and air intakes exist at a height of 9 feet.

Other buildings that have or will have ground level intakes include the Falk building, the Beckman building, and the Hoover MOB. Table 3.5 lists the existing and proposed buildings, their heights, the location of the air intakes, whether or not they have operable windows and the level of filtration, if any, on the HVAC system.

Figure 3.8 shows the overview of building roof receptors for existing buildings to be demolished during the Project and Figure 3.9 shows the building roof receptors for the post-Project building layout. Non-SUMC buildings located offsite do not have operable windows, and air intakes exist at roof levels that range from one-story high to three-stories high.

As these are medical buildings, air intakes generally have some sort of filtration which is effective at removing particulate matter. The ASHRAE efficiency of filtration on each building was provided by Stanford[15] and is presented in Table 3.5. The level of filtration was used to adjust the outdoor air DPM concentration estimated at the HVAC intake to calculate an indoor air concentration. As the ASRHAE rating does not present a filter efficiency by particle size, ENVIRON determined the rating, or the minimum efficiency reporting value (MERV) level of the filter based on the given ASHRAE efficiency and the Camfil Farr ASHRAE Filter Selection Chart (Camfil Farr 2002)[16.] Also based on Camfil Farr, ENVIRON conservatively assumed that only filters with rating above MERV-14 (including HEPA) can effectively remove DPM during air intake.

---

15 Site visit with SUMC Facility Engineers, January 16, 2009.

16 Camfil Farr. 2002. ASHRAE Testing for HVAC Air Filtration – A Review of Standards 52.1-1992 & 52.2-1999

For new buildings to be constructed as part of the Project details on operable windows and HVAC location were not available; therefore, it was assumed that all new buildings did not have operable windows and that HVAC intakes would be found on the roof and filtration was assumed to be similar to that of an existing building with similar use (e.g., hospital, clinic, laboratory, SoM building). This estimated indoor air concentration was assumed to be the exposure point concentration for workers inside those buildings.

3.2.5.3 Offsite Sensitive Receptors

Guidance from the District (BAAQMD 2000) and the Cal/EPA (2003) was used to identify offsite sensitive receptors. Per this guidance, receptors were placed at locations with potentially sensitive populations such as hospitals, schools, preschools, child care facilities, and retirement facilities/senior centers. Searches of on-line databases that contain publicly available information, such as those made available by the California Community Care Licensing Division, California Department of Education, Office of Statewide Health Planning and Development, and Yellow Pages were used in this task. Sensitive receptor locations were identified from searches of the following sources:

- California Community Care Licensing Division (http://www.ccld.ca.gov/docs/ccld_search/ccld_search.aspx)
- California Department of Education, California School Directory (http://www.cde.ca.gov/re/sd/)
- California OSHPD, Licensed Facility Information System (http://alirts.oshpd.ca.gov/LFIS/LFISHome.aspx)
- Google Map (map.google.com)

These on-line databases were searched for the following zip codes in the cities of Palo Alto and Menlo Park encompassed in the modeling domain: 94025, 94307 and 94304. This extends approximately 1.5 miles from the Project boundary.

These searches identified child care centers, preschools, elementary and middle schools, and retirement facilities/senior centers around the Project. Table 3.6 lists all offsite sensitive receptors evaluated in the HHRA. Sensitive receptor locations are also shown in Figure 3.10.

3.3 Source Parameters and Operating Schedules

ENVIRON conducted the dispersion modeling separately for the three DPM source groups: construction equipment, emergency generators, and vehicle/truck traffic associated with the loading dock from the proposed SUMC Project. The source parameters and operating schedules specifically for each source group are summarized below and the detailed modeling methodology for each source group is presented in Appendices B through D.

3.4 Building Construction

Since the BAAQMD has not developed specific methodologies for modeling construction emissions, construction activity was modeled using the localized significance thresholds (LST) methodology developed by SCAQMD. The general construction areas were represented by a series of adjacent volumes sources. Each source was 20 meters by 20 meters, with a release height of 5 meters. ENVIRON conducted the modeling analysis in a year-by-year basis to take into account the relocation of construction activities and employees as the Project progresses. Details of the construction modeling are presented in Appendix B. For this analysis, ENVIRON assumed that the operating schedule of the construction equipment is 9 am to 5 pm, Monday to Friday. The location of the proposed construction activities are represented by adjacent volume sources as shown in Figures 3.11a - 3.11m. The construction source parameters used in the air dispersion model are summarized in Table 3.7.

3.5 Emergency Generators

The locations of the existing and future emergency generator were provided in the SUMC Project application[17], and the stack height, and stack diameter were either measured by ENVIRON staff during an onsite survey[18] or provided by SUMC Project sponsors. As discussed earlier, the locations of the emergency generators are show in Figure 2.3. The stack height for the seven generators associated with SHC is 34 feet each. Stack heights for generators at LPCH and the FIM buildings would equal 20 feet, the height of existing generators at Quarry Road. As the specific models of the emergency generators have not yet been determined, and Tier 4 final engines are not currently available, ENVIRON estimated missing source parameters, such as exhaust velocity and temperature, based on the specification sheet of a currently available Caterpillar engine of a similar size. Source parameters used in the air dispersion model are summarized in Table 3.7. The testing schedule and duration of the emergency generators were provided by SUMC Project sponsors[19] and was assumed to be 30 minutes between 6 am to 7 am, once per week.

Building downwash is the effect of structures on the dispersion of emissions from nearby point (stack) sources. As the emergency generators are modeled as point sources, building downwash was considered in this assessment. The dimensions of most onsite existing and proposed buildings (i.e., location of building corners and heights of buildings) were provided by PBS&J (in the case of onsite buildings). For buildings whose building height was not provided by PBS&J, ENVIRON assumed a height of 10 meters, the approximate height of a four story building.[20] This information was used along with USEPA's Building Profile Input Program (BPIP) to account for building-induced aerodynamic downwash effects using the Plume Rise

---

[17] Stanford University Medical Center Facility Renewal and Replacement Project application (Figure 6-1a and 6-1b, revised 06/2009.

[18] ENVIRON measured the stack heights and diameters of the existing emergency generator during a July 22, 2008

[19] Provided by C. Palter of Stanford Land Use and Environmental Planning on June 11, 2008.

[20] For onsite buildings, 10-meter height was assumed for Falk. For buildings outside the project area boundary, all buildings were assumed to be 10-meters except for Lucas, CCSR, Beckman, Fairchild, Clark, Lokey, Gates and the Psychiatry Building.

Model Enhancements (PRIME) algorithm. Buildings included in this analysis are shown in Figure C.1 of Appendix C.

3.6 Loading Docks

Emissions from vehicles were modeled by representing the mobile sources as line sources (i.e., a series of volume sources) for travel routes and as area sources for truck idling and maneuvering at the parking lot of the proposed loading dock location. Figures 3.1 and 3.2, respectively, show the locations of the modeled sources under two scenarios: 1) all traffic entering the Project boundary from I-280 and 2) all traffic entering the Project boundary from US-101. As a conservative measure, ENVIRON assumed the delivery operating schedule to be 24 hours/day as the detailed delivery schedule was not available. This is a conservative assumption as wind speed tends to be lower at night, which would result in higher predicted concentrations of DPM and therefore higher risk estimates. In actuality, the truck traffic would likely be more concentrated during the day when wind speeds are higher and concentrations (and therefore risks) are lower. As the health effects from DPM are considered chronic (9 years to lifetime exposure), daily variation in exposure does not affect the overall impacts. Therefore, spreading the emissions over 24 hours artificially overestimates the impacts.

In an ARB study (ARB 2006) characterizing risk at the Ports of Los Angeles and Long Beach, ARB staff suggests that the release height of HHDTs was assumed to be 4 meters during the day time and 6 meters at night due to buoyancy. ENVIRON conservatively assumed the release height to be 4 meters for both day time and night time delivery. The length of side of each volume source, which corresponds to the width of the travel lane, was assumed to be 12 feet for each lane, and confirmed using aerial photos. Source parameters used in the dispersion modeling for the volume sources representing vehicle traffic and for the area sources representing vehicle idling and maneuvering are shown in Table 3.7. The air dispersion model was run using USEPA regulatory default options of AERMOD.

Source emission estimation details are discussed in Appendix C.

4 Human Health Risk Assessment

This HHRA was performed to evaluate the potential health effects associated with the incremental increase in emissions resulting from the proposed SUMC Project. Specifically, this HHRA assesses the potential health effects associated with onsite and offsite exposures to the incremental increase in DPM emitted during construction activities and on-going operations. Operational sources of DPM evaluated in this HHRA include emergency generators and truck traffic servicing loading docks associated with the SUMC Project. As described in the Section 3 and Appendix A4, the potential health effects associated with TAC emissions from helipad operations are not evaluated in this section because the incremental increases of TAC emissions from helipad operations are below the BAAQMD TAC Trigger Levels. According to the BAAQMD, TAC Trigger Levels represent the concentration "below which the resulting health risks are not expected to cause, or contribute significantly to, adverse health effects" (BAAQMD Regulation 2, Rule 5, Section 223).

The HHRA was performed in accordance with the June 2005 BAAQMD *Toxic Evaluation Section Staff Report* (BAAQMD 2005a) and consistent with BAAQMD's *Risk Evaluation Procedure and Risk Management Policy* (BAAQMD 2000) as well as methodologies presented in the Cal/EPA Air Toxics Hot Spots Program Risk Assessment Guidelines, *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* (Cal/EPA 2003) and *Technical Support Document for Exposure Assessment and Stochastic Analysis* (Cal/EPA 2000).

As part of this HHRA, excess lifetime cancer risks and chronic noncancer HIs are estimated. The estimated excess lifetime cancer risks and chronic noncancer HIs are compared to the thresholds for significance for TACs in the BAAQMD CEQA Guidelines for a MEI. The thresholds of significance for TACs are a cancer risk of 10 in one million (10×10^{-6} or 1×10^{-5}) and a noncancer HI of one for the MEI (BAAQMD 1999).

The following sections discuss the various components required for conducting the HHRA in detail. Section 4.1 identifies the chemicals that have been included in this assessment. Section 4.2 presents the exposure assessment and includes a discussion of the human populations that may potentially be exposed to DPM emissions and the pathways through which exposure may occur. Section 4.3 presents information related to the toxicity of DPM. Section 4.4 explains the methodology for calculation of excess lifetime cancer risk and chronic noncancer HIs.

4.1 Chemical Selection

Diesel exhaust, as DPM, is the only chemical identified for inclusion in the HHRA. As discussed in Section 3, the potential health effects associated with TAC emissions from helipad operations are not evaluated in this section because the incremental increases of TAC emissions from helipad operations are below the BAAQMD TAC Trigger Levels.

DPM emissions from construction activities and operational sources, including emergency generations and truck traffic servicing the loading docks, are the focus of this HHRA. Diesel exhaust is generated when an engine burns diesel fuel and consists of a mixture of gases and fine particles (also known as soot). Under California regulatory guidelines (Cal/EPA 1998, 2008a), DPM is used as a surrogate measure of exposure for the mixture of chemicals that make up diesel exhaust as a whole, as discussed in Section 4.3.

4.2 Exposure Assessment

The USEPA (1989) defines exposure as "the contact of an organism with a chemical or physical agent" and defines the magnitude of exposure as "the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut,)." Exposure assessments are designed to determine the degree of contact a person has with a chemical. The components of the exposure assessment include the identification of potentially exposed populations, the identification of exposure pathways, and the selection of exposure assumptions to quantify chemical intakes.

4.2.1 Potentially Exposed Populations

To evaluate the potential human health risks posed by a site, it is necessary to identify the populations that may be exposed to the chemicals present and to determine the pathways by which exposures may occur. Identification of the potentially exposed populations requires evaluating the human activity and land-use patterns at the site and in the vicinity of the site. The populations considered in this HHRA include onsite and offsite receptors.

The SUMC Project is located in an area zoned for Medical Office and Medical Research (MOR) and Public Facilities (PF). The SUMC Project is currently comprised of over 2.3 million square feet of occupied hospitals, medical clinics and offices and medical research facilities. Parking structures, paved roads and walkways, and landscaping occupy the areas surrounding the buildings. As discussed in Section 1, the proposed SUMC Project consists of demolishing existing buildings and replacing them with new onsite structures containing hospital, clinic, medical office and medical research space.

Based on the current land use, onsite populations that could potentially be exposed to DPM emissions during construction activities and post renovation operations related to the SUMC Project include occupants of the buildings (indoor workers) and individuals who may work outdoors in the vicinity of the buildings (outdoor workers). Onsite indoor workers include individuals who typically work inside, such as employees of the hospitals, medical clinics and research facilities. Onsite outdoor workers include individuals who typically work outside, such as parking lot attendants/valet, groundskeepers, security personnel, and loading dock personnel. Visitors to the Project may also be exposed to DPM emissions, but their exposure time, frequency and duration would be much less than onsite workers.

Onsite workers are not typically evaluated in an air quality risk assessment performed as part of an EIR. In accordance with State health and safety requirements (8 CCR § 5194), onsite workers are protected by California Occupational Safety and Health Administration (OSHA). Consequently, Cal/EPA does not generally require evaluation of onsite workers in risk assessments performed to satisfy requirements of State air toxic programs (Cal/EPA 2003). However, as requested, ENVIRON evaluated potential onsite worker exposures to DPM from construction and operational sources related to the Project.

For this HHRA, two types of onsite indoor workers were evaluated; stationary workers and relocated workers. Onsite indoor stationary workers were assumed to work inside the same building for the entire 12-year period of construction. Onsite indoor relocated workers are expected to re-locate to different buildings during the construction phase of the SUMC Project.

Land use in the area surrounding the SUMC Project are zoned for residential and community commercial use. Consequently, offsite residents and offsite workers were identified for evaluation in this HHRA. Offsite receptor locations evaluated in the HHRA are shown in Figures 3.6 to 3.10. Consistent with BAAQMD (2005b) and Cal/EPA guidance (Cal/EPA 2003), cancer risks and noncancer HIs are reported for the location of the maximally exposed individual resident (MEIR) and the maximally exposed individual worker (MEIW). The MEIR and MEIW are defined as the receptor locations where individuals may reside or work with the maximum estimated excess lifetime cancer risk or noncancer HI (Cal/EPA 2003).

Potential offsite sensitive populations were also identified for evaluation in this HHRA based on guidance from the District (BAAQMD 2005a) and Cal/EPA (2003). As shown on Table 3.6, offsite sensitive receptors identified for the HHRA included child care centers, preschools, elementary and middle schools, and retirement facilities/senior centers within a 1.5 mile area surrounding the Project. For purposes of this HHRA, cancer risks and chronic noncancer HIs estimated for a school child represent sensitive receptors at child care centers and schools. Sensitive receptors at retirement facilities/senior centers were evaluated as residents.

4.2.2 Exposure Pathways

Once potentially exposed populations are identified, the complete exposure pathways by which individuals in each of these populations may be exposed to DPM from the SUMC Project are determined. An exposure pathway is defined as “the course a chemical or physical agent takes from a source to an exposed organism (USEPA 1989).” A complete exposure pathway requires the following four key elements:

- Chemical source,
- Migration route (i.e., environmental transport),
- An exposure point for contact (e.g., air), and
- Human exposure route (e.g., inhalation).

An exposure pathway is not complete unless all four elements are present.

Only the inhalation exposure pathway was considered in the evaluation of DPM. Selection of additional pathways for a multipathway analysis is specific to the chemical and land use designations in the area potentially impacted by the SUMC Project. Cal/EPA (2003) has identified chemicals that must be evaluated in a multipathway analysis and DPM is not listed by Cal/EPA as a multipathway chemical. Thus, for this HHRA, ENVIRON only conducted an evaluation of inhalation exposures.

4.2.3 Dose Estimate

The next step of the HHRA was to estimate the amount of DPM (i.e., dose) actually taken into the body. The dose for inhalation, $Dose_{inh}$, can be calculated as follows:

$$IF_{inh} = \frac{DBR \times F \times EF \times ED \times CF}{AT} \qquad 4.1$$

Where:

IF_{inh}	=	Intake Factor for Inhalation (m^3/kg-day)
DBR	=	Inhalation Rate (L/kg-day)
F	=	Fraction of the day exposed (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
CF	=	Conversion Factor (0.001 m^3/L)
AT	=	Averaging Time (days)

As discussed in Section 4.2.2, the potentially exposed populations to be addressed in this HHRA include:

- Onsite outdoor workers: Individuals who typically work outside, such as parking lot attendants/valet, groundskeepers, security personnel, and loading dock personnel,
- Onsite indoor workers: Individuals who typically work inside, such as employees of the hospitals, medical clinics and research facilities,
- Offsite residents,
- Offsite workers, and
- Offsite sensitive receptor.

For each of the potentially exposed populations identified, exposures were quantified for two scenarios; (1) exposures that may occur during the construction activities and (2) exposures that may occur during post renovation operations (i.e., long-term emissions from emergency generators and loading docks).

4.3 Construction Scenario

The exposure parameters used to evaluate the construction scenario are presented in Table 4.1a. As discussed earlier in this report, the expected duration of construction for the SUMC Project is 2010 through 2021 (i.e., 12 years).

4.3.1 Workers

For onsite outdoor workers, the exposure point concentration was estimated as the ambient (outdoor) air concentration of DPM estimated at ground level (2 meters) at outdoor worker receptor locations. For indoor onsite workers, exposures were evaluated using DPM concentrations which are representative of an indoor air concentration.[21] Calculation of indoor air concentrations considered three building factors which can affect potential indoor worker exposures to DPM from construction emissions: 1) whether the building has operable windows, 2) the location of the HVAC intakes, and 3) the presence of air filtration for particulate on the HVAC system.

For existing buildings, the status of operable windows and HVAC location was provided by the SUMC Project sponsors. For new buildings to be constructed as part of the Project details on operable windows and HVAC location were not available; therefore, it was assumed that all new buildings did not have operable windows and that HVAC intakes are found on the roof, which is consistent with the current configuration of the existing buildings which have uses similar to those of the proposed buildings.

When an onsite worker was scheduled to re-locate during the 12-year construction period, exposures were quantified for each work location and then summed to estimate the total worker exposure over the life of the construction activities. For onsite workers that relocate to another building onsite or come who onsite for the first time as part of the Project expansion, a composite exposure based on time spent at each location was determined as potential exposure over the Project duration varies significantly based upon the location of the worker relative to the construction activity. To estimate the excess lifetime cancer risk for the onsite worker, ENVIRON calculated the year-by-year excess lifetime cancer risk for every onsite receptor (building specific) based upon the year-by-year concentration derived from the annual emission rates summarized in Table 3.1.

Offsite indoor and outdoor workers in the vicinity of the Project were also evaluated. For this evaluation, it was assumed that an offsite worker would be exposed to construction related DPM emissions for the entire duration of the construction (12 years).

Consistent with Cal/EPA (2003) guidance, an adjustment factor is applied to evaluate the worker. This adjustment factor converts the annual average concentration (estimated assuming exposure occurs 24 hours per day for 7 days per week) to a concentration a worker may breath during an 8 hour workday and 5 day work week assuming the worker is present at the same time as the construction activity (that is, concurrent with the DPM emissions). As shown in Table 4.1a, the adjustment factor for a worker is 4.2 (equal to 24 hours/8 hours times 7 days/5days). Application of this adjustment factor is conservative (I.e., health-protective) because it is assumes that all workers are present during the construction activity even though some workers may work at times when construction activities are not occurring.

---

[21] Depending on HVAC intake location for each building, modeled air concentrations were evaluated at either ground or roof level. If the HVAC system includes filtration, indoor air concentrations were estimated using a conservative filtration efficiency.

4.3.2 Offsite Resident

Offsite adult residents are assumed to be exposed to construction emissions for the duration of the Project (12 years). Consistent with Cal/EPA (2003) guidance, the exposure duration assumed for a child resident is 9 years as shown in Table 4.1a. To evaluate a child resident, it was assumed that the child is exposed to the maximum nine year rolling average concentration within the 12-year construction period.

4.3.3 Offsite Sensitive Receptor

As discussed in Section 4.2.1, potential offsite sensitive populations were identified for evaluation in this HHRA based on guidance from the District (BAAQMD 2005a) and Cal/EPA (2003). As discussed in Section 3.2.5, offsite sensitive receptors identified for the HHRA included child care centers, preschools, elementary and middle schools, and retirement facilities/senior centers within a 1.5 mile area surrounding the Project. For purposes of this HHRA, cancer risks and chronic noncancer HIs estimated for a school child represent sensitive receptors at child care centers and schools

As recommended by the BAAQMD, it is assumed that a child attends school 10 hours per day, 180 days per year for 9 years (BAAQMD 2005b). The high end breathing rate of 581 L/kg-day recommended for a child resident population was used (BAAQMD 2005b; Cal/EPA 2003). The exposure assumptions for school children used in this HHRA are presented in Tables 4-1a.

Consistent with Cal/EPA (2003) guidance, an adjustment factor is applied to evaluate the school child. This adjustment factor converts the annual average concentration (estimated assuming exposure occurs 24 hours per day for 7 days per week) to a concentration a school child may breath during an 10 hour school day assuming the school child is present at the same time as the construction activity. As shown in Table 4.1a, the adjustment factor for a school child is 3.4 (equal to 24 hours/10 hours times 7 days/5 days).

Sensitive receptors at retirement facilities/senior centers were evaluated as residents. As such, potential exposures at retirement facilities/senior centers were evaluated using standard adult residential exposure parameters presented in Table 4.1a.

4.4 Operational Emissions Scenario

Operational sources of DPM include emergency generators and trucks traveling to and from loading docks. The exposure parameters used to evaluate exposures to DPM emissions from emergency generators are presented in Table 4.1b. Table 4.1c presents the exposure parameters used to evaluate exposure to DPM from trucks associated with loading docks.

4.4.1 Worker

Onsite and offsite workers are assumed to be exposed to operational emissions for 40 years (Cal/EPA 2003). This exposure period corresponds to the years between the proposed start of the SUMC Project (2010) to the year 2049. Workers are further assumed to be exposed to DPM emissions 8 hours per day for 245 days per year (Cal/EPA 2003). The exposure time representing an 8 hour work day is factored into the body weight adjusted daily breathing rate. The body weight adjusted breathing rate equates to a value of 149 liter per kilogram per day (L/kg-day). This value corresponds to a body weight of 70 kg and a breathing rate of 1.3 cubic meters per hour (m^3/hour) over an 8 hour work-day. The exposure assumptions for worker exposures to operational sources of DPM are presented in Table 4.1b and Table 4.1c.

As shown on Table 4.1b, the adjustment factor of 4.2 is applied to the modeled annual average concentration of DPM from emergency generators. The emergency generators will be tested once per week for 30 minutes between 6 and 7 am. The adjustment factor converts the annual average concentration (estimated assuming exposure occurs 24 hours per day for 7 days per week) to a concentration a worker may breath during an 8 hour shift which includes the hours the generators are tested. As described in Section 4.3.1, this factor is recommended by Cal/EPA (2003) to estimate the concentration that a worker would breathe assuming they are present when the emissions occur. An adjustment factor was not applied to evaluate potential worker exposure to DPM from trucks related to the proposed loading docks. This is because truck travel occurs over a 24 hour period and thus the annual average concentrations represent the concentration that could potentially be inhaled by a worker.

4.4.2 Offsite Resident

The exposure assumptions used to evaluate potential offsite residential exposures to DPM emissions from operational sources are presented in Tables 4.1b and 4.1c. For this HHRA, it was conservatively (i.e., health-protective) assumed that residents are exposed to operational emissions for 24 hours per day, 350 days per year (USEPA 1989, 1991; Cal/EPA 2003). However, adults spend only 68 to 73% of their total daily time at home (USEPA 1997), rather than the 100% assumed in this HHRA. Accordingly, the actual risks to residents in the vicinity of the Project are likely to be significantly lower than those estimated in this HHRA. Consistent with USEPA (1991) and Cal/EPA (1992, 1994, and 2003) risk assessment guidance, an exposure frequency of 350 days per year is assumed. This assumes that residents are present in their home 7 days a week for 50 weeks a year (or approximately 96 percent of the time). Approximately 2 weeks (or 15 days) are spent away from home. As recommended by Cal/EPA (2003), a daily breathing rate of 302 L/kg-day was used to estimate residential exposures.

Excess lifetime cancer risks estimated assuming a residential exposure duration of 70 years are used by State and local agencies for risk management and public notification purposes (BAAQMD 2005b). Specifically, OEHHA Hot Spots Guidance states that “Lifetime or 70-year exposure is the historical benchmark for comparing facility impacts on receptors for evaluating the effectiveness of air pollution control measures(Cal/EPA 2003).” Use of the 70-year exposure duration in risk assessments is intended to produce a hypothetical estimate of risk that does not underestimate risks and that can be viewed as an upper-bound estimate. To illustrate the conservative nature of the assumption, it is worth noting that the USEPA has estimated that 50% of the U.S. population lives in the same residence for only 9 years, while only 10% remain in the same house for 30 years (USEPA 1997).

4.4.3 Sensitive Receptors

As discussed in Section 4.3.3, the sensitive receptors identified for evaluation include schools and retirement facilities/senior centers. The exposure parameter used to assess potential exposures by school children and senior center residents to operational sources of DPM are provided on Table 4.1b and Table 4.1c.

4.5 Toxicity Assessment

The toxicity assessment examines the potential for a chemical to cause adverse health effects in exposed individuals. Toxicity values used to estimate the likelihood of adverse effects occurring in humans at different exposure levels are identified as part of the toxicity assessment component of a risk assessment. The toxicity values selected for use in evaluating potential adverse health effects associated with exposure to DPM are presented in Table 4.2.

Both the USEPA and Cal/EPA have identified diesel exhaust as a respiratory carcinogen. In 1998, Cal/EPA listed DPM as a TAC based on its potential to cause cancer and other adverse health effects. Diesel exhaust is a complex mixture that includes hundreds of individual constituents (Cal/EPA 1998). Under California regulatory guidelines, diesel exhaust, as a mixture, is identified by the State of California as a known carcinogen (Cal/EPA 1998, 2005). However, under California regulatory guidelines (Cal/EPA 1998, 2007), DPM is used as a surrogate measure of exposure for the mixture of chemicals that make up diesel exhaust as a whole. Consistent with Cal/EPA risk assessment guidance, we used the Cal/EPA cancer potency factor (CPF) for DPM to estimate cancer risks associated with exposure to diesel emissions resulting from the SMUC Project (Cal/EPA 2008a). The chronic reference exposure level (REL) for DPM, presented in Table 4.2 represents the average daily exposure concentrations at (or below) which no adverse health effects are anticipated (Cal/EPA 2008b). An acute REL has not been published by Cal/EPA and therefore acute impacts for DPM were not evaluated.

4.6 Methods Used to Estimate Excess Lifetime Cancer Risks and Noncancer Hazard Indices

Excess lifetime cancer risks are estimated as the upper-bound incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens. The estimated risk is expressed as a unitless probability. The cancer risk attributed to a chemical is calculated by multiplying the chemical intake or dose at the human exchange boundaries (*e.g.,* lungs) by the chemical-specific CPF. The equation used to calculate the potential excess lifetime cancer risk for DPM is as follows:

$$Risk = Dose_{inh} \times CPF \qquad 4.2$$

Where:

Risk	=	Cancer Risk; the incremental probability of an individual developing cancer as a result of exposure to a particular cumulative dose of a potential carcinogen (unitless)
$Dose_{inh}$	=	Dose of a chemical (mg chemical/kg body weight-day)
CPF	=	Cancer Potency Factor (mg chemical/kg body weight-day)$^{-1}$

The potential for exposure to result in chronic noncancer effects is evaluated by comparing the estimated annual average air concentration (which is equivalent to the average daily air concentration) to the chemical-specific noncancer chronic RELs. When calculated for a single chemical, the comparison yields a ratio termed a hazard quotient. To evaluate the potential for adverse chronic noncancer health effects from simultaneous exposure to multiple chemicals, the hazard quotients (HQs) for all chemicals are summed, yielding a HI. As DPM is the only compound evaluated in this HHRA, the HI is equal to the HQ for DPM.

The equations used to calculate the chemical-specific HQs and the overall HI are:

$$HQ_i = C_i / REL_i \qquad 4.3$$

$$HI = \Sigma HQ_i \qquad 4.4$$

Where:

HI	=	Hazard Index
HQ_i	=	Hazard Quotient for $Chemical_i$
C_i	=	Average Daily Air Concentration for $Chemical_i$ (µg/m^3)
REL_i	=	Noncancer Reference Exposure Level for $Chemical_i$ (µg/m^3)

5 Results of Estimated Excess Lifetime Cancer Risks and Chronic Noncancer Hazard Indices

This section presents the results for this HHRA. To focus the presentation and evaluation of the HHRA results, the estimated excess lifetime cancer risks and chronic noncancer HIs are discussed relative to the significance thresholds for TACs identified in the BAAQMD CEQA Guidelines for a MEI (BAAQMD 1999). According to the BAAQMD CEQA Guidelines, the significance threshold for TACs is a cancer risk greater than 10 in one million (10×10^{-6} or 1×10^{-5}) and a non-cancer HI of greater than one (1) for the MEI. Projects that do not have the potential to expose the public to TACs in excess of these thresholds would not be considered to have a significant air quality impact.

For additional reference, the National Contingency Plan (NCP) (40 CFR § 300) is commonly cited as the basis for target risk for risk assessments conducted in regulatory programs outside of the CEQA framework. According to the NCP, cancer risks below or within the target risk range of one in one million (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) are generally considered protective of human health by the USEPA (CFR § 300).

Sections 5.1 and 5.2 present the estimated excess lifetime cancer risks and the chronic noncancer HIs calculated as part of this HHRA for the construction and operational sources, respectively. Uncertainties that may result from the various assumptions used in the estimation of risk are discussed in Section 5.3.

5.1 Estimated Excess Lifetime Cancer Risks and Chronic Noncancer Hazard Indices Associated with DPM from Construction Sources

ENVIRON estimated the excess lifetime cancer risks and chronic noncancer HIs associated with potential exposures to DPM from construction sources. The results of the HHRA indicate that potential exposures to construction-related DPM are below the BAAQMD CEQA significance thresholds for the receptors considered in this HHRA and the exposure assumptions used. Further, cancer risks estimated for all receptors are below or within the target risk range of one in a million (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) generally considered protective of human health by the USEPA (40 CFR § 300).

The estimated excess lifetime cancer risks and chronic noncancer hazard indices associated with potential exposures to DPM from construction sources are discussed for each onsite and offsite receptor below:

5.1.1 Onsite Exposure to DPM from Construction Sources

Onsite receptors evaluated in this HHRA include outdoor and indoor workers who may be exposed to DPM during the construction phase of the SUMC Project. The estimated excess lifetime cancer risk and chronic noncancer HI for the MEIW onsite workers are presented in Table 5.1.

5.1.1.1 Onsite Outdoor Workers

Onsite workers who typically work outside include parking lot attendants/valet, groundskeepers, security personnel, and loading dock personnel. The SUMC Project sponsors estimate that there are a total of 58 to 60 outdoor employees at various locations within the SUMC Project boundary. To estimate exposures to outdoor workers from construction sources of DPM, ground-level (e.g., two-meter modeling receptors) ambient air concentrations of DPM were used. The risks estimated for the onsite outdoor workers are conservative (i.e., health-protective) because the exposure scenario evaluated for this receptor assumes that an individual works outdoors for 8 hours per day at the same location, every working day for the entire duration of construction (i.e., 12 years). These assumptions likely over-predict the risks associated with worker exposures to construction-related DPM because their occupations generally require that they change locations frequently over the course of a day or over an extended period of time and may spend some amount of time indoors.

The estimated excess lifetime cancer risk for the MEIW – onsite outdoor worker is 9.7 in one million (9.7×10^{-6}), as shown on Table 5.1. This estimated excess lifetime cancer risk does not exceed the BAAQMD significance threshold of 10 in one million. For the MEIW - onsite outdoor worker, the estimated chronic noncancer HI is 0.3, which does not exceed the BAAQMD threshold of significance of one (1).

As discussed in Section 4, use of an adjustment factor of 4.2 likely over-predicts the worker exposures to DPM as it reflects the assumption that construction occurs only during the time when the workers are present. Use of this factor does not take into consideration that construction may occur at times when workers are not present. Nor does it consider that workers may choose to adjust their locations and/or schedules to avoid the construction activities.

5.1.1.2 Onsite Indoor Workers

Onsite indoor workers considered in this HHRA include individuals who will work inside buildings located within the SUMC Project area during the construction. For these individuals, exposures are evaluated using DPM concentrations which are representative of an indoor air concentration.[22] As described in Section 4, calculation of indoor air concentrations considered three building factors which can affect potential worker exposures to DPM from construction emissions: 1) whether the building has operable windows, 2) the location of the HVAC intakes, and 3) the presence of air filtration for particulate on the HVAC system. The SUMC Project sponsors provided a listing of buildings with operable windows,[23] and identified the location of HVAC intakes, as shown in Table 5.2. Most onsite workers work in buildings that do not have operable windows, where the HVAC is located on the roof and which usually have some sort of filtration which can remove DPM. As discussed in Section 3.2.5.2., the particulate filtration efficiencies presented in Table 5.2 were estimated based on the filter ASHRAE efficiencies

[22] Depending on HVAC intake location for each building, modeled air concentrations were evaluated at either ground or roof level. If the HVAC system includes filtration, indoor air concentrations were estimated using a conservative filtration efficiency. [NOTE: design goal places intakes at remote locations, eliminating need for filtration]

[23] E-mail from Catherine Palter of Stanford Land Use and Environmental Planning, 9/16/2008.

provided by Stanford Engineers.[24] For this HHRA, it was assumed that some indoor onsite workers will remain in the same building for the entire 12-year construction period while other workers will re-locate to different buildings during the construction phase. Indoor onsite workers who are expected to remain working in the same building throughout the construction activities are referred to as “Onsite Indoor Stationary Workers”. Employees that occupy multiple buildings over the course of the construction period are referred to as “Relocated onsite Indoor Workers”. The HHRA results for these onsite indoor workers are summarized in Table 5.1. Tables 5.2 and 5.3 present the HHRA results for onsite indoor stationary workers and indoor relocated workers, respectively.

5.1.1.3 Onsite Indoor Stationary Workers

Onsite indoor stationary workers were assumed to work inside the same building for the entire 12-year period of construction. To estimate risks for onsite indoor stationary workers, ENVIRON estimated risks for each year of the construction and calculated a total risk for each receptor location by summing the year-by-year risks over the 12-year construction period. As the air concentration was estimated for several receptor locations on each building, the receptor location, corresponding to the appropriate height (ground or roof level) for each building, with the highest risk estimate was selected to represent the risk for the entire building.

The estimated excess lifetime cancer risk for the MEIW – onsite indoor stationary worker is 4.1 in one million (4.1×10^{-6}), as shown on Table 5.1 and 5.2. This estimated excess lifetime cancer risk does not exceed the BAAQMD significance threshold of 10 in one million. For the onsite indoor stationary worker, the maximum estimated chronic noncancer HI is 0.1, which is below the BAAQMD threshold of significance of one (1).

5.1.1.4 Onsite Indoor Relocated Worker

Onsite indoor relocated workers are expected to re-locate to different buildings during the construction phase of the SUMC Project. As discussed in Section 4, a subset of onsite workers relocate to another building onsite or come onsite for the first time as part of the SUMC Project expansion. For these workers, a composite exposure based on time spent at each location was determined as the individual risk over the SUMC Project duration varies significantly based upon the location of the worker relative to the construction activity. Based upon occupancy data (Table 5.3), the annual estimated excess lifetime cancer risks for each building were summed to represent the total estimated excess lifetime cancer risk an onsite worker would experience over the duration of construction. Results of this analysis are shown in Table 5.3.

The estimated excess lifetime risk for the MEIW - relocated onsite indoor worker is 3.1 in a million (3.1×10^{-6}), as shown on Tables 5.1 and 5.3. This estimated excess lifetime cancer risk is below the BAAQMD significance threshold of 10 in one million. The estimated chronic noncancer HI for the MEIW - onsite indoor relocated workers is 0.1, which is also below the BAAQMD threshold of significance of one (1).

[24] Site visit with SUMC Facility Engineers, January 16, 2009.

5.1.2 Offsite Exposure to DPM from Construction Sources

Offsite receptors evaluated in this HHRA include offsite workers, offsite residents and sensitive receptors that may be exposed to DPM during the construction phase of the SUMC Project.

5.1.2.1 Offsite Workers

To evaluate potential risks for offsite workers (i.e., individuals who work at locations outside of the Project boundary throughout the modeling domain discussed earlier), it was assumed that offsite workers may be exposed to ambient or outdoor ground-level DPM concentrations from project construction sources. However, use of outdoor air concentrations of DPM is very conservative (i.e., health-protective) because most offsite workers work inside buildings. These buildings may not have operable windows and/or may have some sort of filtration which can remove DPM and thus reduce worker exposure to DPM.

The estimated excess lifetime cancer risk for the MEIW - offsite outdoor worker is 9.5 in one million (9.5×10^{-6}), as shown on Table 5.4. This estimated excess lifetime cancer risk does not exceed the BAAQMD significance threshold of 10 in one million. For the MEIW - offsite outdoor worker, the estimated chronic noncancer HI is 0.3, below the BAAQMD threshold of significance of one (1).

The estimated excess lifetime cancer risk for the MEIW - offsite indoor worker is 7.8 in one million (7.8×10^{-6}), as shown on Tables 5.2 and 5.4. This estimated excess lifetime cancer risk does not exceed the BAAQMD significance threshold of 10 in one million. For the MEIW - offsite indoor worker, the estimated chronic noncancer HI (0.2) is below the BAAQMD threshold of significance of one (1).

The estimated excess lifetime cancer risks and chronic hazard indices for an offsite outdoor and indoor worker assume that the same worker remains at one location every working day for the entire 12-year period of construction. However, to illustrate the conservative nature of this assumption it is worth noting that the USEPA has estimated that the median occupational tenure of the working US population is 6.6 years; slightly more than half of the exposure duration (12 years) assumed in this HHRA for a worker.

5.1.2.2 Offsite Residents

To evaluate potential risks to offsite residents, it was conservatively assumed that offsite residents may be exposed to ambient or outdoor ground-level DPM concentrations from Project construction sources. The estimated excess lifetime cancer risk associated with emissions from the construction activities at the MEIR – offsite adult resident (0.3 in one million) is below the BAAQMD significance threshold of 10 in one million, as shown on Table 5.4. The chronic noncancer HI at the MEIR – offsite adult resident (0.01) is below the BAAQMD threshold of significance of one (1). For the MEIR – offsite child resident, the estimated excess lifetime cancer risk (0.6 in a million) is also below the BAAQMD CEQA significance threshold of 10 in a million. The chronic noncancer HI (0.02) is below one.

5.1.2.3 Sensitive Receptors

As discussed in Section 4, sensitive receptor locations (schools and retirement facilities/senior centers) were identified for evaluation in this HHRA. Methods used to identify sensitive receptors in the vicinity of the SUMC Project are described in Section 4. As shown on Table 5.4, the estimated excess lifetime cancer risk at the maximum sensitive receptor location (0.3 in one million) is below the BAAQMD significance threshold of 10 in one million. This also reflects a conservative assessment as it is not likely that a child will be in the same location for 10 hours each day of the construction activities. The chronic noncancer HI at the maximum sensitive receptor location (0.01) is below the BAAQMD threshold of significance of one (1).

5.2 Estimated Excess Lifetime Cancer Risks and Chronic Noncancer Hazard Indices Associated with DPM from Operational Sources

ENVIRON estimated the excess lifetime cancer risk and chronic noncancer HI associated with potential exposures to DPM from facility operations (e.g., emergency generators and delivery vehicles servicing the loading docks). The results of the HHRA indicate that potential exposures to facility operation-related DPM at all receptor locations yield cancer risks and HIs estimates that are below the BAAQMD significance thresholds. Further, estimated excess lifetime cancer risks estimated for all receptors are below or within the target risk range of one in one million (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) considered protective of human health by the USEPA (40 CFR § 300).

The estimated excess lifetime cancer risks and chronic noncancer HIs from facility operations (e.g., emergency generators and delivery vehicles servicing the loading docks) are presented in this section.

5.2.1 Emergency Generators

As discussed in Section 4, DPM emissions from the emergency generators were used to estimate the excess lifetime cancer risks and chronic noncancer HIs at all receptor locations. The estimated cancer risks for the school child are likely overstated as the evaluation assumes that school children are present during the testing of the generators. However, the generators are typically tested between 6 and 7 am, when children are not likely present at school.

The estimated excess lifetime cancer risks and chronic noncancer HI associated with potential onsite and offsite exposures to DPM emission from emergency generators are summarized in Table 5.5. As shown on Table 5.5, the estimated excess lifetime cancer risks for all onsite receptors considered in this evaluation are below the BAAQMD threshold of significance of 10 in a million. For the onsite worker, the chronic noncancer HIs were below the BAAQMD threshold of significance of one (1).

The estimated excess lifetime cancer risks for all offsite receptor exposures to DPM emissions from emergency generators were also below the BAAQMD significance threshold of 10 in a million as shown on Table 5.5. The chronic noncancer HIs estimated for these receptors were all below the BAAQMD threshold of significance of one (1).

5.2.2 Delivery Vehicles Servicing Loading Docks

As discussed in Section 4, DPM emissions from the delivery vehicles servicing loading docks were used to estimate excess lifetime cancer risks and noncancer HIs at all receptor locations for two scenarios depending on whether the vehicles travel to the SUMC Project via I-280 or US-101.

As shown in Table 5.6, the estimated excess lifetime cancer risk for the onsite and offsite MEIW, offsite MEIR and maximum sensitive receptor were comparable between the two scenarios. The estimated excess lifetime cancer risks are all below the BAAQMD threshold of significance of 10 in a million. Table 5.5 also shows the chronic noncancer HI at all receptor locations, which were estimated to be below the BAAQMD threshold of significance of one (1).

5.2.3 Cumulative Excess Lifetime Cancer Risks and Chronic Noncancer Hazard Indices from Operational Sources

The estimated DPM concentrations from the emergency generators and loading dock vehicles were added together to determine the cumulative excess lifetime cancer risk and chronic noncancer HI and thus evaluate the potential health effects associated with simultaneous exposures to DPM emissions from both operational sources.

The sum of the excess lifetime cancer risks and noncancer HIs from emergency generator and loading dock vehicles were calculated at each receptor locations. As vehicles delivering to the loading docks will likely come from both I-280 and US-101, the maximum concentration predicted at each receptor point from each of these scenarios was used to calculate conservative cumulative excess lifetime cancer risks and chronic noncancer HIs. Since traffic will likely be split between the two directions, the actual risks and hazards are likely to be lower.

As shown in Table 5.7, the estimated excess lifetime cancer risk associated with potential simultaneous exposure to DPM emissions from emergency generators and trucks related to the loading docks are below the BAAQMD threshold of significance of 10 in a million. The chronic noncancer HI for all receptors is below the BAAQMD threshold of significance of 1 (one).

5.3 Cumulative Excess Lifetime Cancer Risks and Chronic Noncancer Hazard Indices from Construction Activities and Operational Sources

This section presents the estimated excess lifetime cancer risks and chronic noncancer HIs associated with simultaneous exposure to DPM from construction and operational sources related to the Project.

To evaluate the potential risks associated with worker exposure to DPM from both construction and operational sources, the concentrations of DPM from both sources were summed at each MEIW location. This summed DPM concentration was then used to estimate cancer risks for workers at these MEIW locations. As shown in Table 5.8, the excess lifetime cancer risks estimated for workers assuming simultaneous exposure to DPM emissions from construction and operational sources related to the Project are below the BAAQMD threshold of significance of 10 in a million. The chronic noncancer HI for all receptors is below the BAAQMD threshold of significance of 1 (one).

To evaluate the potential health effects associated with simultaneous exposures by offsite residents to DPM from both construction and operational sources, the excess lifetime cancer risks and chronic noncancer His at the MEIR – adult resident estimated for construction emissions (0.3 in a million) and the MEIR – adult resident for operational emissions (0.4 in a million) were summed. The combined cancer risk for the MEIR (0.7 in a million) is below the BAAQMD significance threshold of 10 in a million. This is a conservative approach as the MEIR for construction and operational sources are not at the same location and thus it is not possible for the same individual to be exposed to the maximum DPM concentration emitted from each source. However, based on this worst-case evaluation, it may be assumed that simultaneous exposure to DPM from construction and operational sources at any residential location will be less than the BAAQMD significance thresholds. The same approach was applied to evaluate cumulative risks for MEIR - child residents and sensitive receptors. The estimated risks and HIs associated with simultaneous exposures by these receptors to DPM emissions from construction and operational components of the Project are below the BAAQMD significance thresholds.

5.4 Uncertainties Associated with the Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices

In any risk evaluation, a number of assumptions must be made in order to estimate human exposure and to calculate potential risks. These assumptions may, however, introduce uncertainty in risk calculations. Regulatory guidance requires that conservative assumptions be used to provide an upper-bound estimate of the risk and to avoid underestimating the potential exposures and associated health risks. The key sources of uncertainty in this health risk evaluation include:

- Estimation of truck emissions,
- Estimation of helicopter emissions,
- Estimation of exposure concentrations,
- Exposure assumptions, and
- Chemical toxicity criteria.

In all of these cases, conservative assumptions were used in this assessment. By compounding conservative assumptions, the estimated excess lifetime cancer risks are upper-bound estimates and the actual incidence of cancer is likely to be lower (USEPA 1989).

5.4.1 Identification of Truck Emissions

One uncertainty pertains to the identification of all traffic routes that delivery vehicles would travel to the loading docks. The specific route traveled would affect the spatial allocation of DPM emissions. Although it is most likely these delivery vehicles would travel along the routes presented in Figure 3.1 and Figure 3.2, there is no detailed information on the exact routes that these trucks would travel. ENVIRON has assumed that truck traffic would only occur along the routes presented. Since the predicted DPM air concentrations are a function of the source proximity to the receptors, the actual travel routes may result in higher or lower risk at particular receptors if trucks travel routes other than the route presented. However, ENVIRON estimated risks associated with two extreme scenarios (all trucks traveling from 280 and all traveling from US-101); therefore, as truck traffic would likely be shared between both directions, estimated risks at receptors along these routes will likely be lower than predicted under these scenarios. Additionally, though only 25% of the truck traffic is expected to be tractor-trailer type, ENVIRON conservatively assumed that all trips are generated by HHDTs which have the highest emission profiles for all trucks anticipated to service the Project.

A second source of uncertainty relating to the emissions is that EMFAC 2007 only gives emission factors up to model year 2040. For this HHRA, ENVIRON assumed all the emission factors for model years beyond 2040 would remain unchanged as 2040 while the actual emission factors in the future are expected to be lower than this due to retrofit or use of cleaner engine and/or fuel technology in the future, which would reduce the emissions and lower the health risk impacts.

5.4.2 Identification of Helicopter Emissions

Based on the helicopter operation at Stanford Hospital helipad discussed in Appendix B6, each landing-takeoff cycle should consists with startup, approach, take off and climb out. The release notes of the EDMS 5.1 states that aircraft engine startup HC emissions are estimated using a new methodology only for aircraft with ICAO certified engines. The default engine for helicopter Agusta 109 is not an ICAO certified engine. Therefore, TAC emissions associated with startup could not be estimated. Based on the available information and software, it is not possible to properly estimate the startup emission from helicopters; however, it is not expected that startup emissions would affect the conclusions reached in this HRA.

5.4.3 Estimation of Exposure Concentrations

In addition to uncertainty associated with emission estimates, there is also uncertainty associated with the estimated exposure concentrations. One source of uncertainty is the representation of the mobile sources in the air dispersion model. Although ENVIRON has attempted to capture the uncertainty in the location of the truck idling and maneuvering by representing the equipment with area sources covering general areas, the exact location where specific truck traveling pathway within the parking lot may be different, thereby affecting estimated airborne concentrations.

The limitations of the air dispersion model provide another source of uncertainty in the estimation of exposure concentrations. According to USEPA, errors in the highest estimated concentrations of +/- 10% to 40% are typical (USEPA 2005).

5.4.4 Exposure Assumption Uncertainties

The HHRA estimated risks from facility operation for offsite receptors assuming nine years of exposure for school children, 40 years of exposure for offsite workers, and 70 years of exposure for residents and senior citizens at the senior center. As required in OEHHA Hot Spots Guidance (Cal/EPA 2003) and District HRSA Guidelines (BAAQMD 2005b), it was assumed that a resident may be exposed to operational DPM emissions for their entire lifetime (70-years). Cancer risks estimated assuming a residential exposure duration of 70-years are used by State and local agencies for risk management and public notification purposes. Specifically, OEHHA Hot Spots Guidance states that "Lifetime or 70-year exposure is the historical benchmark for comparing facility impacts on receptors for evaluating the effectiveness of air pollution control measures (Cal/EPA 2003)." Use of the 70-year exposure duration in risk assessments is intended to produce a hypothetical estimate of risk that does not underestimate risks and that can be viewed as an upper-bound estimate. To illustrate the conservative nature of the assumption, it is worth noting that the USEPA has estimated that 50% of the U.S. population lives in the same residence for only nine years, while only 10% remain in the same house for 30 years (USEPA 1997). Adults, moreover, spend only 68-73% of their total daily time at home (USEPA 1997), rather than the 100% assumed in this HHRA. Accordingly, the actual risks to residents in the vicinity of the Project are likely to be significantly lower than those calculated in this HHRA.

5.4.5 Toxicity Assessment Uncertainties

A primary uncertainty associated with the toxicity assessment is related to the derivation of the toxicity values for DPM. The DPM toxicity values established by Cal/EPA were used to estimate potential cancer and noncancer health effects from exposure to DPM from the SUMC Project. These values were derived by applying conservative (*i.e.*, health-protective) assumptions and are intended to protect the most sensitive individuals in the potentially exposed populations.

Toxicity assessment and the quantification of dose-response relationships is an important source of uncertainty in any health risk assessment. The CPF used to estimate excess lifetime cancer risk for DPM has several important uncertainties associated with it. The CPF for DPM is based on workplace epidemiology studies of railroad workers, and as is often the case with epidemiology studies, specific exposure concentration data were lacking. Assumptions were also made regarding which worker groups within the larger study cohort were exposed to diesel exhaust and which groups were not exposed. Information about important lifestyle considerations (*e.g.*, smoking) that would affect the development of lung cancer were also not available to the study's authors. One especially notable finding was that lung cancer risks among the exposed cohort decreased with increasing length of exposure – the opposite trend from what is expected for a carcinogen. Further, the use of a CPF with DPM as a surrogate for all diesel exhaust assumes all diesel exhaust has the same carcinogenic potency as the diesel exhaust to which workers in the railroad worker study were exposed.

The CPF derived by Cal/EPA for DPM is uncertain in both the estimation of response and dose. Public health and regulatory organizations such as the International Organization for Research on Cancer, World Health Organization, and USEPA agree that diesel exhaust may cause cancer in humans. However, after thorough evaluation of the animal test data and epidemiological data on diesel exhaust, and in contrast to the approach used in California, the USEPA concluded that the existing data did not provide an adequate basis for quantitative risk assessment (USEPA 2002).[25]

5.4.6 Uncertainties in Risk

The USEPA (1989) notes that the conservative assumptions used in a risk assessment are intended to assure that the estimated risks do not underestimate the actual risks posed by a site and that the estimated risks do not necessarily represent actual risks experienced by populations at or near a site. By using standardized conservative assumptions in a risk assessment, USEPA further states that:

> *"These values [risk estimates] are upperbound estimates of excess cancer risk potentially arising from lifetime exposure to the chemical in question. A number of assumptions have been made in the derivation of these values, many of which are likely to overestimate exposure and toxicity. The actual incidence of cancer is likely to be lower than these estimates and may be zero."*

The estimated risks in this HHRA are based primarily on a series of conservative assumptions related to predicted environmental concentrations, exposure, and chemical toxicity. The use of conservative assumptions tends to produce upper-bound estimates of risk. Although it is difficult to quantify the uncertainties associated with all the assumptions made in this HHRA, the use of conservative assumptions is likely to result in substantial overestimates of exposure, and hence, risk. BAAQMD acknowledges this uncertainty by stating: "the methods used [to estimate risk] are conservative, meaning that the real risks from the source may be lower than the calculations, but it is unlikely that they will be higher" (BAAQMD 2009).

[25] Note that this conclusion does not affect the USEPA determination that diesel exhaust is a probable human carcinogen but, rather, addresses only the current inability to quantify the relationship between exposure and cancer in humans.

6 Conclusions

ENVIRON estimated the excess lifetime cancer risks and chronic noncancer HIs associated with potential exposures to DPM from construction and operational sources related to the SUMC Project. The results of this HHRA were then compared to BAAQMD CEQA significance thresholds. Pursuant to BAAQMD CEQA Guidelines (BAAQMD 1999), projects that expose the public to toxic air contaminants in excess of the following thresholds would be considered to have a significant air quality impact:

- Probability of contracting cancer for the MEI exceeds 10 in a million (10×10^{-6} or 1×10^{-5}); and
- Ground level concentrations of non-carcinogenic toxic air contaminants would result in a HI greater than 1 for the MEI.

6.1 DPM Exposures Related to SUMC Project Construction Sources

The results of the HHRA indicate that potential exposures to construction-related DPM are below an excess lifetime cancer risk of 10 in one million and chronic noncancer HI of 1.0 at all locations and thus the construction components of the project should not have a significant impact on air quality according to BAAQMD guidelines.

6.2 DPM Exposures Related to SUMC Project Operational Sources

The results of the HHRA indicate that potential exposures to operational sources of DPM (i.e., emergency generators and delivery vehicles servicing loading docks) are below an excess lifetime cancer risk of 10 in one million and chronic noncancer HI of 1.0 at all locations and thus the operational components of the project should not have a significant impact on air quality according to BAAQMD guidelines.

Further, estimated cancer risks associated with DPM emissions from both construction and operational sources are below or within the target risk range of one in one million (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) generally considered protective of human health by the USEPA (40 CFR § 300).

The many conservative assumptions that have been used in this assessment regarding the estimation of emissions, ambient air concentrations, exposure assumptions, and carcinogenic potency lead to an overestimate of potential risks, the magnitude of which could likely be substantial. The USEPA (1989) explains the effect of using conservative assumptions in regulatory risk assessments as follows:

> *"These values are upper-bound estimates of excess cancer risk potentially arising from lifetime exposure to the chemical in question. A number of assumptions have been made in the derivation of these values, many of which are likely to overestimate exposure and toxicity. The actual incidence of cancer is likely to be lower than these estimates and may be zero."*

7 References

Air Resources Board (ARB). 2006. *Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach.* Final Report. April.

Bay Area Air Quality Management District (BAAQMD). 1999. *BAAQMD CEQA Guidelines: Assessing the Air Quality Impacts of Projects and Plans.* December.

BAAQMD. 2000. *Bay Area Air Quality Management Air Toxic Risk Evaluation Procedure (REP) and Risk Management Policy (RMP).* February.

BAAQMD. 2005a. *Bay Area Air Quality Management District Staff Report.* Toxic Evaluation Section. June.

BAAQMD. 2005b. *Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines*. June.

BAAQMD. 2009. *Frequently Asked Questions – Toxic Air Contaminants. Online:* http://www.baaqmd.gov/Help/~/~/link.aspx?_id=C8992846AA0045ECABDB489211201B61&_z=z*. Accessed August 5.*

California Environmental Protection Agency (Cal/EPA). 1992. *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities.* Department of Toxic Substances Control. Sacramento, California. July.

Cal/EPA. 1994. *Preliminary Endangerment Assessment Guidance Manual (PEA).* Department of Toxic Substances Control. January.

Cal/EPA. 1998. *Part B: Health Risk Assessment for Diesel Exhaust. For the "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant"*. Office of Environmental Health Hazard Assessment. May.

Cal/EPA. 2000. *Air Toxics Hot Spots Program Risk Assessment Guidelines: Part IV Technical Support Document for Exposure Assessment and Stochastic Analysis.* Office of Environmental Health Hazard Assessment. September.

Cal/EPA. 2003. *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments.* Office of Environmental Health Hazard Assessment. August.

Cal/EPA. 2005. *Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II Technical Support Document for Describing Available Cancer Potency Factors.* Office of Environmental Health Hazard Assessment. December.

Cal/EPA. 2007. *Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II Technical Support Document for Describing Available Cancer Potency Factors.* Office of Environmental Health Hazard Assessment. December

Cal/EPA. 2008a. *California Cancer Potency Values*. Office of Environmental Health Hazard Assessment. December.

Cal/EPA. 2008b. *All Chronic Reference Exposure Levels (creels)*. Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/air/allrels.html December.

Camfil Farr. 2002. ASHRAE Testing for HVAC Air Filtration – A Review of Standards 52.1-1992 & 52.2-1999.

United States Census Bureau (USCB). 2008. 2005 Population Estimates for Palo Alto-Stanford, California, http://factfinder.census.gov.

United States Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund: Volume 1- Human Health Evaluation Manual (Part A).* Interim Final. Washington, D.C. December.

USEPA. 1991. *Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual. Supplemental Guidance. Standard Default Exposure Factors.* Office of Emergency and Remedial Response. March 25.

USEPA. 1997. *Exposure Factors Handbook*. EPA/600/P-95/002Fa. August.

USEPA. 2002. *Health Assessment Document for Diesel Engine Exhaust.* National Center for Environmental Assessment, Office of Research and Development, Washington, DC. EPA/600/8-90/057F. May.

USEPA. 2004a. *User's Guide for the AMS/EPA Regulatory Model - AERMOD*. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-001. September.

USEPA. 2004b. *Addendum to User's Guide for the AMS/EPA Regulatory Model - AERMOD*. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-001. September.

USEPA. 2005. *Guideline on Air Quality Models (Revised). 40 Code of Federal Regulations, Part 51, Appendix W.* Office of Air Quality Planning and Standards. November.

United States Environmental Protection Agency (USEPA). 2008. *AERMOD Implementation Guide*. Research Triangle Park, North Carolina. January.

Tables

Table 2.1: Existing and Proposed Buildings by Facility - Stanford University Medical Center[1]
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Facility	Pre-Project		Post-Project	
	Building Name	Map Reference	Building Name	Map Reference
Hoover	Hoover Pavilion	Figure 2.1 (37)	Hoover Pavilion	
			Hoover Medical Office Building	Figure 2.2 (11)
SHC	AMC (Cancer Center)	Figure 2.1 (11)	AMC (Cancer Center)	
	Blake-Wilbur	Figure 2.1 (12)	Blake-Wilbur	
	Falk	Figure 2.1 (32)	Falk	
	HMP	Figure 2.1 (31)	HMP	
	D, E, F Pods	Figure 2.1 (38)	D, E, F Pods	
	Original Hospital	Figure 2.1 (31)		
	Core, East, West, Boswell	Figure 2.1 (29)		
	Core Expansion	Figure 2.1 (30)		
			SHC Replacement Hospital Facility	Figure 2.2 (1)
			SHC Clinic/Office Buildings	Figure 2.2 (2)
LPCH	703 Welch	Figure 2.1 (34)		
	701 Welch	Figure 2.1 (35)		
	730 Welch	Figure 2.1 (1)	730 Welch	
	Original LPCH	Figure 2.1 (33)	Original LPCH	
			LPCH Hospital Expansion/Clinic	Figure 2.2 (5)
			LPCH Clinic	Figure 2.2 (6)
SoM On-Project	PSRL	Figure 2.1 (21)	PSRL	
	Grant	Figure 2.1 (29)		
	Edwards	Figure 2.1 (39)		
	Lane	Figure 2.1 (40)		
	Alway	Figure 2.1 (41)		
			FIM 1	Figure 2.2 (8)
			FIM 2	Figure 2.2 (9)
			FIM 3	Figure 2.2 (10)
SoM Off-Project	Clark	Figure 2.1 (27)	Clark	
	Fairchild	Figure 2.1 (26)	Fairchild	
	LKC (under construction)[2]	Figure 2.1 (25)	LKC	
	Beckman	Figure 2.1 (23)	Beckman	
	CCSR	Figure 2.1 (22)	CCSR	
	Lucas	Figure 2.1 (16)	Lucas	
	Redwood	Figure 2.1 (20)	Redwood	

Notes:
1. Information was summarized from the Project Description (dated 06/17/2009) and the data request response from Stanford University on 09/16/2008.
2. Learning and Knowledge Center (LKC) is currently under construction at the site of the former Fairchild Auditorium between Beckman and Fairchild. Footprint is shown on Figure 4-4 of the Project Design.

Abbreviations:
AMC: Advanced Medicine Center
CCSR: Center for Clinical Sciences Research
FIM: Foundations in Medicine
HMP: Hospital Modernization Project
LKC: Learning and Knowledge Center
LPCH: Lucile Packard Children's Hospital
PSRL: Children's Surgical Research Lab
SHC: Stanford Hospital and Clinics
SoM: School of Medicine

Source:
Stanford University Medical Center Facilities Renewal and Replacement Project - Project Design
Text: http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=8801
Figures: http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=8802

Table 3.1: Estimated Diesel Particulate Matter Emissions - Construction Activities[1]
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Annualized Construction DPM Emissions (lb/year)												
Construction Phases	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020	Year 2021
LPCH PARKING	313											
LPCH EXPANSION		161	161	161								
SHC PARKING	334	167										
PARKING STRUCTURE 3 DEMO		32										
SHC REPLACEMENT HOSPITAL			136	136	136	136						
CORE EXPANSION/DEMO								21	21	21		
SHC CLINICS PARKING								54	54	54		
SHC CLINICS											48	48
FIM #1	176	176										
EDWARDS DEMO			32									
FIM #2					96	96						
LANE ALWAY DEMO							17					
FIM #3									52	52		
GRANT DEMO											6	
HOOVER PAVILLION PARKING	171	342										
HOOVER PAVILLION MOB	25	50										
TOTAL PM EMISSIONS	**1018**	**927**	**329**	**298**	**233**	**233**	**17**	**75**	**127**	**127**	**54**	**48**

Notes:
1. The project time frame and the year-by-year annual DPM emissions from building construction were summarized from the emissions calculation provided by PBS&J on August 20, 2009.

Abbreviations:
DEMO: demolition
DPM: Diesel Particulate Matter
FIM: (School of Medicine) Foundations In Medicine Buildings (FIM 1, 2, and 3)
lbs: pounds
LPCH: Lucile Packard Children's Hospital Hospital Expansion and Clinic
MOB: Medical Office Building
PBS&J: Post, Buckley, Schuh & Jenigan
SHC: Stanford Hospital and Clinics Replacement Hospital Facility and Clinic/Office Building
SUMC: Standford University Medical Center

Table 3.2: Proposed Emergency Generator Modifications[1]
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Location on Map	Change based on the Project	Building Served[2]	Number of Units	Emission Factor[3] (g/kW-hr)	Size of Each Generator (MW)	Unit DPM Emissions (g/s)	Unit Annual DPM Emissions (tonnes/year)
S1	Add	SHC	7	0.03	2	1.7E-02	1.6E-03
L1	Add	LPCH	3	0.03	2	1.7E-02	1.6E-03
F1	Add	FIM1	1	0.03	1.5	1.3E-02	1.2E-03
F1[4]	Add	FIM2	1	0.03	1	8.3E-03	7.8E-04
F2	Add	FIM3	1	0.03	1	8.3E-03	7.8E-04
EGD 817	Remove	701 Welch Road	1	0.02	0.1	3.3E-04	3.1E-05
EGD 814	Remove	Grant	1	0.02	0.4	2.2E-03	2.1E-04

Notes:
1. Based on the project summary of utilities and services, it is estimated that an additional 21 MW of emergency generators for SHC and LPCH will be required for future use.
2. The location of the buildings are presented in Figure 2.3.
3. Based upon the completion timeline of the Project, ENVIRON assumes that all the EGs to be added will meet the CARB/USEPA adopted Tier 4 final off-road compression-ignition (diesel) engine standard. Because the parameters for the existing engines are not provided, ENVIRON conservatively assumes that all the engines for removal also meet the Tier 4 final standard. This assumption leads to less emissions reduction (higher net emissions) from removal of the existing engines.
4. Each of the three proposed FIM buildings would have an EG located in one of two locations in proximity to the proposed buildings, with no more than two generators at any location. ENVIRON conservatively assumed the EG of FIM2 to be co-located with that of FIM1, as the FIM1 EG location is closer to potential receptors in the downwind direction.

Abbreviations:
CARB: California Air Resources Board
DPM: Diesel Particulate Matter
EG: Emergency Generator
FIM: (School of Medicine) Foundations In Medicine buildings
g/kW-hr: gram per kilowatts per hour
g/s: gram per second
LPCH: Lucile Packard Children's Hospital
MW: megawatt
SHC: Stanford Hospital and Clinics
USEPA: United States Environmental Protection Agency

Source:
Exhaust Emission Standards for Off-Road Engines, Oct 11, 2007.
http://www.arb.ca.gov/msprog/offroad/off-road-stds.xls
Stanford University Medical Center Facility Renewal and Replacement Project - Utilities and Services
http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=8836

Table 3.3a: Summary of Diesel Particulate Matter Emissions from Truck Trips
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Receptor Scenario	Scenario Years	Number of Years[1]	Cumulative DPM Emissions[2] [lbs]	
			US-101 Scenario	I-280 Scenario
Sensitive	2015 - 2023	9	40	35
Worker	2015 - 2044	40	204	173
Resident	2015 - 2084	70	362	307

Notes:

1. Scenario durations (number of years) are taken from guidelines set in the Office of Environmental Health Hazard Assessment's (OEHHA's) *Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparations of Health Risk Assessments*, August 2003.
2. Cumulative emissions are the sum of CARB's EMFAC 2007 model's output for each of the years listed for the given scenario. For more details on this calculation, see Appendix C.

Abbreviations:

CARB: California Air Resources Board
DPM: Diesel Particulate Matter
EMFAC: EMission FACtor model
lbs: pounds

Table 3.3b: Distribution of the Incremental Trips Associated with the Proposed Project[1]
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Loading Docks	2015	2016	2017	2018+
Proposed LPCH	26%	26%	27%	27%
Existing SHC	74%	74%	73%	73%

Notes:
1. The percentage of deliveries associated with the existing and the proposed loading dock is estimated based on the annual number of deliveries presented in the project description (Demographics and Operations - Loading Zone, 05/2009).
2. Cumulative emissions are the sum of CARB's EMFAC 2007 model's output for each of the years listed for the given scenario. For more details on this calculation, see Appendix C.

Abbreviations:
CARB: California Air Resources Board
DPM: Diesel Particulate Matter
EMFAC: EMission FACtor model
lbs: pounds
LPCH: Lucile Packard Children's Hospital
SHC: Stanford Hospital and Clinics

Table 3.4: Speciated Emissions - Helipad
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

TAC[1]	Current Emissions [2,3]	with Project Emissions[2,3]	Incremental Emission Increase	BAAQMD Trigger Levels - Chronic
	all values in pounds per year			
Formaldehyde	18.1	23.1	5.1	30
Methyl Alcohol	2.6	3.4	0.7	150,000
Benzene	2.5	3.2	0.7	6.4
Acetaldehyde	6.3	8.0	1.8	64
Naphthalene	0.8	1.0	0.2	5.3
o-Xylene	0.2	0.3	0.1	27,000
Ethylbenzene	0.3	0.3	0.1	77,000
Styrene	0.5	0.6	0.1	35,000
1,3-Butadiene	2.5	3.2	0.7	1.1
Acrolein (2-Propenal)	3.6	4.6	1.0	2.3
Toluene	0.9	1.2	0.3	12,000
Phenol (Carbolic Acid)	1.1	1.4	0.3	7,700
Propylene	6.6	8.5	1.9	120,000

Notes:
1. The list of TACs were directly cited from the EDMS modeling output. Chemicals that are not listed in the BAAQMD TAC Trigger Levels table are not included here.
2. The 2006 and 2018 helicopter TAC emissions were calculated using EDMS 5.1 with the helicopter trip numbers given in the Project Application package (06/17/2009).
3. EDMS requires the user to specify the aircraft model and trip number to calculate the emissions. The trip number is given in the Demographics and Operations section of the Project Application (06/17/2009). Because the helicopter model EC 145 is not in the aircraft database of EDMS, ENVIRON ran the model using helicopter model Agusta 109 which has similar capacity, physical dimensions, maximum takeoff weight, and engine power as EC 145. Note that taxi in and taxi out emissions were not evaluated for the helicopter, as helicopters do not taxi in and taxi out during their landing-takeoff cycle (LTO).

Abbreviations:
BAAQMD: Bay Area Air Quality Management District
EDMS: Emission Dispersion Modeling System
lb/yr: pound per year
SUMC: Stanford University Medical Center
TAC: Toxic Air Contaminant

Sources:

BAAQMD. Toxic Air Contaminant Trigger Levels. Table 2-5-1 from Regulation 5 Rule 2.
http://www.baaqmd.gov/pmt/air_toxics/table_2-5-1.pdf
Stanford University Medical Center Facilities Renewal and Replacement Project - Demographics and Operations
http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=8833

Table 3.5: Building Descriptions
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Facility	Building Name		Building Height	Operable Windows	Air Intake[1]	ENVIRON's Assumed Air Intake Level[1]	Final Filter ASHRAE Efficiency[2]	Filter Rating[3]	Assumed Particulate Removal Efficiency[4]
	Pre-Project	Post-Project	(feet)						
Hoover	Hoover Pavilion	Hoover Pavillion	68	varies[5]	Ground Level	Ground Level			0.0%
		Hoover Medical Office Building	60	no	Ground Level	Ground Level			0.0%
SHC	AMC (Cancer Center)	AMC (Cancer Center)	50	no	Roof Level	Roof Level	95.0%	MERV-14	75.0%
	Blake-Wilbur	Blake-Wilbur	40	yes, but fixed shut	Roof Level	Roof Level	95.0%	MERV-14	75.0%
	Falk	Falk	33	yes, but fixed shut	Roof & Ground Level	Ground Level	45.0%	MERV-9	0.0%
	HMP	HMP	49	no	Roof Level	Roof Level	45.0%	MERV-9	0.0%
	D, E, F Pods	D, E, F Pods	49	yes, but fixed shut	Roof Level	Roof Level	95.0%	MERV-14	75.0%
	Original Hospital		49	no	Roof Level	Roof Level	45.0%	MERV-9	0.0%
	Core, East, West, Boswell		37.5	yes, but fixed shut	Roof Level	Roof Level	95.0%	MERV-14	75.0%
	Core Expansion		48.2	no	Roof Level	Roof Level	HEPA	HEPA	99.9%
		SHC Replacement Hospital Facility	42-130	no	Roof Level	Roof Level	85.0%	MERV-13	0.0%
		SHC Clinic/Office Buildings	90-130	no	Roof Level	Roof Level	85.0%	MERV-13	0.0%
LPCH	730 Welch[6]	730 Welch	9	no	Roof Level	Roof Level			0.0%
	Original LPCH[7]	Original LPCH	46	no	varies	Ground Level	HEPA	HEPA	99.9%
		LPCH Hospital Expansion	85	no	Not available	Roof Level	HEPA	HEPA	99.9%
		LPCH Clinic	85	yes, but fixed shut	Not available	Roof Level	HEPA	HEPA	99.9%
SoM On-Project	PSRL	PSRL	20	no	Roof Level	Roof Level			0.0%
	Grant		37.5	yes, but fixed shut	Roof Level	Roof Level	45.0%	MERV-9	0.0%
	Edwards		37.5	yes, but fixed shut	Roof Level	Roof Level	45.0%	MERV-9	0.0%
	Lane		37.5	yes, but fixed shut	Roof Level	Roof Level	45.0%	MERV-9	0.0%
	Alway		37.5	yes, but fixed shut	Roof Level	Roof Level	30.0%	MERV-6	0.0%
		FIM 1	66	no	Roof Level	Roof Level	80.0%	MERV-12	0.0%
		FIM 2	66	no	Roof Level	Roof Level	80.0%	MERV-12	0.0%
		FIM 3	66	no	Roof Level	Roof Level	80.0%	MERV-12	0.0%
SoM Off-Project	Clark	Clark	54	no	Roof Level	Roof Level	95.0%	MERV-14	75.0%
	Fairchild	Fairchild	44	no	Ground Level	Ground Level	95.0%	MERV-14	75.0%
	LKC (under construction)[8]	LKC	Not Available	no	Roof Level	Roof Level	85.0%	MERV-13	0.0%
	Beckman	Beckman	88	no	Ground Level	Ground Level	85.0%	MERV-13	0.0%
	CCSR	CCSR	60	some (interior courtyard)	Roof Level	Roof Level	85.0%	MERV-13	0.0%
	Lucas	Lucas	42	no	Roof Level	Roof Level	85.0%	MERV-13	0.0%
	Redwood	Redwood	33	no	Roof Level	Roof Level	65.0%	MERV-13	0.0%
Other Off-Project	700 Welch (Barn)[9]	700 Welch (Barn)	10	no	Roof Level	Roof Level			0.0%
	Fairchild Center	Fairchild Center	44	no	Roof Level	Roof Level			0.0%
	750 Welch	750 Welch	30	no	Roof Level	Roof Level			0.0%
	777 Welch	777 Welch	10	no	Roof Level	Roof Level			0.0%
	Nordstrom	Nordstrom	30	no	Roof Level	Roof Level			0.0%
	Crate & Barrel	Crate & Barrel	20	no	Roof Level	Roof Level			0.0%
	Andronico's	Andronico's	20	no	Roof Level	Roof Level			0.0%

Notes:

1. Air intake information was summarized from the Project Description (dated 04/16/2008), the data request response from Stanford University on 09/16/2008, and conversation with Stanford engineers during the site visit on 01/16/2009. Buildings that have both roof and ground level air intakes were modeled with ground-level receptors, as ground-level risk is generally higher and therefore more conservative. Despite lack of available information, the LPCH Hospital Expansion and LPCH Clinic were assumed to have roof level air intakes based on the existing (original) LPCH building and on SHC buildings.
2. Based on the conversation with Stanford engineers during the site visit on 01/16/2009.
3. The filter ratings were determined based on the ASHRAE efficiency provided by Stanford engineers.
4. ENVIRON conservatively assumed that only filters with rating of MERV-14 or higher (including HEPA) would effectively remove DPM during air intake.
5. The Hoover Pavilion has a main air intake for package units at roof level, but windows are operable and package air conditioning units exist at all levels, and are used during the summer months. This configuration would change by 2011, however, when major HVAC equipment will be installed as part of the renovation. After the HVAC equipment is installed, windows would be sealed during the construction of the Hoover Medical Office Building (MOB) and Parking Structure.
6. The building height of 730 Welch presented in this table represents the the actual air intake level rather than the physcial building height.
7. Based on the conversation with Stanford engineers, LPCH has a range of air intake levels including ground level. ENVIRON conservatively used the ground level concentration at LPCH for the risk assessment.
8. Learning and Knowledge Center (LKC) is currently under construction at the site of the former Fairchild Auditorium between Beckman and Fairchild. Footprint is shown on Figure 4-4 of the application.

Abbreviations:

AMC: Advanced Medicine Center
ASHRAE: American Society of Heating, Refrigerating and Air-Condition Engineers, Inc
CCSR: Center for Clinical Sciences Research
DPM: Diesel Particulate Matter
FIM: (School of Medicine) Foundations In Medicine buildings
HEPA: High-Efficiency Particulate Air
HMP: Hospital Modernization Project
HVAC: Heating, Ventilating, and Air Conditioning
LKC: Learning and Knowledge Center
LPCH: Lucile Packard Children's Hospital
MERV: Minimum Efficiency Reporting Value
SHC: Stanford Hospital and Clinics
SoM: School of Medicine

Table 3.6: List of Offsite Sensitive Receptor Locations
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Facility	Street Address	City	State	Zip Code
Oak Knoll Elementary School	1895 Oak Knoll Ln	Menlo Park	CA	94025
La Entrada Middle School	2200 Sharon Rd	Menlo Park	CA	94025
Hillview Middle School	1100 Elder Ave	Menlo Park	CA	94025
Castileja School	1310 Bryant St	Palo Alto	CA	94301
Knowledge Beginnings: Palo Alto (child care and preschool)	625 Clark Way	Palo Alto	CA	94304
Rosener House Day Care Program	1095 Cloud Ave	Menlo Park	CA	94025
Avenidas (senior center)	450 Bryant St	Palo Alto	CA	94301
Peninsula Volunteers: Little House (senior and community activity center)	800 Middle Ave	Menlo Park	CA	94025
Littlest Angels Bethany Preschool	500 Arbor Rd	Menlo Park	CA	94025

Notes:

1. Sensitive receptors were placed at sites such as schools, preschools, child care facilities, and retirement facilities/senior centers. Searches of on-line databases that contain publicly available information, such as those made available by the California Community Care Licensing Division, California Department of Education, Office of Statewide Health Planning and Development, and Yellow Pages were used in this task. Sensitive receptor locations were identified from searches of the following sources:

- California Community Care Licensing Division (http://www.ccld.ca.gov/docs/ccld_search/ccld_search.aspx)
- California Department of Education, California School Directory (http://www.cde.ca.gov/re/sd/)
- California Office of Statewide Health Planning and Development, Licensed Facility Information System (http://alirts.oshpd.ca.gov/LFIS/LFISHome.aspx)
- Google Maps (maps.google.com)

Table 3.7: Source Release Parameters for Air Dispersion Modeling
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Activity Description		Modeling Source Type	UTMx [m]	UTMy [m]	Parameters					
					Release Height [m]	Temperature [K]	Exit Velocity [m/s]	Stack Diameter [m]	Initial Lateral Dimension [m]	Initial Vertical Dimension[4] [m]
Construction[1]	Construction Area	Volume			5				4.65	1.16
Emergency Generator[2]	EG817	Point	573,165	4,143,640	2.4	817	17	0.13		
	EG814	Point	573,074	4,143,226	3	761	95	0.15		
	SHC	Point	572,665	4,143,484	10.4	679	63	0.38		
	FIM3	Point	573,074	4,143,189	6.1	791	122	0.20		
	FIM1	Point	572,724	4,143,250	6.1	680	46	0.38		
	FIM2	Point	572,724	4,143,400	6.1	791	122	0.20		
	LPCH	Point	573,149	4,143,408	6.1	679	63	0.38		
Loading Dock[3]	Delivery Trucks	Volume			4				Varies with Road Width	0.93
	Loading Docks	Area			4					0.93

Notes:

1. As the BAAQMD does not have a specific methodology for modeling emissions from construction sources, they were evaluated based on the SCAQMD localized significance threshold (LST) methodology.
2. The locations of the emergency generators are shown in Figure 2.3. Each of the three proposed FIM buildings would have an EG located in one of two locations in proximity to the proposed buildings, with no more than two generators at any location. ENVIRON conservatively assumed the EG of FIM2 to be co-located with that of FIM1 as the FIM1 EG location is closer to potential receptors in th downwind direction. The release height and stack diameter were measured onsite by ENVIRON staff. As the specific models of EG have not yet been determined, ENVIRON assumed engine parameters of the similarly sized Caterpillar EG for temperature and gas exit velocity.
3. ENVIRON assumed that the delivery schedule to be 24 hours since the detailed delivery schedule was not provided. ENVIRON assumed that most of the deliveries would occur during the day time and, therefore, conservatively used the day time release height of heavy heavy-duty truck suggested by CARB (2006).
4. Initial vertical dimension calculated as release height divided by 4.3 based on USEPA guidance (USEPA 2004) for volume sources not on or adjacent to a building.

Abbreviations:

BAAQMD: Bay Area Air Quality Management District
CARB: California Air Resources Board
EG: Emergency Generator
FIM: (School of Medicine) Foundations In Medicine buildings
K: Kelvin
LPCH: Lucile Packard Children's Hospital
LST: Localized Significance Threshold
m: meter
s: second
SCAQMD: South Coast Air Quality Management District
SHC: Stanford Hospital and Clinics
USEPA: United States Environmental Protection Agency
UTM: Universal Transverse Mercator

Sources:

California Air Resources Board (CARB). 2006. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach.
Truck Route Map, City of Palo Alto, California: http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=6922
SCAQMD. 2003. Final Localized Significance Threshold Methodology
http://www.aqmd.gov/CEQA/handbook/LST/Method_final.pdf
United States Environmental Protection Agency (USEPA). 2004. User's Guide for the AMS/EPA Regulatory Model - AERMOD. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-001. September.

Table 4.1a: Exposure Parameters - Construction Activities
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Exposure Parameter	Units	Adult Resident & Senior Center[1]	Child Resident	Worker	School Child[1]
Daily Breathing Rate (DBR)	[L/kg-day]	302	581	149	581
Fraction of Day Exposed (F)[2]	--	1	1	1	0.42
Exposure Frequency (EF)	[days/year]	350	350	245	180
Exposure Duration(ED)[3]	[years]	12	9	12	9
Conversion Factor (CF)	[m^3/L]	0.001	0.001	0.001	0.001
Averaging Time (AT)	[days]	25550	25550	25550	25550
Intake Factor, Inhalation (IF_{inh})[4]	[m^3/kg-day]	0.0041	0.0080	0.0014	0.0017
Modeling Adjustment Factor (T)	--	1	1	4.2 [5]	3.4 [6]

Notes:

1. Offsite sensitive receptors identified for evaluation in this HHRA include childcare centers, schools, and retirement facilities/senior centers. Sensitive receptors at childcare centers and schools were evaluated using exposure parameters recommended by BAAQMD (2005) for school children. Exposure parameters recommended by Cal/EPA (2003) for adult residents were used to evaluate receptors at retirement facilities/senior centers.

2. Fraction of the day exposed for the school child was calculated assuming that the child attends school 10 hours per day (BAAQMD 2005).

3. The exposure duration for adult residents, workers and sensitive receptors at retirement facilities/senior centers corresponds to the planned construction period of 12 years. The exposure duration for a child resident and school child is 9 years per BAAQMD guidance (2005).

4. IFinh = DBR x F x EF x ED x CF / AT

5. Consistent with Cal/EPA (2003) guidance, and adjustment factor is applied to evaluate the worker. The adjustment factor converts the annual average concentration (estimated assuming exposure occurs 24 hours per day for 7 days per week) to a concentration a worker may breath during an 8 hour work day assuming the worker is present at the same time as the construction activity (that is, concurrent with the DPM emissions). The adjustment factor for a worker is 4.2 (equal to [24 hours/8 hours]*[7 days/5 days]).

6. Consistent with Cal/EPA (2003) guidance, an adjustment factor is applied to evaluate the school child. The adjustment factor converts the annual average concentration (estimated assuming exposure occurs 24 hours per day for 7 days per week) to a concentration a school child may breath during an 10 hour school day assuming the school child is presented at the same time as the construction activity (that is, concurrent with the DPM emissions). The adjustment factor for a school child is 3.4 (equal to [24 hours/10 hours]*[7 days/5 days]).

Abbreviations:
BAAQMD: Bay Area Air Quality Management District
Cal/EPA: California Environmental Protection Agency
DPM: Diesel Particulate Matter
HHRA: Human Health Risk Assessment
kg: kilogram
L: liter
m^3: cubic meter

Sources:
Bay Area Air Quality Management District (BAAQMD) 2005. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. June.
California Environmental Protection Agency (Cal/EPA). 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August.

Table 4.1b: Exposure Parameters - Operational Emissions
Emergency Generators
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Exposure Parameter	Units	Adult Resident & Senior Center[1]	Child Resident	Worker	School Child[1]
Daily Breathing Rate (DBR)	[L/kg-day]	302	581	149	581
Fraction of Day Exposed (F)[2]	--	1	1	1	0.42
Exposure Frequency (EF)	[days/year]	350	350	245	180
Exposure Duration (ED)	[years]	70	9	40	9
Conversion Factor (CF)	[m^3/L]	0.001	0.001	0.001	0.001
Averaging Time (AT)	[days]	25550	25550	25550	25550
Intake Factor, Inhalation (IF_{inh})[3]	[m^3/kg-day]	0.29	0.072	0.24	0.052
Modeling Adjustment Factor (T)	--	1	1	4.2 [4]	3.4 [5]

Notes:

1. Offsite sensitive receptors identified for evaluation in this HHRA include childcare centers, schools, and retirement facilities/senior centers. Sensitive receptors at childcare centers and schools were evaluated using exposure parameters recommended by BAAQMD (2005) for school children. Exposure parameters recommended by Cal/EPA (2003) for adult residents were used to evaluate receptors at retirement facilities/senior centers.

2. Fraction of the day exposed for the school child was calculated assuming that the child attends school 10 hours per day (BAAQMD 2005).

3. IFinh = DBR x F x EF x ED x CF / AT

4. Consistent with Cal/EPA (2003) guidance, and adjustment factor is applied to evaluate the worker. The adjustment factor converts the annual average concentration (estimated assuming exposure occurs 24 hours per day for 7 days per week) to a concentration a worker may breath during an 8 hour work day assuming the worker is present at the same time as the emergency generator test (that is, concurrent with the DPM emissions). The adjustment factor for a worker is 4.2 (equal to [24 hours/8 hours]*[7 days/5 days]).

5. Consistent with Cal/EPA (2003) guidance, an adjustment factor is applied to evaluate the school child. The adjustment factor converts the annual average concentration (estimated assuming exposure occurs 24 hours per day for 7 days per week) to a concentration a school child may breath during an 10 hour school day assuming the school child is presented at the same time as the emergency generator test (that is, concurrent with the DPM emissions). The adjustment factor for a school child is 3.4 (equal to [24 hours/10 hours]*[7 days/5 days]).

Abbreviations:
BAAQMD: Bay Area Air Quality Management District
Cal/EPA: California Environmental Protection Agency
DPM: Diesel Particulate Matter
HHRA: Human Health Risk Assessment
kg: kilogram
L: liter
m^3: cubic meter

Sources:
Bay Area Air Quality Management District (BAAQMD) 2005. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. June.
California Environmental Protection Agency (Cal/EPA). 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August.

Table 4.1c: Exposure Parameters - Operational Emissions
Truck Emissions Associated with the Existing and Proposed Loading Docks
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Exposure Parameter	Units	Adult Resident & Senior Center[1]	Child Resident	Worker	School Child[1]
Daily Breathing Rate (DBR)	[L/kg-day]	302	581	149	581
Fraction of Day Exposed (F)[2]	--	1	1	1	0.42
Exposure Frequency (EF)	[days/year]	350	350	245	180
Exposure Duration (ED)	[years]	70	9	40	9
Conversion Factor (CF)	[m^3/L]	0.001	0.001	0.001	0.001
Averaging Time (AT)	[days]	25550	25550	25550	25550
Intake Factor, Inhalation (IF_{inh})[3]	[m^3/kg-day]	0.29	0.072	0.057	0.015
Modeling Adjustment Factor (T)[4]	--	1	1	1	1

Notes:

1. Offsite sensitive receptors identified for evaluation in this HHRA include childcare centers, schools, and retirement facilities/senior centers. Sensitive receptors at childcare centers and schools were evaluated using exposure parameters recommended by BAAQMD (2005) for school children. Exposure parameters recommended by Cal/EPA (2003) for adult residents were used to evaluate receptors at retirement facilities/senior centers.

2. Fraction of the day exposed for the school child was calculated assuming that the child attends school 10 hours per day (BAAQMD 2005).

3. IFinh = DBR x F x EF x ED x CF / AT

4. Modling adjustment not necessary, as emission sources are in operation 24 hours per day.

Abbreviations:

BAAQMD: Bay Area Air Quality Management District
Cal/EPA: California Environmental Protection Agency
HHRA: Human Health Risk Assessment
kg: kilogram
L: liter
m^3: cubic meter

Sources:

Bay Area Air Quality Management District (BAAQMD) 2005. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. June.
California Environmental Protection Agency (Cal/EPA). 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August.

Table 4.2: Inhalation Toxicity Values for Diesel Particulate Matter
Stanford University Medical Center Facilities Renewal and Replacement
Palo Alto, California

Chemical	CPF [(mg/kg-day)$^{-1}$]	Chronic REL (ug/m^3)
Diesel PM	1.1	5

Abbreviations:
CPF: Cancer Potency Factor
PM: Particulate Matter
(mg/kg-day)$^{-1}$: per milligram per kilogram-day
REL: Reference Exposure Level
ug/m^3: microgram per cubic meter

Source:
Office of Environmental Health Hazard Assessment (OEHHA) / Air Resource Board (ARB). 2008. Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values. June 25.

Table 5.1: Estimated Excess Lifetime Cancer Risks and Chronic Noncancer Hazard Indices
Construction Emissions[1] - Onsite Worker Receptors
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Population	UTMx	UTMy	Location	DPM Concentration	Cancer Risk	Chronic HI
	(m)			(µg/m³)	(in one million)	
MEIW - Onsite Outdoor Worker	572,780	4,143,180	South of FIM1	1.5	9.7	0.3
MEIW - Onsite Indoor Worker (Stationary)[2]	573,080	4,143,460	Falk	0.6	4.1	0.1
MEIW - Onsite Indoor Worker (Relocated)[3]			Grant - FIM3	0.5	3.1	0.1

Notes:
1. This table presents estimated excess lifetime cancer risks and chronic noncancer HIs associated with onsite worker exposure to DPM from construction activities related to the Project.
2. Workers who will work in the same building over the entire project duration. See Table 5.2 for building-by-building risk summary for stationary on-site indoor workers.
2. Workers who have to relocate during the SUMC Project. See Table 5.3 for the occupancy analysis.

Abbreviations:
DPM: Diesel Particulate Matter
FIM: (School of Medicine) Foundations In Medicine building
HI: Hazard Index
m: meter
UTM: Universal Transverse Mercator
µg/m³: microgram per cubic meter

Table 5.2: Estimated Excess Lifetime Cancer Risk and Chronic Noncancer Hazard Indices
Construction Emissions – Indoor Stationary Workers
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Facility	Building Name		Assumed Particulate Removal Efficiency	Pre-Filtration DPM Concentration[1] [µg/m³]	Post-Filtration DPM Concentration [µg/m³]	Incremental Cancer Risk [in a million]	Chronic Noncancer HI
	Pre-Project	Post-Project					
Hoover	Hoover Pavilion[2]	Hoover Pavillion	0.0%	0.2	0.2	2	0.05
		Hoover Medical Office Building	0.0%			See Occupancy Analysis	
SHC	AMC (Cancer Center)	AMC (Cancer Center)	75.0%	0.2	0.1	0.3	0.01
	Blake-Wilbur	Blake-Wilbur	75.0%	0.3	0.1	0.5	0.0
	Falk	Falk	0.0%	0.6	0.6	4	0.1
	HMP	HMP	0.0%	0.4	0.4	2.4	0.07
	D, E, F Pods	D, E, F Pods	75.0%	0.3	0.1	0.5	0.01
	Original Hospital		0.0%			See Occupancy Analysis	
	Core, East, West, Boswell		75.0%				
	Core Expansion		99.9%				
		SHC Replacement Hospital Facility	0.0%				
		SHC Clinic/Office Buildings	0.0%				
LPCH	730 Welch	730 Welch	0.0%	0.2	0.2	1.4	0.04
	Original LPCH	Original LPCH	99.9%	1.1	0.001	0.007	0.0002
		LPCH Hospital Expansion/Clinic	99.9%			See Occupancy Analysis	
SoM On-Project	PSRL	PSRL	0.0%	0.3	0.3	1.9	0.06
	Grant		0.0%			See Occupancy Analysis	
	Edwards		0.0%				
	Lane		0.0%				
	Alway		0.0%				
		FIM 1	0.0%				
		FIM 2	0.0%				
		FIM 3	0.0%				
SoM Off-Project	Clark	Clark	75.0%	0.2	0.1	0.4	0.01
	Fairchild	Fairchild	75.0%	0.6	0.2	1.0	0.03
	LKC (under construction)	LKC	0.0%	0.3	0.3	2.2	0.07
	Beckman	Beckman	0.0%	1.2	1.2	7.8	0.2
	CCSR	CCSR	0.0%	0.5	0.5	3.2	0.1
	Lucas	Lucas	0.0%	0.3	0.3	2.1	0.06
	Redwood	Redwood	0.0%	0.3	0.3	2.2	0.07
Off-Project	700 Welch (Barn)	700 Welch (Barn)	0.0%	0.4	0.4	2.6	0.08
	Fairchild Center	Fairchild Center	0.0%	0.3	0.3	2.3	0.07
	750 Welch	750 Welch	0.0%	0.1	0.1	0.7	0.02
	777 Welch	777 Welch	0.0%	0.2	0.2	1.1	0.03
	Nordstrom	Nordstrom	0.0%	0.08	0.1	0.5	0.02
	Crate & Barrel	Crate & Barrel	0.0%	0.08	0.1	0.5	0.02
	Andronico's	Andronico's	0.0%	0.09	0.1	0.6	0.02

Note:
1. For buildings with roof-level air intake, concentrations are from modeled receptors at the height of the building. For buildings with mixed, ground-level, or unspecified air intake level, concentrations are from modeled receptors 2 meters above the ground.
2. Based on Note 5 from Table 3.5, the pre-filtration DPM concentration was calculated using the concentration from 2 meters above the ground for 2010 and roof level concentrations for the rest of the project duration.

Abbreviations:
AMC: Advanced Medicine Center
CCSR: Center for Clinical Sciences Research
FIM: (School of Medicine) Foundations In Medicine building
HI: Hazard Index
HMP: Hospital Modernization Project
LKC: Learning and Knowledge Center
LPCH: Lucile Packard Children's Hospital
PSRL: Children's Surgical Research Lab
SHC: Stanford Hospital and Clinics
SoM: School of Medicine
µg/m3: microgram per cubic meter

Table 5.3: Estimated Excess Lifetime Cancer Risk and Chronic Noncancer Hazard Indices
Construction Emissions – Relocated Onsite Indoor Workers
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Year[2]	1101 Welch[1]	Hoover Medical Office Building	Core, East, West, Boswell	SHC Hospital Replacement	1973 Core Expansion	SHC Hospital Replacement	LPCH Hospital Expansion	Edwards	FIM1	Lane	FIM2	Alway	FIM2	Grant	FIM3
2010			0.1		0.0005			0.8		0.4		0.3		0.3	
2011			0.1		0.0004			0.7		0.4		0.2		0.3	
2012			0.09		0.0003				0.2	0.2		0.2		0.2	
2013		0.02	0.08		0.0003				0.2	0.1		0.1		0.2	
2014		0.009	0.1		0.0002		0.00004		0.3	0.4		0.3		0.2	
2015		0.009	0.1		0.0002		0.00004		0.3	0.4		0.3		0.2	
2016		0.001		0.01		0.008	0.000002		0.007		0.01		0.01	0.05	
2017		0.003		0.06		0.06	0.00002		0.03		0.06		0.06	0.4	
2018		0.004		0.08		0.08	0.00002		0.05		0.1		0.1	0.5	
2019		0.004		0.08		0.08	0.00002		0.05		0.1		0.1	0.5	
2020		0.002		0.07		0.07	0.00001		0.03		0.07		0.07		0.09
2021		0.002		0.07		0.07	0.00001		0.03		0.06		0.06		0.08
Cumulative Risk (in one million)[3]		0.1	1.0		0.4		0.0002	2.6		2.4		1.9		3.1	
Cumulative Chronic Noncancer HI[3]		0.002	0.03		0.01		0.0000049	0.08		0.07		0.06		0.1	

Key:
= demolition
= construction
= building non-existent (demolished or not yet built)
◆/◆/◆/◆/◇/◆ = relocated occupants (each color represents one group of relocated occupants)
◇ = new/growth occupants

Notes:
1. Workers at 1101 Welch were evaluated as onsite indoor stationary workers (Table 5.2) because workers at 1101 Welch relocate to Hoover Pavillion before the construction starts and stays at Hoover for the entire construction period.
2. Risk values presented (next to diamond symbols) for a given building in a given year are the maximum estimated cancer risk of an individual working in that building for the duration of that year.
3. Cumulative risk values for a given building are the sum of that building's maximum estimated cancer risk value for each year of the project. Similarly, cumulative chronic noncancer HI values are the sum of that building's maximum estimated chronic HI for each year of the project.

Abbreviations:
FIM: (School of Medicine) Foundations In Medicine buildings
HI: Hazard Index
LPCH: Lucile Packard Children's Hospital
SHC: Stanford Hospital and Clinics

Table 5.4: Estimated Excess Lifetime Cancer Risk and Chronic Noncancer Hazard Indices
Construction Emissions[1] - Offsite Receptors
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Population	UTMx	UTMy	Location	DPM Concentration	Cancer Risk	Chronic HI
	(m)			($\mu g/m^3$)	(in one million)	
MEIW - Offsite Outdoor Worker	573,471	4,144,070	South of FIM1	1.4	9.5	0.3
MEIW - Offsite Indoor Worker	572,880	4,143,140	Beckman	1.2	7.8	0.2
MEIR - Offsite Adult Resident	572,540	4,143,620	Sand Hill Rd near Mosher Wy	0.07	0.3	0.01
MEIR - Offsite Child Resident	572,540	4,143,620	Sand Hill Rd near Mosher Wy	0.09	0.6	0.02
Maximum Sensitive Receptor	572,742	4,143,801	Knowledge Beginnings	0.05	0.3	0.01

Notes:
1. This table presents estimated excess lifetime cancer risks and chronic noncancer HIs associated with offsite receptor exposure to DPM from construction activities related to the Project.

Abbreviations:
DPM: Diesel Particulate Matter
FIM: (School of Medicine) Foundations In Medicine building
HI: Hazard Index
m: meter
MEIR: Maximally Exposed Individual Resident
MEIW: Maximally Exposed Individual Worker
Rd: Road
UTM: Universal Transverse Mercator
Wy: Way
$\mu g/m^3$: microgram per cubic meter

Table 5.5: Estimated Excess Lifetime Cancer Risk and Chronic Noncancer Hazard Indices
Emergency Generators[1] - Onsite and Offsite Receptors
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Population	UTMx	UTMy	Location	Concentration	Cancer Risk	Chronic HI
	[m]			[$\mu g/m^3$]	in one million	
MEIW - Onsite Outdoor Worker	572,731	4,143,510	Near Northwest Corner of SHC	3.6E-03	1.0	0.00072
MEIW - Onsite Indoor Worker	572,691	4,143,470	SHC Replacement Hospital	1.2E-02	3.1	0.0023
MEIW - Offsite Outdoor Worker	573,160	4,144,180	Shopping Center Open Space	1.5E-03	0.4	0.00031
MEIW - Offsite Indoor Worker	573,160	4,144,240	Stanford Shopping Center	1.6E-03	0.4	0.00031
MEIR - Offsite Adult Resident	573,020	4,144,140	Sand Hill Rd and Arboretum Rd	1.3E-03	0.4	0.00026
MEIR - Offsite Child Resident	573,020	4,144,140	Sand Hill Rd and Arboretum Rd	1.3E-03	0.1	0.00026
Maximum Sensitive Receptor	574,062	4,144,685	Avenidas Senior Center	7.4E-04	0.2	0.00015

Notes:
1. This table presents estimated excess lifetime cancer risks and chronic noncancer HIs associated with onsite and offsite receptor exposure to DPM from operational sources (emergency generators).

Abbreviations:
EG: Emergency Generator
HI: Hazard Index
m: meter
MEIR: Maximum Exposed Individual Resident
MEIW: Maximum Exposed Individual Worker
Rd: Road
SHC: Stanford Hospital and Clinics
UTM: Universal Transverse Mercator
$\mu g/m^3$: microgram per cubic meter

Table 5.6: Estimated Excess Lifetime Cancer Risk and Chronic Noncancer Hazard Indices
Loading Docks[1] - Onsite and Offsite Receptors
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Scenario[2]	Population[3]	UTMx	UTMy	Location	Concentration	Cancer Risk	Chronic HI
		[m]			[µg/m³]	[in one million]	
US-101	MEIW - Onsite Outdoor Worker	573,131	4,143,590	Proposed LPCH Parking Lot	1.0E-02	0.6	0.0020
	MEIW - Onsite Indoor Worker	573,431	4,144,150	Hoover	1.0E-03	0.06	0.00021
	MEIW - Offsite Outdoor Worker	573,160	4,143,700	700 Welch (Barn)	2.7E-03	0.2	0.00053
	MEIW - Offsite Indoor Worker	573,180	4,143,720	700 Welch (Barn)	2.5E-03	0.2	0.00049
	MEIR - Offsite Adult	573,740	4,144,560	Alma St and Everett Ave	8.4E-04	0.3	0.00017
	MEIR - Offsite Child	573,740	4,144,560	Alma St and Everett Ave	9.4E-04	0.07	0.00019
	Maximum Sensitive Receptor	574,062	4,144,685	Avenidas Senior Center	3.0E-04	0.1	0.000061
I-280	MEIW - Onsite Outdoor Worker	573,131	4,143,590	Proposed LPCH Parking Lot	1.0E-02	0.6	0.0020
	MEIW - Onsite Indoor Worker	573,431	4,144,150	Hoover	7.3E-04	0.05	0.00015
	MEIW - Offsite Outdoor Worker	573,160	4,143,700	700 Welch	2.7E-03	0.2	0.00055
	MEIW - Offsite Indoor Worker	573,180	4,143,720	700 Welch	2.5E-03	0.2	0.00051
	MEIR - Offsite Adult	571,850	4,142,950	Near Sand Hill Rd and Stock Farm Rd	1.5E-03	0.5	0.00030
	MEIR - Offsite Child	571,850	4,142,950	Near Sand Hill Rd and Stock Farm Rd	1.4E-03	0.1	0.00027
	Maximum Sensitive Receptor	574,062	4,144,685	Avenidas Senior Center	1.3E-04	0.04	0.000027

Notes:
1. This table presents estimated excess lifetime cancer risks and chronic noncancer HIs associated with onsite and offsite receptor exposure to DPM from operational sources (loading docks).
2. ENVIRON evaluated the cancer risk for two traffic route scenarios:
   Scenario 1: all delivery trucks approach the facility via I-280.
   Scenario 2: all delivery trucks approach the facility via US 101.

Abbreviations:
Ave: Avenue
HI: Hazard Index
LPCH: Lucile Packard Children's Hospital
m: meter
MEIR: Maximum Exposed Individual Resident
MEIW: Maximum Exposed Individual Worker
Rd: Road
UTM: Universal Transverse Mercator
µg/m³: microgram per cubic meter

Table 5.7: Estimated Excess Lifetime Cancer Risk and Chronic Noncancer Hazard Indices
Operational Emissions (Emergency Generators and Loading Docks)[1] - Onsite and Offsite Receptors
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Population	UTMx	UTMy	Location	Concentration	Cancer Risk	Chronic HI
	(m)			($\mu g/m^3$)	($1x10^{-6}$)	
MEIW - Onsite Outdoor Worker	572,731	4,143,510	North of SHC	3.8E-03	1.0	0.00077
MEIW - Onsite Indoor Worker	572,691	4,143,470	SHC Replacement Hospital	1.2E-02	3.1	0.0024
MEIW - Offsite Outdoor Worker	573,160	4,144,180	Shopping Center Open Space	2.4E-03	0.5	0.00049
MEIW - Offsite Indoor Worker	573,160	4,144,240	Shopping Center	2.3E-03	0.5	0.00045
MEIR - Offsite Adult Resident	572,980	4,144,060	Sand Hill Rd and Arboretum Rd	2.5E-03	0.8	0.00050
MEIR - Offsite Child Resident	572,980	4,144,060	Sand Hill Rd and Arboretum Rd	2.4E-03	0.2	0.00049
Maximum Sensitive Receptor	574,062	4,144,685	Avenidas	1.0E-03	0.3	0.00021

Notes:
1. This table presents estimated excess lifetime cancer risks and chronic noncancer HIs associated with onsite and offsite receptor exposure to DPM from operational sources (emergency generators and loading docks).

Abbreviations:
HI: Hazard Index
m: meter
MEIR: Maximum Exposed Individual Resident
MEIW: Maximum Exposed Individual Worker
SHC: Stanford Hospital and Clinics
UTM: Universal Transverse Mercator
$\mu g/m^3$: microgram per cubic meter

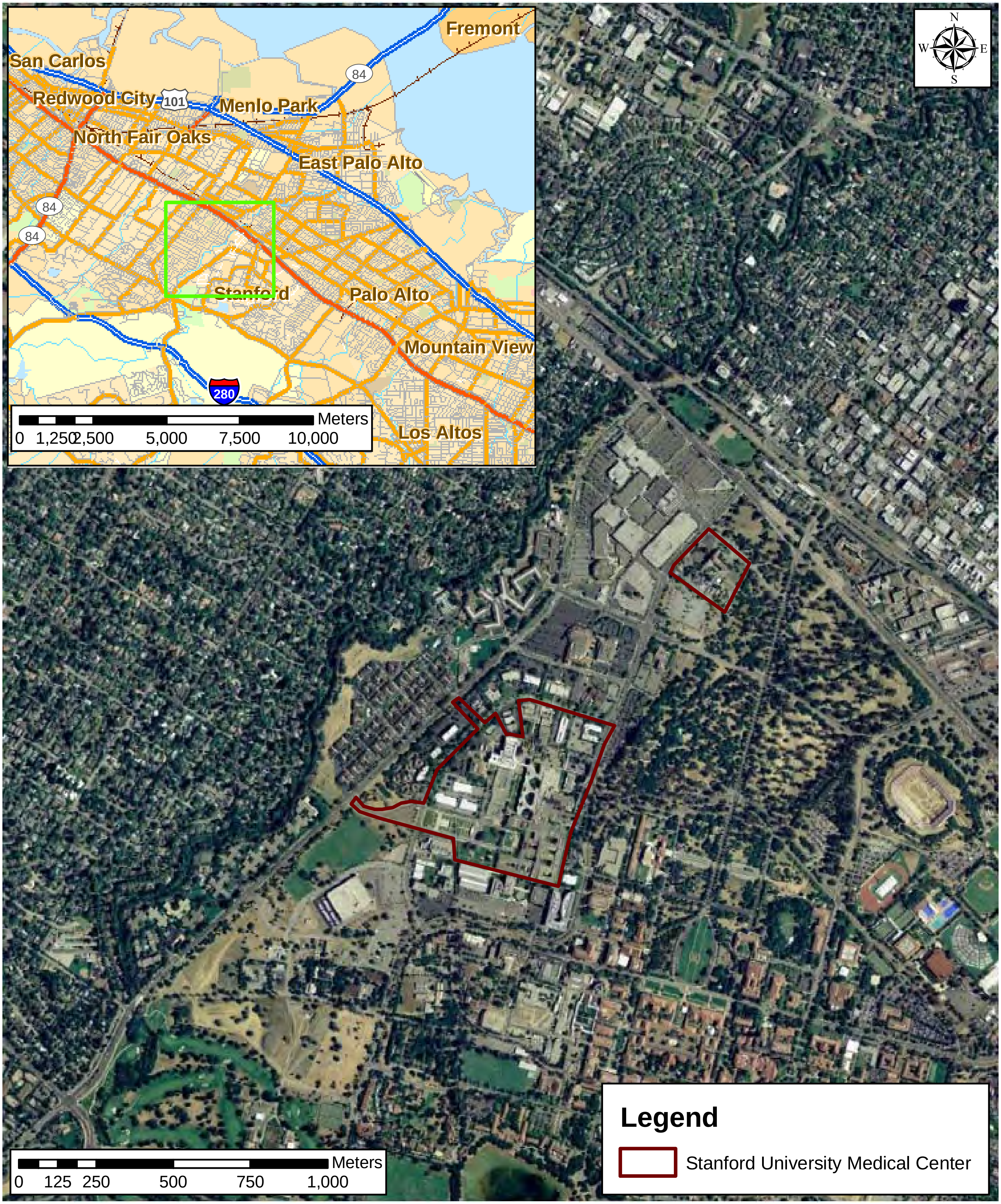
Table 5.8: Estimated Excess Lifetime Cancer Risk and Chronic Noncancer Hazard Indices
Construction Activities and Onsite/Offsite Operational Emissions[1]
Stanford University Medical Center Facilities Renewal and Replacement Project
Palo Alto, California

Scenario	MEIW Location	UTMx	UTMy	Concentration (µg/m^3)			Total Cancer Risk	Total Chronic HI
		(m)		Construction	Facility Operation	Total	(in one million)	
Onsite	Construction	572,780	4,143,180	1.5	2.6E-04	1.5	9.8	0.29
	Operational	572,691	4,143,470	5.3E-03	0.01	0.02	3.1	0.0034
Offsite	Construction	573,471	4,144,070	1.4	1.8E-03	1.4	9.6	0.29
	Operational	573,160	4,144,180	0.04	2.4E-03	0.04	0.7	0.0076

Notes:
1. This table presents estimated excess lifetime cancer risks and chronic noncancer HIs associated with onsite and offsite receptor exposure to DPM from construction activities and operational sources related to the Project.

Abbreviations:
HI: Hazard Index
m: meter
UTM: Universal Transverse Mercator
µg/m^3: microgram per cubic meter

Figures



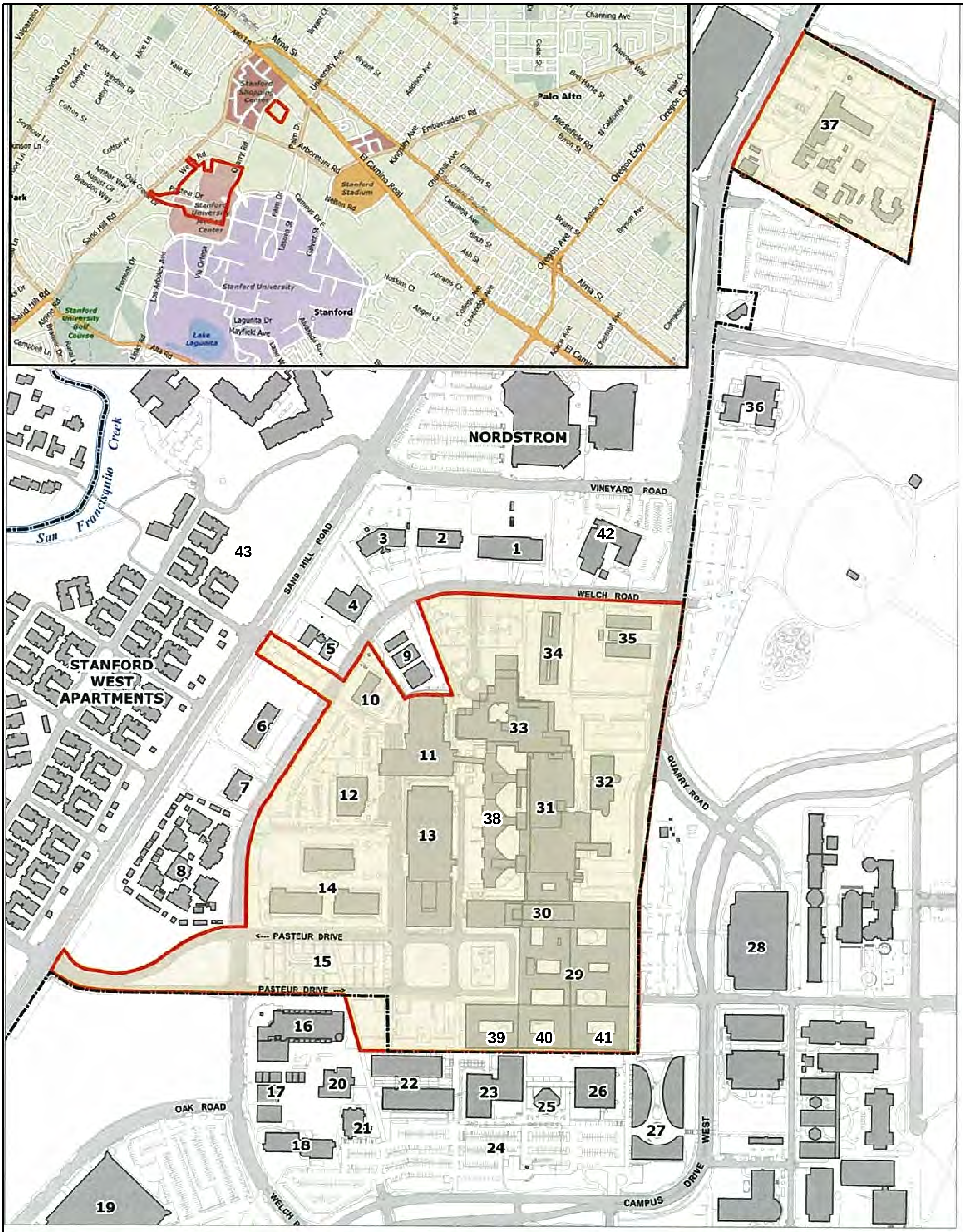
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Project Location Map
Stanford University Medical Center
Palo Alto, California

Figure
1.1

Drafter: KZ | Date: 10/01/2009 | Contract Number: 0320376A



Palo Alto Boundary — Project Area Boundary

1 730 Welch Road
2 750 Welch Road
3 770 Welch Road
4 780 Welch Road
5 800 Welch Road
6 900 Welch Road
7 1000 Welch Road
8 1100 Welch Road Housing
9 777 Welch Road
10 801 Welch Road
11 Center for Cancer Treatment
12 Blake-Wilbur Clinic
13 Parking Structure III
14 1101 Welch Road
15 Parking IV (underground)
16 Lucas Center
17 1215 Welch Road Trailers
18 Medical School Office Building
19 Parking Structure V (shared)
20 Redwood Building
21 Mayer Cancer Biology Labs
22 Center for Clinical Sciences Research
23 Beckman Center
24 Research Animal Fac. (underground)
25 Fairchild Auditorium
26 Fairchild Laboratory
27 Clark Center
28 Parking Structure I (shared)
29 E.D. Stone Complex
30 Core Expansion
31 Hospital Modernization Project
32 Cardiovascular Research Center
33 L. Packard Children's Hospital
34 703 Welch Road
35 701 Welch Road
36 Psychiatry Center
37 Hoover Pavilion
38 D, E, F Pods
39 Edwards
40 Lane
41 Alway
42 Barn
43 Child Care Center

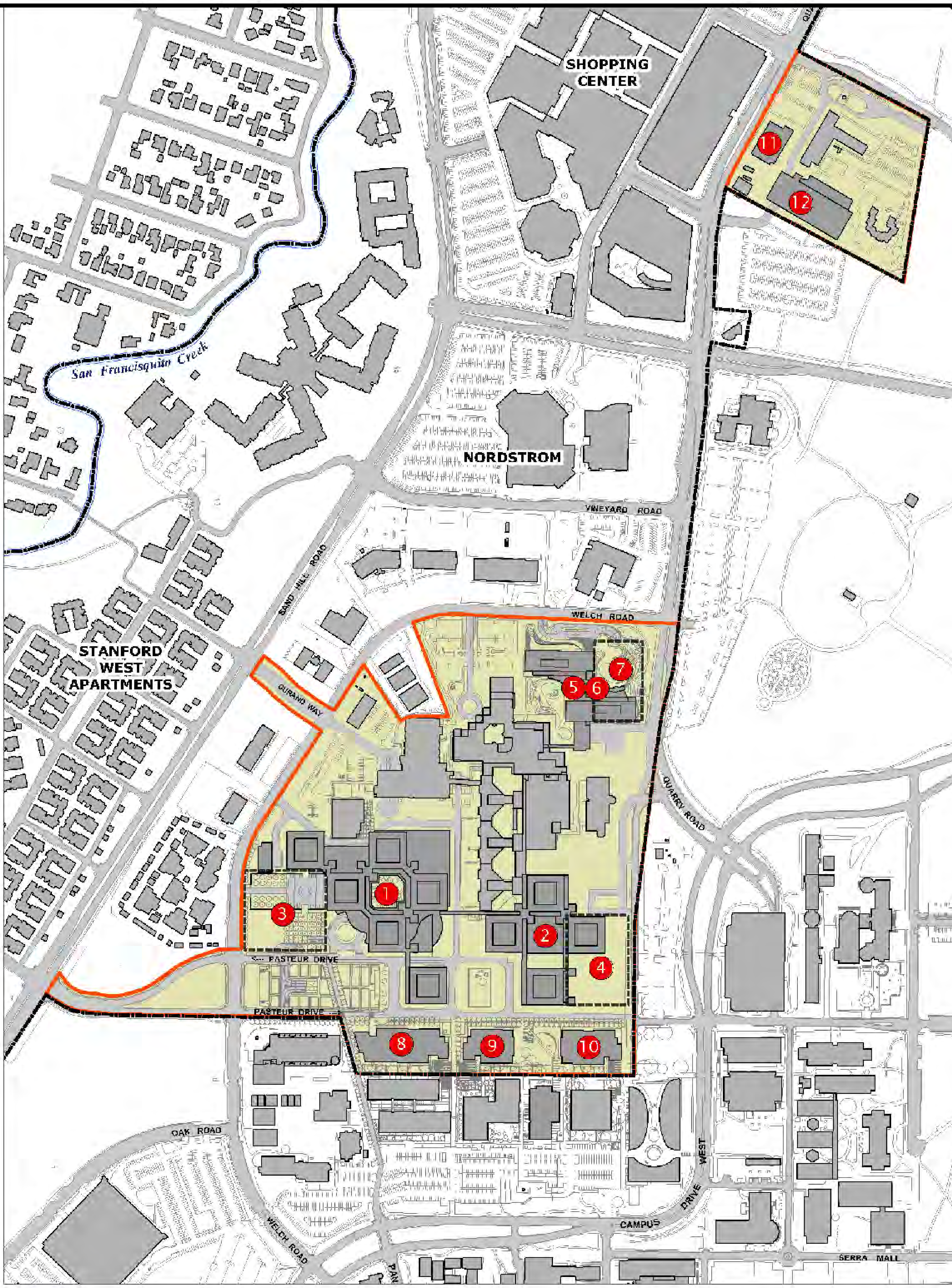
0 400 800 Feet

Stanford University Land Use & Environmental Planning
File: bldgs&location11x17.mxd, Printed: August 10, 2007

1 acre

Source: Adapted from Figure 1-1 SUMC Buildings & Location, Stanford Medical Center Application - Part 1 Entitlements, 04/18/2008.

ENVIRON 6001 Shellmound St., Suite 700, Emeryville, CA 94608	**Existing Project Layout** **Stanford University Medical Center** **Palo Alto, California**	Figure **2.1**
Drafter: KZ	Date: 10/01/2009	Contract Number: 0320376A



Palo Alto Boundary

Project Area Boundary

Builiding Replacement

1. SHC Hospital Facility
2. SHC Clinic/Office Buildings
3. SHC Parking Structure
4. Clinics Parking (underground)
5. LPCH Hospital Facility
6. LPCH Clinic Building
7. LPCH Parking Structure (underground)
8. Foundations in Medicine #1 (FIM1)
9. Foundations in Medicine #2 (FIM2)
10. Foundations in Medicine #3 (FIM3)
11. Hoover Medical Office Building
12. Hoover Parking Structure

0 400 800 Feet

Stanford University Land Use & Environmental Planning
File: fig3-5b_proj_replace11x17.mxd, Printed: Mar. 13, 2008

1 acre

Source: Adapted from Figure 3-5b Project Replacement Buildings/Structures, Stanford University Medical Center Project - Part 3 Project Description (Rev. 05/2009)

Revised: 5/2009

ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Proposed Project Layout
Stanford University Medical Center
Palo Alto, California

Figure
2.2

Drafter: KZ
Date: 10/01/2009
Contract Number: 0320376A

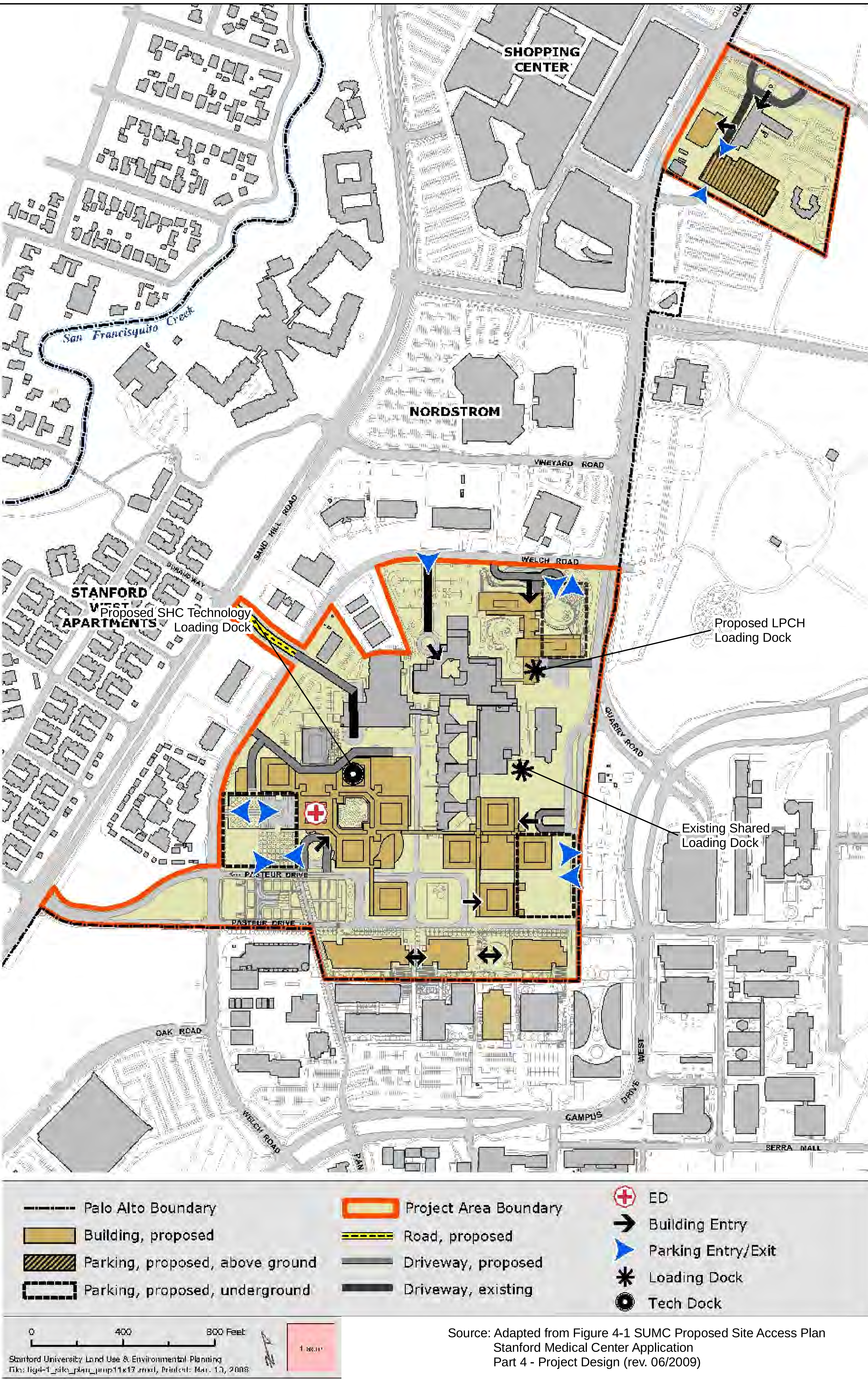
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Emergency Generator Locations
Existing and Proposed
Stanford University Medical Center
Palo Alto, California

Figure
2.3

Drafter: KZ Date: 10/01/2009 Contract Number: 0320376A



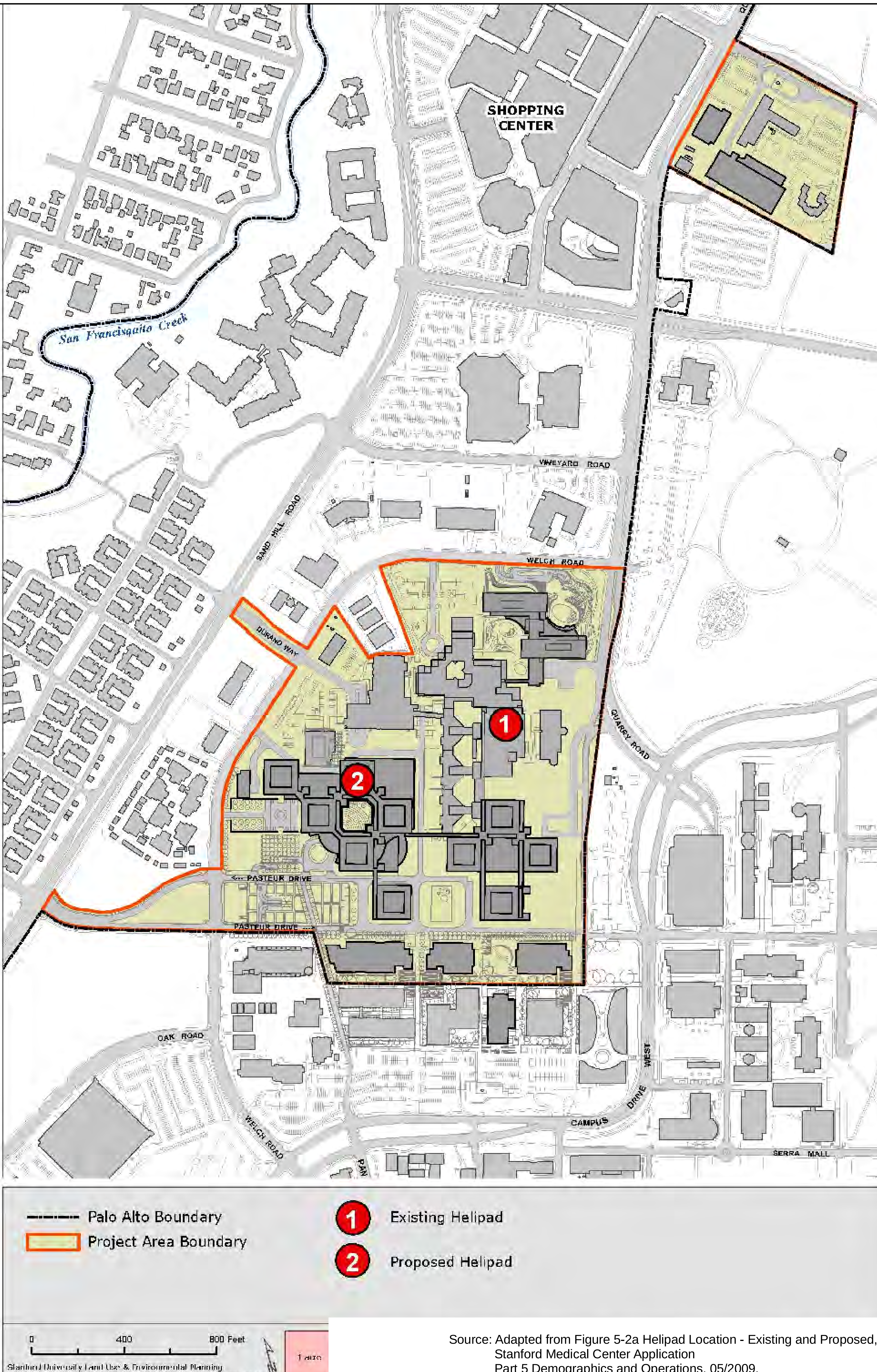
Source: Adapted from Figure 4-1 SUMC Proposed Site Access Plan
Stanford Medical Center Application
Part 4 - Project Design (rev. 06/2009)

ENVIRON
6001 Shellmound St., Suite 700, Emeryville, CA 94608

Loading Dock Locations - Existing and Proposed
Stanford University Medical Center
Palo Alto, California

Figure
2.4

Drafter: KZ
Date: 10/01/2009
Contract Number: 0320376A



Source: Adapted from Figure 5-2a Helipad Location - Existing and Proposed, Stanford Medical Center Application Part 5 Demographics and Operations, 05/2009.

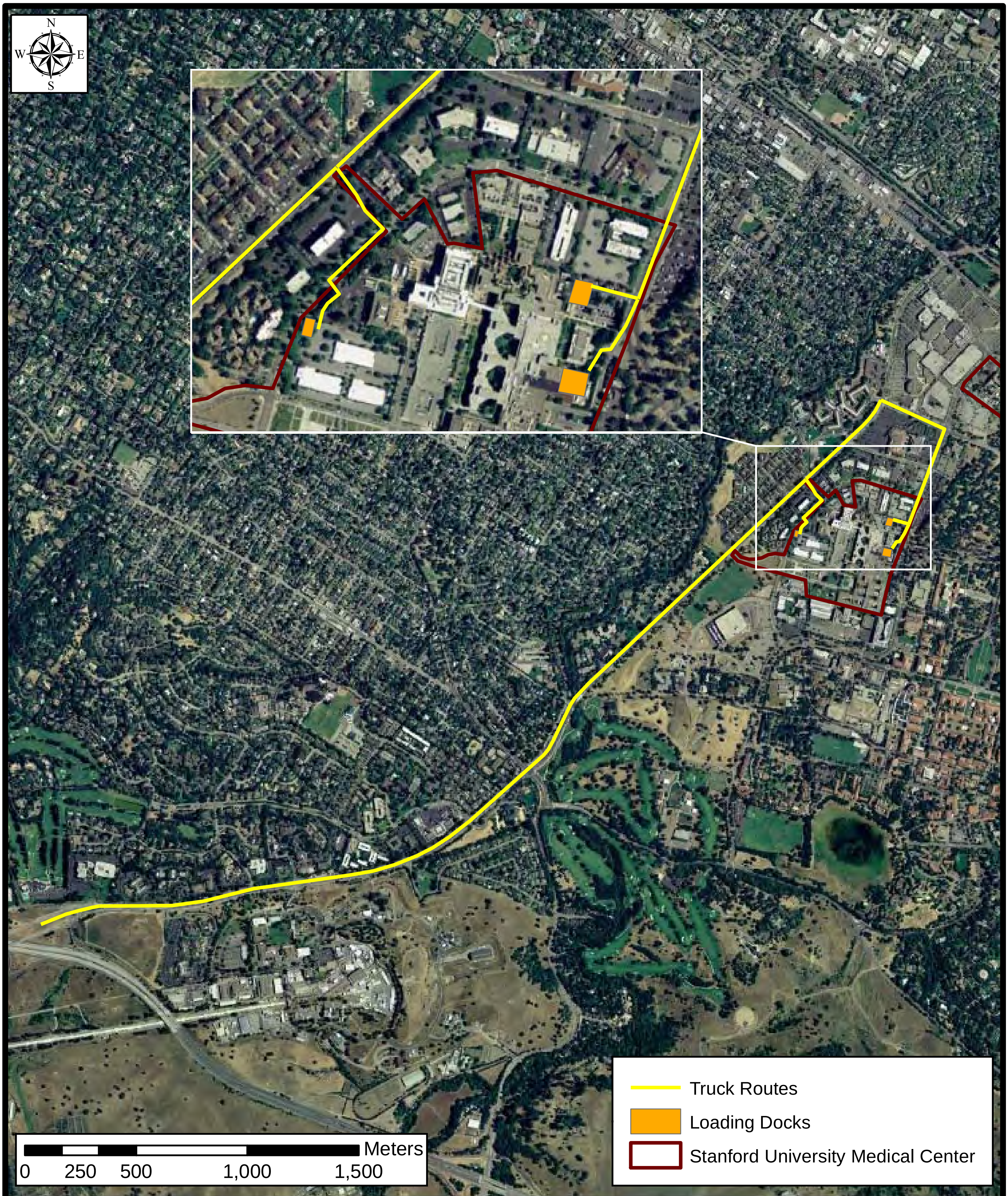
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Helipad Locations - Existing and Proposed
Stanford University Medical Center
Palo Alto, California

Figure **2.5**

Drafter: KZ | Date: 10/01/2009 | Contract Number: 0320376A



ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Locations of Modeled Truck Routes: From I-280
Stanford University Medical Center
Palo Alto, California

Figure
3.1

Drafter: AY Date: 10/01/2009 Contract Number: 0320376A

ENVIRON

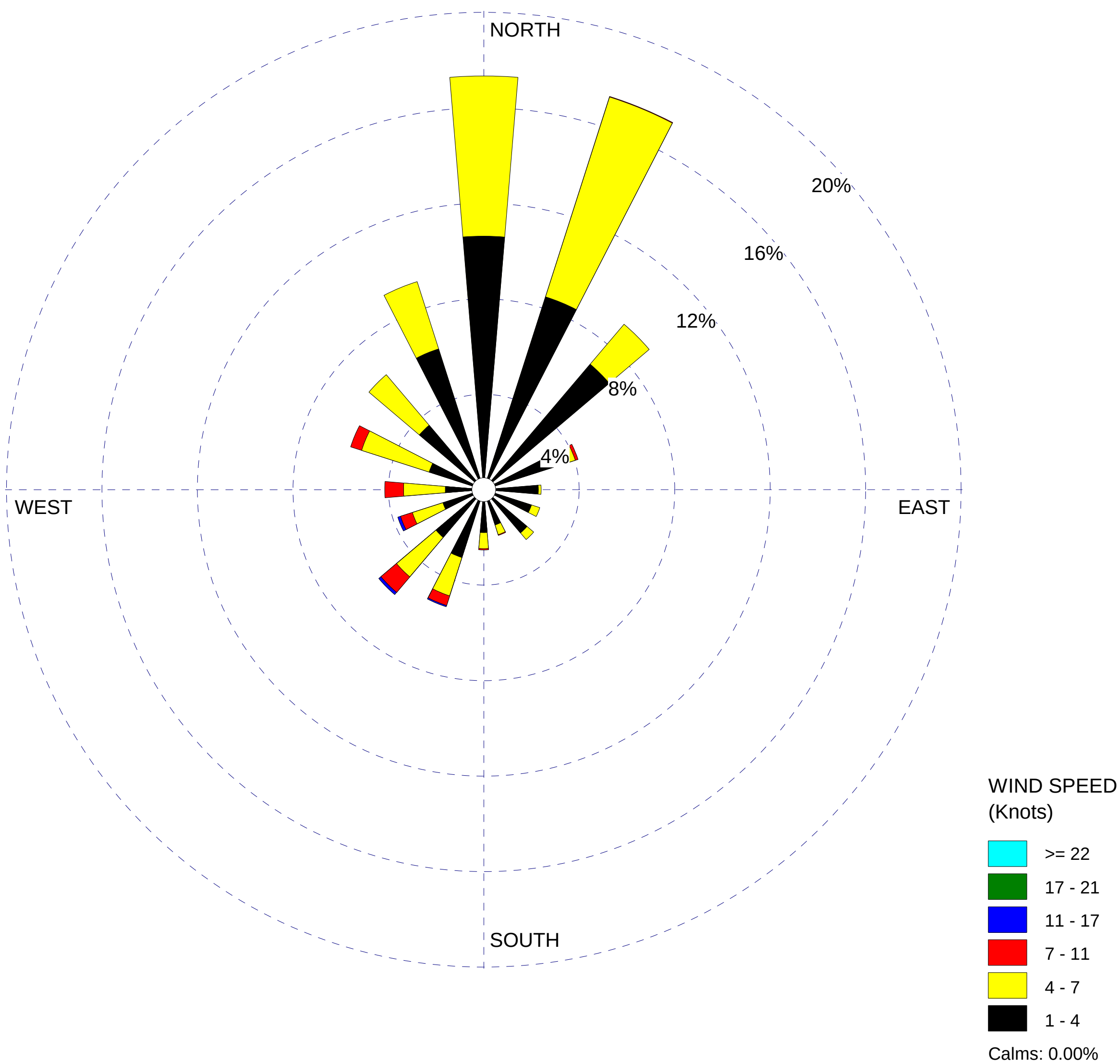
6001 Shellmound St., Suite 700, Emeryville, CA 94608

Locations of Modeled Truck Routes: From US-101
Stanford University Medical Center
Palo Alto, California

Figure
3.2

Drafter: KZ   Date: 10/01/2009   Contract Number: 0320376A

WIND ROSE PLOT:	DISPLAY:
Windrose for Construction Activity Stanford University Medical Center Palo Alto, California	**Wind Speed** **Direction (blowing from)**

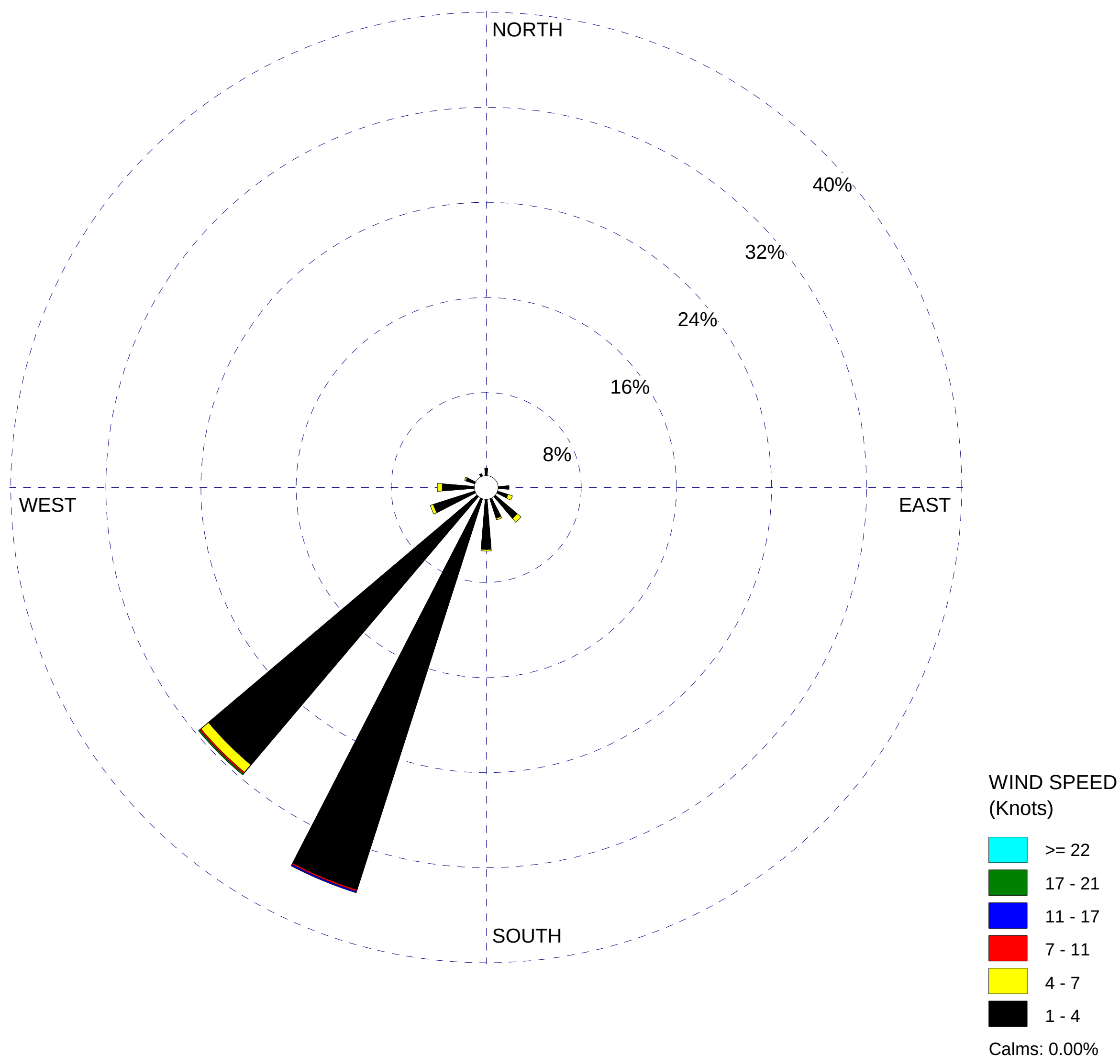


COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure 3.3	**2005** **Jan 1 - Dec 31** **09:00 - 17:00**	MODELER:	
	CALM WINDS: **0.00%**	TOTAL COUNT: **3285 hrs.**	
	AVG. WIND SPEED: **4.10 Knots**	DATE: **10/10/2008**	PROJECT NO.: **0320376A**

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:
Windrose for Emergency Generator Testing
Stanford University Medical Center
Palo Alto, California

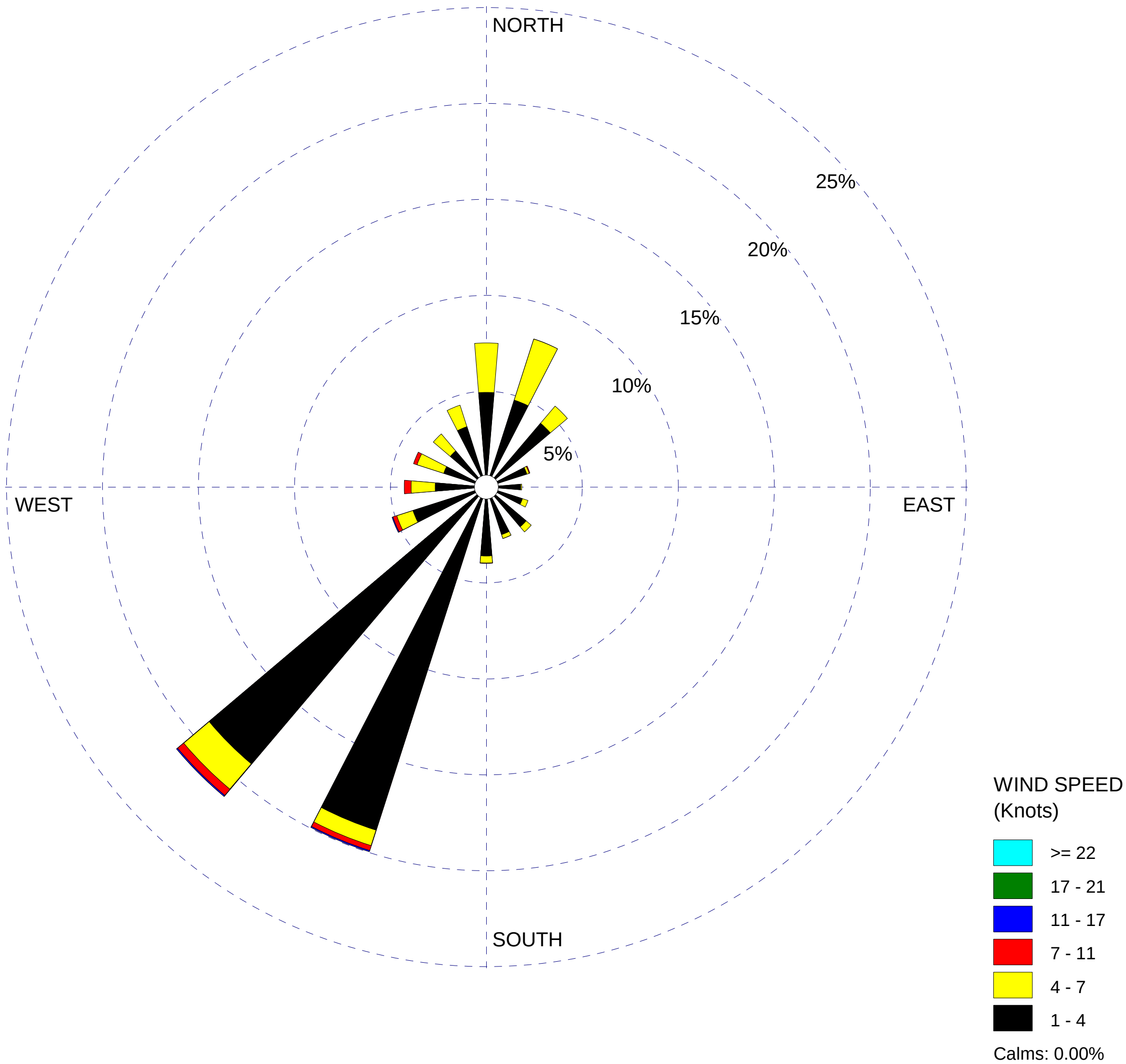
DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS: Figure 3.4	DATA PERIOD: **2005** **Jan 1 - Dec 31** **06:00 - 07:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **0.00%**	TOTAL COUNT: **730 hrs.**	
	AVG. WIND SPEED: **2.29 Knots**	DATE: **10/10/2008**	PROJECT NO.: **0320376A**

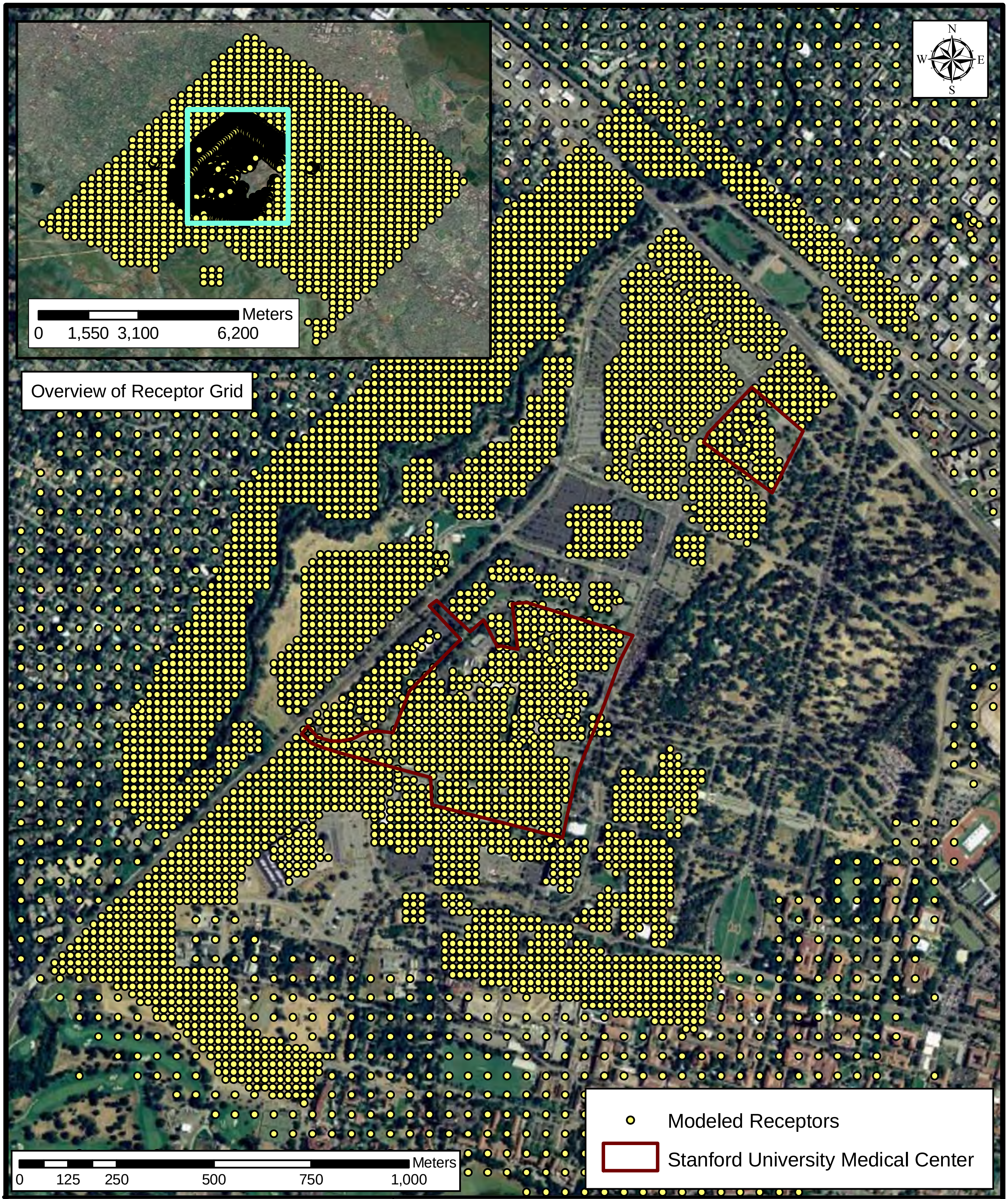
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:	DISPLAY:
Windrose for Loading Dock Truck Delivery Stanford University Medical Center Palo Alto, California	**Wind Speed** **Direction (blowing from)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure 3.5	**2005** **Jan 1 - Dec 31** **00:00 - 23:00**	MODELER:	
	CALM WINDS: **0.00%**	TOTAL COUNT: **8760 hrs.**	
	AVG. WIND SPEED: **3.10 Knots**	DATE: **1/29/2009**	PROJECT NO.: **0320376A**

WRPLOT View - Lakes Environmental Software



ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Receptor Grid - Overview
Stanford University Medical Center
Palo Alto, California

Figure
3.6

Drafter: KZ Date: 10/01/2009 Contract Number 0320376A

ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Receptor Grid - Project Vicinity
Stanford University Medical Center
Palo Alto, California

Figure
3.7

Drafter: KZ Date: 10/01/2009 Contract Number: 0320376A

ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

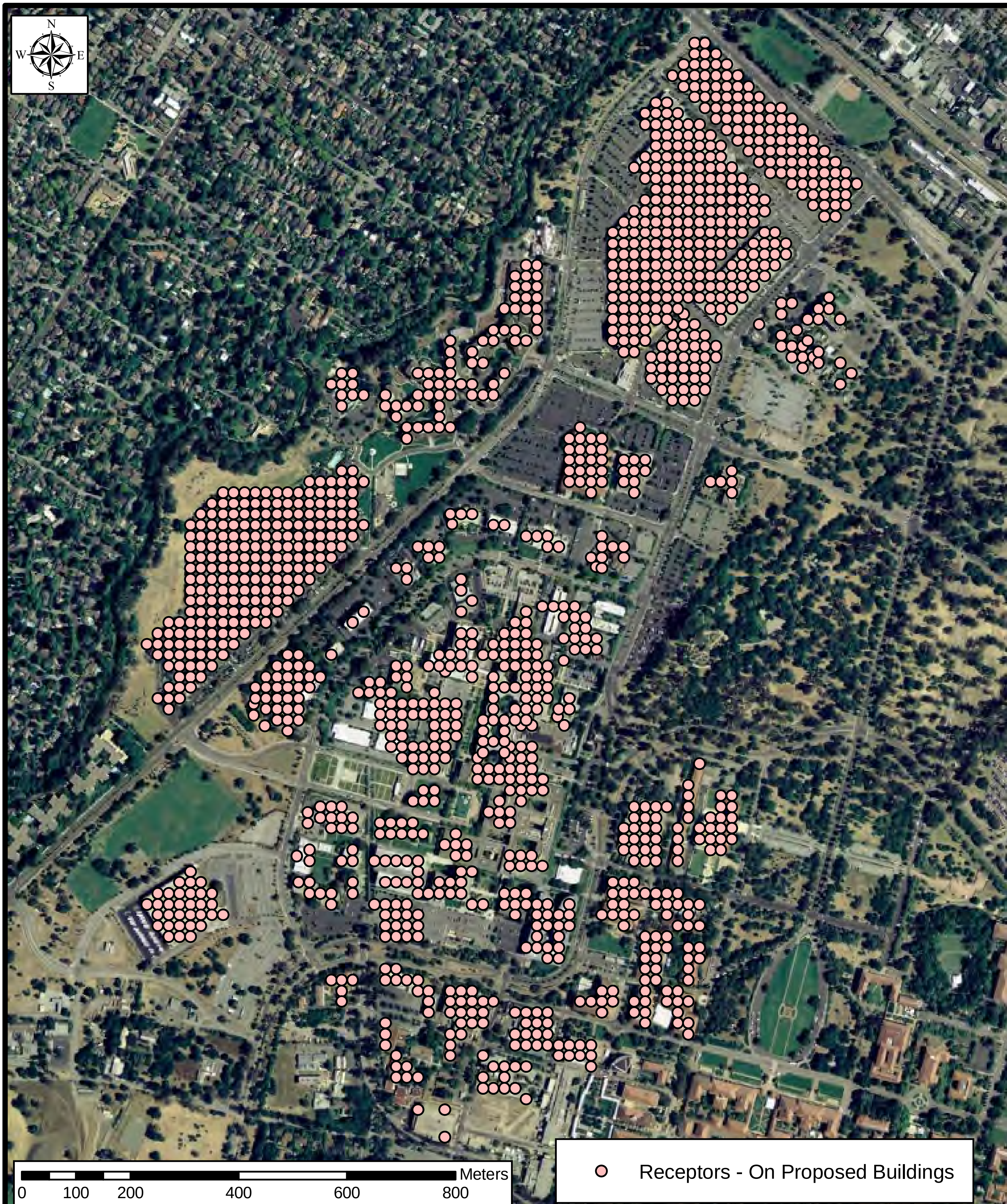
Receptor Grid - Roof Height - Existing Buildings
Stanford University Medical Center
Palo Alto, California

Figure
3.8

Drafter: KZ

Date: 10/01/2009

Contract Number: 0320376A



ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Receptor Grid - Roof Height - Proposed Buildings
Stanford University Medical Center
Palo Alto, California

Figure
3.9

Drafter: KZ | Date: 10/01/2009 | Contract Number: 0320376A

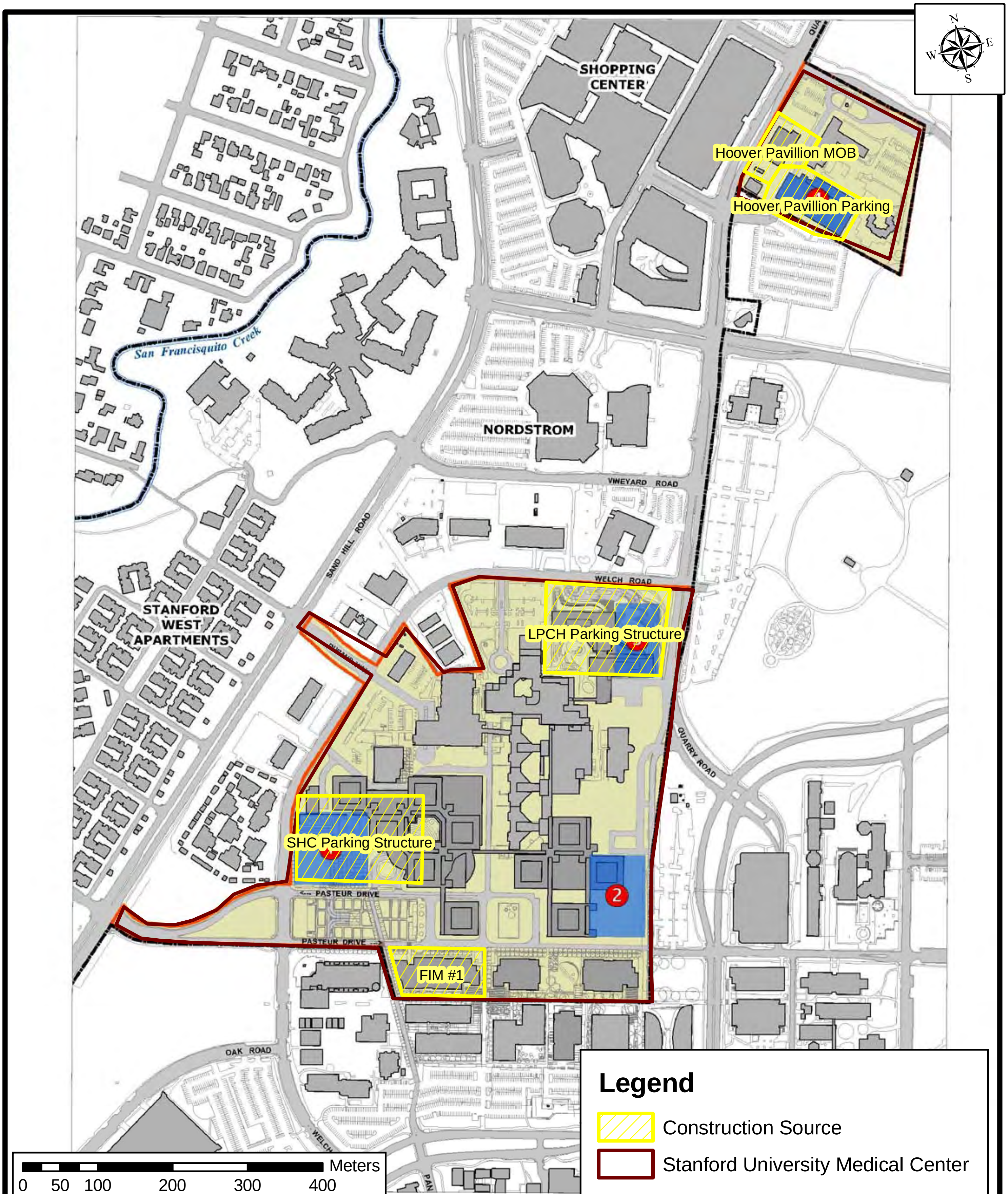
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Receptor Grid - Sensitive Receptors
Stanford University Medical Center
Palo Alto, California

Figure
3.10

Drafter: KZ | Date: 10/01/2009 | Contract Number: 0320376A



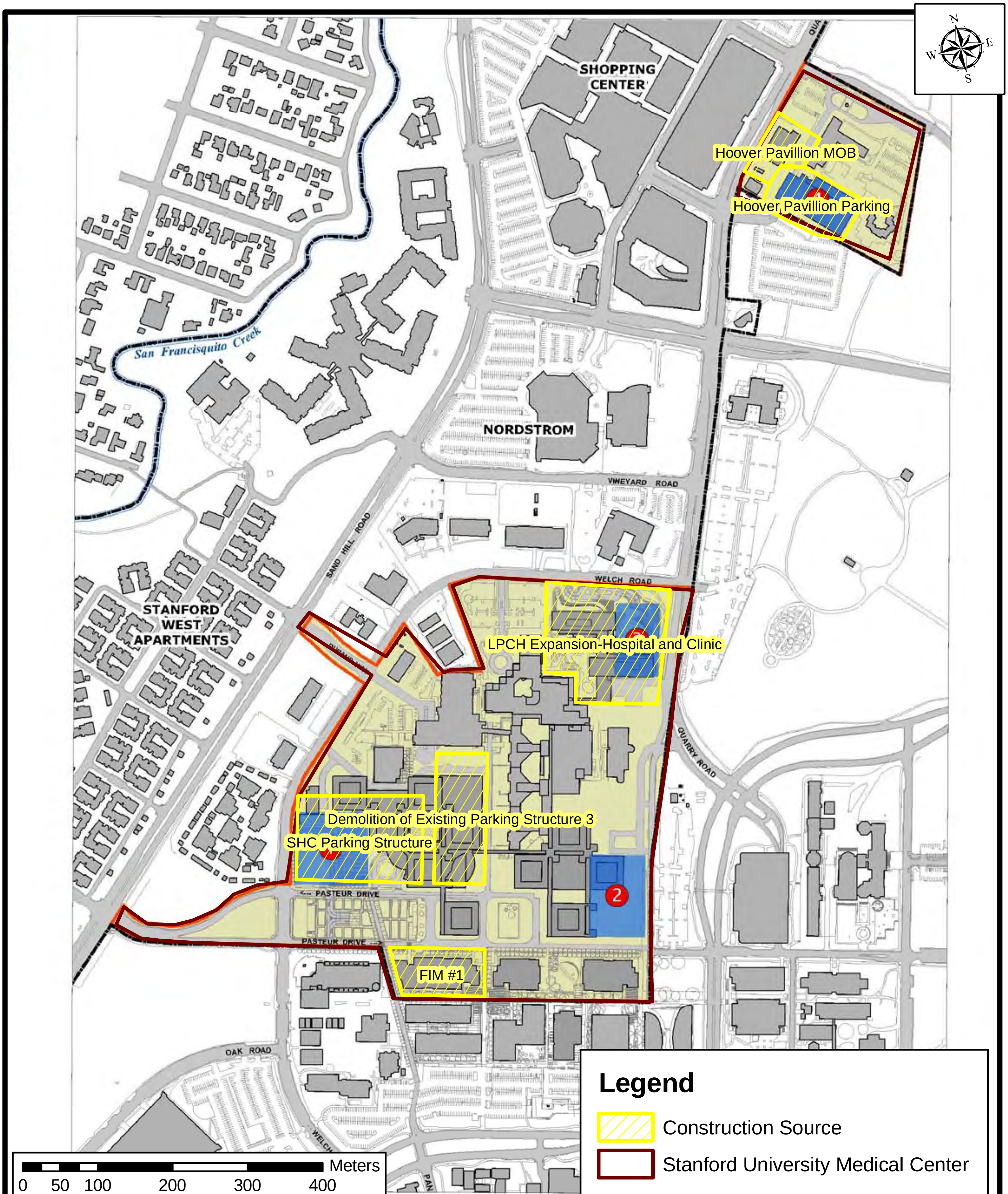
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2010
Stanford University Medical Center
Palo Alto, California

Figure
3.11a

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



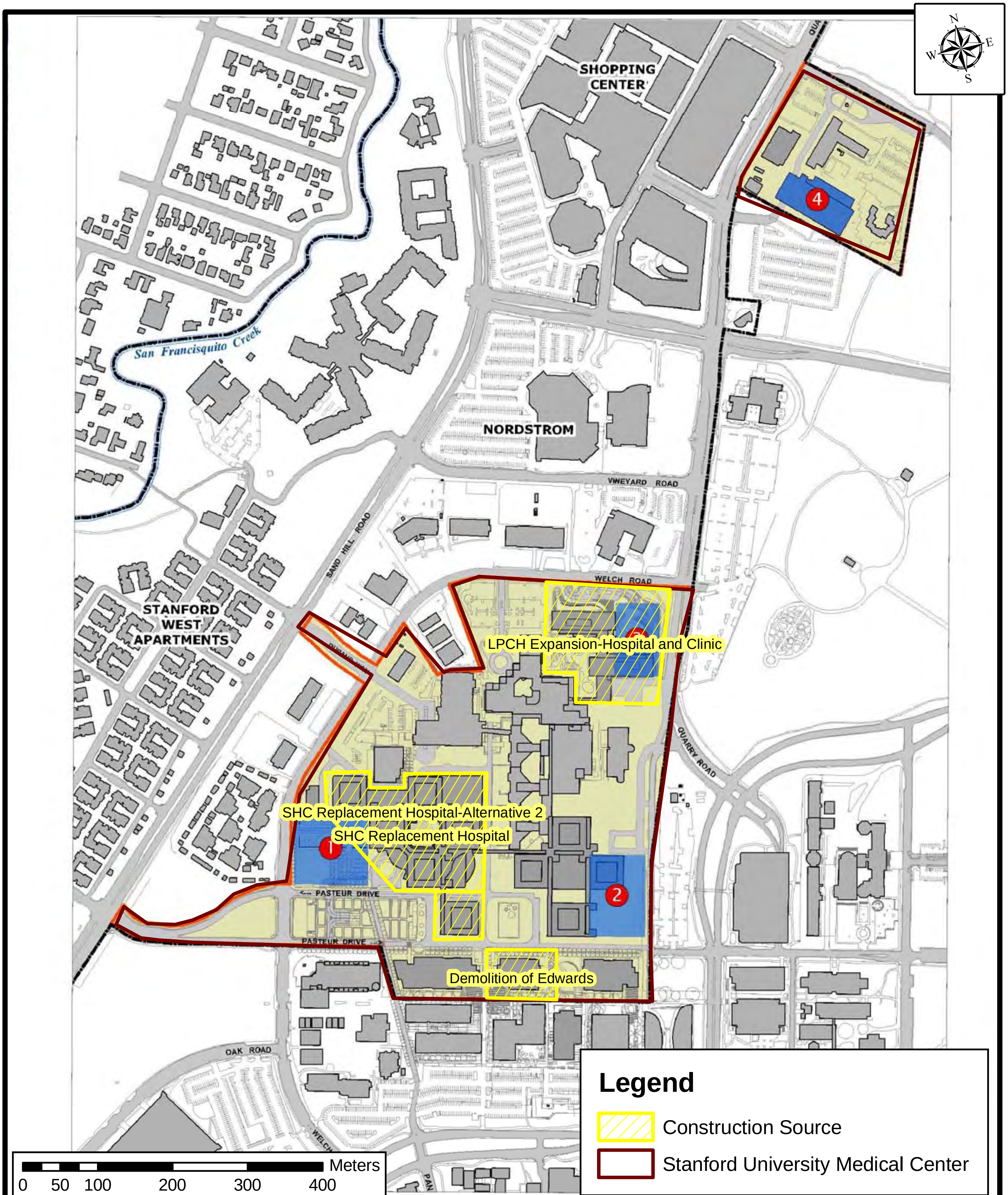
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2011
Stanford University Medical Center
Palo Alto, California

Figure
3.11b

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



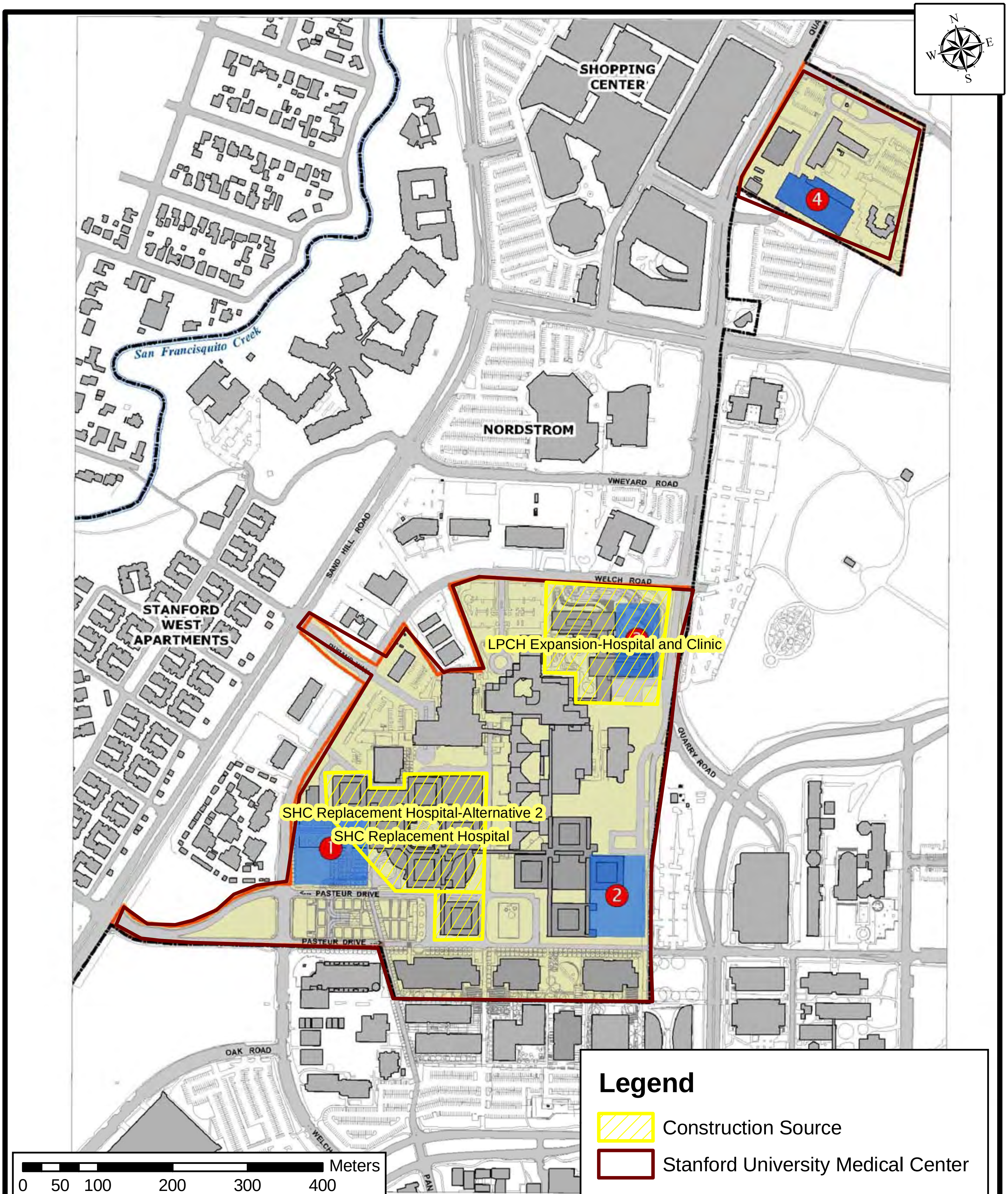
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2012
Stanford University Medical Center
Palo Alto, California

Figure
3.11c

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



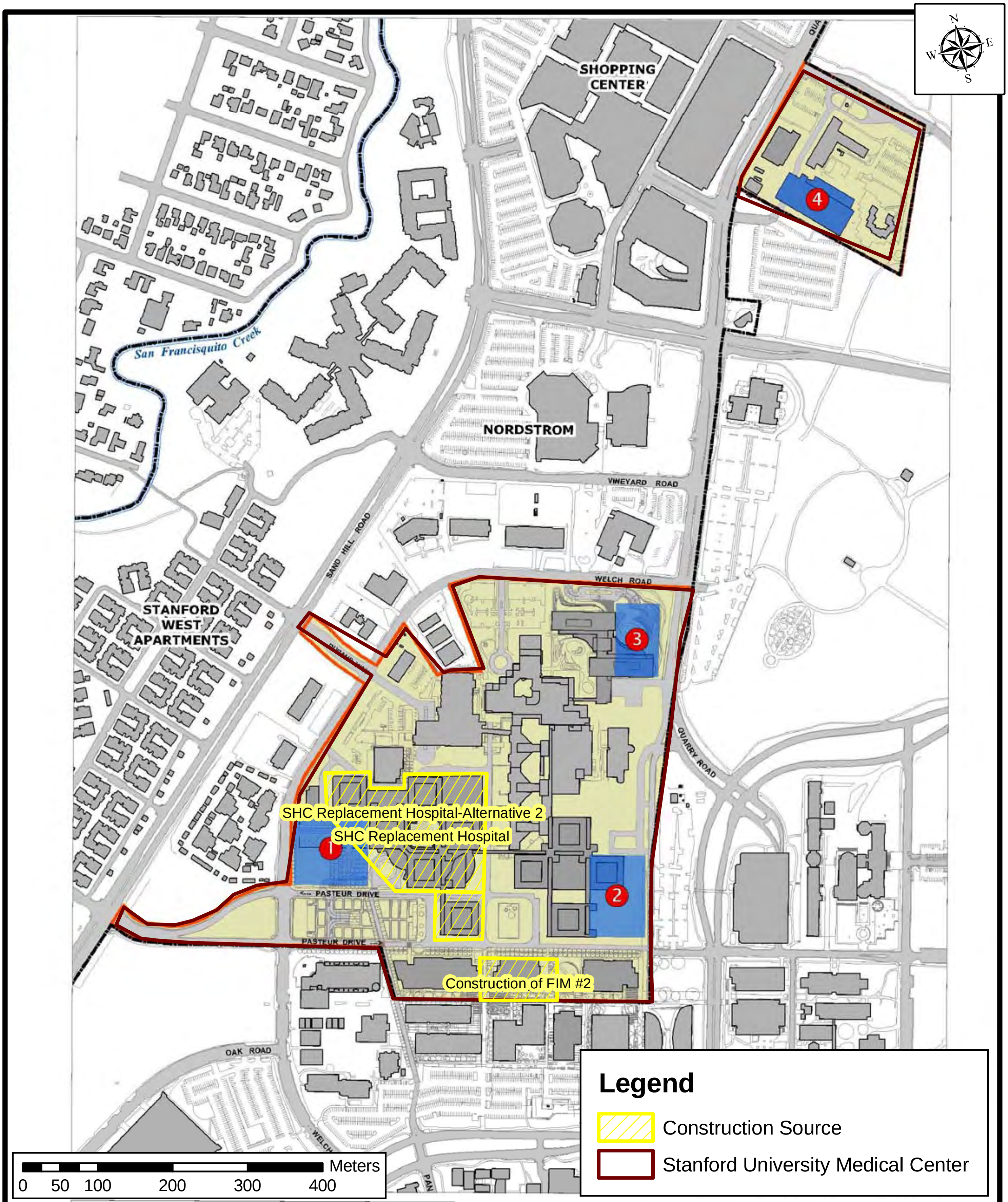
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2013
Stanford University Medical Center
Palo Alto, California

Figure
3.11d

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



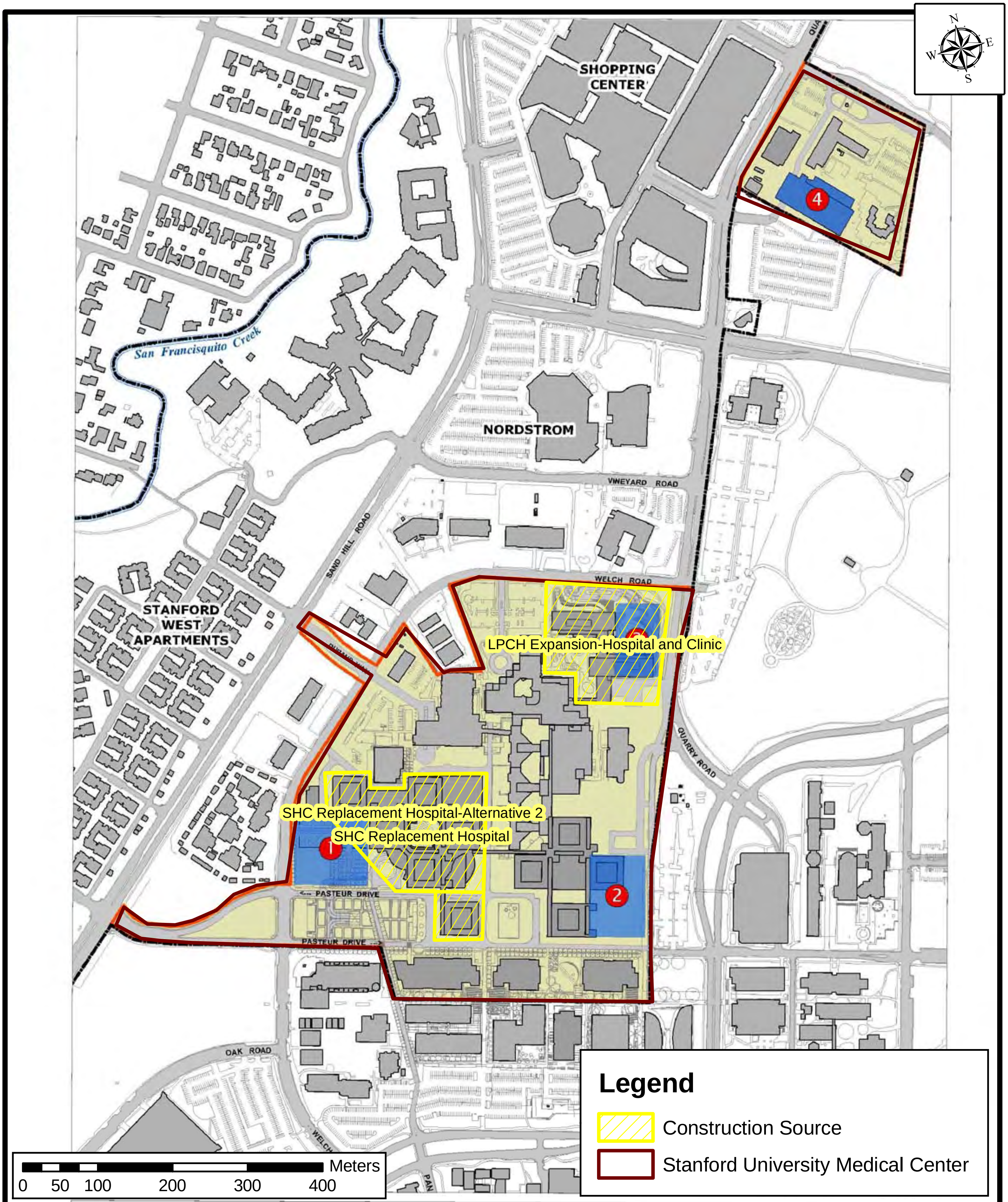
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2014
Stanford University Medical Center
Palo Alto, California

Figure
3.11e

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



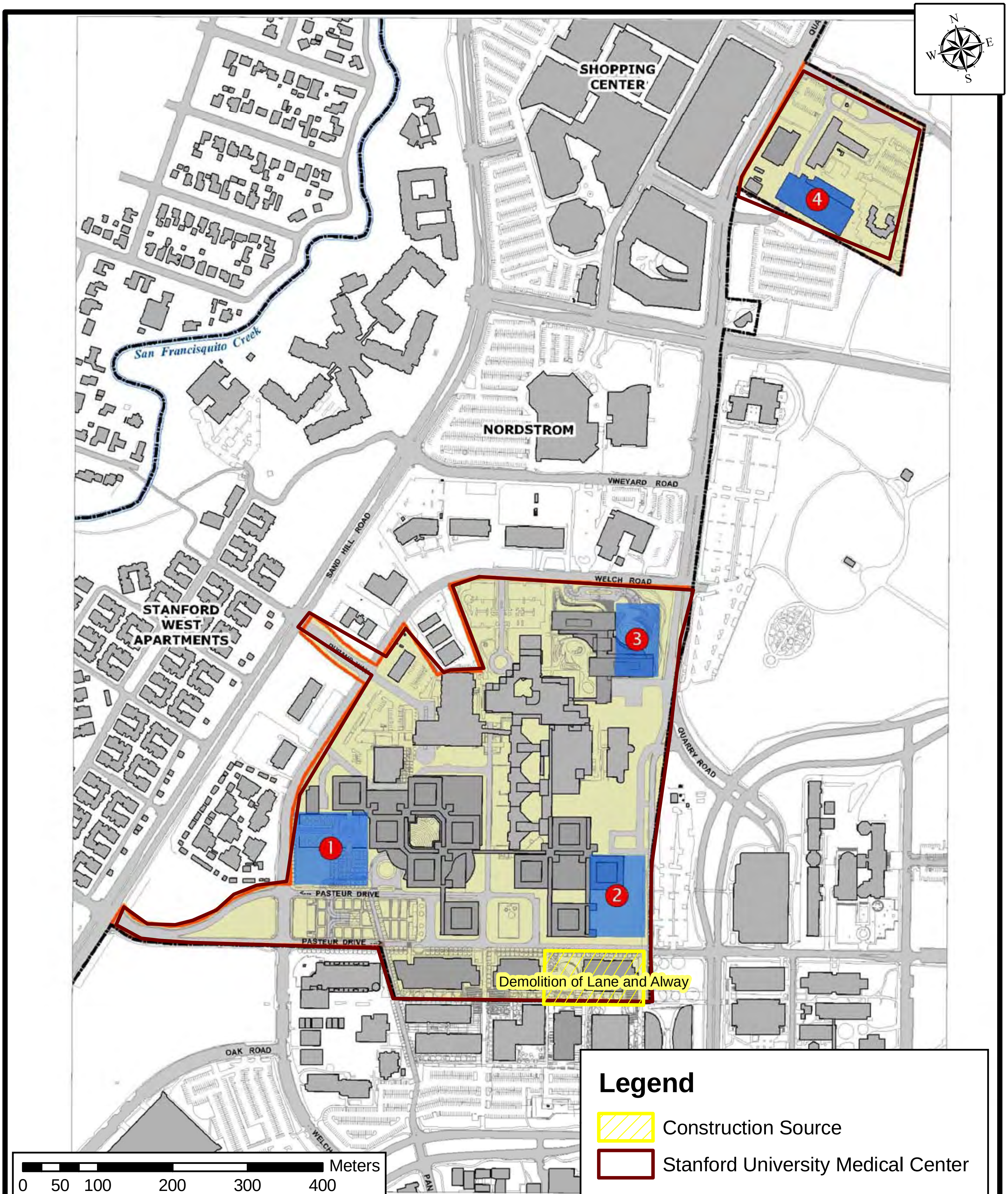
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2015
Stanford University Medical Center
Palo Alto, California

Figure **3.11f**

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



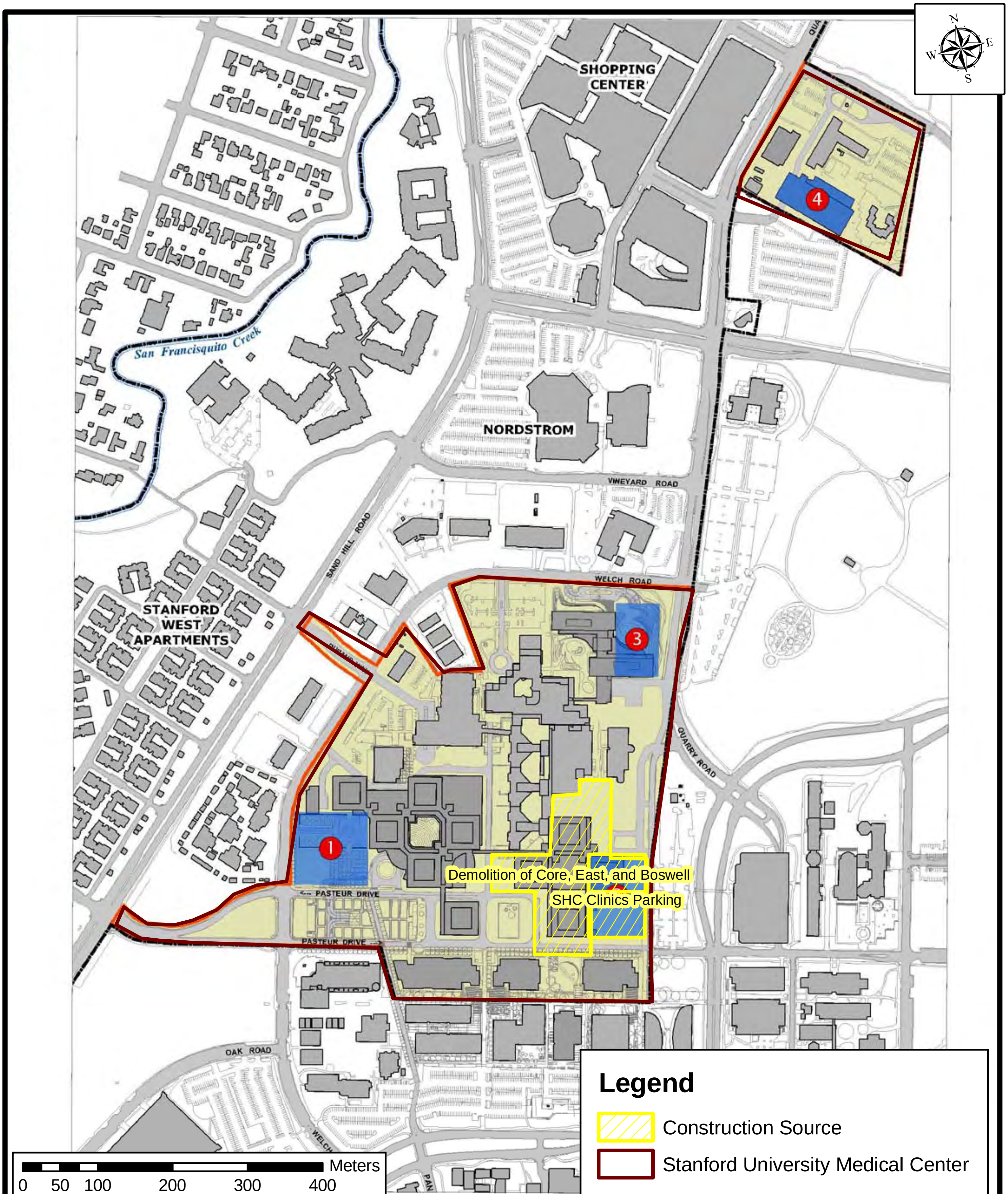
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2016
Stanford University Medical Center
Palo Alto, California

Figure
3.11g

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



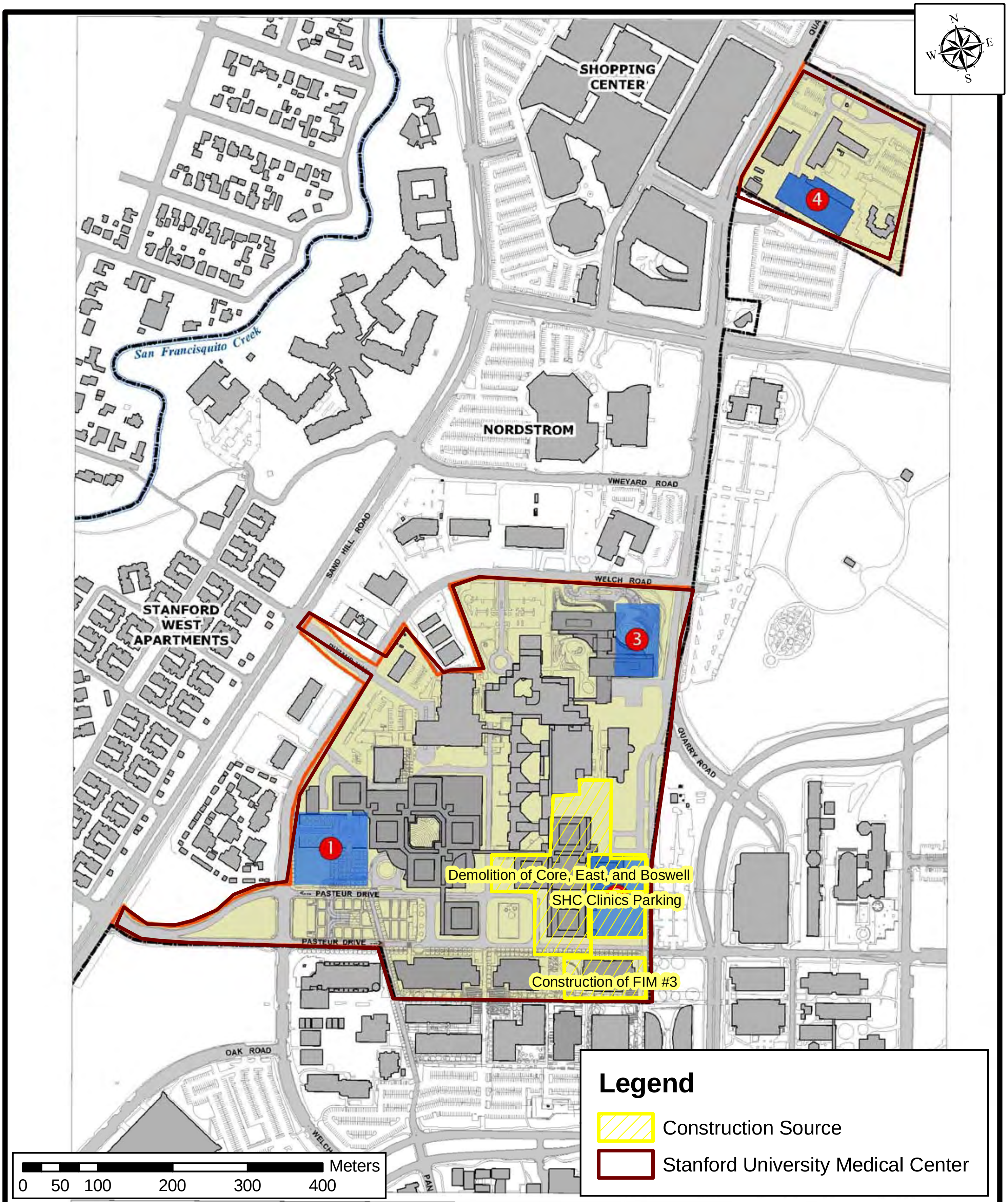
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2017
Stanford University Medical Center
Palo Alto, California

Figure
3.11h

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



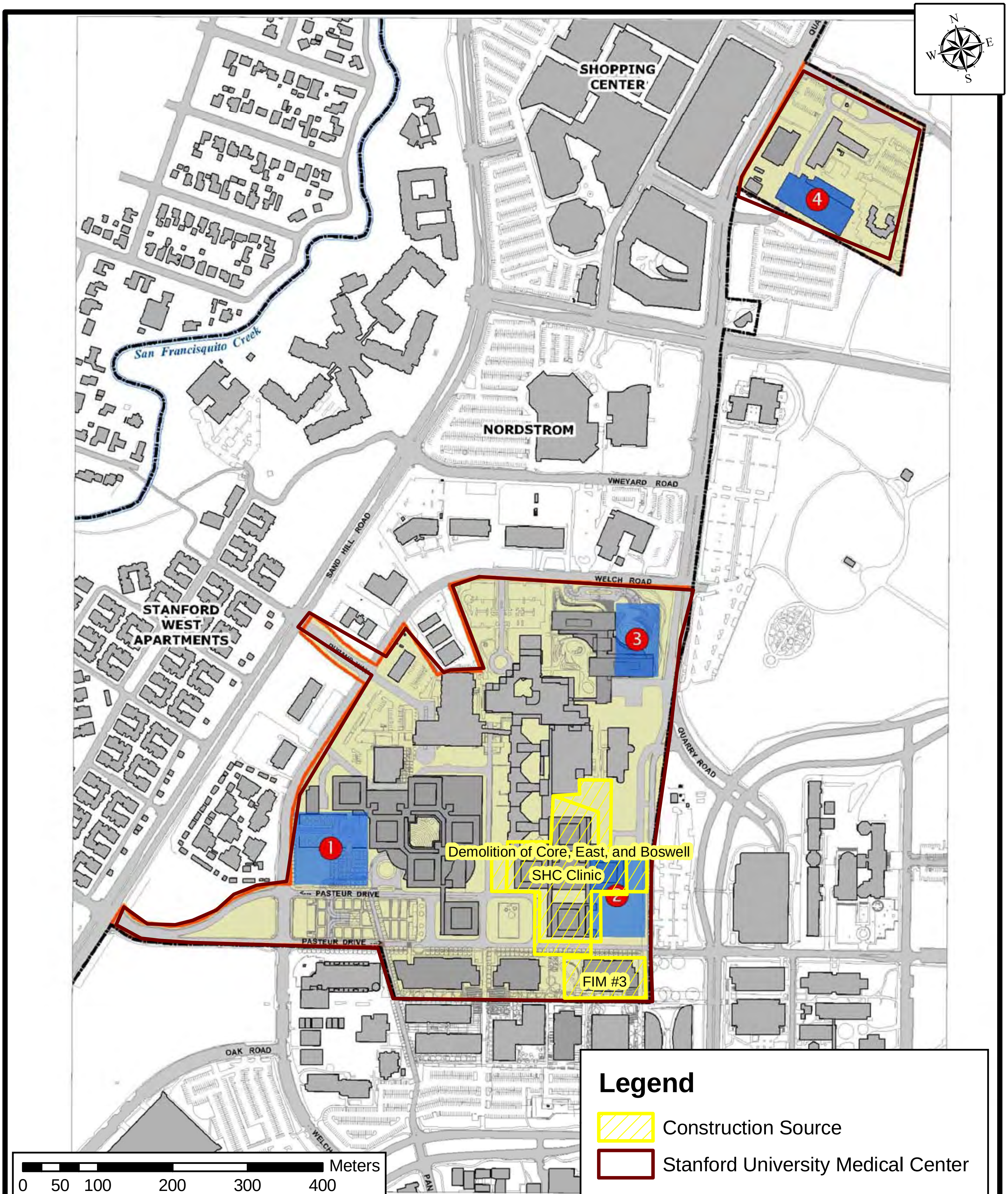
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2018
Stanford University Medical Center
Palo Alto, California

Figure
3.11i

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



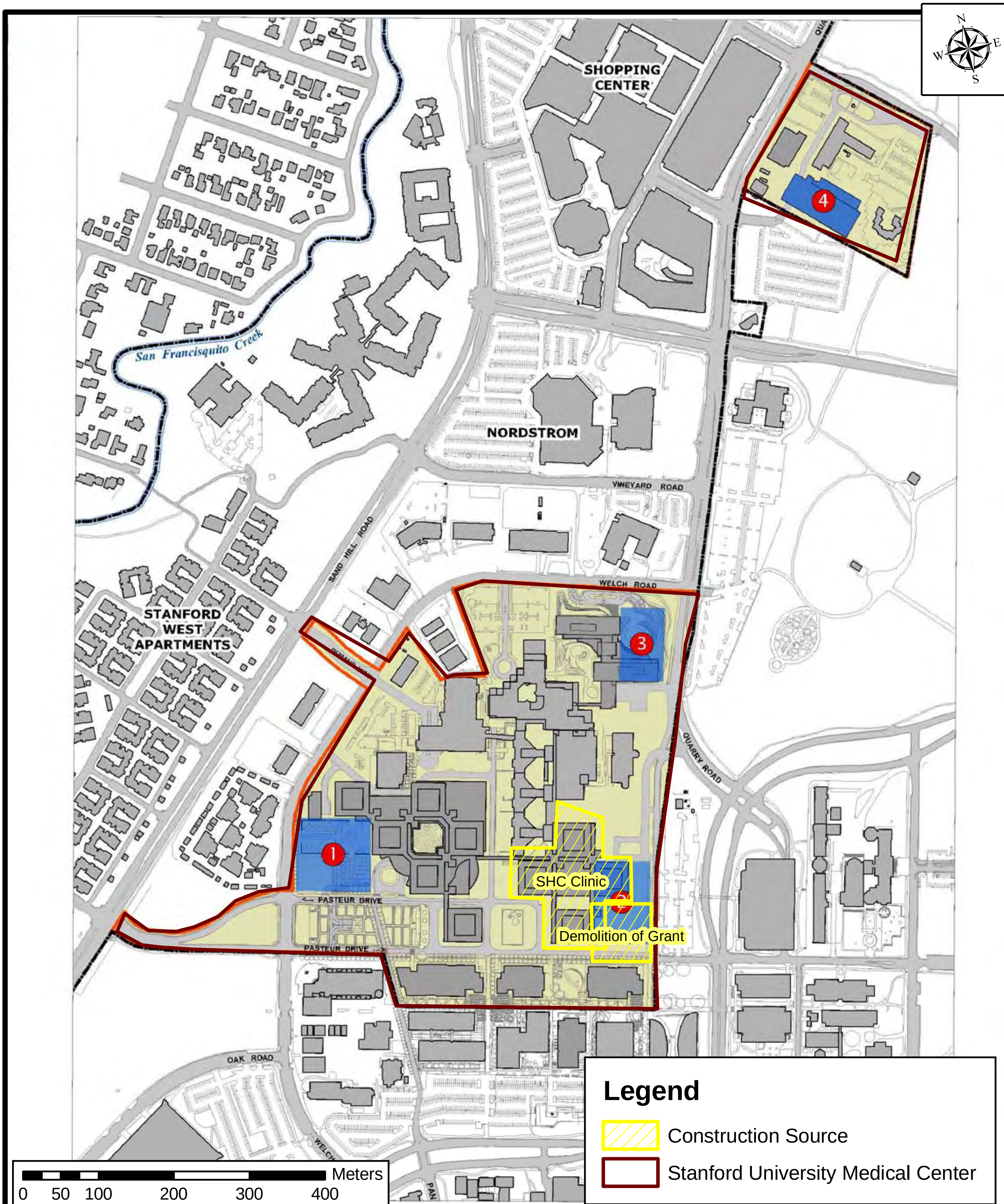
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2019
Stanford University Medical Center
Palo Alto, California

Figure
3.11j

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



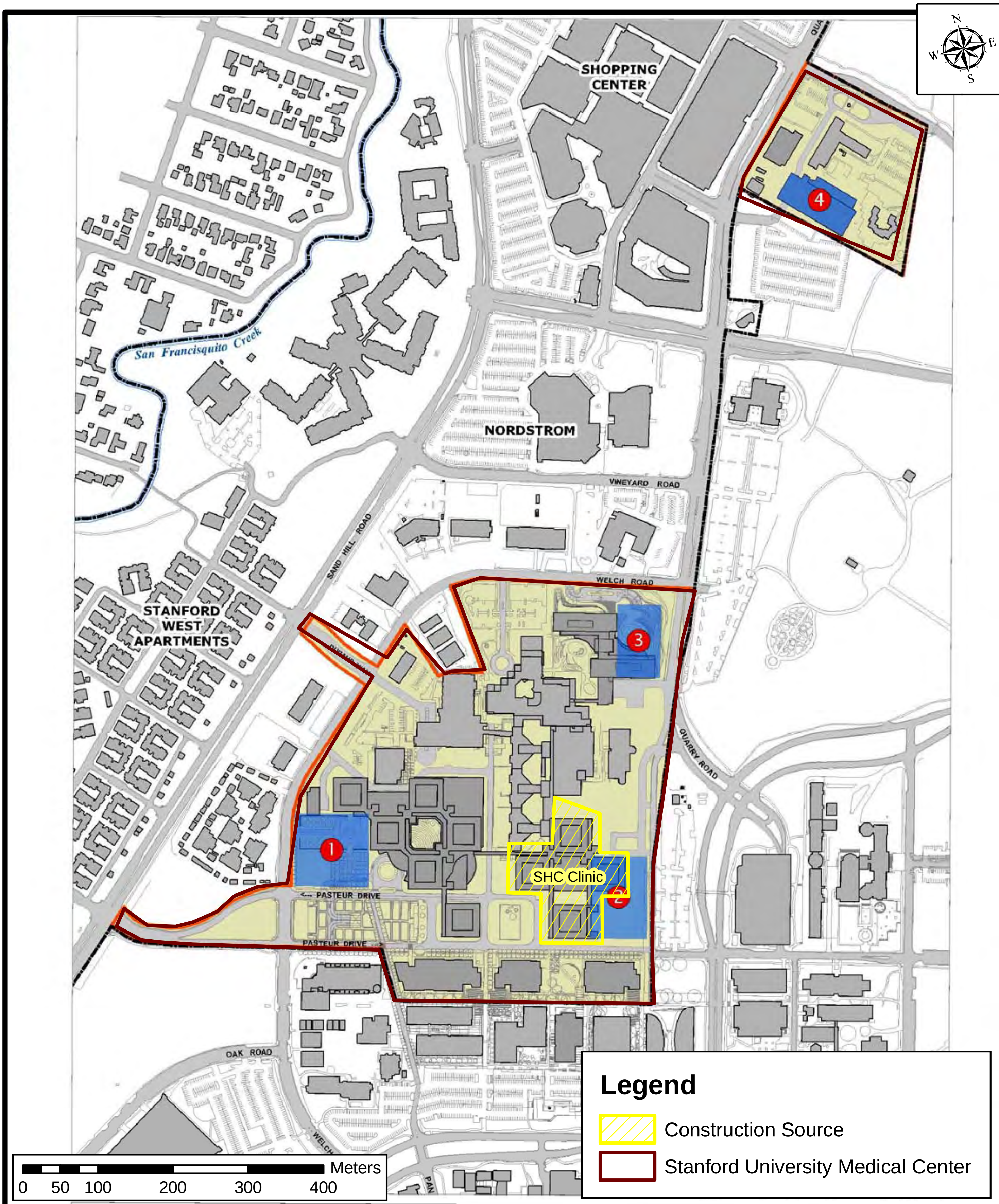
ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2020
Stanford University Medical Center
Palo Alto, California

Figure
3.11k

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised:



ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

Location of Modeled Construction Sources in 2021
Stanford University Medical Center
Palo Alto, California

Figure

3.11l

Drafter: SP | Date: | Contract Number: 0320791A | Approved: | Revised: