4.3 GEOLOGY AND SOILS

4.3.1 INTRODUCTION

This section identifies existing geologic conditions at the proposed Solar Energy Research Center (SERC) project site and analyzes the potential for the project to affect those resources.

In response to the Notice of Preparation for this Environmental Impact Report (EIR), several commenters expressed concern regarding the geology at the planned site. This topic is addressed in the impact assessment presented below (**subsection 4.3.4**).

4.3.2 ENVIRONMENTAL SETTING

The sections below present a description of the environmental setting of the LBNL hill site related to geology and soils, concentrating primarily on aspects that are specific to the SERC project site. Information on geologic conditions at the site was derived from the published literature and maps and from the geotechnical report prepared for the SERC project (Alan Kropp & Associates 2010), which includes the results of investigations conducted at the SERC project site, as well as a compilation of results from other geotechnical investigations conducted in recent years for the immediately surrounding portion of the LBNL hill site. Specific reference information is provided in the text.

Topography and Geology

The LBNL hill site is located near the crest of the Berkeley Hills, within the California Coast Ranges geomorphic province, which is characterized by roughly northwest-trending fault-controlled ridges and valleys approximately parallel to the boundary between the Pacific and North American tectonic plates (Norris and Webb 1990, Alt and Hyndman 2000). To the west, the Berkeley Hills are bounded by the trace of the active Hayward fault, and to the east, they are bounded for most of their length by the trace of the active Calaveras fault (Wagner et al. 1990).

The proposed project site occupies a southwest-facing slope on the west side of the ridge that divides the Strawberry Creek and Blackberry Creek watersheds. The area east of the site is within the upper portion of Chicken Creek Canyon and generally drains south toward Strawberry Creek. The broad surface west of the site drains northwest toward Blackberry Creek. Natural topography in the vicinity of the project site has been modified by grading for previous construction of LBNL facilities, including cuts to create the pads for Buildings 25 and 25A and to realign McMillan Road (Alan Kropp & Associates 2010). The current elevation of the site is approximately 940 feet above mean sea level (MSL).

Geologic mapping shows the SERC project site underlain by volcanic rocks, which themselves overlie continental sedimentary rocks of the Orinda Formation (lower portion of Contra Costa Group). The volcanic rocks consist predominantly of andesite with minor amounts of basalt and tuff. These rocks either belong to or are derived from the Miocene Moraga Formation (also a part of the Contra Costa Group). In the immediate site vicinity, the underlying Orinda Formation consists of massive to well bedded siltstone and claystone with lesser sandstone and conglomerate occurring in lenses (Alan Kropp & Associates 2010). Steep slopes across (north of) McMillan Road from the site are developed in resistant andesite and basalt flow rocks, which also either belong to or are derived from the Moraga Formation. Based on data derived from borings, bedrock occurs at fairly shallow depths (less than 10 feet below grade) on the project site (Alan Kropp & Associates 2010).

Soils

Soils at the proposed SERC project site form a thin (<10-foot-thick) veneer over the underlying bedrock (Alan Kropp & Associates 2010). The soil survey for the western Alameda County area published by the USDA Soil Conservation Service (now the Natural Resources Conservation Service) maps the site as situated on soils assigned to the Xerorthents-Millsholm complex, 30–50 percent slopes, which typically consists of about 70 percent by area xerorthents and 20 percent by area Millsholm loam, with minor inclusions of Maymen loam and Los Gatos loam (Welch 1981).

The xerorthents in the site vicinity consist of soils altered by excavation and/or fill placement to support development, and therefore are highly variable; in general, however, as documented in soil survey mapping, fills consist of loam and silt loam, and excavated areas expose the local bedrock (Welch 1981). Borings in the SERC project site area did not encounter substantial amounts of fill (Alan Kropp & Associates 2010).

The three native soil units mapped in the site vicinity are loamy upland soils developed in material weathered from sedimentary bedrock. The Millsholm loam is a shallow soil and is typically well drained. Permeability is moderate, runoff is rapid, and erosion hazard is high, such that careful management of irrigation and other surface water is necessary. The Maymen loam is also a shallow soil, and is somewhat excessively drained under natural conditions; permeability is moderate, runoff is rapid to very rapid and erosion hazard is high to very high. The Los Gatos loam is a moderately deep soil, and is well drained; permeability is low, runoff is rapid, and erosion hazard is high (Welch 1981).

Shrink-swell (expansion) potential is generally high in the xerorthents, low in Millsholm and Maymen soils, and moderate in Los Gatos soils (Welch 1981).

Geologic Hazards

Seismic Hazards

The project site is located in the seismically active Bay Area, about 0.8 mile northeast of the Hayward fault and within the area potentially affected by earthquakes on a number of other important active structures, as summarized in **Table 4.3-1, Principal Active Faults in the Project Region**.

Table 4.3-1
Principal Active Faults in Project Region

Fault	Distance from Site	Probability of at Least One M6.7 or Larger Earthquake in 2007 – 2036
Hayward	0.5 km southwest	31% (includes the Rodgers Creek Fault to the north)
San Andreas	31 km southwest	21%
San Gregorio	33 km southwest	7%
Calaveras (Northern)	31 km east	7%
Concord – Green Valley	23 km northeast	3%
Greenville	45 km southeast	3%
Mt. Diablo Thrust	22 km east[1]	1%
Combined risk on other Bay Area faults potentially affecting site		14%

Source: Alan Kropp & Associates 2010, except
[1] *GoogleEarth*

For purposes of regulation and risk management, the State of California divides seismic hazards into two categories: primary seismic hazards which include surface fault rupture[1] and earthquake groundshaking, and secondary seismic hazards, which principally include the potentially damaging outcomes of strong groundshaking—seismically induced ground failure such as liquefaction, and seismically induced landslides. The following sections discuss these hazards as they pertain to the SERC project site.

1 *Surface fault rupture* refers to ground surface disruption along the trace (surface expression) of an active fault, as a result of earthquake slip or fault creep.

Primary Seismic Hazards

Surface Fault Rupture

The project site is not located within any Earthquake Fault Zone designated by the State of California pursuant to the Alquist-Priolo Earthquake Fault Zoning Act (Hart and Bryant 2007), and the closest active fault trace to the site (associated with the Hayward fault) is approximately 2,000 feet away (Alan Kropp & Associates 2010) (see **Figure 4.3-1, Fault Zone Map**). Consequently, the project site is not expected to be subject to surface fault rupture (Alan Kropp & Associates 2010).

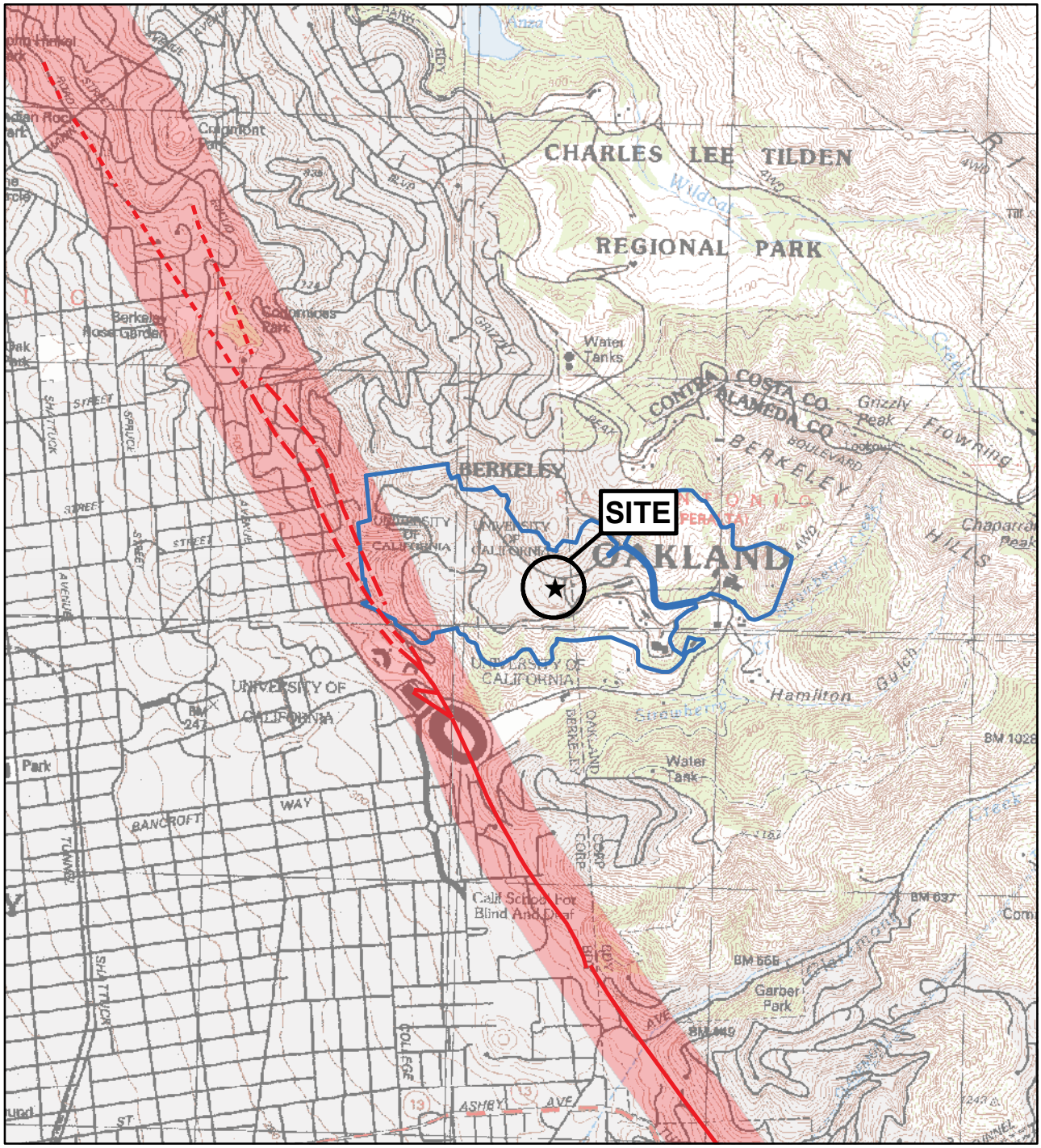
Groundshaking

The intensity of earthquake groundshaking at a particular site depends on the magnitude of the earthquake, the distance of the site from the earthquake epicenter, and the nature of the substrate materials at the site. Other factors being equal, shaking tends to be more intense and prolonged in some types of unconsolidated sediments, and less so in consolidated materials and bedrock. Earthquake hazard maps published by the Association of Bay Area Governments show the project site as subject to violent shaking severity (ABAG 2010a), but in a region of moderately low shaking amplification (ABAG 2010b).

Secondary Seismic Hazards

Seismically Induced Ground Failure

Liquefaction occurs when unconsolidated soils or sediments lose strength and flow or deform as a liquid, due to earthquake shaking. Liquefaction typically occurs in well sorted, saturated sandy materials, at depths of less than 50 feet below ground surface. Densification or seismically induced settling can occur where similar low-cohesion materials are present at shallow depths but are unsaturated (above the local water table). Seismic hazards mapping issued by the State of California pursuant to the Seismic Hazards Mapping Act shows the rangefront and upland areas in the Berkeley Hills as outside the zone of liquefaction hazard (California Geological Survey 2003a, 2003b). Based on the specific characteristics of site soils, neither liquefaction nor densification is expected to be a concern at the SERC project site (Alan Kropp & Associates 2010).



Legend:

Approximate location of Lawrence Berkeley National Laboratory boundary

Hayward Fault Zone

Source: The California Geological Survey, 2001, CD's 2001-04, 2001-05, and 2001-06: GIS Files of Official Alquist-Priolo Earthquake Fault Zones (http://www.consrv.ca.gov/CGS/geologic_hazards/regulatory_hazard_zones/ap_cd_htm.htm).

2000 1000 0 2000

APPROXIMATE SCALE IN FEET

SOURCE: Alan Kropp & Associates – March 2010

FIGURE **4.3-1**

Fault Zone Map

927-007•05/10

Seismically Induced Landslides and Other Landslide Hazards

Earthquake shaking can trigger slope failures in steep hillside areas, particularly those already prone to failure; seismically induced landslides are an important risk factor in hilly portions of the San Francisco Bay region, as in many parts of coastal California. Seismic hazards mapping issued by the State of California pursuant to the Seismic Hazards Mapping Act shows much of the Berkeley hills rangefront, including portions of the UC Berkeley campus and the LBNL hill site, as within the zone of seismically induced landslide hazard (California Geological Survey 2003a, 2003b). However, while such zones occur near the proposed SERC building site, the site itself is not within a seismically induced landslide hazard zone depicted on the official State of California Seismic Hazard maps (California Geological Survey 2003a, 2003b).

The official seismic hazard maps prepared by the California Geological Survey (CGS) delineate zones in which site-specific hazard investigations are required, and not locations where a seismic hazard is known to be present. The California Geological Survey prepares these maps using a methodology that includes a thorough review of aerial photography and pre-existing published landslide maps coupled with slope stability analyses performed based on geologic material types and surface topography. The CGS methodology includes developing a Seismic Hazard Zone Report documenting their analyses and presenting an inventory map showing landslides. All existing landslides with a definite or probable confidence rating are included within the earthquake-induced landslide zone. CGS landslide inventory mapping shows no existing landslides at the SERC project site.

A prior environmental study interpreted the volcanic rock at the SERC project site as part of a large-scale paleolandslide (LBNL/Parsons 2000, cited in Alan Kropp & Associates 2010). Two additional investigations were conducted for the proposed SERC project to evaluate this model (Alan Kropp & Associates 2009 and William Lettis & Associates 2009, cited in Alan Kropp & Associates 2010). Based on geomorphic analysis and results of exploratory trenching, the 2009 study by William Lettis & Associates concluded that if a large-scale landslide does underlie the site at depth, it has been stable for thousands of years and does not pose a current risk of failure (Alan Kropp & Associates 2010).

4.3.3 REGULATORY CONSIDERATIONS

This section briefly summarizes regulatory requirements that govern proposed projects within LBNL, expanding where necessary to describe how the regulations specifically apply to the proposed SERC project.

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code Sec 2621 et seq.) was signed into law in 1972[2] in response to damage sustained from surface fault rupture in the 1971 San Fernando earthquake, with the intent of reducing the potential for similar damage along the state's many active faults in future earthquakes. The Alquist-Priolo Act charges the State of California with defining hazard corridors ("Earthquake Fault Zones") along active faults, within which local jurisdictions must strictly regulate construction; in particular, the Act prohibits construction of structures intended for human occupancy (defined for purposes of the Act as more than 2,000 person-hours per year) across active faults. To support implementation of its provisions, the Act establishes a legal definition for the term *active*, defines criteria for identifying active faults, and establishes a process for reviewing building proposals in and adjacent to defined Earthquake Fault Zones, to be implemented by the state's local jurisdictions (cities and counties), who typically do so through the building permit review process.[3]

Under the Alquist-Priolo Act, a fault is zoned if it meets the dual criteria of "sufficiently active" and "well defined." A fault is considered *sufficiently active* if one or more of its segments or strands shows evidence of surface displacement during Holocene time (conservatively defined for purposes of the Act as referring to approximately the last 11,000 years, although it is more commonly understood as including only the last 10,000 years). A fault is considered *well defined* if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria, and judgment (Hart and Bryant 2007). Because of the Alquist-Priolo Act's statewide purview, the Earthquake Fault Zone maps are a key tool for assessing surface fault rupture risks to projects of all types, even though the Act regulates only construction for human occupancy.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 (California Public Resources Code Sections 2690–2699.6) essentially "takes up where the Alquist-Priolo Act leaves off." The Alquist-Priolo Act focuses narrowly on surface fault rupture hazards, and the Seismic Hazards Mapping Act fills the gap by addressing the earthquake-related hazards of liquefaction, strong ground motion and seismically induced landslides. The Seismic Hazards Mapping Act takes a similar approach to that pioneered by the drafters of the

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2 Originally titled the Alquist-Priolo Special Studies Zones Act, the Act was renamed in 1994.

3 UC projects are not subject to the local jurisdiction building permit process. The University serves as lead agency responsible for enforcing the requirements of the Alquist-Priolo Act and Seismic Hazards Mapping Act (described below) for UC projects to which they apply.

Alquist-Priolo Act: It charges the CGS with identifying and mapping areas at risk of liquefaction, strong ground motion, and earthquake-induced landslides (Seismic Hazard Zones). Pursuant to this charge, the CGS found that strong motion hazard zones are sufficiently covered by building codes in force and so has not pursued mapping of strong ground motion hazard zones.

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act casts local jurisdiction building permit review as the primary mechanism for controlling public exposure to seismic risks. Specifically, cities and counties are prohibited from issuing development permits for sites within Seismic Hazard Zones until or unless appropriate site-specific geologic/geotechnical investigations have been carried out and measures to avoid or reduce damage have been incorporated into the development proposal.

Geotechnical investigations conducted within Seismic Hazard Zones must meet standards specified by CGS Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (California Geological Survey 2008). The guiding premise of Special Publication 117A is that the suitability of the site for the proposed use must be demonstrated. A site's location within a mapped seismic hazard zone is not a presumption that a hazard requiring geotechnical mitigation is present—rather, it reflects the state's judgment, based on regional (non-site-specific) information, that the probability of a hazard requiring mitigation is great enough to warrant a site-specific investigation. The site-specific investigation may demonstrate the absence of liquefaction or landslide hazard, or may identify that a hazard exists, define it, and provide recommendations for mitigation. Such "recommendations" become binding conditions for approval of the building permit.[4]

Like the Alquist-Priolo Earthquake Fault Zone Maps, the maps produced by the Seismic Hazards Mapping Program are useful as a first-order risk assessment tool for liquefaction and seismically induced landslide risks to projects of all types, although the Seismic Hazards Mapping Act, like the Alquist-Priolo Act, regulates only construction for human occupancy.

Local Plans and Policies

The LBNL hill site is an approximately 200-acre site owned by the Regents of the University of California, where the University conducts research, service, and training work within the University's mission. The LBNL hill site includes research and support structures that are primarily part of a multi-program national laboratory called the Lawrence Berkeley National Laboratory, a federally funded research and development center operated and managed by the University of California under a U.S. Department of

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4 For UC projects, which are not subject to the local jurisdiction building permit process, "recommendations" of site-specific geotechnical investigations prepared pursuant to the Alquist-Priolo or Seismic Hazards Mapping Act become binding conditions for UC approval of the project.

Energy (DOE)-UC contract. As such, the University is exempted by the state constitution from compliance with local land use regulations, including general plans and zoning. However, the University seeks to cooperate with local jurisdictions to reduce any physical consequences of potential land use conflicts to the extent feasible. The LBNL hill site is located astride the Berkeley – Oakland city boundary, with a portion of LBNL located in each city. The SERC project site is located within the Berkeley city boundary. The following sections summarize the University of California Seismic Safety Policy, and objectives and policies in the LBNL 2006 LRDP, LBNL Design Guidelines, and the City of Berkeley General Plan.

University of California Seismic Safety Policy

The University of California Seismic Safety Policy requires that all "new buildings…comply with the current provisions of the California Building Code, or local seismic requirements, whichever is more stringent" and that "no new University structures…[will] be constructed on the trace of a known active fault." The current version of the California Building Code is the 2007 edition, which is based on the 2006 International Building Code, with the incorporation of additional requirements for seismic design of structures.

2006 LRDP Principles and Strategies

The 2006 LRDP outlines a series of development strategies to meet the core planning principles to "Preserve and enhance the environmental qualities of the site as a model of resource conservation and environmental stewardship" and to "Build a more campus-like research environment." As listed in the 2006 LRDP, the strategies most relevant to geology and soils include the following:

- Protect and enhance the site's natural and visual resources, including native habitats, streams, and mature tree stands by focusing future development primarily within the already developed areas of the site.
- Increase development densities within the most developed areas of the site to preserve open space, enhance operational efficiencies and access.
- To the extent possible site new projects to replace existing outdated facilities and ensure the best use of limited land resources.
- To the extent possible site new projects adjacent to existing development where existing utility and access infrastructure may be utilized.
- Site and design new facilities in accordance with University of California energy efficiency and sustainability policy to reduce energy, water, and material consumption and provide improved occupant health, comfort, and productivity.

LBNL Design Guidelines

The LBNL Design Guidelines (Appendix B to the 2006 LRDP EIR; LBNL 2007) provide guidelines to meet the planning principles and strategies listed in the 2006 LRDP. The primary guidelines that pertain to geologic resources include the following.

- Minimize impacts of disturbed slopes;
- To the degree practicable cut and fill slopes will be minimized. Cut and fill slopes exposed to view shall be promptly restored, using best management practices to minimize erosion. New vegetation should be planted in a manner to return the visual quality of the slope to a condition similar to its original state or better; and
- Building footprints shall be designed with long narrow aspect ratios in parallel to natural terrain to the degree consistent with program needs.

City of Berkeley General Plan

The Berkeley General Plan contains the following policies and actions relevant to geologic and soils-related hazards.

Policy S-14: Land Use Regulation. Require appropriate mitigation in new development, redevelopment/reuse, or other applications.

Actions:

A. When appropriate, utilize the environmental review process to ensure avoidance of hazards and/or mitigation of hazard-induced risk.

B. Require soil investigation and/or geotechnical reports in conjunction with development/redevelopment on sites within designated hazard zones such as areas with high potential for soil erosion, landslide, fault rupture, liquefaction, and other soil-related constraints.

C. Place structural design conditions on new development to ensure that recommendations of the geotechnical/soils investigation are implemented.

D. Encourage owners to evaluate their buildings' vulnerability to earthquake hazards, fire, landslides, and floods, and to take appropriate action to minimize the risk.

Policy S-15: Construction Standards. Maintain construction standards that minimize risks to human lives and property from environmental and human-caused hazards for both new and existing buildings.

Actions:

A. Periodically update and adopt the California Building Standards Code with local amendments to incorporate the latest knowledge and design standards to protect people and property against known fire, flood, landslide, and seismic risks in both structural and non-structural building and site components.

B. Ensure proper design and construction of hazard-resistant structures through careful plan review/approval and thorough and consistent construction inspections.

Policy S-18: Public Information. Establish public information programs to inform the public about seismic hazards and the potential hazards from vulnerable buildings.

4.3.4 IMPACTS AND MITIGATION MEASURES

Significance Criteria

The impact of the proposed project related to geology and soils would be considered significant if it would exceed the following Standards of Significance, in accordance with Appendix G of the State *CEQA Guidelines* and the UC CEQA Handbook:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area, or based on other substantial evidence of a known fault (refer to CGS Special Publication 42);
  - Strong seismic ground-shaking;
  - Seismic-related ground failure, including liquefaction; or
  - Landslides.
- Result in substantial soil erosion or the loss of topsoil;
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on-site or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
- Be located on expansive soil, as defined in Table 18-1-B of the California Building Code, creating substantial risks to life or property; or
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

Issues Not Discussed Further

No septic systems or other infiltrating wastewater disposal systems are proposed as part of the SERC project. The SERC project Initial Study found no impacts associated with wastewater infiltration facilities. This issue is not discussed further in this section.

Mitigation Measures included in the Proposed Project

The following mitigation measures, adopted as part of the 2006 LRDP, are required by the 2006 LRDP for the proposed project and are thus included as part of the proposed project. The analysis presented below assumes that the proposed project will implement these measures; the level of impact reflects project outcomes with all applicable LRDP EIR mitigation measures in place.

LRDP EIR MM GEO-1: Seismic emergency response and evacuation plans shall be prepared for each new project at LBNL that is developed pursuant to the 2006 LRDP. These plans shall incorporate potential inaccessibility of the Blackberry Canyon entrance and identify alternative ingress and egress routes for emergency vehicles and facility employees in the event of roadway failure from surface fault rupture.

LRDP EIR MM GEO-2: A site-specific, design-level geotechnical investigation shall occur during the design phase of each LBNL building project, and prior to approval of new building construction within the LBNL hill site. This investigation shall be conducted by a licensed geotechnical engineer and include seismic design criteria appropriate for use with the static lateral force procedures of the California Building Code. Geotechnical investigations for sites within either a Seismic Hazard Zone for landslides or an area of historic landslide activity at LBNL, as depicted on Figures IV.E-2 and IV.E-3 [in the LRDP EIR], or newly recognized areas of slope instability at the inception of project planning, shall incorporate a landslide analysis in accordance with CGS Publication 117. Geotechnical recommendations shall subsequently be incorporated into building design.

LRDP EIR MM GEO-3a: Construction under the LRDP shall be required to use construction best management practices and standards to control and reduce erosion. These measures could include, but are not limited to, restricting grading to the dry season, protecting all finished graded slopes from erosion using such techniques as erosion control matting and hydroseeding or other suitable measures.

LRDP EIR MM GEO-3b: Revegetation of areas disturbed by construction activities, including slope stabilization sites, using native shrubs, trees, and grasses, shall be included as part of all new projects.

Project Impacts and Mitigation Measures

SERC Impact GEO-1: **The proposed project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault. (*No impact*)**

As discussed briefly above, the Alquist-Priolo Act charges the State of California with identifying active faults and delineating the area or corridor along each active fault within which there is a risk of surface fault rupture (referred to as the Earthquake Fault Zone). Although the proposed project site is located near the Hayward fault, the site is not within the Earthquake Fault Zone defined by the State of California for the Hayward fault, and no known active fault traces are present on site or in immediate proximity to it. No impact with regard to surface fault rupture is anticipated.

Mitigation Measure: No project-level mitigation measure is required.

SERC Impact GEO-2: **The proposed project would not expose people to potentially substantial adverse effects, including the risk of loss, injury, or death, due to strong seismic ground-shaking. (*Less than Significant*)**

The project site is located in a seismically active area. Seismic groundshaking could damage the proposed building, service road, and other ancillary facilities, and occupancy and operation of the proposed project could expose future facility users to risks associated with structural damage due to seismic groundshaking.

Similar to all new buildings at LBNL, and consistent with the University of California Seismic Safety Policy, the design and construction of the proposed SERC would be consistent with current California Building Code seismic design requirements and the Lateral Force Design Criteria of the LBNL Design Management Procedures. Building code compliance is also achieved by implementing the recommended actions of the site-specific geotechnical studies completed for the project consistent with **LRDP EIR Mitigation Measure GEO-2** (Alan Kropp & Associates 2010 and prior studies cited therein, which are incorporated in this EIR by reference). The structural design of the proposed building would be subject to review by an independent third party structural engineering firm. Consequently, the proposed facility would meet or exceed the prevailing engineering standard of care for seismic design. Although it is impossible to provide complete assurance against damage, the building codes are designed to prevent major structural damage and loss of life.

In addition to structural damage, other hazards directly associated with seismic groundshaking include risks from falling debris, movement or toppling of furniture, gas leaks, and fire. To address these corollary hazards, the UC Seismic Safety Policy requires "adequate anchorage" for nonstructural building elements, which are identified as "including, but not limited to, glass, fixtures, furnishings, and other contents, equipment, material storage facilities, and utilities (gas, high-temperature water, steam, fire protection water, etc.)." Furthermore, in order to reduce the risk of injury during seismic events, the UC LBNL conducts annual earthquake drills and also requires employees to take an on-line earthquake/fire safety course both of which teach employees the appropriate actions to protect themselves from the harmful effects of a major earthquake (or wildland fire) in the Bay Area. With preparation of a site-specific geotechnical investigation, compliance with the current CBC and the requirements of the UC Seismic Safety Policy, and the additional emergency training to be provided to SERC employees, impacts related to the potential for seismic groundshaking damage to the building, and corollary hazards related to falling debris, furniture movement or toppling, etc., are expected to be less than significant.

Mitigation Measure: No project-level mitigation measure is required.

SERC Impact GEO-3: **The proposed project would not expose people and structures to potentially substantial adverse effects due to seismically induced ground failure, including liquefaction. (*No impact*)**

State seismic hazards mapping shows the site vicinity as outside the identified zone of liquefaction hazard (California Geological Survey 2003a, 2003b), and based on the characteristics of site soils, neither liquefaction nor densification is expected to be a concern at the SERC project site (Alan Kropp & Associates 2010). No impact related to seismically induced ground failure hazards is anticipated.

Mitigation Measure: No project-level mitigation measure is required.

SERC Impact GEO-4: **The proposed project would not expose people and structures to potentially substantial adverse effects due to seismically induced landslides or non-seismic landslides. (*Less than Significant*)**

As required by **LRDP EIR Mitigation Measure GEO-2**, a site-specific design-level geotechnical investigation was conducted for the proposed project. This investigation included an evaluation of the potential for landsliding (seismic or non-seismic) at the proposed SERC project site. As discussed previously, State seismic hazards mapping identifies the SERC building site as not within the zone of seismically induced landslide hazard (California Geological Survey 2003a, 2003b). A prior environmental study interpreted bedrock at the SERC project site as part of a large-scale paleolandslide, but the site-specific geologic investigation conducted for the proposed project by William Lettis & Associates[5] concluded that: (1) the hypothesized paleolandslide does not exist, as mapped; and (2) if a paleolandslide exists at depth beneath the site, it has been stable for thousands of years and does not currently pose a slope instability hazard under seismic or non-seismic conditions (Alan Kropp & Associates 2010). No other landslides have been identified in the direct vicinity of the site. Impacts related to the potential for seismically induced landslides and other types of landslides are therefore expected to be less than significant.

Mitigation Measure: No project-level mitigation measure is required.

SERC Impact GEO-5: **The proposed project would not result in substantial topsoil removal or soil erosion. (*Less than Significant*)**

When a previously undeveloped site is graded for construction, topsoil must first be removed from the site because its organic content typically makes it unsuitable for use in engineered fills. However, the SERC project site was previously graded for construction of the existing buildings on the site and is therefore unlikely to preserve an intact topsoil layer. Additional grading for construction of the proposed SERC project is not expected to require substantial removal of topsoil; the impact related to topsoil loss would be less than significant. This analysis focuses on the potential for accelerated erosion, which is of concern even when there is no significant potential for loss of topsoil because of the potential to deliver excessive sediment load to off-site waters (see related discussion in **SERC Impact HYDRO-2** in **Section 4.6, Hydrology and Water Quality**).

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5 The William Lettis & Associates study is incorporated in this EIR by reference.

Disturbance during construction would have the potential to result in accelerated erosion on the site, but the project includes **LRDP EIR Mitigation Measure GEO-3a**, which requires implementation of best management practices to control erosion. In addition, the disturbance footprint would exceed the 1-acre threshold that triggers the federal Clean Water Act requirement to prepare and implement a comprehensive SWPPP, as discussed in more detail in **Section 4.6** of this EIR. With these measures in place as part of the project, impacts related to accelerated erosion during construction would be less than significant.

Once constructed, all project facilities would meet or exceed the site drainage requirements of the California Building Code, and any remaining disturbed areas not hardscaped for parking or building access would be revegetated consistent with **LRDP EIR Mitigation Measure GEO-3b**. Long-term potential for accelerated erosion at the site would thus be less than significant.

Overall, with adherence to the California Building Code and implementation of LRDP EIR mitigation measures as part of the proposed project, impacts related to the potential for accelerated erosion during and following project construction would be less than significant.

Mitigation Measure: No project-level mitigation measure is required.

SERC Impact GEO-6: **The proposed project would not be located on a geologic unit that may be unstable or could become unstable as a result of the project. (*Less than Significant*)**

Potential for inherent instability at the project site is addressed in **SERC Impacts GEO-3** (liquefaction and densification) and **GEO-4** (landslides, including seismically induced landslides) above. The following discussion focuses on the potential for project construction to create or contribute to instability at the site.

Construction of the proposed facilities at the SERC project site would require additional cut (excavation) and fill modifications to site topography. All construction for the project would be required to comply with the current (2007) California Building Code, which contains stringent and specific provisions for the design of cut and fill slopes. These include limitations on the nature of fill materials, maximum slope gradients under various conditions, and requirements for slope drainage to prevent excessive infiltration and control potentially damaging erosion. Additional recommendations relevant to the long-term stability of cut and fill slopes are provided in the site-specific geotechnical investigation prepared for the SERC project (Alan Kropp & Associates 2010). These include recommendations for site preparation; allowable characteristics of fill materials; procedures for excavation, fill placement, and utility trenching; the design of retaining walls; and recommendations for wall backdrainage to prevent the build-up if hydrostatic pressure and an under-drainage system below the concrete floor slab of level 1 of the building

to intercept and drain away seepage. Under the building codes and the terms of **LDRP EIR Mitigation Measure GEO-2**, such "recommendations" would be binding requirements for project approval. With building code compliance and adherence to additional site-specific recommendations in the project geotechnical report, impacts associated with potential instability of cuts and fills required to construct the project would be less than significant.

Mitigation Measure: No project-level mitigation measure is required.

SERC Impact GEO-7: **The proposed project would not be constructed on expansive soils or bedrock that could create substantial risk to life or property. (*Less than Significant*)**

Native soils form a thin veneer over the underlying bedrock at the project site (Alan Kropp & Associates 2010). Available boring and plasticity data from the site vicinity suggest that little if any expansive material is present at the SERC project site (Alan Kropp & Associates 2010). For additional assurance, the following categories of materials will be observed and tested during construction: (1) soils and bedrock exposed in near-surface excavations; (2) on-site materials proposed for reuse as engineered fill; and (3) proposed import fill materials (fill materials brought to the site from off-site sources). The geotechnical report also provides recommendations to preclude the use of unacceptably expansive materials as fill, and cautions that overexcavation and replacement of unsuitable site materials may be needed to provide an appropriate substrate consistent with requirements of the California Building Code (Alan Kropp & Associates 2010). Under the building codes and the terms of LDRP EIR Mitigation Measure GEO-2, the "recommendations" of the site-specific geotechnical report would be binding requirements for UC approval of the project. With building code compliance and adherence to additional site-specific recommendations in the project geotechnical report, impacts associated with potential presence of expansive substrate materials on the site would be less than significant.

Mitigation Measure: No project-level mitigation measure is required.

4.3.5 CUMULATIVE IMPACTS

As stated in **subsection 4.0.4**, the 2006 LRDP EIR included the evaluation of the environmental impacts from the construction of a large building at the proposed site of the SERC project, in conjunction with the rest of the projected growth at the LBNL hill site, growth at UC Berkeley, and in the cities of Berkeley and Oakland. That cumulative impact analysis (LRDP Impact GEO-4) is presented on pages IV.E-26 to IV.E-28 of the 2006 LRDP EIR. The analysis concluded that, to the extent that the 2006 LRDP could indirectly increase the local population subject to earthquake hazards, the increase would not be considerable in the

context of the Bay Area population and regional growth, and therefore the cumulative impact would not be significant.

Because the SERC project and GPL combined (about 83,000 gsf) are much smaller than the 142,000 gsf building evaluated in the 2006 LRDP EIR and the population associated with the proposed project is included in the population growth analyzed in the LRDP EIR, the cumulative analysis of the impact of Lab development through 2025 presented in the 2006 LRDP EIR adequately addresses the long-term cumulative impact of the proposed project related to geology and soils. Further evaluation of the long term cumulative effect is not required. The proposed project's construction-phase cumulative impact is described below.

Cumulative Impact GEO-1: **Construction of multiple projects at the LBNL hill site during the 2010 to 2013 window would not create a significant short-term cumulative impact related to geology, soils, or geologic hazards. (*Less than Significant*)**

Impacts related to geology, soils, and geologic hazards are generally associated with long-term (operational) exposure of structures and their users to risks, such as earthquake risk, landslide risk, the risk of damage to structures whose foundations are not appropriately designed for site soil and slope conditions, and the long-term risk of failure in improperly constructed cut or fill slopes, and are not associated with short term construction activities. There is some short-term potential for failure of cuts and fills while construction is still ongoing, but this risk is managed for each construction project consistent with the prevailing standard of care by adherence to current building codes, and is not considered likely to cumulate. The potential for a significant cumulative impact related to soil erosion would be minimized by the implementation of project-specific storm water pollution prevention plans, consistent with NPDES requirements for each construction project. The cumulative impact related to geology and soils from concurrent construction of projects at the LBNL site is therefore considered less than significant.

Mitigation Measure: No mitigation measure is required.

4.3.6 REFERENCES

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6 In the year 2000, the California Division of Mines and Geology was renamed the California Geological Survey. Maps and other materials produced by this agency are referenced according to the name in use at the time of publication.