LINAC COHERENT LIGHT SOURCE-II
DRAFT ENVIRONMENTAL ASSESSMENT (EA No. DOE/EA-1904)

SLAC National Accelerator Laboratory
2575 Sand Hill Road
Menlo Park, California 94025

U.S. Department of Energy
Office of Science

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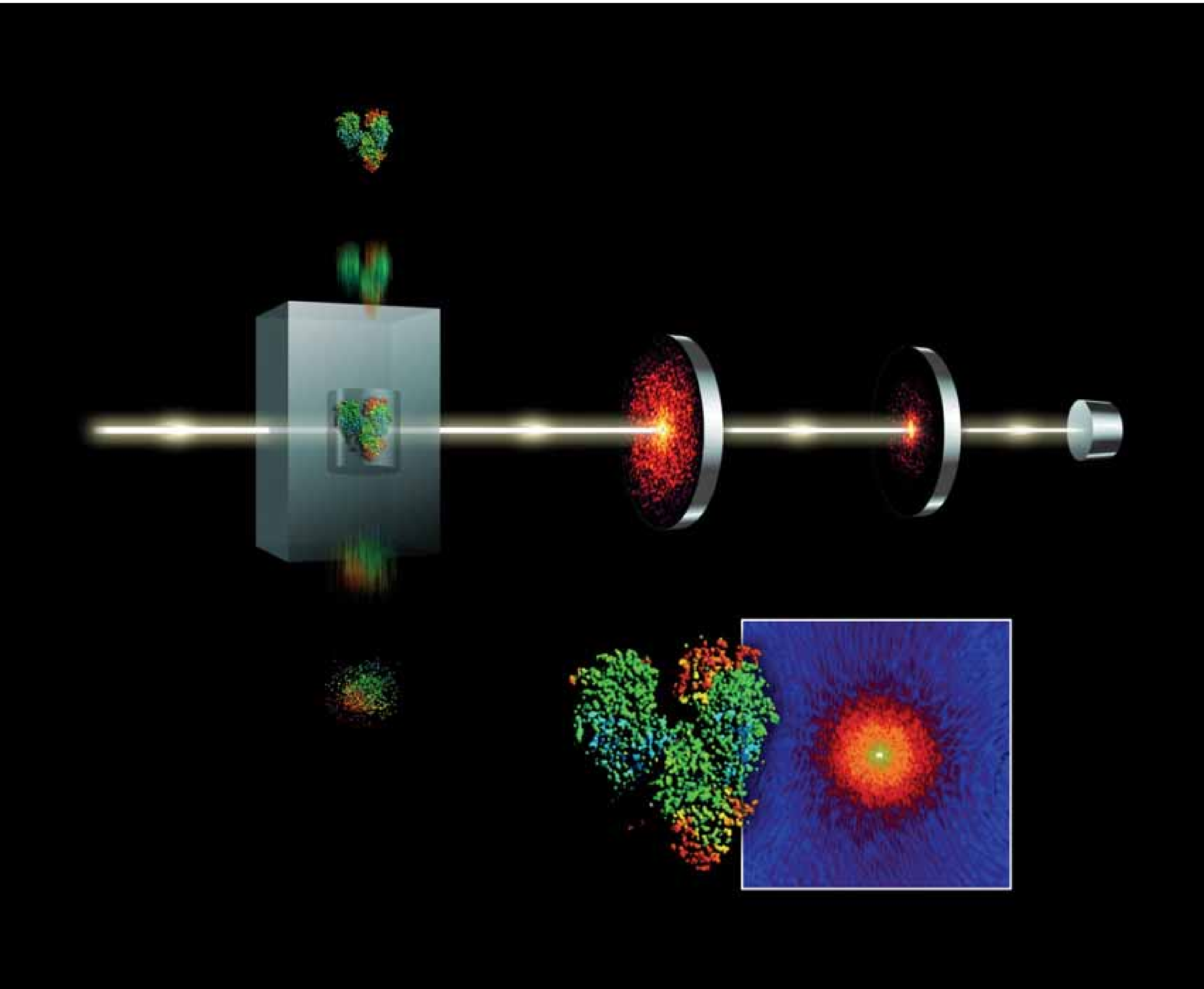

Cover Photo: The LCLS creates 3-D holographic images of single molecules using ultrafast pulses of very intense hard X-rays.

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List of Acronyms and Abbreviations

ACS	Access Control System
ALARA	As Low as Reasonably Achievable
amsl	above mean sea level
AQMD	Air Quality Management District
AUP	Auxiliary Utility Plant
BAAQMD	Bay Area Air Quality Management District
BART	Bay Area Rapid Transit
bgs	below ground surface
BMP	Best Management Practice
BTH	Beam Transport Hall
Cadna A	Computer Aided Noise Abatement Ver. 4.0
CalARP	California Accidental Release Prevention Program
CalOSHA	California Occupational Safety and Health Administration
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CCR	California Code of Regulations
CDP	Census Designated Place
CEQ	Council on Environmental Quality
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CNDDB	California Natural Diversity Database
CO_2	carbon dioxide
CO_2e	CO_2-equivalent
CSSC	California Species of Special Concern
CUPA	Certified Unified Program Agency
cy	cubic yard(s)
dBA	decibel, A-weighted, same as dB with A-weighting applied
District	Fixed Target Linac Historic District
DOE	U.S. Department of Energy
EA	Environmental Assessment
EBD	Electron Beam Dump
EH	Experimental Hall

EIS	Environmental Impact Statement
ENSO	El Nino Southern Oscillation
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973
ESH	Environment Safety and Health Division
eV	electron volts
FEE	Front End Enclosure
FEH	Far Experimental Hall
FEL	free electron laser
FONSI	Finding of No Significant Impact
FTA	United States Department of Transportation, Federal Transit Administration
GHG	greenhouse gas
gpd	gallons per day
HMBP	Hazardous Materials Business Plan
HVAC	heating, ventilation and air conditioning
I-280	Interstate Highway 280
IPCC	Intergovernmental Panel on Climate Change
ISEMS	Integrated Safety and Environmental Management System
ITP	Incidental Take Permit
keV	thousand electron volts
kV	kilovolts
kVA	kilovolt ampere
LCLS	Linac Coherent Light Source
LCLS-I	LCLS Phase I
LCLS-I EA	Environmental Assessment for LCLS-I
LCLS-II	LCLS Phase II
Ldn	day-night average sound level
Leq	equivalent noise energy as the total amount of the time-varying noise levels over a set period
linac	linear accelerator
LLRW	low-level radioactive waste
mrem	millirems
$MTCO_2e$	CO_2-equivalent metric tons
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEH	Near Experimental Hall
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA Fisheries	National Oceanic and Atmospheric Administration National Marine Fisheries Service
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
PCi/L	picoCuries per liter
PEP	Positron-Electron Project
PM_{10}	particulate matter less than 10 microns in size

$PM_{2.5}$	particulate matter less than 2.5 micron in size
ppm	parts per million
Proposed Action	expansion of the LCLS-I facility
PVTC	Portola Valley Training Center
PWL	Power Level
RCRA	Resource Conservation and Recovery Act
RMA	Radiological Material Area
SAAQS	State Ambient Air Quality Standards
SFBAAB	San Francisco Bay Area Air Basin
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SLAC	SLAC National Accelerator Laboratory
SMCWPPP	San Mateo Countywide Water Pollution Prevention Plan
SO	Sulfur Oxides
SPCC	Spill Prevention, Control and Countermeasure
SPEAR	Stanford Positron Electron Asymmetric Ring
SSRL	Stanford Synchrotron Radiation Lightsource
State Water Board	California State Water Resources Control Board
SWPPP	Stormwater Pollution Prevention Plan
TDS	total dissolved solid
TPH	total petroleum hydrocarbon
UH	undulator hall
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXT	undulator X-ray tunnel
VOC	volatile organic compound
WAPA	Western Area Power Administration
WSHP	Worker Safety and Health Program
XFEL	X-ray free electron laser
$\mu g/m^3$	micrograms per cubic meter
3D	three-dimensional

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1.0 PURPOSE AND NEED FOR ACTION

1.1 Introduction

The SLAC National Accelerator Laboratory (SLAC), located in an unincorporated portion of San Mateo County, California, is operated by Stanford University under contract to the U.S. Department of Energy (DOE). Figure 1-1 depicts the regional location of SLAC, which is located on the San Francisco Peninsula in Menlo Park just west of the Stanford University campus. SLAC was founded in 1962 and its scientific missions include accelerator science, photon science, particle physics and astrophysics.

One of SLAC's major scientific facilities is the Linac Coherent Light Source (LCLS), the world's first hard X-ray free electron laser (XFEL). The LCLS X-ray laser beams enable the simultaneous investigation of a material's electronic and structural properties on the size (sub-nanometer) and time (femto-second) scales that determine their function. Investigations at SLAC cover material sciences, catalytic sciences, structural molecular biology and molecular environmental sciences. The LCLS-I and other facilities at SLAC are considered "user" facilities because researchers apply for or compete for access. Users may include SLAC researchers as well as external researchers from universities, industries, foreign institutions and other government laboratories.

Construction of LCLS Phase I (LCLS-I) was completed in 2009 and experiments began during the fall of 2009. The LCLS-I uses the easternmost 0.6 mile (Sectors 20-30) of SLAC's existing 2-mile long linear accelerator (linac) for the electron source. LCLS-I included construction of a tunnel and two experimental halls (EHs) to house a new beamline, undulators and experimental hutches for LCLS-I.

SLAC proposes to expand the LCLS-I facility, which is described in detail in Section 1.3. The LCLS Phase II (LCLS-II) (Proposed Action) would expand the site's technical capabilities by extending the photon energy range, increasing control over the photon pulses and enabling two-color pump-probe experiments. Two color pump-probe experiments serve to understand transient excited states that lie at the heart of chemical and biological reactivity and function. In addition, the Proposed Action would increase the number of users or researchers that can access the facilities. LCLS-I supplies one experimental station with X-rays at a given time. The Proposed Action would allow SLAC to supply multiple experimental stations with X-ray pulses at the same time.

The Proposed Action comprises construction, installation, operation and decommissioning of the following elements:

- Construction of a new tunnel for a hard X-ray undulator source capable of generating 2-13 thousand electron volts (keV) and a soft X-ray undulator source capable of generating 0.250-2 keV.
- A dedicated, independent electron source for these new undulators, using Sectors 10-20 of the existing SLAC linac.

- Construction of a new EH capable of accommodating four experimental stations.
- Modifications to existing SLAC facilities to allow installation of the injector and new shielded enclosures for the undulator sources, beam dumps and X-ray front ends.
- Relocation of two soft X-ray instruments from the existing LCLS-I facilities to the proposed LCLS-II facilities.
- Installation of future undulator sources and experimental stations within the existing experimental hall and routine upgrades of utilities.

The Proposed Action would use the middle third of the existing 1.8-mile linac to accelerate the electrons used in the single-pass free electron laser (FEL). In addition, the Proposed Action would use the existing linac to house an electron injector, electron beam transport system and two electron beam pulse compressors for use in the FEL. Two new undulator magnets would be housed in an extension of the existing tunnel.

This Linac Coherent Light Source-II Draft Environmental Assessment (EA) evaluates the potential environmental effects of construction and operation and eventual decommissioning of the Proposed Action and alternatives. This EA will be used to determine whether DOE will publish a Finding of No Significant Impact (FONSI) or that an Environmental Impact Statement (EIS) is warranted. This EA complies with the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) implementing regulations (CEQ 1978), DOE's NEPA Implementing Procedures (DOE 1996) and DOE's NEPA Compliance Program (DOE 2010).

1.2 Background

SLAC was established in 1962 for the purpose of siting and operating a linear accelerator. The 2-mile linac was completed in 1966. SLAC then constructed several experimental facilities that use the beam produced by the linac. One decade later, SLAC opened the Stanford Positron Electron Asymmetric Ring (SPEAR). Construction of the Stanford Synchrotron Radiation Lightsource (SSRL) began in 1983 and was completed in 1989. In 1994, the Positron-Electron Project (PEP-II) was initiated, to build the Asymmetric B Factory. The Stanford Linear Accelerator Center was renamed the SLAC National Accelerator Laboratory in 2009.

SLAC is comprised of 161 buildings and structures, totaling nearly 1.9 million square feet, as well as site utilities, roadways, tunnels and experimental facilities. The largest facilities are the 2-mile-long Klystron Gallery (356,000 square feet) and the linac housing (115,000 square feet). SLAC is a national research laboratory, probing the structure of matter at the atomic scale and beyond with electron and positron beams. Some of the major research facilities at SLAC include the SSRL, Photon Ultrafast Laser Science and Engineering, Stanford Institute for Material and Energy Sciences, Kavli Institute for Particle Astrophysics and Cosmology, Particle Physics and Astrophysics, and the LCLS-I. Research areas include photon science, particle physics, particle astrophysics and accelerator research and development.

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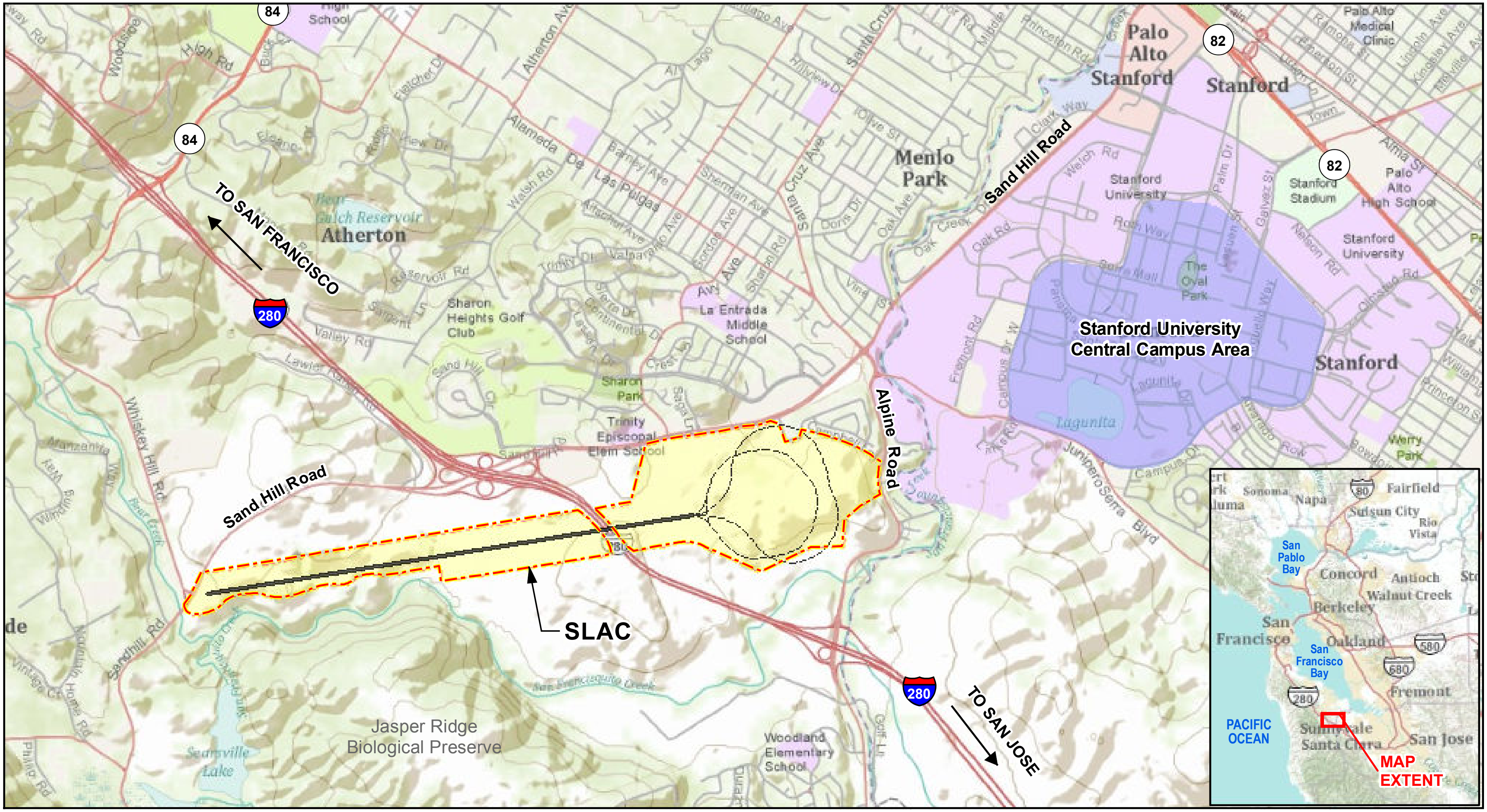

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LEGEND

SLAC LINEAR ACCELERATOR CENTER (SLAC) GROUNDS

SLAC LINEAR ACCELERATOR

SLAC TUNNEL

STANFORD UNIVERSITY CENTRAL CAMPUS AREA

N

0 3,000 Feet

Graphic Scale: 1" = 3000'

SLAC LCLS-II EA

REGIONAL LOCATION MAP

ARCADIS

FIGURE 1-1

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1.3 Description of Existing Facility

Stanford University operates the laboratory under a contract with the DOE, who leases the land from Stanford University. The LCLS-I facilities have been used to investigate multi-photon and non-linear processes within atoms and molecules in the short wavelength regime, non-equilibrium or temporally evolving states of atoms and molecules, nanocrystals and nanostructures, imaging of viruses and cells, soft X-ray single-shot spectroscopy and imaging of chemical bonds, imaging of magnetic nanostructures, superconductivity and magnetoresistance, and hard X-ray single-shot coherent diffraction of disordered and crystalline systems. To augment research performed at SLAC, LCLS-I was constructed between 2006 and 2009. Figures 1-2a, 1-2b and 1-2c depict the existing SLAC facilities. LCLS-I uses the last third of the existing linac and the pre-existing Off-Axis Injector Tunnel at Sector 20 (2/3-point), which was constructed in 1962 to house future injectors. A second short tunnel was constructed at Sector 10 (1/3-point) during the original construction and is proposed to accommodate LCLS-II. During LCLS-I, the Final Focus Test Beam was demolished and a new Beam Transport Hall (BTH) was constructed in its place and connected to a tunnel that houses the undulator, magnets and electron beam dump. LCLS-I included an office building (B902) and two experimental buildings: Near Experimental Hall (NEH) and the Far Experimental Hall (FEH). Both experimental halls buildings are single-story structures, each with approximately 80,000 square feet of research facilities.

LCLS-I added key components to SLAC, including:

- A new “injector” (laser light pulses impinging on a photocathode to produce electrons in a radiofrequency “gun” that are accelerated and steered into Sector 20 of the linac).
- Modification of the easternmost 0.6 mile of the linac, including installation of magnetic bunch compressors and beam diagnostics for the electron beam.
- A BTH to direct the energetic electron beam to the undulator.
- An undulator hall (UH) containing an undulator magnet assembly that produces a magnetic field that oscillates and bunches the electron beam (producing X-rays), and a vacuum system whose chamber vessel is compatible with the electron and X-ray beams.
- Construction of a Front End Enclosure (FEE), NEH, X-ray transport tunnel and FEH, all below grade.
- X-ray beam optics, diagnostics and controls systems.

LCLS-I added 200 parking spaces and dismantled some pre-existing facilities (including concrete shielding). Clean excavated material was relocated on site, while other material was disposed of off-site as regulated waste. LCLS-I additions to SLAC resulted in employment of approximately 60 additional permanent SLAC staff and accommodates up to 40 researchers at a given time. However, LCLS-I facilities support only one experiment at a time, which typically requires five researchers. The additional researchers are on site to prepare upcoming experiments and to close out completed experiments.

The purpose of LCLS-I was the creation of a new type of X-ray light source from a single-pass FEL, and provision of upgraded capabilities to study the basic properties of matter for advancements in quantum mechanics and molecular and plasma physics, as well as in the fields of chemistry and biology (DOE 2002a). LCLS-I allows scientists to examine matter at the atomic level, including evaluation of minute changes with time. The LCLS-I FEL produces X-ray laser pulses that are billions of times more intense than those from previously existing sources. The FEL, like SLAC's synchrotron X-ray source, uses radiation emitted by fast-moving electrons as they change direction. The FEL generates tunable, coherent, high-power radiation, currently spanning wavelengths from millimeter to visible and potentially ultraviolet to X-ray. It can have the optical properties characteristic of conventional lasers such as high spatial coherence; however, it uses electron beams instead of bound atomic or molecular states, hence the term 'free-electron.' The electron bunches are compressed as they pass through an undulating magnetic field. The pulse that emerges from the FEL is a series of high-intensity bursts.

1.4 Purpose and Need

SLAC now has new scientific research needs that derive from the success of LCLS-I. Starting with the first experiments in the fall of 2009, the demand for LCLS-I beam time has exceeded the available time by more than four to one. While there is room in the existing UH to add another X-ray source (see alternatives below), there is inadequate room for new instruments. The Proposed Action would allow researchers to conduct operations in one UH and the associated EH, while maintenance and upgrades are carried out in the other. The Proposed Action would allow expansion to keep pace with the growth in research opportunities.

In addition to adding facility capacity, as a consequence of early success, requests for expanded experimental capabilities have arisen, including:

1. Extension to harder X-rays (>10 keV) for the study of thick three-dimensional (3D) materials with increased X-ray penetration and spatial resolution.
2. Extended soft X-ray spectral range to below the carbon absorption edge at 280 electron volts (eV) for the study of chemical transformations of key carbon-based molecular complexes.
3. Creation of transform-limited X-ray pulses (i.e., optimum intensity per bandwidth and pulse length through seeding for improved signal to noise).
4. Availability of linear and circular polarization for the separation of charge and spin effects in materials.

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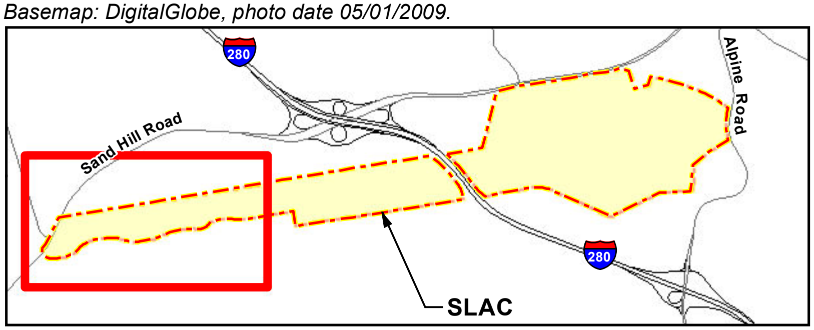

N

0 500 Feet

Graphic Scale: 1" = 500'

SLAC LCLS-II EA

EXISTING SLAC FACILITIES (WEST PORTION)

ARCADIS

FIGURE **1-2a**

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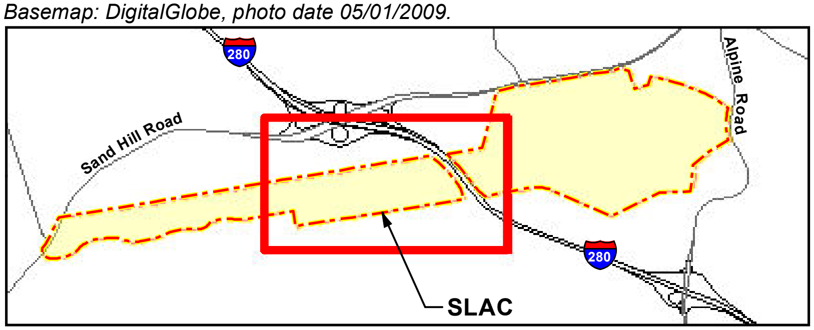

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0 500 Feet

Graphic Scale: 1" = 500'

SLAC LCLS-II EA

EXISTING SLAC FACILITIES
(MIDDLE PORTION)

ARCADIS

FIGURE
1-2b

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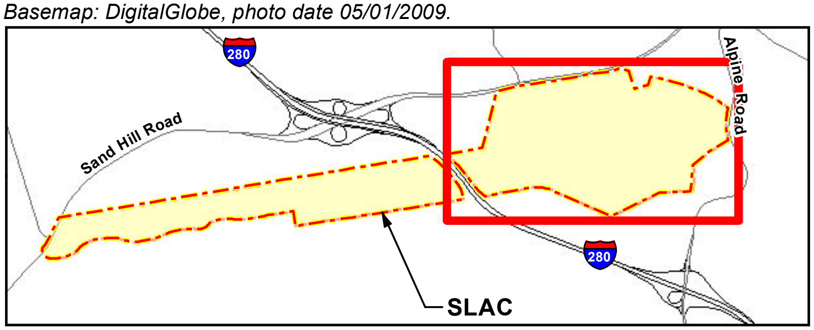

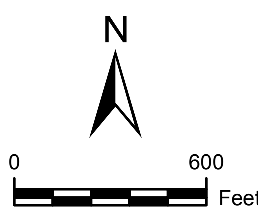

SLAC LCLS-II EA

EXISTING SLAC FACILITIES (EAST PORTION)

ARCADIS

FIGURE 1-2c

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The purpose of the Proposed Action is to meet these expanded research needs. The Proposed Action would help to satisfy the needs for extensions in capability by increasing the present photon energy from 10 keV to 20 keV for the study of thick 3D materials and increasing X-ray penetration and spatial resolution. This would result in extending the soft X-ray spectral range down to the carbon K absorption edge for the study of chemical transformations of key carbon-based molecular complexes. The Proposed Action would continue to support the DOE Office of Science mission, which has identified the need for a new or upgraded XFEL facility that would provide enhanced temporal resolution, coherence and brightness. Without increased capacity, access to these new capabilities would be severely limited and SLAC's ability to fulfill its mission and maintain a global leadership role in XFEL research would be adversely affected. The Proposed Action would provide an increase in both capability and capacity through 2017 and into the subsequent decade, and would allow SLAC to continue its global leading role as the free-electron laser research center with the most powerful X-ray laser facilities and the highest potential to achieve scientific breakthroughs in the fields of energy, environment, health and technology.

1.5 Proposed Action Overview

The Proposed Action would be to construct, operate and decommission the LCLS-II facilities, including new hard and soft X-ray undulator sources, a dedicated electron source using Sectors 10 to 20 of the existing linac, a large X-ray tunnel, a new EH, modification of existing SLAC facilities, and relocation of two soft X-ray instruments currently in the existing LCLS-I NEH to a new EH. The Proposed Action would include construction of the following facilities:

- Sector 10 Injector
- BTH
- Undulator X-ray tunnel (UXT)
- Electron Beam Dump (EBD)
- FEE
- EH
- Research and Control Facilities
- Supporting Facilities

Construction phases would include site preparation, modification of existing facilities including demolition, construction of tunnels and EHs, on-site relocation of clean material, off-site disposal of excavated material, off-site recycling or disposal of demolition debris, installation of utilities and support buildings, impact avoidance and minimization measures, and site restoration. Construction crews would enter SLAC through the Alpine Road gate and would reach a peak workforce of approximately 150 personnel for 6 months during concurrent tunneling and construction of the new EH. Construction is scheduled to begin in 2012 and be completed in 2017, at which time operation (very similar to LCLS-I) would begin.

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2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

The Proposed Action would construct the LCLS-II facilities, which would consist of the construction, installation, operation and decommissioning of the following components:

- New hard X-ray undulator source (2-13 keV).
- New soft X-ray undulator source (250-2,000 eV).
- Dedicated, independent electron source for the new undulators, using Sector 10 of the SLAC linac.
- Modifications to existing SLAC facilities for the injector, and new shielded enclosures for the undulator sources, beam dumps and X-ray front ends.
- New EH with multiple experimental stations.
- Relocation of the two soft X-ray instruments in the existing NEH to the new EH.
- Future expansion to add undulator sources and experimental stations.

The Proposed Action would be similar to the original LCLS-I project completed in 2009; therefore, portions of the descriptions below are based on the descriptions of LCLS-I components contained in the LCLS-I EA (DOE 2002a).

2.1.1 Proposed Facilities

This section provides a general overview of the Proposed Action as well as a brief description of each major component. Figure 2-1 provides a general layout of the proposed facilities (black labels) adjacent to the existing LCLS-I facilities (white labels). The new technical systems and facilities would be similar to those constructed for LCLS-I, including tunnels, an Experimental Hall, support buildings and facilities, and internal research facilities and systems. The following sections describe the Proposed Action’s major facilities, including tunnels and buildings, research and control facilities, as well as supporting buildings, systems and infrastructure. Photographs from the construction of similar LCLS-I facilities are provided in Appendix A.

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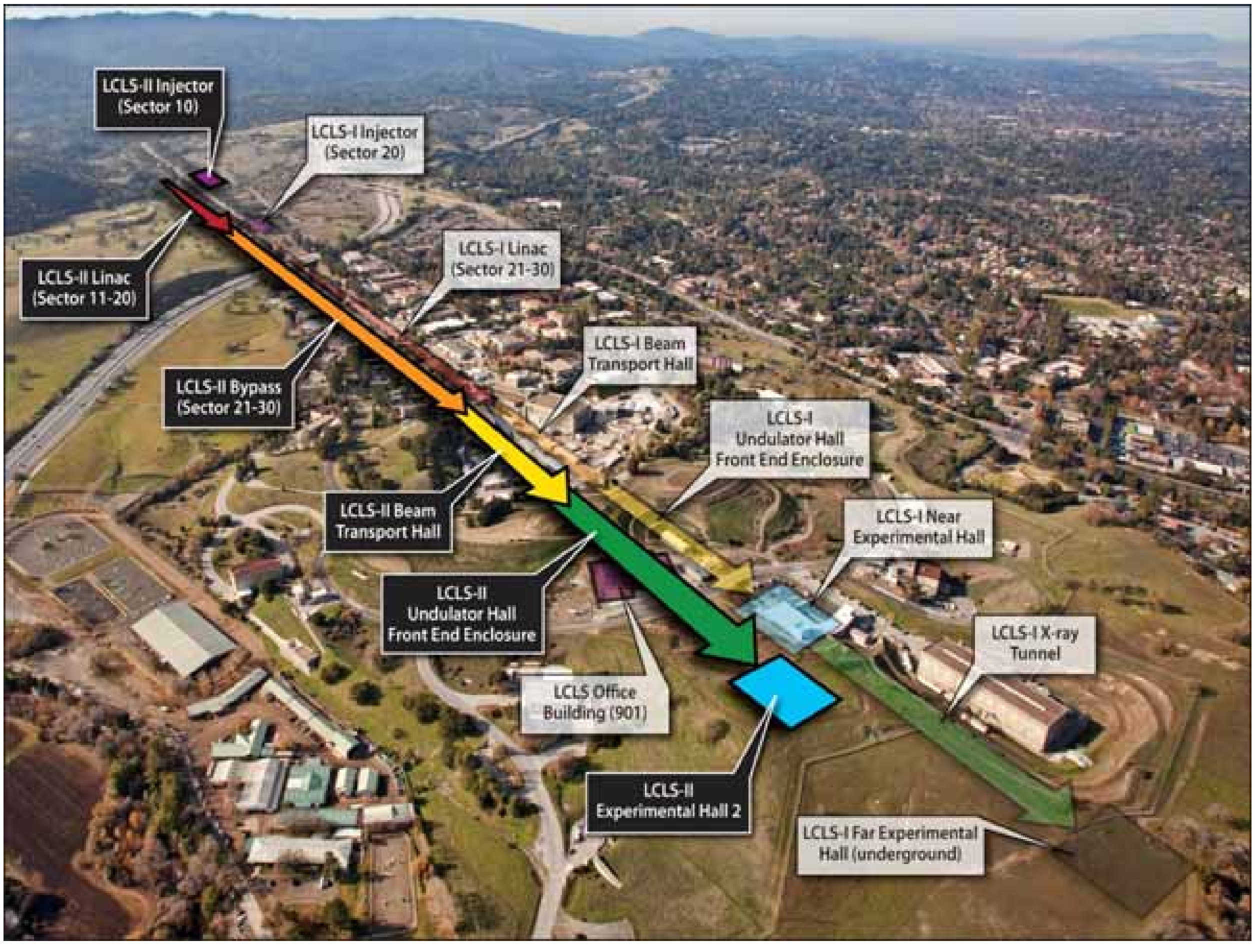
Figure 2-1 Existing Facilities and Proposed Action



2.1.1.1 Tunnels and Buildings

The following paragraphs and subsections describe the main components of the Proposed Action as follows:

- Sector 10 Injector
- Beam Transport Hall
- Undulator X-Ray Tunnel
- Electron Beam Dump
- Front End Enclosure
- Experimental Hall
- Research and Control Facilities
- Supporting Facilities

Sector 10 Injector

The Sector 10 Injector would be located at Sector 10 of the existing linac and would supply electrons and provide initial acceleration (Figure 2-2). The new injector would be installed at the location of an existing branch tunnel constructed in 1962 to accommodate future injectors (see Section 1.3). The construction would include a surface building and utilities to support the injector (Figure 2-2). The support building would be designed to provide an enclosure for the injector laser.

The injector support building would house the laser room, which would require constant volume air distribution. An air handling system would deliver a constant 12,000 cubic feet per minute (cfm) of conditioned air to the laser room, 7,000 cfm to the west end of the building and 3,000 cfm for critical data room applications. The injector would also require a new 12 kilovolt (kV), 1,500 kilovolt ampere (kVA) electrical substation and a 15 kV outdoor medium voltage switchgear. The switchgear would isolate the new substation for Sector 10 injector facility loads from the existing substation.

Beam Transport Hall (BTH)

The BTH is the first linear segment of the Proposed Action and would extend across the research yard. The new BTH would be constructed in a similar manner to the LCLS-I BTH (formed concrete) and would be constructed directly adjacent to the existing LCLS-I BTH. The new BTH would be similar in construction (formed concrete) to the existing UXT and would be located and sized to house two beam lines. The concrete walls of the BTH would be approximately 6 feet thick. Figure 2-3 illustrates the alignment of the BTH and the downstream UXT and EH, both described below. The new BTH would be approximately 525 feet long and would carry the high-energy beam into the UXT. The BTH would be trapezoidal, with an interior width of approximately 15 feet at the west end and 33 feet at the east end, and would extend from the existing BTH to the UXT. The BTH would also include service building(s) to house data racks, electrical panels and transformers. The BTH would be equipped with an air handling unit to remove heat generated by the electronic racks. The air handling unit would be installed on the roof of the BTH, next to the service building.

Undulator X-Ray Tunnel (UXT)

The UXT, which would house the undulator magnets, electron beam dump and many front end X-ray diagnostics and optics, is a new underground tunnel that begins at the BTH and extends horizontally approximately 1,000 feet to a new EH (Figure 2-3). As with LCLS, the undulator magnets would be set on metal stands and girders on the floor of the tunnel.

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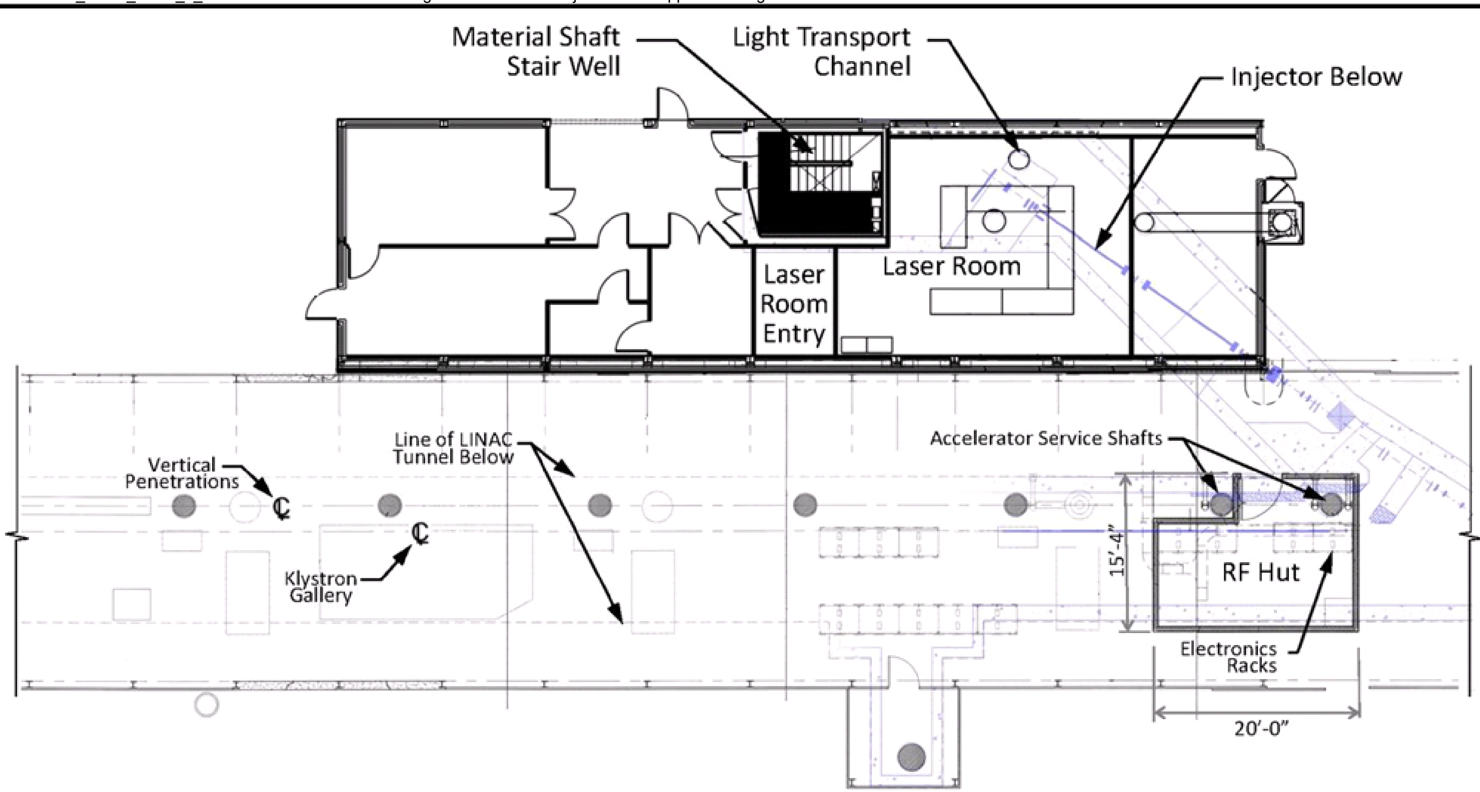
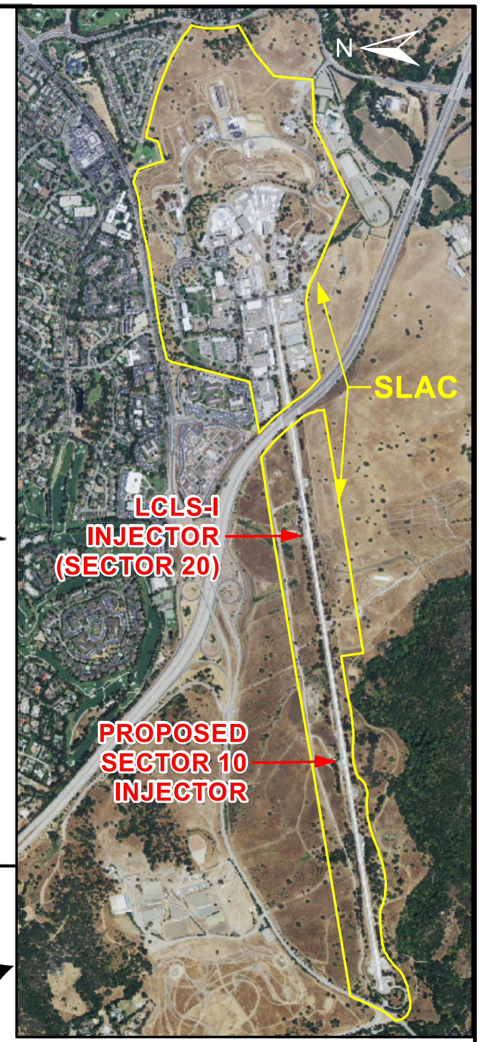
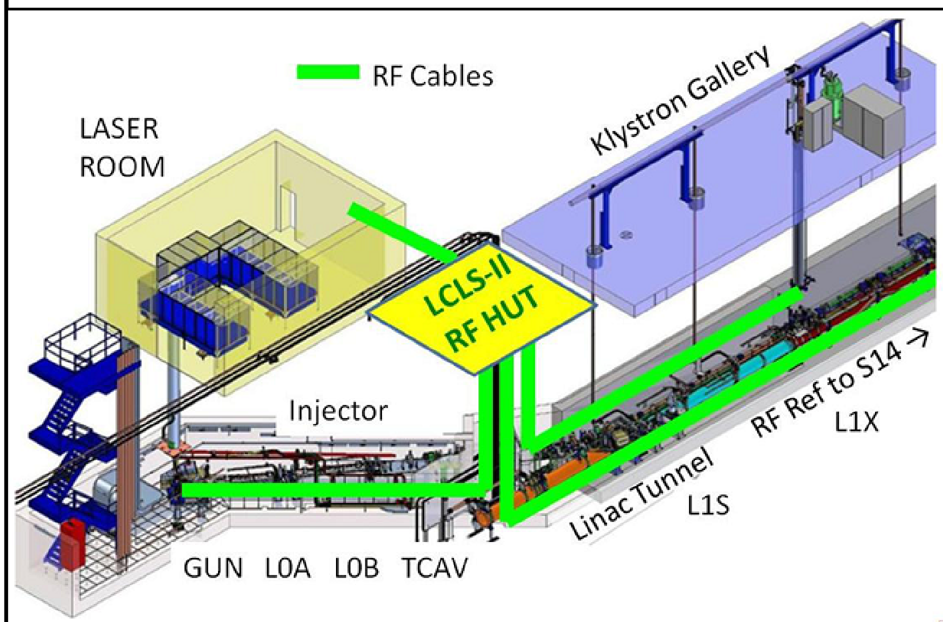


PLAN VIEW



LOCATION MAP



OBLIQUE VIEW

SLAC LCLS-II EA

SECTOR 10 INJECTOR AND SUPPORT BUILDING (OBLIQUE VIEW AND PLAN VIEW)

ARCADIS

FIGURE 2-2

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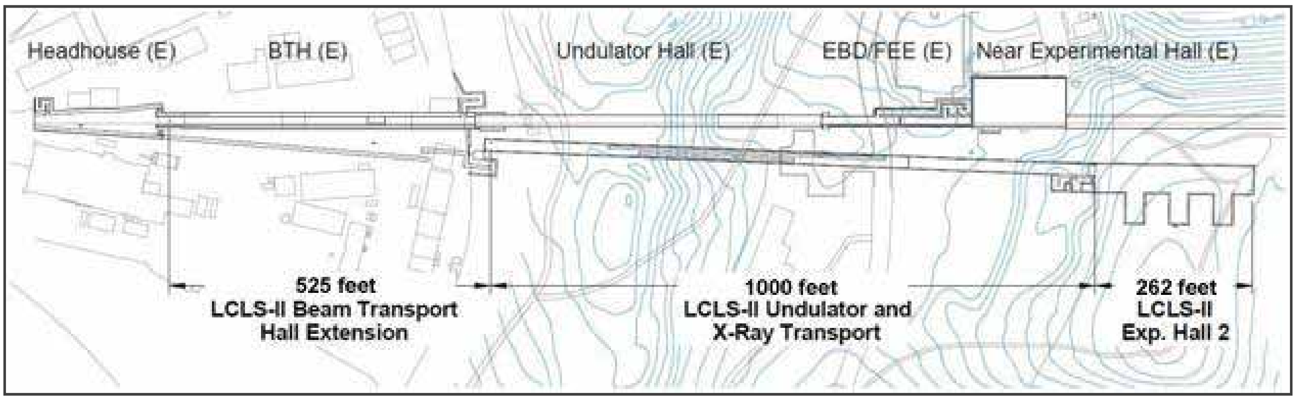
The new UXT would be approximately 1,000 feet long and would be constructed in line with the BTH. It would house an electron beam chicane and the undulator magnets and would continue the beam to the FEE and the beam dump. The UXT would be a tunnel with an arched roof having an internal diameter of approximately 19 feet. The service access would be wide enough to accommodate variable gap magnets. Access would be from either the BTH to the west or the EH to the east. Radiological shielding would be provided by the reinforced concrete and shotcrete tunnel together with the earth cover. The tunnel would be approximately 20 to 70 feet below ground surface (bgs) depending on the terrain. Appendix A contains a photograph of the existing LCLS-I UXT.

Figure 2-3 Layouts of LCLS-I and LCLS-II



Note: (E) = existing LCLS facilities

Electron Beam Dump

The two EBDs would act as terminal points for the high-energy electron beams. After passing through the undulators, the electron beams pass through a series of magnets that deflect the electron beams down into their respective EBD, while photons (X-rays) continue their trajectory toward the EH. The EBD would consist of a series of electromagnets and permanent magnets to deflect the electron beam to a shielded block of dense material that intercepts the electron beam. All the electrons in the beam would be stopped within this block. The kinetic energy of the electron beam is absorbed by the block and dissipated as heat. The total length of the EBD and FEE area would be approximately 440 feet (the dump is situated in the first approximately 130 feet after the UH). The heat deposited in the EBD by the electron beam would require circulated cooling water from the LCLS-II Auxiliary Utilities Plant (see Section 2.1.1.2). The walls would be highly shielded to prevent potential radiation exposure.

Front End Enclosure

The photon beam (without electrons) would then continue into the FEE. The FEE would contain various diagnostic beam line components to separate and distribute the X-ray beams. The FEE and EBD would be 440 feet long and would be in a tunnel (Figure 2-3). Appendix A contains a photograph taken during construction of the LCLS-I FEE. The cross-section would be rectangular in shape. Access to FEE would be from the EH, described below, via a radiation shielding maze. The FEE and the EH would be separated by a wall of up to 13 feet of which no more than 7 feet would be iron, and the rest concrete.

Experimental Hall (EH)

The new EH would house four experimental areas, control rooms, laser labs and set-up space for experiments. The EH would be a two-story structure, approximately 46 feet wide and 40 feet high, with a second floor above the experimental floor dedicated to the laser lab and set up, conference and utility rooms. The experimental (lowest) floor of the hall would provide sufficient space for experimental stations and the associated control rooms, with limited set-up space for instruments. The EH would be located approximately 984 feet downstream of the start of the UXT, immediately downstream of the FEE and just south of the existing LCLS-I NEH (Figure 2-3). The first level (Level 1 – tunnel main floor) would contain hutches and set-up areas (Figure 2-4). The mezzanine level would contain laser labs, set-up areas and mechanical rooms. The EH would have a laser safety system, including emergency shutdown buttons at lab entrances and exits, and status signage.

The Proposed Action would add two new undulator sources and space for four new experimental stations to the existing facility. The Proposed Action would add two X-ray sources, a new UXT and four experimental stations, for a total of 10 experimental stations. The Proposed Action would significantly increase the number of simultaneously operating experimental stations, with the design being sufficiently flexible to accommodate potential future additional upgrades. Utilities would include the power; heating, ventilation and air conditioning (HVAC); water cooling; fire alarm; fire protection; and telecommunication systems.

2.1.1.2 Supporting Facilities

Auxiliary Utilities Plant

Support buildings for the various sections of the new facility would be constructed as required. The new experimental facilities would require an auxiliary utility plant (AUP) to augment the existing central utility plan. The AUP would be a metal building on concrete slab foundation and located above grade, near or above the EH. It would contain a large mechanical room accommodating a make-up air unit and exhaust systems, a boiler room, a chiller room, and an electrical room containing switch gear. The AUP would provide electrical, steam, HVAC, water and compressed air services.

Interior Utilities

All occupied and unoccupied LCLS-II buildings would be constructed with interior utility systems, such as power, lighting, fire alarms, telecommunications, compressed air, heating, cooling, ventilation and hot and cold water. Cooling water would be provided to cool the accelerator components. Air conditioning would be required to keep the research equipment at a constant temperature. The AUP boiler would provide hot water and all facilities would be outfitted with hot and cold water distribution piping.

CITY: Boulder, CO DIV/GROUP: IM/AIT DRAFTER: J. CHEN
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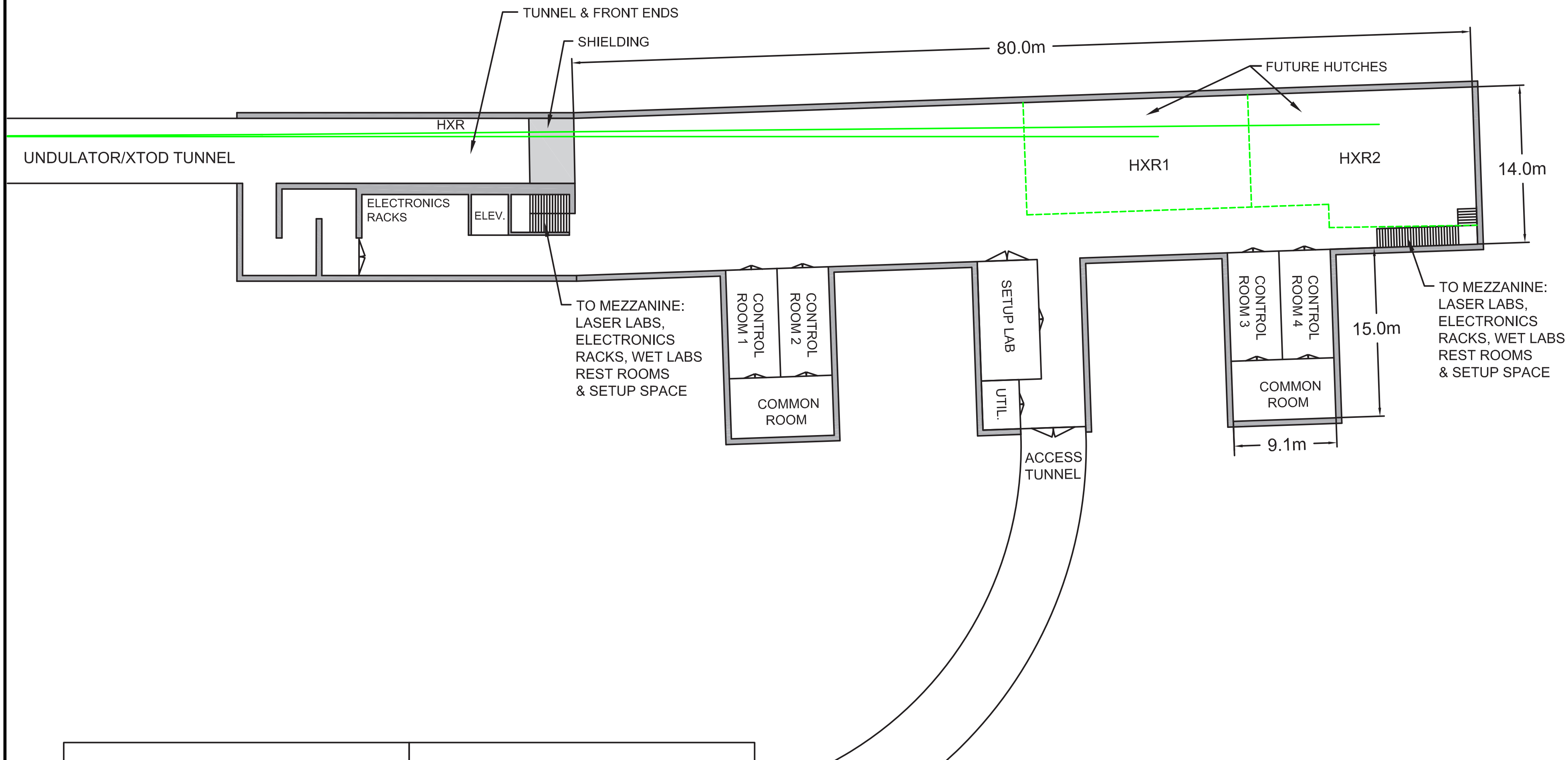
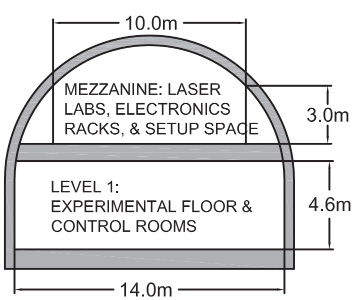
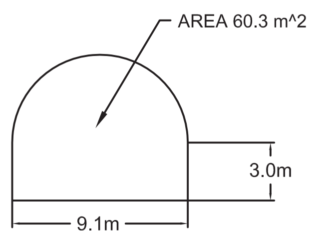
K:\AZ001214_SLAC_LCLS_II_EA\IMAGES\ILLUSTRATOR\Figure 2-4 Experimental Hall Layout.ai -07/26/2011





INSET 1: MAIN CAVERN



INSET 2: SIDE CAVERNS

NOTE: m = meter

SLAC LCLS-II EA

EXPERIMENTAL HALL LAYOUT (LEVEL 1)

ARCADIS

FIGURE 2-4

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Floor Stability and Seismic Protection

All facilities supporting the undulator magnet devices and experimental beams would be designed to minimize the effects of differential settlement, shrinkage, vibration and short-and long-term distortion. In addition to being constructed underground, the floors would be thicker than normal structures and would have zero slope when adjusted for earth curvature.

All buildings would be designed to conform to California Building Code 2010 requirements as well as SLAC Building and Site-Wide Design guidelines (DS-018-000-01-R0) and would be constructed of metal with steel framing. The structures would be designed and constructed to resist seismic loads and to meet related building codes.

2.1.1.3 Site Utilities

LCLS-II buildings and parking lots would require utilities including sanitary sewer service, potable water service, fire protection water service and storm drainage systems. Existing underground utility mains that transport wastewater and stormwater to areas outside SLAC's boundaries have adequate capacity to handle the additional flows that would be generated by the Proposed Action. Any existing utilities that would be abandoned would be removed.

Sewer service would be installed for all new buildings and tunnels. New sanitary sewers from EH and AUP would be connected to existing sewer lines. Sewer mains would be relocated and sized based on slope and needed flow capacity. Storm sewers would be installed based on added impervious surfaces and connected to an existing storm drain.

Domestic, irrigation and fire water service would be provided based on building sizes and landscaping needs, in coordination with the SLAC fire marshal. Water would be provided through an existing water main. Meter boxes would be located away from sidewalks to provide a safe walking area. Fire hydrants would be installed at appropriate spacing per National Fire Protection Association recommendations and requirements of the California Fire Code.

A new parking lot would be constructed at the proposed EH with a minimum of 60 parking spaces, including eight parking stalls with charging stations for government electric vehicles. A second new parking lot would be constructed at the UXT service building with 10 additional spaces. These parking lots would connect to the existing PEP Ring Road with new roadways and sidewalks. Sidewalks would connect the parking lots to the buildings and access tunnels. Lighting and restriping would be provided as needed. Use of permeable pavement would be considered during design to reduce the volume of storm water runoff.

2.1.1.4 Sustainability and Leadership in Energy and Environmental Design Accreditation

As a federal facility, SLAC would be required to comply with Executive Order (EO) 13423, Strengthening Federal Environmental, Energy, and Transportation Management, dated January 24, 2007. The order sets goals in the areas of energy efficiency, acquisition, renewable energy, toxics reductions, recycling, renewable energy, sustainable buildings, electronics stewardships, fleets and water conservation. EO 13423, Section 2(f), requires federal agencies to ensure that new construction and major renovation of agency buildings comply with the Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings set forth in the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (EPA 2006). The Proposed Action would be consistent with EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance, signed by President Obama on October 5, 2009. This EO expands on the energy reduction and environmental performance requirements identified in EO 13423. The goal of EO 13514 is "to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas (GHG) emissions a priority for federal agencies." This EO specifically addresses agency GHG reduction targets, reductions in petroleum, potable water, watering of landscaping, solid waste, construction and demolition debris, and other targets.

2.1.2 Proposed Construction

2.1.2.1 Site Preparation and Demolition

Construction of the Sector 10 Injector would require removal of the existing Sector 10 Alcove Building. This would require removal of the exterior metal roof and wall panels, structural steel framing, and all interior metal and wood walls, doors, and windows. The demolition would also remove all mechanical, electrical, plumbing, fire protection, fire alarm, and telecommunications systems and supporting equipment. A demolition notice would be submitted to BAAQMD at least 10 working days prior to the start of demolition work. Demolition would last up to 3 weeks and likely require the use of one diesel-powered excavator and an estimated 10 construction crewmembers. SLAC estimates the demolition would generate approximately 55 cubic yards (cy) of recyclable solid waste and 10 cy of waste that would require landfill disposal.

Because the BTH would be constructed above ground across the existing research yard, the existing asphalt and the top foot of soil from a 10,000-square-foot area within the research yard would be removed in preparation for construction and disposed of as solid waste. This stage of site preparation would require approximately 1 month and require the use of one diesel-powered backhoe and a 10-person construction crew. This activity would generate approximately 370 cy[1] of debris that would be characterized and disposed of or recycled as appropriate.

[1] A 1-foot-deep excavation of 10,000 square feet of the research yard would generate 10,000 cubic feet or 370 cy of soil and asphalt.

2.1.2.2 Modification of Existing Facilities

The Proposed Action would use existing linac equipment, including klystrons and modulators, but would require modification of existing facilities to accommodate the new injector beam. The Proposed Action would use the eastern 1.2 miles of the existing linac, from Sector 10 through Sector 30. In two sectors, Sector 10 and Sector 15, sections of the linac would be removed and replaced with magnets and vacuum chambers for electron beam pulse compression. Rearrangement of some low-conductivity water and electrical power distribution would be required at these locations, but the total capacity is adequate for the new requirements.

Because the BTH would cross the existing research yard, construction would require removal of several small modular buildings, and relocation of storage containers, utilities, compressed gas tanks and metal stairs. These facilities would either be relocated or dismantled prior to construction.

2.1.2.3 Construction Methods and Equipment

Tunnel excavation for the UH and UXT would require approximately 6 months to complete. Construction crews would use heavy equipment such as electric road headers (Figure 2-5), track-mounted electric excavators, electric hydraulic lifts, muckers, loaders, compressors and dump trucks. The tunnels would be excavated and temporary face support would be installed to protect the final excavation. Support systems may include forepoling, shotcrete and steel lattice girders. To protect the final tunnel invert from construction traffic, construction crews would install a working slab or other invert protection. Based on site conditions and the planned excavation dimensions, tunneling would advance approximately 4 to 8 linear feet per working shift/day. The final tunnel lining would consist of plain or unreinforced shotcrete. Low-permeability shotcrete would be used for waterproofing where needed as well as a drainage sump to collect any surface runoff.

Construction would require excavation of shaft(s). The construction shaft at the east end of the FEE would be constructed of drilled solid piles, wailers and horizontal struts. A utility shaft would be constructed within the construction shaft to connect utilities to the tunnel. The concrete utility shaft would be watertight to prevent water from reaching the tunnel.

The larger EH cavern would be excavated in multiple headings and benches to maintain the stability of the open excavation and facilitate support installation. The initial support for the cavern would consist of fiber-reinforced shotcrete and lattice girders. The final lining would consist of additional layers of plain or unreinforced shotcrete and welded wire fabric. Low-permeability shotcrete would be used for waterproofing where needed, as well as a drainage sump to collect any surface runoff.

Figure 2-5 Road Header Used for Tunneling

2.1.2.4 Staging Areas

The construction contractor would establish several construction staging areas directly adjacent to construction areas along LCLS-II, including areas previously used for LCLS-I construction activity. These areas would include existing open areas, parking lots and yards. These areas would be used for construction trailers and offices, workshops, construction and worker vehicle parking, and building and excavated material storage. Excavated material would be removed from the tunnel and cavern excavations and stored for relocation on site or trucked off site for disposal. All staging areas would be within SLAC property and several would be within the footprint of existing LCLS-I facilities. Several staging areas would require access to basic utilities such as water and electricity. Staging areas would be located within the LCLS-I footprint as well as adjacent to the proposed Sector 10 injector and EH.

2.1.2.5 Excavated Material Handling and Disposal

The proposed tunnel and cavern would require excavation of approximately 60,000 cy of soil. The soils within previously disturbed industrial areas in the SLAC Research Yard were tested according to SLAC's Excavation Clearance Program to determine potential chemical or radiological hazards and disposal options. Further testing will be conducted on soils collected as part of geotechnical borings. Excavated material that is deemed to be uncontaminated and does not require disposal as solid or hazardous waste would be deposited on site and seeded for vegetation. However, as described in detail in Section 3.13, excavated material that is deemed to exceed future land use criteria would require off-site disposal in an appropriate permitted landfill; lined and covered trucks would haul the material. Any soils classified as hazardous waste would be shipped to a licensed hazardous waste landfill, such as the Chemical Waste Management facility at Kettleman Hills in Kettleman City, California, for proper disposal. Travel distances to the potential disposal sites would be less than 1 mile for on-site relocation of clean material, approximately 20 miles or more for off-site solid waste disposal, and approximately 190 miles for off-site hazardous waste disposal. Trucks hauling soil off site would exit the site through the Alpine Gate and travel down Alpine Road to Interstate 280 (I-280).

2.1.2.6 Site Restoration

The staging area and any other disturbed areas would be restored to their general preconstruction condition, including regrading, repaving and reseeding, as applicable.

2.1.2.7 Schedule

Construction would require approximately 4 years, with on-site activities beginning in mid-2012 and concluding in 2017. Figure 2-6 shows the sequence of major phases of construction. Assuming that long-lead equipment orders are placed in 2012, construction would begin in 2012 with site preparation, undulator fabrication and modification of existing facilities. Within the 4-year construction period, construction of the tunnel, experimental hall and other buildings would require from 12 to 14 months to complete. Installation of undulators and other research equipment is estimated to require at least 3 years to complete, and would be accomplished within the 2012 – 2017 period.

2.1.2.8 Work Force

The Proposed Action would be constructed in several phases over 3 to 4 years. The peak construction work force would be present during the period of concurrent construction of the tunnel, experimental hall and tunnel excavation. Tunnel construction would require up to 60 workers for each of two 10-hour shifts. Construction of the EH – the largest facility – would require approximately 50 construction workers and 20 supervisory staff on a daily basis. The peak work force during tunneling, construction of the experimental hall and installation of undulators and other experimental equipment would be approximately 150 personnel.

2.1.3 Operations and Maintenance

2.1.3.1 Hazardous Materials Management

SLAC uses hazardous materials as part of its experimental programs including the manufacturing and maintenance of experimental devices, as well as during construction, operations and maintenance. Examples of hazardous materials managed at SLAC include:

- Cryogens
- Flammable gases
- Compressed gases
- Acids and bases
- Solvents
- Oils and fuels
- Adhesives
- Paints and epoxies
- Metals
- Radioactive materials

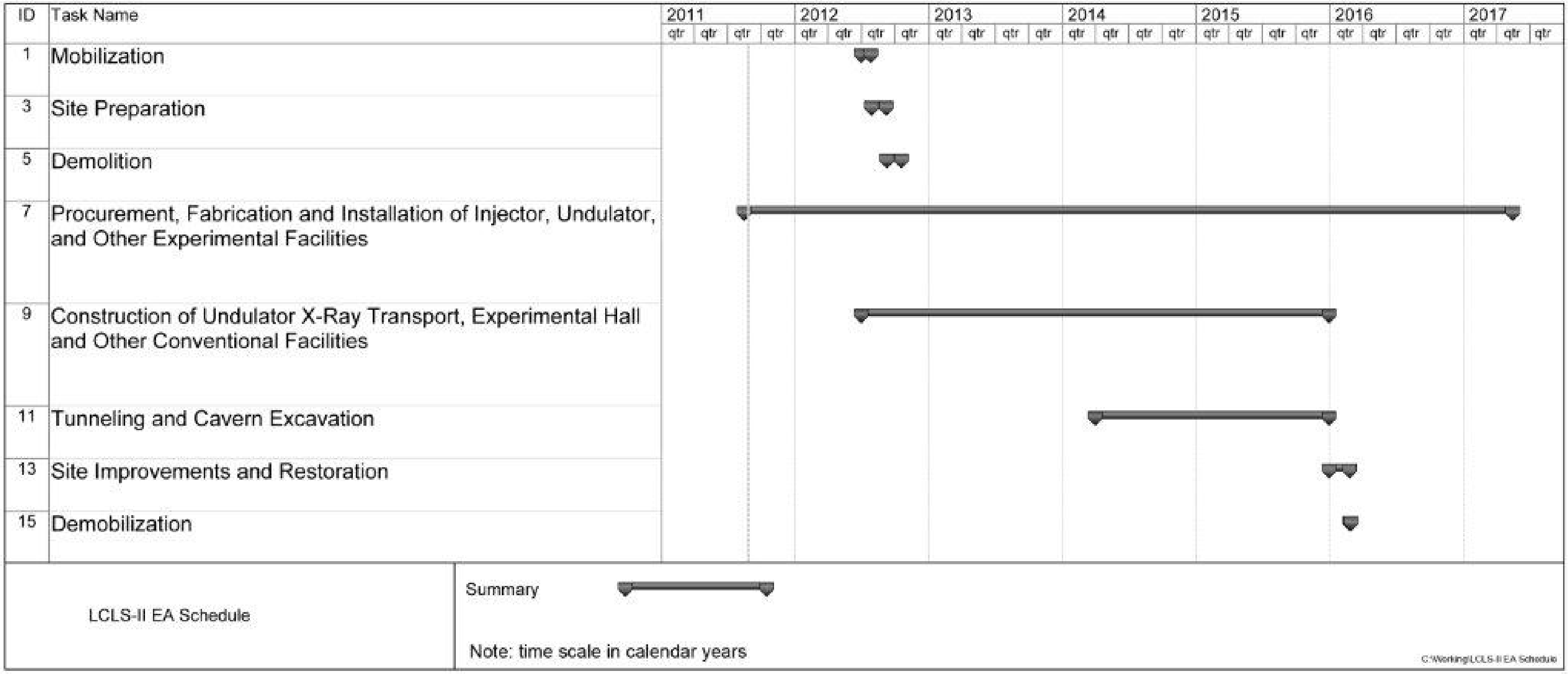
The Proposed Action would implement existing community and worker safety and hazardous materials transport regulatory requirements, including Title III of the Superfund Amendments and Reauthorization Act of 1986 (also referred to as the Emergency Planning and Community Right-to-Know Act), the Occupational Safety and Health Act of 1970, and the Hazardous Materials Transportation Act. SLAC also implements the Toxic Substances Control Act, the federal statute under which polychlorinated biphenyls (PCBs) and asbestos are regulated. Further, the Proposed Action would comply with state requirements including hazardous materials business plans (HMBPs); the California Accidental Release Prevention Program (CalARP); aboveground storage tank programs; pollution prevention and waste minimization programs; and hazardous materials and waste management regulations (e.g., Resource Conservation and Recovery Act [RCRA], Title 22 California Code of Regulations [CCR]).

2.1.3.2 Waste Minimization and Pollution Prevention

The Proposed Action would be consistent with DOE's policy on Waste Minimization and Pollution Prevention (DOE 1992). SLAC would evaluate chemical use and disposal to identify the potential to reduce the amount of chemicals requiring disposal as well as opportunities to employ specific best management practices (BMP) to prevent the release of chemicals to the environment.

SLAC has a comprehensive site-wide Storm Water Pollution Prevention Plan (SWPPP; SLAC 2007a). Pollution prevention for the Proposed Action would begin before construction, with the development of a construction SWPPP for LCLS-II. During operations, the Proposed Action would involve implementing the existing site-wide SWPPP, including site-specific BMPs. The operational BMPs for the Proposed Action would focus on minimizing sediment and other constituents of potential concern in surface runoff.

Figure 2-6 Proposed Action Construction Schedule



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2.1.3.3 Power Requirements

Power for the early stages of construction would be provided by existing on-site power or temporary on-site diesel generators. Generators rated above 50 horsepower would be provided by subcontractors, since SLAC generators of this capacity are currently permitted for emergency use only. During later stages, power would be provided by existing sources and the new electrical substation. Most of the power required during construction would be used to operate the road headers. Power would be provided by constructing a temporary power line between the on-site substation and the tunnel. If a power failure occurred during construction, emergency generators would be required to power essential equipment, such as ventilation for the tunnel, emergency egress and pumps to prevent groundwater infiltration in the tunnel. Power for operations would be provided by Western Area Power Administration (WAPA). WAPA provides power for LCLS-I and would continue to provide power for the Proposed Action's operations. Including power needed to generate laser beams, as well as HVAC, lighting and other electrical systems, the Proposed Action would increase energy use by approximately 38,000 megawatt-hours per year[2]. However, the Proposed Action would use existing energy sources including alternative energy sources available through WAPA. The injector would be powered by existing klystrons in the klystron gallery. No new power resources would be required.

2.1.3.4 Decommissioning

Decommissioning would not occur for decades into the future. Once the decision to decommission the facilities is made, a decommissioning plan would be prepared to ensure that the best available technology is used and that all closure activities are conducted in accordance with applicable laws and regulations, as reflected in established SLAC and DOE policies and procedures. This would include a detailed radiological survey to identify components with residual radioactivity. Such components would be stored in a secure area pending future reuse or final disposal. SLAC has well-developed controls for storage of radioactive materials that would be used during decommissioning. Any radioactive materials would be stored on site within Radioactive Material Areas (RMAs). RMAs are regularly monitored and managed by radiation safety professionals to ensure public safety and compliance with applicable regulations. Decommissioning procedures would include initial decontamination, disconnection of operating systems, drainage of liquid-filled systems, physical and administrative controls to limit access, characterization surveys, and surveillance and maintenance, as necessary. Other decommissioning procedures would likely include dismantling, storage for future use, packaging according to DOT specifications and shipping to approved disposal sites.

2.1.4 Avoidance and Minimization Measures

As part of the Proposed Action, SLAC would implement avoidance and minimization measures to reduce or eliminate potential minor adverse construction and operational impacts from this project. These air quality, biological and cultural resources, surface water and groundwater, traffic, health and safety, noise, and waste management measures are summarized below and described in detail in Section 3.

[2] 38,000 megawatt-hours is the amount of power used if 38,000 megawatts are used for one hour. One megawatt is equal to one million watts

Air Quality

- Implement fugitive dust control measures in compliance with the SWPPP and Bay Area Air Quality Management District (BAAQMD) mandates.
- Minimize GHG emissions in accordance with current reduction activities/programs.

Biological Resources

- Restore staging areas to preconstruction conditions. Reseed disturbed areas with a certified weed-free native seed mix.
- Apply SLAC's tree and shrub protection guidelines, where applicable.
- Clean construction equipment to prevent the introduction of non-native species, prior to mobilization to the site.

Cultural Resources

- Develop and implement an archaeological monitoring and data recovery plan.
- Train construction contractors to ensure avoidance of cultural resources and respond appropriately in the event of an unanticipated discovery.

Surface Water/Groundwater

- Install stormwater BMPs, according to the project specific construction SWPPP, to minimize erosion and protect water quality in accordance with State Water Board and Regional Water Quality Control Board regulations.
- Dispose of any water generated by dewatering the tunnel excavation in a manner compliant with site-wide discharge permits.
- Comply with spill prevention and control measures for generators and construction equipment.

Traffic

- Prepare a Traffic Control Plan to identify transportation routes and facilitate trucking of excavated materials and debris, including access from local roadways.
- Coordinate construction traffic from the Proposed Action with construction from other SLAC projects.

Health and Safety

- Comply with all applicable federal and state regulations that pertain to safety and health programs for construction.
- Develop a site-specific Health and Safety Plan or Job Hazard Analysis and require all workers to read and acknowledge the requirements.

- Hold safety “tailgate” meetings at the start of each workday to discuss potential hazards and lessons learned from previous days.
- During construction and routine operations, all workers and researchers would be required to comply with SLAC’s approved radiological safety programs.
- Provide fire suppression equipment and shut-down devices to work crews, institute a no-smoking policy, and comply with welding and other work permits to minimize fire risk.
- Implement emergency preparedness procedures in the event of a wildfire.

Noise

- Avoid/minimize use of heavy equipment near residences outside of the construction hours defined in the City of Menlo Park Municipal Code (8 am to 6 pm).
- If any fans are used to ventilate tunnels, place the fans to minimize noise effects on nearby residences.

Waste Management

- Provide for off-site disposal of any regulated waste generated during construction or operation, following federal, state and local regulations and DOE and Stanford University policies.

2.1.5 Permits and Approvals

Because the Proposed Action would not require placement of fill in wetlands or waterways or any waterway crossings, few environmental permits would be required. Environmental permits and approvals for the Proposed Action may be required from the following agencies:

- State Water Board for a Construction General Permit for stormwater discharges;
- California Occupational Safety and Health Administration (CalOSHA) Underground Classification Permit;
- National Historic Preservation Act Section 106 consultation with the State Historic Preservation Officer regarding potential impacts on the on-site historic district or surveys for possible archaeological deposits; and
- Bay Area Air Quality Management District permit to operate a stationary emergency standby generator, if needed.

DOE has determined that because the Proposed Action would not affect threatened or endangered species or their habitat, no Endangered Species Act, Section 7 consultation is required.

DOE will consult with the SHPO regarding potential impacts of the installation of the injector at Sector 10 on the proposed historic district. Through submittal of the draft EA to the SHPO, the NEPA process would be used to complete the Section 106 consultation on the rest of the LCLS-II project.

2.2 No Action

Under this alternative, the LCLS-II facilities would not be constructed. The no action alternative would not require import of workers and materials, tunneling, excavation, or other operation of heavy construction equipment. Existing facilities at SLAC would continue to operate under current management practices. In the event that LCLS-II is not constructed, planned research would be constrained to the capabilities and capacity of the existing facilities.

2.3 Alternatives Considered and Eliminated from Detailed Analysis

This section describes three construction alternatives that were considered during conceptual design, but rejected because they do not meet the purpose or mission need, or would be cost prohibitive and therefore infeasible. The alternatives considered included installing new beam lines in the existing tunnel (i.e., the single or "one" tunnel alternative) and constructing a new facility at a "green field" site at SLAC or at another DOE location.

2.3.1 Single Tunnel Alternative

The single tunnel alternative would inject electrons at Sector 10, similar to the Proposed Action. However, the electrons would instead pass through undulators such that two electron beams would be created. This option would not construct a second undulator tunnel and EH. Thus, this alternative is also referred to as the "one tunnel" option. This alternative would support 100 soft X-ray experiments and 268 hard X-ray experiments per year (total of 368 experiments per year). This alternative would provide a second X-ray beam to the existing EHs, but no space for additional instruments and no added capacity for new instruments in the future. It would not provide a new hard X-ray source and would limit delivery of hard X-rays with differing characteristics. Therefore, this alternative would provide somewhat increased capacity but would not meet the rapidly increasing capacity and capability demands described above and would not allow DOE to achieve its stated mission.

2.3.2 Build LCLS-II at a "Green Field" SLAC Location

Under this alternative, the LCLS-II facilities, including the construction of a new linac, would be sited and constructed at a new location at SLAC. The proposed LCLS-II linac location was selected based on geotechnical and hydrologic investigations. An alternative site would require substantial additional investigations and would require construction of a new, duplicate linac. This alternative would not be able to take advantage of existing LCLS-I structures and infrastructure, and there would be increased environmental disturbance from construction of duplicate facilities. Further, construction of duplicate facilities would be cost prohibitive and therefore would be infeasible. For these reasons, this alternative was not included in the detailed environmental evaluation.

2.3.3 Build LCLS-II at another DOE Site

Under this alternative, the LCLS-II facilities would be constructed at another DOE facility, such as Argonne National Laboratory, Lawrence Livermore National Laboratory or Brookhaven National Laboratory. However, none of these facilities has existing linac facilities and all would require construction of duplicate facilities that are already available at SLAC, which would be cost prohibitive. Thomas Jefferson National Laboratory has a linac; however, its length is insufficient to produce a beam with the qualities needed for an XFEL. Furthermore, Thomas Jefferson National Laboratory is committed to supporting DOE's Nuclear Sciences mission for the next 20 years and it would be impractical for this facility to add a second mission. Thus, SLAC is clearly the most effective choice among alternative sites for LCLS-II based on cost and the relatively small incremental environmental consequences of building adjacent to the existing linac. Therefore, building the facility at an alternate DOE site was not considered reasonable and was not evaluated in detail as an alternative in this EA.

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3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the existing physical, biological and socioeconomic features of the area and the potential environmental consequences of each alternative. Section 3.1 summarizes the regional setting including geography, facility history and land use. Section 3.2 describes the methodology used in conducting the environmental impact assessment with a focus on the terms used to characterize environmental impacts. Section 3.3 summarizes the results of the environmental analysis for both the no action and Proposed Action alternatives. Sections 3.4 through 3.13 describe the affected environment and environmental consequences of the alternatives on the following resources:

- Air quality
- Biological resources
- Cultural resources
- Geology and soils
- Health and safety (including radiation)
- Hydrology and water quality
- Noise
- Socioeconomics and environmental justice
- Traffic
- Waste management

Section 3.14 presents an analysis of potential cumulative effects of the no action and Proposed Action alternatives. Figure 3-1 provides an overview of the eastern section of the SLAC campus, the layouts of the LCLS-I and LCLS-II facilities, and other site attributes referred to in the environmental analysis.

The Proposed Action would occur entirely within SLAC boundaries on land leased by DOE from Stanford University and largely within the footprint of existing SLAC facilities. There would be no changes in land use or disruption of existing land uses; therefore, this EA summarizes existing land use conditions but does not address land use effects as a potential environmental consequence. Finally, because the existing experimental facilities are not visible from the site boundary and are only distantly visible from I-280 and the distant hillsides to the west, and because the proposed facilities would be constructed within the existing industrial footprint or underground, the Proposed Action has little or no potential to affect views or to change the character of the area. As a result, visual effects are not addressed in this EA.

3.1 Regional Setting

SLAC is located on approximately 426 acres of Stanford University-owned land within unincorporated San Mateo County, California. SLAC is located in the foothills of the Santa Cruz Mountains, above the alluvial plain that borders the western margin of the San Francisco Bay. Construction of SLAC and the I-280 freeway has altered local topography, although the regional topographic aspect and drainage directions have not been changed (Figure 1-1). The maximum elevation within the SLAC site's boundaries is approximately 375 feet above mean sea level (amsl). Jasper Ridge, located immediately southwest of the SLAC site's boundary, is the local topographic high at 600 feet amsl. SLAC is located approximately 2 miles west of the main Stanford University campus.

Stanford University operates SLAC for the DOE; the facility specializes in fundamental photon science and particle physics research. The original lease agreement was signed in 1962 between the Atomic Energy Commission (DOE's predecessor) and Stanford University for a period of 50 years. The lease was recently extended by approximately 30 years. The SLAC land is part of the original land grant that established Stanford University; under the terms of the grant, the land cannot be sold and must be held in perpetuity by the university's trustees to support its educational mission. Land use at the SLAC facility is a combination of industrial and educational, and includes the SLAC Guest House. The land leased by DOE for SLAC is zoned residential.

Construction of the facility began in 1962. Operations commenced in 1966 and have been continuous since that time. The dominant structure at SLAC is the 1.8-mile-long linac, which lies across the facility in an east-west orientation (Figure 1-2a). I-280 crosses the facility, passing over the linac. Most of the facilities are concentrated in the eastern one-third of the facility (east of I-280) and include offices, research facilities and other structures. The western two-thirds of the SLAC lease holding (west of I-280) support the existing linac (Figures 1-2b and 1-2c).

The 2010 Long Range Development Plan (LRDP; Stanford University 2010) guides the development of facilities and infrastructure in support of SLAC's program development and vision, including redevelopment and removal of outdated and obsolete facilities, future capital facilities, parking, circulation and sustainability. Land use surrounding the eastern portion of the facility is primarily medium to high density, with mixed residential, commercial and agricultural development. Sand Hill Road, a busy thoroughfare, borders SLAC to the north, with the high-density residential and commercial development of Sharon Heights to the north. Private homes (Stanford Hills) and grazing land exist along the eastern and southeastern boundaries. The area directly to the south and southeast supports agricultural land (Webb Ranch) and the Portola Valley Training Center (PVTC), a recreational equestrian facility. To the southwest is the 1,200-acre Jasper Ridge Biological Preserve, which is owned by Stanford University and maintained for research and conservation (Exponent 2007).

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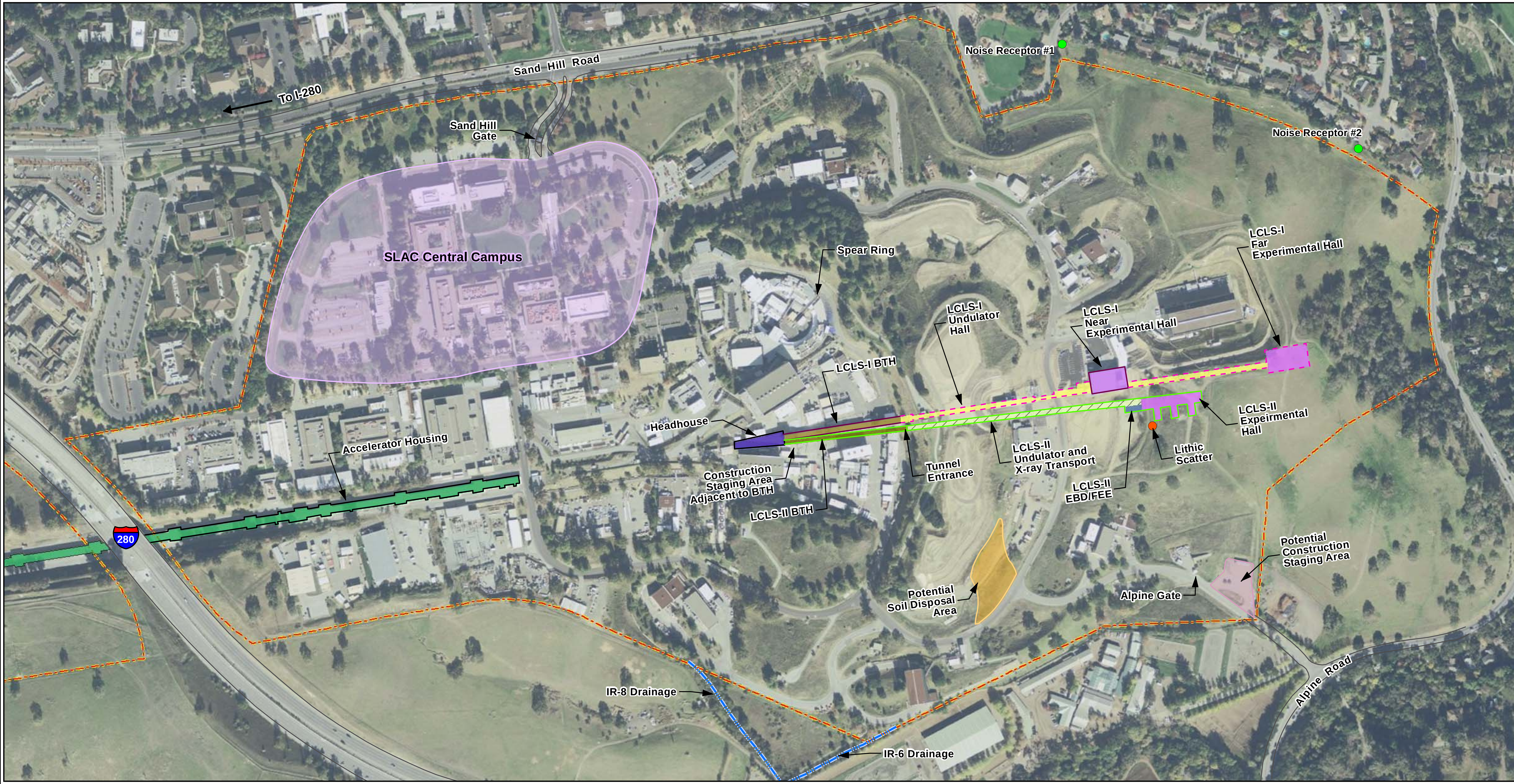

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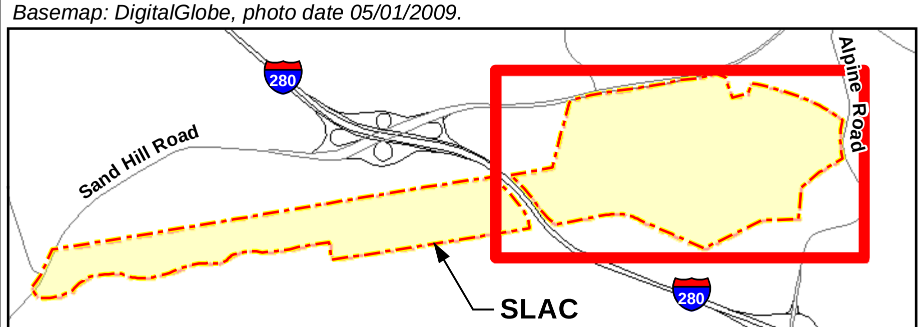

LEGEND

- SLAC LINEAR ACCELERATOR CENTER (SLAC) GROUNDS
- EXISTING LCLS-I UNDERGROUND FACILITY
- EXISTING LCLS-I ABOVEGROUND FACILITY
- PROPOSED LCLS-II FACILITY

BTH = BEAM TRANSPORT HALL
EBD = ELECTRON BEAM DUMP
FEE = FRONT END ENCLOSURE

N

0 400 Feet

Graphic Scale: 1" = 350'

SLAC LCLS-II EA

LCLS-II PROPOSED ACTION FACILITIES AND WORK AREAS

ARCADIS

FIGURE
3-1

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3.2 Environmental Assessment Methodology

This section describes the methodology used to assess potential environmental impacts. Impacts are analyzed by evaluating the Proposed Action and no action alternatives, including the type and magnitude of the effect on each resource. Specifically, the magnitude or type and degree of impacts are analyzed by evaluating the following factors:

- Type (beneficial or adverse, direct or indirect)
- Context (site-specific, local, regional)
- Duration and timing (short- or long-term)
- Intensity (negligible, minor, moderate or major)

For the environmental impact analysis, the following definitions were applied to characterize environmental impacts or effects (the terms "impact" and "effect" are used interchangeably):

- Beneficial impact – an improvement in the condition of the resource or a change that would move the resource toward a desired condition.
- Adverse impact – a change in the resource that would be detrimental or move the resource away from a desired condition or detract from its condition.
- Direct impact – an effect that would result from an action and would occur at the same time and place.
- Indirect impact – an effect that would occur later in time or at a different location, but would be reasonably foreseeable.
- Short-term impact – an effect that, within a short period, would no longer be detectable because the resource would return to its pre-disturbance condition or appearance within several years.
- Long-term impact – a change in a resource or its condition that would not return the resource to pre-disturbance condition or appearance within several years and would essentially be permanent.
- Site-specific impact – the action would only affect areas on site.
- Local impact – the action would affect areas on and adjacent to the site.
- No effect – the action would have no measurable detrimental or beneficial effect on the resource.
- Cumulative impacts - impacts that overlap in space and/or time with the impacts of other past, present or reasonably foreseeable future actions.

3.3 Summary of Impacts

Table 3-1 summarizes the environmental impacts found for each resource evaluated in this section.

Table 3-1 Summary of Environmental Impacts by Resource

Resource Area	No Action	Proposed Action
Air quality	No effect.	Minor adverse impacts from construction and operation.
Biological resources:		
Wetlands	No effect.	No effect.
Vegetation	No effect.	Minor, local adverse impacts due to disturbance from construction and permanent impacts from construction of new buildings.
Wildlife	No effect.	Minor, short-term local impacts on common wildlife species from construction. No impact on special-status species.
Fisheries	No effect.	No effect.
Cultural resources	No effect.	Minor impact on historical district. Minor direct impacts on archaeological resources. Potential minor impacts on paleontological resources from construction.
Geology and soils	No effect.	Minor, short-term impacts on soils from construction. Minor long-term increased risk of landslides from steep slopes and earthquakes.
Health and safety	No effect.	Minor risk of construction health and safety impacts.
Hydrology and water quality	No effect.	Minor, short-term risk of adverse impacts on surface-water quality during construction. Minor operational impacts on stormwater quality.
Noise	No effect.	Minor, short-term impacts during construction. No vibration effects. Potential operational noise level impacts would be minor.
Socioeconomics and environmental justice	No effect.	Minor, short-term beneficial impacts from increased construction employment.
Traffic	No effect.	Minor, short-term impacts during construction.
Waste management	No effect.	Minor, short-term adverse impacts during construction. Minor impacts from hazardous waste generated during operation.
Cumulative effects	No effect.	Minor impacts involving air quality, vegetation, paleontology, soils and geology, health and safety, flooding, water quality, groundwater, noise, traffic, and waste management.

3.4 Air Quality

3.4.1 Affected Environment

California is divided into air basins that are defined generally by their meteorological and topographical characteristics. The Proposed Action is located in San Mateo County, which is within the San Francisco Bay Area Air Basin (SFBAAB). The SFBAAB is characterized by complex terrain, consisting of coastal mountain ranges, inland valleys and bays, which distort wind flow patterns. The Pacific Coast Range is divided by the entrance to San Francisco Bay. Together with the Carquinez Strait to the east, this allows air to flow in and out of the SFBAAB and the Central Valley.

The climate is dominated by the strength and location of a semi-permanent, subtropical high-pressure cell. During the summer, the Pacific high-pressure cell is centered over the northeastern Pacific Ocean, resulting in stable meteorological conditions and a steady northwesterly wind flow. Upwelling of cold ocean water from below the surface because of the northwesterly flow produces a band of cold water off the coast. The cool and moisture-laden air approaching the coast from the Pacific Ocean is further cooled by the cold water band, resulting in condensation, fog and stratus clouds along the coast.

In the winter, the Pacific high-pressure cell weakens and shifts southward, resulting in wind flow offshore, the absence of upwelling and storms. Weak inversions coupled with moderate winds result in more dilution and dispersion and a lower potential for adverse effects. El Nino, or more precisely the El Nino Southern Oscillation (ENSO), is an ocean cycle that periodically produces heavy winter rains in California. During an El Nino event, wind and ocean currents flow eastward, so warm water collects off the west coast of North and South America. Strong El Nino conditions can produce heavier rainstorms, especially in northern California. In contrast a La Nina event, which sometimes alternates with El Nino, wind and water flow westward away from the coast and a pool of cooler water forms just offshore, producing drier winters. The ENSO is an integral aspect of the meteorology for the US Pacific Coast. This cycling between El Nino and La Nina occurs every 3-7 years, with widely varying amplitude.

Air quality management programs in California are the responsibility of the local air quality management district (AQMD), the California Air Resources Board (CARB) and the U.S. Environmental Protection Agency (EPA). The local AQMD is the BAAQMD.

3.4.1.1 Criteria Pollutants

The ambient air quality in an area can be characterized in terms of whether it complies with National Ambient Air Quality Standards (NAAQS) and State Ambient Air Quality Standards (SAAQS), where applicable. The Clean Air Act (42 U.S.C. 7401 et seq.) requires the EPA to set national standards for emissions that are considered harmful to public health and the environment (criteria pollutants). Based on air monitoring data, the SFBAAB is currently classified by EPA as a non-attainment/marginal area for the 8-hour ozone standard. In addition, the SFBAAB was recently designated as non-attainment for the new federal fine particle ($PM_{2.5}$) standard. For all other federal standards, the SFBAAB is in attainment or unclassified. The SFBAAB is currently in non-attainment for both the 1-hour and 8-hour standards for ozone, particles with a diameter of 10 micrometers or less (PM_{10}) and $PM_{2.5}$ based on State standards. Table 3-2 presents the NAAQS and SAAQS for each criteria pollutant and the 2011 attainment designations for the SFBAAB.

Table 3-2 Air Quality Standards Attainment Status for the San Francisco Bay Area Air Basin

Parameter		State Standard		Federal Standard	
Ozone	1-Hour	0.90 ppm (180 µg/m³)	Non-attainment	--	
	8-Hour	0.070 ppm	Non-attainment	0.075 ppm	Non-attainment
Carbon Monoxide	1-Hour	20 ppm (23 mg/m³)	Attainment	35 ppm (40 mg/m³)	Attainment
	8-Hour	9.0 ppm (10 mg/m³)	Attainment	9 ppm (10 mg/m³)	Attainment
Nitrogen Dioxide	1-Hour	0.18 ppm	Attainment	0.100 ppm	Unclassified
	Annual Arithmetic Mean	0.030 ppm (57 µg/m³)		0.053 ppm (100 µg/m³)	Attainment
Sulfur Dioxide	1-Hour	250 ppb	Attainment	75 ppb	Attainment
	24-Hour	0.40 ppm (105 µg/m³)	Attainment	0.14 ppm (365 µg/m³)	Attainment
	Annual Arithmetic Mean	--		0.030 ppm (80 µg/m³)	Attainment
Particulate Matter (PM_{10})	24-Hour	50 µg/m³	Non-attainment	150 µg/m³	Unclassified
Particulate Matter – Fine ($PM_{2.5}$)	24-Hour	--		35 µg/m³	Non-attainment
	Annual Arithmetic Mean	12 µg/m³	Non-attainment	15 µg/m³	Attainment
Lead	30 day Average	1.5 µg/m³		--	
	Rolling 3-Month Avg	--		0.15 µg/m³	Attainment

Notes:
-- no standard available
µg/m³ = micrograms per cubic meter
ppm = parts per million
Sources: EPA 2011a; BAAQMD 2011

3.4.1.2 Conformity

EPA requires each state to prepare and submit a State Implementation Plan (SIP) describing how the state will achieve the federal standards by specified dates, depending on the severity of the air quality within the state or air basin. EPA adopted the General Conformity Rule in November 1993 to implement the conformity provision of Title I, Section 176 (c)(1) of the Federal Clean Air Act. This provision requires that the federal government not engage, support or provide financial assistance to licensing, permitting or approving any activity not conforming to an approved SIP. The *de minimis* levels for conformity of each criteria pollutant in non-attainment along with SLAC's Synthetic Minor Operating Permit (SMOP) limits are presented in Table 3-3.

Table 3-3 Applicable General Conformity to de Minimis Levels

Pollutant	de minimis Levels (Tons/Year)	SLAC's SMOP Limits (Tons/Year)
Ozone (NO_x)*	100	35
Ozone (VOC)*	100	35
PM_{10}/$PM_{2.5}$**	100	35

Notes:

* Ozone is a gas formed when volatile organic compounds (VOCs) and nitrogen oxides (NO_x) undergo photochemical reactions in the presence of sunlight. For this analysis, these two precursors were evaluated as surrogates for ozone. The *de minimis* values for non-attainment areas were used.

** No *de minimis* values have been established for $PM_{2.5}$. As a surrogate, the *de minimis* level for PM_{10} in a moderate non-attainment and maintenance area was used.

3.4.2 Environmental Consequences

3.4.2.1 No Action

Under the no action alternative, the Proposed Action would not be constructed and no air quality impacts would occur. Therefore, the no action alternative would not result in impacts on air quality.

3.4.2.2 Proposed Action

Construction Impacts

Under the Proposed Action alternative, air quality impacts would be intermittent and short term. Construction would generate emissions including those listed as non-attainment in the SFBAAB (VOCs, NO_x, PM_{10} and $PM_{2.5}$) (Appendix B). Emissions were calculated using the CalEEMod Environmental Management Software. The CalEEMod model provides a platform to calculate both construction and operational source emissions using equipment emission factors (mass of emissions per unit time) from sources such as EPA, CARB and site-specific information. CalEEMod also provides default values when site-specific information is not available. Table 3-4 summarizes the site-specific information used in the construction emissions calculations, including activity durations, types of equipment and shift length.

Annual emissions calculated from CalEEMod were compared with general conformity *de minimis* levels and SLAC's SMOP limits for emissions of criteria pollutants (Table 3-5). Proposed Action construction emissions would not exceed general conformity *de minimis* levels for any of the evaluated pollutants. In addition, it would not result in overall SLAC emissions of VOC (12.8 tons/year), NO_x (19.5 tons/year), PM_{10} (less than 1 ton/year) or $PM_{2.5}$ (less than 1 ton/year) exceeding permit limits. Modeling methods and results are presented in Appendix B.

Table 3-4 Construction Description by Activity (Estimated)

Activity	Start	Duration	Diesel Construction Equipment	Hours per Day Construction	Daily Workers	Material for Relocation or Disposal
Procurement/ Installation	Q3 2012	5 years	1 forklift	8 hours	<10*	None
Demolition of Sector 10 Alcove	Q3 2012	3 weeks	1 excavator	8 hours	10	55 cy of demolished concrete and 55 cy of sheet metal
Site preparation	Q1 2013	4 weeks	1 backhoe	8 hours	10	370 cy of soil
Tunneling**	Q3 2014	6 months	1 mucker 1 loader 1 compressor 2 dump trucks	20 hour	60	60,000 cy of soil
Building Construction	Q3 2014	14 months	3 compressors 2 front-end loaders 2 backhoes 2 cranes 2 pick-up trucks	8 hours	70	None

Notes:

* Typical, based on LCLS-I.

** Electric-powered construction equipment used during tunneling includes three road headers, one track-mounted excavator with boom and one electric hydraulic machine.

Table 3-5 Estimated Proposed Action Construction Emissions

Construction Year	Annual Emissions (tons per year) VOCs	NO_x	PM_{10}	$PM_{2.5}$
2012	0.05	0.35	0.03	0.02
2013	0.08	0.60	0.08	0.03
2014	1.65	12.27	1.51	0.59
2015	1.10	5.82	0.34	0.32
2016	0.06	0.38	0.04	0.02
2017	0.03	0.17	0.02	0.01
de minimis Levels	100	100	100	100
Overall SLAC Emissions*	12.8	19.5	<1	<1
SLAC's SMOP Limits	35	35	35	35
Exceed *de minimis* Levels or SMOP Limits?	No	No	No	No

Note:

*Overall SLAC emissions do not include emissions from the proposed action.

Further, fugitive dust control measures would be installed in compliance with the SWPPP, which would reduce PM_{10} and $PM_{2.5}$ emissions.

Operational Impacts

The Proposed Action would result in an increase in energy, water and vehicle use. Operational emissions associated with the daily activities of the Proposed Action would result from increased vehicular trips to and from the site (i.e., various types of mobile vehicles). Increases in vehicular trips would result from a larger number of researchers using the LCLS-II facilities (up to 60 additional researchers per day). Energy consumption would include electricity for laser beam generation, lighting and equipment and natural gas for water and space heating. CalEEMod was used to estimate criteria pollutant emissions from mobile, area and energy sources during operations (Table 3-6). Operational emissions from LCLS-II as well as overall SLAC emissions with the Proposed Action would not exceed *de minimis* levels or SLAC's SMOP limits for VOCs, NO_x, PM_{10} or $PM_{2.5}$; therefore, air quality impacts would be minor.

Table 3-6 Estimated Proposed Action Operational Emissions

	Annual Emissions (tons per year)			
Emission Source	**VOCs**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
Area	0.12	0.00	0.00	0.00
Energy	0.00	0.03	0.00	0.00
Motor Vehicles	0.04	0.05	0.07	0.00
TOTAL	0.16	0.08	0.00	0.00
de minimis Levels	100	100	100	100
Overall SLAC Emissions*	12.8	19.5	<1	<1
SLAC's SMOP limits	35	35	35	35
Exceed *de minimis* Levels or SMOP Limits?	No	No	No	No

Note:
*Overall SLAC emissions do not include emissions from the proposed action.

3.5 Biological Resources

This section addresses potential impacts on biological resources including wetlands and aquatic habitat, vegetation, wildlife, and fisheries. The evaluation addresses the area directly affected by the construction as well as staging areas, ingress and egress routes, and directly adjacent habitat.

3.5.1 Affected Environment

The following sections describe the existing biological resources at SLAC. This EA incorporates portions of the 2002 Environmental Assessment prepared by DOE for LCLS-I (LCLS-I EA; DOE 2002a). The LCLS-I EA and FONSI (DOE 2003) are available for review online or by appointment at SLAC. The EA can be accessed online at http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/EA-1426-FEA-2002.pdf and the FONSI can be accessed at http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/EA-1426-FONSI-2002.pdf.

3.5.1.1 Wetlands and Aquatic Habitats

There are no wetlands or standing water habitats in the Proposed Action area.

3.5.1.2 Vegetation

The SLAC grounds comprise urban industrial uses and grasslands. The area east of I-280 consists primarily of industrial areas associated with SLAC's existing experimental facilities. The area west of I-

280 consists primarily of grasslands, but also supports two small tributaries of San Francisquito Creek that pass under the existing linac, which was constructed approximately 50 years ago. The LCLS-I EA (DOE 2002a) lists the grass species present at SLAC and the vegetation types present in the adjacent Jasper Ridge Biological Preserve. The site's annual grasslands are dominated by non-native annual grasses, several notable native grasses and occasional occurrences of scrub and tree species.

3.5.1.3 Wildlife

Wildlife habitat on the eastern portion of the site is limited. The development and human activity associated with SLAC operations and adjacent properties preclude significant use as habitat by most wildlife species. Furthermore, the I-280 corridor to the south and west, Sand Hill Road to the north, and Alpine Road to the east form a continuous barrier to migration that limits transient wildlife passage. Routine wildlife use of this area is likely limited to species that are highly tolerant of human activity and attracted to maintained lawns, buildings and landscaped areas (e.g., songbirds, small mammals). For example, grassy areas support California ground squirrel (*Otospermophilus beecheyi*) and black-tailed jackrabbit (*Lepus californicus*) (Exponent 2007). The western portion of the site south of the linac is small but is adjacent to the largely pristine Jasper Ridge Biological Preserve and therefore has a higher potential habitat value. The existing accelerator housing may inhibit some wildlife dispersal because it lies between the Jasper Ridge Biological Preserve and undeveloped land to the north. The LCLS-I EA (DOE 2002a) provides additional examples of wildlife that occur at SLAC. Species that occur at SLAC include deer, fox, coyotes, bobcats and various birds. Potential bird species include special-status raptors such as burrowing owl; however, no special-status birds have been observed on site.

Other special-status species occurring on the San Francisco peninsula include California red-legged frog, California tiger salamander, western pond turtle, San Francisco garter snake and steelhead trout. However, none of the species listed above are known to occur at SLAC (California Natural Diversity Database [CNDDB] 2011).

3.5.1.4 Fisheries

The Central California Coast Distinct Population Segment of steelhead (*Oncorhynchus mykiss*) is a population of an anadromous fish that is federally listed as threatened. San Francisquito Creek provides habitat for steelhead; however, no habitat occurs within SLAC boundaries.

3.5.2 Environmental Consequences

3.5.2.1 No Action

The no action alternative would not involve construction or operation of new LCLS-II facilities at SLAC; therefore, no impacts would occur. SLAC would continue to operate existing experimental facilities, including LCLS-II. Therefore, the no action alternative would not impact wetlands, vegetation, wildlife or fisheries.

3.5.2.2 Proposed Action

Construction

Wetlands and Aquatic Habitat

The Proposed Action would not directly or indirectly affect wetlands or other aquatic habitat.

Vegetation

The Proposed Action would have both temporary and permanent effects on grasslands at SLAC. Although no effects would occur in urban/industrial areas, such as where the BTH would cross the research yard, tunneling of the X-ray transport hall and construction of the EH would affect grasslands. Temporarily disturbed areas (e.g., staging areas and graded areas) would be reseeded. Similarly, areas used for soil relocation would be graded and revegetated using a seed mix as described above. However, the area of the EH and support facilities (approximately 1 acre) would permanently displace grasslands. Given that these grasslands are located directly adjacent to existing industrial areas and do not support special-status species, this loss of grassland would be a permanent but minor impact.

To prevent the introduction of non-native species, construction equipment would be cleaned prior to mobilization to the site. To the extent practicable, the staging areas and access roads used during construction of LCLS-I would be used for the Proposed Action. Disturbed areas would be restored to preconstruction conditions by reseeding with a certified weed-free native seed mix. Few native trees and shrubs exist within the construction footprint. Any impact on native trees or shrubs in or near construction areas would be minimized per SLAC's Tree and Shrub Protection Guidelines (SLAC 2010a).

Wildlife

The Proposed Action would not directly or indirectly affect federally or state-listed species. No special-status species have been observed within the SLAC boundary (CNDDB 2011), likely because of industrial development, fragmented terrestrial habitat and absence of aquatic habitat (Exponent 2007). Construction would take place within existing urban/industrial areas or disturbed grasslands. Trees that could provide potential nesting habitat for birds would not be removed as part of construction activities. Construction would occur largely within the footprint of existing facilities, and wildlife impacts would be limited to grasslands. However, the affected grasslands are mowed and therefore would not provide suitable habitat for the burrowing owl, so no impacts would occur.

Fisheries

The Proposed Action would not affect steelhead or other fish species. The streams at SLAC are primarily intermittent tributaries of San Francisquito Creek that originate north of the existing linac and flow through culverts. None of the tributaries at SLAC support fish. Construction would not directly affect any tributaries and indirect effects from stormwater runoff would be addressed through stormwater BMPs (see Section 3.9 of this EA).

Operations

Wetlands and Aquatic Habitat

Daily operations of the Proposed Action would have no effect on wetlands or aquatic habitat. Operations would occur within the footprint of urban/industrial facilities and would not affect wetlands or the San Francisquito Creek tributaries on site. The potential for impact of chemical spills would be minimized by SLAC's existing industrial SWPPP (SLAC 2007a) and Spill Prevention, Control and Countermeasure (SPCC) Plan (SLAC 2008). Any potential increase in turbidity or stormwater runoff volume from new parking lots and other impervious surfaces is addressed in Section 3.9 of this EA.

Vegetation

LCLS-II operations would have no effect on grasslands or other vegetation.

Wildlife

Operations would occur within the footprint of urban/industrial facilities and would have no effects on wildlife. The Proposed Action would not affect migration corridors because most operations would occur inside the new experimental facilities. Because operations would occur within the footprint of existing facilities and parking lots, any incremental impact on wildlife would be minor because preferred habitat for the species described above does not occur on SLAC grounds.

Fisheries

Proposed action operations would not affect steelhead populations in San Francisquito Creek or watershed because LCLS-II operations would occur within the proposed new experimental facilities. Any impacts on water quality or the volume of stormwater runoff would be addressed by the site-wide industrial SWPPP (see Section 3.9 of this EA).

3.6 Cultural Resources

3.6.1 Affected Environment

Cultural resources include the broad range of objects, places, structures and districts created or influenced by human use or occupation or recognized in past or current cultural practice. Examples include: single artifacts; habitation sites; resource collection areas; ritual or social observation locations; landforms of significance; trash dumps; roads, buildings and structures; and paleontological localities

The affected environment for cultural resources is the footprint of the Proposed Action area, including the facilities, and the staging and other work areas outside the facilities' footprint within the SLAC boundary. A previous investigation was completed for the LCLS-I EA (DOE 2002a). More recently, as SLAC approaches its 50-year anniversary, and in compliance with the NHPA, SLAC is identifying historic properties during environmental review of proposed projects and consulting with the SHPO. The survey includes archaeological and paleontological resources as well as historic structures and their contribution to scientific history: SLAC experimental facilities are associated with six Nobel Prizes—four in physics and two in chemistry.

As part of these surveys, the Stanford University archaeologist recently completed a site-wide archaeological investigation (Jones 2011). Records for all known cultural resources in the affected environment are on file at Stanford University and were included in the investigation (Jones 2011). The Muwekma Ohlone tribe is engaged in the ongoing site investigation. Information regarding the site has been reported by Dr. Jones and in the previous EA (DOE 2002a).

Prehistoric and historic properties discovered in the SLAC area during previous investigations were located outside of the footprint of the Proposed Action. Historic properties are cultural resources eligible for the National Register of Historic Places (36 CFR 800). Previous cultural resource studies identified two lithic scatter sites and remnants of Camp Fremont tunnels (DOE 2002a; Jones 2011; Page and Turnbull 2011). The two lithic scatter sites are south of the Proposed Action area within the SLAC boundary. Tunnels associated with Camp Fremont were identified during construction of SLAC in the 1960s. There are no Indian Trust Assets within or near the affected environment.

Previous paleontological studies identified vertebrate and invertebrate fossil resources, including six invertebrate fossil localities within 1 mile of SLAC. The most common invertebrate fossils in the area are marine fossils such as clams and snails. The Ladera Sandstone contains a sandstone unit with abundant barnacle shells stratigraphically above the contact between the Ladera Sandstone and the Page Mill Basalt. Because they commonly occur in Tertiary sediments of the San Francisco Peninsula, these invertebrate fossils would not add new information to the paleontological record.

The most notable vertebrate fossil found in the area is a nearly complete specimen of *Paleoparadoxia*, which was discovered during SLAC excavations in 1964 (DOE 2002a). *Paleoparadoxia* is an herbivorous marine mammal of the extinct order Desmostylia, and the SLAC specimen represents the only complete post-cranial skeleton of *Paleoparadoxia* from North America. Other vertebrate sites in the area include fossils of a seal-like mammal (*Allodesmus*) and other marine mammals. Younger (Pleistocene) fossil resources identified in the area include a large mastodon tusk found in the bank of San Francisquito Creek, a multi-taxon terrestrial fauna site found near the Stanford University Medical Center and other various isolated remains (Branner et al 1906). Because vertebrate fossils are less common than invertebrate fossils and taxa are often represented by very few or individual specimens, identifiable remains could add important information to the fossil record.

Within the Proposed Action area, previous studies also identified the proposed Fixed Target Linac Historic District (District). SLAC concluded that this resource appears significant under National Register Criterion A for its contributions to high-energy physics and Criterion C for its unique, site-specific design (Page and Turnbull 2011).

To evaluate potential effects on archaeological resources in the Proposed Action area, SLAC worked with the Stanford University archaeologist to complete a reconnaissance survey of the area. In addition, Stanford University is consulting with the Muwekma Ohlone Tribe on cultural resources at SLAC. As part of this study, Stanford University completed archaeological investigations in the Proposed Action area on July 14, 2011, including two hillsides that would be affected by tunneling. The western hillside (near the existing PEP ring) was highly disturbed by fill and grading and no artifacts were found. Surveys of the relatively intact eastern hillside identified a lithic scatter composed of pieces of red Franciscan chert adjacent to the proposed location of the EH (see Figure 3-1). This potential workshop (area where stone [lithics] were prepared for manufacture of tools) will be investigated further by the Stanford University archaeologist, reviewed with the SHPO, and treated, if necessary. Treatment would require data recovery, including recording and mapping.

3.6.2 Environmental Consequences

3.6.2.1 No Action

The no action alternative would not affect historic properties or tribal interests. Current procedures for resource identification, evaluation and management established by Stanford University would remain in effect.

3.6.2.2 Proposed Action

Construction

Construction would have a minor impact on the lithic scatter adjacent to the proposed EH. This site would be addressed by the Stanford University archaeologist. Other known archaeological resources in the vicinity include lithic scatters and remnants of Camp Fremont training facilities. Although impacts on undiscovered archaeological sites could occur, these types of resources are unlikely to be found in the previously excavated research yard where surface excavation would occur. Discovery of human remains is possible, but very unlikely. Such discovery requires securing the find to protect it, redirection of project activity away from the find and immediate notification of the County Coroner. Discovery of human remains requires development of a treatment plan to be determined for the specific case, with input from the principals involved.

The District boundaries encompass contributing and noncontributing elements. The Proposed Action area encroaches into the District boundary at Sector 10 where a new injector is proposed. This location involves two contributing elements: Building 001 (the Acceleration Housing) and Building 002 (the Klystron Gallery). Buildings 001 and 002 were recommended as not individually significant, but eligible as contributors to the District (Page and Turnbull 2011). Because the proposed injector is consistent with designed use and would attach to an existing connection incorporated in the original design, the Proposed Action would have only a minor direct impact on the District and its setting.

Training tunnels were constructed by Camp Fremont for training purposes during World War I and abandoned in 1919. Remnant sections of those tunnels were encountered in the 1960s during SLAC construction. The Proposed Action area is not likely to expose or encounter remnant sections of the Camp Fremont training tunnels.

Invertebrate fossil resources are likely to be encountered at multiple points along the LCLS-II alignment during excavating activities. Because invertebrate fossils would not add to the fossil record, this impact would be minor. Vertebrate fossil resources have moderate potential to be discovered during excavating activities, particularly in bedrock of the Ladera Sandstone. Construction crews would be trained to redirect project activity away from the discovery and to contact a qualified paleontologist to secure the site and determine a course of action.

Operations

Once constructed, operations of the Proposed Action would involve access to, and use of support facilities and buildings at SLAC. These activities would have no impact on archaeological, historical or paleontological resources.

3.7 Geology and Soils

3.7.1 Affected Environment

3.7.1.1 Geology

SLAC is located in the foothills of the Santa Cruz Mountains, west of San Francisco Bay on the San Francisco Peninsula. The steep topography of the region has been created by active strike-slip and compressional tectonics. Bedrock underlying SLAC consists primarily of a thick sequence of marine sandstones, siltstones and shales that range in age from Eocene to Miocene (55 to 5 million years old). These sedimentary units include (from oldest to youngest) the Whiskey Hill Formation, Ladera Sandstone and Monterey Formation.

Steeply dipping beds of the Whiskey Hill Formation are exposed at the western and east-central portions of SLAC. The Whiskey Hill Formation is between 3,000 to 4,000 feet thick near SLAC and is composed of poorly sorted, coarse-grained sandstone and interbedded claystones, siltstone, and glauconitic sandstone. The Whiskey Hill Formation also contains extensively deformed chaotic zones consisting of a mudstone matrix with mostly sandstone blocks (Pampeyan 1993, SLAC 2006). The Ladera Sandstone is exposed in a broad syncline along the eastern portion of SLAC and in a tightly folded overturned syncline (Central Syncline) near the center of the project area (Page 1993). The Ladera Sandstone consists of silty sandstone, which grades to sandy siltstone and lesser amounts of claystone, siltstone and pebbly sandstone. The Ladera Sandstone has produced numerous fossils, including *Paleoparadoxia*, seal and whalebones, shark teeth, mollusks, fish scales, and foraminifera (SLAC 2006). Prior to the Linac cut and cover excavation, the hard, silty claystones of the Monterey Formation were exposed along the axis of the Central Syncline between linac Sectors 17.5 and 20.5. Stratigraphic thickness of the Monterey Formation where exposed along the Central Syncline is approximately 300 feet (SLAC 2006).

The middle Miocene Page Mill Basalt is present at the east end of SLAC and separates the Whiskey Hill Formation and Ladera Sandstone. Also at the eastern end of SLAC, the Ladera Sandstone is unconformably overlain by terrestrial silts, sands and gravels of the late Pliocene to Pleistocene (2 million to 100,000 years old) Santa Clara Formation (Pampeyan 1993, SLAC 2006).

Quaternary (less than 10,000 years old) alluvium, colluvium, landslide and terrace deposits are also intermittently present at SLAC. These deposits reach a maximum thickness of 22 feet. Native fill derived from excavation of Miocene and Eocene sedimentary rocks is present along the entirety of the existing accelerator and beneath many of the other existing facilities. Non-native (i.e., not locally derived) fill material is present beneath the Sand Hill Road – I-280 interchange north of SLAC (SLAC 2006).

Geologic Hazards

Most geologic hazards at SLAC are seismically induced and include ground shaking, fault rupture, ground deformation, slope instability and liquefaction. However, mass wasting events such as landslides can also occur due to heavy precipitation.

Seismic Conditions

SLAC is located in a tectonically active area, consisting of numerous faults and fault-related geological features. The San Andreas Fault system is located approximately 1 mile west of SLAC. Although movement along the San Andreas Fault is dominantly strike-slip (dextral shear), the presence of Quaternary-age folds and reverse faults subparallel to the fault suggest that compression has occurred perpendicular to the fault (SLAC 2006). Along the SLAC alignment, this is represented by the Central Syncline and other folds and high-angle reverse faults to the east (Page 1993, SLAC 2006). In addition to the San Andreas Fault, the informally named “Test Lab Fault” is present at linac Sector 27.5. During the 1989 Loma Prieta earthquake, damage to the accelerator housing, Test Lab floor and A&E Building patio reportedly occurred along the mapped trace of the Test Lab Fault (SLAC 2006).

The U.S. Geological Survey (USGS) 2007 Working Group on California Earthquake Probabilities estimated a 63 percent probability for a magnitude 6.7 or greater earthquake to occur in the San Francisco region between 2008 and 2038. By comparison, the 1989 Loma Prieta and 1994 Northridge earthquakes were magnitudes 6.9 and 6.7, respectively. The Hayward-Rodger Creek and San Andreas faults are the most likely sources of an earthquake of magnitude 6.7 or greater, with lesser probabilities that such an event will occur along the Calaveras Fault, San Gregorio Fault or others (USGS 2008).

Hazard Zones

Geologic hazards were identified by the San Mateo County Planning Department and State of California (CGS 2006; SMC 2011). Areas of potential earthquake-induced landslides and liquefaction are present along the existing linac and Proposed Action alignments. Current landslide potential is greatest at the eastern end of the LCLS-I along the flanks of the hill to the east of the linac and on the steep cut-slopes that were excavated for installation of the linac (i.e., between Sectors 17 and 22 and between 23 and 27). Liquefaction hazards are present along the length of San Francisquito Creek and the area south of the linac.

3.7.1.2 Soils

Soils at SLAC were described in the LCLS-I EA (DOE 2002a) and are based on U.S. Department of Agriculture (USDA) mapping from 1991 (USDA 1991). Designated soil groups at SLAC are defined by the USDA as:

- *Accelerator-Fagan Association and Accelerator-Fagan Urban Complex.* These are the main soils at SLAC and consist of clay-loam soils. They formed in material weathered from softer sandstone and siltstone at SLAC. Permeability is moderately low to low; available water capacity is moderately high to high.
- *Botella Loam and Botella-Urban Land Complex.* These are thicker and better-drained soils that formed from unconsolidated sediments, such as alluvial materials found at SLAC.
- *Urban Land Association.* These are areas where no soil exists or where more than 85 percent of the surface is covered by asphalt, concrete or buildings.

3.7.2 Environmental Consequences

3.7.2.1 No Action

The no action alternative would not involve excavation or tunneling; therefore, no impacts on geological or soils resources would occur.

3.7.2.2 Proposed Action

Construction

SLAC geology has been extensively researched and documented since the 1950s, culminating in the publication of a SLAC-specific geological report (SLAC 2006). Although construction of the Proposed Action would require extensive excavation of bedrock, surficial expressions of geologic features have been documented and excavation would not result in the loss of significant geologic data. Additionally, excavation would provide geologists the opportunity to further document subsurface geology of SLAC. No existing points of geologic interest, such as quarries or natural bedrock exposures, would be disturbed by the Proposed Action. Potential impacts on paleontological resources are discussed in Section 3.6 of this EA.

Short-term impacts on soils located on hillsides at the tunnel location and the new EH would include increased risk of erosion due to vegetation removal caused by the use of heavy equipment, such as road headers and other excavators. Soil slope destabilization may create increased erosion and risk of sedimentation in San Francisquito Creek. The construction contractor would implement a SWPPP during construction to control soil erosion. To minimize soil impacts, soil disturbance and grading would be minimized. Regrading of slopes would be completed during site restoration and stabilization, as necessary. Soil erosion control measures would be implemented and would include BMPs such as diverting runoff from exposed soil surfaces, revegetating disturbed areas, and other measures to collect and filter runoff over disturbed land surfaces (e.g., sediment/silt fences). Given the use of BMPs, excavation and grading would result in only minor, short-term adverse impacts on soils.

Operation

Project facilities may be at risk of damage due to seismic activity. Damage to SLAC facilities, including the linac accelerator housing, along the 'Test Lab Fault' may be repeated in the event of an earthquake of similar or greater magnitude. The probability of such an event occurring before 2038 is approximately 63 percent (USGS 2008). To minimize potential impacts on safety of employees deployed in LCLS-II buildings and tunnels, all structures would be designed to conform to California Building Code 2010[3] requirements as well as SLAC Building and Site-Wide Design guidelines (SLAC 2011a), including seismic performance requirements and would be constructed of metal with steel framing. The structures would be designed and constructed to resist seismic loads. In addition, SLAC has an Emergency Preparedness Plan (SLAC 2007b) that addresses risks to employees in buildings in the event of an earthquake or fire, including establishment of an emergency operations center, emergency communications procedures, emergency medical and firefighting support. The plan requires training, drills and exercises, and evaluations. Local fire departments serving SLAC as well as SLAC's Emergency Response Teams would also assist with search and rescue operations. Therefore, any impacts on worker safety during seismic events or other emergencies such as fires (wildlands or buildings) would be minimized through employing current structural design criteria and SLAC's emergency procedures and would be minor.

The Proposed Action would require the excavation of significant amounts of soil and bedrock, resulting in creation of steep slopes and removal of vegetation. These areas would be subject to increased likelihood of mass wasting (i.e., landslides) in the event of earthquakes or periods of intense precipitation. SLAC would incorporate applicable construction and building codes, including those applicable to geotechnical concerns.

Operation of the Proposed Action would have no impact on soils. Ongoing grounds maintenance includes mowing and soil erosion and would be addressed by the existing site-wide SWPPP. Operations would not require excavation or grading. The Proposed Action would not result in any incremental impacts beyond those resulting from facility and grounds maintenance.

[3] Title 24, California Code of Regulations, "California Building Standards Code", Part 2, "California Building Code"

3.8 Health and Safety

3.8.1 Affected Environment

SLAC has a mature safety program to protect workers and the public from hazards associated with activities conducted at SLAC's facilities. SLAC has integrated safety into its management and work practices at all levels by developing and implementing an Integrated Safety and Environmental Management System (ISEMS). The ISEMS applies the following five core functions:

- Define scope.
- Analyze hazards.
- Develop/implement hazard controls.
- Perform work within controls.
- Feedback and Improvement.

SLAC's Worker Safety and Health Program (WSHP) document is the primary ISEMS document (SLAC 2011b). All DOE sites are required to establish a WSHP in accordance with 10 CFR 851 to reduce or prevent the potential for injuries, illnesses and accidental losses by providing workers with a safe and healthful workplace. The WSHP applies to all non-radiological safety and health issues associated with design, construction, operation, maintenance, decontamination and decommissioning, research and development, and restoration activities at SLAC's facilities.

In addition to ongoing worker health and safety programs, SLAC has developed and implemented processes to adequately identify and address hazards before authorization and release of project activities (e.g., Experimental Project Review Process). These review processes involve input from subject matter experts and institutional safety officers (e.g., radiation, electrical). In addition, SLAC assures consistency of engineering conventional facility designs with applicable codes and standards through independent peer review and internal evaluations conducted by the SLAC Building Inspection Office. Hazards with environmental impact are addressed in other sections of this EA (i.e., air quality, hazardous materials and waste management, geology for soil and groundwater issues, hydrology and water quality).

The primary operational health and safety issue for the Proposed Action would be the potential for beam radiation to penetrate the accelerator shielding during beam operation. However, beam radiation is only present during beam operation and ceases instantly when the beam is turned off. The paragraphs below describe both the physical shielding and radiological safety programs that minimize radiological safety impacts.

The first line of protection against radiation is the Beam Containment System, which would be designed to contain the beam in proper channels. For example, collimators are designed to contain the beam if it should deviate from the designed beam path. The LCLS-II dump would be heavily shielded such that there would be no groundwater activation. The residual activity in the soil would be negligible and limited to a localized area immediately around the beam dump shielding.

Radiation protection would also be provided by shielding. SLAC's Radiation Protection Department includes the Radiation Physics Group, provides expertise in shielding design for new experiments and facilities, and provides oversight for the safe operation of beam lines and safety systems to protect workers, the public and the environment. Radiological protection for the accelerators and primary electron beams at SLAC requires thick concrete walls. The concrete walls of the LCLS-II BTH would be 6 feet thick. The EBD would be equipped with a specially designed separation wall and radiation shielding maze. Other beam loss locations would require local steel shields. LCLS-II shielding would conform to SLAC's Radiological Control Manual (SLAC 2010b) and Radiation Safety Systems Technical Basis Document (SLAC 2010c) guidelines and requirements. Radiological hazards are addressed through SLAC's Radiation Protection Program (SLAC 2010d), which complies with 10 CFR 835 for occupational radiation protection. The Radiation Safety System at SLAC is designed to ensure that radiation doses above background that are received by workers and the public are as low as reasonably achievable (ALARA) and to prevent any person from receiving more radiation exposure than is permitted under federal government regulations.

SLAC Radiation Protection's Field Operations Group (RPFO) oversees radiological monitoring and control. SLAC's Dosimetry and Radiological Environmental Protection Group provides dosimetry services for site workers and environmental impact monitoring and assessment. Radiation loss monitors in the EH would detect radiation from beam radiation escaping to areas outside the shielding. An Access Control System (ACS), consisting of electrical interlocks and mechanical barriers, would protect SLAC employees and researchers from radiation. This system would turn off the beam if site workers inadvertently breached the beam containment systems or if a security violation were detected.

SLAC's Radiological Environmental Program assesses direct radiation and radioactivity in water, air and soil to determine the potential radiation dose to the public and impacts on the environment. Radiation that escapes to the environment is minimized by facility design (i.e., underground construction, beam containment, shielding); however, substances exposed to photons and neutrons that escape the accelerator housing and strike soil or water may create activation products or radioactive isotopes of atoms present in soil (oxygen, nitrogen, carbon, beryllium) as well as water. The half-lives of most of these isotopes are measured in minutes; however, the half-life of beryllium (^{7}Be) is 53.6 days and the half-life of hydrogen ^{3}H (tritium or heavy water) is 12.3 years.

SLAC monitors the small fraction of photons and neutrons that pass through the accelerator components, through the surrounding earth or walls, to reach areas outside of the accelerator housing. Federal and DOE regulations (10 CFR 835 and DOE O 5400.5) require SLAC to demonstrate that radiation and radioactivity does not expose the public to radiation doses greater than 100 millirems (mrem; a unit used to quantify radiation dose to humans) during the year (10 CFR 835). In 2010, the maximum dose was less than 0.13

mrem at off-site receptor locations, or 0.13 percent of the 100 mrem regulatory limit (RP-DREP-10110421-MEM-01). This dose was estimated by measuring site boundary radiation dose at 43 locations using environmental Thermo Luminescent Dosimeters.

SLAC also assesses and reports on airborne radioactivity as required by its policies and by state or federal regulations. EPA regulations (40 CFR 61) enacted under the Clean Air Act and DOE Order 5400.5 requires SLAC to demonstrate that airborne radioactivity does not result in annual doses greater than 10 mrem (DOE Order 5400.5). In 2010, the maximum dose was 0.00086 mrem at off-site receptor locations, or less than 0.009 percent of the 10 mrem regulatory limit (SLAC 2010e). SLAC reports filed annually with EPA estimate airborne doses based on conservative estimates of radioactive isotopes in air (e.g., Argon [^{41}Ar], Nitrogen [^{13}N], Oxygen [^{15}O] and Carbon [^{11}C]) generated using EPA software, CAP88-PC.

SLAC also monitors radioactivity in industrial wastewater, stormwater and groundwater. Federal (10 CFR 20.2003) and state (17 CCR 30253) regulations limit the radioactivity in industrial wastewater. In 2010, SLAC released less than 0. 24 percent of the applicable limits, primarily as tritium 12 mCi in calendar year 2010) (SLAC 2011c). No radioactivity other than naturally occurring background was detected in stormwater (SLAC 2010f). Groundwater monitoring under SLAC’s groundwater Self-Monitoring Program found only radioactivity of tritium in four monitoring wells. For 2009, the maximum quarterly average tritium value was 3970 picoCuries per liter (pCi/L), with a range from below detection limits (500 pCi/L) to 3970 pCiL (SLAC 2010f). However, this radioactivity (tritium) was below the federal and state drinking water standards, which are both 20,000 pCi/L (40 CFR 141.66 and 22 CCR 64443). In addition, groundwater is not used at SLAC as a source of drinking water because of insufficient quantity and total dissolved solid (TDS) concentrations; thus, no exposure pathway occurs.

To minimize exposure to radionuclides in soil during construction projects, SLAC’s Excavation Clearance Program ensures proper disposal of excavated soil. Any excavation on site requires completion of an excavation permit form to identify potential hazards, methods to reduce potential exposure to elevated chemical concentrations and radiological hazards, and disposal options for excavated soil.

The SLAC LCLS-II area is considered a low risk site for wildfire under the guidelines of NFPA 1144, "Protection of Life and Property from Wildfire."

3.8.2 Environmental Consequences

3.8.2.1 No Action

The no action alternative would not result in new health and safety impacts to the public or site workers. SLAC’s existing health and safety hazards would exist and continue to be managed in accordance with established programs, policies and procedures.

3.8.2.2 Proposed Action

Effects from Construction

Similar to the effects of construction identified in the LCLS-I EA (DOE 2002a), the potential construction health and safety impacts would be limited to within SLAC site boundaries. While there would be an increase in off-site truck traffic from import of construction materials and waste hauling, any risk of accidents would be minimized by implementing avoidance and minimization measures, including preparing and implementing a traffic control plan. Therefore, any health and safety impacts of the Proposed Action to the public would be minor and short term.

SLAC employees and contractors may encounter hazards associated with construction activities, including excavation, heavy equipment, high voltage, traffic, dust, fumes and noise. These hazards are addressed through existing programs, engineering and/or administrative controls, and use of appropriate personal protective equipment. All areas accessible to workers would be routinely monitored and appropriate signs would be posted. These controls and protective measures are designed to adhere to applicable safety standards, which would reduce the probability of construction accidents. As described in the LCLS-I EA (DOE 2002a), the potential for exposure to radiation during construction would be minimal.

Potential on-site employee and general worker health and safety hazards associated with LCLS-II construction activities include heavy equipment use, material handling/rigging, and excavation and tunneling. Hazardous materials used during construction may include paints, epoxies, oils and lead for construction of shielding. These hazards would be avoided or minimized by conducting task-specific hazard analyses; delineating and establishing project boundaries and barriers; implementation of existing safety programs, procedures and training; and conducting routine inspections. These programs are in place for all SLAC employees and other on-site workers. It is anticipated that LCLS-II construction workers would primarily consist of subcontractors selected by SLAC that must meet safety qualification criteria. SLAC has well-established safety procedures for subcontractors, which are summarized in the site Environment, Safety and Health (ESH) Manual (SLAC 2011d). SLAC would require contractors to develop and implement site-specific health and safety plans that are reviewed and approved by SLAC prior to performance of work, as well as to complete appropriate site-specific health and safety training. Daily tailgate safety meetings would be conducted during LCLS-II construction activities.

SLAC's Excavation Clearance Program would minimize exposure to hazards in excavated soil. As described in Section 2.1.2.5 of this EA, the areas that would be tunneled and excavated during Proposed Action construction would be sampled and SLAC would identify potential hazards and methods to reduce potential exposures to elevated chemical concentrations and radiological hazards, as well as proper disposal options.

Wildfire risk on the east side of the SLAC site, where the LCLS-II exterior construction work would occur, involves the potential for ignition of dried grass. For any large-scale exterior construction work occurring during the wildfire season (typically beginning about April and continuing through about

October), grass fire risk is primarily contained by requiring that all grass within the construction site and for a minimum of 30 feet around the maximum anticipated boundary of the construction site be controlled. The grass would cut to ground level as soon as it is dry. Contractors are required to follow all construction site fire safety precautions contained in OSHA, the California Fire Code, and NFPA 241, "Standard for Safeguarding Construction, Alteration and Demolition Operations." In addition, all ignition sources on the construction site are controlled. Smoking would be limited to designated areas, and all hot work would be controlled through the hot work permit program. Exterior hot work would be prohibited on hot, dry, windy days designated by the State of California as red flag days, which are very rare at SLAC.

Given the safety and health protection programs already in place at SLAC, including protection of workers and residents from construction hazards and exposure to chemicals and radiation in excavated soil, construction of the Proposed Action would result in only minor impacts to worker health and safety.

Effects from Operations

The Proposed Action would not generate new operational hazards that have not already been contemplated and addressed during previous SLAC projects (e.g., LCLS-I) or routine operations. Potential hazards for SLAC employees and other site workers include fire, electric shock, exposure to hazardous materials, seismic risks and other adverse effects from the environment. Hazardous materials generated during operations may include very small quantities of lead, beryllium and oily waste. Electrical systems would produce high voltages. These risks are addressed in the ESH Manual (SLAC 2010g), which describes lockout and tagout procedures for electrical safety, emergency preparedness, and construction safety measures and accident reporting. Tunneling and excavation risks would only affect LCLS-II workers and would be addressed by occupational health and safety regulations.

SLAC research facilities also produce a hazard of ionizing and non-ionizing radiation exposure. Radiation exposure risk was addressed in the LCLS-I EA (DOE 2002a), including a comparison of exposure to naturally occurring radiation with exposures at SLAC. Typical background exposure of humans to radiation, including cosmic radiation, naturally occurring radiation on earth (e.g., building materials, water supplies) and medical sources is approximately 620 mrem per year) (NCRP 2009). Radiation exposure at SLAC is minimized through engineering measures including electron beam dumps, and through construction of thick concrete walls. Design criteria for radiation shielding at SLAC are based on controlling individual doses from external radiation sources to less than 1,000 mrem total effective dose per year and kept ALARA (SLAC 2010g). For LCLS-II operation, SLAC is providing the following conservative radiation risk calculations even though radiation risks at low dose levels are subject to large uncertainties. The uncertainties in risk estimates result in a 90 percent confidence interval for the lifetime risk for fatal cancer from 1.20×10^{-4} to 8.84×10^{-4} per rem, with an average risk for the U.S. population of 4×10^{-4} per rem (NCRP 2009). SLAC has assumed conservatively that a maximally exposed individual (MEI) for any single year would be exposed at the maximum dose rate for the entire 30 years of assumed LCLS-II operation, which is very unlikely.

Conservative estimates have been made to calculate radiation doses and associated risks to MEI and to the surrounding population within 80-km radius of SLAC (approximately 5 million persons). The estimates are based on two radiation pathways: from direct radiation and from the air pathway. The results of these estimates are shown in Table 3-7 below:

Table 3-7 SLAC Radiation Dose Estimates and Associated Risks

Pathway	MEI Dose (rem per year)	Population Dose (person-rem per year)	MEI Lifetime Risk for 30 years of Operation	Population Dose Lifetime Risk for 30 years of Operation
Direct	0.00052 (5.2E-04)	0.049 (4.9E-02)	6.2/1,000,000 (6.2E-06)	590/1,000,000 (5.9E-04)
Air	0.000055 (5.5E-05)	0.31 (3.1E-01)	0.66/1,000,000 (6.6E-07)	3,700/1,000,000 (3.7E-03)
Total	**0.00058 (5.8E-04)**	**0.36 (3.6E-01)**	**6.9/1,000,000 (6.9E-06)**	**4,300/1,000,000 (4.3E-03)**

Notes:
Dose values are presented as decimal values (e.g., 0.00052) and in scientific notation (e.g., 5.2E-04)
Risk values represent incremental cancer incidence per 1 million people (e.g., 6.9 per 1,000,000 or 6.9E-06 (6.9 x 10^{-06})

Dose estimate for the direct radiation pathway is based on the monitoring results of environmental dosimeters placed around SLAC site boundary during CY2010 for LCLS-I operations (SLAC 2011e). The monitoring results were conservatively scaled up for LCLS-II operations to account for differences in supporting klystron operations.

Dose estimates for the potential radioactive air pathway were based on the calculations using the EPA approved CAP88-PC software, with the physical designs and beam operating LCLS-II parameters.

The lifetime dose risk to the MEI from 30 years of LCLS-II operation is 6.9 in 1 million (6.9×10^{-06}). For comparison, the natural lifetime risk of fatal cancer in the U.S. population is about 0.2 (2 in 10). All the risk values in the above table are significantly less than this reference value by many orders of magnitude.

Workers engaged in the proposed action would also not be expected to incur harmful health effects from radiation exposures that they could potentially receive during normal operations. The maximum exposure to a radiological worker from the LCLS-II operations would be well below 0.5 rem in one year (SLAC Administrative Control Level), and the average annual dose to an individual worker would not exceed 0.1 rem. For reference, the average dose to the limited SLAC worker population who has received doses from work was approximately 0.28 rem per year between 2005 and 2009, much lower than the DOE dose limit of 5 rem for radiological workers. The number of radiation-induced fatal cancers in the potentially exposed SLAC population (conservatively assumed to be 50 individuals and that each worker would receive 0.1 rem per year) over the operating period of 30 years is less than 0.06, with a 90 percent confidence interval ranging from 0.02 to 0.14. In comparison, the cumulative number of naturally occurring cancer deaths expected in the same population (50) would be about 10. Therefore, the total lifetime fatal cancer incidence for SLAC workers would be 10.06.

Additional risks to workers under potential accident scenarios are negligible because of deployment of robust and layered engineered and interlocked radiation safety systems for LCLS-II operations.

Since preparation of the LCLS-I EA, SLAC has continued to monitor radiation doses to off-site receptors from all SLAC sources and publishes these data in the site's annual reports. Radioactivity in air, soil, groundwater and wastewater, and modeled doses based on constant presence on site results in only a minor human health risk beyond naturally occurring levels (SLAC 2010f). The Proposed Action would create an additional source of radiation; however, given the design measures described above, off-site radiation exposure would remain much lower than the naturally occurring background levels.

Similarly, any exposure of biological resources would be below exposure standards. DOE risk assessment methods (DOE 2002b) state that exposure of plants and animals should not exceed 1 rad[4] per day for aquatic receptors and terrestrial plants and 0.1 rad per day for terrestrial animals (DOE 2002b). Monitoring conducted for 6 months in 2009 at 400 on-site locations found average doses of less than 0.00019 rad per day. Because many of the monitoring locations were inside shielding facilities (i.e., concrete walls), SLAC found that any exposure of plants and animals outside the shielding would be below DOE standards. SLAC also determined that any doses to plants and animals from the tritium concentrations found in isolated samples would not result in greater than 1 rad per day for plants and animals. Therefore, any impact from LCLS-II radiation would be minor.

Other potential health and safety impacts could result from accidents and malevolent acts from internal or external sources. Possible consequences involving radiation include beam-loss events and release of induced radioactivity into the air from normally sealed spaces. The most serious radiation accident that could occur during operations would be the total loss of the injector beam at the maximum possible current and energy. Based on maximum credible beam power of 100 kilowatts at 15GeV and beam loss at a location where the shielding is least extensive (4 feet concrete roof at BTH), the calculated dose equivalent rate to the nearest residential area (a distance of approximately 1640 feet) would be 0.20 mrem per hour (SLAC 2011f). This exposure would last for only a fraction of a second before the beam would shut down, thereby producing a negligible radiation dose as compared to the DOE dose limit of 100 mrem/year. To minimize the potential for malevolent acts, SLAC has assessed potential risks and implemented site security countermeasures. Therefore, impacts from accidents or malevolent acts and any related radiation releases would have only minor health and safety impact on SLAC workers and area residents. Risks to SLAC employees and other on-site workers would be avoided or minimized by the Personnel Protection Systems, including interlocks to control access, emergency shutoff capabilities, Beam Containment System with automatic shutdown, a laser safety program, and radiation safety training requirements. Furthermore, construction projects such as the Proposed Action are required to comply with the Excavation Support Program to minimize exposure to hazards in site soils. Overall, safety and health hazards would be reduced or avoided through established and previously referenced SLAC ESH programs, policies and procedures. Therefore, operation of the Proposed Action would result in only minor impacts on health and safety.

[4] absorbed ionizing radiation dose equivalent to an energy absorption per unit mass of 0.01 joule per kilogram of irradiated material

3.9 Hydrology and Water Quality

3.9.1 Affected Environment

3.9.1.1 Surface Water

SLAC is located within the watershed of San Francisquito Creek, a perennial stream that flows from the foothills of the Santa Cruz Mountains eastward near the southern border of the SLAC site and eventually discharges into San Francisco Bay. San Francisquito Creek forms the boundary between San Mateo and Santa Clara counties (Figure 1-1). The USGS has measured streamflow since 1930 at a gauging station on San Francisquito Creek, downstream of SLAC. The mean monthly stream flow varies from 20,643,361 gallons per day (gpd) in the wet months (October to May) to 387,790 gpd in the dry months (June to September) (San Francisco Bay Regional Water Quality Control Board [SFBRWQCB] 2009).

Stormwater from the existing SLAC facilities is discharged to San Francisquito Creek via a storm drain network. It is first collected in two major surface-water channels: IR-6 and IR-8 (see Figure 3-1) drainage channels. The storm drain network includes surface channels and a culvert located underneath property owned by Stanford University and leased to the PVTC, which operates an equestrian facility. Stormwater from these areas flows into a sedimentation pond prior to its discharge to San Francisquito Creek. The IR-6 watershed (approximately 30 acres) is primarily covered by pavement and buildings, including the SLAC research yard. The IR-8 watershed (approximately 65 acres) is also largely paved and includes the SLAC campus. Stormwater from the area of the western portion of the linac flows off site through local drainage ditches (SFBRWQCB 2009). Undeveloped areas west of I-280 drain south through five stormwater channels to San Francisquito Creek. The extreme western portion of the SLAC facility drains west into Bear Creek, a tributary of San Francisquito Creek (Exponent 2007).

As described in the LCLS-I EA (DOE 2002a), no portion of the SLAC facility boundary is located in the 100-year floodplain. San Francisquito Creek is subject to flooding, primarily in areas downstream of SLAC. Most runoff from the developed areas east of I-280 is captured by a storm drain network. Runoff from the existing facilities drains to the southeast. SLAC has 25 separate discharge points, including tributaries of San Francisquito Creek that flow through culverts under the linac (see Figures 1-2a and 1-2b). Some of these drainages under the linac also collect groundwater seepage and may have low base flow levels, even in dry weather.

Water quality in San Francisquito Creek is typical of urban areas and the creek is on the 2006 Clean Water Act Section 303(d) list of water quality limited segments (State Water Board 2006) for diazinon and sedimentation/siltation. New development must comply with the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP).

3.9.1.2 Groundwater

SLAC is adjacent to the northern boundary of the Santa Clara Valley groundwater basin and straddles the western boundary of the San Mateo Plain groundwater basin. Based on topography, the regional groundwater flow direction is generally to the south and southeast toward San Francisquito Creek. However, groundwater flow directions and gradients across SLAC have been modified locally due to grading and previous construction as well as the subdrain system constructed at the base of the linac approximately 35 to 40 feet bgs.

3.9.2 Environmental Consequences

3.9.2.1 No Action

The no action alternative would avoid surface waters and groundwater impacts because SLAC would not conduct excavation or construction. No impervious surfaces would be added to the site and, under the no action alternative, no additional stormwater pollution or volume would be generated such as to risk potential spills that could affect water quality.

3.9.2.2 Proposed Action

Surface Water

Construction

Construction of the Proposed Action, including on-site soil relocation, would take place at least 1,500 feet from the San Francisquito Creek. Construction, trenching, grading and stockpiling activities would, if not properly addressed, result in bare soil that could be eroded by wind and rainfall and ultimately migrate into drain into San Francisquito Creek. The resulting sedimentation in San Francisquito Creek could degrade water quality and channel siltation could affect hydraulic capacity and habitat quality. Discharge of stormwater into San Francisquito Creek is regulated under a general industrial storm water discharge permit issued by the State Water Resources Control Board.

To address potential water quality impacts, SLAC would obtain a General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit Order 2009-0009-DWQ. The permit requires the development and implementation of a construction SWPPP, which includes project-specific BMPs, a visual monitoring program, and a chemical monitoring program, if there is a failure of BMPs. The construction SWPPP would focus on preventing sediment from reaching San Francisquito Creek through implementation of BMPs that focus on management of disturbed soil and excavated material, and use of secondary containments and drip pans for temporary storage of chemicals and heavy and oil-filled equipment. Therefore, potential water quality impacts from the accidental release of hazardous materials would not likely occur.

Operations

Proposed Action operations would have minor effects on stormwater quality. Additional vehicles may contribute increases in oil and fuel use, as is the case in any parking lot or roadway; however, all parking areas at SLAC are managed through BMPs as required by the SWPPP. Stormwater would continue to be sampled and analyzed as required by the SWPPP. The new impervious surfaces added with the Proposed Action would not result in an increase in runoff volume that would result in flooding. Because the Proposed Action would be constructed largely within the footprint of existing facilities and would use existing disturbed or paved areas for staging, its construction would result in only a 2 percent increase in impervious surfaces on site. The Proposed Action would comply with existing stormwater regulations and would allow percolation of stormwater in detention basins or similar BMPs. Therefore, the Proposed Action would have no impact on flooding.

SLAC's wastewater discharges are regulated under Mandatory Wastewater Discharge Permit No. WB061216 issued by the South Bayside System Authority and the West Bay Sanitary Sewer District. Given compliance with this discharge permit, operational discharges from the Proposed Action would result in no impacts.

Groundwater

Construction

Groundwater quality would not be impacted by Proposed Action construction. The depth to groundwater is 5 to 10 feet below the construction activities in the research yard. Any impacts on groundwater flow would be temporary and localized. Potential impact on groundwater quality would be addressed through implementation of pollution prevention BMPs described above.

Operations

Groundwater quality would not be affected by operation of the Proposed Action. The depth to groundwater is 5 to 10 feet below the research yard, and at least 25 feet below the base of the LCLS-I FEH. Use of chemicals during operation of the Proposed Action would be in small quantities and indoors and would have only minor potential impacts on groundwater.

Proposed Action operations would have only minor, localized impacts on groundwater hydrology. Bedrock groundwater from a thick sequence of marine sandstones is present beneath SLAC. This groundwater has naturally high TDSs, sulfate and chloride levels that make it unsuitable for drinking. In addition, the bedrock has low hydraulic conductivity and well yields are too small (less than 60 gallons per day) to provide a single private well with adequate supply (SLAC 2001). Recent alluvium does not occur in sufficient saturated thickness at SLAC to form an aquifer. Groundwater is not used as a water supply source at SLAC. The Proposed Action would include a drainage system to control groundwater infiltration. Collected water would be discharged to the sanitary sewer after a sample is collected. Therefore, the Proposed Action would have a minor, localized impact on groundwater flow and direction. Pursuant to San Mateo County well ordinances, the construction contractor would identify any groundwater wells in the project area and would implement a wellhead protection program as warranted for wells that provide drinking water. None of the wells at SLAC are used for potable water.

3.10 Noise and Vibration

This section evaluates potential noise and vibration effects of construction and operation of the Proposed Action. Appendix C provides supplemental technical information to support the analysis, including ambient noise levels and typical noise and vibration levels produced by heavy construction equipment used in noise modeling as well as terms and definitions.

3.10.1 Affected Environment

Land adjacent to the Proposed Action includes intermixed residential, commercial, agricultural and undeveloped areas of Menlo Park. The existing ambient noise environment near the project site is mainly affected by vehicle noise associated with I-280 and the existing SLAC operations. Residences adjacent to SLAC are found to the north, east and south; the nearest residence is approximately 1,200 feet from the eastern portion of the Proposed Action construction area.

In 2006, SLAC completed an ambient noise study (Charles M. Salter Associates, Inc. 2006), including 24-hour ambient noise measurements in residential areas near SLAC on March 8 and 9, 2006 (Appendix C, Figure C-1). Monitor 1 was located 450 feet south of Sand Hill Road, along SLAC's northern boundary. Monitor 2 was located on the southeastern corner of Campbell Lane and Branner Road. Monitor 3 was located on the southeastern corner of the SLAC property line, approximately 340 feet south of the intersection of Alpine Road, Sneckner Court and Bishop Road. Detailed results are presented in Appendix C. Monitoring results are shown in Table 3-8.

Table 3-8 Existing Noise Levels at the Nearest Sensitive Receptors

Sensitive Receptor	City of Menlo Park Daytime/Nighttime Noise Limit (Leq, dBA)	Monitored 24-hour Noise Level (Leq, dBA)	Monitored Daytime Noise Level (Leq, dBA)	Monitored Nighttime Noise Level (Leq, dBA)
1	60/50	56.2	57.7	49.5
2	60/50	54.2	55.7	47.7
3	60/50	66.4	67.7	60.8

Notes:
dBA = decibels A-scale

The table shows that the existing monitored daytime levels are 2.3 to 4.3 dBA below the City of Menlo Park's noise limits at receptors 1 and 2, and exceed limits at receptor 3. Existing nighttime levels are 0.5 to 2.3 dBA below the City of Menlo Park's limits at receptors 1 and 2, and exceed the City's limits at receptor 3. These data show that ambient noise sources such as automobile and truck traffic generate noise that exceeds local noise standards.

EPA (1974) published noise criteria for protection of public health and welfare using the day-night average sound exposure (Ldn) metric (Appendix C). These guidelines, which provide standards intended to be generally applicable throughout the U.S., include an Ldn of 45 dBA indoors and 55 dBA outdoors for residential areas in a rural setting. Table 3-9 summarizes the maximum noise level exposure guidelines for specified land uses.

Table 3-9 Summary of EPA Noise Guidelines

Effect	Noise Level	Land Use Area
Hearing Loss	Leq(24) = < 70 dB	All Areas
Outdoor activity interference and annoyance	Ldn = < 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time, and other places in which quiet is a basis for use.
	Leq(24) = < 55 dB	Outdoor areas where people spend limited amounts of time (e.g., school yards, playgrounds)
Indoor activity interference and annoyance	Ldn = < 45 dB	Indoor residential areas.
	Leq(24) = < 45 dB	Other indoor areas with human activities (e.g., schools)

Note:
dB = decibel
Source: EPA 1974

The City of Menlo Park Municipal Code contains limits for the generation of typical construction noise on adjacent properties within the city. Section 8.06.030 includes criteria for maximum noise levels at residential property lines, as summarized in Table 3-10. The code limits construction hours to the hours of 8:00 a.m. through 6:00 p.m. The code permits powered equipment used on a temporary, occasional or infrequent basis within these hours, as long as it does not generate noise in excess of 85 dBA at 50 feet. SLAC requests its contractors to follow City of Menlo Park requirements when practicable.

Table 3-10 City of Menlo Park Municipal Code Sound Level Limits

Maximum Sound Level Measured from Residential Property (Leq, dBA)	Time Period
60	Daytime Hours: 7:00am to 10:00pm
50	Nighttime Hours: 10:00pm to 7:00am

Source: City of Menlo Park 2010

3.10.2 Environmental Consequences

This section evaluates the potential effects of LCLS-II construction and operational noise and vibration on the environment. All effects discussed in this section would be direct effects.

3.10.2.1 No Action

Under this alternative, there would be no construction, operation or decommissioning of equipment. Ongoing activities associated with the existing experimental facilities would continue. No increases in noise levels would occur under this alternative. Therefore, the no action alternative would not have additional noise effects on sensitive receptors.

3.10.2.2 Proposed Action

Construction

Construction would require the use of heavy equipment including excavators, loaders and haul trucks. The majority of the construction would be conducted during the daytime hours from 8:00 a.m. to 6:00 p.m.; however, tunneling and other excavation and construction of the major facilities (e.g., EH) would be completed in two 10-hour shifts per day, encompassing evening and nighttime hours. To minimize nighttime noise impacts and comply to the extent practicable with the City of Menlo Park's noise standards, the construction contractor would conduct heavy excavation during the day. For example, the excavation and hauling required for construction of the EH and to create the tunnel entrance (and exit) would be conducted during the day. After the tunnel entrance is created, the majority of excavation would occur within the tunnel and would proceed day and night. Construction noise within the tunnel would be attenuated by the tunnel walls. To limit nighttime noise impacts, the construction contractor would remove excavated material from the tunnel during the day and would generally minimize nighttime noise in areas outside the tunnel, including use of loaders and idling of equipment.

To evaluate potential construction noise impacts, reference noise levels were used to estimate construction equipment noise sources (U.S. Department of Transportation, Federal Highway Administration 2009). Based on these reference values (Appendix C, Table C-4) and the construction equipment required for the Proposed Action, the loudest equipment would generally emit noise in the range of 80 to 86 dBA maximum noise level at 50 feet. Noise levels at any specific receptor would be dominated by the closest and loudest equipment. The types and numbers of construction equipment affecting any specific receptor location would vary through time.

To evaluate potential noise effects of the Proposed Action, a robust (multiple, simultaneous noise sources) noise model, Computer Aided Noise Abatement Ver. 4.0 (Cadna A), was used to predict noise levels at each receptor. A detailed description of the Cadna A noise model used in this analysis is provided in Appendix C, Section C.4.

The following model input data and assumptions were used:

- For conservative modeling purposes, detailed noise deflection effects of terrain and intervening buildings were not considered.
- Construction equipment for tunneling and construction of buildings, including the EH, would include road headers, loaders, dump trucks and haul trucks, operating simultaneously (see Appendix C, Section C.5).
- No pile drivers or explosives would be used.

- Receptors 1, 2 and 3 were modeled at the same locations where noise levels were monitored (see above). Receptor 1 would be located approximately 1,460 feet from construction, Receptor 2 would be located approximately 1,500 feet from construction and Receptor 3 would be located approximately 1,600 feet from construction.
- Daytime construction noise modeling assumed a reasonable worst-case scenario of simultaneous tunnel excavation and facility construction at the EH and BTH.
- Nighttime construction noise modeling assumed that all activity occurred at the tunnel entrance (i.e., as a worst case, no attenuation was assumed from construction equipment inside the tunnel).
- Construction hours: Two 10-hour shifts of 8:00 a.m. to 6:00 p.m. and 6:00 p.m. to 4:00 a.m., Monday through Saturday.
- Utilization factors (percent of time each piece of equipment would be used): 80 to 100 percent (see Appendix C).

Table 3-11 lists the predicted noise levels for each receptor. The results show that construction noise would not exceed any of the City of Menlo Park's noise limits and would not exceed any existing monitored noise levels at any location. The highest predicted Leq noise levels from construction equipment would be 56.4 dBA during the day and 45.2 at night at Receptor 1. These levels would be at least 3 to 4 dBA below the City of Menlo Park's limits. Addition of this noise source to existing conditions would not likely increase noise levels above the City of Menlo Park's noise limits because the modeled levels are conservative (higher than expected actual conditions) and the majority of excavation would be completed within the tunnel and cavern excavations. Use of powered equipment would also not exceed the City of Menlo Park's limits of 85 dBA for occasional use. Therefore, construction-related noise impacts would be minor.

Table 3-11 Construction Equipment Noise Levels at the Nearest Sensitive Receptors

Sensitive Receptor	City of Menlo Park Noise Limit (Leq, dBA)	Monitored Noise Level (Leq, dBA)	Predicted Construction Noise Level (Leq, dBA)
Daytime			
1	60	57.7	56.4
2	60	55.7	47.2
3	60	67.7	53.0
Nighttime			
1	50	49.5	45.2
2	50	47.7	40.7
3	50	60.8	40.3

During construction, use of heavy equipment would generate ground-borne vibration. Potential sources of vibration would include road headers, excavators, dump trucks, backhoes, compactors and other vibration-intensive equipment. According to the United States Department of Transportation, Federal Transit

Administration (FTA) guidelines, a vibration level of 65 VdB[5] is the threshold of perceptibility for humans (FTA 1995) and levels exceeding 80 VdB during infrequent events could have a substantial effect. Based on the FTA-published construction equipment vibration levels (Appendix C, Table C-5), the types of equipment to be used and the distances to the receptors, vibration levels would be approximately 41.0, 40.6 and 39.8 VdB at Receptors 1, 2 and 3, respectively. Therefore, vibration levels at all selected receptors would be below perception and consequently, no vibration impacts would occur. For further information regarding the vibration calculation methodology, please refer to Appendix C, Section C.4.

Operations

During operations, the Proposed Action would increase the number of employees and users of the site from approximately 1,900 now to approximately 1,950 to 1,960 in the future. This increase would be inconsequential and is approximately equal to the fluctuation in the number of SLAC employees over a year (60 to 100 people) because of shutdowns, construction activities and temporary labor. The projected increase would result in a 0.1 dBA increase in traffic-related noise levels, which would likely be below detection at the locations of sensitive receptors. Therefore, any operational effects from the Proposed Action on traffic noise would be minor.

Potential sources of long-term operational noise would stem from the air handling and HVAC units for each of the conventional facility buildings. The Sector 10 Injector Building would incorporate three air handling units. The BTH would incorporate a single air handling unit, and the EH would incorporate several rooftop HVAC units. Typical highest noise emission levels for the air handling and HVAC units would be 96 dBA power level (PWL) for a 12,000 cfm air handling unit and 78 dBA PWL for a commercial rooftop air conditioner (Carrier 1992).

The Sector 10 Injector Building would also include a new 12 kV, 1,500 kVA electrical substation and a 15 kV outdoor medium-voltage SF6 switchgear. The main source of noise within the substation would be the transformer and cooling fans. The National Electrical Manufacturers Association standard describes sound levels for 2,000 kVA commercial transformers (e.g., vent-dry type) at a distance of 1 foot from the source as 66 dBA for self-cooled and 71 dBA for fan-cooled units (General Electric 1999).

The noise values for the air handling systems and substation were used to model noise impacts at receptor locations. Model input data also included source elevations (building heights) and topography. Model input assumptions were similar to those used for the construction noise model (see Appendix C).

Table 3-12 presents the model results for the three sensitive receptor locations. The highest predicted operational noise level from the combination of air handling units and the substation would be 24.3 dBA at Receptor 1. This noise level would be well below the City of Menlo Park's Leq noise threshold limit of 60 dBA. Maintenance activities, such as visual inspections, vegetation mowing and equipment parts replacement, would be part of the Proposed Action. Potential effects from these activities on noise levels

[5] VdB is a unit that denotes 20 times the logarithm of the ratio of the measured particle velocity to a reference particle velocity (usually 10^{-8} m/s).

may be detectable over short durations and on local roads (i.e., minor increases in traffic). However, given the distances to the nearest sensitive receptors, any potential increases in operational noise levels would be minor.

Table 3-12 Combined Operational Noise Levels at the Nearest Sensitive Receptors

Sensitive Receptor	City of Menlo Park Noise Threshold Limit (Leq, dBA)	Operational Noise Impact Level (Leq, dBA)
1	60	24.3
2	60	12.9
3	60	19.5

Decommissioning would not occur for many years but would likely result in noise levels similar to construction. This phase of the Proposed Action would be based on a decommissioning plan consistent with applicable laws and requirements and that protects public health and safety and the environment. Any noise impacts during decommissioning would be localized and short term. Noise produced by the decommissioning of the Proposed Action would be similar to the construction noise levels and would be minor due to the distance to the nearest sensitive receptor.

3.11 Socioeconomics and Environmental Justice

3.11.1 Affected Environment

The Proposed Action is located in unincorporated San Mateo County, California, on the grounds of the SLAC National Accelerator Laboratory, a federally owned, contractor-operated national laboratory. The SLAC National Accelerator Laboratory is operated by Stanford University under a contract from the DOE’s Office of Science.

The Proposed Action is located adjacent to the communities of Woodside, Portola Valley, Menlo Park, Los Altos Hills, Palo Alto and Atherton. These communities and the Census Designated Places (CDPs) of Ladera, Stanford University and West Menlo Park comprise the area of study for the socioeconomics and environmental justice discussions.

3.11.1.1 Population, Race and Ethnicity

The population and ethnicity of residents within the area of study are shown below in Table 3-13 (U.S. Census Bureau 2011). For comparison, this information is also provided for San Mateo and Santa Clara Counties, the State of California, and the United States as a whole.

The population of the area of study is less diverse than that of the counties in which the communities and CDPs are found. The large proportion of individuals identifying as Asian in San Mateo and Santa Clara counties, as well as in several of the communities within these counties, is likely attributable in large part to their location near Silicon Valley, which is a center for high-tech industries (e.g., computing, biomedical).

Table 3-13 Population and Ethnicity of Residents within the Area of Study

		Ethnicity (Percentage of Total Population)							
	Total Population	**White**	**American Indian/ Alaska Native**	**Asian**	**Black or African American**	**Native Hawaiian or Other Pacific Islander**	**Some Other Race**	**Two or More Races**	**Hispanic**
Atherton	6,914	80.5	0.1	13.2	1.1	0.7	1.4	3.1	3.9
Ladera CDP	1,426	89	0.1	6.9	0.2	0	0.4	3.5	2.3
Los Altos Hills	7,922	68.4	0.1	26.6	0.5	0.1	0.6	3.7	2.7
Menlo Park	32,026	70.2	0.5	9.9	4.8	1.4	8.7	4.5	18.4
Palo Alto	64,403	64.2	0.2	27.1	1.9	0.2	2.2	4.2	6.2
Portola Valley	4,353	91	0.1	5.6	0.3	0	0.7	2.4	4
Stanford	13,809	57.4	0.6	27.4	4.7	0.2	1.9	7.8	10.4
West Menlo Park CDP	3,659	81.5	0.1	11.4	0.8	0.1	1.4	4.8	5.5
Woodside	5,287	89.2	0.1	6.3	0.4	0.1	1.2	2.7	4.6
United States	**308,745,538**	**72.4**	**0.9**	**4.8**	**12.6**	**0.2**	**6.2**	**2.9**	**16.3**
California	**37,253,956**	**57.6**	**1**	**13**	**6.2**	**0.4**	**17**	**4.9**	**37.6**
San Mateo County	**718,451**	**53.4**	**0.5**	**24.8**	**2.8**	**1.4**	**11.8**	**5.3**	**25.4**
Santa Clara County	**1,781,642**	**47**	**0.7**	**32**	**2.6**	**0.4**	**12.4**	**4.9**	**26.9**

3.11.1.2 Minority Populations

There are 52 Census Tracts that are fully or partly within the communities and CDPs identified as constituting the area of interest. Of these, only four have a population where a minority group (or groups) accounts for more than 50 percent of the population of the tract: Tract 6117 (population 5,970; 1,130 Black or African American; 2,270 Other), which is located north of Highway 101 along the southern end of San Francisco Bay and more than 4 miles from the site of the Proposed Action; Tract 6130 (population 10; 6 Black or African American), which is located within 1 mile of the site of the Proposed Action; Tract 5117 (population 106; 54 Asian), which is located in Los Altos Hills more than 5 miles from the site; and Tract 5093 (population 437; 159 Asian; 22 Black or African American; 33 Other), which is located more than 6 miles east of the site.

Of the 52 Census Tracts, two have populations that are majority Hispanic: 6117 and 6118. Both are located more than 4 miles from the site of the Proposed Action (U.S. Census Bureau 2011).

3.11.1.3 Income

The Census Bureau's 2005-2009 American Community Survey estimates the median household incomes of Santa Clara County and San Mateo County to be $85,569 and $84,426, respectively. By comparison, the median household income for the State of California as a whole was estimated to be $60,392. The median household and per capita incomes for the communities and CDPs contained in the area of study are shown in Table 3-14 (U.S. Census Bureau 2010).

Table 3-14 Median Household and Per Capita Incomes within the Area of Study

	Median Household Income	Per Capita Household Income
Atherton	185,000	109,762
Ladera CDP	93,348	49,077
Los Altos Hills	218,922	108,502
Menlo Park	107,261	66,415
Palo Alto	119,483	68,944
Portola Valley	168,750	103,990
Stanford CDP	49,970	26,396
West Menlo Park CDP	123,267	69,178
Woodside	214,310	122,679
California	**60,392**	**29,070**
San Mateo County	**84,426**	**43,286**
Santa Clara County	**85,569**	**39,201**

This data illustrates the considerable affluence of the two counties and the communities and CDPs within the area of study. The lower income levels in the Stanford CDP is attributable to the presence of the university and its student body (the average age for the CDP is 22.6, and 76.2 percent of the population is between the ages of 15 and 29).

3.11.1.4 Housing

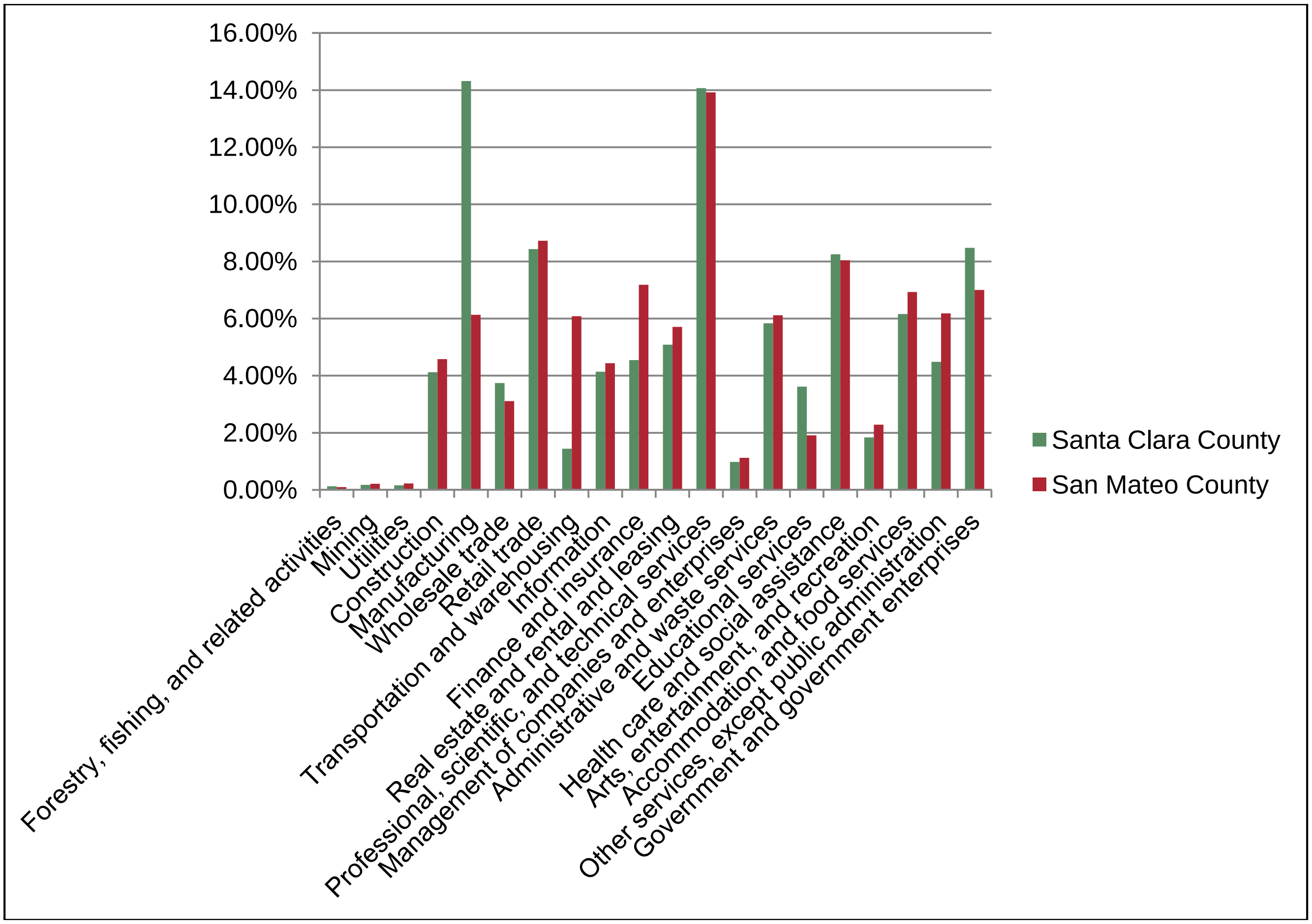
Reflecting the affluence of the area , home prices in the area of study are significantly higher than found across the state as a whole. In May 2011, the median list price of a house in California was approximately $364,000; in Santa Clara County it was $498,500 and in San Mateo it was $579,500 (Data Quick Information Systems 2011).

3.11.1.5 Industrial Sectors

Santa Clara and San Mateo counties have the diversified economies typical of urban metropolitan areas. The percentages of workers employed in major industrial sectors are shown in Figure 3-2.

Unsurprisingly for an area that is home to Silicon Valley, the manufacturing and professional, scientific, and technical services sectors account for almost 30 percent of the workers in Santa Clara County.

Figure 3-2 Workers Employed in Major Industrial Sectors



Source: Bureau of Economic Analysis 2011

The SLAC National Accelerator Laboratory employs approximately 1,500 individuals, and hosts up to 1,000 visiting scientists and researchers each year. Other major employers in the area include Stanford University (approximatly 8,300 employees), SRI International in Menlo Park, the U.S. Department of Interior in Menlo Park, Hewlett Packard in Menlo Park and the Veterans's Administration Medical Center in Palo Alto (State of California, Employment Development Department 2011).

3.11.1.6 Low-Income Populations

While 14.2 percent of California's population is estimated to be living below the poverty line, in San Mateo and Santa Clara counties only 7.6 and 9.1 percent, respectively, of the population is estimated to be living below the poverty line. Using a conservative definition of a low-income population (those earning less than 150 percent of the household income for a family of four, or $50,288 per year), only the Stanford CDP meets the definition of a low-income population. However, as stated above, the Stanford CDP comprises the university and its student population, and thus is an anomaly and not representative of the area of study as a whole. Therefore, there are no identified low-income populations with the area of study relevant to this socioeconomic analysis (U.S. Census Bureau 2009a).

Three secondary school districts serve the area of interest: Sequoia Union High School District, Palo Alto Unified School District and the Mountain View-Los Altos Unified School District. The poverty rates for students attending these schools are 8.7, 8.7 and 6.3 percent, respectively. Six elementary school districts serve the area of interest: Redwood City, Woodside, Las Lomitas, Menlo Park City, Portola Valley and Palo Alto. The poverty rates for students attending these schools are 10.7, 3.7, 2.7, 2.6, 3.7 and 4.6 percent, respectively. For comparison, the state-wide poverty rate for those attending school is 18.2 percent. This indicates that fewer students attending schools in the area of interest live below the poverty line than statewide (U.S. Census Bureau 2009b).

3.11.2 Environmental Consequences

3.11.2.1 No Action

Selection of the no action alternative would result in no socioeconomic impacts in the area of study, no impact on the existing population or demographics of the area, no impacts on the housing market, and no environmental justice impacts.

3.11.2.2 Proposed Action

Socioeconomics

Construction

The Proposed Action would have negligible, if any, impacts on the population or demographics of the area of study. Construction of the Proposed Action would be extremely unlikely to result in any in-migration that could negatively or positively impact the population or demographics of the area of study. Construction of the Proposed Action would require, at its peak, no more than 130 construction workers per day. Employment in the construction industry (North American Industry Classification System) in San Mateo and Santa Clara Counties has fallen from 64,098 in 2007 to 43,898 in 2010. As a result, there exists a large, experienced construction labor pool in the two counties, indicating that the construction employment needs of the Proposed Action could easily be met with local resources (Bureau of Labor Statistics 2011). Therefore, there would be no in-migration of workers to meet the construction labor demands of the Proposed Action, and no impacts on the population or demographics or to the local housing market.

The Proposed Action has a total estimated cost of $300 to $400 million. Construction spending in California has fallen from a high of nearly $100 billion in 2005 to a low of approximately $40 billion in 2009. Residential construction activity rose the fastest and fell the most. Public construction suffered a lesser loss, dropping from a high of approximately $25 billion in 2005 to a low of approximately $15 billion in 2009 (Reaser 2010). The construction industry is currently depressed and is projected to remain depressed, with only slow or stagnant growth through the start of construction of the Proposed Action. The

Proposed Action would generate a small positive economic benefit to the construction industry and associated industries (e.g., transportation, warehousing). The greatest impacts would be realized in San Mateo and Santa Clara counties, with smaller impacts on other counties in the region. The size and duration of the Proposed Action's construction cost and schedule are not sufficiently large to increase the costs for labor or materials in the region, and thus would not present the risk of negative economic impacts.

Operations

Similarly, operation of the Proposed Action would have no impacts on the population or demographics of the area of study. No additional employees would be hired at SLAC and operation of the Proposed Action would not result in any in-migration of individuals to the area. Because no additional employees would be hired, there would be no indirect or induced economic effects generated from the earning and spending of new employees. There would similarly be no impact on local housing markets.

Environmental Justice

Construction

As described above, no concentrations or large numbers of low-income populations have been identified within the area of study. The communities that make up the area of study have high per capita and median household incomes; fewer families in Santa Clara and San Mateo counties live in poverty when compared to the State of California and the United States and the poverty rate for students in the school districts that serve the area of study is lower than for the state as a whole.

There are no majority or minority populations in any of the communities or CDPs that comprise the area of study. Concentrations of non-white populations exist within some portions of the study area, notably Asians in Lost Altos Hills, Palo Alto, Stanford and West Menlo Park, and Hispanic populations in Menlo Park and Stanford. The concentrated Asian populations (those areas where Asians account for greater than 25 percent of the population) are located generally to the south and east of the site of the Proposed Action, at distances greater than approximately 2.5 miles. The concentrated Hispanic population in Menlo Park is found in the northeastern portion of the city, north of Highway 101 and more than 4 miles from the site of the Proposed Action. The minority populations in the Stanford CDP are assumed to be students, and thus are presumed to have access to information and advice regarding environmental activities and associated risks that are addressed in the DOE's Environmental Justice Strategy.

There would be no environmental or socioeconomic impacts as a result of the construction of the Proposed Action. Potential impacts such as noise and increased traffic would be addressed through impact avoidance and minimization measures (see Section 2.1.4). These impacts would be borne uniformly by the population as a whole; thus, there would be no disproportionate effects from construction to minority or low-income populations.

Operations

There are no identified concentrations or large numbers of low income populations or majority minority populations in any of the communities or CDPs that comprise the area of study. There would be no major environmental or socioeconomic impacts as a result of the operation of the Proposed Action. Any potential impacts would be mitigated as part of the proposed project, and these impacts would be borne uniformly by the population as a whole. Thus, there would be no disproportionate effects on minority or low-income populations.

3.12 Traffic and Circulation

3.12.1 Affected Environment

SLAC is accessed by two gated entrances, one on Sand Hill Road and the other on Alpine Road. Primary access is from Sand Hill Road, a four-lane arterial that connects to a full interchange with I-280 to the west and the Stanford University campus and the cities of Palo Alto and Menlo Park to the east. Approximately 90 percent of the daily vehicular traffic enters the site from Sand Hill Road (DOE 2002a). There are several signalized intersections along Sand Hill Road near SLAC, most of which fall within the jurisdiction of the City of Menlo Park. There is one San Mateo County-controlled intersection (Sand Hill Road/Sharon Park Drive); the I-280 ramp intersections are maintained by the California Department of Transportation (Caltrans). Traffic counts conducted at the Sand Hill Gate (CSG Consultants 2011) recorded approximately 325 vehicles per hour on a weekday.

The second entrance located on Alpine Road (Figure 3-3) accounts for the balance of site traffic. Alpine Road is a two-lane roadway that connects to a full-access interchange with I-280. To the east, Alpine Road connects to Santa Cruz Avenue/Junipero Serra Boulevard at a signalized intersection. Alpine Road falls within San Mateo County between I-280 and just west of Santa Cruz Avenue; the Alpine/Santa Cruz/Junipero Serra intersection is in Menlo Park. Alpine Road provides a secondary access to SLAC, only for workers trained and authorized to enter the linear accelerator area. This entrance is also used for special and limited conditions, such as the delivery of construction materials to construction sites from I-280. The Alpine Road entrance was used for site access during LCLS-I construction. The Alpine gate has an automated gate system that allows authorized staff to access the site.

The approximately 1.2-mile length of Alpine Road between I-280 and Junipero Serra Boulevard frequently backs up during the morning and evening commute period. Expanding the capacity of Alpine Road presents challenges because of the topography of the roadway and the proximity of residential neighborhoods. San Mateo County currently has no plans to widen Alpine Road near SLAC.

Vehicles traveling on site roadways affect pedestrian movement. Pedestrian pathways connect major parking areas with buildings. Outside SLAC's Central Campus, there are fewer pedestrian pathways and pedestrians often share the road with vehicles. Increased vehicle use and speed have become a concern for pedestrians at SLAC.

3.12.2 Environmental Consequences

3.12.2.1 No Action

With no action, there would be no construction or additional operational vehicular traffic. Therefore, this alternative would not affect traffic or circulation.

3.12.2.2 Proposed Action

Effects from Construction

Construction-related vehicular traffic would be added due to trips to and from the site by workers and material hauling/delivery. Table 3-4 summarizes the phases of construction. While construction activities would occur for 4 to 5 years beginning in the 3rd quarter of calendar year 2012, they would reach their peak beginning in the 3rd Quarter 2014 when the tunneling and building construction work would take place. These activities would employ up to 150 daily workers and generate trips from associated material handling activities. The Alpine Road access would be used for all construction-related traffic.

Construction traffic typically would occur outside the normal commute peak periods. Workers would arrive early at the site before the morning commute peak period, and leave before the start of the evening commute peak. Even in case of the tunneling activities, where there are likely to be multiple shifts, the ingress and egress patterns of construction workers and vehicles would not coincide with the commute peak traffic.

Figure 3-3 illustrates the access to the site from Alpine Road. Minor disruption of traffic may occur when the trucks and other construction-related vehicles turn left into the campus from Alpine Road. However, this impact would be minor because entrance to the campus is restricted due to security and construction-related vehicles must be staged and then escorted onto the campus. Figure 3-4 illustrates the potential staging area adjacent to the security gate. SLAC would establish procedures for inspecting and clearing vehicles through the gated entrance to prevent excessive queuing of construction vehicles and haul trucks.

In conclusion, because construction-related traffic would use the Alpine Road entrance, which is used by only 10 percent of campus traffic, and because construction traffic would occur outside the normal peak commuting hours, the Proposed Action’s construction traffic impacts would be minor.

Effects from Operations

Based on a conservative estimate of 1,900 employees and users with additional traffic due to visitors and vendors, approximately 5,700 vehicle trips enter or exit SLAC daily. Approximately 90 percent use the main entrance on Sand Hill Road. The Proposed Action would not add to the number of permanent employees and would add a total of approximately 50 to 60 researchers. This increase would be inconsequential and is approximately equal to the fluctuation in the number of SLAC employees throughout a year (60 to 100 people) because of shutdowns, construction activities and temporary labor. In addition, many users would reside in SLAC’s guest facilities and would be less likely to use site entrance gates during peak traffic periods. Therefore, no adverse traffic or circulation impacts would occur as a result of project operations. The Proposed Action would add several parking areas, with a total of more than 200 parking spaces. Therefore, the Proposed Action would not result in pressure on parking capacity in off-site areas or at Stanford University.

The Proposed Action would increase the number of vehicles on site, which would result in a minor increase in shared use of site roads by vehicles and pedestrians. To reduce crowding, SLAC is considering several options including use of electric carts and/or an internal shuttle system, expanded use of bike lanes, and more pedestrian walkways. SLAC is also considering clustering its major research programs around a central open space. These improvements would offset any increased sharing of roadways between vehicles and pedestrians during LCLS-II operations when construction is completed in 2017.

3.13 Waste Management

3.13.1 Affected Environment

3.13.1.1 Hazardous Materials

SLAC handles, stores and uses hazardous materials as part of its experimental programs, which may include manufacturing, operation and maintenance of experimental devices, as well as general facilities operations, maintenance and construction projects. Examples of hazardous materials present at SLAC include flammable gases, compressed gases, corrosives, organic solvents, oils and fuels, adhesives, paints and epoxies, and metals. Radioactive materials are discussed in Section 3.8 of this EA.

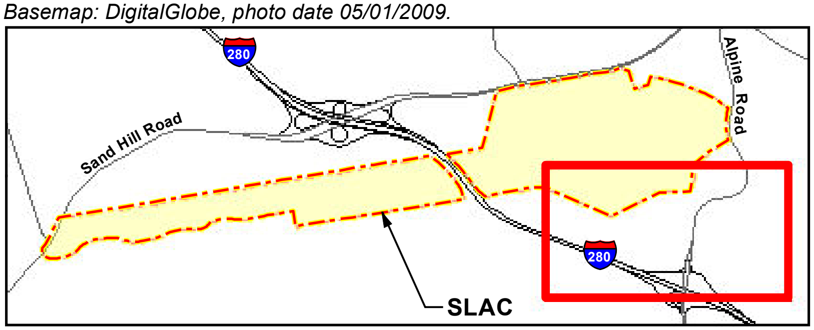
SLAC has established various hazardous materials programs and associated training to comply with regulatory requirements, including but not limited to:

- HMBPs/Emergency Response Plans
- Hazard Communication Program/Chemical Hygiene Plan
- Chemical Management System
- Aboveground Storage Tanks
- Spill Prevention Control and Countermeasure Plan
- CalARP
- California Fire Code Hazardous Materials Management Plan

All of the applicable hazardous materials programs and procedures are summarized in SLAC's ESH Manual (SLAC 2011d). The intent of these programs and procedures is to help ensure the safe handling of hazardous materials for the protection of SLAC workers, the surrounding community and public, and the environment.

CITY: Boulder, CO DIV/GROUP: IM/AIT DRAFTER: J. CHEN
Project (Project #): AZ001214
K:\AZ001214_SLAC_LCLS_II_EA\GIS\ArcMaps\Site Access for Construction Vehicles from I-280 via Alpine road.mxd - 8/29/2011 @ 10:35:15 AM

Basemap: DigitalGlobe, photo date 05/01/2009.



N

0 500 Feet

Graphic Scale: 1" = 500'

SLAC LCLS-II EA

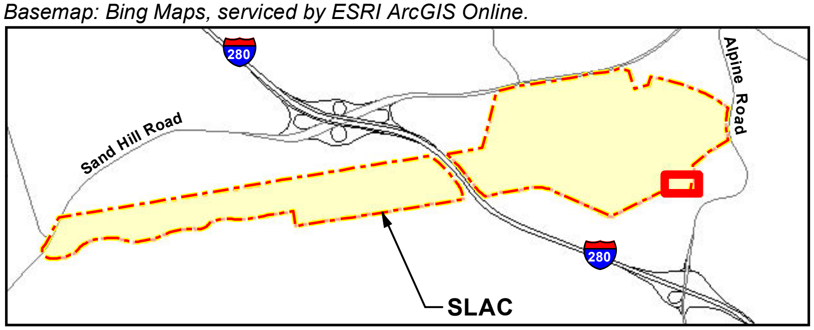
SITE ACCESS FOR CONSTRUCTION VEHICLES FROM I-280 VIA ALPINE ROAD

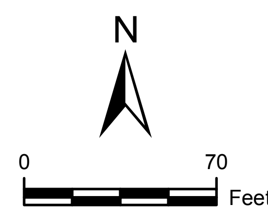
ARCADIS

FIGURE **3-3**

CITY: Boulder, CO DIV/GROUP: IM/AIT DRAFTER: J. CHEN
Project (Project #): AZ001214
K:\AZ001214_SLAC_LCLS_II_EA\GIS\ArcMaps\Security Gate - Alpine Road Access.mxd - 8/29/2011 @ 10:36:04 AM

Basemap: Bing Maps, serviced by ESRI ArcGIS Online.





SLAC LCLS-II EA

SECURITY GATE - ALPINE ROAD ACCESS
POSSIBLE HOLDING AREA FOR CONSTRUCTION-RELATED VEHICLES

ARCADIS

FIGURE 3-4

The local implementing agency for hazardous materials regulation in California is primarily the Certified Unified Program Agency (CUPA). The CUPA responsible for providing regulatory oversight of hazardous materials and hazardous waste management at SLAC is the San Mateo County Health Services Agency, Environmental Health Division.

3.13.1.2 Waste Management

During its research operations, SLAC generates a variety of waste streams, including but not limited to hazardous waste, universal waste, non-hazardous industrial waste, municipal solid waste and scrap metal.

Whenever practicable, SLAC actively practices the following pollution prevention hierarchy for managing its waste streams in accordance with established procedures in the ESH Manual (SLAC 2011d).

- Reduce waste and prevent pollution at the source through process changes, substitutions and/or work practices.
- Reduce waste and prevent pollution by reusing or recycling materials.
- Reduce waste and prevent pollution by using appropriate control technologies.
- After exhausting the previous three approaches, exercise proper disposal.

SLAC is classified as a large quantity hazardous waste generator and manages its hazardous waste in accordance with federal, state and local laws and regulations which are implemented through the SLAC the ESH Manual (SLAC 2011d). Hazardous waste is generated from activities that include, but are not limited to, routine laboratory operations, facility operations and maintenance, and remediation, and/or cleanup/stabilization projects.

The EPA has delegated authority to the state of California for implementing the federal RCRA program. In turn, the state has delegated its authority for certain aspects of hazardous waste program oversight to the local CUPA. The San Mateo County Health Services Agency, Environmental Health Division, serves as the CUPA with delegated authority to oversee SLAC’s hazardous waste management.

SLAC uses a self-developed, site-specific computerized hazardous waste tracking system for cradle-to-grave management of its hazardous wastes. Hazardous waste containers are tracked from the time they are issued to the generator to their eventual disposal off site at permitted facilities.

Non-hazardous waste includes non-hazardous industrial waste and municipal solid waste. In addition to its hazardous waste management program, SLAC’s Waste Management Group manages industrial waste resulting from SLAC’s laboratory operations and remediation operations that, while not classified as hazardous, does not meet the acceptance criteria of municipal or sanitary solid waste landfill. Examples of industrial wastes include soils with low levels of petroleum hydrocarbons, PCBs or metals such that they qualify as non-hazardous but are not acceptable to municipal landfills. In California, industrial wastes are generally termed Class 2 waste because they are specifically required to be disposed of at permitted Class 2 landfills (these provide an intermediate level of protection to the environment between Class 1 hazardous waste landfills and Class 3 municipal solid waste landfills).

SLAC's Facilities Department operates a municipal solid waste program that collects a variety of recyclable materials, as well as regular dumpster refuse. SLAC's Property Control Department operates a salvage operation that sells metal and other industrial recyclables (construction materials, such as concrete, clean soils, asphalt and wood) and equipment for their cash value. Collection stations are strategically distributed around the site. Dumpsters for cardboard collection are also strategically placed around the site and a specific location is provided for waste wood and non-hazardous construction and demolition debris. Scrap metal and electronic waste is collected and construction materials from building demolition and rehabilitation projects are recycled.

SLAC generates low-level radioactive waste (LLRW) sporadically from routine operations, repairs and special projects or experiments. The Radioactive Waste Management Group oversees radioactive waste management and LLRW disposal at SLAC. All property exposed to radioactivity is surveyed before removal from SLAC. Any material with detectable radioactivity is retained for reuse on site or disposed of as radioactive waste. Non-routine operations generate the bulk of LLRW at SLAC, amounting to 150 cubic feet in 2009 (SLAC 2010f). SLAC minimizes the volume of LLRW through education and training for the waste generator, operational planning, material surveys, segregation, reuse and volume reduction when applicable.

SLAC sporadically generates a small quantity of LLRW from routine operations, repairs and special projects or experiments. SLAC manages its LLRW in accordance with applicable laws and regulations. As needed, SLAC ships LLRW to appropriate treatment and disposal facilities.

SLAC's Excavation Clearance Program continues to support SLAC-wide projects to ensure proper disposal of excavated soil. An excavation permit form must be completed and submitted for activities that involve excavation or relocation of soil at SLAC. The program is intended to identify potential hazards associated with excavation work at SLAC and ways to reduce worker exposure to these hazards. These hazards include underground utility lines, chemical contamination, radiological hazards and ensuring proper management and disposal of excavated materials.

3.13.2 Environmental Consequences

3.13.2.1 No Action

The no action alternative would not result in additional generation, transportation or disposal of hazardous waste; therefore, no impacts would occur due to hazardous materials use and storage.

3.13.2.2 Proposed Action

Effects from Construction

To construct the LCLS-II facility, an estimated 60,000 cy of soil would require excavation and disposal. Soil samples from 10 borings along the Proposed Action alignment were previously collected and analyzed as part of the Excavation Clearance Program. Based on the analytical results of the samples, soil may potentially contain elevated concentrations of total petroleum hydrocarbons (TPHs) and/or cobalt. As indicated, excavated soils with elevated TPH and/or cobalt concentrations (i.e., between borehole Nos. 3 and 5) would be disposed of at a Class II landfill. All other clean excavated soils would be relocated at SLAC. Excavated materials would be segregated and stockpiled in designated areas. Stockpiles for disposal would be placed on plastic or other impervious surface to prevent release of contaminants, and would be covered as necessary to prevent generation of fugitive dust and potential exposure to stormwater.

SLAC's Excavation Clearance Program ensures proper screening, waste characterization and disposal of excavated soil. An excavation permit form must be completed for activities that involve excavation or relocation of soil at SLAC. The permitting process is intended to identify and minimize potential hazards associated with excavation work at SLAC.

In addition to excavated materials, oily debris would be generated from construction activities. The quantities and types of waste streams generated from construction would have only a minor, short-term impact on waste generation. During excavation and construction, generation of hazardous materials would be limited to fuels and lubricants for heavy equipment maintenance and fueling. Maintenance activities would occur in a designated area with appropriate means to prevent overflow or spills. Construction of the LCLS-II structures may include limited use of hazardous materials, such as paints, epoxies, fuels and lubricants, as well as lead for shielding purposes. Hazardous materials would be handled in accordance with established procedures. Minimal impact on the use and storage of hazardous materials would result from Proposed Action construction. The Proposed Action would not result in any incremental impacts on hazardous materials and waste generation beyond that caused by previous or existing LCLS-I construction activities. As described above, SLAC would minimize generation of solid waste by salvaging and recycling construction materials and demolition debris, such as concrete, clean soils, asphalt and wood. Therefore, these potential adverse impacts would be short term and minor.

The Proposed Action would require removal of some hardware (e.g., magnets and vacuum chambers) and the installation of new components suited to the proposed facility. Removal of these materials and the subsequent installation activities may potentially produce small quantities of hazardous, non-hazardous and radioactive waste that would be managed through defined processes. Past history indicates that normal operation of the accelerator does not typically produce waste.

Any material removed from within the accelerator housing would be surveyed for residual radioactivity, labeled and held on site for disposal evaluation, in accordance with procedures established in the SLAC

Radiation Safety Program (SLAC 2010g). Items with residual radioactivity would be stored on site in the radioactive material storage yard for future reuse or disposal. Any hazardous waste would be handled and disposed of in accordance with SLAC procedures.

Component manufacturing and system installation may also produce hazardous wastes, such as used solvent from degreasing operations or spent cutting fluids. These wastes are managed and controlled routinely during operations at SLAC, in compliance with SLAC's existing policies and procedures for the management of hazardous materials and waste minimization.

Effects from Operations

During the operational phase of the LCLS-II, only minimal quantities of hazardous materials would be used. Examples include paints, epoxies, solvents, oils and lead in the form of shielding. Site- and facility-specific procedures described above and in SLAC's ESH Manual (Chapter 40, Hazardous Materials) are in place for the safe handling, storage and transport of hazardous materials. SLAC follows procedures for chemical storage, storage inspection and secondary containment. There would be little to no impact on hazardous materials handling, use or storage as a result of operation of the LCLS-II facility.

Wastes expected to be generated as a result of LCLS-II operations would be similar to wastes generated at current experimental facilities. There would be minimal impact on hazardous waste generation during operation of the facility. Minimal hazardous waste would be generated. Therefore, the Proposed Action would not result in any incremental impacts on hazardous materials and waste management beyond that resulting from previous or existing LCLS-I operations, and impacts would be minor.

3.14 Cumulative Effects

The cumulative impact analysis presented below is based on consideration of past, present and reasonably foreseeable future projects that could, based on their location or types of impacts, result in cumulative effects when considered together with the Proposed Action. Projects included in the cumulative effects analysis were identified based on review of recent environmental documents, contact with local planning departments and internet research.

Table 3-15 lists the recently completed past projects, projects currently under construction and future projects that would overlap with the construction and/or operation of the Proposed Action and could affect the same resources. Table 3-15 describes the projects, their locations, estimated construction schedules, access roadways and nearby waterways, and potential types of cumulative impacts that could occur in combination with those of the Proposed Action. For future projects, the analysis was based on estimated construction schedules. Where construction schedules were unavailable, it was conservatively assumed that construction periods would overlap with those of the Proposed Action. The cumulative projects identified are associated with SLAC, San Mateo County projects, utility projects, Caltrans, Caltrain, county transportation agencies and the San Francisco Public Utilities Commission. These projects involve residential construction, commercial developments, offices, research and development space, hospital facilities, electricity generation and transmission facilities, rail service extension (including BART), a college campus, wetland restoration, and various highway improvements.

Areas where the Proposed Action would have no impacts, as identified above, are not addressed because no cumulative impacts would occur. Cumulative effects were not evaluated for wetlands, land use, recreation, socioeconomics and environmental justice because the Proposed Action would have no effects in these areas. For example, because the Proposed Action would have no impacts on recreation (e.g., parks, bicycle trails), there would be no cumulative recreation effects in conjunction with any of the cumulative projects.

According to CEQ regulations for implementing NEPA (50 CFR § 1508.7), an action may cause cumulative impacts on the environment if its impacts overlap in space and/or time with the impacts of other past, present or reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place through time.

Sections 3.14.1 through 3.14.9 of this EA assess the potential cumulative effects of the Proposed Action together with the identified cumulative projects. Cumulative effects were evaluated for air quality, biological resources, cultural resources, geology and soils, health and safety, hydrology and water quality, noise, socioeconomics and environmental justice, and waste management. CEQ regulations also require an assessment of cumulative impact of the no action alternative as a baseline for evaluation of cumulative impacts with the Proposed Action

Under the no action alternative, SLAC would not construct the LCLS-II facilities, resulting in no contribution to cumulative effects on air quality, biological resources, cultural resources, geology and soils, health and safety, hydrology, water quality, noise, traffic, or waste management. Cumulative impacts from the no action alternative would be similar to baseline conditions. Ozone and other air pollutants would remain in non-attainment of air quality standards. Projects throughout the area would minimize impact on cultural resources by complying with local, state and federal laws, including consulting with SHPO in compliance with the NHPA, as applicable. Geology and soil impacts would be addressed by design measures and BMPs, as required, to minimize erosion. The no action alternative would limit the scientific and medical advances that would likely be afforded human health by the proposed LCLS-II facilities. The cumulative projects listed in Table 3-15, including those at SLAC and Stanford University, would have cumulative effects that would be minimized by existing flood control and water quality regulatory programs. These projects could have cumulative impacts if they occur at the same time in the same area. Planned improvements and upgrades at SLAC are located throughout the campus during the upcoming years and would not result in significant cumulative effects. Other projects at SLAC and Stanford University, as well as local infrastructure projects, could contribute to traffic congestion on Alpine Road. In contrast, traffic volumes would be reduced as older facilities, such as PEP and BABAR, are shut down. In addition, other projects listed on Table 3-15, including demolition and modernization projects at SLAC, would generate solid and radioactive waste requiring management and reuse or disposal.

3.14.1 Air Quality

As described above, the EPA requires each state to prepare and submit an SIP describing how the state will achieve federal standards by the specified dates, depending on the severity of the air quality within the state or air basin. To determine whether the Proposed Action would conform or conflict with an approved SIP, the DOE completed a conformity review. The Proposed Action was below the *de minimis* levels for a conformity analysis as well as below SLAC's SMOP limits for each of the non-attainment criteria pollutants. Thus, the future cumulative air quality impacts would be minor.

Unlike emissions of criteria air pollutants, which have local or regional impacts, GHG emissions can contribute to global warming or climate change due to their accumulation in the atmosphere. The principal GHGs are carbon dioxide (CO_2), methane, nitrous oxide and fluorinated compounds. These gases allow visible and ultraviolet light from the sun to pass through the atmosphere, but prevent heat from escaping back out into space. Global climate change has the potential to impact sea level, water supply, agricultural resources and natural wildlife habitats.

The Council on Environmental Quality (CEQ), which is the agency responsible for administering NEPA, released draft NEPA guidance on GHG emissions (CEQ 2010). The guidance recommends a threshold of 25,000 CO_2-equivalent[6] metric tons ($MTCO_2e$) of direct emissions as a threshold for analysis within NEPA documents and that emissions below this threshold would not warrant detailed evaluation under NEPA. The draft NEPA guidance focuses on direct emissions only (GHG emissions generated on site by the project) and not off-site indirect emissions, such as those generated by vehicle trips to and from the project site or from the generation of electricity used by the Proposed Action.

The CalEEMod model was used to estimate GHG emissions from construction, including from heavy equipment (e.g., excavators, loaders), trucks and construction worker vehicles. Table 3-16 summarizes GHG emissions from construction of the Proposed Action. The table shows that annual emissions would be much less than the 25,000 metric ton standard recommended by the CEQ. Therefore, air quality impacts from construction would be intermittent, short term and minor and do not require further evaluation.

6 CO_2-equivalent (CO_2e) is a measurement used to account for the fact that different GHGs have different potentials to retain infrared radiation in the atmosphere and contribute to the greenhouse effect. This potential, known as the global warming potential of a GHG, is dependent on the lifetime, or persistence, of the gas molecule in the atmosphere. Expressing emissions in CO_2e takes the contributions of all GHG emissions to the greenhouse effect and converts them to one unit equivalent to the effect that would occur if only CO_2 were being emitted.

Table 3-15 Projects Considered in Cumulative Impacts Analysis for the Proposed Action

Project	Project Description	Location	Construction Schedule	Major Access Roads	Nearby Waterways	Potential Cumulative Impact Issues
SLAC LCLS-I	Existing LCLS-I facilities	SLAC	2006-2009	Alpine Road, I-280	San Francisquito Creek	Cultural resources, health and safety, waste disposal
SLAC SSRL SPEAR3 Seismic Upgrades	Upgrade enclosure, office modernization and demolition of aging trailers	SLAC	2012-TBD	Alpine Road, I-280	San Francisquito Creek	Air quality, water quality, noise, traffic
SLAC Facility Disassembly	Disassemble BaBar facility	SLAC	2011-TBD	Alpine Road, I-280	San Francisquito Creek	Air quality, water quality, noise, traffic
SLAC Facilities Modernization	Infrastructure upgrades – substation, server farm, erosion control, electrical, piping, Alpine Road gate automation, athletic field	SLAC	2011-TBD	Alpine Road, I-280	San Francisquito Creek	Air quality, water quality, noise, traffic
SLAC Capital Improvements and Renovations	Science and User Support Bldg., Scientific Research Computing Facility, Photon Science Laboratory Bldgs.	SLAC	2012-TBD	Alpine Road, I-280	San Francisquito Creek	Air quality, cultural resources, water quality, traffic
Santa Clara County	Permanente Quarry & soil storage	Santa Clara Co.	2012-TBD	I-280	Permanente Creek	Air quality, traffic
Stanford University Medical Center Renewal Project	Renovation and expansion of Hoover Pavilion, Stanford Hospital, Lucile Packard Children’s Hospital, and the School of Medicine	Santa Clara Co.	2011-2013	Sand Hill Road and Alpine Road	San Francisquito Creek	Air quality, water quality, traffic
Stanford University	General Use Permit allows construction of new academic facilities, student and faculty housing, and parking spaces.					
San Mateo County	Pilarcitos Quarry and Water Resource Project	San Mateo Co.	2012-TBD	SR 92, I-280	Pacific Ocean	Air quality, traffic
Lower Crystal Springs Dam	Dam repairs for flood protection	San Mateo Co.	2010–2011	I-280, SR 92	Lower Crystal Springs Reservoir	Air quality, biological resources, construction traffic
CA High-Speed Rail Project	San Francisco to San Jose Section	San Francisco – San Jose	Unknown	US 101	San Francisquito Creek, S. F. Bay	Traffic

Table 3-15 Projects Considered in Cumulative Impacts Analysis for the Proposed Action

Project	Project Description	Location	Construction Schedule	Major Access Roads	Nearby Waterways	Potential Cumulative Impact Issues
New Crystal Springs Bypass Tunnel	Construct new water conveyance tunnel	San Mateo Co., Hillsborough	2008–2011	Polhemus Road, Crystal Springs Road	Polhemus Creek, San Mateo Creek	Air quality, biological resources, traffic
Dumbarton Rail Corridor Project	Commuter rail corridor from Redwood City and Menlo Park to East Bay.	San Mateo Co.	2008–2010	Multiple	Multiple	Air quality, biological resources, traffic
Redwood City Recycled Water Project	Pipelines, pump station and storage reservoir construction	Redwood City	Annually through 2010	Multiple	San Francisquito Creek	Construction traffic
San Mateo County	Seismic replacement of bridge on Crystal Springs Road	San Mateo Co., Hillsborough	2010–2011	I-280, Skyline Blvd, Polhemus, SR 92	Lower Crystal Spgs, San Mateo Creek	Air quality, biological resources, construction traffic
Dumbarton Rail Station	Redevelopment of Dumbarton Rail Station	Menlo Park, San Mateo	2008–2009	US 101	Dependent on project location	Construction and traffic impacts
City of Menlo Park	Offices, hotel, fitness center and restaurant construction	San Mateo Co.	2009–2012	US 101	San Francisquito Creek	Air quality, water quality, construction traffic
Redwood City Abbot Labs	Research facility construction	San Mateo Co.	2006–2009	US 101	San Francisquito Creek	Air quality, water quality, construction traffic
Stanford Outpatient Center Project	Renovation and conversion of four commercial bldgs. totaling 369,500 square feet.	Redwood City	2007–2009	US 101	Smith Slough, San Francisco Bay	Air quality, solid waste disposal, water quality
Kaiser Hospital Master Plan	New construction and seismic upgrades	Redwood City	2009–2014	US 101	San Francisco Bay	Air quality, solid waste disposal, water quality, construction traffic
South Bay Salt Pond Restoration Project	Tidal wetland restoration project to convert 15,100 acres of commercial salt ponds to tidal marsh	Santa Clara Co., San Mateo Co.	2008-TBD	US 101	San Francisquito Creek, San Francisco Bay	Solid waste disposal
San Francisquito Creek Project	Flood protection measure in Palo Alto, East Palo Alto and Menlo Park	San Mateo Co., Santa Clara Co.	2005–2009	US 101	San Francisquito Creek	Air quality, construction traffic

Note:
TBD = to be determined

Table 3-16 Estimated Proposed Action Construction GHG Emissions

	Annual Emissions (metric tons per year)
Construction Year	**CO_2e**
2012	45
2013	85
2014	1,617
2015	812
2016	75
2017	37
Threshold	25,000

Operation of the Proposed Action would generate GHG emissions from direct sources such as natural gas combustion and motor vehicles as well as indirect sources, such as water and wastewater use, waste generation, and electricity consumption. Table 3-17 summarizes total estimated GHG emissions from Proposed Action operation. Direct emissions of 90 MTCO_2e would not exceed the standard of 25,000 MTCO_2e proposed by the CEQ, above which further evaluation is required, and therefore would not be a major GHG emitter. Table 3-17 summarizes indirect GHG emissions, which would be well below the standard. Overall, impacts on air quality from operation of the proposed facility would be minor.

Table 3-17 Estimated Proposed Action Operational GHG Emissions

	Annual Emissions (metric tons per year)	
Source	**CO_2e**	**CEQ Threshold**
Direct		
Natural Gas	33	
Motor Vehicles	57	
Total Direct	90	25,000
Indirect		
Electricity	16,590	
Water Use	38	
Waste Generation	0.8	
Total Indirect	16,629	N/A

In addition to the proposed facility, several other sources of emissions in the region will contribute to the regional emission inventory. Table 3-18 compares the construction and operational emissions for the Proposed Action with the most recent data available for regional emissions. Regional criteria pollutant emissions included industrial and commercial stationary sources, and on- and off-road mobile sources, as well as miscellaneous area sources for San Mateo County and were obtained from CARB's Almanac Emission Projection Data (CARB 2009). Regional direct and indirect GHG emissions including industrial, commercial, transportation, residential, forestry and agriculture activities in San Mateo were obtained from BAAQMD's Source Inventory of Bay Area Greenhouse Gas Emissions (BAAQMD 2010). As shown in Table 3-18 the Proposed Action would result in emissions that would be a small percentage of the regional emissions, ranging from 0.008 to 0.2 percent. Therefore, the Proposed Action's contribution to regional air quality impacts would be minor.

Table 3-18 Proposed Action and Regional Emissions

	Annual Emissions				
Source	VOCs (tons/year)	NO_x (tons/year)	PM_{10} (tons/year)	$PM_{2.5}$ (tons/year)	CO_2e (MMT/year)
Proposed Action – Construction*	1.63	12.2	0.59	0.59	0.001617
Proposed Action - Operation	0.16	0.08	0.07	0	0.02
San Mateo County**	12,888	21,042	7,464	2,708	8.50
Percent of Proposed Action Emissions to Regional Emissions*	0.01%	0.06%	0.008%	0.02%	0.2%

Notes:
* Estimates for worst case year of construction
** Daily emissions converted to annual estimates assuming 365 days/year of emissions
MMT/yr = Million metric tons per year

3.14.2 Biological Resources

In conjunction with the cumulative projects, the Proposed Action alternative would have a local, long-term, minor impact on vegetation. Other SLAC projects and Stanford University developments would affect grasslands, together with construction of the EH and creation of disturbed areas. However, the grassland areas at SLAC are adjacent to existing industrial facilities. They do not provide suitable habitat for special-status species and none have been observed at SLAC. After the other projects are completed, any disturbed grassland areas would be restored to preconstruction conditions. Therefore, the Proposed Action alternative would have only minor cumulative effects on grasslands when considered together with the cumulative projects.

3.14.3 Cultural and Historic Resources

The Proposed Action alternative would involve excavation and could affect undiscovered cultural resources. Any unanticipated discoveries during LCLS-II or other SLAC or Stanford University construction would be addressed through consultation with a qualified archaeologist. Construction of the Sector 10 Injector would involve demolition of facilities in the proposed District. However, none of the other SLAC projects would affect the District; therefore, no cumulative impacts would result. Excavation of the tunnel could result in impacts on paleontological resources. Any fossil discoveries on SLAC or other major excavations on other projects would be addressed through consultation with a qualified paleontologist and, with minimization measures in place, only minor cumulative impacts would result.

3.14.4 Geology and Soils

Under the Proposed Action alternative, short-term impacts on soils would occur, including increased risk of erosion due to vegetation removal, caused by the use of heavy equipment. These potential effects would be reduced through erosion control BMPs. Other SLAC and Stanford University projects would result in short-term impacts on geologic and soil resources from grading and road construction. These impacts would be reduced through BMPs and site restoration. Other projects would be subject to similar geologic and seismic engineering design and geotechnical measures as required by local and state building codes. Considered together with the cumulative projects, the Proposed Action alternative would have minor cumulative effects on soils and geology.

3.14.5 Health and Safety

In conjunction with LCLS-I, the Proposed Action alternative would have long-term minor impacts on worker health and safety by proportionately increasing radiation sources and frequency of operation. However, these impacts would be managed through SLAC's existing health and safety programs and any cumulative effects would be minor. In addition, LCLS-I and the Proposed Action could have a cumulative beneficial effect on public health from breakthroughs related to health care, such as cancer treatments.

3.14.6 Hydrology and Water Quality

The Proposed Action and previous SLAC projects, including LCLS-I, have created impervious surfaces, potentially resulting in stormwater runoff with elevated chemical concentrations and the potential for downstream flooding. Past developments along San Francisquito Creek have resulted in flooding. To address cumulative flooding impacts, local San Mateo and Santa Clara municipalities developed flood control programs requiring stormwater detention. Current and future urban development projects, including SLAC projects, are required to control stormwater runoff. In addition, regulatory agencies initiated the San Francisquito Flood Protection and Ecosystem Restoration Project to evaluate flood control measures, including stormwater detention. Because the Proposed Action would be constructed largely within the footprint of existing facilities and would comply with stormwater detention requirements, any increased runoff volume would be addressed through existing stormwater programs and would not increase the peak runoff rate. Therefore, any cumulative flooding impacts would be minor.

Similarly, past projects throughout the watershed have resulted in impaired water quality in San Francisquito Creek. This may have included past SLAC projects involving substantial grading and excavation. San Francisquito Creek was historically impaired by sediments and landscaping pesticides. Accordingly, Santa Clara Valley Urban Runoff Pollution Prevention Plan and SMCWPPP established NPDES permit requirements to reduce pollution in runoff. In conjunction with other SLAC and Stanford University projects, and given implementation of the SWPPP and other BMPs constructed in the watershed, the Proposed Action would have only minor cumulative effects on water quality that would be monitored and addressed according to state and local stormwater regulations.

The Proposed Action would result in only minor, local groundwater impacts. Dewatering would have a minor local impact on groundwater and risks of contamination would be minimized through BMPs to prevent leaks and spills, and according to procedures presented in site-specific SWPPP and SPCC plans. Other projects, including SLAC renovations and Stanford University projects would use similar measures to minimize any impacts on groundwater through spills. Considered together with these projects, the Proposed Action would have only minor cumulative impacts on groundwater.

3.14.7 Noise

During construction, the Proposed Action alternative would generate noise from excavators at the tunnel and cavern site, as well as on the site access roads, from vehicles transporting workers, equipment and materials to and from the site. Noise modeling demonstrated that noise and vibration from construction equipment would not exceed applicable noise standards. The other projects at SLAC, including construction of research buildings and facility upgrades, could generate short-term, local noise impacts. Based on the schedule for other planned construction at SLAC, some projects would overlap with the Proposed Action. There would be limited nighttime construction on other SLAC or Stanford University construction projects in the area. In addition, based on the noise analysis for individual components, construction of the Proposed Action combined with LCLS-I operational noise (air handling systems) would not exceed Menlo Park noise standards. Therefore, considered together, LCLS-I, other SLAC projects and the Proposed Action would have only minor cumulative noise impacts.

3.14.8 Traffic

The Proposed Action alternative would result in short-term construction-related increases in traffic during demolition and waste removal activities, and from delivery of construction equipment and materials. However, most worker traffic and deliveries would occur at off-peak times. Other scheduled SLAC infrastructure upgrades would consist of minor upgrades and renovations. Construction would also overlap with other local projects including the Stanford University Medical Center Renewal Project (see Table 3-15). Some construction and renovation would overlap with the Proposed Action, particularly the peak traffic period in 2014 and 2015. However, given the planned site circulation improvements, addition of an automated gate at the Alpine Road entrance, and timing of deliveries, the Proposed Action considered together with other projects including at SLAC, would result in only minor cumulative traffic impacts on Alpine Road. Other projects in the area would not have substantial traffic impacts on roads affected by Proposed Action construction. For example, the Stanford University Medical Center Renewal Project would implement a number of traffic mitigation measures including traffic adaptive signal technology, additional bicycle and pedestrian undercrossings, demand management and intersection improvements. In the long term, the other SLAC infrastructure upgrades identified in Table 3-15 would have no cumulative impacts because they would not overlap with the Proposed Action's operational traffic.

Other cumulative projects in the region would add truck trips on regional highways. Residential and commercial developments as well as mining projects could add truck traffic on I-280. However, these added truck trips would be inconsequential when considered together with the Proposed Action. Any cumulative impacts would be minor considering the short-term construction at SLAC and the relatively small number of truck trips given on-site relocation of excavated material.

Several large construction projects are planned in the region, including dam improvements, mass transit, hospital construction, roadway improvements and habitat restoration. However, these projects are located primarily in urban areas of San Mateo and Menlo Park along the U.S. 101 corridor and would only overlap with the Proposed Action if trucks carrying excavated spoil to disposal areas use State Route 92 or U.S. 101. Because a relatively small volume of excavated material and demolition debris will be transported off site for disposal, any cumulative traffic impacts on regional highways would be inconsequential.

3.14.9 Waste Management

The Proposed Action alternative would generate only a nominal amount of hazardous waste in the form of oily waste, but would generate substantial amounts of solid waste from demolition and excavation. However, solid waste disposal impacts on landfill capacity and operations would be minimized by recycling approximately 75 percent of the building demolition debris and by relocating excavated material on site. Through maximizing recycling and proper disposal of minor quantities of construction-generated hazardous waste, the Proposed Action would have a minor effect on waste management. Other projects would also produce solid waste, including excavated material and construction and demolition wastes. However, in compliance with state and local regulations and federal EOs, much of this material would be reused or recycled, reducing their effect on waste management. Considered together with these projects, the Proposed Action alternative would have a minor impact on waste management.

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4.0 CONSULTATION AND COORDINATION

This section summarizes federal and state agency coordination in support of the Proposed Action. Section 4.1 lists the permits and approvals required for construction. Section 4.2 describes the required agency consultations. Documentation of correspondence with federal and state agencies is included in Appendix D.

4.1 Permits and Approvals

Environmental permits and approvals for the Proposed Action may be required from the following agencies:

- State Water Resources Control Board for a Construction General Permit for stormwater discharges;
- National Historic Preservation Act Section 106 consultation with the State Historic Preservation Officer;
- CalOSHA Underground Classification Permit;
- Bay Area Air Quality Management District for a permit to operate a stationary emergency standby generator, if installed.

The Proposed Action would be covered under the site-wide Synthetic Minor Operating Permit issued by the BAAQMD. DOE has determined that no ESA Section 7 consultation with the USFWS or NOAA would be required as no protected (endangered or threatened) species or their habitat have been found at the project site. . DOE will consult with the SHPO regarding potential impacts of the installation of the injector at Sector 10 on the proposed historic district. Through submittal of the draft EA to the SHPO, the NEPA process would be used to complete the Section 106 consultation on the rest of the LCLS-II project. A copy of the formal letter from the DOE to the SHPO is provided in Appendix D.

Agency Coordination

4.1.1 San Francisco Regional Water Quality Control Board

SLAC would obtain a Construction General Permit for stormwater discharges from the State Water Board. The Regional Water Quality Control Board (RWQCB) provides oversight of implementation of the Construction General Permit. All associated documentation and monitoring results would be submitted to the RWQCB.

4.1.2 U.S. Fish and Wildlife Service and NOAA Fisheries

The ESA, as amended, prohibits any person from taking (harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, relocating, or collecting or attempting to engage in any such conduct) any federal-listed threatened or endangered species. Section 7 of the ESA outlines the procedures for federal interagency cooperation to conserve federal-listed species and designated critical habitats. Section 7(a)(2) requires federal agencies to consult with the natural resources agencies to ensure that they are not undertaking, funding, permitting or authorizing actions that are likely to jeopardize the continued existence of listed species, or destroy or adversely modify designated critical habitat.

4.1.3 California State Historic Preservation Office

The Proposed Action would constitute an undertaking subject to Section 106 of the NHPA, as set forth in 36 CFR 800.16(y). Section 106 of the NHPA and its implementing regulations require federal agencies to consider the effects of undertakings on historic properties. An effect is defined as an "alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the National Register (36 CFR 800.16(i))." If an undertaking will affect a historic property, the nature of the effect must be assessed. DOE would be required to consult with SHPO regarding potential impact on historic properties as well as the historic district. DOE would also consult with the appropriate Indian Tribes/Nations and the Bureau of Indian Affairs.

5.0 LIST OF PREPARERS AND REVIEWERS

Table 5-1 lists the individuals responsible for preparing this EA. The EA was prepared for DOE and SLAC through a contract with ARCADIS.

Table 5-1 List of Preparers

Name	Resource Area
DOE	
Dave Osugi	NEPA Coordinator, SLAC Site Office
Gary Hartman	NEPA Compliance Officer, SC Integrated Support Center, Oak Ridge Office
Jim Elmore	SC Integrated Support Center, Oak Ridge Office
Patrick Burke	SC Legal Counsel
SLAC	
Ian Evans	LCLS-II ESH Manager
John Galayda	LCLS-II Project Director
Michael Hug	ESH Division, Environmental Engineer
Daren Marsh	LCLS-II Quality Assurance Manager
Steve Porter	SLAC Legal Counsel
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Susan Witebsky	ESH Division, Environmental Protection Department, Assistant Department Head
Sayed Rokni	ESH Division, Radiation Protection Department, Department Head
Brian Sherin	ESH Division, Deputy Director
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Bernard Frist	Principal-in-Charge
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Bryan Chen	Air Quality
Carrie Hofer	Biological Resources
Russ Collett	Cultural Resources
Jason Adams	Geology and Soils
Carl Spath, Ph.D.	Cultural Resources
Kevin Fowler	Noise
Cindy Cox	Health and Safety
Conrad Mulligan	Socioeconomics and Environmental Justice
Jie Chen	Geographic Information Systems
Ram Kumar	Traffic
Emily Leamer	Waste Management

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APPENDIX A: PHOTOGRAPHS OF LCLS-I CONSTRUCTION (2005 – 2009)

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Photo A-1: Construction of the LCLS Beam Transport Hall across the SLAC Research Yard

Photo A-2: Construction of the LCLS-I Undulator X-Ray Transport

Photo A-3: Construction of the LCLS-I FEE

APPENDIX B: AIR QUALITY ASSESSMENT TECHNICAL INFORMATION

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B.1 Emissions Calculations

Emissions were calculated using the CalEEMod Environmental Management Software. The CalEEMod model provides a platform to calculate both construction and operational source emissions using equipment emission factors (mass of emissions per unit time) from sources such as EPA, CARB and site-specific information. CalEEMod calculates emissions of Volatile Organic Compounds (VOC), Nitrogen Oxides (NOx), Particulate Matter less than 10 microns (PM_{10}), Particulate Matter less than 2.5 microns ($PM_{2.5}$), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). For PM_{10} and $PM_{2.5}$, CalEEMod separates emissions from fugitive and exhaust sources. CalEEMod also provides default values when site-specific information is not available.

Construction Emissions

Construction emissions include different sources including off-road equipment usage, on-road vehicle travel, fugitive dust, architectural coating, and paving off-gassing.

Off-Road Equipment Usage

For off-road equipment usage, CalEEMod calculates the exhaust emissions for the evaluated compounds using the equation presented below:

$$\text{Emissions} = \Sigma\ EF_i \times Pop_i \times HP_i \times \text{Load Factor}_i \times \text{Activity}_i$$

Where:

EF = Emission factor in grams per horsepower-hour (g/bhp-hr)

Pop = Population (i.e., the number of pieces of equipment)

Hp = Equipment horsepower

Load = Load factor

Activity = Hours of operation

i = equipment type

On-Road Vehicle Travel

On-road vehicle exhaust, evaporative, and dust emissions from personal vehicles for worker and vendor commuting, and trucks for soil and material hauling are based on the vehicle miles traveled (VMT) along with vehicle emission factors as follows:

$$Emissions_{pollutant} = VMT * EF_{running,pollutant}$$

Where:

$Emissions_{pollutant}$ = emissions from operating vehicles

VMT = vehicle miles traveled

$EF_{running,pollutant}$ = emission factor for running emissions

Fugitive Dust

CalEEMod calculates fugitive dust associated with the site preparation and grading phases from three major activities: haul road grading, earth bulldozing, and truck loading. The fugitive dust emissions from the grading phase are calculated using the methodology described in EPA AP-42[1] Section 11.9 for grading equipment and Section 13.2 for truck dumping or loading out. For demolition dust emissions, the methodol.ogy is described in a report prepared for the EPA by Midwest Research Institute (MRI)[2].

Architectural Coatings and Asphalt Off-Gassing

CalEEMod calculates the VOC evaporative emissions from application of surface coatings using the following equation:

$$E = EF \times A \times F$$

Where:

E = emissions (lb VOC)

EF = emission factor (lb/sqft)

A = building surface area (sqft)

F = fraction of surface area.

1 EPA. 1995. AP 42, Compilation of Air Pollution Emission Factors, Fifth Edition. http://www.epa.gov/ttn/chief/ap42

2 Midwest Research Institute. 1988. Gap Filling PM10 Emission Factors for Selected Open Area Dust Sources.

CalEEMod estimates VOC off-gassing emissions associated with asphalt paving of parking lots using the following equation:

$$E = EF \times A$$

Where:

E = emissions (lb)

EF = emission factor (lb/acre). The default emission factor is 2.62 lb/acre.

A = area of the parking lot (acre)

The contributions from the various sources (i.e., off-road equipment usage, on-road vehicle travel, fugitive dust, architectural coating, and paving off-gassing) are summed for the duration of each applicable construction activity and reported on an annual basis.

Operational Emissions

Operational Mobile

CalEEMod calculates the emissions associated with on-road mobile vehicles visiting the project. The emissions associated with on-road mobile sources include running and starting exhaust emissions, evaporative emissions, brake and tire wear, and fugitive dust from paved and unpaved roads.

The emissions from mobile sources were calculated using trip rates, trip lengths and emission factors for running from EMFAC2007 as follows:

$$Emissions_{pollutant} = VMT * EF_{running,pollutant}$$

Where:

$Emissions_{pollutant}$ = emissions from vehicle running for each pollutant

VMT = vehicle miles traveled

$EF_{running,pollutant}$ = emission factor for running emissions

Area Sources

CalEEMod calculates area sources of air emissions located at the project site including consumer product use, architectural coatings, and landscape maintenance equipment.

Consumer Products

Consumer products evaluated include detergents; cleaning compounds; polishes; floor finishes; cosmetics; personal care products; home, lawn, and garden products; disinfectants; sanitizers; aerosol paints; and automotive specialty products. To calculate the VOC emissions from consumer product use, the following equation is used:

Emissions = EF x BuildingArea

Where:

Emissions = Emissions from consumer products

EF = pounds of VOC per building square foot per day

BuildingArea = Total square footage of all buildings.

Architectural Coatings

VOC off-gassing emissions result from evaporation of solvents contained in surface coatings such as in paints and primers. CalEEMod calculates the VOC evaporative emissions from application of surface coatings assuming an annual 10% reapplication rate.

Landscape Equipment

Landscape maintenance includes fuel combustion emissions from equipment such as lawn mowers, roto-tillers, shredders/grinders, blowers, trimmers, chainsaws, and hedge trimmers, as well as air compressors, generators, and pumps. Emissions are estimated as off-road equipment.

Energy

Energy use in buildings is divided into energy consumed by the built environment and energy consumed by uses independent of building construction, such as in plug-in appliances. In California, Title 24 governs energy consumed in the built environment, mechanical systems, and some types of fixed lighting. Non-building energy use, or "plug-in" energy use can be further subdivided by specific end-use (refrigeration, cooking, office equipment, etc.). CalEEMod calculates energy use by:

1. Calculating energy use from systems covered by Title 24 (HVAC system, water heating system, and the lighting system).
2. Calculating energy use from lighting.
3. Calculating energy use from office equipment, appliances, plug-ins, and other sources not covered by Title 24 or lighting.

Emissions from energy use are calculated by multiplying the energy use times the energy source specific emission factor. In general:

$$\text{Emissions} = \Sigma_i \text{ (EF x Energy Intensity x Size)}$$

Where:

Emissions = Emissions from energy use

EF = energy emission factor

Energy Intensity = energy intensity for a land use

Size = size of the building or Dwelling units

i = land use type

Since the proposed action will require electricity for a source not accounted for in CalEEMod (laser generation), the results from CalEEMod for electricity were scaled based on the known electrical demand (38,000 megawatt-hours per year) and the CalEEMod-calculated electrical demand of 198 megawatt-hours per year for a typical research facility and an estimated GHG emission of 86.7 MT CO2e/yr. This emission value was scaled up proportionately by a factor of 38,000/198 for the proposed action as follows:

86.7 MT CO2e/yr / 198 megawatt-hours/year *38,000 megawatt-hours/year = 16,590 MT CO2e/yr

Water

The amount of water used and wastewater generated by a project has indirect GHG emissions. Emissions result from the energy used to supply, distribute, and treat the water and wastewater. In addition to indirect GHG emissions from energy use, wastewater treatment can directly emit both methane and nitrous oxide.

Waste Generation

Municipal solid waste is the amount of material disposed of in landfills or by recycling or composting. CalEEMod calculates the indirect GHG emissions associated with waste disposed of in landfills. The program quantifies the GHG emissions associated with waste decomposition, which generates methane based on the total amount of degradable organic carbon. It also quantifies CO_2 emissions associated with the combustion of methane, if applicable.

Table B-1 summarizes the site-specific information used in the construction emissions calculations, including activity durations, types of equipment and shift length.

Annual construction emissions from criteria pollutants calculated from CalEEMod are presented in Table B-2.

Table B-1 Construction Details by Activity

Activity	Start	Duration	Diesel Construction Equipment	Hours per Day Construction	Daily Workers	Material for Relocation or Disposal
Procurement/ Installation	Q3 2012	5 years	1 forklift	8 hours	<10*	None
Demolition of Sector 10 Alcove	Q3 2012	3 weeks	1 excavator	8 hours	10	55 cy of demolished concrete and 55 cy of sheet metal
Site preparation	Q1 2013	4 weeks	1 backhoe	8 hours	10	370 cy of soil
Tunneling**	Q3 2014	6 months	1 mucker 1 loader 1 compressor 2 dump trucks	20 hour	60	60,000 cy of soil
Building Construction	Q3 2014	14 months	3 compressors 2 front-end loaders 2 backhoes 2 cranes 2 pick-up trucks	8 hours	70	None

Notes:

* Typical, based on LCLS-I.

** Electric-powered construction equipment used during tunneling includes three road headers, one track-mounted excavator with boom and one electric hydraulic machine.

Table B-2 Estimated Proposed Action Construction Emissions

Construction Year	Annual Emissions (tons per year)			
	VOCs	NO_x	PM_{10}	$PM_{2.5}$
2012	0.05	0.35	0.03	0.02
2013	0.08	0.60	0.08	0.03
2014	1.65	12.27	1.51	0.59
2015	1.10	5.82	0.34	0.32
2016	0.06	0.38	0.04	0.02
2017	0.03	0.17	0.02	0.01

Operational emissions associated with the daily activities were calculated based on increased vehicular trips to and from the site (i.e., mobile sources) and multiplied by the number of annual workdays to estimate annual emissions. Increases in vehicular trips would result from a larger number of researchers using the LCLS-II facilities (up to 60 additional researchers per day). CalEEMod was used to estimate criteria pollutant emissions from mobile, area and energy sources during operations (Table B-3).

Table B-3 Estimated Proposed Action Operational Emissions

Emission Source	Annual Emissions (tons per year)			
	VOCs	NO_x	PM_{10}	$PM_{2.5}$
Area	0.12	0.00	0.00	0.00
Energy	0.00	0.03	0.00	0.00
Motor Vehicles	0.04	0.05	0.07	0.00
Total	0.16	0.08	0.00	0.00

Table B-4 summarizes GHG emissions from construction of the proposed action.

Table B-4 Estimated Proposed Action Construction GHG Emissions

Construction Year	Annual Emissions (metric tons per year) CO_2e
2012	45
2013	85
2014	1,617
2015	812
2016	75
2017	37

Operation of the proposed action would generate GHG emissions from direct sources such as natural gas combustion and motor vehicles as well as indirect sources, such as water and wastewater use, waste generation, and electricity consumption. CalEEMod was used to estimate GHG emissions from proposed action operation (Table B-5).

Table B-5 Estimated Proposed Action Operational GHG Emissions

Source	Annual Emissions (metric tons per year) CO_2e
Direct	
Natural Gas	33
Motor Vehicles	57
Total Direct	90
Indirect	
Electricity	16,590
Water Use	38
Waste Generation	0.8
Total Indirect	16,629

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SLAC LCLS II

San Mateo County, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	24	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Climate Zone 5

Wind Speed (m/s) 2.2

Precipitation Freq (Days) 70

Utility Company Statewide Average

1.3 User Entered Comments

Project Characteristics - SLAC uses WAPA as Utility Company. Use Statewide average as surrogate

Land Use - LCLS II will be a research facility with the experimental labls being approximately 24,000 sf in size. Population accounts for 60 additional researchers that would be using LCLS II.

Construction Phase - Demo - 9/1/12 - 9/20/12; BTH - 1/1/13 - 1/28/13; Tunnelling 7/1/14-12/31/14; Building constr -7/1/14-9/1/15; Paving 8/1/15 - 8/14/15; Coating 8/16/15 - 8/28/15
Fab/Install 7/1/12-7/1/17

Off-road Equipment - coating: 1 compressor, 6 hr/day

Off-road Equipment - BTH: 1 backhoe, 8 hr/day

Off-road Equipment - Building construction: 3 compressors, 2 loaders, 2 backhoes, 2 cranes, 2 trucks; all 8 hrs/day

Off-road Equipment - Demo: 1 excavator, 8hr/day

Off-road Equipment - Fab/install: 1 forklift, 8hr/day

Off-road Equipment - Paving (default): 4 mixers, 1 pavers, 1 roller, 1 backhoe; 6-7 hrs/day

Off-road Equipment - Tunnelling: 1 mucker (other material handling equipment), 1 loader, 1 compressor, 2 dump trucks (off-hwy); all 2, 10-hr shifts

Trips and VMT - Class II landfill (Altamont, 100 mi rt); Nearby landfill: 20 mi rt; Tunnelling material placed onsite (2 mi rt)
Demo: 5 trips to Altamont; 5 trips to nearest landfill (20 mi rt); BTH: 35 trips to Altamont

Grading - BTH site prep: 370 cy
Tunneling: 60,000 cy

Vehicle Trips - Assumes additional 60 researchers associated with project each day of the week

2.0 Emissions Summary

2.1 Overall Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2012	0.05	0.35				0.02	0.03		0.02	0.02			44.48	0.00	0.00	44.56
2013	0.08	0.60				0.03	0.08		0.03	0.03			84.62	0.01	0.00	84.75
2014	1.65	12.27				0.59	1.51		0.59	0.59			1,613.94	0.13	0.00	1,616.70
2015	1.10	5.82				0.32	0.34		0.32	0.32			810.40	0.07	0.00	811.80
2016	0.06	0.38				0.02	0.04		0.02	0.02			74.63	0.00	0.00	74.73
2017	0.03	0.17				0.01	0.02		0.01	0.01			37.12	0.00	0.00	37.16
Total	**2.97**	**19.59**				**0.99**	**2.02**		**0.99**	**0.99**			**2,665.19**	**0.21**	**0.00**	**2,669.70**

2.2 Overall Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	0.12	0.00				0.00	0.00		0.00	0.00			0.00	0.00	0.00	0.00
Energy	0.00	0.03				0.00	0.00		0.00	0.00			119.18	0.00	0.00	119.74
Mobile	0.04	0.05				0.00	0.07		0.00	0.00			56.71	0.00	0.00	56.75
Waste						0.00	0.00		0.00	0.00			0.37	0.02	0.00	0.83
Water						0.00	0.00		0.00	0.00			27.89	0.36	0.01	38.34
Total	**0.16**	**0.08**				**0.00**	**0.07**		**0.00**	**0.00**			**204.15**	**0.38**	**0.01**	**215.66**

APPENDIX C: NOISE ASSESSMENT TECHNICAL INFORMATION

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C.1 Noise Terms

Noise is generally defined as unwanted or objectionable sound. The effects of noise on people can include general annoyance, interference with speech communication, sleep disturbance, and, in the extreme, hearing impairment. An assessment of the potential for the proposed action to result in adverse noise effects requires an evaluation of the site's general setting (e.g., isolated, rural, suburban or urban), nature of the existing ambient noise sources or activities occurring in those settings, proximity of the noise-sensitive receptor to the existing ambient noise source or activity, time of day, and various sound-attenuating factors (e.g., vegetation, ground absorption, topographic features, buildings and atmospheric conditions).

Noise standards and sound measurement equipment have been designed to account for the sensitivity of human hearing to different frequencies. This is accomplished by applying "A-weighted" correction factors. This correction factor is widely applied in the industry and is known to de-emphasize the very low and very high frequencies of sound in a manner similar to the response of the human ear. A-weighted sound levels correlate well to a human's subjective reaction to noise. When the A-weighted scale is applied, units are referred to as A-weighted decibels (dBA).

An individual's sound exposure is valued based on a measurement of the noise that the individual experiences over a specified time interval. A sound level is a measurement of noise that occurs during a specified period of time. A continuous source of noise is rare for long periods of time and is typically not a characteristic of community noise. Community noise refers to outdoor noise in the vicinity of a community and most commonly originates from transportation vehicles or stationary mechanical equipment. A community noise environment varies continuously over time with respect to the contributing sources. Within a community, ambient noise levels gradually change throughout a typical day and the changes can be correlated to the increase and decrease of transportation noise or to the daytime/nighttime operation of stationary mechanical equipment. The variation in community noise throughout a day is also due to the addition of short-duration single-event noise sources, such as aircraft and sirens as well as various natural sources.

The metrics for evaluating the community noise environment are based on noise exposure over a period of time sufficient to characterize noise impacts. These metrics are time-varying and are defined as statistical noise descriptors. The most common metrics for evaluating community noise are as follows:

Leq: The equivalent sound level, or the time-integrated continuous sound level, that represents the same sound energy as the varying sound levels, logarithmically averaged over a specified monitoring period. A 3-dBA change in a 1-hour Leq is barely noticeable to people located within a community. However, a 5-dBA change in noise level is clearly noticeable. A 10-dBA change in noise level is perceived as a doubling or halving of noise loudness, while a 20-dBA increase represents a dramatic change.

Lmax: The instantaneous greatest noise level measured on a sound level meter during a designated time interval.

Lmin: The instantaneous lowest noise level measured on a sound level meter during a designated time interval.

Lx: The base sound level that is exceeded x percent during a specified time.

DNL: The Day-Night Average Sound Level (abbreviated as DNL or LDN) that represents a 24-hour A-weighted sound level average conducted from midnight to midnight, where sound levels during the nighttime hours of 10:00 PM to 7:00 AM have an added 10 dB weighting, but no added weighting on the evening hours.

CNEL: The Community Noise Equivalent Level that represents a 24-hour A-weighted sound level average conducted from midnight to midnight, where sound levels during the evening hours of 7:00 PM to 10:00 PM have an added 5 dB weighting, and nighttime hours of 10:00 PM to 7:00 AM have an added 10 dB weighting.

C.2 Ambient Noise Levels at SLAC

In 2006, SLAC completed an ambient noise study (Charles M. Salter Associates, Inc 2006). This study conducted three simultaneous 24-hour ambient noise measurements at three (3) residential locations within the City of Menlo Park, nearest to the SLAC property line. Monitor 1 was located 450 feet south of Sand Hill Road along the SLAC northern property line. Monitor 2 was located on the southeastern corner of Campbell Lane and Branner Road. Monitor 3 was located on the southeastern corner of the SLAC property line approximately 340 feet south of the intersection of Alpine Road, Sneckner Court, and Bishop Road.

The Charles M. Salter Associates study collected data from March 8th through March 9th of 2006, logging the community ambient noise monitoring data every hour for a continuous 24 hour time period. The three residential locations were determined to be the nearest residential receptors to the SLAC LCLS-I project area. The result of this study is presented in Table C-1.

Table C-1 Measured Existing 1-hour Ambient Noise Levels from March 8, 2006 to March 9, 2006

Monitor Start Time (Military Time)	Date	Monitor 1 (dBA Leq)	Monitor 2 (dBA Leq)	Monitor 3 (dBA Leq)
10:00:00	3-8-2006	59	58	67
11:00:00	3-8-2006	58	51	67
12:00:00	3-8-2006	57	52	67
13:00:00	3-8-2006	57	51	67
14:00:00	3-8-2006	57	50	67
15:00:00	3-8-2006	58	52	69
16:00:00	3-8-2006	57	51	69
17:00:00	3-8-2006	59	59	69
18:00:00	3-8-2006	56	56	68
19:00:00	3-8-2006	53	48	66
20:00:00	3-8-2006	54	51	65
21:00:00	3-8-2006	54	50	64
22:00:00	3-8-2006	50	48	62
23:00:00	3-8-2006	50	48	60
0:00:00	3-9-2006	41	45	56
1:00:00	3-9-2006	40	45	52
2:00:00	3-9-2006	38	45	49
3:00:00	3-9-2006	45	48	53
4:00:00	3-9-2006	45	47	55
5:00:00	3-9-2006	51	49	61
6:00:00	3-9-2006	56	51	68
7:00:00	3-9-2006	60	56	70
8:00:00	3-9-2006	60	61	70
9:00:00	3-9-2006	61	61	69
24-Hour LDN		**59 dBA**	**57 dBA**	**69 dBA**

Source: Charles M. Salter Associates, Inc 2006

From the Charles M. Salter Associates report, a graphical representation showing the three 24-hour ambient noise monitoring locations and resultant measurement values is presented in Figure C-1.

C.3 Noise Regulations

Federal, state, and local governments have established noise standards and guidelines to protect citizens from potential hearing damage and various other adverse physiological and social effects associated with noise. The SLAC is a federal U.S. Department of Energy facility and is subject to the federal noise standards. The State of California and local noise standards are not applicable to the LCLS-II project. However, SLAC considers the noise threshold limits set forth by the City of Menlo Park.

C.3.1 Federal Laws and Regulations

The Environmental Protection Agency (EPA 1974) has developed and published criteria for environmental noise levels with a directive to protect public health and welfare with an adequate margin of safety. This EPA criterion (Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety) was developed to be used as an acceptable guideline when no other local, county, or state standard has been established. However, the EPA criterion is not meant to substitute for agency regulations or standards where states and localities should use the developed criteria accordingly to their individual needs and situations.

The EPA established its criteria using the day-night average sound exposure (LDN) metric. This metric represents a 24 hour average noise level as calculated by obtaining the daytime noise level from the hours of 7:00 a.m. to 10:00 p.m. and applying a 10 dB penalty for the more restrictive quietest nighttime noise levels between the hours of midnight to 7:00 a.m. and 10:00 p.m. to midnight.

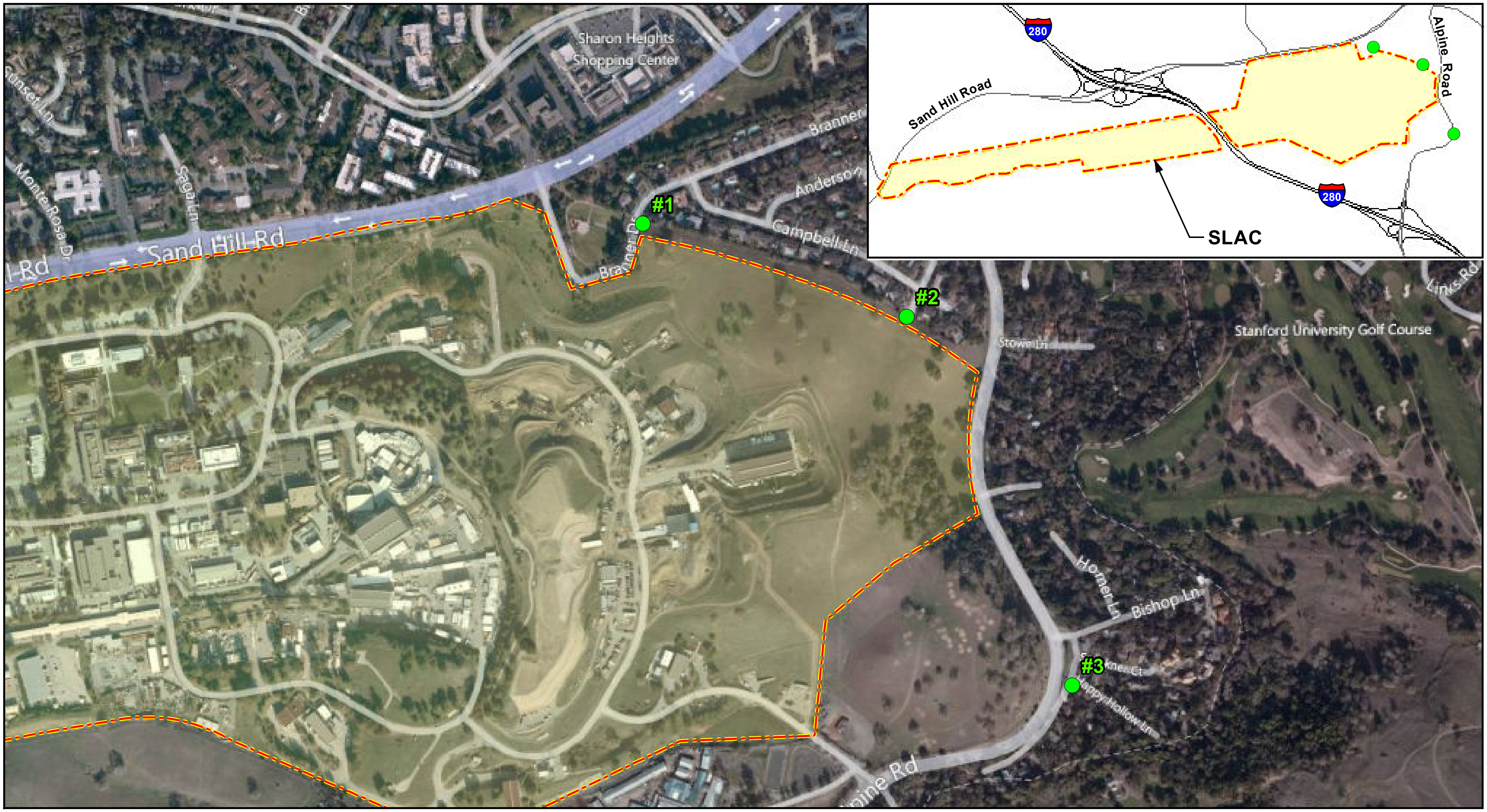
According to the EPA guidelines, an LDN of 45 dBA indoors and 55 dBA outdoors for residential areas in a rural setting is identified as the maximum allowable noise level which no effects on public health and welfare occur due to interference with speech or other activities. These levels would also protect the vast majority of the population under most conditions against annoyance, in the absence of intrusive noises with particularly aversive content. Table C-2 is published by the EPA and summarizes the maximum allowable noise level for specified land use areas.

Table C-2 Summary of Noise Levels Identified as Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety

Effect	Noise Level	Land Use Area
Hearing Loss	Leq(24) =< 70 dB	All Areas
Outdoor activity interference and annoyance	Ldn =< 55 dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	Leq(24) =< 55 dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	Ldn =< 45 dB	Indoor residential areas.
	Leq(24) =< 45 dB	Other indoor areas with human activities such as schools, etc.

Source: EPA 1974

CITY: Boulder, CO DIV/GROUP: IM/AIT DRAFTER: J. CHEN
Project (Project #): AZ001214
K:\AZ001214_SLAC_LCLS_II_EA\GIS\ArcMaps\Noise_Receptors.mxd - 8/29/2011 @ 10:37:59 AM



Basemap: Bing Maps, serviced by ESRI ArcGIS Online

LEGEND

SLAC LINEAR ACCELERATOR CENTER (SLAC) GROUNDS

NOISE RECEPTOR

N

0 700 Feet

Graphic Scale: 1" = 700'

SLAC LCLS-II EA

NOISE RECEPTORS

ARCADIS

FIGURE C-1

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C.3.2 State Agencies

The State of California - Office of Noise Control Standards has also developed land use compatibility guidelines for community noise (California Office of Noise Control, 1976). Following these guidelines, establishing residences, churches, libraries, hospitals, and schools in areas exceeding 70 dB CNEL is normally unacceptable. These facilities are conditionally acceptable in areas that measure between 60 and 70 dB CNEL. Professional and commercial office buildings are normally unacceptable in areas exceeding 75 dB CNEL, and are conditionally acceptable in areas that measure between 67 dB and 77 dB CNEL. These guidelines, however, can be modified to reflect sensitivities of individual communities to noise.

C.3.3 Local Agencies

The City of Menlo Park Municipal Code contains limits for the generation of noise on adjacent properties. Sections regarding construction activities are summarized below.

Section 8.06.030 includes criteria for maximum noise levels at residential property lines, as summarized in Table C-3.

Table C-3 City of Menlo Park Municipal Code Sound Level Limits

Maximum Sound Level Measured from Residential Property	Time Period
50 dBA	Nighttime Hours: 10:00pm to 7:00am
60 dBA	Daytime Hours: 7:00am to 10:00pm

Source: City of Menlo Park 2010

Section 8.06.0404 states: "The following are exceptions to the noise limitations set forth in section 8.06.030. These activities may occur at other times provided they meet the noise levels set forth in Section 8.06.030."

Construction Activities: Construction activities between the hours of eight (8) am and six (6) pm Monday through Friday.

Powered Equipment: Powered equipment used on a temporary, occasional or infrequent basis operated between the hours of eight (8) am and six (6) pm Monday through Friday. No piece of equipment shall generate noise in excess of eighty-five (85) dBA at fifty (50) feet.

C.4 Noise and Vibration Calculation Methodology

Noise modeling for the proposed construction and operation was completed using Cadna A (Computer Aided Noise Abatement), Ver. 4.0, a model developed by DataKustik to predict noise impacts in a wide variety of conditions. Predicted noise levels are based on the International Standards Organization (ISO) 9613 standard. This standard methods for calculating the attenuation of sound and noise levels at receptors at a given distance. Model inputs include noise source data, barriers, structures, and topography.

Vibration levels at receptors were calculated based on propagation of construction equipment vibration over the distance from the source to the receptor. The equation used is supplied below.

$L_v(D) = L_v(25\text{ ft}) - 30\log(D/25)$ (FTA 1995)

$L_v(25\text{ ft})$ = reference vibration level (VdB) at 25 feet
D = distance from the vibration source to the receptor
$L_v(D)$ = calculated vibration level (VdB) at a specified distance

C.5 Noise Generated by Construction Equipment

The Construction Noise Handbook (Federal Highway Administration [FHWA] 2009) which provides a comprehensive assessment of noise levels from construction equipment. Based on the reference values in the guide and the list of construction equipment to be used on the Project, as presented in Table C-4, the loudest equipment would generally emit noise in the range of 80 to 85 dBA Lmax at 50 feet, with utilization factors of 80 to 100 percent that account for the time period the equipment would be used over a 14-hour daytime work shift and a 6 hour nighttime work shift.

Noise predictions assumed that all the construction equipment summarized in Table C-4 would operate simultaneously. It assumed the construction equipment associated with the conventional facilities would be located at the experimental hall and beam transport hall and that tunneling equipment would be located at the tunnel entrance.

Table C-4 Typical Construction Equipment Noise Levels

Construction Operations	Equipment	Quantity	Daytime Typical Utilization Factor (%)	Nighttime Typical Utilization Factor (%)	Noise Level (dBA Lmax) at 50 feet
Conventional Facilities Construction	Backhoe	3	100	0	80
	Compactor	1	80	0	80
	Compressor	3	100	0	80
	Concrete mixer truck	2	80	0	85
	Crane	2	80	0	85
	Dozer	1	80	0	85
	Excavator	1	80	0	85
	Loader	2	100	0	80
	Pick-up Truck	2	100	0	55
Tunneling Excavation	Compressor	1	100	100	80
	Excavator with Electric-Powered Hydraulic Machine	1	80	80	80
	Loader	1	100	100	80
	Heavy truck	2	100	100	84
	Road Header *	3	100	100	86

Sources: FHWA 2009, *Charles M. Salter Associates, Inc 2006

C.6 Typical Construction Equipment Vibration Levels

The construction of the proposed facility would include the use of equipment that would generate ground-borne vibration. Possible sources of vibration may include road headers, excavators, dump trucks, backhoes, compactors, and other vibration intensive equipment. Table C-5 presents typical vibration levels for construction equipment.

Table C-5 Vibration Source Levels for Construction Equipment

Equipment		Vibration Level (VdB1) at 25 Feet
Pile Driver (Impact)	Upper Range	112
	Typical	104
Pile Driver (Sonic)	Upper Range	105
	Typical	93
Clam shovel drop (slurry wall)		94
Hydro-mill (slurry wall)	In soil	66
	In rock	75
Vibratory Roller		94
Hoe Ram		87
Large bulldozer		87
Caisson drilling		87
Loaded trucks		86
Jackhammer		79
Small bulldozer		58

Source: FTA 2006

Cadna A Noise Model Software Version 4.1

Construction and Operation Data Output

SLAC LCLS-II Project

The first table titled, Construction Operation Receivers, shows the receptor number (Name), day and night modeled noise level results (Level Lr), residential/commercial standards and guidelines used in the calculations (Land Use), height of receptor above the ground in meters (Height), and the locations of receivers evaluated in the model (Coordinates).

The second table titled, Construction Operation Noise Sources, shows the construction equipment (Name), the sound power level for each source (Result. PWL), the type of sound level and the name of the noise source (Lw/Li), the operating time for the day and night time period in minutes (Operating Time), height of source above ground in meters (Height), and the locations of receivers evaluated in the model (Coordinates).

The third table titled, Operation Receivers, shows the receptor number (Name), day and night modeled noise level results (Level Lr), residential/commercial standards and guidelines used in the calculations (Land Use), height of receptor above ground in meters (Height), and the locations of receivers evaluated in the model (Coordinates).

The forth table titled, Operation Noise Sources, shows the equipment (Name), the sound power level for each source (Result. PWL), the type of sound level and the name of the noise source (Lw/Li), the operating time for the day and night time period in minutes (Operating time), height of source above ground in meters (Height), and the locations of receivers evaluated in the model (Coordinates).

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Construction Operation Receivers

Name	M.	ID	Level Lr Day (dBA)	Level Lr Night (dBA)	Land Use Type	Land Use Auto	Land Use Noise Type	Height (m)		Coordinates X (m)	Coordinates Y (m)	Coordinates Z (m)
1			56.4	45.2		x	Total	1.52	r	2036.43	1265.60	68.07
2			47.2	40.7		x	Total	1.52	r	2428.05	1130.12	61.09
3			53.0	40.3		x	Total	1.52	r	2650.32	619.95	49.81

Construction Operation Noise Sources

Name	M.	ID	Result. PWL			Lw / Li		Operating Time			Height		Coordinates		
			Day (dBA)	Evening (dBA)	Night (dBA)	Type	Value	Day (min)	Special (min)	Night (min)	(m)		X (m)	Y (m)	Z (m)
Excavator			119.7	119.7	119.7	Lw	excavator	900.00	0.00	0.00	3.65	r	2123.21	788.25	93.60
Backhoe			114.7	114.7	114.7	Lw	backhoe	900.00	0.00	0.00	3.65	r	2083.63	798.02	92.33
Backhoe			114.7	114.7	114.7	Lw	backhoe	900.00	0.00	0.00	3.65	r	1405.50	742.46	93.52
Backhoe			114.7	114.7	114.7	Lw	backhoe	900.00	0.00	0.00	3.65	r	1141.72	700.45	91.81
Loader			114.7	114.7	114.7	Lw	Loader	900.00	0.00	0.00	3.65	r	2077.57	767.66	91.17
Loader			114.7	114.7	114.7	Lw	Loader	900.00	0.00	270.00	3.65	r	1370.22	730.70	93.13
Loader			114.7	114.7	114.7	Lw	Loader	900.00	0.00	0.00	3.65	r	1111.48	693.73	91.70
Dozer			119.7	119.7	119.7	Lw	dozer	900.00	0.00	0.00	3.65	r	2064.13	784.46	91.53
compressor			114.7	114.7	114.7	Lw	compressor	900.00	0.00	0.00	3.65	r	2092.69	779.42	92.39
compressor			114.7	114.7	114.7	Lw	compressor	900.00	0.00	270.00	3.65	r	1387.02	723.98	93.34
compressor			114.7	114.7	114.7	Lw	compressor	900.00	0.00	0.00	3.65	r	1123.24	681.97	91.64
compressor			114.7	114.7	114.7	Lw	compressor	900.00	0.00	0.00	3.65	r	926.66	666.85	92.60
crane			119.7	119.7	119.7	Lw	crane	900.00	0.00	0.00	3.65	r	2050.69	767.66	90.76
crane			119.7	119.7	119.7	Lw	crane	900.00	0.00	0.00	3.65	r	1418.95	722.30	93.03
dump truck			118.7	118.7	118.7	Lw	dumptruck	900.00	0.00	270.00	3.65	r	1339.98	713.90	92.63
dump truck			118.7	118.7	118.7	Lw	dumptruck	900.00	0.00	270.00	3.65	r	1272.77	690.37	91.57
pickup			89.7	89.7	89.7	Lw	pickup	900.00	0.00	0.00	3.65	r	2060.77	755.90	89.93
pickup			89.7	89.7	89.7	Lw	pickup	900.00	0.00	0.00	3.65	r	1371.90	707.18	93.06
road header			120.7	120.7	120.7	Lw	roadheader	900.00	0.00	270.00	3.65	r	1321.50	718.94	92.39
road header			120.7	120.7	120.7	Lw	roadheader	900.00	0.00	270.00	3.65	r	1160.20	698.77	91.30
road header			120.7	120.7	120.7	Lw	roadheader	900.00	0.00	270.00	3.65	r	998.90	671.89	91.80
hydraulic			114.7	114.7	114.7	Lw	hydraulic	900.00	0.00	270.00	3.65	r	1289.57	715.58	91.92
compactor			114.7	114.7	114.7	Lw	compactor	900.00	0.00	0.00	3.65	r	1244.21	708.86	91.28
concrete			116.7	116.7	116.7	Lw	concrete	900.00	0.00	0.00	3.65	r	2050.69	796.22	90.25
concrete			116.7	116.7	116.7	Lw	concrete	900.00	0.00	0.00	3.65	r	1207.24	707.18	91.17

Operation Receivers

Name	M.	ID	Level Lr Day (dBA)	Night (dBA)	Land Use Type	Auto	Noise Type	Height (m)		Coordinates X (m)	Y (m)	Z (m)
1			24.3	24.3		x	Total	1.52	r	2036.43	1265.60	68.07
2			12.9	12.9		x	Total	1.52	r	2428.05	1130.12	61.09
3			19.5	19.5		x	Total	1.52	r	2650.32	619.95	49.81

Operation Noise Sources

Name	M.	ID	Result. PWL Day (dBA)	Lw / Li		Operating Time			Height (m)		Coordinates		
				Type	Value	Day (min)	Special (min)	Night (min)			X (m)	Y (m)	Z (m)
air handler			96.0	Lw	airhandler				4.00	r	252.86	595.83	60.03
air handler			96.0	Lw	airhandler				4.00	r	266.30	598.35	62.99
			96.0	Lw	airhandler				4.00	r	278.90	600.03	65.77
			96.0	Lw	airhandler				6.00	r	1790.21	732.55	89.63
hvac			78.0	Lw	hvac				1.52	g	2110.54	781.66	96.17
hvac			78.0	Lw	hvac				1.52	g	2111.04	772.49	96.17
hvac			78.0	Lw	hvac				1.52	g	2112.20	764.49	96.17
hvac			78.0	Lw	hvac				1.52	g	2112.04	758.99	96.17
hvac			78.0	Lw	hvac				1.52	g	2095.87	778.99	96.17
hvac			78.0	Lw	hvac				1.52	g	2096.20	772.16	96.17
hvac			78.0	Lw	hvac				1.52	g	2095.20	766.16	96.17
hvac			78.0	Lw	hvac				1.52	g	2095.53	758.32	96.17
hvac			78.0	Lw	hvac				1.52	g	2083.87	774.49	96.17
hvac			78.0	Lw	hvac				1.52	g	2083.70	765.32	96.17
substation			105.7	Lw	substation				4.00	r	233.80	595.03	55.82

APPENDIX D: AGENCY CORRESPONDENCE

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U.S. DEPARTMENT OF ENERGY | Office of Science

SLAC Site Office
SLAC National Accelerator Laboratory
2575 Sand Hill Road, MS-8A
Menlo Park, CA 94025

November 15, 2011

Milford W. Donaldson
State Historic Preservation Officer
Office of Historic Preservation
Department of Parks and Recreation
State of California
1416 9th Street, Rm. 1442-7
Sacramento, CA 95814
Attention: Project Review Unit

Subject: Notification of National Environmental Policy Act Environmental Assessment for the Linac Coherent Light Source-II at the SLAC National Accelerator Laboratory

Dear Mr. Donaldson:

The purpose of this letter is to notify you that the U.S. Department of Energy is preparing a National Environmental Policy Act (NEPA) Environmental Assessment for the Linac Coherent Light Source-II (LCLS-II) project at the SLAC National Accelerator Laboratory (SLAC). In our letter to your office, dated November 3, 2011, we transmitted documentation initiating the Section 106 consultation for a proposed project to replace one alcove located at Sector 10 of the Klystron Gallery (Building 002) with a slightly larger alcove that will contain a drive laser for the proposed LCLS-II X-ray laser. The Sector 10 Project is subject to review under Section 106 of the National Historic Preservation Act (NHPA), Title 36, Part 800 of the *Code of Federal Regulations*, and NEPA.

Concurrent with the completion of your review of the NHPA Section 106 consultation documentation for the SLAC Sector 10 Project and your concurrence on the draft *SLAC Historic Resource Study*, also transmitted to you in a separate letter, dated November 3, 2011, we are notifying you and the Advisory Council on Historic Preservation, by copy of this letter, that we intend to use the process and documentation required to comply with NEPA to meet the NHPA Section 106 consultation requirements for the rest of the LCLS-II project. In using the NEPA process in lieu of the procedures set forth in §800.3 through §800.6 of the Council's regulations (i.e., the Section 106 process), we will ensure that the standards set forth in §800.8(c)(1) through §800.8(c)(5) are met.

If you have any questions or concerns regarding this letter, please feel free to contact me at (650) 926-3305 or Susan Witebsky of SLAC at (650) 926-4331.

Sincerely,

Dave Osugi

Dave Osugi
Cultural Resources Management Coordinator
SLAC Site Office

cc: Brian Sherin, SLAC
Alexander Merola, SLAC
Helen Nuckolls, SLAC
Susan Witebsky, SLAC
Mike Hug, SLAC
Steve Porter, SLAC
Laura Jones, Stanford University
Ed Carroll, Office of Historic Preservation
Tom McCulloch, Advisory Council on Historic Preservation

U.S. DEPARTMENT OF ENERGY | Office of Science

SLAC Site Office
SLAC National Accelerator Laboratory
2575 Sand Hill Road, MS-8A
Menlo Park, CA 94025

September 30, 2011

Ms. Cynthia Bryant
Director
Office of Planning and Research
State of California
1400 Tenth St.
Sacramento, CA 95814

Subject: Notice of Preparation of a National Environmental Policy Act (NEPA) Environmental Assessment (EA) for the Linac Coherent Light Source-II Project at the SLAC National Accelerator Laboratory (SLAC), San Mateo County, California

Dear Ms. Bryant:

In accordance with the U.S. Department of Energy (DOE) NEPA regulations, DOE is preparing an EA for the subject project. This letter supersedes a previous letter to your office, dated September 15, 2011, on the EA for the subject project.

The proposed action would take place at SLAC, located on 426 acres of land in an unincorporated portion of San Mateo County, California. The land is owned by Stanford University and leased to DOE. SLAC was founded in 1962 and its scientific missions include accelerator science, photon science, particle physics and astrophysics.

The LCLS Phase II Project (LCLS-II) is a proposed expansion of the existing Linac Coherent Light Source facility at SLAC. The LCLS X-ray laser works much like a high-speed camera, enabling scientists to take stop-motion pictures of atoms and molecules in motion and shedding light on the fundamental processes of life on unprecedented timescales. The LCLS is expected to enable breakthrough discoveries across many areas of science, including materials and catalytic sciences, structural molecular biology and molecular environmental sciences.

The LCLS-II project will expand the technical capabilities that have been successfully demonstrated in the first generation version of this light source, the LCLS-I, by extending the photon energy range, increasing control over the photon pulses and enabling two-color pump-probe experiments. Two-color pump-probe experiments seek to understand transient excited states that lie at the heart of chemical and biological reactivity and function. In addition, LCLS-II will greatly increase SLAC's capacity to accommodate numbers of users by simultaneously supplying multiple experimental stations with 120 Hz X-ray pulses.

The proposed LCLS-II Project is comprised of the following: 1) new tunnel for a hard X-ray undulator source (2-13 keV) and a soft X-ray undulator source (250-2,000 eV); 2) dedicated, independent electron source for these new undulators, utilizing Sectors 10-20 of the existing SLAC linac; 3) new experimental hall capable of accommodating multiple experimental stations; 4) modifications to existing SLAC facilities for the injector and new shielded enclosures for the undulator sources, beam dumps and X-ray front ends; 5) relocation of the two soft x-ray instruments from the existing Near Experimental Hall to the new experimental hall. The proposed LCLS-II Project will have sufficient capacity to allow for the installation of future undulator sources and experimental stations within the existing experimental hall and routine upgrades of utilities.

The NEPA Compliance Officer for this document, Mr. Gary S. Hartman of the DOE Office of Science, Integrated Support Center, may be contacted at (865) 576-0273.

If you have any questions regarding the NEPA document or process for this project, please feel free to contact me, the NEPA Document Manager, at (650) 926-3305.

Sincerely,

Dave Osugi

Dave Osugi
NEPA Coordinator
SLAC Site Office

cc:
Carol Borgstrom, GC-20, HQ/FORS
Distribution List