3.7. GEOLOGY AND SOILS

The following summarizes the applicable regulations and the existing setting and provides a detailed impact assessment related to Geology and Soils and Paleontological Resources. Refer to the Geology and Soils Technical Report (Appendix H) and the Paleontological Resources Technical Report (Appendix O) for additional details related to applicable regulations and the existing setting.

3.7.1 Regulatory Framework

3.7.1.1 Federal Regulations

National Earthquake Hazards Reduction Program. The National Earthquake Hazards Reduction Program was established by the United States Congress when it passed the Earthquake Hazards Reduction Act of 1977. Congress recognized that earthquake-related losses could be reduced through improved design and construction methods and practices, land use and redevelopment controls, prediction techniques and early-warning systems, coordinated emergency preparedness plans, and public education and involvement programs.

National Engineering Handbook. The National Engineering Handbook was prepared by the U.S. Department of Agriculture in 1983. Chapter 3 (Erosion) of Section 3 (Sedimentation) states that in planning programs, to reduce erosion and sediment yield, it is most important that the various types of erosion be thoroughly investigated as sources of sediment. Proper conservation practices and land stabilization measures can then be planned and applied.

Federal Soils Protection Act. The purpose of the Federal Soil Protection Act is to protect or restore the functions of the soil on a permanent sustainable basis. Protection and restoration activities include prevention of harmful soil changes, rehabilitation of the soil of contaminated sites and of water contaminated by such sites, and precautions against negative soil impacts. If impacts are made on the soil, disruptions of its natural functions and of its function as an archive of natural and cultural history should be avoided, as far as practicable. In addition, the requirements of the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) through the National Pollution Discharge Elimination System (NPDES) provide guidance for protection of geologic and soil resources.

U.S. Geological Survey (USGS) Landslide Hazards Program. The USGS created the Landslide Hazard Program in the mid-1970s. According to USGS, the primary objective of the Landslide Hazards Program is to reduce long-term losses from landslide hazards by improving understanding of the causes of ground failure and suggesting mitigation strategies. The federal government takes the lead role in funding and conducting this research, whereas the reduction of losses due to geologic hazards is primarily a state and local responsibility.

Clean Water Act (CWA). The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and regulating quality standards for surface waters. USEPA has implemented pollution control programs such as setting wastewater standards for

industry. USEPA has also developed national water quality criteria recommendations for pollutants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. The NPDES permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

3.7.1.2 State Regulations

California Building Standards Code. The California Building Standards Code is a compilation of three types of building standards from three different origins: 1) Building standards that have been adopted by State agencies without change from building standards contained in national model codes; 2) Building standards that have been adopted and adapted from national model codes to address California's ever-changing conditions; and 3) Building standards, authorized by the California legislature, that constitute amendments not covered by national model codes, that have been created and adopted to address particular California concerns. All occupancies in California are subject to national model codes adopted into Title 24, and occupancies are further subject to amendments adopted by State agencies and ordinances implemented by local jurisdictions' governing bodies. The 2019 California Building Code, California Code of Regulations, Title 24 was published July 1, 2019, with an effective date of January 1, 2020.

California Government Code. The California Government Code requires that planning agencies of all cities and counties prepare comprehensive, long-term general plans for physical development within their jurisdictions. The plans should provide objectives and policies addressing public health and safety, including protection against the impacts of seismic ground motions, fault ruptures, and other geological and soils hazards. As stated in Section 6302 (g) (1) of the California Government Code, a general plan shall include:

> *"A safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; liquefaction; and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body; flooding; and wildland and urban fires. The safety element shall include mapping of known seismic and other geologic hazards. It shall also address evacuation routes, military installations, peakload water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards."*

Chapter 7.8 (Section 2690) of Division 2 of the PRC, referred to above, is known as the Seismic Hazards Mapping Act (SHMA), which is described below.

The California PRC (Chapter 1.7), Sections 5097 and 30244, includes requirements for the assessment and management of paleontological resources. These statutes require reasonable mitigation of adverse impacts to paleontological resources resulting from development on State

lands, and define the excavation, destruction, or removal of paleontological “sites” or “features” from public lands without the express permission of the jurisdictional agency as a misdemeanor. As used in Section 5097, “State lands” refers to lands owned by, or under the jurisdiction of, the state or any State agency. “Public lands” is defined as lands owned by, or under the jurisdiction of, the State, or any city, county, district, authority, or public corporation, or any agency thereof.

California Stormwater Best Management Practices Handbook. The California Stormwater Quality Association develops four Best Management Practices Handbooks (i.e., construction, industrial and commercial, municipal, and new development and redevelopment) generally matched to the three NPDES permit types (i.e., municipal separate storm sewer systems, construction activities, and industrial activities) offering stormwater runoff management support.

Southern California Catastrophic Earthquake Response Plan. The Southern California Catastrophic Earthquake Response Plan provides a coordinated State/federal response to a catastrophic earthquake in southern California. The mission of the unified effort of local, State, tribal, and federal emergency response is to support the needs of the impacted community by saving and sustaining human life, minimizing suffering, stabilizing and restoring critical infrastructure and setting conditions for recovery.

Seismic Hazards Mapping Act. The SHMA of 1990 directs the Department of Conservation to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides and amplified ground shaking. The purpose of the SHMA is to reduce the threat to public safety and to minimize the loss of life and property by identifying and mitigating these seismic hazards. The SHMA was passed by the legislature following the 1989 Loma Prieta earthquake. The SHMA requires the State Geologist to establish regulatory zones (Zones of Required Investigation) and to issue appropriate maps (Seismic Hazard Zone maps).

Alquist-Priolo Earthquake Fault Zoning Act. The Alquist-Priolo Earthquake Fault Zoning Act was enacted as the Special Studies Zones Act in 1971 to prevent land development and construction of structures for human occupancy directly across the trace of active faults. The law required the State Geologist to delineate approximately one quarter mile-wide zones along surface traces of active faults. The act defines an active fault as one that has ruptured the ground surface within the past 11,000 years or Holocene period. Prior to approving construction of structures for human occupancy, permit authorities must require a project’s applicant to submit a fault investigation report for review and approval by the local jurisdiction. Although the Alquist-Priolo Act does not regulate transit or transportation projects, it provides relevant information about areas that would be susceptible to ground rupture from an earthquake.

National Hazards Disclosure Act. The Natural Hazards Disclosure Act came into effect on June 1, 1998 and requires sellers and their listing agents to provide prospective buyers with a Natural Hazards Disclosure statement that designates whether the home they are selling is located in a hazard area. Hazard areas include flood, fire, earthquake fault, and seismic hazard zones.

3.7.1.3 Local Regulations

The California Government Code requires that planning agencies of all cities and counties prepare comprehensive, long-term general plans for the physical development within their jurisdictions. The plans should provide objectives and policies addressing public health and safety, including protection against the impacts of seismic ground motions, fault ruptures, and other geological and soils hazards. The legislative bodies of all California cities and counties must adopt general plans that include the following elements related to geology, soils, seismicity, and paleontological resources:

- Conservation Element, which addresses the following topics relevant to soils and paleontological resources:
  - Reclamation of land and waters;
  - Soil erosion prevention, control, and correction;
  - Location, quantity and quality of rock, sand, and gravel resources; and
  - Preservation of Paleontological resources.

- Safety Element, which addresses the protection of the community from any unreasonable risks associated with the effects of the following seismic and geologic hazards and which is required to include mapping of such known hazards:
  - Seismically-induced surface rupture;
  - Ground shaking;
  - Ground failure;
  - Slope instability leading to mudslides and landslides;
  - Subsidence due to fluid or gas withdrawal;
  - Liquefaction;
  - Other seismic hazards identified pursuant to California PRC Chapter 7.8 (commencing with Section 2690) of Division 2; and
  - Other geologic hazards known to the legislative body.

City of Los Angeles

The City of Los Angeles General Plan (Chapter III of the Safety Element) describes goals, objectives, policies and programs that are broadly stated to reflect the comprehensive scope of the Emergency Operations Organization.[1] All City of Los Angeles emergency preparedness, response and recovery programs are integrated into Emergency Operations Organization operations and are reviewed and revised continuously.

The Conservation Element of the General Plan identifies paleontological resources in the City of Los Angeles and contains resource management objectives and policies. The objective is to protect the City's archaeological and paleontological resources for historical, cultural, research and/or educational purposes. The primary policy is to continue to identify and protect significant

[1] City of Los Angeles, *Safety Element of the Los Angeles General Plan*, 1996.

archaeological and paleontological sites and/or resources known to exist or that are identified during land development, demolition or property modification activities.

Chapter IX (Building Regulations) of the City of Los Angeles Municipal Code of 2020 was prepared to safeguard life, limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures erected or to be erected within the City, and by regulating certain grading operations within the City. Section 91.1804 (Excavation, Grading, and Fill) adopts Section 1804 of the California Building Code.

City of Burbank

The goals and policies contained in the Safety Element (Chapter 7) of the Burbank 2035 General Plan of 2013 provide a framework for keeping residents, businesses, and visitors safe from natural and human hazards.[2] They also provide increased safety for the emergency response personnel.

The Open Space and Conservation Element of the General Plan contains resource management goals and policies related to paleontological resources. The goal is to ensure open space areas and mountain ranges are protected spaces supporting important habitat, recreation, and resource conservation. The primary policy is to recognize and maintain cultural, historical, archaeological, and paleontological structures and sites essential for community life and identity.

Article 1 (Grading, Fills and Excavations) of Chapter 7 (Excavations) of the City of Burbank Municipal Code of 2007 was prepared to safeguard life, health, property and the public welfare by establishing minimum requirements for grading, fills and excavations and the prevention of environmental and other damage, and to prescribe procedures by which these requirements may be enforced.

City of Glendale

The goals and policies contained in Safety Element of the City of Glendale General Plan of 2003 provides an assessment of the natural and manmade hazards in the City, including, but not limited to, earthquakes, landslides, fire, flood, dam, inundation, hazardous materials incidents, terrorism, and vector control and provides a framework by which safety considerations are introduced into the land use planning process and the redevelopment process.[3] Section 3.1 of Chapter 3 covers seismic and geologic hazards.

The City of Glendale General Plan does not contain any goals, objectives, or policies pertaining to paleontological resources.

[2] City of Burbank, *Burbank 2035 General Plan,* February 19, 2013.
[3] City of Glendale, *Safety Element of the Glendale General Plan*, 2003.

Chapter 15 (Grading in Hillside Areas and Excavation Blasting) of the City of Glendale Municipal Code was prepared to safeguard life, health, property, public welfare and preservation of the environment by establishing minimum requirements for regulating hillside grading and excavations in addition to the grading requirements in Appendix Chapter 33 of the Glendale Building and Safety Code which adopts the latest version of the California Building Code.

City of Pasadena

Section 5 (Implementation) of the Safety Element of the City of Pasadena General Plan of 2002 addresses a variety of natural and man-made hazards and provides goals and policies aimed at reducing the risk associated with these hazards.[4]

The City of Pasadena General Plan does not contain any goals, objectives, or policies pertaining to paleontological resources.

Chapter 14.05 (Excavation and Grading in Hillside Areas) of the City of Pasadena Municipal Code was prepared to regulate excavation and grading within hillside districts and excavation and grading on a slope any portion of which is greater than 15 percent in order to: a) Safeguard life, limb, property and public welfare; b) Protect streams, lakes, reservoirs, and any other water bodies from pollution with chemicals, fuels, lubricants or any other harmful materials associated with construction or grading activities; c) Avoid pollution of the water bodies described above with nutrients, sediment materials, or other earthen or organic materials generated on or caused by surface runoff on or across the permit area; d) Preserve the contours of the natural landscape and land forms; and e) Prevent erosion and control sedimentation.

3.7.2. Existing Setting

The Proposed Project topography is relatively flat with elevated areas along the southern San Rafael Hills. The eastern third of the Proposed Project route lays on an alluvial plain (alluvium: a deposit of clay, silt, sand, and gravel left by a flowing stream in a valley or delta) of the San Fernando Valley transitioning to alluvial fans emanating from creeks and canyons draining the south-west aspect of the Verdugo Mountains and Verdugo Canyon. The Proposed Project section with the most topographic relief lays along the southern San Rafael Hills before descending onto the alluvial plain of Pasadena. Generally, the western third of the Proposed Project lays at around 600 feet above mean sea level, gradually increasing to 800 feet above mean sea level at the Brand Boulevard/Broadway intersection and elevation 1,000 feet above mean sea level at the Brand Boulevard/SR-134 interchange, and descends to elevation 800 feet above mean sea level onto the alluvial plain of Pasadena.

[4] City of Pasadena, *Safety Element of the Pasadena General Plan*, 2002.

Geology and Soils

The Project Area is located within the Transverse Ranges Geomorphic Province at its southern boundary with the Peninsular Ranges Geomorphic Province. A geomorphic province is a geographical area of distinct landscape character with related geophysical features, including relief, landforms, orientations of valleys and mountains, type of vegetation, and other geomorphic attributes. Geologic mapping indicates that the Project area is underlain by Holocene-age younger sedimentary deposits (Qa, Qf, Qg), Pleistocene-age older sedimentary deposits (Qoa, Qof), Miocene-age Topanga Formation (Ttsc, Ttqdb), and Cretaceous-age igneous rocks (gr, qpd). Additionally, mapped within the half mile buffer of the Project Area are recent artificial fill (af) and Tertiary-age dikes (Tb). Refer to the Geology and Soils Technical Report (Appendix H) for additional details and maps related to soil details and location maps.

Subsurface Soil Conditions

Subsurface soil conditions were evaluated based on data from previous explorations performed in the Project Area. Using the Unified Soil Classification System, previous explorations encountered mostly coarse-grained cohesionless soils (sand, silty sand, gravel) with cobbles and boulders. Interbedded fine-grained cohesionless and cohesive soils (sandy silt, sandy silty clay, clay) are also present. Conglomeratic sandstone of the Topanga Group conglomerate (Ttcg) was encountered in the Eagle Rock Valley (i.e., intersections of Colorado Boulevard and Figueroa Street with SR-134). Granitic rock (Mzbhd) was encountered at shallow depths at the intersection of Arroyo Seco and the SR-134.

Faulting

Special Publication 42 defines a fault as a shear or zone of closely associated shears across which earth materials on one side have been displaced with respect to those on the other side because of tectonic forces.[5] A fault is distinguished from those fractures or shears caused by landsliding or other gravity-driven surficial failures. The Proposed Project is located in a seismically active region containing several historic (<200 years), numerous Holocene (<11,700 years), and potentially active (<1.6 million years) faults.

The three active faults in the Project Area are the Verdugo Fault, the Raymond Fault, and the Hollywood Fault. The Verdugo Fault intersects and parallels the Proposed Project along the SR-134 from mid of Route Options E3 to its transition into the Eagle Rock and San Rafael Faults. The Raymond Fault, along with the Hollywood Fault described next, lies within the Santa Monica-Hollywood-Raymond Fault system of oblique, reverse and left-lateral faults. The fault does not intersect the Proposed Project, running roughly parallel and approximately 1.4 to 1.7 miles to the south. The Hollywood Fault trends east-northeast for about 10.5 miles. The fault does not intersect the Proposed Project, running roughly parallel and approximately 1.8 to 3.5 miles to the south. Refer to the Geology and Soils Technical Report (Appendix H) for additional details and maps related to faults.

[5] CGS, 2018.

Seismic Hazards

Primary seismic hazards include ground shaking and surface fault rupture. Secondary seismic effects resulting from soil responses to ground shaking includes liquefaction. These hazards may cause deformation of man-made structures.

Earthquake-induced ground-shaking is a seismic hazard that can result in liquefaction, lurching and lateral spreading of soils, and landslide of soil and rock as well as dynamic oscillation of man-made structures. Differential settlements can occur at the ground surface due to subsurface liquefaction and densification caused by strong ground-shaking.

Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture generally can be assumed to be along an active major fault trace. Refer to the Geology and Soils Technical Report (Appendix H) for additional details and maps related to Earthquake Fault Zones.

Liquefaction

Liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction. Clays are generally not susceptible to liquefaction. According to the Van Nuys(a), Burbank(b), Pasadena(c), and Mount Wilson(d) 7.5-minute Quadrangle Seismic Hazard Zone maps (CGS, 2005a, 2006b, 2006c, and 2006d), with the exception of Route Options E1, E2, H1, H2, and H3, most of the Project corridor is located within or adjacent to liquefaction-prone designated areas.

Lateral Spreading

One of the consequences of seismic liquefaction in sloping ground areas is lateral spreading, which refers to the translation of ground laterally after the loss of support due to liquefaction. For this to occur, the liquefied area must be relatively near a free face, a vertical, or sloping face such as a road cut or stream/riverbank. Considering that the liquefaction potential hazard for the Project Area is low due to the absence of groundwater, and if liquefaction occurred, that the potential liquefied area must be relatively near to a free face, a vertical, or sloping face such as a road cut or stream/riverbank, the potential for lateral spreading is low along the Project corridor.

Seismically-Induced Slope Failure

Slope failure can occur when the force of gravity overcomes the strength of the soil or rock within a hillside or built embankment. The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock, slope geometry (height and steepness), rainfall, and groundwater. Excavation or erosion of material at the toe of a slope can destabilize the slope above it. Slope failure can be initiated or exacerbated by seismic movements. Earthquake-induced ground-shaking can cause activation of new or previously existing landslides and other slope instabilities, especially during periods of high groundwater. According to the Van Nuys,

Burbank, Pasadena, and Mount Wilson 7.5-minute Quadrangle Seismic Hazard Zone maps prepared by California Geological Survey (CGS), small areas of the Project corridor east of SR-2 are located within earthquake-induced landslide areas. Most specifically along Route Options F1/F2, F3, G1, and G2.

Groundwater

Groundwater depth in the Project Area varies between 10 and 30 feet below ground surface (bgs) along Route Options A1, A2, B, C, and a portion of D; between 40 and 80 feet bgs at the easternmost portion of Route Option D and along Route Options E1, E2, and E3; about 20 feet bgs along Route Options F1/F2 and F3; and about 100 feet bgs along Route Options G1, G2, H1, H2, and H3. Groundwater is not expected within the upper 50 feet below ground surface in the Project Area, with localized exceptions within the Eagle Rock Valley (i.e., intersection of Figueroa Street and SR-134) along Route Options F1, F2, and F3. There is potential for perched water can be encountered at discrete locations along the Project corridor. Also, groundwater depths may vary due to irrigation, season, and anthropogenic and natural influences.

Expansive Soils

The shrink-swell potential is a reflection of the ability of some soils with high clay content to change in volume with a change in moisture content. Shrink-swell potential poses a less significant hazard where soil moisture is relatively constant (either always wet or always dry). Shrink-swell potential poses a significant hazard to sites, which undergo seasonal variation in soil moisture content, such as on hillsides or flatlands with a seasonally fluctuating water table. Most of the Proposed Project lies within low expansion prone areas. Localized areas of the Proposed Project south of the San Rafael Hills and within the alluvial plain of Pasadena are located within low to moderate expansion prone areas.

Collapsible Soils

Collapsible soils are soils that undergo volume reduction or settlement upon the addition of water, which weakens or destroys soil particle bonds of loosely packed structure, reducing the bearing capacity of the soil. Other mechanisms for soil collapse include the sudden closure of voids in a soil, whereby the sudden decrease in volume results in loss of the soil's internal structure, causing the soil to collapse. Specific soil types, such as loess and other fine-grained aeolian soils, are most susceptible to collapse, although certain coarser-grained, rapidly deposited alluvial soils can also be susceptible. The Project Area includes coarser-grained and rapidly deposited alluvial soils.

Erodible Soils

The National Engineering Handbook defines erosion as a series of complex and interrelated natural processes that loosen or dissolve and move earth or rock material. The land surface is worn away through the detachment and transport of soil and rock materials by moving water, wind, or other geologic agents. Erosion can be divided into two categories according to the conditions under which it occurs. The first category is normal (geologic) erosion, which has been

occurring at variable rates, depending on climatic and terrestrial conditions, since the first solid materials formed on earth. The second category is accelerated erosion caused by the activities of man. The Proposed Project is underlain by mostly coarse- grained cohesionless soils (sand, silty sand, gravel) with cobbles and boulders, which can be susceptible to erosion. However, the majority of the Proposed Project is to be constructed within urbanized areas covered by impervious surfaces.

Consolidation Settlement

Consolidation settlement occurs when a fine-grained soil (silt or clay) is loaded with the weight of new fill or of improvements such as structures or fills. New loads cause increases in soil pore water pressure. As the excess pore pressures dissipates, the soil volume decreases, and water is expelled slowly. Settlement rate depends on the soil permeability and layer thickness. Thick layers of clay with low permeability can take years for pore pressures to fully dissipate. There is no evidence of thick clay layers in the Project Area. It is expected that most of the sporadic cohesive soil lenses underlying the Project Area be normally consolidated under the load of the structures and buildings.

Shallow Landslides

Shallow landslides are a common and widespread phenomenon during periods of intense winter rainfall in Southern California. Debris flows can occur as isolated flows, in small numbers or can number in the tens of thousands during a single rainfall event. Areas susceptible to shallow landslides and debris flows include the southern San Rafael Hills in Route Options E, F1, F2, G1, and G2.

Natural Slope Instability

Landslides occur when shear stress in a soil or rock mass exceeds their shear strength. Landslide movements often result in significant deformation of ground surfaces, producing open cracks with vertical and horizontal displacements measured in a few inches to multiple feet. An analysis of one-meter resolution digital elevation data obtained from the USGS indicates that the majority of the Project Area lies on areas with a slope of less than one degree. The SR-134 lays adjacent to slopes varying from about 25 to 40 degrees.

Land Subsidence

Land subsidence is a form of ground settlement that usually results from change in fluid content within soil or rock. The volume change can result from localized dewatering of peat, organic soils, or soft silts and clay. This type of ground settlement is often associated with construction activities when groundwater is lowered to allow construction below the groundwater table. The other form of land subsidence is from a regional withdrawal of groundwater, petroleum, or geothermal resources. Regional subsidence can also result from vertical fault movement. Although the mechanism is different, another cause of land subsidence is the ongoing decomposition of organic-rich soils. There is little susceptibility of large-scale land subsidence in the Project Area. There is, however, a moderate susceptibility of small, localized areas of subsidence, or settlement, from construction-related dewatering of excavations.

3.7.3 Significance Thresholds and Methodology

3.7.3.1 Significance Thresholds

In accordance with Appendix G of the State CEQA Guidelines, the Proposed Project would have a significant impact related to Geology and Soils if it would:

a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving:
   i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault. Refer to division of Mines and Geology Special Publication 42.
   ii. Strong seismic ground shaking.
   iii. Seismic-related ground failure, including liquefaction.
   iv. Landslides.
b) Result in substantial soil erosion or the loss of topsoil;
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potential result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
d) Be located on expansive soil as defined in Table 18-1-B of the Uniform Building Code (UBC, 1994), creating substantial direct or indirect risks to life or property;
e) 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 waste water; and/or
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

3.7.3.2 Methodology

The methodology used to evaluate the potential environmental impacts associated with geology, soils, and seismicity included a review of published maps, professional publications, and reports pertaining to the geology, soils, and seismicity of the Project Area. The analysis focuses on the potential of the Proposed Project to increase the risk of personal injury, loss of life, and damage to property as a result of existing geologic conditions in the Project Area. The information was researched from State and federal agencies as well as information compiled and evaluated by the Cities of Los Angeles, Burbank, Glendale, and Pasadena.

The methodology used to evaluate the potential environmental impacts associated with paleontological resources included an analysis of existing data consisting of a geologic map review, a review of literature and online databases, and a record search conducted at the Natural History Museum of Los Angeles County. The literature review included published and unpublished scientific papers and database searches.

3.7.4 Impact Analysis

This section includes the impact analysis, mitigation measures (if necessary), and significance after mitigation (if applicable). The potential for the Proposed Project to result in an impact to Geology and Soils is independent of the specific alignment and components. The following impact conclusions are valid for the Proposed Project and all route variations, treatments, and configurations.

Impact 3.7-1) Would the Proposed Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving:

i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to division of Mines and Geology Special Publication 42.

ii. Strong seismic ground shaking?

iii. Seismic-related ground failure, including liquefaction?

iv. Landslides?

Construction

No Impact. The impact analysis involves assessing if the location of the Proposed Project would result in impacts related to seismic activities, including landslides. Other than potential risks of landslides, the potential for an impact is not related to construction activities. The Proposed Project with route options crosses earthquake-induced landslide areas in Eagle Rock and western Pasadena. Construction activities, including staging, would not involve substantial earthmoving along slopes, such that existing landslide risks would be worsened or exacerbated. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

Surface Fault Rupture

No Impact. It is possible for surface lurching as a result of earthquakes generated from nearby faults to occur in the Project Area. However, the Proposed Project is not intersected by designated Alquist-Priolo Earthquake Fault Zones and surface rupture is not expected to occur across local roadways. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Strong Seismic Ground Shaking

Less-Than-Significant Impact with Mitigation. The Proposed Project is located within the seismically active Southern California region. Hence, ground shaking as a result of earthquake generated from nearby faults is anticipated. Therefore, without mitigation, the Proposed Project would result in a potentially significant impact related to operational activities. Implementation of

Mitigation Measure **GEO-1** would reduce this impact to less than significant by ensuring that the latest federal, state, local, and Metro seismic and environmental requirements are implemented for the Proposed Project. As required by Mitigation Measure **GEO-1**, the final design of the Project would comply with the latest versions of local and State building codes and regulations in order to construct seismically-resistant structures that help counteract the adverse effects of ground shaking and reduce this potential impact to less than significant.

Liquefaction

Less-Than-Significant Impact with Mitigation. Liquefaction is unlikely to happen in the Project Area due to the deep groundwater (50 feet bgs and deeper) and may only occur at isolated areas (i.e., within the Eagle Rock Valley, along the Project Route and route options). However, seismically-induced settlements (dry settlements) are a potential hazard due to mostly granular soil deposits, deep groundwater, and expected high peak ground acceleration in the Project Area. Therefore, without mitigation, the Proposed Project would result in a potentially significant impact related to operational activities. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by ensuring that seismic risk solutions shall be incorporated into final design (e.g., deep foundations, ground improvement, remove and replace, among others) for those areas where liquefaction potential may be experienced. This measure would also ensure the Project is designed to satisfy the most recent latest federal, state, local and Metro seismic environmental requirements.

Seismically-Induced Slope Failure and Landslides

Less-Than-Significant Impact with Mitigation. The Proposed Project with route options crosses earthquake-induced landslide areas in Eagle Rock and western Pasadena. Slope failure could affect surface streets associated with the Proposed Project. Therefore, without mitigation, the Proposed Project would result in a potentially significant impact related to operational activities. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by requiring, during final design, stability analyses of slopes located within earthquake-induced landslides areas and requiring appropriate slope stabilization measures (e.g., retaining walls, slopes with shotcrete faces, slopes re-grading, among others) and ensuring the Project is designed to satisfy the most recent latest federal, state, local and Metro environmental requirements.

Mitigation Measures

Ground Shaking, Liquefaction, and Seismically-Induced Slope Failure

GEO-1: The Proposed Project shall be designed based on the latest versions of local and State building codes and regulations in order to construct seismically-resistant structures that help counteract the adverse effects of ground shaking. During final design, site-specific geotechnical investigations shall be performed at the sites where structures are proposed within liquefaction-prone designated areas. The investigations shall include exploratory soil borings with groundwater measurements. The exploratory soil borings shall be advanced, as a minimum, to

the depths required by local and State jurisdictions to conduct liquefaction analyses. Similarly, the investigations shall include earthquake-induced settlement analyses of the dry substrata (i.e., above the groundwater table). The investigations shall also include seismic risk solutions to be incorporated into final design (e.g., deep foundations, ground improvement, remove and replace, among others) for those areas where liquefaction potential may be experienced. The investigation shall include stability analyses of slopes located within earthquake-induced landslides areas and provide appropriate slope stabilization measures (e.g., retaining walls, slopes with shotcrete faces, slopes re-grading, among others). The geotechnical investigations and design solutions shall follow the "Guidelines for Evaluating and Mitigating Seismic Hazards in California" Special Publication 117A of the California Geologic Service, as well as Metro's Design Criteria and the latest federal and State seismic and environmental requirements.

Surface Fault Rupture

No mitigation measures are required.

Significance of Impacts after Mitigation

Mitigation Measure **GEO-1** would ensure that the Proposed Project is designed to limit potential impacts related to ground shaking, liquefaction, lateral spreading, and seismically-induced slope failure. Therefore, with mitigation, the Proposed Project would result in a less-than-significant impact related to operational activities.

Impact 3.7-2) Would the Proposed Project result in substantial soil erosion or the loss of topsoil?

Construction

No Impact. The majority of the Proposed Project would be constructed within urbanized areas covered by impervious surfaces. The BRT would operate on existing paved roadways and construction activities, including staging, would involve minimal work around exposed soils. The Proposed Project would be designed based on the latest versions of local and State building codes and regulations in order to counteract erosion. During construction, earthwork activities for street lanes, stations, and utility trenches would be conducted based on local and State regulations and appropriate permits, and during the period of the year designated for those activities to be undertaken. There is no potential for the surface-running BRT to result in substantial soil erosion or the loss of topsoil. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

No Impact. The surface-running BRT would operate on existing roadways. There is no potential for operations to result in substantial soil erosion or loss of topsoil. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Mitigation Measures

No mitigation measures are required.

Significance of Impacts after Mitigation

No impact.

Impact 3.7-3) Would the Proposed Project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potential result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

Construction

No Impact. The impact evaluation involves assessing if unstable soils would impact the Proposed Project. The potential for impact is related to permanent conditions and is considered in the operational analysis. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

Landslide

Less-Than-Significant Impact with Mitigation. There is potential for landslides and debris flows in the Project Area. Areas most susceptible to shallow landslides and debris flows include the southern San Rafael Hills in the eastern Glendale, Eagle Rock, and western Pasadena portions of the Project Area. Therefore, without mitigation, the Proposed Project would result in a potentially significant impact on shallow landslides related to operational activities. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by requiring final design to include appropriate slope stabilization measures (e.g., retaining walls, slopes with shotcrete faces, slopes re-grading, among others) and by ensuring that the Proposed Project is designed in a manner that meets all federal, state, local, and Metro seismic and environmental requirements. .

Lateral Spreading

Less-Than-Significant Impact. The Proposed Project is not expected to experience lateral spreading since liquefaction is not likely to occur in the Project Area. Furthermore, the liquefied area must be relatively near a free face, a vertical or sloping face such as a road cut or stream/riverbank, which is unlikely to occur (or may be limited to very specific areas) in the Project Area. Therefore, the Proposed Project would result in a less-than-significant impact on lateral spreading related to operational activities.

Subsidence

No Impact. The Proposed Project is not located within the areas of subsidence. Therefore, the Proposed Project would result in a less-than-significant impact on land subsidence related to operational activities.

Liquefaction

Less-Than-Significant Impact. The potential for liquefaction is related to water-saturated soils. Deep groundwater is expected in the Project Area (50 feet bgs and deeper) with isolated cases of shallower groundwater depth (i.e., between 24 and 42 feet bgs) within the Eagle Rock Valley. Shallow groundwater (i.e., less than 10 feet bgs) is not expected in the Project Area. Therefore, the Proposed Project would result in a less-than-significant impact related to operational activities.

Collapse

Less-Than-Significant Impact. The Proposed Project would be located on exiting roadways that do not have a history of collapsible soils. The relatively deep groundwater conditions substantially reduce the potential for collapse. There is low potential for the Proposed Project to encounter collapsible soil. Therefore, the Proposed Project would result in a less-than-significant impact related to operational activities.

Mitigation Measures

Landslides

Refer to Mitigation Measure **GEO-1**.

Lateral Spreading, Subsidence, Liquefaction, and Collapse

No mitigation measures are required.

Significance of Impacts after Mitigation

Mitigation Measure **GEO-1** would ensure that the Proposed Project would be designed to limit potential impacts related to landslides. Therefore, the Proposed Project would result in a less-than-significant impact with implementation of Mitigation Measure **GEO-1**.

Impact 3.7-4) Would the Proposed Project be located on expansive soil as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

Construction

No Impact. The Impact Statement involves assessing the potential risk to life or property related to operating the Proposed Project on expansive soils. The potential for an impact is not related to construction activities. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

No Impact. The surface-running BRT would operate on existing roadways. Soils in the Project Area are mostly granular in nature and lay within "low expansion" and "low to moderate expansion" prone areas. The roadway network in the Project Area is not prone to expansive soil. Field research indicates that the existing roadway network to be utilized by the Proposed Project is not affected by expansive soils. In addition, the final design would be performed in accordance with Metro's Design Criteria, the latest federal and state seismic and environmental requirements, and State and local building codes. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Mitigation Measures

No mitigation measures are required.

Significance of Impacts after Mitigation

No impact.

Impact 3.7-5) Would the Proposed Project 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?

No Impact. Neither construction nor operation of the BRT would require use of a septic tank or alternative wastewater disposal systems. Therefore, the Proposed Project would not result in a significant impact related to construction or operational activities.

Mitigation Measures

No mitigation measures are required.

Significance of Impacts after Mitigation

No impact.

Impact 3.7-6) Would the Proposed Project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

Construction

Less-Than-Significant Impact. One paleontological locality was recorded from Pleistocene-age deposits within the western portion of the Project Area from a depth of 60 to 80 feet and additional localities were recorded from the Pleistocene-age deposits and Miocene-age Topanga Formation. Furthermore, it is possible that buried paleontological resources or buried unique geological features are present within native, undisturbed sediments of high paleontological potential Pleistocene-age older sedimentary deposits (Qoa, Qof) or Miocene-age Topanga Formation (Ttsc, Ttqdb) in the subsurface of the Project Area. However, the excavations would be within previously disturbed sediments in the upper three feet of the site. These shallow excavations would not result in impacts to significant paleontological resources.

Therefore, there is a low likelihood of uncovering significant paleontological or unique geologic resources during tree removal. In the unanticipated event that fossil resources are discovered, they should be protected from further excavation, destruction, or removal as required by the California PRC. Therefore, construction of the Proposed Project would result in a less-than-significant impact to paleontological or unique geologic features.

Operations

No Impact. The surface-running BRT would operate on existing roadways. There is no potential for operations to directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Mitigation Measures

No mitigation measures are required.

Significance of Impacts after Mitigation

No impact.