G. GEOLOGY, SOILS, SEISMICITY, MINERAL AND PALEONTOLOGICAL RESOURCES

1. Introduction

This section describes the geologic, soils, and seismic conditions and mineral/ paleontological resources as they relate to the BART to Livermore Extension Project; discusses the applicable State of California (State) and local regulations; and assesses the potential impacts to geology, soils, seismicity, and mineral and paleontological resources from construction and operation of the Proposed Project and Alternatives.

For the purpose of analyzing potential impacts relative to geology and soils, the study area is defined as the collective footprint of the Proposed Project, the DMU Alternative, and the Express Bus/BRT Alternative. In addition, the bus routes and bus infrastructure improvements for the Enhanced Bus Alternative, as well as for the feeder buses for the Proposed Project and other Build Alternatives, which would extend along existing streets and within the street rights-of-way (ROWs), are addressed programmatically in this analysis, as described in Chapter 2, Project Description. The study area for seismic shaking impacts extends to approximately 20 miles around the collective footprint.

The analysis presented in this section is based on a review of existing reports and geologic maps; available geologic and geotechnical reports and information from the United States Geological Survey (USGS) and California Geological Survey (CGS); and project-specific investigations for various project components. The primary geotechnical documents reviewed in preparation of this EIR are as follows:

- Parikh Consultants (2016). Preliminary Geotechnical Report, BART to Livermore Extension (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.
- Parikh Consultants (2009). Geotechnical and Seismic Report, BART to Livermore Alternatives, Draft Environmental Impact Report, Alameda County, California.

The evaluation of paleontological resources is based on official records collection searches from the University of California Museum of Paleontology and the Natural History Museum of Los Angeles County and review of other maps and reports published by the CGS. In addition, published and unpublished paleontological literature was reviewed to determine previous paleontological resources recovered in the study area.

No comments pertaining to geology, soils, seismicity, mineral resources, or paleontology were received in response to the Notice of Preparation for this EIR or during the public scoping meeting held for the EIR.

2. Existing Conditions

This subsection describes the existing conditions for geology, soils, seismicity, mineral, and paleontological resources, providing the regional context and local setting, including the geologic units, seismicity and faults, landslides and subsidence, soils, mineral resources, and paleontological resources.

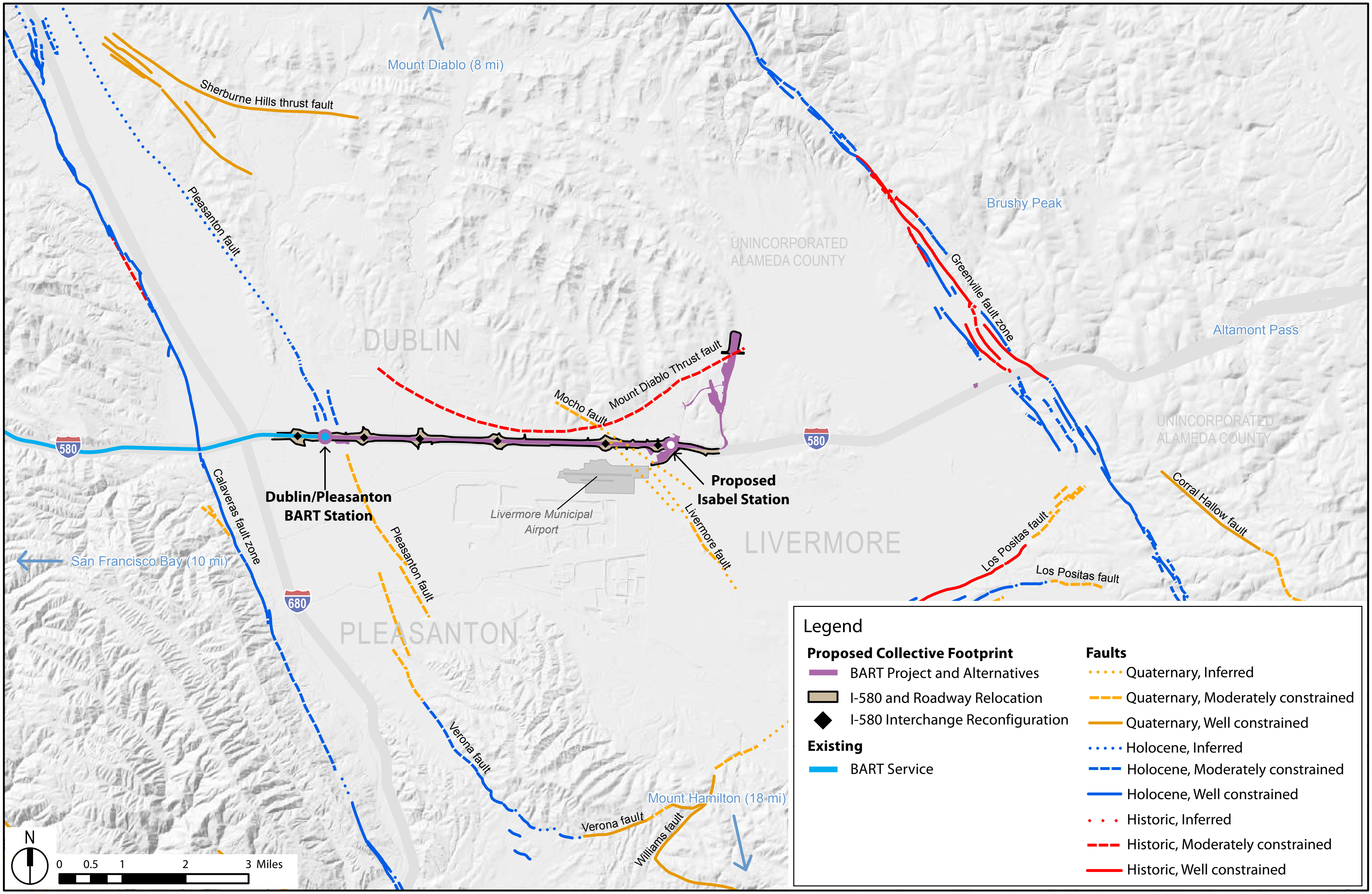
a. Regional Overview

The study area is located in eastern Alameda County within the Livermore-Amador Valley at the northern end of the Diablo Range. This range is part of the northwest-trending Coast Ranges Geomorphic Province of mountain ranges and valleys that trend northwest, parallel to the San Andreas Fault.[1] The ranges have been intensely uplifted, folded, and faulted, and thus contain profound structural discontinuities. The diverse geologic conditions underlying the Livermore-Amador Valley and greater San Francisco Bay Area (Bay Area) are largely defined by the network of major active faults that occur within the region. The San Andreas Fault System is one of the most prominent geologic features in the region; it includes several major fault zones (San Andreas, Hayward, and Calaveras) as well as smaller active and potentially active faults. The San Andreas Fault System is one of the most seismically active areas in the United States. As such, the region is susceptible to potential seismic hazards, including fault rupture and groundshaking.

Figure 3.G-1 illustrates the local topography and locations of active faults in the study area. The existing Dublin/Pleasanton BART Station (Dublin/Pleasanton Station) is about 2 miles east of the active Calaveras Fault Zone. The proposed Isabel Station would be about 7 miles east of the Calaveras Fault Zone and about 5 miles southwest of the Greenville Fault Zone.

The Livermore-Amador Valley is underlain by water-bearing unconsolidated alluvial stream channels and basin sediments, which were deposited beginning in the late Pleistocene epoch. Early in the period of alluvial deposition, large streams draining the Livermore-Amador Valley from east to west converged in the northwest corner of the valley and flowed northward through the San Ramon Valley to what is now Suisun Bay. When the northwest outlet of the valley was open and the stream gradient was steep,

[1] A geomorphic province is an area that possesses similar bedrock, structure, history, and age. California has 11 geomorphic provinces. (California Geological Survey [CGS], 2002. California Geomorphic Provinces, CGS Note 36.)



Source: Arup, 2017; Sawyer, 2015; USGS, 2010.

BART to Livermore Extension Project EIR

Figure 3.G-1
Geology, Soils, Seismicity, Mineral, and Paleontological Resources
Regional Topography and Faults

sheets of gravel gradually accumulated over much of the valley floor. When the northwest outlet of the valley was blocked, swamps and lakes formed in the area, particularly in the western portion of the valley, and continuous sheets of silt and clay were deposited on top of the previously deposited gravel layers.

b. Local Setting

The following sections describe the geologic and seismic setting of the study area, with a focus on potential hazards. The description of the geologic units was updated from the 2010 Program EIR, with additional information from the geotechnical investigations conducted by Parikh Consultants and recent geologic mapping of Quaternary units compiled by Witter et al.[2, 3, 4] The geologic units underlying the alignment of the Proposed Project and Build Alternatives are shown on Figure 3.G-2 and described below.

(1) Geologic Units

(a) Quaternary Alluvial Deposits

Quaternary Alluvial surficial deposits underlie the entire collective footprint, except within the Cayetano Creek Area. The alluvial deposits include gravels, sands, silts, and clays of the Holocene epoch and late Pleistocene epoch.[5] The deposits generally are fluvial in origin consisting of material eroded from the surrounding Coast Ranges that filled the structural trough, which today forms the Livermore-Amador Valley between the Calaveras fault on the west and the Greenville fault on the east.[6] The deposits are a heterogeneous mixture, the individual components of which vary proportionally to their mode of deposition. Coarser materials are from higher energy environments (main channels), whereas finer materials are from lower energy environments (backwaters). The alluvial deposits are common and widespread and would not be considered “unique geological features” under Title 14, Division 6, Chapter 3, California Code of Regulations 15000 et seq. (see CEQA Statute and Guidelines in the Regulatory Framework subsection below).

---

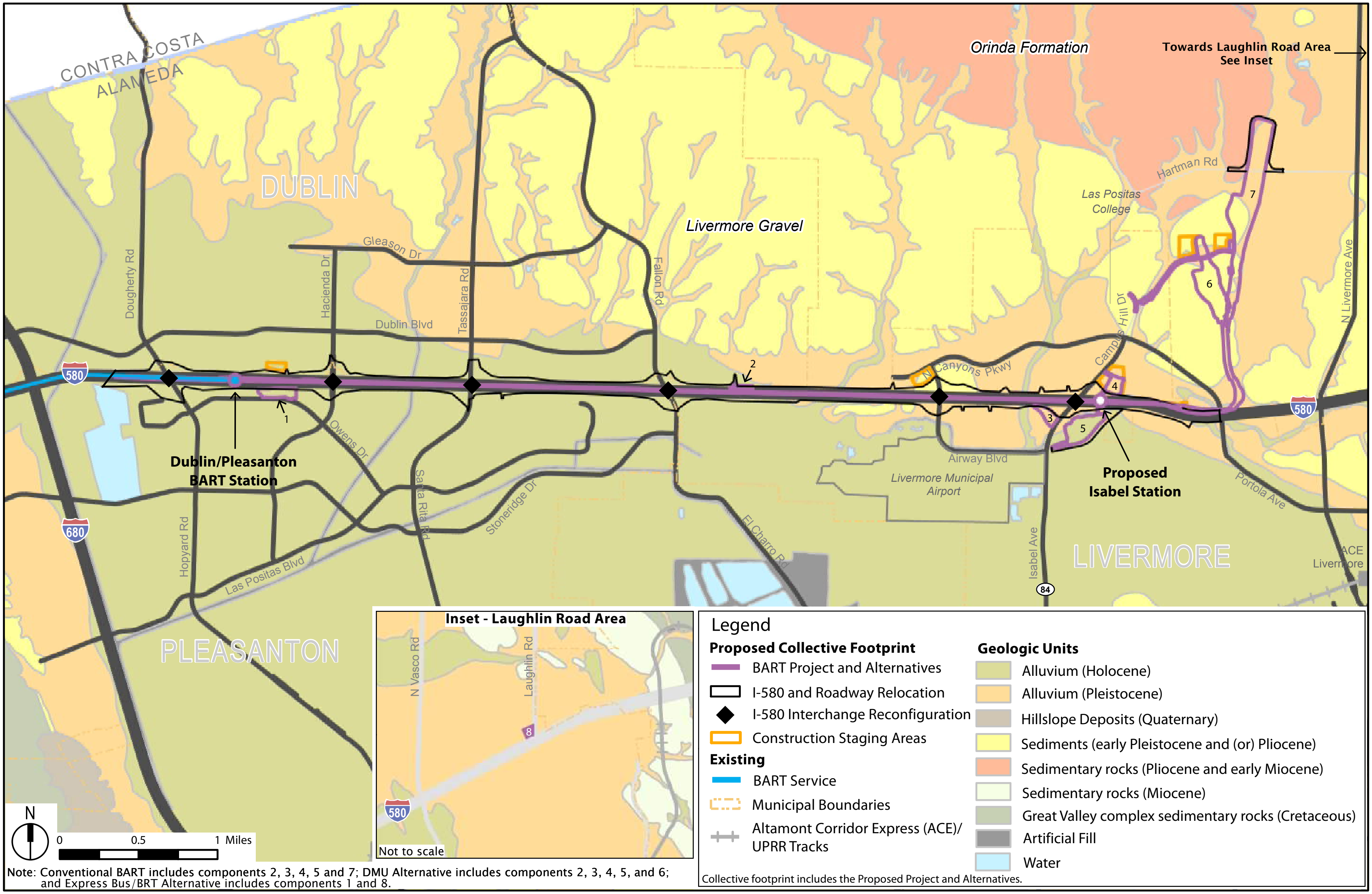
[2] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[3] Parikh Consultants, 2009. Geotechnical and Seismic Report, BART to Livermore Alternatives, Draft Environmental Impact Report, Alameda County, California.

[4] Witter, R.C., Knudsen, K.L, Sowers, J.M., Wentworth, C.M., Koehler, R.D., Randolph, C.E., Brooks, S.K., and Gans, K.D., 2006. Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California: U.S. Geological Survey Open-File Report 2006-1037.

[5] The CGS considers Holocene time to be from the present to about 11,000 years ago, whereas the USGS considers it to be from the present to about 15,000 years ago.

[6] Fluvial deposits are borne, deposited, produced, or eroded by rivers and streams.



Source: Arup, 2017; USGS, 2006.

Figure 3.G-2
Geology, Soils, Seismicity, Mineral, and Paleontological Resources
Geological Units

The geotechnical investigations completed for the Proposed Project and Build Alternatives summarize the materials encountered in exploratory borings that were drilled along the Interstate Highway (I-) 580 corridor during its construction and subsequent modifications.[7] The geotechnical investigations evaluate the study area along the I-580 alignment, including the Dublin/Pleasanton Station Area, the I-580 Corridor Area, the Isabel North and South Areas, and the southern portion of the Cayetano Creek Area. The Laughlin Road Area was not included in the geotechnical investigations; however, given that the Laughlin Road Area is also adjacent to the I-580 alignment, the geologic conditions are anticipated to be similar to those described in the I-580 Corridor Area.

The borings encountered non-native imported granular fill material over medium- to high-plasticity clay at shallow depth within the I-580 corridor. The surface and upper soil layers were modified during grading operations within the I-580 corridor to be the pavement subgrade. Generally, the near-surface soils all have the possibility of containing fine-grained materials (sandy to silty clay).

Beneath the fill materials, the subsurface soil conditions within the I-580 corridor generally consist of firm to stiff and very stiff clays interbedded with sand lenses and pockets to at least 80 feet below grade. Farther east toward the proposed Isabel Station and the hillside along the north side of the I-580 corridor (Cayetano Creek Area), the material grades to hard and dense, with more granular material. The clays range from lean to fat with high plasticity common at shallow depths. From an engineering standpoint, the plastic clays are typical indicators of materials with the potential to be expansive, also referred to as moderate to high shrink and swell potential due to the plasticity, as discussed further below.

Groundwater was generally encountered at approximately 15 to 25 feet below grade. In the vicinity of creeks, groundwater levels could be shallower, at less than about 10 feet in depth.

(b) Livermore Gravel

The Pliocene to early Pleistocene Livermore Gravel unit underlies the Cayetano Creek Area.[8] This unit consists of reddish cobble-pebble gravel and sand, and may be mixed with some clay. Elsewhere and deeper, the unit is composed of gray, poorly to moderately consolidated, indistinctly bedded, cobble conglomeratic sandstone, and gray

[7] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[8] Pliocene time is from approximately 2.6 million to 5.3 million years ago, and Pleistocene time is from approximately 11,000 to 1.6 million years ago.

coarse-grained sandstone with some siltstone and claystone.[9] The Livermore Gravel deposits are common and widespread and would not be considered unique geological features.

(2) Seismicity and Faults

This section characterizes the study area's existing faults, describes historic earthquakes, estimates the likelihood of future earthquakes, and describes probable groundshaking effects.

(a) Earthquake Terminology and Concepts

Earthquake Mechanisms and Fault Activity. Faults are planar features within the earth's crust that have formed to release strain caused by the dynamic movements of the earth's major tectonic plates. An earthquake on a fault is produced when these strains overcome the inherent strength of the earth's crust, and the rock ruptures. The rupture causes seismic waves that propagate through the earth's crust, producing the groundshaking effect known as an earthquake. The rupture also causes variable amounts of slip along the fault, which may or may not be visible at the earth's surface.

Geologists commonly use the age of offset rocks as evidence of fault activity—the younger the displaced rocks, the more recently earthquakes have occurred. To evaluate the likelihood that a fault would produce an earthquake, geologists examine the magnitude and frequency of recorded earthquakes and evidence of past displacement along a fault. An active fault is defined by the State as a fault that has had surface displacement within Holocene time, up to 11,000 years ago.[10] A potentially active fault is defined as a fault that has shown evidence of surface displacement during the Quaternary period, unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer.[11] This definition does not mean that a fault lacking evidence of surface displacement is necessarily inactive. The term "sufficiently active" is also used to describe a fault if there is some evidence that Holocene displacement has occurred on one or more of its segments or branches.[12]

For the purpose of delineating fault rupture zones, the CGS historically sought to apply a setback zone to faults defined as potentially active, which are faults that have shown

[9] California Geological Survey (CGS), 2008a. Seismic Hazard Evaluation of the Livermore 7.5-Minute Quadrangle, Alameda County, California, Seismic Hazard Zone Report 114.

[10] The CGS considers Holocene time to be from the present to about 11,000 years ago, whereas the USGS considers it to be from the present to about 15,000 years ago.

[11] The Quaternary period is from the present to 1.6 million years ago.

[12] California Geological Survey (CGS), 2007. Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps, CGS Special Publication 42.

evidence of surface displacement during Quaternary time. However, usage of the term potentially active under the Alquist-Priolo Earthquake Fault Zoning Act was discontinued when it became apparent that the sheer number of Quaternary-age faults in the state made it meaningless to zone all of them.[13] In late 1975, the State geologist made a policy decision to zone only those faults that had a relatively high potential for ground rupture, determining that a fault be considered for zoning only if it was sufficiently active and well defined.[14] Blind faults do not show surface evidence of past earthquakes, even if they occurred in the recent past, and faults that are confined to pre-Quaternary rocks are considered inactive and incapable of generating an earthquake.

Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification assumes that if a fault has moved during the last 11,000 years, it is likely to produce earthquakes in the future. As noted above, the term potentially active, previously used to describe faults with geologic evidence of movement between 11,000 and 1.6 million years ago, is no longer used by the CGS, but the term does still appear on older reports and maps. In addition, potentially active faults are sometimes referred to as Quaternary faults.

Earthquake Magnitude. When an earthquake occurs along a fault, its size can be determined by measuring the energy released during the event. Seismographs record the amplitude and frequency of the seismic waves that an earthquake generates. The Richter magnitude (M) of an earthquake represents the highest amplitude measured by the seismograph at a distance of 100 kilometers from the epicenter. Richter magnitudes vary logarithmically with each whole-number step, representing a tenfold increase in the amplitude of the recorded seismic waves and 32 times the amount of energy released. While Richter magnitude was historically the primary measure of earthquake magnitude, seismologists now use Moment Magnitude as the preferred way to express the size of an earthquake. The Moment Magnitude scale (M_w) is related to the physical characteristics of a fault, including the rigidity of the rock, the size of fault rupture, and the style of movement or displacement across the fault. Although the formulae of the scales are different, they both contain a similar continuum of magnitude values, except that M_w can reliably measure larger earthquakes and do so from greater distances.

Peak Ground Acceleration. A common measure of ground motion at any particular site during an earthquake is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal acceleration. PGA is expressed as

[13] Bryant, W.A. and Earl W. Hart, 2007. Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps, California Geological Survey (CGS) Special Publication 42, Interim Revision.

[14] Faults that show geologic evidence of movement during the Holocene along one or more of their segments or branches, and the traces of which may be identified by direct or indirect methods, are defined as sufficiently active and well-defined.

the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. In terms of automobile accelerations, one 'g' of acceleration is equivalent to the motion of a car traveling 328 feet from rest in 4.5 seconds. For comparison purposes, the maximum PGA value recorded during the Loma Prieta earthquake in the vicinity of the epicenter, near Santa Cruz, was 0.64 g. Unlike measures of magnitude, which provide a single measure of earthquake energy, PGA varies from place to place and is dependent on the distance from the epicenter and the character of the underlying geology (e.g., hard bedrock, soft sediments, or artificial fills).

Modified Mercalli Intensity Scale. The Modified Mercalli (MM) Intensity Scale assigns an intensity value based on the observed effects of groundshaking produced by an earthquake. Unlike measures of earthquake magnitude and PGA, this scale is qualitative, in that it is based on observed effects rather than measured values. Similar to PGA, MM intensity values for an earthquake at any one place can vary depending on the earthquake's magnitude, the distance from its epicenter, the focus of its energy, and the type of geologic material. The MM values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage. Because the MM is a measure of groundshaking effects, intensity values can be related to a range of average PGA values, as shown below in Table 3.G-1.

(b) Faults and Historic Earthquake Activity

The Bay Area is in a seismically active region near the boundary between two major tectonic plates—the Pacific Plate to the southwest and the North American Plate to the northeast. For approximately the past 23 million years, about 200 miles of right-lateral slip has occurred along the San Andreas Fault System to accommodate the relative movement between these two plates.[15] The relative movement between the Pacific Plate and the North American Plate generally occurs across approximately a 50-mile-wide zone extending from the San Gregorio and Seal Cove Faults, offshore of the San Francisco peninsula, to the Great Valley Thrust Belt, northeast of the Coast Ranges. In addition to the right-lateral slip movement between tectonic plates, a compressional component of relative movement has developed between the Pacific Plate and a smaller segment of the North American Plate at the latitude of San Francisco Bay during the last 3.5 million

[15] To an observer of movement on a right-lateral fault, the far side of the fault moves to the right relative to the closer side of the fault.

TABLE 3.G-1 MODIFIED MERCALLI INTENSITY SCALE

Intensity Value	Intensity Description	Average Peak Ground Acceleration[a]
I	Not felt	< 0.0017 g
II	Felt by people sitting or on upper floors of buildings	0.0017 to 0.014 g
III	Felt by almost all indoors. Hanging objects swing. Vibration like passing of light trucks. May not be recognized as an earthquake.	0.0017 to 0.014 g
IV	Vibration felt like passing of heavy trucks. Stopped cars rock. Hanging objects swing. Windows, dishes, doors rattle. Glasses clink. In the upper range of IV, wooden walls and frames creak.	0.014 to 0.039 g
V (Light)	Felt outdoors. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing. Pictures move. Pendulum clocks stop.	0.035 to 0.092 g
VI (Moderate)	Felt by all. People walk unsteadily. Many frightened. Windows crack. Dishes, glassware, knickknacks, and books fall off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster, adobe buildings, and some poorly built masonry buildings cracked. Trees and bushes shake visibly.	0.092 to 0.18 g
VII (Strong)	Difficult to stand or walk. Noticed by drivers of cars. Furniture broken. Damage to poorly built masonry buildings. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices, unbraced parapets and porches. Some cracks in better masonry buildings. Waves on ponds.	0.18 to 0.34 g
VIII (Very Strong)	Steering of cars affected. Extensive damage to unreinforced masonry buildings, including partial collapse. Fall of some masonry walls. Twisting, falling of chimneys and monuments. Wood-frame houses moved on foundations if not bolted; loose partition walls thrown out. Tree branches broken.	0.34 to 0.65 g
IX (Violent)	General panic. Damage to masonry buildings ranges from collapse to serious damage unless modern design. Wood-frame structures rack, and, if not bolted, shifted off foundations. Underground pipes broken.	0.65 to 1.24 g
X (Very Violent)	Poorly built structures destroyed with their foundations. Even some well-built wooden structures and bridges heavily damaged and needing replacement. Water thrown on banks of canals, rivers, lakes, etc.	> 1.24 g
XI (Very Violent)	Few, if any, masonry structures remain standing. Bridges destroyed. Rails bent greatly. Underground pipelines completely out of service.	> 1.24 g
XII (Very Violent)	Damage nearly total. Practically all works of construction are damaged greatly or destroyed. Large rock masses displaced. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown into the air.	> 1.24 g

Notes:
[a] Average peak ground acceleration is expressed as a fraction of the acceleration due to gravity (g). g is 9.8 meters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.
Sources: Association of Bay Area Governments (ABAG), 2016a; Wald, D., V. Quitoriano, T. Heaton, and H. Kanamori, 1999.

years.[16] Strain produced by the relative motions of these plates is relieved by right-lateral strike-slip faulting on the San Andreas and related faults, and by vertical reverse-slip displacement on the Great Valley and other thrust faults in the central California area.[17]

The Bay Area and surrounding areas are characterized by numerous geologically young faults, with the active faults close to the study area, as shown on Figure 3.G-1. Active faults within a 20-mile radius of the study area include the Greenville, Northern Calaveras, Concord-Green Valley, Pleasanton, and Las Positas faults. The Hayward and San Andreas faults are farther to the west within the Bay Area. These faults are considered to be the most probable sources of future earthquakes for this area and are in Alquist-Priolo Earthquake Fault Zones (see Regulatory Framework, below, for a discussion of Alquist-Priolo Earthquake Fault Zones and the Alquist-Priolo Earthquake Fault Zoning Act). In addition, the Mount Diablo Thrust Fault is considered active, as discussed further below. Other Quaternary faults within a 20-mile radius of the study area include the inactive Quaternary Livermore, Verona, and Williams Faults, none of which are in designated Alquist-Priolo Earthquake Fault Zones. Of all these faults, the Greenville, Northern Calaveras, Pleasanton, Las Positas, Livermore, and Mount Diablo Thrust faults are in, or closest to, the study area. These various fault zones are described below and are summarized in Table 3.G-2.

Mount Diablo Thrust Fault. The Mount Diablo Thrust Fault is a buried thrust fault/ inferred fault shown on Figure 3.G-1. The eastern end of the thrust fault extends to beneath the collective footprint in the Cayetano Creek Area. The central portion of the fault trace passes within about 0.25 mile of the north side of I-580 Corridor Area. The Association of Bay Area Governments identifies the Mount Diablo Thrust Fault as the most active thrust fault in the Bay Area.[18] According to a study of earthquake probabilities for the San Francisco Bay Region conducted by the USGS Working Group of California Earthquake Probabilities, the Mount Diablo Thrust Fault is capable of generating a magnitude 6.7 or greater earthquake with an estimated 0.03 probability (i.e., 3 percent probability) of occurrence over the next 30 years.[19] The geotechnical investigation cites

[16] Fenton and Hitchcock, 2001. Recent geomorphic and paleoseismic investigations of thrust faults in Santa Clara Valley, California, in H. Ferriz and R. Anderson, eds., Engineering Geology Practice in Northern California: California Geological Survey Bulletin 210, p. 239-257.

[17] A reverse-slip fault is one with predominantly vertical movement in which the upper block moves upward in relation to the lower block.

[18] Association of Bay Area Governments (ABAG), 2016b. See What Thrust Faults Can Do. Available at: http://resilience.abag.ca.gov/students/fieldtrip-mtdiablo/, accessed November 11, 2016.

[19] United States Geologic Survey (USGS), 2003. Earthquake Probability for the San Francisco Bay Region 2002-2031. Working Group on California Earthquake Probabilities. Open File Report 03-214.

TABLE 3.G-2 ACTIVE AND POTENTIALLY ACTIVE FAULTS WITHIN THE STUDY AREA

Fault or Fault Zone	Proximity to Collective Footprint and Direction	Recency and Classifica-tion of Faulting	Slip Rate (millimeters/ year)	Maximum Moment Magnitude (M_w)	Historical Seismicity[a]
Mount Diablo Thrust	Beneath Cayetano Creek Area and 0.25 mile north of I-580 Corridor Area	Active	1.7 to 1.8	6.6	None known
Calaveras (northern)	2 miles west of Dublin/ Pleasanton Station Area	Historic – Active	12 to 18	6.9	6.2, 1984 6.5, 1911 6.3, 1897
Greenville	5 miles northeast of Isabel North/South Areas	Historic – Active	1 to 3	6.9	M_L 5.8, 1980
Las Positas	5 miles southeast of Isabel North/South Areas	Active	unknown	6.4	1980
Hayward	10 miles southwest of Dublin/ Pleasanton Station Area	Historic – Active	7 to 11	7.3	5.6, 1889 5.8, 1870 7.0, 1868 5.8, 1864
Concord-Green Valley	16 miles north of Isabel North/South Areas	Historic – Active	2 to 8	unknown	5.4, 1954
San Andreas	27 miles southwest of Isabel North/South Areas	Historic – Active	13 to 21	7.1	6.0, 2004 6.9, 1989 7.8, 1906 6.7, 1898 6.5, 1885
Pleasanton	0.25 mile southeast of Dublin/ Pleasanton Station Area	Quaternary	unknown	6.6	None known
Livermore	Beneath the I 580 Corridor Area, 0.5 mile west of Isabel North/South Areas	Quaternary	unknown	unknown	None known

Note:
[a] Richter (ML) or Moment Magnitude (M_w) of 6 or larger or causing damage
Sources:
Parikh Consultants, 2016; Bonilla, M.G., J.J. Lienkaemper, and J.C. Tinsley, 1980; California Geological Survey (CGS), 2007; California Geological Survey (CGS), 2008a; 2007 Working Group on California Earthquake Probabilities, 2008; Sawyer, Thomas L., 2015.

the Mount Diablo Thrust Fault as having a maximum earthquake potential of M_w 6.6.[20] A recent geomorphological investigation identified late Holocene deformation on the thrust fault with movement during the last 900 years and a slip rate of 1.7 to 1.8 millimeters per year.[21] The State recognizes that buried thrust faults exist; however, their fault planes tend to extend under a wide area and are extremely difficult to identify and characterize. Consequently, regulations such as the Alquist-Priolo Earthquake Fault Zoning Act have not been applied to the Mount Diablo Thrust Fault.

The Mocho Fault is associated with the Mount Diablo Thrust Fault and is inferred to extend through the collective footprint near Airway Boulevard/I-580 interchange.[22] It is not known to be active.

Northern Calaveras Fault Zone. The Holocene Northern Calaveras Fault Zone is part of the 75-mile-long Calaveras Fault, which extends north from Hollister through the Diablo Range, east of San Jose, and along the Pleasanton-Dublin-San Ramon urban corridor. The Northern Calaveras Fault is in an Alquist-Priolo Earthquake Fault Zone, has a relatively low level of seismicity, and may be locked.[23] The fault transects I-580 at San Ramon Road, approximately 2 miles west of the existing Dublin/Pleasanton BART Station and would not directly transect the collective footprint. The Calaveras Fault Zone has a maximum earthquake potential of M_w 6.9.[24]

Greenville Fault Zone. The Holocene Greenville Fault is a major zone of faults of the San Andreas Fault System extending about 56 miles northwest from Mount Diablo to San Antonio Valley.[25] It is in an Alquist-Priolo Earthquake Fault Zone with surface traces along the western face of the Altamont Hills 5 miles northeast of Isabel Station. The Greenville Fault is a strike-slip fault. The fault is not a single trace, but contains numerous splays and en-echelon segments. Estimates of current slip rates, based on geologic structures and geomorphology, are in the range of 1 to 3 millimeters per year (0.04 to 0.12 inch per year).[26] The Greenville Fault has an estimated maximum earthquake potential of M_w 6.9,

---

[20] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[21] Sawyer, Thomas L., 2015. Characterizing Rates of Contractional Deformation on the Mount Diablo Thrust Fault, Eastern San Francisco Bay Region, Northern California, April 7.

[22] Parikh Consultants, 2009. Geotechnical and Seismic Report BART to Livermore Alternatives, Draft Environmental Impact Report, Alameda County, California.

[23] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[24] Ibid.

[25] Ibid.

[26] Parikh Consultants, 2009. Geotechnical and Seismic Report BART to Livermore Alternatives, Draft Environmental Impact Report, Alameda County, California.

and the recurrence interval is estimated to be about 550 years.[27, 28] On January 24, 1980, an earthquake of M 5.8 struck approximately 11 miles north of Livermore on the Greenville-Marsh Creek Fault.[29] The earthquake caused discontinuous surface rupture along several fault traces in the Greenville Fault Zone. The Greenville Fault does not transect the collective footprint.

Las Positas Fault Zone. The Las Positas Fault is an active Holocene fault trending northeast to southwest approximately 2.5 miles southeast of Downtown Livermore. Two traces are designated as Alquist-Priolo Earthquake Fault Zones. The Las Positas Fault is about 5 miles southeast of the proposed Isabel Station. The January 1980 earthquake on the Greenville Fault also resulted in rupture along the Las Positas Fault.[30] The Las Positas Fault zone has a maximum earthquake potential of M_w 6.4.[31] The Las Positas Fault does not transect the collective footprint.

Hayward Fault Zone. The active Hayward Fault extends northwest approximately 55 miles from San Jose to Point Pinole. It is a right-lateral strike-slip fault and is in an Alquist-Priolo Earthquake Fault Zone. The fault is very active, producing large historic earthquakes, fault creep, and abundant geomorphic evidence of fault rupture.[32] The Hayward Fault Zone is within about 10 miles of the Dublin/Pleasanton BART Station and has a maximum earthquake potential of M_w 7.3.[33]

The historic Hayward earthquake of 1868 is considered to have been one of the most destructive in California history. Surface rupture of the ground as a result of the earthquake was traced for 20 miles along the Hayward Fault from Warm Springs in Fremont to San Leandro, and caused major damage to the East Bay towns. Since then, powerful earthquakes on the Hayward Fault have occurred repeatedly. The USGS describes the Hayward Fault as a tectonic hazard due anytime for another M_w 6.8 to M_w 7.0

---

[27] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[28] Parikh Consultants, 2009. Geotechnical and Seismic Report BART to Livermore Alternatives, Draft Environmental Impact Report, Alameda County, California.

[29] Bonilla, M.G., J.J. Lienkaemper, and J.C. Tinsley, 1980. Surface Faulting near Livermore, California, Associated with the January 1980 Earthquakes, U.S. Geological Survey Open-File Report 80-523.

[30] Ibid.

[31] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[32] San Francisco Bay Area Rapid Transit District (BART), 2006. Final Environmental Impact Statement, and 4(f)/6(f) Evaluation BART Warm Springs Extension.

[33] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

earthquake.[34] Specifically, the estimated probability for earthquakes of magnitude equal to or greater than M_w 6.7 in the 30 years between 2000 and 2030 on the Hayward Fault system is 32 percent.

Concord-Green Valley Fault Zone. Formerly considered two faults because their surface expressions are separated by Suisun Bay, the active Concord-Green Valley Fault is a Holocene strike-slip fault and is the easternmost expression of the northwest movement in the San Andreas Fault System in the Bay Area. Segments of the fault on both sides of Suisun Bay are historically active and the fault is in an Alquist-Priolo Earthquake Fault Zone. It is approximately 16 miles north of the proposed Isabel Station does not transect the collective footprint.

San Andreas Fault Zone. The active right-lateral San Andreas Fault Zone is expected to produce strong earthquakes in Northern California. The Loma Prieta Earthquake of October 17, 1989, on the San Andreas Fault Zone, caused major damage throughout most of the Bay Area, but relatively minor damage in eastern Alameda County. Onshore segments of the fault are in Alquist-Priolo Earthquake Fault Zones. The San Andreas Fault Zone is about 27 miles west of the Dublin/Pleasanton BART Station and has a maximum earthquake potential of M_w 7.1.[35]

Pleasanton Fault Zone. The Pleasanton Fault is a Holocene strike-slip fault extending northwest of I-580 about 1.7 miles east of the Calaveras Fault. It is mostly concealed beneath the alluvial deposits of the Livermore-Amador Valley, but is sufficiently well-defined to be in an Alquist-Priolo Earthquake Fault Zone. The Pleasanton Fault zone extends southward toward the existing Dublin/Pleasanton Station, as shown in Figure 3G-1, but is not known to be present beneath the station. Recent trenching investigations indicate that the Pleasanton Fault was not observed in trenches just south of I-580 and there is no evidence of Holocene movement. The Pleasanton Fault Zone has a maximum earthquake potential of M_w 6.6.[36]

Livermore Fault Zone. The Livermore Fault is considered a Quaternary fault approximately 5 miles long in Downtown Livermore. The fault is concealed and is inferred to possibly extend beneath the collective footprint in the I-580 Corridor Area, approximately 0.5 mile west of the proposed Isabel Station. The fault is not listed as an Alquist-Priolo Earthquake Fault Zone.

---

[34] United States Geological Survey (USGS), 2008. Understanding Earthquake Hazards in the San Francisco Bay Area – USGS Fact Sheet 2008-3019.

[35] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[36] Ibid.

(c) Groundshaking

Because active fault zones occur in study area, the area is susceptible to potentially high-intensity groundshaking in the event of an earthquake on these fault zones. The intensity of groundshaking depends on several factors, including soil and rock conditions, distance from the causative fault, and direction from the epicenter. Areas that are underlain by loosely compacted soils may experience the greatest amount of groundshaking damage, even if these areas are not closest to the fault rupture.

Historically, earthquakes have caused strong groundshaking and damage in the Bay Area. For example, the M_w 6.9 Loma Prieta earthquake in October 1989 on the San Andreas Fault, with an epicenter near Santa Cruz, produced very damaging groundshaking in Santa Cruz, but also in the Bay Area more than 50 miles away. However, disregarding local variations in ground conditions, the intensity of shaking at different locations within the area can generally be expected to decrease with distance from an earthquake source. A total of 44 earthquakes of magnitude 5.5 or greater (Richter or moment magnitude) have occurred in the Bay Area in historical times.[37] Earthquakes of this magnitude pose significant groundshaking hazard to the study area.

In 2007, the USGS, the CGS, and the Southern California Earthquake Center formed the Working Group on California Earthquake Probabilities to evaluate the probability of one or more earthquakes of M_w 6.7 or higher occurring in the state over the next 30 years. Accounting for the wide range of possible earthquake sources, the Working Group estimated that the Bay Area has a 72 percent chance of experiencing an earthquake of M_w 6.7 or higher over the next 30 years.[38] Using predictive seismic parameters, Parikh Consultants, Inc., estimated an earthquake moment magnitude of M_w 6.6 and a PGA of 0.63 g at the location of the Airway Boulevard/I-580 overcrossing.[39]

(d) Liquefaction and Lateral Spreading

Liquefaction occurs when groundshaking increases pore pressure in loose, fine-grained, uniformly sized, saturated soil causing it to react like quicksand. The potential for liquefaction depends on soil conditions and groundwater levels. An area of loose, fine-grained, uniformly sized soil has higher susceptibility to liquefaction when

---

[37] Toppozada, T. R. and D. Branum, 2002. California M >= 5.5 earthquakes, history and areas damaged, in Lee, W. H., H. Kanamori, and P. Jennings, International Handbook of Earthquake and Engineering Seismology, International Association of Seismology and Physics of the Earth's Interior.

[38] Working Group on California Earthquake Probabilities (WGCEP), 2015. UCERF3: A new earthquake forecast for California's complex fault system: U.S. Geological Survey Fact Sheet 2015–3009. March.

[39] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

groundwater tables are high. Lateral spreading occurs when liquefaction causes subsurface soil layers to move horizontally. Lateral spreads are most common on slopes in areas of loose, saturated soils with high or very high potential for liquefaction.

Figure 3.G-3 illustrates the area of liquefaction and lateral spreading susceptibility for the study area.[40, 41] Table 3.G-3 summarizes liquefaction and lateral spreading susceptibility hazard categories and describes the relative level of susceptibility to the PGA that a given area could be subjected to. The western portion of the study area along the I-580 corridor would be located within areas with moderate potential liquefaction susceptibility. The eastern portion of the study area along the I-580 corridor would be located within areas with variable liquefaction susceptibility ranging from very low to moderate. Further, the I-580 corridor is located within a relatively flat area and would have a very low susceptibility to lateral spreading. The Cayetano Creek Area is located within an area of very low liquefaction and lateral spreading susceptibility. The Laughlin Road Area is within an area with a potential for low liquefaction and lateral spreading.

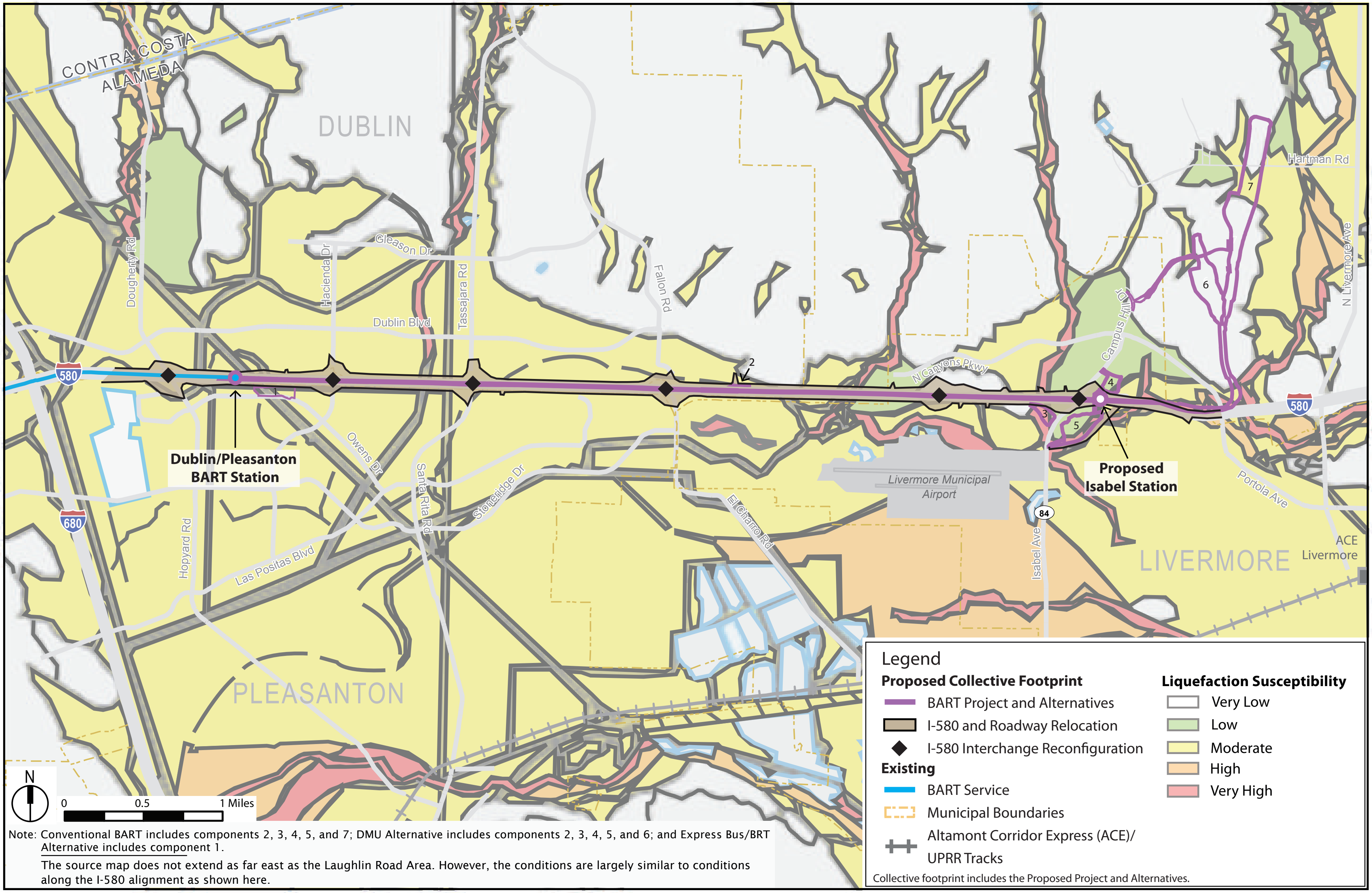
TABLE 3.G-3 CATEGORIES OF LIQUEFACTION AND LATERAL SPREADING SUSCEPTIBILITY

Susceptibility	Description
Very Low	Expect less than 2% of future liquefaction effects to occur within geologic units assigned very low susceptibility. An estimated PGA of 0.6 times the force of gravity (0.6g) is necessary to trigger liquefaction in deposits assigned very low susceptibility.
Low	Expect about 2% of future liquefaction effects to occur within geologic units assigned low susceptibility. An estimated PGA of 0.5g is necessary to trigger liquefaction in deposits assigned low susceptibility.
Moderate	Expect about 20–30% of future liquefaction effects to occur within geologic units assigned moderate susceptibility. An estimated PGA of 0.2 to 0.3g is necessary to trigger liquefaction in deposits assigned moderate susceptibility.
High	Expect about 20–30% of future liquefaction effects to occur within geologic units assigned high susceptibility. An estimated PGA of 0.1 to 0.2g is necessary to trigger liquefaction in deposits assigned high susceptibility.
Very High	Expect about 40–50% of future liquefaction effects to occur within geologic units assigned very high susceptibility. An estimated PGA of 0.1 is necessary to trigger liquefaction in deposits assigned very high susceptibility.

Note: PGA = peak ground acceleration
Source: Witter, R.C., Knudsen, K.L, Sowers, J.M., Wentworth, C.M., Koehler, R.D., Randolph, C.E., Brooks, S.K., and Gans, K.D., 2006.

[40] Ibid.

[41] Witter, R.C., Knudsen, K.L, Sowers, J.M., Wentworth, C.M., Koehler, R.D., Randolph, C.E., Brooks, S.K., and Gans, K.D., 2006. Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California: U.S. Geological Survey Open-File Report 2006-1037.



Note: Conventional BART includes components 2, 3, 4, 5, and 7; DMU Alternative includes components 2, 3, 4, 5, and 6; and Express Bus/BRT Alternative includes component 1.
The source map does not extend as far east as the Laughlin Road Area. However, the conditions are largely similar to conditions along the I-580 alignment as shown here.

Source: Arup, 2017; Witter, et al., 2006.

Figure 3.G-3
Geology, Soils, Seismicity, Mineral, and Paleontological Resources
Liquefaction Susceptibility

(3) Landslides and Subsidence

Other potential geologic hazards that may occur in the study area include landslides and subsidence.

(a) Landslides

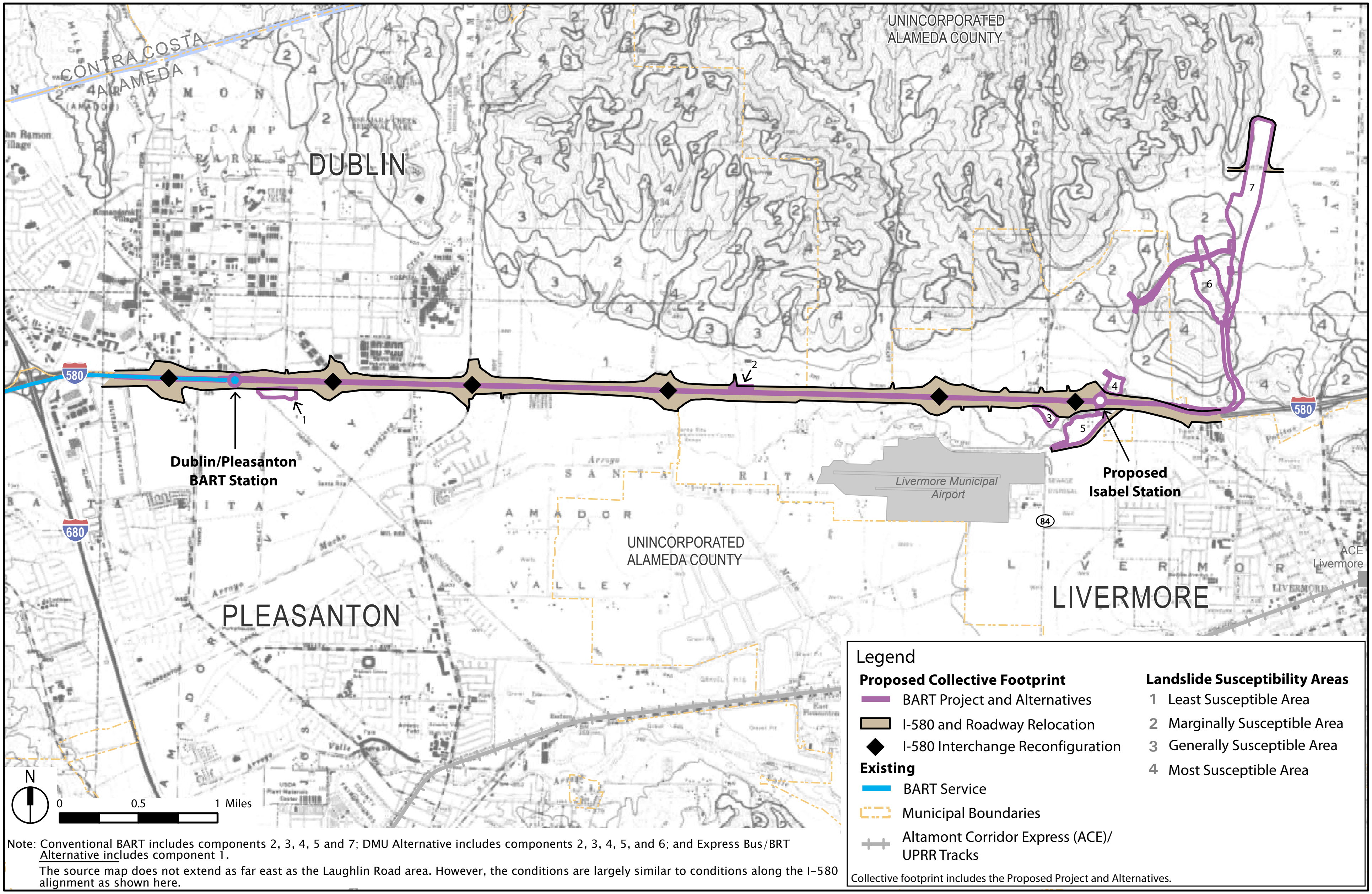
Areas with landslide potential generally have steeper slopes than the soil or rock material forming the slope can support. As shown on Figure 3.G-4, landslide potential is mapped in four categories—ranging from 1 (least susceptible) to 4 (most susceptible).[42] In the I-580 corridor, the study area is on relatively flat land with little to no susceptibility to landslides (area of least susceptibility). However, the Cayetano Creek Area, has higher landslide susceptibility due to the steeper slopes in the area (marginally to most susceptible), as shown on Figure 3.G-4.

(b) Subsidence

Subsidence is the sinking of an area with little or no horizontal motion. In the Bay Area, it is caused primarily by excessive groundwater or natural gas withdrawal.[43] Weak soils also are prone to subsidence. The cities of Dublin, Livermore, and Pleasanton supplement their water supply with groundwater obtained from the groundwater basins underlying the cities. Long-term groundwater withdrawals have the potential to cause subsidence if recharge rates are not sufficient to maintain current water table levels. The Main Basin (managed by the Zone 7 Water Agency of the Alameda County Flood Control and Water Conservation District [Zone 7]) serves large capacity municipal production wells and is used to store and distribute high-quality imported water through Zone 7's recharge program. Groundwater recharge occurs through natural and artificial recharge from rainfall, releases from the South Bay Aqueduct of Lake Del Valle, and gravel mining recharge to the Arroyo Mocho and Arroyo Del Valle. However, the majority of recharge is through artificial recharge and recharge through stream channels. Consequently, potential for groundwater-induced subsidence is considered to be low within the study area because Zone 7 monitors and maintains groundwater levels.

[42] Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

[43] City of Pleasanton, 2008. Proposed Pleasanton General Plan 2005-2025 Draft Environmental Impact Report.



Note: Conventional BART includes components 2, 3, 4, 5 and 7; DMU Alternative includes components 2, 3, 4, 5, and 6; and Express Bus/BRT Alternative includes component 1.

The source map does not extend as far east as the Laughlin Road area. However, the conditions are largely similar to conditions along the I-580 alignment as shown here.

Source: Arup, 2017; California Division of Mines and Geology, 1991.

BART to Livermore Extension Project EIR

Figure 3.G-4
Geology, Soils, Seismicity, Mineral, and Paleontological Resources
Landslide Susceptibility

(4) Soils

According to the Natural Resources Conservation Survey, the soils in the study area include clay, clay and silty loams, and loams, as shown in Figure 3.G-5.[44] Soils within the study area are as follows:

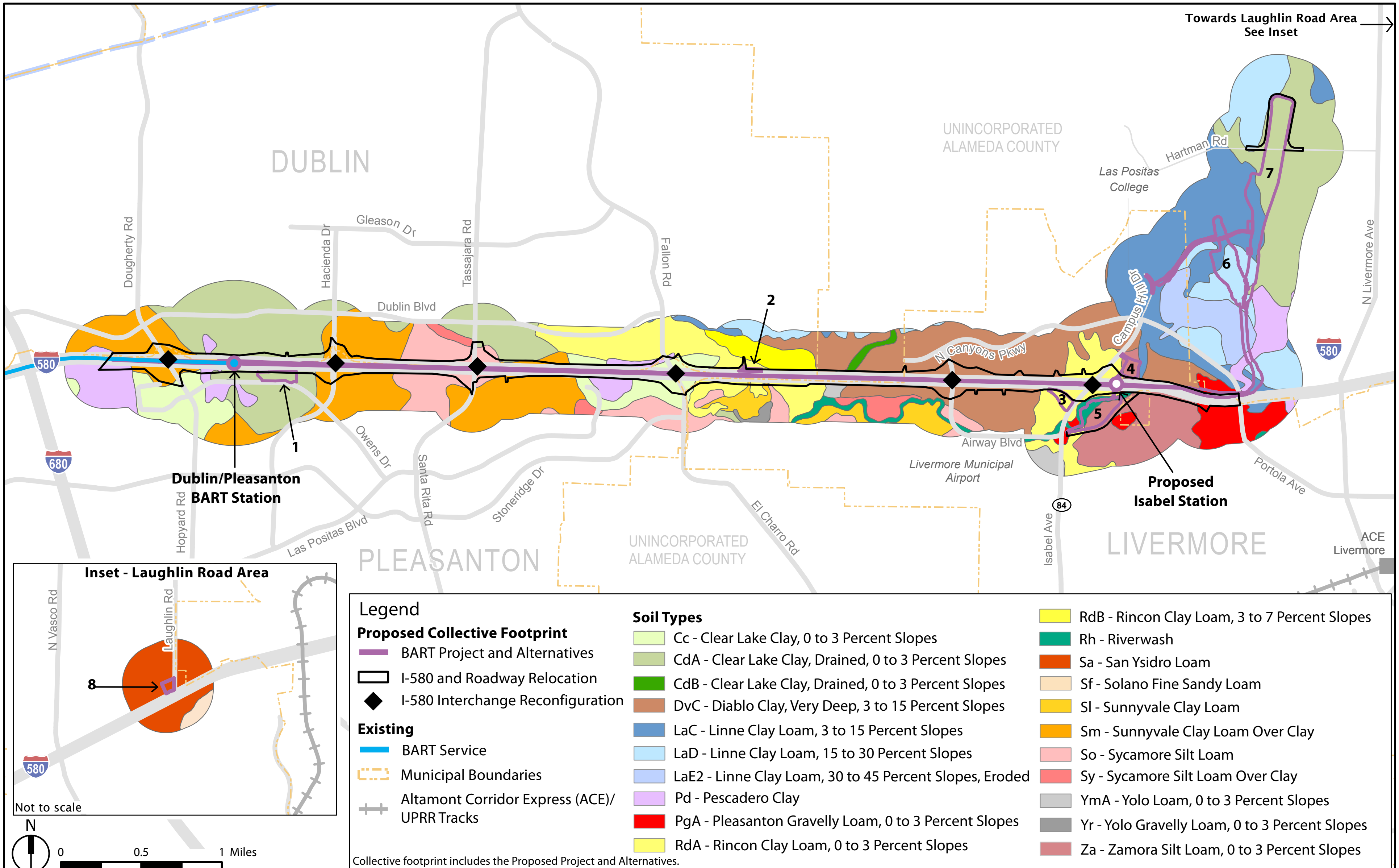
- Dublin/Pleasanton Station Area and I-580 Corridor Area – clay, clay loam, clay loam over clay, silty loam
- Isabel North and South Areas – clay loam (station area) and silt loam (parking garage area)
- Cayetano Creek Area – clay, clay loam, and gravelly loam
- Laughlin Road Area – loam

(a) Expansive Soils

Expansive soils are soils that swell or shrink when they absorb or lose water. The potential for expansion, also referred to as linear extensibility or shrink-swell potential, refers to the change in length of an unconfined clod of soil as moisture content is increased or decreased between a moist and dry state. The amount and type of clay minerals in the soil influence changes in soil volume. This reaction can cause cracking, tilting, and, occasionally, collapse of foundations or structures. The presence of expansive soils may indicate a potential for settlement. Settlement takes place when vertical loads compress weak soils by squeezing out air and water, causing supported structures to sink. If different soil conditions cause the ground under a structure to settle to different depths (differential settlement), structural damage such as cracked foundations, cracked columns, and even collapse could result.

The clayey soils underlying the study area, as shown in Figure 3.G-5, have a high expansion potential that could damage structure foundations. Areas with such soils include the Dublin/Pleasanton Station Area, I-580 Corridor Area, Isabel North and South Areas, and the Cayetano Creek Area. The Laughlin Road Area does not include clayey soils.

[44] Loam is a soils term that generally means a mix of grain sizes, along with organic matter. For example, a clay loam will have clay, silt, and sand particles but will be predominantly clay.



Note: Soil Types shown here for the area are approximately 0.25 mile around the proposed collective footprint and 0.5 mile around stations.
Conventional BART includes components 2, 3, 4, 5 and 7; DMU Alternative includes components 2, 3, 4, 5, and 6; and Express Bus/BRT Alternative includes components 1 and 8.

Source: Arup, 2017; NRCS, 2016a.

Soil Types in the Study Area

(b) Erosive Soils

Erosive soils are those that are easily worn away and transported to another area either by wind, water, or gravity. Soils that contain high amounts of loose sand and silt (fine soil particles smaller than sand) are more easily erodible than soils that are more consolidated. Excessive soil erosion can lead to damage of building foundations and roadways. Erodible soils generally do not occur beneath the collective footprint.[45]

(c) Corrosive Soils

Corrosivity is the ability of soil to break down certain substances, particularly metals. Corrosive soils may have adverse effects on the long-term structural stability of steel and concrete. Soils that are highly alkaline or highly acidic are likely to be corrosive. Clayey soils in the area, as identified in Figure 3.G-5, extend beneath the collective footprint, except within Laughlin Road Area.

(5) Mineral Resources

The CGS is responsible for preparing Mineral Land Classification Maps that designate Mineral Resource Zones (MRZ). MRZs define areas where important mineral deposits occur, based on the value of the mineral resource. MRZs are defined as follows:

- MRZ-1 – Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence
- MRZ-2 – Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists
- MRZ-3 – Areas containing mineral deposits, the significance of which cannot be evaluated from available data
- MRZ-4 – Areas where available information is inadequate for assignment to any other MRZ zone

The region has been mapped by the CGS and the I-580 corridor is designated as MRZ-1 and the Cayetano Creek Area is designated as MRZ-4.

The Livermore-Amador Valley is underlain by alluvial deposits, which contain significant reserves of sand and gravel suitable for use as aggregate in cement production. In the study area, sand and gravel mining has been a common regional operation in the past.[46]

---

[45] U.S. Department of Agriculture, 1977. Soil Survey Alameda County Area, California.

[46] City of Livermore, 2007. Final Environmental Impact Report for the El Charro Specific Plan. April. Available at: http://www.cityoflivermore.net/citygov/cedd/planning/charro.htm.

The region has been mapped by the CGS and much of the Livermore-Amador Valley south of I-580 is classified as an area of significant mineral resources, including areas mapped as either MRZ-2 or MRZ-3.[47]

The City of Livermore General Plan Open Space and Conservation Element describes State-designated Mineral Resource Sectors—areas where mineral extraction is occurring and areas that have current land uses that are similar to areas where mining has occurred.[48] The General Plan identifies specific mineral resource sectors in the vicinity of the area in lands classified as MRZ-2.[49] Gravel is mined in an area known as the Chain of Lakes, in unincorporated Alameda County between I-580 and the Union Pacific Railroad tracks, south of Stanley Boulevard. Aggregate mining operations are 1 mile or more south of the I-580 corridor.

(6) Paleontological Resources

Paleontological resources are the fossilized remains or impressions of plants and animals, including vertebrates (animals with backbones such as mammals, birds, fish, etc.), invertebrates (animals without backbones such as starfish, clams, coral, etc.), and microscopic plants and animals (microfossils). They are nonrenewable, scientific resources that may be valuable to document the existence of extinct life forms and to reconstruct the environments in which they lived. Fossils can be used to determine the relative ages of the depositional layers in which they occur and of the geologic events that created those deposits. The age, abundance, and distribution of fossils depend on the geologic formation in which they occur and the topography of the area in which they are exposed. The geologic environments within which the plants or animals became fossilized usually were quite different from the present environments in which the geologic formations now exist. The fossil-bearing geologic formations in the area are relatively young, having been deposited between about 1 million and about 24 million years ago.

The unconsolidated deposits, such as recent Quaternary Alluvium (see Holocene and Pleistocene deposits on Figure 3.G-2), occur in the Livermore-Amador Valley along the majority of the collective footprint. The bedrock formations are just north of the I-580 corridor, in the Cayetano Creek Area. Many of the fossils in the undivided Quaternary sediments and the Livermore Gravel are fragmented vertebrate fossils, including extinct bison, camels, boney fish, mammoths, and horses. The distribution of fossil localities and the location of corresponding geologic units indicate that most of the vertebrate paleontological resources in Alameda County are southeast of I-680 in the upland foothills of the Diablo Range and in the Livermore Valley. Fossil localities diminish west of I-680

[47] City of Livermore, 2004. City of Livermore General Plan: 2003-2025.
[48] Ibid.
[49] California Department Of Conservation, Division of Mines and Geology, 1996. Mineral Resources Sectors Within Planning Area, Figure 8 3.

because much of that area is underlain by young alluvial and basin deposits that typically do not contain abundant fossil remains in their uppermost layers. Invertebrate paleontological resources occur throughout the Altamont Hills east of the study area.

Over 120 fossil localities are recorded for Alameda County in the University of California Museum of Paleontology database. Slightly more than half the localities contain megafossils (vertebrates or invertebrates identifiable without the aid of a microscope). Most of these localities—75 percent—are on the west slope of the Coast Ranges or in the valleys near Walnut Creek and Livermore in the undivided Quaternary deposits or the Livermore Gravel. All are vertebrate fossil sites, mostly containing fragmentary records of large vertebrates, including the extinct camel (Camelidae), horse (*Equus* sp.), giant ground sloth (Xenarthra), tapir (*Tapirus* sp.), and mammoth (*Mammuthus* sp.). The presence of mammoth, giant ground sloth, tapir, and camel suggests a Pleistocene rather than Holocene age for the fossil assemblage. The Cayetano Creek Area on the Livermore Gravel would be located on Pleistocene age materials. Additionally, a records search from the UCMP revealed three fossil localities to the northwest of the study area near the county line, where mammals such as mammoth, camel, and rodents were recovered).[50] A records search from the Natural History Museum of Los Angeles County returned an additional fossil locality where a specimen of fossil horse was discovered northwest of the study area near Martinez.[51]

Jefferson reported 11 vertebrate fossil localities from Livermore and Pleasanton, California.[52] Fossil taxa from these localities include frog (*Rana* sp.), salamander (*Aneides lugubris*), snake (*Colubridae*), turtle (*Clemmys* sp.), ducks or geese (*Anatidae*), dire wolf (*Canis dirus*), American lion or giant jaguar (*Panthera atrox*), mastodon (*Mammut* sp. cf. *M. americanum*), mammoth (*Mammuthus* sp.), horse (*Equus* sp.), camel (*Camelops hesternus* (type locality) and *Hemiauchenia* sp.), bison (*Bison antiquus*) and *Bison alaskensis*, ground sloth (*Paramylodon harlani*), gopher (*Thomomys* sp.), vole (*Microtus* sp.), and various rodents (*Thomomys* sp., *Reithrodontomys* sp., *Peromyscus* sp., *Neotoma* sp., *Microtus longicaudus*).

The Conformable Impact Mitigation Guidelines Committee of the Society of Vertebrate Paleontology (SVP) published Standard Guidelines in response to a recognized need to establish procedures for the investigation, collection, preservation, and cataloguing of

[50] Finger, 2016. University of California Museum of Paleontology (UCMP) Database, Livermore Extension.
[51] McLeod, 2016. Letter from Samuel A. McLeod, Vertebrate Paleontology, Los Angeles County Natural History Museum, with Environmental Science Associates. September 19.
[52] Jefferson, G.T., 1991. A Catalog of Late Quaternary Vertebrates from California: Part Two: Mammals. Natural History Museum of Los Angeles County. Technical Report No. 7.

fossil-bearing sites.[53] The Standard Guidelines are widely accepted among paleontologists, followed by most investigators, and identify the two key phases of paleontological resource protection: assessment and mitigation. 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. Mitigation involves formulating and applying measures to reduce such adverse effects, including pre-project survey and salvage, monitoring and screen washing during excavation to salvage fossils, conservation and inventory, and final reports and specimen curation. The SVP defines the level of potential as one of four sensitivity categories for sedimentary rocks—high potential, undetermined potential, low potential, and no potential—as listed below.

- **High Potential** – Rock units from which vertebrate or significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional significant paleontological resources. Rocks units classified as having high potential for producing paleontological resources include, but are not limited to, sedimentary formations and some volcaniclastic formations (e.g., ashes or tephras), and some low-grade metamorphic rocks that contain significant paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils (e.g., middle Holocene and older, fine-grained fluvial sandstones, argillaceous and carbonate-rich paleosols, cross-bedded point bar sandstones, fine-grained marine sandstones, etc.). Paleontological potential consists of both (1) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils; and (2) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data. Rock units that contain potentially datable organic remains older than late Holocene, including deposits associated with animal nests or middens and rock units that may contain new vertebrate deposits, traces, or trackways are also classified as having high potential.
- **Undetermined Potential** – Rock units for which little information is available concerning their paleontological content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine if these rock units have high or low potential to contain significant paleontological resources. A field survey by a qualified professional paleontologist to specifically determine the paleontological resource potential of these rock units is required before a paleontological resource impact mitigation program can be developed. In cases where no subsurface data are available, paleontological potential

[53] Society of Vertebrate Paleontology (SVP), 2010. Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources.

can sometimes be determined by strategically located excavations into subsurface stratigraphy.

- **Low Potential** – Reports in the paleontological literature or field surveys by a qualified professional paleontologist may allow determination that some rock units have low potential for yielding significant fossils. Such rock units will be poorly represented by fossil specimens in institutional collections or, based on general scientific consensus, only preserve fossils in rare circumstances and the presence of fossils is the exception not the rule, e.g., basalt flows or Recent (i.e., Holocene) colluvium. Rock units with low potential typically will not require impact mitigation measures to protect fossils.
- **No Potential** – This designation is assigned to geologic formations that are entirely plutonic (volcanic rocks formed beneath the earth's surface) in origin, and therefore have no potential for producing fossil remains.

In the context of CEQA, fossils of land-dwelling and marine vertebrates, their environment, and associated geological, stratigraphical, taphonomical, and geographical data are considered important (i.e., significant) paleontological resources. Such fossils typically are found in river, lake, and bog deposits, although they may occur in nearly any type of sedimentary sequence.

As shown in Figure 3.G-2, according to surficial geological mapping by Dibblee and Minch at a scale of 1:24,000, the majority of the study area along the I-580 corridor—including the Dublin/Pleasanton Station Area, the I-580 Corridor Area, Isabel North and South Areas, and Laughlin Road Area—is underlain by Quaternary alluvium.[54] Because it consists of recently deposited sediments, surficial exposures of Quaternary alluvium are considered to have low potential for paleontological resources; however, paleontological potential increases with depth below the ground surface (bgs), as age increases with depth. Therefore, below a depth of 5 feet bgs the Quaternary alluvium is considered to have high paleontological potential. In addition, within the Cayetano Creek Area, surficial geological units are composed of the Livermore Gravel geological unit. The Livermore Gravel fits the definition of high potential for paleontological resources, as these are readily identifiable sedimentary deposits with a discrete age range that does not extend to the Holocene.

In summary, areas of the study area that are generally along the I-580 corridor, are underlain by Quaternary alluvium and are considered to have low paleontological potential from the surface to 5 feet bgs and high paleontological potential below 5 feet bgs. While areas below 5 feet bgs could have high paleontological potential, the I-580 corridor has generally been previously disturbed and includes an unknown thickness of fill that was

[54] Dibblee, T.W. and J.A. Minch, 2006. Geologic Map of the Livermore Quadrangle, Contra Costa & Alameda Counties, California. In Parikh Consultants, 2016. Preliminary Geotechnical Report, BART to Livermore Extension, (Existing Dublin/Pleasanton Station to Future Isabel Station & Storage Yard), Alameda County, California. January 21.

placed for the freeway. The fill would not yield significant paleontological resources. The Cayetano Creek Area is underlain by the Livermore Gravel and is considered to have a high potential for paleontological resources. A field paleontological survey has not been completed for this analysis due to access limitations.

3. Regulatory Framework

This subsection describes the State and local environmental laws and policies relevant to geology, soils, seismicity, minerals, and paleontological resources.

a. State Regulations

(1) Alquist-Priolo Earthquake Fault Zoning Act

The State legislation protecting the population of California from the effects of fault-line ground-surface rupture is the Alquist-Priolo Earthquake Fault Zoning Act. This law was passed in 1972 in response to the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. At the directive of the Act, in 1972, the State Geologist began delineating Earthquake Fault Zones (called Special Studies Zones prior to 1994) around active and potentially active faults to reduce fault rupture risks to structures for human occupancy. Each earthquake fault zone extends approximately 200 to 500 feet on either side of the mapped fault trace because many active faults are complex and consist of more than one branch that may experience ground surface rupture. This Act has resulted in the preparation of maps delineating Earthquake Fault Zones to include, among others, recently active segments of the San Andreas and Hayward faults. The Act prohibits the building of structures intended for human occupancy across traces of active faults and provides for strictly regulated special seismic design considerations if developments are planned in areas adjacent to active or potentially active faults.[55]

The CGS is charged with identifying active faults and delineating the Earthquake Fault Zones around such traces where surface fault rupture is most likely to occur. According to the Act, a fault is considered active and eligible for zoning consideration if one or more of its segments shows evidence of surface displacement in the last 11,000 years.

(2) Seismic Hazard Mapping Act

The State regulations protecting the public from geoseismic hazards, other than surface faulting, are contained in California Public Resources Code, Division 2, Chapter 7.8 (the Seismic Hazards Mapping Act), described here, and 2007 California Code of Regulations,

[55] San Francisco Bay Area Rapid Transit District (BART), 2006. Warm Springs Extension Final Environmental Impact Statement, Section 4(f)/6(f) Evaluation.

Title 24, Part 2 (the California Building Code [CBC]), described below. Both of these regulations apply to public buildings, and a large percentage of private buildings, intended for human occupancy.

The Seismic Hazard Mapping Act was passed in 1990 following the Loma Prieta earthquake to reduce threats to public health and safety and to minimize property damage caused by earthquakes. The act directs the CGS to identify and map areas prone to the earthquake hazards of liquefaction, earthquake-induced landslides, and amplified groundshaking. The act requires site-specific geotechnical investigations to identify potential seismic hazards and formulate corrective measures prior to permitting most developments designed for human occupancy (which would include BART stations and maintenance facilities) in the Zones of Required Investigation. Seismic Hazard Maps have been published for the 7.5-minute quadrangles of Livermore and Altamont, which include the study area.

Section 2697 of the Seismic Hazards Mapping Act mandates that, prior to the approval of a project in a seismic hazard zone, a geotechnical report must be prepared by the project applicant defining and delineating any seismic hazard and providing recommendations to address seismic hazards. After the report is approved by the permitting agency, subsequent geotechnical reports are not required, provided that new geologic information warranting further investigation is not recorded for the subject project. The CBC requires that the recommendations of the report be incorporated in the building design.

(3) California Building Code

The CBC, which is codified in Title 24 of the California Code of Regulations, Part 2, was promulgated to safeguard the public health, safety, and general welfare by establishing minimum standards related to structural strength, means of egress facilities, and general stability of buildings. The purpose of the CBC is to regulate and control the design, construction, quality of materials, use/occupancy, location, and maintenance of all buildings and structures within its jurisdiction. 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 or they are not enforceable. The provisions of the CBC apply to the construction, alteration, movement, replacement, location, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California.

The 2016 edition of the CBC is based on the 2015 International Building Code published by the International Code Council. The code is updated every 3 years, and the 2016 edition of the CBC was published by the California Building Standards Commission in July 1, 2016, and takes effect starting January 1, 2017. The 2016 CBC contains California amendments based on the American Society of Civil Engineers Minimum Design Standard ASCE/SEI 7-10, Minimum Design Loads for Buildings and Other Structures, provides requirements for general structural design and includes means for determining earthquake loads as well as other loads (such as wind loads) for inclusion into building codes.[56] Seismic design provisions of the building code generally prescribe minimum lateral forces applied statically to the structure, combined with the gravity forces of the dead and live loads of the structure, which the structure then must be designed to withstand. The prescribed lateral forces are generally smaller than the actual peak forces that would be associated with a major earthquake. Consequently, structures should be able to (1) resist minor earthquakes without damage; (2) resist moderate earthquakes without structural damage, but with some nonstructural damage; and (3) resist major earthquakes without collapse, but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute a guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake. However, it is reasonable to expect that a structure designed in accordance with the seismic requirements of the CBC should not collapse in a major earthquake.

The earthquake design requirements take into account the occupancy category of the structure, site class, soil classifications, and various seismic coefficients, all of 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; SDC ranges from A (very small seismic vulnerability) to E/F (very high seismic vulnerability and near a major fault). Seismic design specifications are determined according to the SDC in accordance with Chapter 16 of the CBC. Chapter 18 of the CBC covers the requirements of geotechnical investigations (Section 1803), excavation, grading, and fills (Section 1804), load-bearing of soils (1806), as well as foundations (Section 1808), shallow foundations (Section 1809), and deep foundations (Section 1810). For Seismic Design Categories D, E, and F, Chapter 18 requires analysis of slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading, plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also addresses measures to be considered in structural design, which may include ground stabilization, selecting appropriate foundation type and depths, selecting appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. The potential for liquefaction and soil strength loss must be evaluated for site-specific peak ground acceleration magnitudes and source characteristics consistent with the design earthquake ground motions.

[56] A load is the overall force to which a structure is subjected in supporting a weight or mass, or in resisting externally applied forces. Excess load or overloading may cause structural failure.

Chapter 18 also describes analysis of expansive soils and the determination of the depth to groundwater table. Expansive soils are defined in the CBC as follows:

> **1803.5.3 Expansive Soil.** In areas likely to have expansive soil, the building official shall require soil tests to determine where such soils do exist. Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2, and 3 shall not be required if the test prescribed in Item 4 is conducted:
>
> 1. Plasticity index of 15 or greater, determined in accordance with American Society for Testing and Materials (ASTM) D 4318
> 2. More than 10 percent of the soil particles pass a No. 200 sieve (75 micrometers), determined in accordance with ASTM D 422
> 3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422
> 4. Expansion index greater than 20, determined in accordance with ASTM D 4829

The design of the Proposed Project and Build Alternatives would be required to comply with CBC requirements, which would make the proposed action consistent with the CBC.

(4) California Department of Transportation

Much of the study area is located in the I-580 ROW, and any work in this ROW is subject to California Department of Transportation (Caltrans) requirements governing allowable actions and modifications to the ROW. The State of California has established construction standards and design criteria for roadways to safeguard life and property. Construction standards and seismic design criteria are contained in such regulatory codes as Caltrans Seismic Design Criteria Version 1.7 (April 2013), Highway Design Manual, Sections 110.6, Earthquake Consideration (May 7, 2012), and 113, Geotechnical Design Report (May 7, 2012), or similar codes adopted by a city for roadway corridor protection. These criteria deal with pavement and subsurface utility design (flexible joints and couplings, overpass construction, etc.), slope stability (especially slumping, settling, and liquefaction in fills), alignment modification to reduce exposure to fault rupture or intense groundshaking, and ground failures such as liquefaction. Prior to construction, geotechnical studies are required to be undertaken and recommended seismic-protection measures are required to be accommodated in project design. The recommendations provide the required protection from the anticipated effects of seismic groundshaking. Adherence to these standards of protection is mandatory and would reduce the risk of injury or death from earthquakes to the maximum extent technically practicable.

The State regulations guidelines protecting bridges and overpasses from geoseismic hazards are contained in Caltrans Bridge Design Specifications, Bridge Memos to

Designers, Bridge Design Practices Manual, and Bridge Design Aids Manual. These manuals provide state-of-the art information to address geoseismic issues that affect the design of transportation infrastructure. Bridge design is required to be based on the "Load Factor Design methodology with HS20-44 live loading (a procedure to incorporate the estimated weight of the vehicles and/or pedestrians on the bridge with the weight of the bridge for loading calculations)." Seismic resistant design is required to conform to the Bridge Design Specifications, and Section 20 of Bridge Memos to Designers, as well as the Caltrans Seismic Design Criteria. The seismic provisions contained in these design guidelines, or similarly accepted ones, would be applied to the construction of the rail overcrossings proposed for the study area.

(5) California Public Resources Code

Several sections of the California Public Resources Code protect paleontological resources. Section 5097.5 prohibits knowing and willful excavation, removal, destruction, injury, and defacement of any paleontologic feature on public lands (lands under state, county, city, district, or public authority jurisdiction, or the jurisdiction of a public corporation), except where the agency with jurisdiction has granted permission. Section 30244 requires reasonable mitigation for impacts on paleontological resources that occur as a result of development on public lands. The sections of the California Administrative Code pertaining to the California Department of Parks and Recreation afford protection to geological features and paleontological materials, but grant the director of the State park system authority to issue permits for specific activities that may result in damage to such resources, if the activities are in the interest of the State park system and for State park purposes (California Administrative Code Sections 4307–4309[57]).

California Public Resources Code Section 5097.5 specifies that any unauthorized removal of paleontological remains is a misdemeanor. Further, the California Penal Code Section 622.5 sets the penalties for the damage or removal of paleontological resources. Other State requirements for paleontological resource management are in California Public Resources Code Chapter 1.7, Section 5097.5 through 5097.9 (Stats. 1965, c. 1136, p. 2792), Archaeological, Paleontological, and Historical Sites. This statute defines any unauthorized disturbance or removal of a fossil site or remains on public land as a misdemeanor and specifies that State agencies may undertake surveys, excavations, or other operations as necessary on State lands to preserve or record paleontological resources.

[57] As cited in United States Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG), 2006.

(6) National Pollutant Discharge Elimination System Construction General Permit

The National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order 2009-0009-DWQ, NPDES No. CAS000002, Construction General Permit, as amended by Orders 2010-0014-DWQ and 2012-006-DWQ). The Construction General Permit regulates discharges of pollutants in stormwater associated with construction activity to waters of the U.S. from construction sites that disturb 1 or more acres of land surface, or that are part of a common plan of development or sale that disturbs more than 1 acre of land surface. The permit regulates stormwater discharges associated with construction or demolition activities, such as clearing and excavation; construction of buildings and structures; and linear underground projects.

The Construction General Permit requires that construction sites be assigned a Risk Level of 1 (low), 2 (medium), or 3 (high), based both on the sediment transport risk at the site and the receiving waters risk during periods of soil exposure (e.g., grading and site stabilization). The sediment risk level reflects the relative amount of sediment that could be discharged to receiving water bodies and is based on the nature of the construction activities and the location of the site relative to receiving water bodies. The receiving waters risk level reflects the risk to the receiving waters from the sediment discharge. The Construction General Permit contains requirements for each Risk Level category. Depending on its location within a sensitive watershed area or floodplain, the level of receiving water risk could be considered low, medium, or high. Depending on the Risk Level, the construction projects could be subject to the following Construction General Permit requirements:

- Effluent standards
- Good site management housekeeping
- Non-stormwater management
- Erosion and sediment controls
- Run-on and runoff controls
- Inspection, maintenance, and repair
- Monitoring and reporting requirements

The Construction General Permit requires the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) that includes specific best management practices (BMPs) designed to prevent pollutants from contacting stormwater and keep all products of erosion from moving offsite into receiving waters. The SWPPP BMPs are intended to protect surface water quality by preventing the offsite migration of eroded soil and construction-related pollutants from the construction area. Routine inspection of all BMPs is required under the provisions of the Construction General Permit. In addition, the SWPPP is required to contain a visual monitoring program, a chemical monitoring program for non-visible pollutants, and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment.

The SWPPP must be prepared before the construction begins. The SWPPP must contain a site map(s) that delineates the construction work area, existing and proposed buildings and structures, parcel boundaries, roadways, stormwater collection and discharge points, general topography both before and after construction, and drainage patterns across the study area. The SWPPP must list BMPs and the placement of those BMPs that the applicant would use to protect stormwater runoff. Examples of typical construction BMPs include scheduling or limiting certain activities to dry periods, installing sediment barriers such as silt fence and fiber rolls, and maintaining equipment and vehicles used for construction. Non-stormwater management measures include installing specific discharge controls during certain activities, such as paving operations and vehicle and equipment washing and fueling. The Construction General Permit also sets post-construction standards (i.e., implementation of BMPs to reduce pollutants in stormwater discharges from the site following construction).

In the study area, the Construction General Permit is implemented and enforced by the San Francisco Bay Regional Water Quality Control Board (RWQCB), which administers the stormwater permitting program. Dischargers are required to electronically submit a notice of intent and permit registration documents to obtain coverage under this Construction General Permit. Dischargers are responsible for notifying the RWQCB of violations or incidents of non-compliance, as well as for submitting annual reports identifying deficiencies of the BMPs and how the deficiencies were corrected.

The permit contains several additional compliance items, including (1) additional mandatory BMPs to reduce erosion and sedimentation, which may include vegetated swales, setbacks and buffers, rooftop and impervious surface disconnection, bioretention cells, rain gardens, rain cisterns, implementation of pollution/sediment/spill control plans, training, and other structural and nonstructural actions; (2) sampling and monitoring for non-visible pollutants; (3) effluent monitoring and annual compliance reports; (4) development and adherence to a Rain Event Action Plan; (5) requirements for post-construction; (6) numeric action levels and effluent limits for pH and turbidity; (7) monitoring of soil characteristics on site; and (8) mandatory training under a specific curriculum.

(7) California Environmental Quality Act Statute and Guidelines

CEQA requires that public agencies identify the environmental consequences of their proposed projects and project approvals and as such, unique paleontological resources and geologic features are afforded consideration under CEQA. Appendix G of the CEQA guidelines (Title 14, Division 6, Chapter 3, California Code of Regulations: 15000 et seq.)

includes as one of the questions to be answered in the Environmental Checklist (Appendix G, Section V, Part c) the following: "Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?"

b. Local Regulations

(1) BART Facilities Standards

The BART Facilities Standards specify design criteria to protect structures and persons from seismic hazards. The BART Facilities Standards specify design criteria to ensure that all structures, equipment, and supports are designed to survive ground motions without collapse. The objectives are to ensure safety, prevent prolonged interruption of project operations due to structural failure or damage, and to protect the permanent stationary facilities.

All BART structures—including aboveground passenger stations, rail structures, retaining walls, and cut-and-cover subway structures—would be designed and built in accordance with seismic design standards contained in the BART Facilities Standards, Release 3.0.2 (January 2015), The design criteria include the following:

- Aerial structure design shall meet the requirements of the Caltrans Bridge Design Specifications, American Concrete Institute Building Code Requirements for Reinforced Concrete, ACI 318 (which covers material design and construction of concrete structures); American Institute of Steel Construction, Steel Construction Manual Allowable Stress Design, Part 5 – Specifications and Codes; and American Institute of Steel Construction, Load and Resistance Factor Design.
- Design of at-grade-station structures and buildings would be governed by the provisions of the CBC as modified in Articles 6.5.2 through 6.5.7 of the BART Facilities Standards. Station structures and buildings shall be designed with an importance factor of 1.5 (specified in the BART Design Standard as structures whose integrity is essential to the normal operation of BART trains).
- Parking Station (classified as non-essential structures) shall be designed with an importance factor of 1.25 and shall comply with the provision of Articles 6.5.4 and 6.5.5 set forth in the BART Facilities Standards.

(2) Soil Erosion Control Regulations

Also see Section 3.H, Hydrology and Water Quality, Regulatory Framework, for an additional description of the NPDES Construction General Permit and the Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4) Permit, administered by the RWQCB.

4. Impacts and Mitigation Measures

This subsection lists the standards of significance used to assess impacts, discusses the methodology used in the analysis, summarizes the impacts, and then provides an in-depth analysis of the impacts with mitigation measures identified as appropriate.

a. Standards of Significance

For the purposes of this EIR, impacts on geology, soils, seismicity, mineral resources, or paleontological resources are considered significant if the Proposed Project or one of the Alternatives would result in any of the following:

- Expose people or structures to potential substantial adverse effects, including 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 or Seismic Hazards Map issued by the State Geologist for the area or based on other substantial evidence of a known fault [refer to CGS Special Publications 42]

    Strong seismic groundshaking

    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 on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse
- Be located on expansive or corrosive soil creating substantial risks to life or property[58]
- 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
- Result in a loss of availability of a known mineral resource that would be of value to the region and the residents of the State
- Result in a loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan
- Directly or indirectly destroy unique paleontological resource or site or unique geologic feature

[58] As discussed in Regulatory Framework, the current CBC no longer provides Table 18-1-B, which is still cited in the Appendix G Guidelines.

b. Impact Methodology

The analysis focuses on the proposed activities that would result in ground disturbing activities and the construction of new or additional infrastructure for the Proposed Project and Build Alternatives. The EMU Option would result in the same impacts as the DMU Alternative; therefore, the analysis and conclusions for the DMU Alternative also apply to the EMU Option.

The analysis of the Enhanced Bus Alternative, which addresses the potential impacts of construction of the bus infrastructure improvements and operation of the bus routes at a programmatic level, would also apply to the bus improvements and feeder bus service under the Proposed Project and other Build Alternatives. Therefore, the analyses and conclusions for the Enhanced Bus Alternative also apply to the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative, and are not repeated in the analysis of the Proposed Project and other Build Alternatives.

Many of the potential impacts related to geologic, soils, and seismic conditions could be the same during construction and operation of the Proposed Project or Build Alternatives. Because the nature of many these impacts would be the same, they are collectively discussed below under Operational Impacts. However, permanent erosion or loss of topsoil, loss of mineral resources, and loss of paleontological resources occurring only during construction are discussed in the Construction Impacts subsection below.

c. Summary of Impacts

Table 3.G-4 summarizes the impacts of the Proposed Project and Alternatives described in the analysis below.

TABLE 3.G-4 SUMMARY OF GEOLOGY, SOILS, SEISMICITY, MINERAL, AND PALEONTOLOGICAL RESOURCES IMPACTS

Impacts	No Project Alternative	Conventional BART Project[b]	DMU Alternative (with EMU Option)[b]	Express Bus/BRT Alternative[b]	Enhanced Bus Alternative
Construction					
		Project Analysis			
Impact GEO-1: Soil erosion or loss of topsoil during construction	NI	LS	LS	LS	LS
Impact GEO-2: Result in a loss of availability of mineral resources during construction	NI	LS	LS	NI	NI
Impact PALEO-1: Loss of paleontological resources during construction	NI	LSM	LSM	LSM	NI
		Cumulative Analysis			
Impact GEO-3(CU): Soil erosion or loss of topsoil during construction under Cumulative Conditions	NI	LS	LS	LS	LS
Impact GEO-4(CU): Result in a loss of availability of mineral resources during construction under Cumulative Conditions	NI	LS	LS	NI	NI
Impact PALEO-2(CU): Loss of paleontological resources during construction under Cumulative Conditions	NI	LS	LS	LS	NI
Operational					
		Project Analysis			
Impact GEO-5: Fault rupture during operations	NI	LSM	LS	LS	LS
Impact GEO-6: Seismic shaking, seismic-induced ground failure, and landslides during operations	NI	LS	LS	LS	LS
Impact GEO-7: Unstable geologic units or soil during operations	NI	LS	LS	LS	LS

TABLE 3.G-4 SUMMARY OF GEOLOGY, SOILS, SEISMICITY, MINERAL, AND PALEONTOLOGICAL RESOURCES IMPACTS

Impacts	No Project Alternative	Conventional BART Project[b]	DMU Alternative (with EMU Option)[b]	Express Bus/BRT Alternative[b]	Enhanced Bus Alternative
Impact GEO-8: Expansive or corrosive soil during operations	NI	LS	LS	LS	LS
Impact GEO-9: Soils supporting septic tanks or alternative wastewater systems during operations	NI	NI	NI	NI	NI
Cumulative Analysis					
Impact GEO-10(CU): Fault rupture, seismic shaking, seismic-induced ground failure, landslides, unstable geologic units or soil, and expansive or corrosive soil during operations under Cumulative Conditions	NI	LS	LS	LS	LS

Notes: NI=No impact; LS=Less-than-Significant impact, no mitigation required; LSM=Less-than-Significant impact with mitigation.
DMU = diesel multiple unit; EMU = electrical multiple unit; BRT = bus rapid transit
[a] All significance determinations listed in the table assume incorporation of applicable mitigation measures.
[b] The analysis of the Enhanced Bus Alternative also applies to the feeder bus service and bus improvements under the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative, as described in the Impact Methodology subsection above.

d. Environmental Analysis

Impacts related to project construction are described below, followed by operations impacts.

(1) Construction Impacts

Potential impacts pertaining to project construction are described below, followed by cumulative construction impacts.

Construction associated with the Proposed Project and Alternatives would permanently affect potential geological and paleontological resources during ground disturbing activities. Therefore, the construction impacts described below are considered to be permanent (rather than temporary).

(a) Construction – Project Analysis

Impact GEO-1: Result in substantial soil erosion or the loss of topsoil during construction.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: LS)

As discussed in Chapter 2, Project Description, the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative would each disturb more than 1 acre of ground. The Enhanced Bus improvements would be in previously developed, urbanized (generally paved) areas. Collectively, the improvements under the Enhanced Bus Alternative could disturb more than 1 acre and, if so, would be required to comply with the Construction General Permit and the MS4 Permit, similar to the Proposed Project. Project construction would involve short-term ground disturbance (e.g., grading, excavation, and drilling) associated with the construction of buildings and structures. While many of the facilities would be constructed in relatively flat areas with minimal slope, which would minimize the potential for soil erosion during construction, the Cayetano Creek Area is an area with greater topographic slope, and therefore has a greater potential for erosion.

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented and there would be no physical changes in the environment associated with construction of the Proposed Project or any of the Build Alternatives. However, planned and programmed transportation improvements for segments of I-580, local roadways and intersections, and core transit service improvements for BART, the Altamont Corridor Express (ACE), and the Livermore-Amador Valley Transit Authority (LAVTA) would be constructed. In addition, population and employment increases throughout Alameda County would result in continued land use development, including construction of both residential and commercial uses.

Construction of these improvements and development projects could adversely impact soil erosion or the loss of topsoil. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented, and the No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. Therefore, the No Project Alternative is considered to have no impacts related to soil erosion and topsoil. **(NI)**

Conventional BART Project. Approximately 411 acres are within the permanent project footprint and approximately 29 acres are within the temporary construction staging area footprint. While much of the permanent footprint consists of I-580 and would have a limited amount of ground disturbance for construction, many parcels are not currently developed with transportation uses and would be redeveloped—approximately 182 acres.

Because the overall footprint of construction activities would exceed 1 acre, the Proposed Project would be required to comply with the NPDES Construction General Permit and the MS-4 Permit, described in the Regulatory Framework subsection above. These State requirements were developed to ensure that stormwater is managed and erosion is controlled on construction sites. The Construction General Permit requires preparation and implementation of a SWPPP, which requires application of BMPs to control runoff of water from construction work sites. The BMPs would include but not be limited to physical barriers to prevent erosion and sedimentation, construction of sedimentation basins, limitations on work periods during storm events, use of bioinfiltration swales, protection of stockpiled materials, and a variety of other measures that would substantially reduce or prevent erosion from occurring during construction.

Because project construction activities would be subject to the requirements discussed above, which would control erosion, the Proposed Project would not cause substantial increases in soil erosion during construction. Therefore, through compliance with the Construction General Permit, the Proposed Project would have less-than-significant impacts related to soil erosion, and no mitigation measures are required. **(LS)**

DMU Alternative. Approximately 405 acres are within the permanent DMU Alternative footprint and approximately 32 acres are within the temporary construction staging area footprint. While much of the permanent footprint consists of I-580 and would have a limited amount of ground disturbance for construction, many acres are not currently developed with transportation uses and would be redeveloped—approximately 137 acres. The DMU Alternative would have the same general footprint as the Proposed Project with the addition of improvements at the Dublin/Pleasanton Station Area, and would thus have the same potential for substantial soil erosion as the Proposed Project. However, similar to the Proposed Project, construction activities would be subject to the requirements of the Construction General Permit and the MS-4 Permit and would not cause substantial increases in soil erosion. Therefore, the DMU Alternative would have less-than-significant impacts related to soil erosion and no mitigation measures are required. **(LS)**

Express Bus/BRT Alternative. Approximately 77 acres are within the permanent Express Bus/BRT Alternative footprint and approximately 6 acres within the temporary construction staging area footprint. The Express Bus/BRT Alternative would entail improvements at the Dublin/Pleasanton Station Area, as well as at the Laughlin Road Area. While much of the permanent footprint consists of I-580 and would have a limited amount of ground disturbance for construction, many acres are not currently developed with transportation uses and would be redeveloped—approximately 22 acres. The Express Bus/BRT Alternative would disturb more than 1 acre, and therefore would be required to comply with the Construction General Permit and the MS-4 Permit. Therefore, the Express Bus/BRT Alternative would have less-than-significant impacts related to soil erosion, and no mitigation measures are required. **(LS)**

Enhanced Bus Alternative. The bus infrastructure improvements that would be constructed under the Enhanced Bus Alternative within existing street ROWs, east of the Dublin/Pleasanton Station. Collectively, the improvements under the Enhanced Bus Alternative may disturb more than 1 acre and, if so, would be required to comply with the Construction General Permit and the MS-4 Permit. Therefore, the Enhanced Bus Alternative would have less-than-significant impacts related to soil erosion and no mitigation measures are required. **(LS)**

Mitigation Measures. As described above, the Proposed Project and Alternatives would not result in significant impacts related to soil erosion, and no mitigation measures are required.

Impact GEO-2: Result in a loss of availability of a known mineral resource that would be of value to the region and the residents of the State or a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan during construction.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: NI; Enhanced Bus Alternative: NI)

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented and there would be no physical changes in the environment associated with construction of the Proposed Project or any of the Build Alternatives. Construction of the planned and programmed transportation improvements and continued land use development, including construction of residential and commercial uses under the No Project Alternative, could adversely impact mineral resources. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented, and the No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. Therefore, the No Project Alternative is considered to have no impacts related to mineral resources. **(NI)**

Conventional BART Project and DMU Alternative. As discussed in the Mineral Resources subsection above, the I-580 corridor is designated as MRZ-1 and the Cayetano Creek Area is designated as MRZ-4.[59] There are no known mineral resources that would be of value to the region and the residents of the State or a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan within the

[59] MRZ-1 zones are areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence. MRZ-4 zones are areas where available information is inadequate for assignment to any other MRZ zone with mineral deposits.

footprints of the Proposed Project or DMU Alternative. While the Cayetano Creek Area extends into an area underlain by the Livermore Gravel, which could be a source of aggregate, it has been designated as MRZ-4 by the CGS, and therefore is not a known mineral resource. Additionally, as described in Section 3.C, Land Use and Agricultural Resources, this area is zoned for agricultural uses. Therefore, the Proposed Project and DMU Alternative would have less-than-significant impacts related to mineral resources. **(LS)**

Express Bus/BRT Alternative and Enhanced Bus Alternative. As described above, the I-580 corridor is designated as MRZ-1. There are no known mineral resources that would be of value to the region and the residents of the State or a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan within the footprints of the Express Bus/BRT Alternative and Enhanced Bus Alternative. Therefore, the Express Bus/BRT Alternative and Enhanced Bus Alternative would have no impacts related to mineral resources. **(NI)**

Mitigation Measures. As described above, the Proposed Project and Alternatives would not result in significant impacts related to loss of mineral resources, and no mitigation measures are required.

Impact PALEO-1: Directly or indirectly destroy unique paleontological resource or site or unique geologic feature during construction.

(No Project Alternative: NI; Conventional BART Project: LSM; DMU Alternative: LSM; Express Bus/BRT Alternative: LSM; Enhanced Bus Alternative: LSM)

As discussed in the Geologic Units subsection above, the Quaternary Alluvial Deposits and the Livermore Gravel are not unique geologic units and are not discussed further. Therefore, the analysis below focuses on the potential for paleontological resources within those units.

As discussed in the Paleontological Resources subsection above, the I-580 corridor—including the Dublin/Pleasanton Station Area, the I-580 Corridor Area, Isabel North and South Areas, and Laughlin Road Area—is generally underlain by Quaternary alluvium and is considered to have low paleontological potential from the surface to 5 feet bgs, but has high paleontological potential below 5 feet bgs. The I-580 corridor has generally been previously disturbed due to prior construction activities and has an unknown thickness of fill placed for the construction of the freeway, which would not yield significant paleontological resources. Within the Cayetano Creek Area, the Livermore Gravels are considered to have a high potential for paleontological resources.

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented, and there would be no physical changes in the environment associated with construction of the Proposed Project or any of the Build Alternatives. Construction of the planned and programmed transportation improvements and continued land use development, including construction of residential and commercial uses under the No Project Alternative, could adversely impact paleontological resources. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented, and the No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. Therefore, the No Project Alternative is considered to have no impacts related to paleontological resources. **(NI)**

Conventional BART Project. As described above, within the I-580 corridor, the soils have low potential for paleontological resources up to 5 feet bgs. However, excavation and construction below 5 feet bgs could disturb previously undisturbed native materials with high paleontological potential. Within the Cayetano Creek Area, the Livermore Gravels have high paleontological potential.

As shown in Table 2-13 in Chapter 2, Project Description, typical construction activities for the Proposed Project would generally be up to 4 feet bgs for such activities as construction staging, I-580 relocation and surface frontage road relocations, installation of new or replacement rail tracks, Isabel Station pedestrian touchdown structures, storage and maintenance facility buildings and structures, and construction of surface parking lots and parking garage structures. The range of excavation for other construction activities would include approximately 10 feet bgs for construction of the Isabel Station; approximately 25 feet bgs for construction of the underpass structure under westbound I-580 for the tail tracks; and up to 70 feet for the hillside tunnel in the Cayetano Creek Area. Where piles are needed for structural support, they could be driven or drilled to approximately 60 feet bgs. Where pile driving is required, the upper 5 feet of soils would be exposed due to other construction activities, thus exposing paleontological resources if present. For deeper depths, the process of installing the piles would not enable the inspection of subsurface materials.

Construction of the Proposed Project has the potential to damage paleontological resources and could result in significant impacts to these resources. This potential impact would be reduced to a less-than-significant level with implementation of the following mitigation measures: **Mitigation Measure PALEO-1A**, which includes provisions for conducting the paleontological survey in the Cayetano Creek Area; **Mitigation Measure PALEO-1B**, which requires a paleontological monitor during construction activities in areas with a high paleontological potential; and **Mitigation Measure PALEO-1C**, which provides protocols to follow in the event of an unanticipated discovery of a paleontological resource during any construction activities. **(LSM)**

DMU Alternative. The DMU Alternative would have the same general footprint as the Proposed Project, as well as improvements at the Dublin/Pleasanton Station Area. As shown in Table 2-13 in Chapter 2, Project Description, excavation and construction activities for the components of the DMU Alternative would generally be approximately 4 feet bgs, with some areas of excavation ranging from 10 to 70 feet bgs, similar to the Proposed Project. The DMU Alternative components would be located on the same geologic units as the Proposed Project and there would be a similar potential for encountering paleontological resources during construction. Thus, impacts related to paleontological resources under the DMU Alternative could be significant.

Implementation of the following mitigation measures would reduce potential impacts to a less-than-significant level: **Mitigation Measure PALEO-1A**, which includes provisions for conducting the paleontological survey in the Cayetano Creek Area; **Mitigation Measure PALEO-1B**, which requires a paleontological monitor during construction activities in areas with a high paleontological potential; and **Mitigation Measure PALEO-1C**, which provides protocols to follow in the event of an unanticipated discovery of a paleontological resource during any construction activities. **(LSM)**

Express Bus/BRT Alternative. The Express Bus/BRT Alternative would entail improvements at the existing Dublin/Pleasanton Station Area, as well as at the Laughlin Road Area. As shown in Table 2-13 in Chapter 2, Project Description, excavation and construction activities for the components of the Express Bus/BRT Alternative would generally be approximately 4 feet bgs, with some areas of excavation ranging up to 25 feet bgs. Although the locations of the improvements for the Express Bus/BRT Alternative are all in previously disturbed areas within existing ROWs, the construction of the bus transfer platform would include excavation to 25 feet bgs and could encounter previously undisturbed soil. Thus, impacts related to paleontological resources under the Express Bus/BRT Alternative could be significant.

Implementation of the following mitigation measures would reduce potential impacts to a less-than-significant level: **Mitigation Measure PALEO-1B**, which requires a paleontological monitor during construction activities in areas with a high paleontological potential; and **Mitigation Measure PALEO-1C**, which provides protocols to follow in the event of an unanticipated discovery of a paleontological resource during any construction activities. **(LSM)**

Enhanced Bus Alternative. Under the Enhanced Bus Alternative, construction would occur within existing street ROWs, east of the Dublin/Pleasanton Station. Excavation and construction activities for the components of the Enhanced Bus Alternative would be up to approximately 2 feet bgs. It is likely that paleontological resources, if any had been present, would have already been destroyed or removed due to construction of roadways and infrastructure. Consequently, the improvements for the Enhanced Bus Alternative would be constructed in areas with no paleontological resource potential. Therefore, there would be no impacts related to paleontological resources under the Enhanced Bus Alternative and no mitigation measures are required. **(NI)**

Mitigation Measures. As described above, the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative would have potentially significant impacts to paleontological resources. However, for the Proposed Project and DMU Alternative, with implementation of **Mitigation Measure PALEO-1A**, which would require a paleontological survey of the Cayetano Creek Area, potential impacts would be reduced. Furthermore, for the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative, with implementation of **Mitigation Measure PALEO-1B**, which requires a paleontological monitor during construction activities in areas with a high paleontological potential, and **Mitigation Measure PALEO-1C**, which would require discovery protocols be followed in the event of an unanticipated discovery of a paleontological resource during any construction activities, potential impacts would be reduced to a less-than-significant level.

As described above, the Enhanced Bus Alternative would not result in significant impacts related to paleontological resources, and no mitigation measures are required for this alternative.

Mitigation Measure PALEO-1A: Surface Paleontological Survey of the Cayetano Creek Area (Conventional BART Project and DMU Alternative).

During the design phase and prior to any ground disturbing activity in the Cayetano Creek Area, BART shall retain a professional paleontologist, who meets the professional standards of the SVP, to conduct a field (surface) paleontological survey of the Cayetano Creek Area in accordance with SVP standards. The survey shall include a formal evaluation to determine if paleontological resources are present pursuant to SVP Guidelines. If unique paleontological resources are present, the paleontologist shall review project design plans and geotechnical investigations to ascertain which activities could impact highly sensitive sediments. The paleontologist shall prepare a detailed monitoring plan that describes where and when paleontological monitoring shall be required during construction in the Cayetano Creek Area, which shall be implemented as part of **Mitigation Measure PALEO-1B**.

Mitigation Measure PALEO-1B: Paleontological Monitoring (Conventional BART Project, DMU Alternative, and Express Bus/BRT Alternative).

All construction workers, regardless of where they are working, shall receive training in the recognition of paleontological resources by a qualified paleontologist. During any excavation or grading activities that extend to below 5 feet bgs, either along the I-580 alignment (Dublin/Pleasanton Station Area, I-580 Corridor Area, Isabel North and South Areas, and Laughlin Road Area) or in the Cayetano Creek Area (if required by the monitoring plan developed under **Mitigation Measure PALEO-1A**), BART shall retain a qualified paleontologist meeting the professional standards of the SVP and Caltrans to conduct paleontological monitoring in accordance with Caltrans standards. The paleontological monitor shall have the authority to halt any excavation or grading activities to collect discovered paleontological resources and implement **Mitigation Measure PALEO-1C**.

Mitigation Measure PALEO-1C: Discovery of Previously Unknown Paleontological Resources (Conventional BART Project, DMU Alternative, and Express Bus/BRT Alternative).

1. If paleontological resources are encountered by construction personnel, all construction activities within 100 feet shall halt until a qualified paleontologist can assess the significance of the find.
2. If the resources are significant, the paleontologist shall prepare a mitigation plan that shall recommend avoidance or, if avoidance is not feasible, resource recovery through excavation.
3. If avoidance is feasible, this may be accomplished through one of the following means: (1) modifying the construction plan to avoid the resource; (2) incorporating the resource within open space; or (3) deeding the resource site into a permanent conservation easement.
4. If avoidance is not feasible, a qualified paleontologist shall document, excavate, preserve, and recover the paleontological resource. The paleontological resource shall be sent to a facility appropriate for the preservation of paleontological resources as designated by the paleontologist.

(b) Construction – Cumulative Analysis

The geographic study area for the cumulative analysis would be the same as that described in the Introduction subsection above. The cumulative context for construction impacts includes various projects in the Livermore-Amador Valley, and the cities of Dublin, Pleasanton, and Livermore as described in Section 3.A, Introduction to Environmental Analysis and Appendix E, and focuses on the projects that would occur along the I-580 corridor.

Impact GEO-3(CU): Result in substantial soil erosion or the loss of topsoil during construction under Cumulative Conditions.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: LS)

No Project Alternative. As described in **Impact GEO-1** above, the No Project Alternative would have no impact on soils during construction. Therefore, the No Project Alternative would not contribute to cumulative impacts. **(NI)**

Conventional BART Project and Build Alternatives. Several of the cumulative projects could be under construction at the same time as the Proposed Project and Build Alternatives. For example, a portion of the Isabel Neighborhood Plan (INP) is scheduled to be under construction concurrently with the Proposed Project and DMU Alternative. A similar schedule overlap could occur for the Kaiser Dublin Medical Center project as well as several other cumulative projects. Each of these projects would be subject to the State Construction General Permit, which requires the preparation and implementation of a SWPPP for each project that disturbs more than 1 acre. The SWPPPs would describe BMPs to control runoff and prevent erosion. The Construction General Permit has been developed to address cumulative conditions arising from construction throughout the state, and maintains the cumulative effects of projects subject to this requirement below levels that would be considered significant. For example, two adjacent construction sites would both be required to implement BMPs to reduce and control the release of sediment and/or other pollutants in any runoff leaving their respective sites. The runoff water from both sites would be required to achieve the same action levels, measured as a maximum amount of sediment or pollutant allowed per unit volume of runoff water. Thus, even if the runoff waters were to combine after leaving the sites, the sediments and/or pollutants in the combined runoff would still be at concentrations (amount of sediment or pollutants per volume of runoff water) below action levels. Therefore, the Proposed Project and Build Alternatives, in combination with cumulative projects that may be under construction currently, would result in less-than-significant cumulative impacts related to soil erosion. **(LS)**

Mitigation Measures. As described above, Proposed Project and Alternatives in combination with probable future projects would not result in significant cumulative impacts related to soil erosion, and no mitigation measures are required.

Impact GEO-4(CU): Result in a loss of availability of a known mineral resource that would be of value to the region and the residents of the State or a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan during construction under Cumulative Conditions.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: NI; Enhanced Bus Alternative: NI)

No Project Alternative. As described in **Impact GEO-2** above, the No Project Alternative would have no impact related to loss of mineral resources. Therefore, the No Project Alternative would not contribute to cumulative impacts. **(NI)**

Conventional BART Project and DMU Alternative. Some of the cumulative projects could be constructed in areas with potential for mineral resources. Together, the Proposed Project or DMU Alternative and the cumulative projects could result in the general loss of the resource due to construction of projects in areas with potential resources. However, the cumulative projects would undergo their own environmental review and would be required to comply with regulations pertaining to mineral resources. Therefore, potential cumulative impacts to mineral resources would be avoided and/or reduced to less than significant. Therefore, cumulative impacts to mineral resources would be less than significant. **(LS)**

Express Bus/BRT Alternative and Enhanced Bus Alternative. As described in **Impact GEO-2** above, these alternatives would have no impact related to loss of mineral resources. Therefore, the Express Bus/BRT Alternative and Enhanced Bus Alternative would not contribute to cumulative impacts. **(NI)**

Mitigation Measures. As described above, the Proposed Project and Alternatives would not result in significant cumulative impacts related to loss of mineral resources, and no mitigation measures are required.

Impact PALEO-2(CU): Directly or indirectly destroy unique paleontological resource during construction under Cumulative Conditions.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: NI)

No Project Alternative. As described in **Impact PALEO-1** above, the No Project Alternative would have no impact on paleontological resources during construction. Therefore, the No Project Alternative would not contribute to cumulative impacts. **(NI)**

Conventional BART Project, DMU Alternative, and Express Bus/BRT Alternative. Several of the cumulative projects, including the INP, would be constructed in areas with potential for paleontological resources, similar to the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative. Together, the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative, and the cumulative projects, could result in the general loss of the resource due to construction of projects in areas with potential resources.

However, as described in **Impact PALEO-1**, the Proposed Project and DMU Alternative would implement **Mitigation Measure PALEO-1A**, which would require a paleontological survey of the Cayetano Creek Area. In addition, the Proposed Project, DMU Alternative, and Express Bus/BRT Alternative, would implement **Mitigation Measure PALEO-1B**, which requires a paleontological monitor during construction activities in areas with a high paleontological potential, and **Mitigation Measure PALEO-1C**, which requires discovery protocols be followed in the event of an unanticipated discovery of a paleontological resource during any construction activities. In addition, cumulative projects would undergo their own environmental review and would also be required to comply with the similar requirements to mitigate potential impacts to paleontological resources. With implementation of these measures, potential cumulative impacts to paleontological resources would be avoided and/or reduced to less than significant. Therefore, cumulative impacts to paleontological resources would be less than significant. **(LS)**

Enhanced Bus Alternative. The Enhanced Bus Alternative would result in no project impacts as described in **Impact PALEO-1** above, and therefore would not contribute to cumulative paleontological impacts (no impact). **(NI)**

Mitigation Measures. As described above, the Proposed Project and Alternatives, in combination with past, present, or probable future projects, would not result in significant cumulative impacts to paleontological resources, and no mitigation measures are required.

(2) Operational Impacts

Potential impacts related to project operations are described below, followed by cumulative operations impacts.

(a) Operations – Project Analysis

Impact GEO-5: Expose people or structures to potential substantial adverse effects, including 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 during operations.

(No Project Alternative: NI; Conventional BART Project: LSM; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: LS)

As discussed in the Local Setting subsection above, there are a number of known active faults within 20 miles of the collective footprint. A significant impact relative to the rupture of a known active fault could occur if the new structures and facilities were to be located directly on a known active fault. The rupture of a fault could damage rail lines, foundations, and structures, resulting in the risk of injury or death to the public or structural failure.

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented and there would be no physical changes in the environment associated with the Proposed Project or any of the Build Alternatives. Construction of the planned and programmed transportation improvements and continued land use development, including construction of residential and commercial uses under the No Project Alternative, could have adverse impacts related to fault rupture. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented, and the No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. Therefore, the No Project Alternative is considered to have no fault rupture impacts. **(NI)**

Conventional BART Project. None of the new structures or facilities that would be constructed under the Proposed Project would be located within a State-designated Alquist-Priolo Earthquake Fault Zone (i.e., on a State-recognized active fault trace).

Although there are no State-designated Alquist-Priolo Earthquake Fault Zones beneath the footprint of the Proposed Project, several other faults extend beneath the footprint. Both the Mocho and Livermore faults are not known to be active; therefore, the area beneath these faults is not designated as an Alquist-Priolo Earthquake Fault Zone. However, the Mount Diablo Thrust Fault is active, with movement over the past 900 years and a slip rate of 1.7 to 1.8 millimeters per year, according to recent studies.[60] Therefore, while the Mount Diablo Thrust Fault is not a State-designated Alquist-Priolo Earthquake Fault Zone, the fault could experience fault rupture. The storage and maintenance facility in the Cayetano Creek Area is bisected by the Mount Diablo Thrust Fault. Therefore, placement of structures on the Mount Diablo Thrust Fault could result in significant impacts related to fault rupture that could damage structures and place workers at risk.

Given the location of the Mount Diablo Thrust Fault beneath the proposed storage and maintenance facility, the Proposed Project could result in significant impacts related to fault rupture, although the Proposed Project would not alter the seismic environment or increase the risk of fault rupture. This potential impact would be reduced with the

[60] Sawyer, Thomas L., 2015. Characterizing Rates of Contractional Deformation on the Mount Diablo Thrust Fault, Eastern San Francisco Bay Region, Northern California. April 7.

implementation of **Mitigation Measure GEO-5**, which requires a geotechnical investigation of the storage and maintenance facility area to determine the location of the fault and development of project design features in compliance with the CBC and BART design standards to reduce the risk of damage from a potential fault rupture. With compliance with existing regulations and implementation of **Mitigation Measure GEO-5**, potential impacts would be reduced to less than significant. **(LSM)**

DMU Alternative. The DMU Alternative would have the same general footprint as the Proposed Project along the I-580 corridor, with the following exceptions: (1) additional improvements that would be constructed at the Dublin/Pleasanton Station Area; and (2) different footprint in the Cayetano Creek Area. Thus, it would be located on or near many of the same faults. However, unlike the Proposed Project, the storage and maintenance facility would not be located on the Mount Diablo Thrust Fault. Under the DMU Alternative, none of the proposed structures would be located on a known active fault or within an Alquist-Priolo Earthquake Fault Zone. Therefore, the DMU Alternative would have a less-than-significant impact related to fault rupture, and no mitigation measures are required. **(LS)**

Express Bus/BRT Alternative. The Express Bus/BRT Alternative would entail improvements at the Dublin/Pleasanton Station Area as well as the Laughlin Road Area. None of the proposed structures or facilities would be located within an Alquist-Priolo Earthquake Fault Zone or on a known active fault. Therefore, the Express Bus/BRT Alternative would have a less-than-significant impact related to fault rupture, and no mitigation measures are required. **(LS)**

Enhanced Bus Alternative. Bus infrastructure improvements that would be constructed under the Enhanced Bus Alternative would be located within the existing street ROWs east of the Dublin/Pleasanton Station. None of the proposed structures or facilities would be located within an Alquist-Priolo Earthquake Fault Zone or on a known active fault. Therefore, the Enhanced Bus Alternative would have a less-than-significant impact related to fault rupture, and no mitigation measures are required. **(LS)**

Mitigation Measures. As described above, the Proposed Project would have a potentially significant impact related to fault rupture related to the placement of structures on the Mount Diablo Thrust Fault. However, this impact would be reduced with implementation of **Mitigation Measure GEO-5**, which requires a geotechnical investigation of the storage and maintenance facility area to determine the location of the fault and development of project design features in compliance with the CBC and BART design standards to reduce the risk of damage from a potential fault rupture. With compliance with existing regulations and implementation of **Mitigation Measure GEO-5**, the potential impacts would be reduced to less than significant.

As described above, the DMU Alternative, Express Bus/BRT Alternative, and Enhanced Bus Alternative would not result in significant impacts related to fault rupture and no mitigation measures are required for these alternatives. **(LS)**

Mitigation Measure GEO-5: Geotechnical Investigation of the Cayetano Creek Area and Development of Project Design Features (Conventional BART Project).

During the design phase and prior to any ground disturbing activity in the Cayetano Creek Area, where the Mount Diablo Thrust Fault is inferred, BART shall retain a professional geotechnical engineer or engineering geologist to conduct a field (surface) geotechnical investigation of the Cayetano Creek Area with a focus on the Mount Diablo Thrust Fault. The investigation shall include the following tasks:

1. Conduct a literature search of the most recent local investigations. The search shall include contacting and discussing the thrust fault location with the author of the most recent fault investigation (completed by Thomas L. Sawyer of Piedmont GeoSciences).[61]
2. Conduct a field investigation consisting of trenching the Cayetano Creek Area to investigate whether the Mount Diablo Thrust Fault is located within the storage and maintenance facility footprint.
3. The geotechnical investigator shall prepare a detailed report that describes the results and provide that report to BART design engineers.
4. BART's engineers shall evaluate the results of the geotechnical investigation and develop project design features in compliance with the CBC and BART design standards to reduce the risk of damage from a potential fault rupture.

Impact GEO-6: Expose people or structures to potential substantial adverse effects, including risk of loss, injury, or death involving strong seismic groundshaking, and seismic-induced ground failures, including liquefaction, and landslides during operations.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: LS)

As discussed in the Local Setting subsection above, the Bay Area may experience a large regional earthquake (M_w 6.7 or greater) over the next 30 years. There is a potential for high-intensity groundshaking associated with a characteristic earthquake in this region. The intensity of such an event would depend on the causative fault and the distance to the epicenter, the moment magnitude, the duration of shaking, and the nature of the geologic materials beneath the project components. Intense groundshaking and high ground

[61] Ibid.

accelerations could affect the entire study area. Seismic groundshaking could damage rail lines, foundations, and structures, resulting in structural failure.

In addition, the groundshaking and high ground accelerations as the result of an earthquake could cause seismic-induced ground failures, such as liquefaction or lateral spreading, which could also damage rail lines, foundations, and structures, resulting in structural failure.

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented and there would be no physical changes in the environment associated with the Proposed Project or any of the Build Alternatives. The planned and programmed transportation improvements and continued land use development, including new residential and commercial uses under the No Project Alternative would be subject to potential risk of loss, injury, or death from strong seismic groundshaking, and seismic induced ground failures, including liquefaction, and landslides during operations. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented. These improvements would be required to follow applicable geotechnical evaluations and regulations that would reduce the significant exposure of people or structures to harm. The No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. Therefore, the No Project Alternative is considered to have no impacts related to strong seismic shaking, seismic-induced ground failure, and landslides. **(NI)**

Conventional BART Project. As discussed in the Liquefaction and Lateral Spreading subsection above and shown on Figure 3.G-3, portions of the Proposed Project footprint along I-580 would be underlain with soils susceptible to moderate liquefaction and lateral spreading. The western portion of the footprint within the I-580 corridor would be located within areas with moderate liquefaction susceptibility. The eastern half of the footprint along the I-580 corridor would be located within areas with variable liquefaction susceptibility ranging from very low to moderate.

The groundshaking and high ground accelerations could also cause seismic-induced landslides, which could damage rail lines, foundations, and structures, resulting in structural failure. In addition, landslides can be caused by inappropriate grading, such as the removal of the toe or lower portions of a landslide-prone slope, which is supporting the upper portions of the landslide-prone material. Alternatively, landslides can be caused by the inappropriate addition of water, such irrigation at the top of a landslide-prone area, which would increase the weight of materials or result in erosion. As discussed in the Landslides and Subsidence subsection and shown on Figure 3.G-4, the I-580 Corridor Area is on relatively flat land with little to no susceptibility to landslides, whereas the Cayetano

Creek Area extends through an area with steeper slopes and a higher susceptibility to landslides.

In the event of an earthquake, intense groundshaking could cause damage and outages to facility infrastructure and could result in hazards to the public associated with falling debris (e.g., collapsing roofs) and damaged infrastructure (e.g., tripping and falling hazards).

The structural elements of the Proposed Project would undergo appropriate design-level geotechnical evaluations prior to final design and construction. The Proposed Project would implement the applicable regulatory requirements in the CBC, Caltrans construction standards and design criteria, and BART Facilities Design Standards. Specifically, the California Professional Engineers Act (Building and Professions Code Sections 6700-6799), and the Codes of Professional Conduct, as administered by the California Board of Professional Engineers and Land Surveyors, provide the basis for regulating and enforcing engineering practice in California. During project design, the geotechnical engineer, as a registered professional with the State of California, is required to comply with the CBC, Caltrans construction standards and design criteria, and BART Facilities Standards, while applying standard engineering practice and the appropriate standard of care for the particular region in California.[62] In addition, Caltrans and BART are responsible for inspections and ensuring compliance with the applicable codes and standards described above. Therefore, compliance with regulatory standards would reduce potential impacts related to strong seismic shaking, seismic-induced ground failure, and landslides to less-than-significant levels, and no mitigation measures are required. **(LS)**

DMU Alternative. The DMU Alternative would have the same general footprint as the Proposed Project, with the addition of improvements that would be constructed at the Dublin/Pleasanton Station Area. This area is generally exposed to the same level of seismic shaking and risk of seismic-induced ground failure, has moderate liquefaction susceptibility, and is relatively flat land with little to no susceptibility to landslides. Thus, the DMU Alternative components would be exposed to the same level of seismic shaking and risk of seismic-induced ground failure as the Proposed Project. Similar to the Proposed Project, the DMU Alternative would undergo appropriate design-level geotechnical evaluations prior to final design and construction and would implement the applicable regulatory requirements in the CBC, Caltrans construction standards and design criteria, and BART Facilities Design Standards, described above. Caltrans and BART are responsible for inspections and ensuring compliance with the applicable codes and standards. Therefore, the DMU Alternative would have less-than-significant impacts

[62] Geotechnical engineers specialize in structural behavior of soil and rocks. They conduct soil investigations, determine soil and rock characteristics, provide input to structural engineers, and provide recommendations to address problematic soils.

related to strong seismic groundshaking and seismic-induced ground failure, and landslides, and no mitigation measures are required. **(LS)**

Express Bus/BRT Alternative. The Express Bus/BRT Alternative would entail improvements at the Dublin/Pleasanton Station Area, as well as at the Laughlin Road Area. These areas would generally be exposed to the same level of seismic shaking and risk of seismic-induced ground failure as the Proposed Project; however, unlike the Proposed Project, there would be no facilities in the Cayetano Creek Area, which has higher susceptibility to landslides. The design of the Express Bus/BRT Alternative would be required to comply with the same regulatory codes and standards as the Proposed Project, described above. Therefore, the Express Bus/BRT Alternative would have less-than-significant impacts related to strong seismic groundshaking and seismic-induced ground failure, as well as landslides, and no mitigation measures are required. **(LS)**

Enhanced Bus Alternative. The bus infrastructure improvements that would be constructed under the Enhanced Bus Alternative would be along existing street ROWs, east of the Dublin/Pleasanton Station. These facilities would be exposed to the same level of seismic shaking and risk of seismic-induced ground failure as the Proposed Project. Therefore, the Enhanced Bus Alternative would have less-than-significant impacts related to strong seismic groundshaking, seismic-induced ground failure, and landslides, and no mitigation measures are required. **(LS)**

Mitigation Measures. As described above, the Proposed Project and Alternatives would not result in significant impacts related to strong seismic groundshaking, seismic-induced ground failure, and landslides and no mitigation measures are required.

Impact GEO-7: 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 during operations.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: LS)

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented and there would be no physical changes in the environment associated with the Proposed Project or any of the Build Alternatives. Construction of the planned and programmed transportation improvements and continued land use development, including construction of residential and commercial uses under the No Project Alternative, could be located on an unstable geologic unit that could result in landslide, lateral spreading, subsidence, liquefaction, or collapse. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented, and the No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. Therefore, the No Project Alternative is considered to have no impacts related to unstable geologic units. **(NI)**

Conventional BART Project and Build Alternatives. Potential impacts from the Proposed Project and Alternatives related to liquefaction, lateral spreading, and landslides are addressed in **Impact GEO-6** above.

Subsidence is caused by the extraction of groundwater in excess of an aquifer's sustainable yield. The Proposed Project and Build Alternatives do not include the extraction of any groundwater, and therefore would not cause subsidence. Collapse is also associated with the extraction or movement of water, which is not included as a part of the Proposed Project or Build Alternatives. In addition, the Zone 7 administers oversight of the local groundwater basin—the Livermore Groundwater Basin—and prevents groundwater overdraft through its Groundwater Management Program.[63] The recently enacted Sustainable Groundwater Management Act designates Zone 7 as the exclusive Groundwater Sustainability Agency with the responsibility for preventing "undesirable results," such as subsidence due to groundwater overdraft. Zone 7 implemented conjunctive use as part of its Groundwater Management Program.[64] Zone 7's policy is to maintain groundwater levels above historic lows to minimize the risk of inducing land subsidence. As a result, the components of the Proposed Project and Build Alternatives would not be placed in areas subject to potential subsidence that could damage facility components and pose risks to people from falling debris.

Therefore, impacts related to unstable geologic units that could result in landslide, lateral spreading, subsidence, liquefaction, or collapse would be less than significant. **(LS)**

Mitigation Measures. As described above, the Proposed Project and Alternatives would not result in significant impacts related to liquefaction, lateral spreading, landslides, subsidence, or collapse and no mitigation measures are required.

Impact GEO-8: Be located on expansive or corrosive soil creating substantial risks to life or property during operations.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: LS)

[63] Zone 7 Water Agency, 2016. 2015 Urban Water Management Plan, March 31.

[64] Conjunctive use means the use of groundwater mixed with surface water to meet water demands and water quality requirements and includes the use of surface water resources to artificially recharge groundwater

Surface structures with foundations constructed in expansive soils would experience expansion and contraction depending on the season and the amount of surface water infiltration. The expansion and contraction, also referred to as linear extensibility or shrink-swell, could exert enough pressure on the structures to result in cracking, settlement, and uplift. Depending on the depth of buried utilities, soil in expansion or contraction could lead to lateral stress and stress of structural joints. Lateral stresses could, over time, lead to rupture or leaks in the coupling joints. Shrinkage cracks could form in native soils adjacent to utility trenches or in backfill material if expansive soils are used. If shrinkage cracks extend to sufficient depths, groundwater can infiltrate into the trench, causing piping (progressive erosion of soil particles along flow paths) or settlement failure of the backfill materials. Settlement failure can also occur if expansive soils are used in backfill and undergo continued expansion and contraction. Over time these soils could settle, resulting in misalignment or damage to buried facilities. Proper removal or reconditioning of expansive soils during construction can prevent such effects and the resulting damage.

In addition, clayey soils can be corrosive to unprotected steel or concrete. Over time, the corrosion could weaken the materials, resulting in fatigue and eventual failure of steel or concrete materials. Clayey soils are considered to have a high corrosion potential, and could cause damage to surface piping and weaken building foundations, unless treated.

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented and there would be no physical changes in the environment associated with the Proposed Project or any of the Build Alternatives. Construction of the planned and programmed transportation improvements and continued land use development, including construction of residential and commercial uses under the No Project Alternative, could be located on expansive or corrosive soil creating substantial risks to life or property during operations. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented, and the No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. These improvements would be required to follow applicable geotechnical evaluations and regulations that would reduce the significant exposure of people or structures to harm. Therefore, the No Project Alternative is considered to have no impacts related to expansive or corrosive soils. **(NI)**

Conventional BART Project. As discussed in the Soils subsection above, and shown in Figure 3.G-5, clayey soils that could be expansive or corrosive in the footprint of the Proposed Project extend under the I-580 Corridor Area, Isabel North and South Areas, and the Cayetano Creek Area. Therefore, the entire footprint of the Proposed Project has the potential for expansive or corrosive soils. As described in **Impact GEO-6** above, the structural elements of the Proposed Project would undergo appropriate design-level geotechnical evaluations prior to final design and construction, which would include additional investigations for the presence of expansive or corrosive soils, and inclusion of recommendations to address such soils. Therefore, with compliance with regulatory standards, impacts related to expansive or corrosive soil under the Proposed Project would be less than significant, and no mitigation measures are required. **(LS)**

DMU Alternative. The DMU Alternative would have the same general footprint as the Proposed Project, with the addition of areas at the Dublin/Pleasanton Station Area, which includes clayey soils that could be expansive or corrosive. Therefore, the footprint of the DMU Alternative has the potential for expansive or corrosive soils. Similar to the Proposed Project, the DMU Alternative would be subject to the same requirements to investigate for expansive or corrosive soils and address them. Therefore, the DMU Alternative would have less-than-significant impacts related to expansive and corrosive soils, and no mitigation measures are required. **(LS)**

Express Bus/BRT Alternative. The Express Bus/BRT Alternative would entail improvements at the Dublin/Pleasanton Station Area, as well as at the Laughlin Road Area. The Dublin/Pleasanton Station Area has potential for expansive or corrosive soils; however, the Laughlin Road Area does not. Similar to the Proposed Project, the Express Bus/BRT Alternative would be subject to requirements to investigate for expansive or corrosive soils and address them, where present. Therefore, the Express Bus/BRT Alternative would have less-than-significant impacts related to expansive and corrosive soils, and no mitigation measures are required. **(LS)**

Enhanced Bus Alternative. The bus infrastructure improvements that would be constructed under the Enhanced Bus Alternative would be located in the existing street ROWs, east of the Dublin/Pleasanton Station. This alternative would be subject to the same requirements described above for the Proposed Project—to investigate for expansive or corrosive soils and address them, if present. Therefore, the Enhanced Bus Alternative would have less-than-significant impacts related to expansive and corrosive soils, and no mitigation measures are required. **(LS)**

Mitigation Measures. As described above, the Proposed Project and Alternatives would not result in significant impacts related to expansive or corrosive soil and no mitigation measures are required.

Impact GEO-9: 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 during operations.

(No Project Alternative: NI; Conventional BART Project: NI; DMU Alternative: NI; Express Bus/BRT Alternative: NI; Enhanced Bus Alternative: NI)

No Project Alternative. Under the No Project Alternative, the BART to Livermore Extension Project would not be implemented and there would be no physical changes in the environment associated with the Proposed Project or any of the Build Alternatives. Construction of the planned and programmed transportation improvements and continued land use development, including construction of residential and commercial uses under the No Project Alternative, could be located in areas where sewers are not available for the disposal of wastewater during operations and have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems. However, the effects of the other projects associated with the No Project Alternative have been or will be addressed in environmental documents prepared for those projects before they are implemented, and the No Project Alternative would not result in new impacts as a consequence of the BART Board of Directors' decision not to adopt a project. Therefore, the No Project Alternative is considered to have no impacts related to use of septic tanks or alternative wastewater disposal systems. **(NI)**

Conventional BART Project and Build Alternatives. The structures proposed for construction under the Proposed Project and Build Alternatives would be located in areas where connections to sewers are available. The Proposed Project and Build Alternatives do not include the construction of buildings or structures for human occupancy that would require the use of septic systems or alternative wastewater disposal systems. All wastewater from the station and facilities would be treated by the local wastewater service providers as described in Section 3.P, Utilities. Therefore, the Proposed Project and Build Alternatives would have no impact related to septic treatment of wastewater. **(NI)**

Mitigation Measures. As described above, the Proposed Project and Alternatives would not result in significant impacts related to use of septic tanks or alternative wastewater disposal systems and no mitigation measures are required.

(b) Operations – Cumulative Analysis

The geographic study area for the cumulative analysis would be the same as that described in the Introduction subsection above. The cumulative context for impacts relative to geology, soils, and seismicity includes various projects in the Livermore-Amador Valley and the cities of Dublin, Pleasanton, and Livermore, as described in Section 3.A, Introduction to Environmental Analysis and Appendix E, and focuses on the projects that would occur along the I-580 corridor.

As described in **Impact GEO-9** above, the Proposed Project and Alternatives would have no impact related to septic tanks or alternative wastewater. Therefore, the Proposed Project and Alternatives would not contribute to cumulative septic tank or alternative wastewater impacts during operations.

Impact GEO-10(CU): Expose people or structures to potential substantial adverse effects related to known faults, strong seismic groundshaking, seismic-related ground failure, including liquefaction, landslides, unstable soils or geologic units, or expansive or corrosive soils during operations under Cumulative Conditions.

(No Project Alternative: NI; Conventional BART Project: LS; DMU Alternative: LS; Express Bus/BRT Alternative: LS; Enhanced Bus Alternative: LS)

No Project Alternative. As described in **Impact GEO-5** through **GEO-8** above, the No Project Alternative would have no impacts related to exposure of people or structures to potential substantial adverse effects related to known faults, strong seismic groundshaking, seismic related ground failure, including liquefaction, landslides, unstable soils or geologic units, or expansive or corrosive soils during operations. Therefore, the No Project Alternative would not contribute to cumulative impacts. **(NI)**

Conventional BART Project and Build Alternatives. Several of the cumulative projects would be located along the I-580 corridor and would subject to similar geological and soils conditions as the Proposed Project and Build Alternatives. The Dublin/Pleasanton BART Station Parking Expansion and the INP would both involve the operations of facilities that could result in similar impacts relative to geology, soils, and seismicity to the Proposed Project and Build Alternatives. However, because of the localized nature of the potential geologic impacts, it is not anticipated that the impacts would combine with the potential impacts of the Proposed Project or Build Alternatives.

For example, if a future expansive soils issue were to damage a component of the Proposed Project or Build Alternatives, as well as nearby cumulative projects, the damage would be limited to the footprints of the respective structures and the expansion of soil at one property would not combine to worsen the damage of an adjacent structure. Similarly, impacts relative to each of the significance criteria would be largely limited to the footprints of those individual structures and would not typically be additive or cumulative in nature. As discussed above for **Impact GEO-5**, under the Proposed Project, the location of the storage and maintenance facility on the Mount Diablo Thrust Fault would result in potential impacts that would be reduced to less than significant with compliance with existing regulations and implementation of **Mitigation Measure GEO-5**. In addition, any potential impacts would be localized and would not result in cumulative impacts. Therefore, potential cumulative geologic, soil, or seismic impacts associated with fault rupture, seismic shaking, seismic-related ground failure, landslides, unstable geologic units or soil, or expansive or corrosive soils would not be anticipated to result from the operation of the Proposed Project or Build Alternatives and other cumulative projects.

In addition, each individual project, including the Proposed Project and Build Alternatives, would also be required to comply with the same CBC and local geotechnical requirements during the design phase of the project, including the preparation of geotechnical investigations, identification of geotechnical issues, and implementation of recommendations to address such issues, if present. Therefore, the operation of the Proposed Project and Build Alternatives, in combination with the cumulative projects, would result in less-than-significant cumulative impacts. **(LS)**

Mitigation Measures. As described above, the Proposed Project and Alternatives in combination with past, present, or probable future projects would not result in significant cumulative impacts related to geologic, soil, or seismic impacts associated with fault rupture, seismic shaking, seismic-related ground failure, landslides, expansive or corrosive soil, unstable geologic units, or soil expansive or corrosive soils, and no mitigation measures are required.