

3.6 Geology and Soils

This section addresses potential impacts related to geology, soils, and seismicity as well as paleontological resources that may result from implementation of the proposed Larkspur Ferry Service Expansion and Parking Project (Project). The following discussion addresses existing geology, soils, seismicity, and paleontological conditions of the Project area and surroundings; considers applicable goals and policies; identifies and analyzes environmental impacts; and recommends measures to reduce or avoid adverse impacts anticipated from Project implementation, as applicable. Information in this section is based on the Preliminary Geotechnical Report (Geotechnical Report) prepared for the proposed Project, unless otherwise noted (Jacobs 2026). Impacts related to the No-Project Alternative are discussed in Chapter 5, Alternatives to the Project.

3.6.1 Existing Conditions

3.6.1.1 Regulatory Setting

The Golden Gate Bridge, Highway and Transportation District, as the owner of the Larkspur Ferry Terminal, is the California Environmental Quality Act (CEQA) Lead Agency for the Project and has prepared this Draft Environmental Impact Report to evaluate potential impacts and identify required mitigation to avoid or reduce potentially significant impacts. The federal, state, and regional and local regulations applicable to the Project are provided in this section.

Federal

Earthquake Hazard Reduction Act of 1977

Federal laws codified in United States Code Title 42, Chapter 86, were enacted to reduce risks to life and property from earthquakes in the U.S. through the establishment and maintenance of an effective earthquake hazards reduction program. Implementation of these requirements is regulated, monitored, and enforced at the state and local levels.

State

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 (Alquist-Priolo Act)

The Alquist-Priolo Act (Public Resources Code Section 2621 et seq.) is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location and construction of most types of structures intended for human occupancy¹ over active fault traces and strictly regulates construction in the corridors along active faults. The state geologist has established regulatory zones along active faults,² called "Earthquake Fault Zones," and published maps that identify areas where surface traces of active faults are present (CGS 2018). The state guidelines for fault rupture hazards are explained in the California Geological Survey (CGS) Special Publication 42. Strict regulations on development within these zones are enforced to reduce the potential for damage because of fault displacement.

¹ According to the Alquist-Priolo Act, a structure for human occupancy is defined as one "used or intended for supporting or sheltering any use or occupancy that is expected to have human occupancy rate of more than 2,000 person-hours per year" (California Code of Regulations, title 14, division 2, section 3601[e]).

² An active fault, for the purposes of the Alquist-Priolo Act, is one that has ruptured in the past 11,000 years.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (SHMA) of 1990 (California Public Resources Code, Chapter 7.8, Sections 2690–2699.6) directs the CGS to identify and map areas prone to the liquefaction and landslides resulting from seismic events. The act mandates that project sponsors have a site-specific geotechnical investigation performed to identify potential seismic hazards and formulate mitigation measures before the permitting of most developments within specific zoned areas. The SHMA requires the State Geologists to establish regulatory zones (Zones of Required Investigation) and to issue appropriate maps (Seismic Hazard Zone maps).

California Building Standards Code

The California Building Standards Code, or state building code, is codified in Title 24 of the California Code of Regulations. The state building code provides standards that must be met to safeguard life or limb, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within the state. The state building code generally applies to all occupancies in California, with modifications adopted in some instances by state agencies or local governing bodies. The current California Building Code (CBC) (CBCS 2025) incorporates, by adoption, the 2024 edition of the International Building Code of the International Code Council, with the California amendments. These amendments include building design and construction criteria that have been tailored for California earthquake conditions.

Chapter 16 of the state building code deals with structural design requirements governing seismically resistant construction (Section 1604) including, but not limited to, factors and coefficients used to establish a seismic site class and seismic occupancy category appropriate for the soil/rock at the building location and the proposed building design (Sections 1613.5 through 1613.7). Chapter 18 includes, but is not limited to, the requirements for foundation and soil investigations (Section 1803); excavation, grading, and fill (Section 1804); allowable load-bearing values of soils (Section 1806); foundation and retaining walls (Section 1807); and foundation support systems (Sections 1808 through 1810). Chapter 33 includes, but is not limited to, requirements for safeguards at work sites to ensure stable excavations and cut-and-fill slopes (Section 3304) as well as the protection of adjacent properties, including requirements for noticing (Section 3307). Appendix J of the state building code includes, but is not limited to, grading requirements for the design of excavation and fill (Sections J106 and J107), specifying maximum limits on the slope of cut-and-fill surfaces and other criteria, required setbacks and slope protection for cut-and-fill slopes (Section J108), and erosion control through the provision of drainage facilities and terracing (Sections J109 and J110).

The CBC, in conjunction with 2022 edition of American Society of Civil Engineers (ASCE) *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, ASCE 7-22 (ASCE 2022) establishes minimum design criteria and construction requirements, including design of concrete and steel structures, buildings, excavation and shoring, grading, and foundations.

California Division of Occupational Safety and Health Regulations

Construction activities are subject to occupational safety standards for excavation, shoring, and trenching, as specified in California Division of Occupational Safety and Health regulations (Title 8).

State Historic Significance Criteria

Section 4.7.5.2, Significance Criteria, Appendix G of the CEQA Guidelines includes the following question: "Would the project directly or indirectly destroy a unique paleontological resource or site?" Although CEQA

does not define what constitutes “a unique paleontological resource or site,” Section 21083.2 defines *unique archaeological resources* as any archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

- Contains information needed to answer important scientific research questions and shows that there is a demonstrable public interest in that information.
- Exhibits a special and particular quality, such as being the oldest of its type or the best available example of its type.
- Is directly associated with a scientifically recognized important prehistoric or historic event or person.

This definition is equally applicable to recognizing a unique paleontological resource or site. CEQA Section 15064.5(a)(3)(D) provides additional guidance, indicating that, generally, a resource is considered historically significant if it has yielded, or may be likely to yield, information important in history before or after European contact.

The CEQA lead agency having jurisdiction over a project is responsible for ensuring that paleontological resources are protected in compliance with CEQA and other applicable statutes. California Public Resources Code Section 21081.6 requires the CEQA lead agency to demonstrate project compliance with the mitigation measures developed during the environmental impact review process.

Local

Larkspur Municipal Code

15.07.010 - California Existing Building Code. The Larkspur Municipal Code adopts the following recognized codes by reference: 2025 Edition, California Existing Building Code (CEBC 2025).

15.08 – California Building Code. The Larkspur Municipal Code adopts the following recognized codes by reference: 2025 Edition, California Building Code, with amendments to Chapters 1, 2, 3, 7, 9, 15, 31, and 33.

15.20.320 – Erosion and Sediment Control Plan Requirements. When required by the Phase II Stormwater Permit or by the agency, a project shall have an Erosion and Sediment Control Plan, which addresses erosion and sediment control and pollution prevention during the construction phase and final stabilization control measures.

18.41.140 – Development Plan. New development applications require geotechnical reports consistent with general plan requirements to assess such hazards as potential seismic hazards, liquefaction, landslides, debris flows, erosion, sedimentation and settlement and hazardous soils conditions to determine the optimum location for structures, to advise of special structural requirements and to evaluate the feasibility and desirability of a proposed facility in a specific location.

The Larkspur Municipal Code does not reference paleontological resources.

City of Larkspur 2040 General Plan

The City of Larkspur 2040 General Plan (City of Larkspur 2024) contains goals, policies, and programs describing the community's vision for economic viability, livable neighborhoods, and environmental protection. *The City of Larkspur 2040 General Plan* includes the following policies associated with geology

and soil. *The City of Larkspur 2040 General Plan* does not reference paleontological resources (City of Larkspur 2024).

Chapter 7, Section A, Seismic Hazards. Requires enforcing the application of CBC during project review and construction to areas identified as at-risk to seismic hazards to ensure reduction in potential loss of life and property damage because of an earthquake.

Chapter 7, Section A, Geologic Hazards. Requires identification of geologic hazards that include landslides, debris flows, subsidence, and differential sediment; performing geotechnical analysis during project review; implementation of appropriate stormwater management practices; and encourages property owners to familiarize themselves with the risk their properties may face, to reduce the risk of damage from geologic hazards.

Chapter 7, Section B.1, Community Preparedness. No new development in areas prone to natural hazards without adequate mitigation.

3.6.1.2 Environmental Setting

Physiography

The Project area is in a depression within the Coast Ranges geomorphic province of California (CGS 2002). The Coast Ranges are northwest-trending mountain ranges (2,000 to 4,000 and occasionally up to 6,000 feet elevation above sea level) and valleys, composed of thick Mesozoic and Cenozoic sedimentary strata. The northern and southern ranges are separated by a depression containing the San Francisco Bay. The northern Coast Ranges are dominated by irregular, knobby, landslide-topography of the Franciscan Complex. The eastern border is characterized by strike-ridges and valleys in Upper Mesozoic strata.

In several areas, Franciscan rocks are overlain by volcanic cones and flows of the Quien Sabe, Sonoma, and Clear Lake volcanic fields. The Coast Ranges are generally parallel to the San Andreas Fault Zone, mapped roughly 8 miles southwest of the site. The Hayward Fault Zone (mapped approximately 9 miles northeast of the site) is a prime example of the northwest-trending geologic structure associated with the Coastal Ranges province. The San Andreas fault is more than 600 miles long, extending from Point Arena to the Gulf of California. West of the San Andreas fault is the Salinian Block, a granitic core extending from the southern extremity of the Coast Ranges to the north of the Farallon Islands.

Subsurface Conditions

The Project area is in the northern portion of the Coast Ranges. Below the surficial deposits, the site is underlain by Franciscan Complex bedrock (CGS 1976). The Franciscan Complex can generally be described as a mix of small-to-large resistant rock masses (mainly sandstone, greenstone, chert, and serpentine) in a matrix of highly sheared to pulverized rock material. The Complex represents one or more immense, geologically ancient fault zones that resulted from the collision of the North American and Pacific plates roughly 60 to 100 million years ago. The surficial soils consist of artificial fills, overlying Bay Mud, alluvium, and Franciscan Complex bedrock.

The Main Lot is underlain by 8 to 13 feet of artificial fill, generally consisting of medium dense to dense clayey sand with gravels. The Bay Mud is high plasticity, soft to very soft, and very compressible silt and clay with scattered organic peat. This very compressible silt and clay were encountered from about 13 to 15 feet below ground surface (bgs), with layer thickness ranging from 38 to 55 feet. The alluvium underlying Bay Mud predominantly consists of lean and fat clays, sand, and sandy clays of moderate to

high strength and low compressibility. Bedrock predominantly comprises mudstone, encountered at depths of about 60 to 90 feet bgs.

The North Lot is underlain by shallow (12 to 18 feet), medium stiff to stiff, sandy lean clays with moderate to high strength and low compressibility, overlaying the bedrock.

Seismicity and Seismic Hazards

Primary Seismic Hazards

Surface Fault Rupture

The Project area is not within an Alquist-Priolo earthquake fault zone, and no known active faults or potentially active faults are mapped on the Project area (CGS 2018). Therefore, the likelihood of surface fault rupture within the Project area is considered low. In a seismically active area such as the San Francisco Bay Area, the possibility of future surface fault rupture occurring in areas where active faults have not been mapped is small, but the possibility exists.

Seismic Ground Shaking

Ground shaking is the most prominent hazardous phenomenon associated with seismic activity. The Project is between two active fault zones: the Hayward Fault Zone, approximately 9 miles northeast of the Project, and the San Andreas Fault Zone, approximately 8 miles southwest of the Project (CGS 2018). Large earthquakes could occur on these faults, producing significant ground shaking at the Project site.

There is a 72% probability of a major (6.7 or greater magnitude) earthquake occurring in the San Francisco Bay Area by 2043 (USGS 2016). The San Andreas fault (22%) and Hayward fault (33%) are the major contributors to this hazard. The Project area could experience "severe"³ ground shaking (Modified Mercalli Intensity [MMI] Shaking Severity Level 8) from a major seismic event that can be expected to occur during the design lifetime of the proposed Project (ground shaking with a 10% probability of exceedance in 50 years) (ABAG 2020). During such a seismic event, the Project area could experience "violent"⁴ ground shaking (MMI Shaking Severity Level 9) (CGS 2025).

According to the Geotechnical Report, the mean site-adjusted Maximum Credible Earthquake (MCE_R) peak horizontal ground accelerations (PGA_M) were estimated to be 0.45g (g=acceleration due to gravity) and 0.56g for the Main and North Lots, respectively. An MCE event corresponds to a rare earthquake event with 2% probability of exceedance in 50 years (2,475-year return period).

Secondary Seismic Hazards

Liquefaction

Liquefaction occurs when saturated loose cohesionless soil loses its strength and stiffness when subject to rapid loading, such as that from an earthquake. Liquefied soil behaves like a liquid (viscous material), resulting in ground failure. When a load, such as a structure, is placed on ground that is subject to liquefaction, ground failure can result in the structure sinking and tilting. Ground failure can take on many

³ A "very strong" earthquake is defined on the MMI Scale as an VIII, which could result in extensive damage to unreinforced masonry buildings (for example, masonry walls falling, wood-frame houses moving off their foundations, loose partition walls being thrown out of alignment) (ABAG 2020).

⁴ A "violent" earthquake is defined on the MMI Scale as an IX, which could result in buildings shifted off foundations, cracked, or tilted; ground cracked; underground pipes broken (CGS 2025).

forms, including flow failures, lateral spreading, ground settlement, loss of bearing strength, ground fissures, and sand boils. Liquefaction that occurs at great depths may result in less settlement, compared to liquefaction that occurs at shallow depths.

The Project is within the San Rafael Quadrangle, an area that has not been evaluated by the California Geological Survey for seismic hazards, including liquefaction (CGS 2026). However, the Marin Countywide Plan identifies the majority of the Project area as an area with high to very high levels of liquefaction susceptibility (County of Marin Community Development Agency 2023).

The Project area was evaluated for liquefaction hazard in the Geotechnical Report using the field exploration data obtained at the Project site. No liquefiable soils were identified in the exploratory soil borings, but isolated liquefiable soils were identified in the cone penetrometer test (CPT) soundings. These analysis results indicate that most of the liquefiable soils are within the upper 14 feet below the existing ground surface and limited thin liquefiable soil layers exist at greater depths. These thin liquefiable soil layers at greater depths are not expected to adversely impact the proposed development at the site. In addition, it is anticipated that the upper 5 to 10 feet of these liquefiable soils will be excavated at the parking lot foundation locations for the construction of pile caps. Therefore, the potential for liquefaction to occur and the impacts on the proposed parking lots are considered low.

Lateral Spreading

Lateral spreading is a phenomenon in which a surficial soil displaces/moves along a shear zone that formed within an underlying liquefied layer. The surficial soil blocks are transported downslope or in the direction of a free face, such as a bay or creek, by earthquake shakings and gravitational forces. Lateral spreading is generally the most pervasive and damaging type of liquefaction-induced ground failure generated by earthquakes.

At the Main Lot, there are free faces in the areas to the east and south of the Project site associated with a history of previous site reclamation/development. The conditions of these free faces or slopes are unknown, and their stability under the gravity and anticipated seismic loads were not evaluated in the preliminary geotechnical study. These areas could provide a free face toward which liquefiable soils could displace. Because the risk of liquefaction is low in the soils underlying much of the Project area, the potential of lateral spreading because of liquefaction toward the eastern and southern portions of the Project area is judged to be low.

Expansive Soils and Weak Soils

Expansive soils are characterized by their ability to undergo substantial volume changes (that is, shrink and swell) because of variation in moisture content. Expansive soils are typically very fine grained and have a high to very high percentage of clay. They can damage structures and buried utilities and increase maintenance requirements. Generally, projects in areas with expansive soils may require special building foundations or grade preparation, such as the removal of problematic soils and replacement with engineered soils.

Based on expansive soil criteria, in accordance with Section 1803.5.3 of the CBC, soils with expansion index more than 20 shall be considered expansive. According to the Geotechnical Report, the clayey sandy soils encountered at shallow depths have high expansion index values, with expansion indexes of 24 and 30 measured at the Main Lot and expansion index of 63 measured at the North Lot. Note that the shallow subsurface soils in the Project area have plasticity index ranging from 14 to 45. Therefore, the subsurface soils at the Project site are considered to have medium to high expansion potential.

Landslides

Landslides occur when the stability of a slope changes from a stable to an unstable condition. The stability of a slope is affected by the following primary factors: inclination, material type, moisture content, orientation of layering, and vegetative cover. In general, steeper slopes are less stable than more gently inclined ones. No official landslide hazard zone report/map for the Project site has been published by the CGS. Moreover, the available geologic maps published by USGS (1997⁵) for Marin County indicate that the Project site is relatively flat and no natural slopes are present. Therefore, the potential for landslides at the Project site is considered low.

Paleontological Resources

Fossils preserve information about ancient animals and plants (UCMP n.d.). There are two types of fossils: body fossils (remains of an organism) and trace fossils (for example, footprints, burrows, trails). Fossils can add to the scientific record by providing information about the anatomy of an organism, clues to its life processes, successive evolutionary development, and habitat use over time. If fossils are destroyed, they cannot be replaced. Fossils thus represent irreplaceable evidence of past life on the planet (NPS 2023).

Fossils occur within geologic units. A geologic unit is a volume of rock or sediment of identifiable origin with an age range defined by distinctive and dominant features. The geologic units exposed at and near the ground surface in the Project area are artificial fill over marine and marsh deposits (Qmf; Quaternary) and Jurassic and Cretaceous Franciscan Complex mélange (fsr) (Blake et al. 2000).

Geologic units from the Quaternary contain both Holocene and Pleistocene deposits. In general, Holocene deposits are considered too young to contain fossils, while those from the Pleistocene may be richly fossiliferous (SVP 2010, 2026). The Jurassic and Cretaceous Franciscan Complex mélange has yielded some fossils, though most of these are invertebrates (for example, bivalves, brachiopods, and tubeworms) and microfossils (for example, radiolarians).

3.6.2 Environmental Impacts

The study area for geology and soils and paleontology includes the project footprints within the Main and North Lots.

3.6.2.1 Methodology

Geology, Soils, and Seismicity

Geology, soils, and seismicity impacts were analyzed for the Project area. Information in this section is based on the Geotechnical Report prepared for the proposed Project, unless otherwise noted (Jacobs 2026). The Geotechnical Report discusses the data from field explorations and design recommendations from a geotechnical standpoint.

In the *California Building Industry Association v. Bay Area Air Quality Management District* case, decided in 2015,⁶ the California Supreme Court held that CEQA does not generally require lead agencies to consider how existing environmental conditions might affect a project, except where the project would significantly

⁵ U.S. Geological Survey (USGS). 1997. Summary Distribution of Slides and Earth Flows in Marin County, California. Plot Derived from Open-File Report 97-745 C.

⁶ *California Building Industry Association v. Bay Area Air Quality Management District*, 62 Cal.4th 369. Opinion filed December 17, 2015. Available: <https://caselaw.findlaw.com/ca-supreme-court/1721100.html>. Accessed: May 26, 2026.

exacerbate an existing environmental condition. Accordingly, placing new development in an existing or future seismic hazard area or an area with unstable soils is not considered an impact under CEQA unless the project would significantly exacerbate a seismic hazard or unstable soil conditions. Therefore, the following analysis evaluates whether the proposed Project would exacerbate existing or future seismic hazards or unstable soils in the Project area and result in potentially significant environmental impacts or a substantial risk of loss, injury, or death.

Paleontological Resources

The *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (Procedures) (SVP 2010) include procedures for the investigation, collection, preservation, and cataloging of fossil-bearing sites. This includes the designation of paleontological sensitivity. The Procedures are widely accepted among paleontologists and followed by most investigators. The Procedures identify two key phases of paleontological resource protection: (1) assessment and (2) implementation. Assessment involves identifying the potential for a project site or area to contain significant, nonrenewable paleontological resources that could be damaged or destroyed by project excavation or construction. Implementation involves formulating and applying measures to reduce such adverse effects. *Paleontological potential* refers to the potential for yielding abundant fossils, a few significant fossils, or recovered evidence for new and significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data.

For the assessment phase, the Society of Vertebrate Paleontology uses one of four sensitivity categories for sedimentary rocks (that is, high, undetermined, low, and no potential) to define the level of potential, described further as follows:

- **High Potential.** Assigned to geologic units from which vertebrate or significant invertebrate, plant, or trace fossils have been recovered as well as sedimentary rock units suitable for the preservation of fossils (for example, middle Holocene and older fine-grained fluvial sandstones, fine-grained marine sandstones).
- **Undetermined Potential.** Assigned to geologic units for which little information is available concerning their paleontological content, geologic age, and depositional environment. In cases where no subsurface data already exist, paleontological potential can sometimes be assessed by subsurface site investigations.
- **Low Potential.** Field surveys or paleontological research may determine that a geologic unit has low potential for yielding significant fossils (for example, basalt flows). Mitigation is generally not required to protect fossils.
- **No Potential.** Some geologic units have no potential to contain significant paleontological resources (for example, high-grade metamorphic rocks [gneisses and schists] and plutonic igneous rocks [granites and diorites]). Mitigation is not required.

3.6.2.2 Thresholds of Significance

The following CEQA Guidelines Appendix G thresholds identify significance criteria to be considered for determining whether a project could have significant impacts related to geology and soils.

Would the proposed Project:

- Directly or indirectly cause 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 Division of Mines and Geology Special Publication 42.)

- Strong seismic ground shaking?
- Seismic-related ground failure, including liquefaction?
- 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 onsite or offsite landslide, 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 direct or indirect risks to life or property?
- 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?
- Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

3.6.2.3 Impacts

Project geology and soils impacts are substantively the same for both Alternative 1 and Alternative 2. Within this section impacts for Alternative 1 and Alternative 2 are discussed together as the Build Alternatives

Directly or Indirectly Cause Potential Substantial Adverse Effects, Including the Risk of Loss, Injury, or Death Involving Rupture of a Known Earthquake Fault, Strong Seismic Ground Shaking, Seismic-Related Ground Failure (Including Liquefaction), or Landslides

Construction and Operation

Build Alternatives

Fault Rupture

As discussed under Seismicity and Seismic Hazards, the Project area is not mapped within an Alquist-Priolo earthquake fault zone, and no known active and potentially active faults exist in the vicinity of the Project. It is concluded that the risk of surface fault rupture from a seismic event is very low. Therefore, construction and operation of the Build Alternatives would not exacerbate the risk of surface fault rupture, and this impact would be ***less than significant***. No mitigation required.

Ground Shaking

As discussed under Seismicity and Seismic Hazards, the Project area is in a seismically active area between two major active faults (the San Andreas and Hayward faults). Consequently, the Project area could experience significant ground shaking (MMI Shaking Severity Levels 8 or 9) during major seismic events.

However, the proposed Project would comply with the California Buildings Standard Code, Marin County policies, and Larkspur Municipal Code seismic requirements, which would ensure the design of the proposed Project would reduce risks to life from damage. Therefore, construction and operation of the

Build Alternatives would not exacerbate the risk of ground shaking resulting from a seismic event, and this impact would be ***less than significant***. No mitigation required.

Soil Liquefaction

As discussed under Seismicity and Seismic Hazards, portions of Marin County are underlain by liquefiable soils and the Project area is in an area identified by the Marin Countywide Plan as being susceptible to liquefaction. The Geotechnical Report found that most of the liquefiable soils are within the upper 14 feet of the existing ground surface, and only limited thin liquefiable soil layers are encountered at greater depths. In addition, the upper 5 to 10 feet of these potentially liquefiable soils will likely be excavated and replaced with suitable engineered fill at the foundation locations for the construction of parking lots. Therefore, construction and operation of the Build Alternatives would not exacerbate the risk of soil liquefaction resulting from a seismic event, and this impact would be ***less than significant***. No mitigation required.

Seismic Densification

The Geotechnical Report estimated the liquefaction-induced seismic settlements at the Project site to be less than 1 inch. There are no loose, unsaturated granular soils encountered in the soil borings and CPT sounding drilled on the Project area, which are susceptible to settlement from a seismic event. Therefore, with adherence to design and construction recommendations presented in the Geotechnical Report, construction and operation of the Build Alternatives would not result in adverse conditions related to seismic densification, and this impact would result in a ***less-than-significant*** impact. No mitigation required.

Lateral Spreading

There are free faces in the areas to the east and south of the Main Lot associated with the previous site reclamation/development. The stability of these free faces under gravity and seismic loads would be evaluated in the future design, and mitigation measures would be recommended, as required, to stabilize these faces. Therefore, construction and operation of the Build Alternatives would not result in adverse conditions related to lateral spreading, and this impact would result in a ***less-than-significant*** impact. No mitigation required.

Landslides

As discussed under Landslides, the Project area is relatively flat, and there have been no reported landslides or recorded landslide deposits in the immediate vicinity of the Project site. Therefore, construction and operation of the Build Alternatives would result in ***no impact*** related to landslides.

Mitigation Measures

No mitigation required.

Result in Substantial Soil Erosion or the Loss of Topsoil

Construction and Operation

Build Alternatives

The proposed Project is in an urbanized area within existing paved parking lots. Construction of the Build Alternatives would require excavation and grading to provide a secure foundation, allow for positive drainage, and enable the installation of piles. Because the proposed Project would disturb more than 1 acre of land, the Project will be required to comply with the requirements of the National Pollutant Discharge Elimination System Construction General Permit, *The City of Larkspur 2040 General Plan* (City of Larkspur 2024), and the Larkspur Municipal Code. Implementation of MM-HYD-CNST-1 would include measures to avoid and minimize erosion and implement best management practices to control sediment and minimize erosion during construction. Examples of the types of best management practices include the installation of erosion control measures (for example, silt fences, staked straw bales/wattles, silt/sediment basins or traps), geofabric, sandbag dikes, covers for stockpiles, or storage precautions for outdoor material storage areas. Therefore, with implementation of MM-HYD-CNST-1, construction of the Build Alternatives would not result in substantial soil erosion or loss of topsoil, and impacts would be ***less than significant with mitigation***.

After the construction of Build Alternatives, the Project sites would consist of paved and impervious surfaces, and there would be no loss of top soil or soil erosion and operation of the Build Alternatives would result in ***no impact***.

Mitigation Measures

Refer to MM-HYD-CNST-1 in Section 3.9, Hydrology and Water Quality.

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 Onsite or Offsite Landslide, Lateral Spreading, Subsidence, Liquefaction, or Collapse

Construction and Operation

Build Alternatives

As discussed under Seismicity and Seismic Hazards, the potential for liquefaction, lateral spreading, and seismic settlement at the Project site is considered low. Adhering to the design and construction recommendations provided in the Geotechnical Report further reduces these seismic hazards.

The Geotechnical Report determines that the Main Lot is underlain by soft Bay Mud. When loaded, this soft Bay Mud would undergo significant compression or settlement over time (that is, consolidation process). But with adherence to design recommendations presented in the Geotechnical Report, the impacts related to compression and settlement of the soft Bay Mud would be reduced to an acceptable level.

Dewatering, if it is extensive, can result in subsidence, which occurs when the compaction of underlying soils results in a lowering of land surface. However, the amount of dewatering necessary for the proposed Project would not be great enough to result in subsidence.

Therefore, the impacts related to potential liquefaction, lateral spreading, soil compression, settlement, and subsidence because of dewatering in soil that is unstable or could become unstable because of

construction and operation of the Build Alternatives would be *less than significant*. No mitigation required.

Mitigation Measures

No mitigation required.

Be Located on Expansive Soil, as Defined in Table 18-1-B of the Uniform Building Code (1994), Creating Substantial Direct or Indirect Risks to Life or Property

Construction and Operation

Build Alternatives

As discussed under Expansive Soils and Weak Soils, subsurface soils encountered at the Project site have low to high expansion potential. Adherence to the design and construction recommendations provided in the Geotechnical Report for onsite expansive soils would reduce soil expansion hazard. Therefore, construction and operation of the Build Alternatives would not create a direct or indirect risk to life or property by being located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), and this impact would be *less than significant*. No mitigation required.

Mitigation Measures

No mitigation required.

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

Construction and Operation

Build Alternatives

The proposed Project would connect to the City of Larkspur's existing sewer, water, and power infrastructure to operate the Project facilities. The proposed Project would not use a septic tank or alternative water disposal system. Therefore, construction and operation of the Build Alternatives would have *no impact* regarding the support of septic tanks.

Mitigation Measures

No mitigation required.

Directly or Indirectly Destroy a Unique Paleontological Resource or Site or Unique Geologic Feature

Construction and Operation

Build Alternatives

Only construction activities associated with the Build Alternatives that have the potential to disturb native soils would have potential to disturb paleontological resources or geologic features. Construction would occur within the bedrock geologic unit (Franciscan Complex mélange) underlying the Project area. Excavation activities would be primarily limited to areas of fill within the top 10 feet of the surface. Additionally, either 90-foot-long 18x204 steel H-piles or 90-foot-long 36-inch concrete auger cast piles

would be installed for the foundation across the site, as discussed in Chapter 2. The underlying geologic unit is not known to have yielded significant fossils (UCMP 2026). Franciscan mélange is known to contain abundant microfossils (for example, *radiolaria* and *foraminifera*) and invertebrate fossils (for example, bivalves), but not vertebrates (UCMP 2026). Franciscan Complex mélange is thus considered to have low potential for paleontological resources (refer to Section 3.6.2.1, Methodology). Mélanges within the Franciscan Complex are known for their chaotic and disjointed structure and the typical assemblage of diverse rock types present at most locations. The chaotic assemblage is primarily the result of deformation, folding, breaking, and mixing of sometimes sedimentary deposits, associated with movement along faults (for example, at transform or overthrust boundaries). The nearby San Andreas Fault Zone is one of these. Because of this, rocks within the mélange zone near the Project area contain only a sparse assemblage of fossils, which include mostly microfossils and marine invertebrates. Vertebrate fossils are extremely rare. Based on this information, the likelihood of paleontological resources being present in the Project area is low and paleontological sensitivity is also considered low.

In addition, excavation would only occur within the Quaternary marsh deposits overlying the mélange in the Project area, which are most likely too young (that is, Holocene in age) to contain fossils; these deposits have low paleontological sensitivity as well.

Therefore, based on the anticipated subsurface site conditions and low sensitivity, soil disturbance associated with construction of the Build Alternatives would have ***no impact*** on unique paleontological resources, sites or geological features.

Mitigation Measures

No mitigation required.