# 4.7 Geology and Soils

This section describes the existing geological conditions of the project site and vicinity, identifies associated regulatory requirements, evaluates potential impacts, and identifies mitigation measures related to implementation of the proposed project. The analysis included in this section is based on the findings of the documents listed below, as well as publicly available information referenced throughout this section and provided in full in Section 4.8.8, References. Sources used for this section include the following:

- **Appendix E-1:** Preliminary Geotechnical Subsurface Evaluation, Residential Development, Gateway Village, Irvine, California; prepared by LGC Geotechnical Inc.; dated November 22, 2024
- **Appendix E-2:** Paleontological Resources Assessment, Irvine Gateway Village; prepared by Dudek; dated January 21, 2025

## 4.7.1 Existing Conditions

### 4.7.1.1 Geologic Setting

The project site is located along the southeastern margin of the Los Angeles Basin, a large structural depression within the Peninsular Ranges geomorphic province of California. The project site is specifically located in the easternmost portion of the Tustin Plain and is within the mouth of a tributary drainage of the San Diego Creek Watershed that reaches the ocean at Newport Bay (Appendix E-1, Preliminary Geotechnical Evaluation).

Locally, the project site is within the relatively narrow Hicks Canyon at the base of the foothills that support the Santa Ana Mountain Range to the northeast of the site. Bedrock hills to the north and south of the site generally consist of the bedrock units that form the foothills, the Tertiary Vaqueros and Sespe Formations. The project site is underlain by interfingered alluvial fan and alluvial deposits that thicken to the west where the neighborhoods located west of Portola Parkway were constructed on relatively low-relief terrain. To the east of the site, there are branches of smaller tributary drainages from the foothills, and a localized stream channel crosses the project site (Appendix E-1).

### 4.7.1.2 Soils and Geologic Formation

Generalized subsurface conditions at the project site are summarized in the sections below, from youngest to oldest, and are based on project-specific geotechnical soil borings, test pits, and surface geology observations (Appendix E-1). It should be noted that borings and exploratory test pits completed during the geotechnical study are only representative of the location and time where/when they were completed, and varying subsurface conditions may exist outside of the performed location. In addition, subsurface conditions can change over time. The soil descriptions provided should not be construed to mean that the subsurface profile is uniform, and that soil is homogeneous within the project area (Appendix E-1).

#### Artificial Fill

##### Undocumented Artificial Fill

Native on-site alluvial deposits are generally overlain by a thin veneer of older artificial fill and/or agricultural fill, which was found to range from approximately 1 to 7 feet below the existing grade (Figure 4.7-1, Geologic Map). Material was observed to be similar to the alluvium, generally consisting of brown, clayey to silty sand and sandy

silt. Areas of deeper undocumented artificial fills and possible refuse may be present due to previous filling of drainages for leveling the agricultural fields, such as for a reported buried high-line canal tunnel (not encountered during site investigations).

A stockpile located on the center-northern portion of the site consists of two lobes with irregular topography (Figure 4.7-1). Stockpiled soils were reportedly imported since 2018, from various locations in the Irvine Ranch. Material in the stockpile was observed to be a varied mix of soils, including loosely layered dark-brown, light reddish-brown, and orangish-brown sandy silt, silty sand, and clayey silt, with scattered fragments of construction debris and organics.

### Documented Artificial Fill

Approximate limits of older artificial fills placed under observation and testing by others were not encountered during the recent site investigation. However, approximate limits of older artificial fills related to the cut-and-fill grading of the Bee Canyon Access Road along the eastern boundary of the project site and Portola Parkway along the southern boundary of the project site; fills placed in preparation for the future Jeffrey Open Space Trail and Jeffrey Road; and the ascending slope in support of the large residential development to the north of Jeffrey Road are illustrated on Figure 4.7-1.

## Slopewash

Limited areas of material identified as slopewash were mapped by others as a relatively thin mantle of eroded material built up at the toe of bedrock slope areas around the eastern and northern perimeter of the project site (Figure 4.7-1). The slopewash has been described by others as a layer (or layers) of material similar to topsoil or colluvium that interfingers with the alluvium and is considered potentially compressible.

## Quaternary Alluvium

Based on regional mapping and observations of the project site, the site is generally underlain by Quaternary alluvial deposits (Figure 4.7-1). The alluvial deposits are described as Holocene to Late Pleistocene Epoch deposits predominantly consisting of brown, reddish-brown, and light-yellowish-brown sandy silt to silty sand, clayey sand, and silty to sandy clay, slightly moist to moist and loose to medium dense. Quaternary alluvium was observed by others in borings extending up to approximately 90 feet below the ground surface of the project site.

## Bedrock

A narrow zone of bedrock, partially covered with variable thicknesses of slopewash, is present along the eastern boundary of the site, along a relatively small slope ascending to the Bee Canyon Access Road that runs parallel to the eastern side of the project site (Figure 4.7-1). The large slope at the northernmost portion of the site is also a bedrock ridge with variable slopewash around the toe of slope. The Tertiary Vaqueros and Sespe Formation bedrock units, undifferentiated in some areas, are present on the slopes noted above and underlie the alluvial deposits at depth throughout the site.

The Vaqueros bedrock unit is described as a massive to thickly bedded marine sandstone and sandy siltstone unit, while the Sespe Formation is described as massive to thickly bedded, marine and non-marine, conglomeratic sandstone, clayey to silty sandstone of various colors. Areas of bedrock indicated to be Tertiary Vaqueros and Sespe, Undifferentiated, are labeled as both formations due to similarities and localized interfingering of the units. Geologic

bedding and structure of the bedrock formations were observed to be massive to thickly bedded, steeply north-dipping, gently folded, and tectonically sheared where observed in off-site borings by others. Where observed during a previous site investigation, the material was fractured and highly weathered clayey sandstone to sandy claystone, and was generally observed to be dipping moderately steeply to the northwest

### 4.7.1.3 Groundwater

Groundwater was not encountered within the maximum explored depth of 30 feet below the existing grade in the recent geotechnical investigation (Appendix E-1). During a previous geotechnical evaluation, groundwater was encountered at depths ranging from approximately 64 to 99 feet below the existing grade. Regional mapping indicates the historic high groundwater table at a depth ranging from 20 to 40 feet below the existing grade. Based on previous investigations by others and eventual removal of the crops and irrigation from the area, groundwater may currently be present at a deeper depth than previously described. In general, groundwater levels fluctuate with the seasons and local zones of perched groundwater may be present within the near-surface deposits due to local seepage or during rainy seasons. Groundwater conditions below the site may be variable, depending on numerous factors including seasonal rainfall, local irrigation, and groundwater pumping, among others (Appendix E-1).

### 4.7.1.4 Seismicity

#### Fault Rupture

Surface fault rupture is the displacement of ground surface that occurs along a fault line during an earthquake event. Based on criteria established by the California Geological Survey (CGS), faults are classified as either Holocene-active, pre-Holocene, or age-undetermined. Faults are considered active when they have shown evidence of movement within the past 11,700 years (i.e., Holocene epoch). Pre-Holocene faults, or potentially active faults, are those that have shown evidence of movement more than 11,700 years ago and generally before 1.6 million years ago (Quaternary age). Faults whose age of most recent movement is not known or is unconstrained by dating methods or by limitations in stratigraphic resolution are designated as age-undetermined and are considered inactive.

California's Alquist–Priolo Earthquake Fault Zoning Act of 1972 (formerly known as the Alquist–Priolo Special Studies Zones Act) established state policy to identify active faults and determine a boundary zone on either side of a known fault trace, called the Alquist–Priolo Earthquake Fault Zone. The delineated width of an Alquist–Priolo Earthquake Fault is based on the location, precision, complexity, or regional significance of the fault and can be between 200 and 500 feet in width on either side of the fault trace. If a site lies within a designated Alquist–Priolo Earthquake Fault Zone, before development permits may be issued a geologic fault rupture investigation must be performed to demonstrate that a proposed building site is not threatened by surface displacement from the fault.

No Holocene-active or pre-Holocene faults are known to exist within the project site or in the near vicinity, and the site is not located within an Alquist–Priolo Earthquake Fault Zone (CGS 2025). The possibility of fault rupture is considered low because no active faults are known to cross the project site (Appendix E-1). Holocene-active and pre-Holocene faults in the project site region are shown on Figure 4.7-2, Fault Map. Prominent faults in the vicinity of the site include the Whittier Fault, 12 miles to the north; the Elsinore Fault, approximately 13 miles to the northeast; and the Newport–Inglewood Fault, 15 miles to the southwest. The San Jacinto and San Andreas Faults are located approximately 38 miles and 46 miles northeast of the site, respectively (CGS 2025). In addition, the potentially active San Joaquin Hills Fault is a blind thrust fault that underlies the City of Irvine just north of the San Joaquin Hills and generally below the City Civic Center (City of Irvine 2024).

### Ground Shaking

Geologic conditions refer to the stability of the soil during an earthquake. For example, loose, unconsolidated, saturated soil is more prone to liquefaction during an earthquake than compacted soil or rock. Because the City is located within proximity to faults, the project site could be subject to significant ground shaking. Ground shaking is the effect of surface motion generated by an earthquake that results in the majority of damage during seismic events (City of Irvine 2020). Several factors control how ground motion interacts with structures, making the hazard of ground shaking difficult to predict. Seismic waves propagating through the Earth's crust are responsible for the ground vibrations normally felt during an earthquake. Structures throughout the City could be affected by ground shaking during a seismic event. The City's Local Hazard Mitigation Plan (LHMP) (City of Irvine 2020) includes a summary of the Uniform California Earthquake Rupture Forecast, Version 3 (USGS 2015), which includes an assessment of the probability of a major earthquake on various faults between 2014 to 2044. The San Joaquin Hills Fault, which underlies a portion of the City, has a 0.40% probability of a major earthquake (moment magnitude [$M_W$] 6.7+) occurring, while the Newport–Inglewood Fault, approximately 15 miles southwest of the project site, has a 0.95% probability of a large earthquake occurring. The San Jacinto and San Andreas Faults, 38 and 46 miles from the project site, respectively, have probabilities of $M_W$ 6.7+ earthquakes of 5% and 19%, respectively.

## 4.7.1.5 Liquefaction and Lateral Spreading

### Liquefaction

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave like a fluid when subject to high-intensity ground shaking. Liquefaction occurs when three general conditions coexist: (1) shallow groundwater; (2) low-density, noncohesive (granular) soils; and (3) high-intensity ground motion. Studies indicate that loose, saturated, near-surface, cohesionless soils exhibit the highest liquefaction potential, while dry, dense, cohesionless soils and cohesive soils exhibit low to negligible liquefaction potential. In general, cohesive soils are not considered susceptible to liquefaction. Effects of liquefaction on level ground include settlement, sand boils, and bearing capacity failures below structures. Furthermore, dynamic settlement of dry sands can occur as the sand particles tend to settle and densify as a result of a seismic event.

Based on regional mapping by CGS (2025), the northern portion of the project site is an area of potential liquefaction. However, soils present at the project site are not generally susceptible to liquefaction due to a lack of groundwater in the upper 50 feet. Isolated layers may be susceptible to dry sand seismic settlement (Appendix E-1).

### Lateral Spreading

Lateral spreading is a type of liquefaction-induced ground failure associated with the lateral displacement of surficial blocks of sediment resulting from liquefaction in a subsurface layer. Once liquefaction transforms the subsurface layer into a fluid mass, gravity plus the earthquake's inertial forces may cause the mass to move downslope toward a free face (such as a river channel or an embankment). Lateral spreading may cause large horizontal displacements, and such movement typically damages pipelines, utilities, bridges, and structures. Due to the low liquefaction potential and lack of a free face, the potential for lateral spreading on the project site is considered very low (Appendix E-1).

#### 4.7.1.6 Landslides

Landslides, slope failures, and mudflows of earth materials generally occur where slopes are steep and/or the earth materials are weak. Earthquake-induced landslides may also occur due to seismic ground shaking. Based on the project-specific geotechnical report (Appendix E-1), the geologic bedding and structure of the bedrock formations were observed to be massive to thickly bedded and steeply north-dipping. Based on regional mapping by CGS, the project site is not located in an area of potential seismically induced landslides (CGS 2025). However, based on regional mapping in the City LHMP (City of Irvine 2020) and City General Plan Safety Element (City of Irvine 2024), small portions of the project site along the northern, western, and eastern boundary consist of areas of deep-seated landslide susceptibility.

#### 4.7.1.7 Expansive Soils

Expansive soils include clay minerals characterized by their ability to undergo significant volume change (shrink or swell) due to variation in moisture content over time. Sandy soils are generally not expansive, while clayey soils generally are expansive. Changes in soil moisture content can result from rainfall, irrigation, pipeline leakage, perched groundwater, drought, or other factors. Cyclical volumetric change of expansive soils may cause excessive cracking and heaving of structures with shallow foundations, concrete slabs-on-grade, or pavements supported on these materials. Based on observations made during the geotechnical investigation, finished grade soils are anticipated to have a very low to medium expansion potential (Appendix E-1).

### 4.7.2 Relevant Plans, Policies, and Ordinances

#### Federal

##### OSHA Excavation and Trenching Standard, Title 29

Excavation and trenching are among the most hazardous construction activities. The federal Occupational Safety and Health Administration (OSHA) Excavation and Trenching standard, Title 29 of the Code of Federal Regulations, Part 1926.650 et seq., covers requirements for excavation and trenching operations. OSHA requires that excavations in which employees could potentially be exposed to cave-ins be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area.

#### State

##### California Building Standards Code (Title 24)

The California Building Standards Code, commonly referred to as the California Building Code (CBC), has been codified in the California Code of Regulations as Title 24, Part 2. Title 24 is administered by the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building standards must be centralized in Title 24 to be enforceable. The purpose of the CBC is to establish minimum standards to safeguard public health, safety, and general welfare through structural strength, means of egress facilities, and general stability by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within its jurisdiction.

The 2022 edition of the CBC is based on the 2021 International Building Code published by the International Code Conference. The 2022 CBC contains California amendments based on the American Society of Civil Engineers Minimum Design Standards 7-16, which provides requirements for general structural design and includes means for determining earthquake loads and other loads (such as wind loads) for inclusion in building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure, or any appurtenances connected or attached to such buildings or structures, throughout California.

The CBC uses data on frequency of earthquakes, as well as locations of fault zones, to set forth requirements for new developments to be prepared for earthquake events. The earthquake design requirements also consider the occupancy category of the structure, site class, soil classifications, and various other seismic coefficients, which are used to determine a Seismic Design Category (SDC) for a project. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to SDC E/F (very high seismic vulnerability and near a major fault). Design specifications are then determined according to the SDC.

### Alquist–Priolo Earthquake Fault Zoning Act

The Alquist–Priolo Earthquake Fault Zoning Act was established to mitigate the hazard of surface faulting to structures for human occupancy. Pursuant to the act, the state geologist has established regulatory zones (known as earthquake fault zones) around surface traces of active faults. Application for a development permit for any project within a delineated earthquake fault zone shall be accompanied by a geologic report, prepared by a geologist registered in the state of California, that is directed to the problem of potential surface fault displacement through a project site.

### Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (SHMA) was adopted in 1990 to protect the public from the effects of non-surface fault rupture earthquake hazards, including strong ground shaking, liquefaction, seismically induced landslides, and ground amplification or other ground failure caused by earthquakes. The goal of the act is to minimize loss of life and property by identifying and mitigating seismic hazards. CGS is the primary agency responsible for the implementation of SHMA. CGS prepares maps identifying seismic hazard zones and provides them to local governments. The maps include areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures. SHMA requires responsible agencies to approve projects within these zones only after a site-specific investigation has been performed to determine whether the hazard is present, and if so, to include appropriate mitigation. In addition, SHMA requires real estate sellers and agents at the time of sale to disclose whether a property is within one of the designated seismic hazard zones.

### California Public Resources Code Section 5097.5(a)

According to the provisions of Section 5097.5(a) of the California Public Resources Code, no person shall knowingly and willfully excavate upon, or remove, destroy, injure, or deface, any historic or prehistoric ruins, burial grounds, or archaeological or vertebrate paleontological site, including fossilized footprints, inscriptions made by human agency, rock art, or any other archaeological, paleontological, or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over the lands.

## Local

### Irvine 2045 General Plan

#### Safety Element

The following goal, objective, and policies from the Safety Element of the 2045 General Plan (City of Irvine 2024a) are relevant to the proposed project:

Goal 2: Improve the community's resilience to seismic and geologic hazards by ensuring the integrity of the built environment.

Objective S-2: Seismic and Geologic Hazards

Policy (a): Coordinate with Irvine Ranch Water District and Orange County Water District on emergency water storage and distribution following a liquefaction or landslide event.

Policy (b): Coordinate groundwater management with Orange County Water District to avoid subsidence impacts in Irvine.

Policy (c): Promote the strengthening of planned utilities, the retrofit and rehabilitation of existing weak structures and lifeline utilities, and the relocation or strengthening of certain critical facilities to increase public safety and minimize potential damage from seismic and geologic hazards.

Policy (d): Encourage replanting bare or disturbed areas after landslides to reduce erosion.

#### Conservation and Open Space Element

The following goals, objectives, and policies from the Conservation and Open Space Element of the 2045 General Plan (City of Irvine 2024b) are relevant to the proposed project:

Goal 3: Use and preserve geophysical resources, including, but not limited to, ridgelines, hillsides, and waterways, as part of the City's land use pattern.

Objective COS-3: Effectively utilize and safeguard geophysical resources, encompassing ridgelines, hillsides, and waterways, within the City's land use framework to maintain ecological integrity, enhance aesthetic value, and promote sustainable development practices that harmonize with the natural landscape.

Policy (i): Minimize the danger to life and property from geophysical hazards, including, but not limited to, unstable soils, liquefaction, steep slopes, and floodways.

Goal 4: Use and maintain societal resources, including but not limited to, archaeological, historical, and paleontological resources, as a part of the City's land use pattern.

Objective COS-4: To effectively utilize and preserve societal resources, encompassing archaeological, historical, and paleontological assets, within the City's land use framework, ensuring their integration and maintenance in alignment with conservation and open space goals.

Policy (a): Continue to coordinate General Plan level resource information to determine the level and type of resource(s) potentially impacted by proposed development.

### Municipal Code

#### Title 5 (Planning), Division 9 (Building Regulations)

The City's Building Code Regulations are included in Division 9 of the City's Municipal Code, as adopted under Section 5-9-101 (Adoption of Building Code). Division 9 adopted by reference the most recent version of the CBC.

#### Title 5 (Planning), Division 10 (Grading Code and Encroachment Regulations), Chapter 1 (Grading Code)

The City's Grading Code establishes rules and regulations to control excavation, grading, and earthwork construction (including fills and embankments), and establishes administrative requirements for issuance of permits, approval of plans, and inspection of grading construction in accordance with the requirements for grading and excavation contained in the Uniform Building Code as adopted and modified by City ordinance. The Grading Code also contains water quality requirements.

### Grading Manual

The City's Grading Manual is a compilation of rules, procedures, and interpretations necessary to carry out the provisions of the City's Grading Code. The purpose of the Grading Manual is to assist users of the Grading Code by supplementing it with detailed information regarding rules, interpretations, standard specifications, procedures, requirements, forms, and other information applicable to control excavation, grading, and earthwork construction in the City. The Grading Manual also contains guidelines for the preparation of geotechnical and geology reports, slope stability analysis and erosion control plans. The geotechnical and geology reports, slope stability analysis, and erosion control plan are required to be submitted as part of the grading plan and are reviewed and approved by the Building & Safety Division of the Community Development Department.

## 4.7.3 Thresholds of Significance

The significance criteria used to evaluate the project's impacts to geology and soils are based on Appendix G of the California Environmental Quality Act (CEQA) Guidelines. According to Appendix G, a significant impact related to geology and soils would occur if the project would:

1. Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:
    a. 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 as known fault. Refer to Division of Mines and Geology Special Publication 42.
    b. Strong seismic ground shaking.
    c. Seismic-related ground failure, including liquefaction.
    d. Landslides.

2. Result in substantial soil erosion or the loss of topsoil.
3. 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- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
4. 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.
5. Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.
6. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

## 4.7.4 Impacts Analysis

***1. Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:***

***a. 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.***

No Impact. As detailed in Section 4.7.1, Existing Conditions, the project site is in a seismically active region with numerous Holocene-active faults. However, no Alquist–Priolo Earthquake Fault Zones are located within or immediately adjacent to the project site. As such, no impacts would occur with respect to surface fault rupture.

***b. Strong seismic ground shaking?***

Less-Than-Significant Impact. As mentioned in Section 4.7.4(1)(a), the project site is in an area of high seismic activity. According to the U.S. Geological Survey, there is a 93% chance of a $M_W$ 6.7 or greater earthquake occurring in the Southern California region by 2045 (USGS 2015). If not designed appropriately, the proposed project could be subject to substantive damage and risk injury or death of occupants due to ground shaking from one of these regional faults. The amount of ground shaking would depend on a number of different factors, including the magnitude of the event, the distance to the source, the depth of displacement, the duration of shaking, and the characteristics of the underlying materials. According to the project-specific geotechnical investigation (Appendix E-1), the peak ground acceleration was estimated at 0.592 g (percent of gravity), which could cause damage if the project were not designed in accordance with seismic design requirements.

The proposed project would be required to comply with the current CBC and local amendments, which includes requirements to ensure that new development is designed to include seismic safety measures. The 2022 CBC design parameters are specifically tailored to minimize the risk of structure failure due to seismic hazards and include a requirement for a standard, project-specific geotechnical report (also known as a soils investigation report) as part of the building permit process (CBC Chapters 18 and 18A). A preliminary project-specific geotechnical report was prepared for the project site and is included as Appendix E-1 of this Draft EIR. In accordance with the CBC, this geotechnical report provides specific recommendations related to soils and seismic engineering, including recommendations for remedial grading, foundation design, and retaining walls, thus minimizing the potential for structural distress from seismically induced ground shaking.

The CBC requires compliance with these recommendations, thus minimizing the potential for structural damage during an earthquake. As with all development in the City, the City's plan check and building inspection procedures would ensure that the proposed project is constructed in accordance with CBC standards, including the seismic design recommendations provided in a final-design-level geotechnical report that must be included in the final design plans of construction.

The project would be designed in a manner consistent with applicable CBC regulations and local amendments with respect to seismic engineering and would therefore be considered seismically safe. Constructing new structures within an earthquake-prone area would not, in and of itself, increase seismic risks in the project area. Therefore, development of the proposed project would not directly or indirectly cause or exacerbate adverse effects involving strong seismic ground shaking. Impacts would be less than significant.

***c. Seismic-related ground failure, including liquefaction?***

Less-Than-Significant Impact. Liquefaction is a geotechnical hazard that occurs when loose, unconsolidated saturated soils are subjected to ground shaking, causing the pore pressure to exceed frictional forces and resulting in the soil units behaving more like a liquid than a solid. Liquefaction hazards are generally considered to be highest in susceptible soils within 50 feet of the ground surface. If susceptible soils are present, liquefaction can cause substantive damage. Based on mapping by CGS (2025), the northern portion of the site is an area of potential liquefaction. However, based on the project geotechnical report (Appendix E-1), soils present at the project site are not generally susceptible to liquefaction due to a lack of groundwater in the upper 50 feet. Isolated layers may be susceptible to dry sand seismic settlement. Nonetheless, all the proposed improvements that would be associated with the project would be required to comply with the current version of the CBC, along with local applicable amendments that include requirements for addressing liquefaction hazards, as appropriate. These requirements include incorporation of recommendations from a final-design-level project-specific geotechnical report, which would evaluate the potential for liquefaction and provide recommendations to incorporate design measures such as site preparations and foundation design measures to minimize the potential for structural damage caused by seismic-related ground failure such as liquefaction. Furthermore, development of the proposed project would not directly or indirectly cause or exacerbate adverse effects involving seismic-related ground failure, including liquefaction. Therefore, impacts would be less than significant.

***d. Landslides?***

Less-Than-Significant Impact. According to the 2045 Irvine General Plan Safety Element (City of Irvine 2024a) and the City LHMP (City of Irvine 2020), a small portion of the project site along the northern, western, and eastern boundary consists of areas of deep-seated landslide susceptibility (Figure 4.7-3, Deep-Seated Landslide Susceptibility Map). However, these areas are designated as having a moderately low risk of landslides due to seismic conditions and a low likelihood of a landslide under other conditions (City of Irvine 2024a). Geologic bedding and structure of the bedrock formations on site were observed in the geotechnical investigation to be massive to thickly bedded and steeply north-dipping. Steeply dipping bedding on gentle to moderate slopes is generally not susceptible to deep-seated landslides due to an absence of unsupported bedding.

The project-specific geotechnical report, dated November 22, 2024 (Appendix E-1), was completed in the absence of a tentative tract map (i.e., preliminary grading plans). The geotechnical report indicated that the existing slopes in the northern and eastern portions of the project site would not be disturbed during grading and would be outside the limits of the proposed development. The report indicated that any proposed slopes included in the final design should be evaluated. The geotechnical report also indicated that, pending final design grades, stabilization fill keyways may be recommended for the design cut slopes where bedrock is exposed within the small ascending slope along the eastern site boundary and within the prominent ridgeline at the northern boundary. Additionally, areas of bedrock exposed at design cut pad grade are recommended to be overexcavated a minimum of 5 feet below design grade. These recommendations would be refined in a forthcoming grading plan review report.

Based on a review of Vesting Tentative Tract Map 19352 (Fuscoe Engineering 2024), dated November 27, 2024 (after issuance of the geotechnical report), grading would result in engineered slopes of up to 30 feet above the existing grade along the eastern project boundary and up to 10 feet above the existing grade along the northern boundary. The preliminary geotechnical recommendations described above would tentatively be followed during project grading. However, as stated in the geotechnical report, the final project design would be further evaluated with respect to slope stability and recommendations would be included in the final design geotechnical report. Such recommendations for these slopes are standard geotechnical engineering practice and it can reasonably be assumed that no unmitigable slope-stability impacts would remain, pending additional slope stability analysis and associated geotechnical engineering.

In addition, the proposed improvements would include drainage control features in accordance with local drainage control requirements, which would also reduce the potential for adverse effects related to debris flows. Therefore, based on the recommendations of the geotechnical investigation, which would include standard geotechnical engineering for on-site slopes, the potential for earthquake-induced landslides or other types of slope failures would be less than significant.

### *2. Would the project result in substantial soil erosion or the loss of topsoil?*

Less-Than-Significant Impact. Project construction would include demolition of existing farm-related structures, utilities, septic/leach field systems, and an underground drainage tunnel; substantial grading and earthwork activities; and new residential construction. Each of these activities could expose soils to the effects of wind and water erosion if not managed appropriately. However, the project applicant would be required to comply with South Coast Air Quality Management District Rule 403, Fugitive Dust, to minimize wind erosion at the site. Because project construction would involve ground disturbance in excess of 1 acre, a stormwater pollution prevention plan (SWPPP) would be implemented in accordance with the National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order WQ 2022-0057-DWQ), effective September 1, 2023 (i.e., the Construction General Permit). The site-specific SWPPP would be prepared prior to earthwork activities and would be implemented during project grading and construction. The SWPPP would include best management practices (BMPs) and erosion control measures to prevent pollution in stormwater discharge, including erosion-induced siltation.

Typical BMPs that could be used during construction include erosion/sediment control measures such as silt fences, fiber rolls, gravel bags, stormwater inlet protection, soil stabilization measures, and street sweeping. The SWPPP would be subject to review and approval by the City. Additionally, all project

construction activities would be required to comply with the City's Grading Code and Grading Manual, which require the implementation of grading, dust, and erosion control measures, including an erosion control plan approved by the Chief Building Official, as well as inspections to ensure that sedimentation and erosion are minimized.

Through compliance with these existing regulations, the proposed project would not result in significant impacts related to soil erosion during the construction phase. Additionally, after project completion, most of the project site would be developed with impervious surfaces and landscaping, and all stormwater flows would be directed to storm drain features, which would reduce the potential for erosion. Therefore, project impacts related to soil erosion or the loss of topsoil would be less than significant.

*3. Would the project 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- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?*

Less-Than-Significant Impact. The project site is underlain by alluvial deposits, artificial fill, some minor areas of slopewash, and bedrock. If not addressed appropriately, areas of the site may not adequately support the proposed improvements. However, the project site was evaluated in a site-specific preliminary geotechnical investigation (Appendix E-1) that considered the breadth of geotechnical hazards present, including characteristics of underlying materials; topography; and potential for liquefaction, lateral spreading, subsidence, and collapse. The on-site soils are generally considered suitable for use as general compacted fill, provided they are screened for significant organic materials, construction debris, and any oversized material.

Proposed design soil cuts would be up to approximately 30 feet below the existing grade within the on-site stockpile, and design fills up to 11 feet above the existing grade or more would occur in the current detention basin at the southeast corner of the site. However, the majority of the site has proposed cuts/fills of approximately 5 feet below/above the existing grade (Appendix E-1). The on-site soil would be temporarily removed, screened, and recompacted to a minimum depth ranging from approximately 5 feet below the existing grade to 12 feet below the existing grade, or 3 feet below the bottom of proposed foundations, whichever is deeper. Import soils for general fill (i.e., non-retaining-wall backfill) would consist of clean, granular soils of low expansion potential (expansion index of 50 or less). The potential for seismic-related ground failure, including liquefaction, is discussed in Section 4.7.4(1)(c) and the hazard has been determined to be low at the project site. Therefore, lateral spreading, which is related to liquefaction, would also not be a hazard present at the site.

The City's LHMP and General Plan Safety Element identified that the most likely locations for subsidence are the low-lying areas overlying the Orange County Groundwater Basin, which includes the project site. The City does not have a history of seismically induced subsidence. Although there is evidence of subsidence due to excessive groundwater pumping in the first half of the twentieth century, prior to imported surface water, currently it is estimated that the greater Los Angeles Basin, which includes Orange County, experiences approximately 20 millimeters (0.8 inches) of net subsidence annually due to groundwater pumping and artificial recharge (City of Irvine 2020, 2024a). As discussed in more detail in Section 4.10, Hydrology and Water Quality, of this Draft EIR, the Irvine Sub-basin of the Orange County Groundwater Basin, which underlies the project site, is considered a high-priority basin with respect to the Sustainable Groundwater Management Act (DWR 2020). As a result, the groundwater basin is managed under a groundwater sustainability plan, which regulates groundwater pumping in the basin, thus minimizing the potential for ground subsidence. Subsidence due to earthwork equipment is expected to be 0.1 feet (Appendix E-1).

Soils that are typically susceptible to hydrocollapse (or collapsible soils) are predominantly sand and silt held in a loose honeycomb structure. This relatively loose honeycomb structure is held together by small amounts of clay or calcium carbonate acting as a temporary (soluble) cementing agent. If the soil remains dry the soil maintains its structure; however, the addition of water to the soil will greatly weaken the honeycomb structure and the soil can subsequently experience immediate collapse. This collapse results in rapid soil settlement and potential damage to any improvements that are located within the zone of influence of the collapsible soils. The measured collapse potential of the soils on the project site ranged from approximately 0.06% to 0.36%, which is considered to be low and not a significant issue (Appendix E-1). The geotechnical evaluation for the project also determined that with implementation of site preparations, including earthwork and recompaction of loose soils consistent with building code requirements, the potential for subsidence would be reduced to less-than-significant levels (Appendix E-1). Furthermore, development of the proposed project would not directly or indirectly cause or exacerbate any adverse effects involving these seismic-related hazards.

The proposed improvements would be required to comply with the most current CBC and applicable local amendments, which includes requirements to ensure that new development would not cause or exacerbate geological and soil hazards, including unstable soils and collapsible soils (e.g., by ensuring that underlying materials can adequately support the loadings [i.e., weight] of new structures). These requirements include incorporation of recommendations from a final-design-level project-specific geotechnical report, which would include recommendations for grading, treatment of soils, engineered fills, foundation design, and retaining walls, if warranted. Adherence to building code requirements would also ensure that all proposed improvements associated with the project are evaluated for potential unstable soils and that recommendations for site preparations (e.g., soil compaction) and/or building foundation designs to minimize the potential for settlement are incorporated into final project design plans. Compliance with these recommendations would minimize the potential for structural damage associated with potentially unstable soils. In addition, project development would not create unstable conditions related to unstable soils. Therefore, impacts would be less than significant.

***4. Would the project 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?***

Less-Than-Significant Impact. Expansive soils, if present, can adversely affect improvements over time through cyclical volumetric changes. These volumetric changes include shrinking during drying and swelling during the rainy winter season, or when irrigation is resumed, which can crack foundations, pathways, and other improvements. According to the 2020 LHMP for the City of Irvine, expansive soils are present in the City. However, the City requires compliance with the CBC, which is intended to mitigate hazards associated with this condition (City of Irvine 2020). Based on the results of the preliminary geotechnical investigation and previous evaluations from nearby sites (Appendix E-1), finished grade soils are anticipated to have a very low to medium expansion potential. Based on this soil classification, the geotechnical report preliminarily recommends post-tensioned concrete foundation design, which is common for expansive soils.

As part of adherence to current building code requirements, prior to approval of a building permit the project applicant would be required to prepare a final-design-level geotechnical report that would include an evaluation for the presence of expansive soils at the completion of grading. Recommendations from this final-design-level geotechnical report would include measures to address expansive soils, as appropriate, which could include treatment of soils, engineered fills, and foundation design parameters. Therefore, with adherence to current building code requirements, the potential impact related to expansive soils would be less than significant.

*5. Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?*

No Impact. The project would not include septic tanks or alternative wastewater disposal systems. The project would be connected to the City's wastewater disposal and treatment system. As a result, there would be no impact related to this threshold.

*6. Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?*

Less-Than-Significant Impact with Mitigation Incorporated. No paleontological resources were identified within the project site as a result of the institutional records search or desktop geological and paleontological review (Appendix E-2, Paleontological Resources Assessment). In addition, the project site is not anticipated to be underlain by unique geologic features. Portions of the project site underlain by Early Holocene to Late Pleistocene young alluvial fan deposits have high paleontological sensitivity (sensitivity increases with depth), and the Early Miocene to Late Eocene Sespe and Vaqueros Formations have high paleontological sensitivity. Ground-disturbing activities associated with construction of the proposed project, such as grading during site preparation and trenching for utilities, have the potential to destroy a unique paleontological resource or site. As such, the project site is considered to be potentially sensitive for paleontological resources. Without mitigation, the potential for adverse impacts to paleontological resources during construction associated with the project would be significant. Given the proximity of past fossil discoveries in the surrounding area in the same or similar deposits, the project site is highly sensitive for supporting paleontological resources below the depth of fill. However, upon implementation of Mitigation Measure (MM) GEO-1 (Paleontological Resources Impact Mitigation Program), impacts would be reduced to below a level of significance. Impacts of the proposed project would be considered less than significant with mitigation incorporated during construction.

## Impact Summary

While the project site is in an area of seismic activity, there are no known fault lines that cross the site or are near the site. The proposed project would be required to comply with the current CBC and local amendments, which include requirements to ensure that new development is designed to include seismic safety measures. The project site was evaluated in a site-specific preliminary geotechnical investigation that considered the breadth of geotechnical hazards present, including characteristics of underlying materials; topography; and potential for liquefaction, lateral spreading, subsidence, landslides, and collapse. The on-site soils are generally considered suitable for use as general compacted fill, provided they are screened for significant organic materials, construction debris, and any oversized material. Therefore, all impacts relating to these geotechnical hazards would be less than significant or would not occur.

Portions of the project site are underlain by deposits that have high paleontological sensitivity, which increases with depth. Ground-disturbing activities associated with construction have the potential to destroy a unique paleontological resource or site. Therefore, impacts related to project destruction of a unique paleontological resource or site or geologic feature would be significant, absent mitigation.

## 4.7.5 Mitigation Measures

Implementation of the following mitigation measure would reduce impacts related to destruction of a unique paleontological resource or site or unique geologic feature:

MM-GEO-1 Paleontological Resources Impact Mitigation Program. Prior to commencement of any grading activity on site, the applicant shall retain a qualified paleontologist per the 2010 Society of Vertebrate Paleontology guidelines. The paleontologist shall prepare a Paleontological Resources Impact Mitigation Program for the Project. The Paleontological Resources Impact Mitigation Program shall be consistent with the 2010 Society of Vertebrate Paleontology guidelines and shall outline requirements for preconstruction meeting attendance and worker environmental awareness training, where monitoring is required within the proposed project site based on construction plans and/or geotechnical reports, procedures for adequate paleontological monitoring and discoveries treatment, and paleontological methods (including sediment sampling for microvertebrate fossils), reporting, and collections management. The qualified paleontologist shall attend the pre-construction meeting and a qualified paleontological monitor, per the 2010 Society of Vertebrate Paleontology guidelines, shall be on site during all rough grading and other significant ground-disturbing activities (including augering) in previously undisturbed, fine-grained Pleistocene alluvial deposits. In the event that paleontological resources (e.g., fossils) are unearthed during grading, the paleontological monitor will temporarily halt and/or divert grading activity to allow recovery of paleontological resources. The area of discovery will be roped off with a 50-foot-radius buffer. Once documentation and collection of the find is completed, the paleontological monitor will remove the rope and allow grading to recommence in the area of the find.

## 4.7.6 Level of Significance After Mitigation

Impacts related to destruction of a unique paleontological resource or site or unique geologic feature would be addressed by implementation of MM-GEO-1, which would reduce impacts to a less-than-significant level.

## 4.7.7 Cumulative Impacts

Cumulative projects listed in Table 3-1 in Chapter 3, Project Description, of this Draft EIR would be subject to relatively similar seismic hazards as that of the proposed project. However, the effects of these projects would not cause cumulatively significant effects from geologic impacts or on soils because such impacts are site specific, are expected to be mitigated on a site-specific basis through the CEQA documentation prepared for those projects, and would only have the potential to combine with impacts of the project if they occurred in the same location as the project.

Development of the project would not be subject to fault rupture hazards because it is not located within an Alquist–Priolo Fault Hazard Zone and thus would not result in an impact related to exposing persons or structures to adverse effects. Fault rupture hazards are entirely dependent on site location. Therefore, because the project site is not located within an Alquist–Priolo Fault Hazard Zone, it could not combine with other cumulative projects to become cumulatively considerable and no cumulative impact would occur.

Development of the project, with implementation of the regulatory requirements discussed in Section 4.7.4, Impacts Analysis, would result in less-than-significant impacts related to exposing persons or structures to strong seismic ground shaking. As stated in Section 4.7.4, the entire region is a seismically active area where conditions vary widely within a short distance, making the cumulative context for potential impacts resulting from ground shaking hazards more localized, or even site specific. Like the proposed project, other projects in the area would be required to adhere to the CBC, which would reduce the risk to people and property from ground shaking hazards to less-than-significant levels. While future seismic events cannot be predicted, adherence to all federal, state, and local programs, requirements, and policies pertaining to building safety and construction would limit the potential for cumulative impacts related to injury or damage to a less-than-significant level.

Development of the project, with implementation of the regulatory requirements discussed above, would result in less-than-significant impacts related to exposing persons or structures to seismic hazards, including ground failure and liquefaction. Although the entire region is a seismically active area, geologic and soil conditions vary widely within a short distance, making the cumulative context for potential impacts resulting from exposing people and structures to related risks more localized, or even site-specific. Like the proposed project, other projects in the area would be required to adhere to the CBC, which would reduce the risk to people and property from any localized hazards such as ground failure and liquefaction to less-than-significant levels. While future seismic events cannot be predicted, adherence to all federal, state, and local programs, requirements, and policies pertaining to building safety and construction would limit the potential for cumulative impacts related to injury or damage from seismic-related ground failure and liquefaction to a less-than-significant level.

With implementation of the regulatory requirements, the project would result in less-than-significant impacts related to exposing persons or structures to adverse effects due to landslides. Cumulative projects all have varying underlying soil conditions, and hazards associated with landslides are generally site specific. All projects, including the proposed project, would be required to adhere to the CBC, which would reduce the risk to people and property from localized hazards such as landslides to a less-than-significant level for each cumulative project such that cumulative effects would be less than significant.

With implementation of the regulatory requirements, including grading, dust, and erosion control measures, ground-disturbing activities would have a less-than-significant impact related to erosion and loss of topsoil. Although each cumulative project's soil disturbance could result in off-site water and wind erosion, each project has undergone or would undergo an environmental review under CEQA, as well as being subject to existing regulatory requirements. As a result, each cumulative project would be required to abide by existing regulations such that it would have an erosion control plan, drainage plan, and SWPPP that would reduce wind and water erosion and prevent dust and soil from leaving the site. Therefore, because the BMPs that would be included in the SWPPP would minimize the potential for wind and water erosion and prevent any substantive off-site transport, the proposed project would not result in a cumulatively considerable contribution to this impact.

With implementation of the regulatory requirements, the proposed project would result in less-than-significant impacts related to exposing persons or structures to adverse effects due to unstable soils such as landslides, lateral spreading, subsidence, liquefaction, or collapse. Cumulative projects all have varying underlying soil conditions, and hazards associated with unstable soils, such as landslides, lateral spreading, subsidence, liquefaction, or collapse, are generally site specific. All projects, including the proposed project, would be required to adhere to CBC, which would reduce the risk to people and property from localized hazards such as landslides, lateral spreading, subsidence, liquefaction, or collapse to a less-than-significant level for each cumulative project such that cumulative effects would be less than significant.

Through adherence to geotechnical recommendations provided by a licensed geotechnical engineer, the project would have less-than-significant impacts related to expansive soils. As with the other geologic hazards such as subsidence, collapse, and liquefaction, the hazards related to expansive soils are entirely dependent on site-specific conditions. Like the proposed project, each cumulative project would be required to adhere to current CBC requirements, which would reduce the potential for adverse effects occurring from any presence of expansive soils. Therefore, the proposed project would not have a cumulatively considerable contribution to this impact and cumulative impacts would be considered less than significant.

The proposed project would not include septic tanks or alternative wastewater disposal systems. As a result, there would be no cumulative impact related to this threshold. The ability of soils to adequately support the construction and installation of subsurface sewage disposal or septic systems is also site specific. Other projects in the area would also be required to adhere to all County Public Health Code requirements related to septic or other alternative wastewater disposal systems. Therefore, the project would not result in a cumulatively considerable contribution to this impact.

The proposed project would have the potential to indirectly destroy a unique paleontological resource or site or unique geologic feature during ground-disturbing activities. Potential cumulative impacts to paleontological resources would result from projects that combine to create an environment where fossils exposed on the surface are vulnerable to destruction by earthmoving equipment, looting by the public, and natural causes such as weathering and erosion. The majority of impacts to paleontological resources are site specific and are therefore generally mitigated on a project-by-project basis. Cumulative projects would be required to assess impacts to paleontological resources through the environmental review (CEQA) process. Additionally, as needed, projects would incorporate individual mitigation for site-specific geological units present on each individual project site. Furthermore, the proposed project does not include construction (including grading/excavation) or design features that could directly or indirectly contribute to an increase in a cumulative impact to paleontological resources, because the implementation of MM-GEO-1 (Paleontological Resources Impact Mitigation Program) would ensure that any significant paleontological resources uncovered during project excavations would be properly analyzed and salvaged by the on-site paleontological monitor. Therefore, the project would result in less-than-cumulatively considerable impacts to paleontological resources.

## 4.7.8 References

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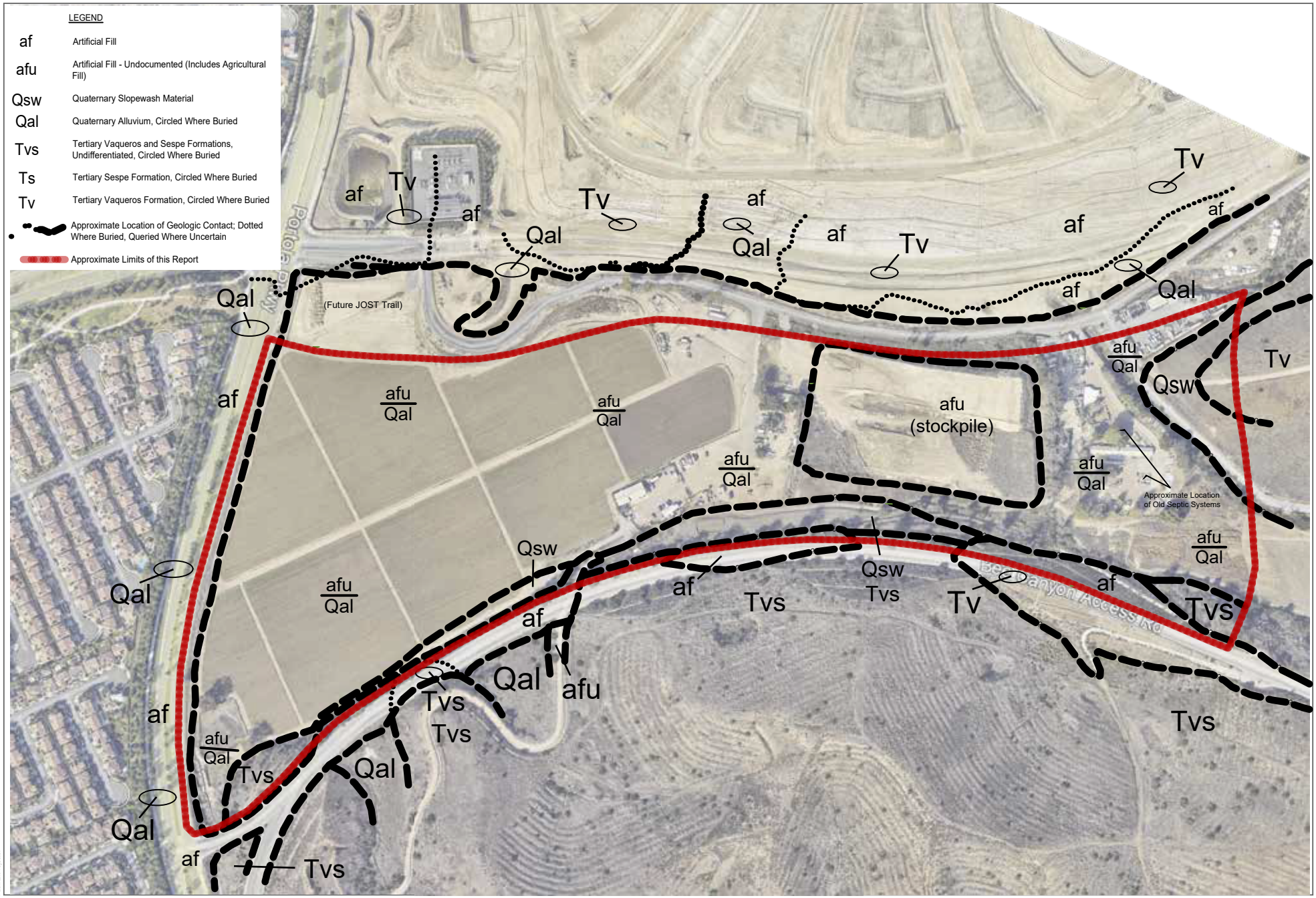


SOURCE: LGC Geotechnical, Inc 2024

**FIGURE 4.7-1**

Geologic Map

Irvine Gateway Village Project EIR

DUDEK

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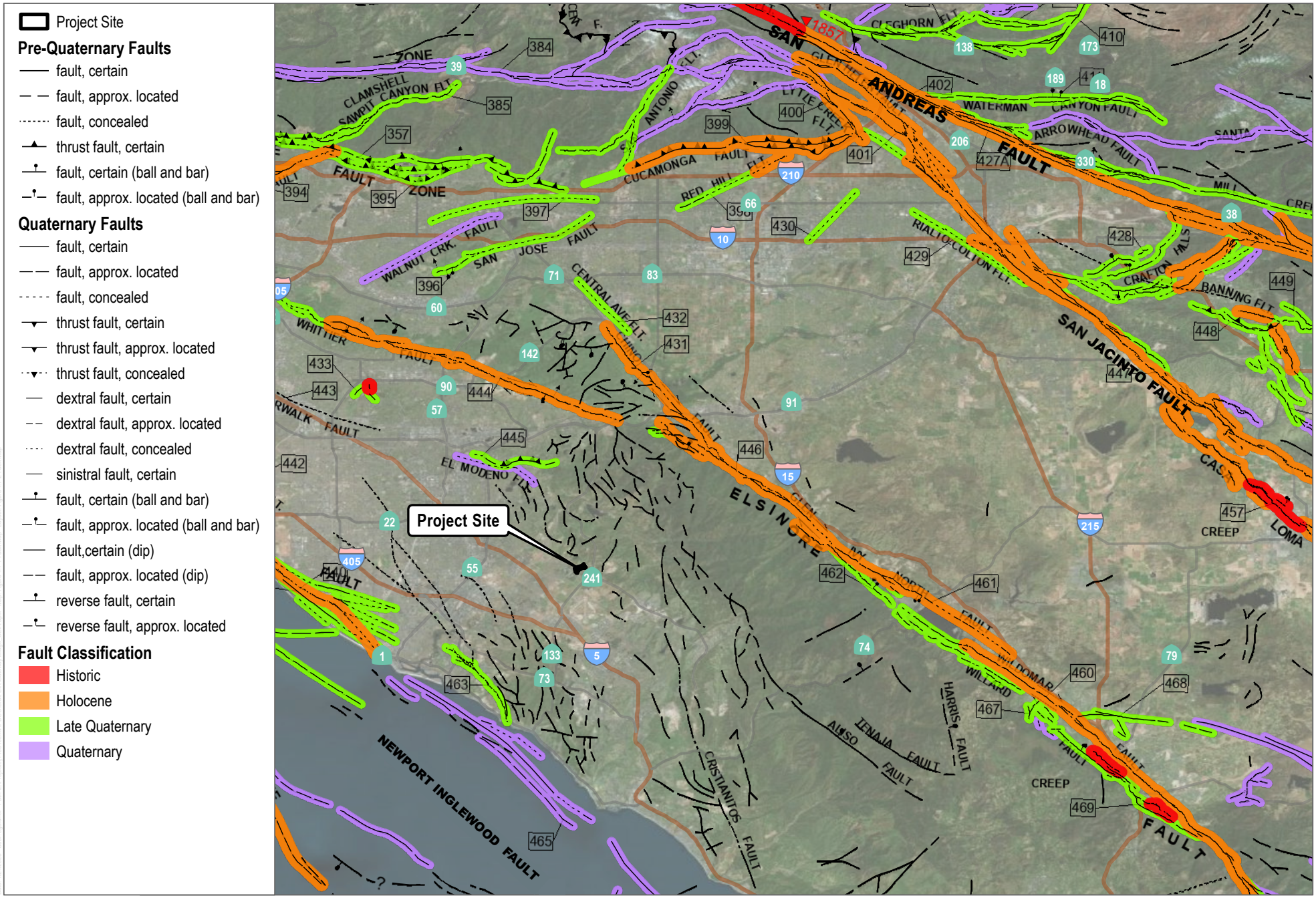


SOURCE: Bing Maps (Accessed: 2025); USGS 2024; California Department of Conservation 2024

DUDEK

0 4.625 9.25 Miles

**FIGURE 4.7-2**

Fault Map

Irvine Gateway Village Project EIR

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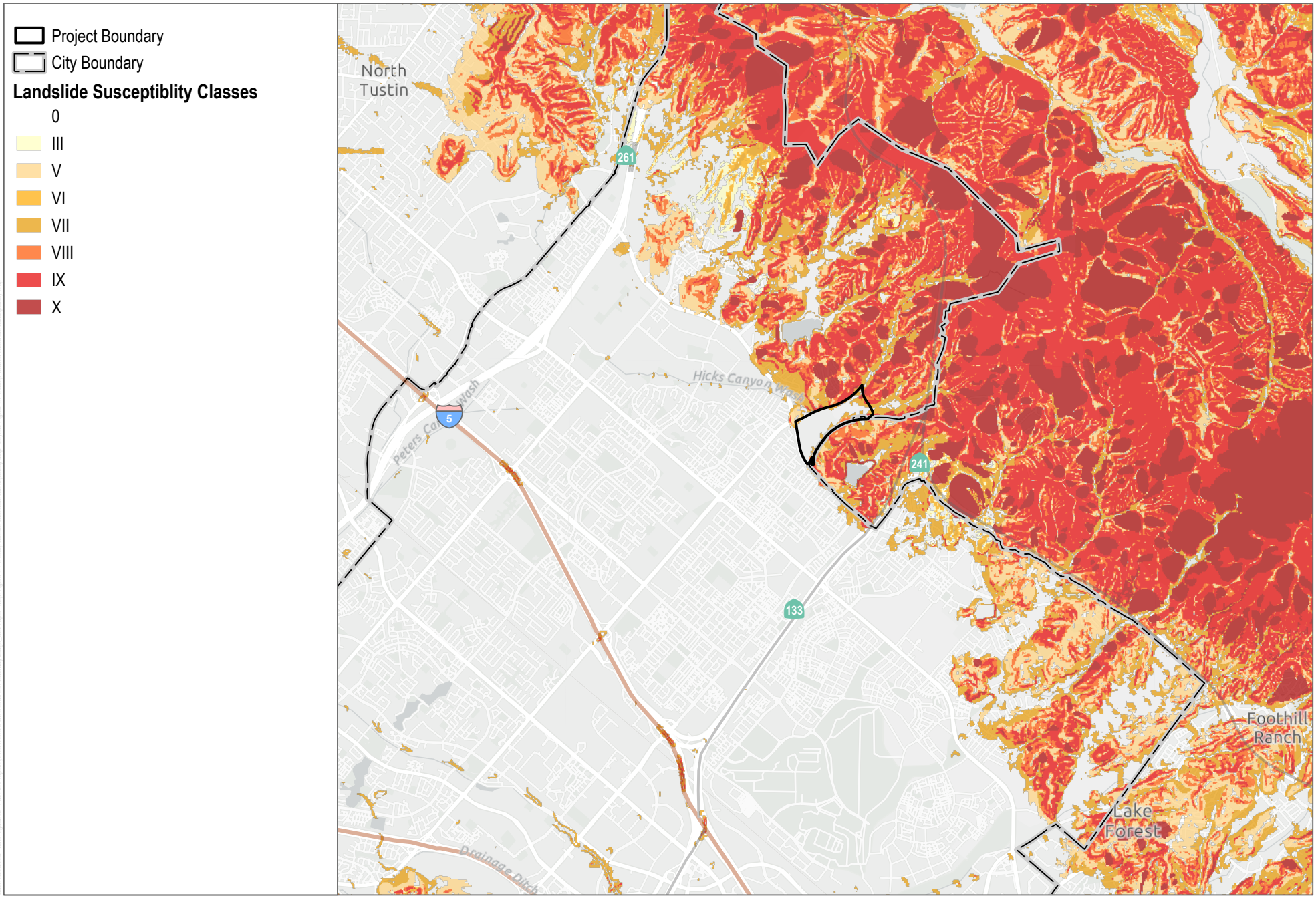


SOURCE: Esri 2023; California Department of Conservation 2025

DUDEK

0 2,500 5,000 Feet

**FIGURE 4.7-3**

Deep-Seated Landslide Susceptibility Map

Irvine Gateway Village Project EIR

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