4.5 GEOLOGY AND SOILS

4.5.1 INTRODUCTION

This section of the Revised Draft EIR evaluates the potential impacts related to geology and soils from the implementation of the proposed Student Housing West (SHW) project. It also presents potential impacts related to geology and soils from the anticipated construction and operation of the separate, but related, Porter and Rachel Carson Colleges dining facilities expansion project, which would serve residents of the SHW project and the existing colleges (see **Section 4.5.5** below).

The analysis in this section is tiered from the geology and soils impact analysis contained in the 2005 LRDP EIR, supplemented by project-specific information, including a geotechnical report prepared for the site of the Family Student Housing (FSH) complex in 2010.

The section is largely the same as the section in the Draft EIR, because the proposed improvements under the revised project would be located on the same two project sites and utility corridors that were studied and evaluated for impacts in the Draft EIR. However, the description of site conditions and the analysis has been revised to include the results of the detailed geotechnical and geophysical investigations which were completed after publication of the Draft EIR (Pacific Crest Engineering 2018a and 2018b) In addition, comments received on the Draft EIR related to geology and soils were reviewed and the key issues raised in the comments are summarized below:

- The Draft EIR's discussion of the geology of the Hagar site is based on insufficient geotechnical investigation and the EIR puts forth a mitigation measure to address the karst hazard that seems to be based on incomplete information.
- How many test borings were conducted on the Hagar site and what is the degree of certainty that other sinkholes do not exist under the area proposed for development?
- The Draft EIR should explain what an acceptable design void span is. If there is a sinkhole in the area how will the design void span prevent the building from collapsing? The term "doline" should be defined.
- The Draft EIR does not describe or analyze the effects of the cut and fill earthmoving that would be conducted on the Hagar site for both site geology and aesthetic reasons.
- The Draft EIR contemplates removal of soil and earth materials at depths between 12 and 38 feet below ground surface. This excavation could alter the fracture zones in the karst system that direct the flow of groundwater or result in the filling of fracture zones with silt and engineered fill. The Draft EIR does not adequately address the impacts from this excavation and filling.

These comments are addressed in the revised analysis presented in this section.

4.5.2 ENVIRONMENTAL SETTING

4.5.2.1 Site Description

The UC Santa Cruz campus is situated atop a series of marine terraces that rise northwest from the City of Santa Cruz. The Heller site is located along the western border of the campus, directly east of Empire Grade Road, at an elevation of approximately 700 feet above mean seal level (msl). Directly west lies Cave Gulch, a major campus drainage running north-south across the southern two-thirds of campus. Many of the caves on the campus are along Cave Gulch, due the marble/schist substrate fracturing and hollowing over time, as a result of the dissolution of the marble bedrock by groundwater. Most of the Heller site is underlain with schist, although the southern portion of the site is underlain by marble.

The Hagar site is located at the southern end of the campus, northeast of the intersection of Hagar Drive and Glenn Coolidge Drive. It sits at an elevation of approximately 400 feet msl. The Hagar site is largely underlain by marble, with multiple infilled dolines on the site, and one active sinkhole located in the southwestern corner. Doline or sinkhole refers to a basin- or funnel-shaped hollow in marble, ranging in width from a few meters to a kilometer and in depth from few to several hundred meters.

4.5.2.2 Regional Geologic Overview

Geology

The campus is situated in the central portion of the Coast Ranges Physiographic Province, which parallels the coastline from the California/Oregon border down to Santa Barbara. The Ben Lomond Mountain, part of the Santa Cruz Mountains, lies northeast of the campus and is one of the northwest-southeast-trending coastal mountain ranges that characterize the province. The ranges are primarily controlled by faulting along the San Andreas Fault System. The area is underlain by metamorphic rocks such as quartz-mica schist and limestone marble, which are surrounded and intruded by igneous rocks, predominantly quartz diorite (UCSC 2006).

Much of the bedrock beneath the campus is composed of marble that is dense and solid in some areas and highly fractured in others. The fractures have been eroded in geologic time by groundwater flowing through the jointed areas and dissolving the marble. The result is cavities and surface expressions of these cavities, where soil and overlying rock have collapsed or washed into the voids in the bedrock, causing sinkholes. There are at least 30 sinkholes on the campus, with the majority of them in the lower and central campus. Ravines, drainages, and cave systems are also developed due to karst geology. There are also three major campus drainages, Cave Gulch, Moore Creek, and Jordan Gulch, which run through the southern portion of campus in a north-south direction (Pacific Crest Engineering 2010).

Seismicity

The coastal areas of Northern California are seismically active, and the campus can be expected to experience periodic minor earthquakes and possibly a major earthquake (Moment magnitude 7 or greater) on one of the nearby active faults during the life of the proposed project. The seismicity in the site vicinity is related to activity on the San Andreas Fault system (UCSC 2006).

Beneath the UC Santa Cruz campus are two main fracture systems, trending approximately north-south and east-west, as well as a secondary set of fractures trending northwest-southeast, and many small fractures with no particular trending pattern. The Ben Lomond fault runs vertically along the eastern boundary of campus and is the nearest large fault. While it is in the immediate vicinity of the campus, it is a bedrock fault that is not known to be active. The San Andreas fault, a major active strike-slip fault, lies approximately 20 miles north of the campus and its branches, the Hayward, Calaveras, and San Gregorio faults, are also active and in the vicinity. The Zayante-Vergeles fault and the Sargent fault are in the area as well and are believed to be potentially active (UCSC 2006). These and other faults of the region are shown on Figure 4.6-3 in the 2005 LRDP EIR**.**

Since 1800, three major earthquakes have been recorded on the San Andreas Fault system. In 1836 an earthquake with an estimated magnitude intensity of VII on the Modified Mercalli (MM) scale and an estimated Moment magnitude (M_w) of 6.25 occurred east of Monterey Bay on the San Andreas fault. In 1838, an earthquake with an estimated intensity of approximately VII-IX on the MM scale and an M_w of 7.5 also occurred on the San Andreas fault. The third major earthquake on the San Andreas fault occurred in 1906. The San Francisco earthquake of 1906 had a maximum intensity of XI (MM), an M_w of 7.9 and caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. The Loma Prieta earthquake of 1989, which also occurred on the San Andreas Fault system, with its epicenter located in the Santa Cruz Mountains and an M_w of 6.9, affected the greater Bay Area.

In 2014, the Working Group on California Earthquake Probabilities (WGCEP) at the U.S. Geologic Survey predicted a 30-year probability of a magnitude 6.7 or greater earthquake to occur in the San Francisco Region, which includes the UC Santa Cruz campus, to be about 93 percent. According to WGCEP estimates, there is a 7.4 percent chance that a magnitude 6.7 or greater earthquake would occur on the Calaveras fault within 30 years and a 9.9 percent chance of a major earthquake on the San Andreas fault in the San Francisco region (WGCEP 2015).

4.5.2.3 Project Site Geology

Seismicity

Fault Rupture

The Heller and Hagar sites are not located within an Alquist-Priolo Earthquake Fault Zone. No active faults or extensions of active faults are mapped on either site. The nearest mapped potentially active fault to the project sites is the Monterey Bay-Tularcitos fault, approximately 6.1 miles southwest of the Heller site and 5.1 miles southwest of the Hagar site. Other faults in the area include the Zayante- Vergeles fault, about 7.9 and 8.9 miles northeast of the Heller and Hagar sites, respectively, and the San Gregorio fault 8.5 and 7.5 miles southwest of the Heller and Hagar sites, respectively. The San Andreas fault, which is a major seismic hazard in northern California, is about 11.5 and 11 miles northeast of the Heller and Hagar sites, respectively (CCCarto 2017). As there are no active faults at either project site, the potential for fault rupture at the project sites is low.

Seismic Hazards

Strong ground shaking caused by large earthquakes can induce ground failures, such as liquefaction,[1] lateral spreading,[2] and cyclic densification.[3] A site's susceptibility to these hazards relates to the site topography, soil conditions, and/or depth to groundwater (NRCS 2017). Based on the soils present on both sites and the depth to groundwater, the potential for liquefaction, seismically induced differential settlement, and lateral spreading to occur at these sites is considered low.

Landslides

Potential hazards from landslides occur in areas with steep slopes topped with colluvium and soil. There are a few landslide deposits in the vicinity of the Heller site near Cave Gulch, directly west of the Heller site. However, the metamorphic rock that underlies the Heller site is stable and unlikely to experience landslides (Pacific Crest Engineering 2010). Conditions at the Hagar site are not conducive to landslides and no landslide deposits have been discovered in the vicinity of the site (UCSC 2006).

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1 Liquefaction is a phenomenon in which saturated, cohesionless soil experiences a temporary loss of strength due to the buildup of excess pore water pressure, especially during cyclic loading such as that induced by earthquakes. Soil most susceptible to liquefaction is loose, clean, saturated, uniformly graded, fine-grained sand; however, low plasticity silts and clay can also liquefy.

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

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

Project Site Geology

Heller Site

The Heller site is primarily located in an area underlain by schist bedrock and designated as Karst Hazard Level 2, which is an area with a low potential for karst-related hazards. The southern end of the Heller site extends into an area designated as Karst Hazard Level 3 in the Campus's 2005 geology and geologic hazards study, which is defined as having a moderate karst hazard potential (**Figure 4.5-1, Karst Hazard Levels at the Project Sites**) (Nolan, Zinn, and Associates 2005).

The schist bedrock portion of the site is composed of three predominant types of earth materials – soil, weathered schist bedrock and schist bedrock. The soil is derived from a mix of weathering products derived from the underlying weathered schist bedrock and possibly marine terrace deposits from a fossil marine terrace that has been completely dissected and degraded from hundreds of thousands of years of erosion. The soil transitions at depth to a layer of weathered schist that has remnant bedrock structure but is weathered to the point that it verges on being soil. The weathered schist bedrock transitions at depth to schist bedrock that is very strong, massive, fresh, and intensely to moderately fractured.

The top of the unweathered schist occurs at between 28 and 60 feet below ground surface. The thickness of the unweathered schist bedrock is unknown, since the bottom of that unit was not encountered during exploration.

Although no large voids were encountered during the drilling program by Pacific Crest Engineering, two distinct dolines have been identified as lying within the southern portion of the development area. Relatively soft soil was found between about 20 and 50 feet below the ground surface in borings (2018) SD-2 and (2010) B-10 for one doline and between 35 and 44 feet below the ground surface in boring (2018) SD-1 in the other doline. The depth to "intact" marble bedrock ranged between 30 feet and deeper than 50 feet below the ground surface in the few borings advanced within the dolines. Based upon this evidence, it is likely that two dolines, filled with some relatively soft soil, underlies the development area. Hazards associated with the soft sediment zones within the doline include subsidence of the ground surface due to settlement of doline fill on top of marble bedrock and downward movement of materials into any cavities that were not detected during the investigation.

Hagar Site

The Hagar site is located within areas designated Karst Hazard Levels 3 and 4 in the Campus's 2005 geology and geologic hazards study, which respectively have moderate and high potentials of being affected by karst-related hazards (**Figure 4.5-1**) (Nolan, Zinn, and Associates 2005). There would be no construction within areas designated Level 4 at the Hagar site. The potential karst-related hazards to the proposed Hagar site concern the presence of dolines and zones of soft soil within the development area.

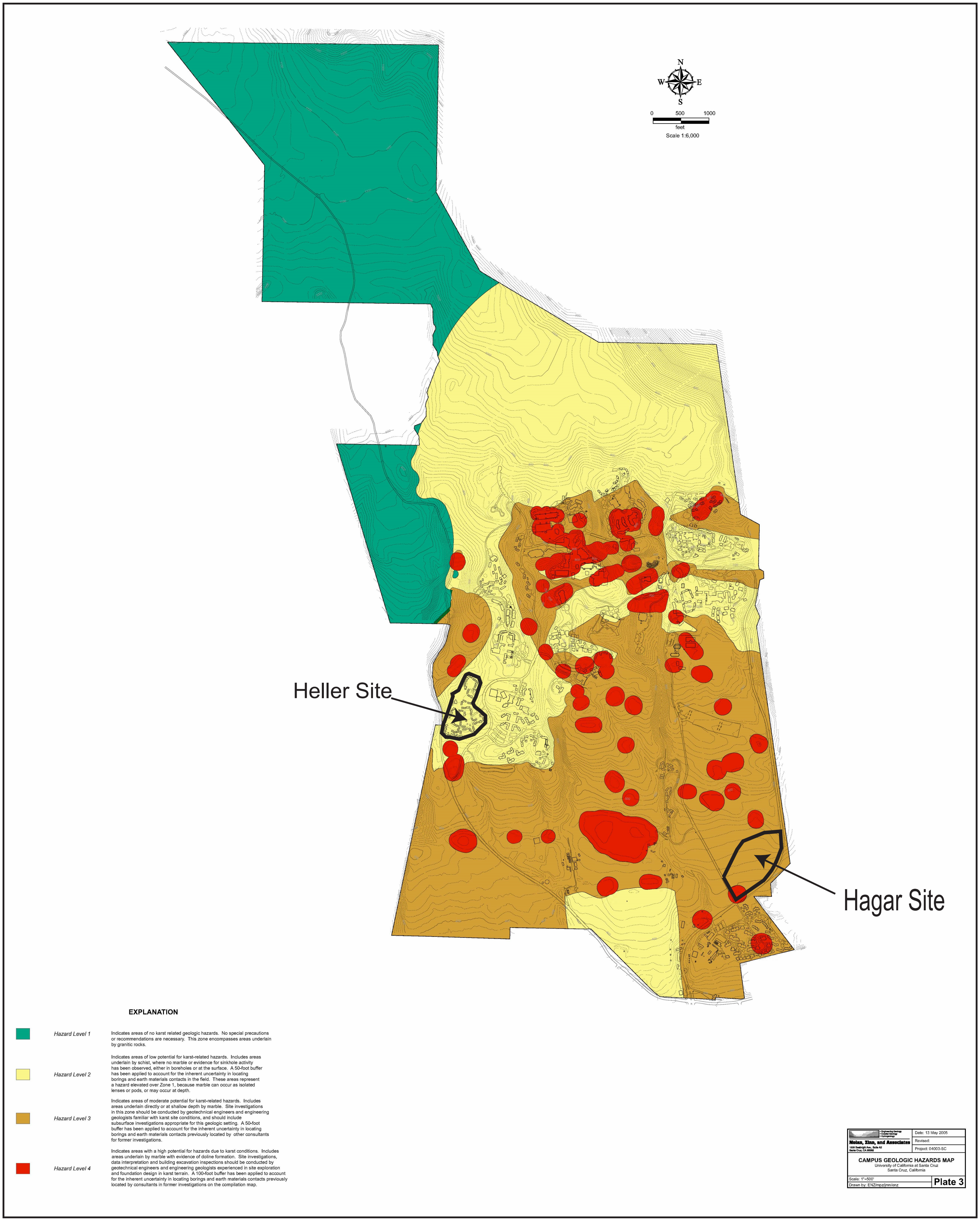
The geotechnical investigation for the proposed development at the Hagar site included 52 small-diameter borings, as well as a multi-technique geophysical survey completed by Enviroscan in December 2017. The geophysical work included electromagnetic mapping to locate the footprints of karst-related features (i.e., active or incipient sinkholes that are clay- or water-filled); microgravity mapping to detect and delineate soil cavities or zones of low-density soils which; and seismic refraction profiling to map the depth to bedrock and identify features that may represent zones of less dense material or other subsurface anomalies within the upper part of the karst.

This investigation identified two dolines that present a potential risk to several of the proposed residential structures. Both dolines are relatively deep and filled with very soft soil possibly containing voids. The depth to "intact" marble bedrock was determined to range between 12 and 38 feet below the ground surface for the widely spaced borings. It is likely that the development site is underlain by some relatively soft soil. Hazards associated with the soft sediment zones include subsidence of the ground surface due to settlement of the soil on top of marble bedrock and downward movement of materials into any cavities that were not detected during the geotechnical engineering or geophysical investigation.

An existing sinkhole lies at the southwest corner of the development project, adjacent to the intersection of Hagar Drive and Coolidge Drive. This sinkhole has experienced episodic settlement and collapse in the past decades, which was likely triggered by the disposal of collected storm water drainage from Coolidge Drive and Hagar Drive.

Project Site Soils

The soil at the Heller site are mapped in the Santa Cruz County Soil Survey as a mix of Lompico-Felton complex, Watsonville loam, Tierra-Watsonville complex, as well as small amounts of Elkhorn sandy loam and Aptos loam towards the southern end of the site. Lompico-Felton complex is found on the foot-slopes and near ridgetops and is composed of material weathered from sandstone, shale, siltstone, or schist. It has moderate permeability but a very high erosion hazard. Watsonville loam is found on coastal terraces and formed in alluvium. It has low permeability and slight to moderate erosion potential. The Tierra-Watsonville complex is composed of alluvium derived from sedimentary rock and is moderately permeable and has severe erosion potential. Elkhorn sandy loam is found on old alluvial fans and has moderate-low permeability and a slight- moderate erosion hazard. Similarly, Aptos loam has moderate erosion potential and permeability, but comes from the weathering of siltstone, shale, and sandstone (UCSC 2006).



SOURCE: UCSC, 2017

FIGURE **4.5-1**

IMPACT SCIENCES

Karst Hazard Levels at the Project Sites

680.019•3/18

Expansive soils shrink or swell with changes in moisture content. Clay mineralogy, clay content, and porosity of the soil influence the change in volume. The shrinking and swelling caused by expansive clay-rich soil can result in damage to overlying structures. Tierra-Watsonville complex soils have a high shrink-swell potential at depths greater than 14 inches (UCSC 2006). Based on the results of laboratory testing conducted as part of the project, the near-surface soils are clay-rich and considered to be moderate to highly expansive (Pacific Crest Engineering 2018b).

Soils at the Hagar site are mapped as Danville loam and Elkhorn sandy loam. Danville loam is formed in alluvium and is common on fans and terraces. Similar to Elkhorn sandy loam, Danville Loam has slight to moderate potential for erosion and low permeability. With regards to soil expansion, Elkhorn loam has low to moderate shrink-swell potential and Danville loam generally has moderate shrink-swell potential. However, at depths between 17 to 29 inches, Danville loam has high shrink-swell potential (UCSC 2006). The project geotechnical investigation found that the surficial soils at the site are composed of interlayered and at times intermixed clay and sand with lesser amounts of silt and gravel. Laboratory testing indicated that the surficial clay soils are not expansive (Pacific Crest Engineering 2018a).

4.5.3 REGULATORY CONSIDERATIONS

4.5.3.1 Federal Laws and Regulations

Clean Water Act

The Federal Water Pollution Control Act of 1972, often referred to as the Clean Water Act, empowers the US Environmental Protection Agency (US EPA) with regulation of wastewater and storm water discharges into surface waters by using National Pollutant Discharge Elimination System (NPDES) permits and pretreatment standards. At the state level, these permits are issued by the Regional Water Quality Control Boards, but the US EPA may retain jurisdiction at its discretion. The Clean Water Act's primary relevance for geology and soils is with respect to the control of soil erosion during construction.

4.5.3.2 State Laws and Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code Section 25523(a); 20 CCR 1752(b) and (c); 1972 [amended 1994]) was passed in 1972 to regulate development on or near active fault traces to reduce the hazards associated with surface faulting. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to ensure public safety by prohibiting the construction of most structures used for human occupancy across traces of active faults that constitute a potential hazard to structures from surface faulting or fault creep. For projects proposed within Alquist-Priolo Earthquake

Fault Zones, site-specific geologic investigations must be performed prior to permitting, and must demonstrate that a proposed building would not be constructed across active faults. If an active fault is found, any structures for human occupancy must be set back from the fault, generally 25 to 50 feet.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act addresses seismically induced hazards, including liquefaction and landsliding (slope instability). Seismic hazard zones, which show areas where there is potential for ground shaking, liquefaction, landsliding, and other types of ground failure, have been developed to better regulate development in hazard-prone areas. For sites located within a seismic hazard zone, geotechnical investigations must be conducted to assess if a hazard exists, and the investigations must provide options for mitigation if any hazards are identified. Geotechnical investigations within seismic hazard zones should be conducted following guidelines specified by California Geological Survey (CGS) Special Publication 117, "Guidelines for Evaluating and Mitigating Seismic Hazards." The California Public Resources Code Chapter 7.8, 1990 Seismic Hazards Mapping Act, allows the lead agency to withhold permits until geologic investigations are conducted and mitigation measures are incorporated into plans.

California Building Standards Code

The State of California's minimum standards for structural design and construction are given in the 2016 California Building Standards Code (CBSC) (CCR Title 24). The CBSC is based on the federal Uniform Building Code (International Code Council 2015), which is used widely throughout United States (generally adopted on a state-by-state or district-by-district basis) and has been modified for California conditions with numerous, more detailed or more stringent regulations. The CBSC provides standards for various aspects of construction, including but not limited to: excavation, grading, and earthwork construction; fills and embankments; expansive soils, foundation investigations, and liquefaction potential; and soil strength loss.

4.5.4 IMPACTS AND MITIGATION MEASURES

4.5.4.1 Significance Criteria

The impacts on geology from the implementation of the proposed project would be considered significant if they would exceed the following significance criteria, in accordance with Appendix G of the State CEQA Guidelines, and the 2005 LRDP EIR:

- 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;
- strong seismic ground shaking;
- seismic-related ground failure, including liquefaction; and
- landslides;

- Result in substantial soil erosion or the loss of topsoil;
- Be located on a geologic unit or soil that is unstable or would become unstable as a result of the project, and potentially result in on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse;
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), 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.

4.5.4.2 CEQA Checklist Items Adequately Analyzed at the 2005 LRDP Level or Not Applicable to the Project

Although redevelopment of the FSH complex on the Heller site was evaluated in the 2005 LRDP EIR, the currently proposed Heller site housing is substantially different from the previous proposal. The Hagar site was not envisioned for any development under the 2005 LRDP. Therefore, although the analysis below uses the prior LRDP level analysis to the extent appropriate, none of the CEQA checklist items listed above under Significance Criteria are scoped out; all of the items are addressed in the project-level analysis below. Furthermore, the cumulative impacts evaluated in the 2005 LRDP EIR are re-analyzed to address the proposed development of the Hagar site and the higher density of development proposed for the Heller site.

4.5.4.3 Methodology

The following resources were reviewed to assess the potential for impacts associated with site geologic conditions:

- Prior geotechnical investigations conducted for campus construction projects
- Prior environmental review documents for the campus
- Project-specific geotechnical investigations

- Regional and state data related to geologic, seismic, and soils conditions (e.g., seismic hazard mapping prepared by the US Geological Survey and California Geographical Society [CGS])
- Relevant federal and state regulations

The analysis compares identified impacts to the standards of significance stated above and determines the impact's level of significance under CEQA. If the impact is determined to be significant, the analysis identifies feasible mitigation measures to eliminate the impact or reduce it to a less than significant level. If the impact cannot be reduced to a less than significant level after implementation of all feasible mitigation measures, then the impact is identified as significant and unavoidable. The project's potential contribution to cumulative impacts is also identified.

4.5.4.4 2005 LRDP EIR Mitigation Measures Included in the Proposed Project

Table 4.5-1, 2005 LRDP EIR Mitigation Measures, presents the mitigation measures in the 2005 LRDP EIR that are applicable to the proposed project. Since these previously adopted mitigation measures are already being carried out as part of implementation of the 2005 LRDP, they are included in and are a part of the proposed project and will not be readopted. Implementation of these mitigation measures is assumed as part of the project impact analysis.

Table 4.5-1
2005 LRDP EIR Mitigation Measures

Mitigation Measure	Description
GEO-1	Where existing information is not adequate, detailed geotechnical studies shall be performed for areas that will support buildings or foundations. Recommendations of the geotechnical investigations will be incorporated into project design.

Source: UC Santa Cruz 2006

4.5.4.5 Project Impacts and Mitigation Measures

SHW Impact GEO-1: The proposed project would not expose people and structures to substantial adverse effects related to fault rupture, seismic ground shaking, and/or seismic-related ground failure. (*Less than Significant*)

Neither site is located within an Alquist-Priolo Fault Zone and there are no known active, potentially active, or inactive faults that transect either project site. The potential for fault rupture is considered to be low and the impact related to fault rupture would be less than significant.

Strong ground shaking caused by large earthquakes can induce ground failures, such as liquefaction, lateral spreading, and cyclic densification. Because the potential for liquefaction to occur at the sites is low, the potential for ground failures associated with liquefaction (i.e., post-liquefaction reconsolidation and loss of bearing support) is also low. However, areas containing expansive soils were discovered on both sites and could pose a significant threat to life and property. As required by the CBC and UC policy, and consistent with LRDP Mitigation GEO-1, the Campus would ensure that further detailed geotechnical investigations would be carried out on additional areas on the project sites that would support pavement or foundations, to provide geological information where investigations have not previously been completed. A site-specific evaluation of the Heller site was performed in 2010 in order to assess and minimize the risk from construction on expansive soils through appropriate engineering. Compliance with the recommendations of the site-specific geotechnical reports as well as with the CBC would ensure that this impact would be less than significant.

Mitigation Measures: No mitigation is required.

SHW Impact GEO-2: The proposed project would not result in substantial soil erosion or the loss of topsoil. *(Less than Significant*)

The proposed project would require grading and earthwork leaving bare earth that could result in soil erosion and loss of topsoil on both project sites. Although Tierra-Watsonville complex and Lompico-Felton complex have a high erosion potential, most of the soils at the sites have low to moderate erosion potential and do not present a substantial threat regarding soil erosion. Furthermore, UC Santa Cruz (Campus) has developed a set of erosion control standards that are based substantially on Chapter 16.22 of the Santa Cruz County Code (Erosion Control Ordinance) and would be adhered to throughout the development of the proposed project.

As discussed in **Section 4.7, Hydrology and Water Quality**, the contractor is required to prepare a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the National Pollution Discharge Elimination System (NPDES). The SWPPP shall be prepared by a Qualified Storm Water Pollution Prevention Plan Developer (QSD) and include both construction-phase erosion control measures and permanent erosion control measures for the proposed subdivision per the requirements of the California State Water Resources Control Board (SWRCB) adopted in accordance with the General Construction Activity Storm Water Permit. As the proposed project would be in accordance with Campus erosion control standards and would include the development and implementation of an SWPPP, the impact related to erosion and sedimentation would be less than significant and no mitigation is required.

Mitigation Measures: No mitigation is required.

SHW Impact GEO-3: The proposed project would result in construction of facilities in an area underlain by karst features, which could lead to settlement or collapse beneath the structures. (*Potentially Significant; Less than Significant with Mitigation*)

Heller Site

The Heller site is primarily located in an area designated as Karst Hazard Level 2, which is an area with a low potential for karst-related hazards. The southern end of the Heller site includes an area designated as Karst Hazard Level 3, which is defined as having a moderate karst hazard potential. Although no large voids were encountered during the drilling program completed on the Heller site by Pacific Crest Engineering, two distinct dolines[4] have been identified as lying within the southern portion of the development footprint. Relatively soft soil was found between about 20 and 50 feet below the ground surface in two borings extended in the first doline and between 35 and 44 feet below the ground surface in a boring made in the second doline. The depth to "intact" marble bedrock ranged between 30 feet and deeper than 50 feet below the ground surface in the few borings advanced within the dolines.

Based on this evidence, it is likely that two dolines, filled with some relatively soft soil, underlie the southern portion of the development area on the Heller site. Hazards associated with the soft sediment zones within the dolines include subsidence of the ground surface due to settlement of doline fill on top of marble bedrock and downward movement of materials into any cavities that were not detected during the investigation.

Another concern would be the potential for recycled water that is discharged into one or more dry wells to result in the formation of one or more sinkholes. However, as discussed in **SHW Impact HYD-2**, the proposed dry wells would be located within the soil layer over the weathered schist bedrock, and would not be located in the portion of the site that is underlain by karst where it could lead to sinkhole formation. There would be no impact related to discharge of recycled water via dry wells.

Hagar Site

The Hagar site is located within areas designated Karst Hazard Levels 3 and 4, which were identified in the 2005 Campus geology and geologic hazard study as having moderate and high potentials of being

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4 Doline refers to a basin- or funnel-shaped hollow in marble, ranging in width from a few meters to a kilometer and in depth from few to several hundred meters.

affected by karst-related hazards. An area designated Karst Hazard Level 4 is located in the southeastern corner of the Hagar site where a sinkhole is also present. There would be no construction within areas designated as Karst Hazard Level 4 area at the Hagar site. With regard to the rest of the site which is Level 3, the potential karst-related hazards at the proposed Hagar site concern the presence of dolines and zones of soft soil within the building footprints which were encountered during the geotechnical investigation for the proposed project. There are two dolines that present an elevated risk to several of the proposed residential structures for the project. These dolines are relatively deep and filled with very soft soil possibly containing voids. The depth to "intact" marble bedrock ranged between 12 and 38 feet below the ground surface for the 52 borings conducted on the site. As described above, a geophysical study was also conducted using several different methods to further define the extent and depth of these dolines. Hazards associated with the soft sediment zones include subsidence of the ground surface due to settlement of the soil on top of marble bedrock and downward movement of materials into any cavities that were not detected during the geotechnical engineering or geophysical investigation.

Based on the information above, construction of the proposed housing on the Hagar site and in the southern portion of the Heller site would have the potential to expose the buildings to hazards related to settlement or collapse. The impact would be potentially significant.

As with all development on the campus under the 2005 LRDP, the project will implement LRDP Mitigation GEO-1 which requires collection of additional site specific information (as needed) and implementation of the recommendations of the final geotechnical report. The geotechnical report recommends that the karst hazard be mitigated by a combination of the following: (1) structures founded upon mat foundation systems designed and constructed to span a 10-foot diameter void appearing anywhere beneath the structure and distributing foundations loads; (2) foundation elements bearing upon a uniform zone of engineered fill comprised of chemically treated native material or geogrid-reinforced native material, and pressure grouting of potentially collapsing soils subject to foundation loads in areas mapped as dolines.

The anticipated site grading will involve cuts and fills to minimize topographic relief across the development area. Cuts and fills will have little to no effect on solid marble bedrock and shallow surficial soils lying on top of shallow marble bedrock. Cuts placed on top of existing infilled dolines will reduce load on the dolines, thereby lessening the risk of future collapse, provided that the original loading from the removed soil is not exceeded. Where fills would be placed beneath structures on existing infilled dolines, the karst hazard and potential for differential settlement will be addressed by following the recommendations described above. Where fills are placed on dolines away from structures, this may cause the underlying doline fill to settle or collapse, but this would not result in a hazard to people or structures.

Engineered fill would not be placed within infilled dolines except within the footprints of habitable structures that are underlain by soft soil. Furthermore, groundwater was not encountered on the project site at the depth of the proposed cuts. Therefore, the proposed cut and fill would not alter the movement of groundwater in filled dolines and would not reach the depth of fractures zones in the marble.

With the implementation of the recommendations of the geotechnical reports at the time of project design and construction, the potential for significant settlement or collapse impacts would be reduced to a less than significant level. Additional mitigation (**SHW Mitigation GEO-3A**) is set forth to address the contingency that a void that is larger than the specified design void may exist under the building footprints. If such a void exists, and if soil washes or collapses into it after the building has been constructed, the structure may be damaged, a potentially significant adverse impact.

As discussed in **SHW Impact HYD-3**, a portion of the storm water from the Hagar site would be collected, detained and treated in bioswales and then discharged into the existing detention basin/sinkhole on the site. A portion of the runoff would be directed into a bioswale for treatment from where it would discharge into a storm drain and a dissipation structure that would convey and dispose the runoff by infiltration into Jordan Gulch. Given its location, site storm water runoff that is discharged into Jordan Gulch would have the potential to result in the formation of one or more sinkholes. The sidewall of Jordan Gulch appears to be solid marble that defines the boundaries of the linear doline that forms this gulch. Therefore, the potential that a reactivated sinkhole within Jordan Gulch would affect the adjacent bike path, road or infrastructure is very low. However, should a sinkhole expand beneath critical infrastructure such as Ranch View Road, Coolidge Drive, or utility infrastructure, the impact would be significant. However, this impact would be mitigated by **SHW Mitigation HYD-3B**, which requires that a minimum 60-foot buffer shall be established between infiltration areas and critical structures, existing or planned, such as buildings, roadways, and life/safety infrastructure.

Mitigation Measures:

SHW Mitigation GEO-3A: At the time of the building foundation excavation in areas underlain by dolines, the excavation shall be examined by the project geologist and geotechnical engineer, prior to backfilling of the excavation. A geologic map portraying the distribution of rock and soil shall be prepared by the project geologist, particularly showing the geometry of the exposed marble bedrock. If previously unidentified dolines in excess of the design void span are mapped in the excavation, the project shall be redesigned to span those voids, or further subsurface work shall be performed to adequately characterize the hazard and attendant risks related to karst processes.

SHW Mitigation GEO-3B: Implement **SHW Mitigation HYD-3B.**

Significance after Mitigation: Implementation of the recommendation of the final geotechnical report per LRDP Mitigation GEO-1, and **SHW Mitigations GEO-3A**and **-3B** would reduce the impacts related to karst hazard to a less than significant level.

SHW Impact GEO-4: The proposed project would not be located on expansive soils or a geologic unit that could become unstable as a result of the project. (*Less than Significant*)

As described in **Section 4.6.2** under **Project Site Geology**, soils on the Heller site are moderately to highly expansive. Expansive soils, which shrink and swell cyclically as they are wetted and dried by seasonal rains or irrigation, can result in substantial damage to improperly designed or constructed structures over time. However, as discussed above, UC policy requires compliance with the CBC, which includes provisions for foundation design and construction in areas with expansive soils. Depending on site conditions and the nature of a project, a variety of approaches are possible, including over-excavation and replacement of native soils with non-expansive fills, amendment (such as lime treated engineered fill) and on-site use of native soils, and implementation of specialized foundation designs, such as structural mat foundations and pier and grade beam foundations where needed due to high structural loads.

Consistent with LRDP Mitigation GEO-1, site-specific geotechnical investigations have been prepared for the project. Implementation of the foundation design recommendations of these investigations would reduce the potential impact of development on expansive soils to a less than significant level.

Mitigation Measures: No mitigation is required.

SHW Impact GEO-5: The proposed project would not be located on soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems. (*Less than Significant*)

The use of septic tanks is not proposed as part of this project. Therefore, there would be no impact associated with the use of septic tanks.

Alternative wastewater treatment systems that utilize a membrane bioreactor to treat wastewater are proposed for both project sites. These systems would generate recycled water which would be used for toilet and urinal flushing and irrigation, and would not require disposal to any surface waters or to the City's wastewater collection system, although a pipeline connection to the sanitary sewer main located in Heller Drive and a pipeline connection to the sanitary sewer in Jordan Gulch will be constructed to allow an emergency discharge into the sanitary sewer system in case of system upset at the two sites. Some of the recycled water that would be generated would be used within the Heller site development for toilet and urinal flushing, as well as landscape irrigation. Unused recycled water would be discharged onsite via dry wells in the soil overlying the schist bedrock and within the weathered schist bedrock at locations with soils capable of receiving infiltration. The impacts from the infiltration of excess recycled water via dry wells at the Heller site and disposal of excess recycled water from the Hagar site via discharge to Jordan Gulch are addressed in **Section 4.7, Hydrology and Water Quality**, and are determined to be less than significant with mitigation. Note that, as discussed in **Section 7.1, LRDP Water Supply Impact Assessment**, the Campus will evaluate the feasibility of using the excess recycled water in Porter and Kresge Colleges and at the Arboretum.

Mitigation Measures: No mitigation is required.

4.5.5 PORTER AND RACHEL CARSON DINING FACILITIES EXPANSION PROJECT IMPACTS AND MITIGATION MEASURES

Environmental Setting

The proposed dining facilities expansion project would add to existing facilities on the west side of Rachel Carson College and to the southern end of Porter College. In both instances, the facilities would be located above or adjacent to existing buildings, or would replace the existing buildings with larger buildings. The areas where the improvements would be constructed are classified as Hazard Level 2 areas on the UC Santa Cruz's karst hazards map, based on previous geotechnical studies. Such areas have a low potential for karst-related hazards.

Impacts and Mitigation Measures

DF Impact GEO-1: The proposed dining facilities expansion project would not expose people and structures to substantial adverse effects related to fault rupture, seismic ground shaking, seismic-related ground failure, landslides and cut slopes, or existing geologic conditions. Project implementation would also not result in substantial soil erosion or involve soils incapable of adequately supporting the use of septic tanks. (*Less than Significant*)

Fault Rupture and Seismic–Related Ground Failure

The proposed dining facilities expansion project is not located within an Alquist-Priolo Fault Zone and there are no known active, potentially active, or inactive faults that transect the campus. The potential for fault rupture is considered to be low and the impact would be less than significant. The potential for liquefaction and seismic-related ground failure to occur is also considered low. Furthermore, the project will be required to implement LRDP Mitigation GEO-1, which requires the completion of a site-specific geotechnical investigation and the implementation of the investigation's recommendations. Therefore the impact related to ground failure due to seismic ground shaking would be less than significant.

Erosion

The areas to be disturbed to construct the proposed improvements are small and previously graded in conjunction with the existing development at both colleges. Furthermore, the project will be required to implement a Storm Water Pollution Prevention Plan, or, if the project would disturb less than an acre of land, an Erosion and Sediment Control Plan would be required to comply with Campus Standards, to minimize erosion and sedimentation during construction. Therefore, erosion impacts would be less than significant.

Landslides

The proposed improvements are not within an area where landslides are likely to occur.

Unstable Geologic Unit

The proposed project will be required to implement LRDP Mitigation GEO-1 which requires a geotechnical investigation of the sites and implementation of the recommendations of the geotechnical investigation during project design and construction. As a result, if construction on expansive soils or units that could become unstable is proposed as part of the project, the building sites would be made stable by way of compaction and placement of engineered fill, including lime-treated fill if needed, and the foundations would be designed appropriately. Therefore the impact related to expansive soils and unstable geologic units would be less than significant.

Septic Tanks

There would be no septic tank use associated with the dining facilities expansion project. Therefore, there would be no impacts with regards to septic tanks.

Mitigation Measures: No mitigation is required.

4.5.6 CUMULATIVE IMPACTS AND MITIGATION MEASURES

SHW Impact C-GEO-1: Implementation of the proposed SHW project would not result in significant cumulative impacts related to geology and soils. (*Less than Significant*)

As stated in the 2005 LRDP EIR, most impacts related to geology and soils tend to be site specific and do not cumulate. The LRDP EIR did evaluate the cumulative impact of the campus development under the 2005 LRDP as well as other reasonably foreseeable development in the region (LRDP Impact GEO-6) associated with exposing people and structures to adverse effects from seismic ground shaking and determined that compliance with the CBC would render the cumulative impact less than significant.

Although development on the Heller site is within the scope of the previous cumulative analysis, development of the Hagar site was not envisioned in the 2005 LRDP and therefore was not evaluated programmatically in the LRDP EIR. However, as set forth in the analysis above, the development of the Hagar site would not result in new or more severe impacts related to geology and soils. Furthermore, as the impact analysis above notes, , the proposed project is an element of the planned development under the 2005 LRDP and would implement applicable mitigation measures from the 2005 LRDP EIR as well as comply with the CBC. Therefore, the project would not result in new or greater cumulative impacts than previously analyzed in the 2005 LRDP EIR. The cumulative impacts of the proposed project are adequately addressed by the analysis in the 2005 LRDP EIR, and would be less than significant.

Mitigation Measures: No mitigation is required.

4.5.7 REFERENCES

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