3.6 Geology, Soils, and Paleontological Resources

3.6.1 Introduction

This section discusses the Project setting in relation to geology, soils, seismicity, and paleontological resources. It describes existing conditions, current applicable regulatory setting, and potential impacts from construction and operation of the Build Alternatives, including design options and MSF site options. Information in this section is based on the Eastside Transit Corridor Phase 2 Geology, Soils, Seismicity, and Paleontological Resources Impacts Report (Appendix G).

3.6.2 Regulatory Framework

3.6.2.1 Federal

There are no specific federal regulations related to the geologic hazards of soils and seismicity or to paleontological resources.

3.6.2.2 State

The principal state guidance relating to geologic hazards is contained in the Alquist-Priolo Act and the Seismic Hazards Mapping Act of 1990. The Alquist-Priolo Act prohibits the location of most structures for human occupancy across active traces of faults in earthquake fault zones. The Seismic Hazards Mapping Act requires the state to identify areas at risk of strong ground shaking, liquefaction, landslides, and other corollary hazards.

The California Building Code (CBC), codified in Title 24 California Code of Regulations, encompasses a number of requirements related to geologic issues and sets standards for the investigation and mitigation of the site conditions related to fault movement, liquefaction, landslides, differential compaction/seismic settlement, ground rupture, ground shaking, and seismically-induced flooding. This includes strict requirements to reduce the risks associated with building in seismic areas to the maximum extent practicable. The CBC provides standards for various aspects of construction, including but not limited to: (1) excavation, grading, and earthwork construction; (2) preparation of the site prior to fill placement; (3) specification on fill materials and fill compaction and field testing; (4) retaining wall design and construction; (5) foundation design and construction; and (6) seismic requirements. The CBC also includes requirements to perform site-specific geotechnical investigations and prepare design reports in accordance with CBC methodologies. Various sections of the CBC are applicable, including Chapter 16 which provides structural design requirements governing seismically resistant construction, Chapter 18 which requires that geotechnical evaluations be conducted, and recommended action(s) must be made a condition to the building permit, and Chapter 33 which includes requirements for excavation safeguards so that excavation and cut or fill slopes are stable. CBC requirements applicable to the Project are discussed in greater detail in Appendix G.

The California Public Resources Code prohibits the removal of any paleontological site or feature from public lands without permission of the jurisdictional agency, defines the removal of paleontological sites or features as a misdemeanor, and requires reasonable mitigation of adverse impacts to paleontological resources from developments on public (state, county, city, district) lands.

The National Pollutant Discharge Elimination System (NPDES) administered through the California State Water Resources Control Board regulates stormwater discharges and is discussed in more detail in Section 3.9, Hydrology and Water Quality and Appendix J.

3.6.2.3 Regional

Los Angeles Regional Water Quality Control Board is responsible for issuing the Los Angeles County Municipal Storm Water Permit which covers the permittees for contributions to discharges of stormwater and urban runoff from municipal separate storm sewer systems (MS4s). The current MS4 permit imposes basic programs, or minimum control measures, that mitigate stormwater quality issues. To illustrate, the implementation of temporary construction BMPs, such as erosion control and spill management and safe storage of fluids, are required under the development construction program. Post-construction stormwater BMPs are required for most public and private development under the planning and land development program. Compliance with the MS4 permit is discussed in more detail in Section 3.9, Hydrology and Water Quality, and Appendix J.

3.6.2.4 Local

Metro, through the Metro Rail Design Criteria (MRDC), establishes the design criteria and specifications for Metro transit projects, including LRT guideways and facilities (Metro 2018). The MRDC incorporates various design specifications from the Federal Highway Administration (FHWA), California Department of Transportation (Caltrans), the State of California, the County of Los Angeles, and other sources by reference. Section 5 of the MRDC provides specifications for structural and geotechnical work. Section 5 governs all matters pertaining to the design of Metro-owned facilities including bridges, aerial guideways, cut-and-cover subway structures, tunnels, passenger stations, earth-retaining structures, surface buildings, miscellaneous structures such as culverts, sound walls, and equipment enclosures, and other non-structural and operationally critical components and facilities supported on or inside Metro structures. These criteria also establish the design parameters for temporary structures. The main reference document controlling the seismic design of Metro facilities under these criteria is Section 5 Appendix, Metro Supplemental Seismic Design Criteria.

Section 5.3 of the MRDC provides specifications for aerial guideways and structures, including bridges. Specifications include wind load, vertical vibration, fatigue, uplift, friction, sound barriers, bearings, camber growth and deflection, longitudinal tension stresses, structure deformation and settlement, precast segmental guideway construction, and crack control. For bridges and aerial structures that support rail transit loadings, the MRDC requires using the current American Association of State Highway and Transportation Officials (AASHTO) *Load and Resistance Factor Design (*LRFD) Bridge Design Specifications with California Amendments (AASHTO-CA LRFD BDS) and Caltrans technical publications and guidelines (including the latest the latest version of the Caltrans Bridge Design Specifications, Caltrans Seismic Design Criteria, and Metro-specified rail transit loading for bridges supporting rail.) This includes applying Caltrans geotechnical investigation and design of bridge foundations. Compliance with the American Railway Engineering and Maintenance-of-Way Association (AREMA) specifications are also required to be used for various applications.

Section 5.4 of the MRDC provides specifications for underground structures used for rail transit. The design of tunnel linings is not addressed in standard design codes. This section established the procedure for the design of tunnel linings utilizing the FHWA FHWA-NHI-09-010, Chapter 10, Tunnel Lining, current edition which incorporates load and LRFD. LRFD is a design philosophy that takes into account the variability in the prediction of loads and the variability in the behavior of structural elements. The MRDC provides instruction on applying the LRFD specification to tunnel lining design and provides a uniform interpretation of the FHWA document as it applies to tunnel linings. Specifications include tunnel lining, structural design (including loads, concrete design criteria, ventilation shafts, tunnel break-outs, portals and u-sections, underground stations and cut-and-cover sections, retaining walls, shafts, water and gas proofing, and materials), surface facility specifications, pedestrian areas, and seismic design (supplemented by MRDC Section 5 Appendix).

Section 5.6 of the MRDC requires subsurface investigation and laboratory testing, geotechnical reporting and temporary excavation, and detailed foundation design requirements that would address the hazards discussed in this section. All new structures must be designed to resist the earthquake forces and ground displacement defined in the MRDC. Specifically, MRDC Section 5.6.2.1 requires preparation of a Geotechnical Planning Report to define the engineering and design approach to develop the most cost-effective and technically and environmentally acceptable foundations, cut and fill slopes, retaining structures, and geotechnical designs for the aerial/bridge, underground, and at-grade portions of the project. As described in MRDC Section 5.6.2, further geotechnical investigations are required to follow, including subsurface investigations, geotechnical data report, and a geotechnical design report.

The MRDC Section 5 Appendix, Metro Supplemental Seismic Design Criteria, dictates the required seismic performance criteria for structures. For structures other than above ground and below ground guideway and structures, the MRDC requires conformance with the Los Angeles County Building Code (which is based on the CBC). The Supplemental Seismic Design Criteria provides seismic design requirements for the Build Alternatives using a two-level design approach for aerial and underground structures. Over the design life of the project (typically 100 years for Metro rail projects), an operating design earthquake (ODE) and a maximum design earthquake (MDE) are used to define the performance scenarios. Structures are designed to respond without significant structural damage to the ODE with a 150-year average return period, and to respond with repairable damage and maintaining life safety to the MDE with a 2,500-year average return period. The Supplemental Seismic Design Criteria also requires the following:

- Bridges, aerial, and underground structures would be designed in accordance with the Metro MDE (as described above), which has a 2,500-year average return period.
- Surface structures not covered by the Caltrans seismic design criteria would be designed in accordance with the Los Angeles County Building Code, which uses the Maximum Considered Earthquake, with a 2,500-year average return period.
- Bridges supporting railroad loads would be designed in accordance with the requirements of the applicable railroad, or in accordance with AREMA standards in lieu of specific railroad requirements.

Los Angeles County and the cities within the Build Alternative DSAs have local regulations related to geology, soils, seismicity, and paleontological resources. These regulations include the relevant general plan policies, ordinances, and municipal codes of Los Angeles County and the cities of Commerce, Montebello, Pico Rivera, Santa Fe Springs, and Whittier. Generally, these policies and

ordinances aim to protect the public from geological and seismic hazards, establish low impact development (LID) practices to improve stormwater management and minimize erosion and sedimentation into water bodies, and protect paleontological resources. More information about these laws and policies can be found in Appendix G.

3.6.3 Methodology

The following documentation was reviewed and evaluated in preparation of the discussion of the environmental setting and evaluate the geologic hazards and potential for paleontological resources to occur:

- Reports and data collected during previous geotechnical investigations of the GSA
- *Eastside Transit Corridor Phase 2 Washington Boulevard Alternative Preliminary Geotechnical Design Report* prepared by Diaz Yourman and Associates (2021)
- Available published and unpublished literature, and consultants' reports within the GSA for known geologic hazards. Documents reviewed included:
    - The safety elements of the general plans for Los Angeles County and cities of Commerce, Montebello, Pico Rivera, Santa Fe Springs, and Whittier
    - The official Alquist-Priolo Earthquake Fault Zone Maps; official Seismic Hazard Zone Maps, geologic and topographic maps, and other publications by the California Geological Survey (CGS), United States Geological Survey (USGS), and California Division of Oil and Gas)
    - The as-built drawings for the bridge crossings along the Rio Hondo and San Gabriel River along Washington Boulevard
- Paleontological records search report from the Natural History Museum of Los Angeles County
- Available published and unpublished literature, and consultants' reports within the GSA for known paleontological resources
- Available descriptions of details of construction of the Build Alternatives

Geologic and seismic impacts pertain to both construction and operational activities. The potential impacts during construction are generally related to failure of temporary structures and safety concerns related to soil stability. The potential for erosion and loss of topsoil is primarily related to the potential for soil disturbance during construction activities but can also be related to operations if soils are exposed following completion of construction. The potential impacts during operations are generally associated with the safety of built elements relative to geologic stability, including safety impacts resulting from an earthquake and exposure to secondary seismic hazards such as ground settlement or liquefication.

Paleontological impacts pertain to ground disturbance activities occurring in paleontologically sensitive geologic units and are therefore primarily associated with construction activities. Generally, for project sites that are underlain by paleontologically sensitive geologic units, the greater the amount

of ground disturbance associated with the project, the higher the potential for impacts to significant paleontological resources to occur. A significant paleontological resource includes any identifiable fossil that is unique, unusual, rare, uncommon, diagnostically or stratigraphically important, and/or those that add to an existing body of knowledge in specific areas – stratigraphically, taxonomically, and/or regionally. The Society of Vertebrate Paleontology (2010) asserts that any identifiable vertebrate fossil is a significant paleontological resource. Direct impacts to paleontological resources primarily concern the potential destruction of nonrenewable paleontological resources and the loss of information associated with these resources. This includes the unauthorized collection of fossil remains. If potentially fossiliferous bedrock or surficial sediments are disturbed, the disturbance could result in the destruction of paleontological resources and subsequent loss of information.

3.6.4 Thresholds of Significance

In accordance with Appendix G of the State CEQA Guidelines, a Build Alternative would have a significant impact related to geology and seismology under the following conditions:

Impact GEO-1: Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:

- **Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (refer to Division of Mines and Geology Special Publication 42)**
- **Strong seismic ground shaking**
- **Seismic-related ground failure, including liquefaction**
- **Landslides**

Impact GEO-2: Result in substantial soil erosion or the loss of topsoil.

Impact GEO-3: Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

Impact GEO-4: Be located on expansive soil, as defined in Section 1803.5.3 of the CBC,[1] creating substantial direct or indirect risks to life or property.

Impact GEO-5: Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

Appendix G of the State CEQA Guidelines also includes a significance criterion for impacts relating to the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater. The Build Alternatives are in an urban area with an established sewer

1 Appendix G of the CEQA Guidelines refers to Table 18-1-B of the Uniform Building Code. That provision no longer exists. Instead, Section 1803.5.3 of the CBC describes the criteria for analyzing expansive soils.

system. There are no existing or proposed septic tanks or other alternative wastewater disposal system associated with the Build Alternatives; therefore, this criterion is not applicable.

3.6.5 Existing Setting

This section provides an overview and general information for the GSA and DSAs, including regional and local geology, faulting and seismicity, and paleontological resources.

3.6.5.1 Regional Setting

The Build Alternatives are located near the northwest boundary of the Los Angeles Basin in the general vicinity of the Whittier Narrows, a prominent gap in the Puente Hills. The Build Alternatives traverse the physiographic features known as the Montebello Plain and Montebello Hills, the Rio Hondo, and the San Gabriel River. Topography along the Washington Boulevard corridor consists of gentle slopes along the side of the valley. The elevation ranges from 150 to 260 feet along the Build Alternatives.

3.6.5.1.1 Topography and Drainage

The ground surface along the Build Alternatives is generally flat except where it crosses the Rio Hondo and San Gabriel River. Drainage along the Build Alternatives is typically controlled by engineered infrastructure including curbside storm drains and gutters. The two major surface water drainages within the GSA are the Rio Hondo river channel and spreading grounds and the San Gabriel River. The Rio Hondo and San Gabriel River are in the DSA for Alternative 1 and would be crossed by the alignment. The Rio Hondo and San Gabriel River are not in the DSA for Alternative 2 or Alternative 3 and would not be crossed by the alignment for these two Build Alternatives.

3.6.5.1.2 Regional Geology

On a regional scale, the GSA lies within the Peninsular Ranges geomorphic province, which is bounded by the San Jacinto fault zone to the east, the Pacific Ocean coastline to the west, and the Transverse Ranges geomorphic province to the north. The Peninsular Ranges province is characterized by northwest-trending mountain ranges and hills separated by sub-parallel, sediment-filled valleys.

Bedrock in the GSA consists of silty sandstone of the Pliocene Fernando Formation, one of the uppermost units of the marine sedimentary units filling the Los Angeles Basin. Bedrock is overlain by unconsolidated Quaternary alluvial fan and fluvial deposits. The regional geology in the GSA is shown on **Figure 3.6.1** (the GSA is the same for all three Build Alternatives, and the figure identifying the geology within the GSA that shows Alternative 1 is applicable to all three Build Alternatives).

Historic high groundwater levels along the Build Alternatives range from approximately 110 feet below ground surface (bgs) on the northwest at Atlantic Boulevard, to 50 to 60 feet bgs at the end of Washington Boulevard. To the west of Montebello Boulevard, the historical high groundwater is generally deeper than 50 feet bgs. Groundwater becomes shallower, as shallow as approximately 15 feet bgs, in the vicinity of the Rio Hondo and the San Gabriel River. Fluctuations in the groundwater levels could occur due to changes in seasons, precipitation, irrigation, groundwater pumping in the vicinity, and other factors.

Source: Metro; CDM Smith/AECOM JV, 2021.

Figure 3.6.1. GSA Geology Map

3.6.5.1.3 GSA Geologic Units

The main geologic units along the Build Alternatives are discussed below and shown on **Figure 3.6.1** (Bedrosian and Roffer 2012). Geotechnical work for the Build Alternatives indicates bedrock is a few hundred to several hundred feet deep in the GSA and is unlikely to be encountered (Diaz-Yourman & Associates 2021).

Landslide deposits (Qls) (late Holocene) are slope-failure deposits that consist of displaced bedrock blocks and/or chaotically mixed rubbles. These deposits exist near the toe of hills the east boundary of the GSA. Most deposits are likely active or recently active

Wash deposits (Qw) are associated with the action of active or recently active stream beds and include some debris flow deposits. These areas are frequently exposed to episodes of bank-full stream flow and support heavy vegetation. The hydrologic actions of the streams or rivers result in deposits of unconsolidated gravel, sand, and silt which are present in active or recently active reaches. Wash deposits are anticipated in the immediate vicinity of the Rio Hondo and the San Gabriel River.

Young alluvial fan deposits (Qyf) (Holocene and late Pleistocene) generally consist of unconsolidated to slightly consolidated boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon. These deposits include all soils in the project vicinity east of the Rio Hondo.

Young deposits of axial valley floors (Qya) (Holocene and late Pleistocene) consist of slightly to moderately consolidated sand and pebble-cobble gravel. These deposits exist near the west portion of the northern boundary of the GSA in small areas.

Old alluvial fan deposits (Qof) (late to middle Pleistocene) consist of slightly to moderately consolidated silt, sand, and gravel deposits. These deposits are anticipated along Washington Boulevard extending near Rio Hondo to the west and essentially covering the Build Alternatives west of Rio Hondo.

Tertiary sandstone (Tss), the bedrock represented by the Fernando Formation, exists in the portion of the Montebello Hills north of the Build Alternatives and in the portion of the Hacienda Hills east of the Build Alternatives. Bedrock is a few hundred to several hundred feet deep along the Build Alternatives and is unlikely to be encountered.

Tertiary shale and siltstone (Tsh), the bedrock also represented by the Fernando Formation, exist in the portion of the Hacienda Hills east of the Build Alternatives. The bedrock is deep near the Build Alternatives and is unlikely to be encountered.

3.6.5.1.4 GSA Geologic Conditions

Based on the review of the data available, the subsurface soils along the Build Alternatives mainly consist of layers or mixtures of sands, silts, and clays.

Collapsible soils are generally unsaturated soil that goes through a radical rearrangement of particles and great decrease in volume upon wetting, additional loading, or both. Based on review of the data currently available, there are no known collapsible soils along the Build Alternatives.

Expansive soils are clay-rich soils that swell and shrink with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement below or adjacent to a structure. This

differential movement can result in significant damage to pavements, as well as foundations and associated structures. Clay-rich soils may exist locally within alluvial soils present in the GSA.

Consolidation is the soil settlement due to expulsion of pore water in saturated clay resulting in rearrangement of soil particles. Consolidation settlement occurs in clay, especially in unconsolidated or normally consolidated soft clay when the soil is loaded. Although clay-rich soils may exist locally in the GSA, consolidation settlement may occur within the GSA.

A limited number of corrosion tests were performed from samples collected from the limited field exploration conducted for the design phase of the Project. The on-site soils at the site-specific boring locations do not pose a corrosive environment.

In California, most of the large area land subsidence is a result of excessive groundwater pumping. Based on the map illustrating areas of recorded subsidence — historical and current — across California, the Build Alternatives are not located within a subsidence area (USGS 2022).

3.6.5.2 Faulting and Seismicity

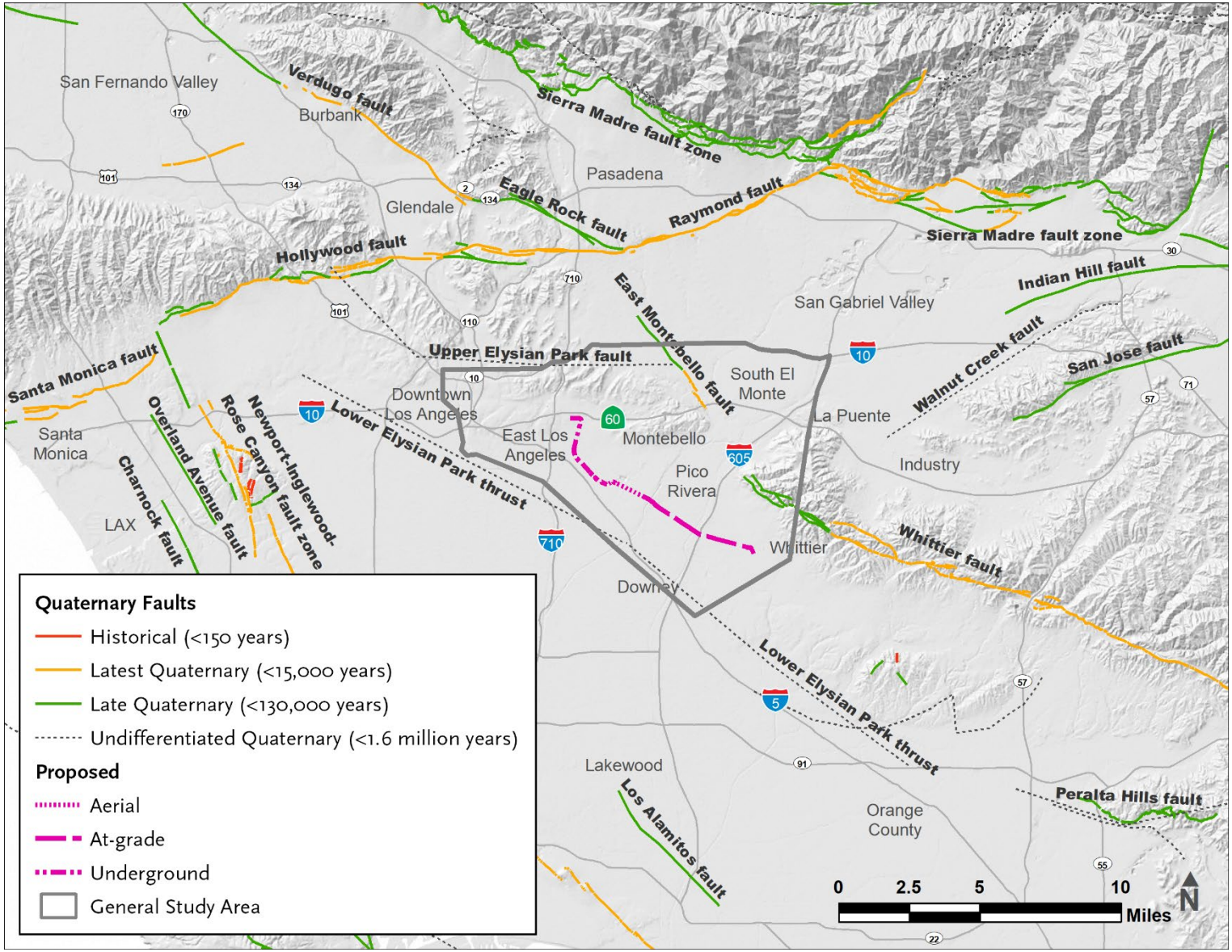
3.6.5.2.1 General Setting

The primary impacts that could result from faulting and seismicity are surface rupture of the earth along fault traces and seismically-induced ground shaking. There are numerous faults in Southern California including active, potentially active, and inactive faults. Criteria adopted by the CGS for the Alquist-Priolo Earthquake Zoning Program classify active faults as faults that have had surface displacement within Holocene time (about the last 11,700 years) and potentially active faults as faults that has demonstrated surface displacement of Quaternary age deposits (last 1.6 million years). Inactive faults have not moved in the last 1.6 million years. Active faults that are located within 20 miles of the Build Alternatives are discussed below.

The location of the GSA and the Build Alternatives in relation to known regional fault systems is shown in **Figure 3.6.2**. There is one Alquist-Priolo Earthquake Fault zone within the GSA, which includes the East Montebello Fault approximately four miles northeast, as shown on **Figure 3.6.3**.

3.6.5.2.2 Active Faults

Holocene active faults within 20 miles from the closest point of the Build Alternatives are presented in Appendix G. The Holocene active fault with surface expression that is closest to the Build Alternatives is the Whittier Fault, which is one of the two upper branches of the Elsinore fault zone, located within the GSA and approximately 2.8 miles northeast of the eastern terminus of the Build Alternatives.



Source: Metro; USGS, 2019; CDM Smith/AECOM JV, 2021.

Figure 3.6.2. Regional Faults

Source: Metro; CDM Smith/AECOM JV, 2021.

Figure 3.6.3. Alquist-Priolo Earthquake Fault Zone for the East Montebello Fault

3.6.5.2.3 Potentially Active Faults

The inferred trace of the MacArthur Park Fault is in the Los Angeles downtown area approximately five miles northwest of the western terminus of the Build Alternatives. The fault has not been definitively proven to exist, but it is inferred west of downtown Los Angeles (Dolan and Sieh 1992). The Eagle Rock Fault, a late Pleistocene active fault, is located approximately 10 miles to the north of the Build Alternatives.

3.6.5.2.4 Blind Thrust Fault Zones

Blind thrust faults are faults that do not rupture all the way up to the Earth's surface and do not show evidence on the ground. They are buried under the uppermost layers of rock in the Earth's crust; consequently, they are typically characterized as fault zones or fault systems without designation of specific mapped fault lines. Several blind thrust faults underlie the Los Angeles Basin at depth. These faults are not exposed at the ground surface and are typically identified at depths greater than three kilometers (1.86 miles). These faults do not present a potential surface fault rupture hazard; however, they are considered active and potential sources for future earthquakes. The Build Alternatives sit atop the Puente Hills blind thrust fault system, which is the source of the 1987 Whittier Narrows earthquake. Additionally, the Elysian Park Thrust is believed to underlie the central Los Angeles Basin north of the SR 60 Freeway.

3.6.5.2.5 Seismic Hazards

The potential to experience substantial seismic ground shaking is a common hazard for every project in Southern California. Structures (aerial, at-grade, and underground) have been and continue to be successfully designed and constructed based on mandatory design criteria. During a moderate to severe earthquake occurring on the nearby faults, strong ground shaking within the GSA would likely occur. In addition to ground shaking, effects of seismic activity on a project site may include surface fault rupture, soil liquefaction, and seismically induced differential settlement of structures, and landslides.

Ground Shaking

Seismic hazards that could affect the Build Alternatives include ground shaking from an earthquake along one of the several active faults in the region. The MRDC requires a two-level seismic evaluation approach to seismic design based on earthquake statistical probability. The two-level approach requires the design to provide a high-level of assurance that the overall system will continue to operate during and after an earthquake event anticipated to occur once during the design life; this is referred to as an operating design earthquake (ODE). Design for the ODE would enable safe shut down and inspection before returning to operation. Furthermore, the system design will provide a high-level of assurance that public safety will be maintained during and after an earthquake event with a low probability of occurring during the design life, where structures are designed to withstand the earthquake with repairable damage, thereby maintaining life safety; this is referred to as a maximum design earthquake (MDE). See **Section 3.6.2.4** for additional information on the two-level seismic evaluation.

Liquefaction

Liquefaction-induced ground failure has historically been a major cause of earthquake damage in Southern California. In portions of the GSA, sediments susceptible to liquefaction comprise the young (Holocene to late Holocene age) alluvial fan deposits and the wash sediments. When liquefaction occurs, the strength of the soil decreases, and the ability of the soil to support structures is reduced. The potential impacts of liquefaction may include settlement of the ground surface, additional forces pushing down on foundation piles as a result of soil settlement above the liquefied layers (downdrag), lateral spreading (similar to a landslide), and reduction of the shear strength of the liquefied soil, resulting in reduced load-carrying capacity. Liquefied soils can also exert additional dynamic pressures on retaining walls, which can cause them to tilt or slide. Liquefaction-induced ground failure has historically been a major cause of earthquake damage in Southern California.

The CGS has prepared seismic hazard maps for the Los Angeles Basin that delineate liquefaction zones where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacement. The CGS hazard map identifies the Holocene sediments along Alternative 1 between South Bluff Road and the eastern terminus at Lambert Road as a potential liquefaction zone as shown on **Figure 3.6.4.** Alternatives 2 and 3 and the MSF site options are not within the liquefaction zone.

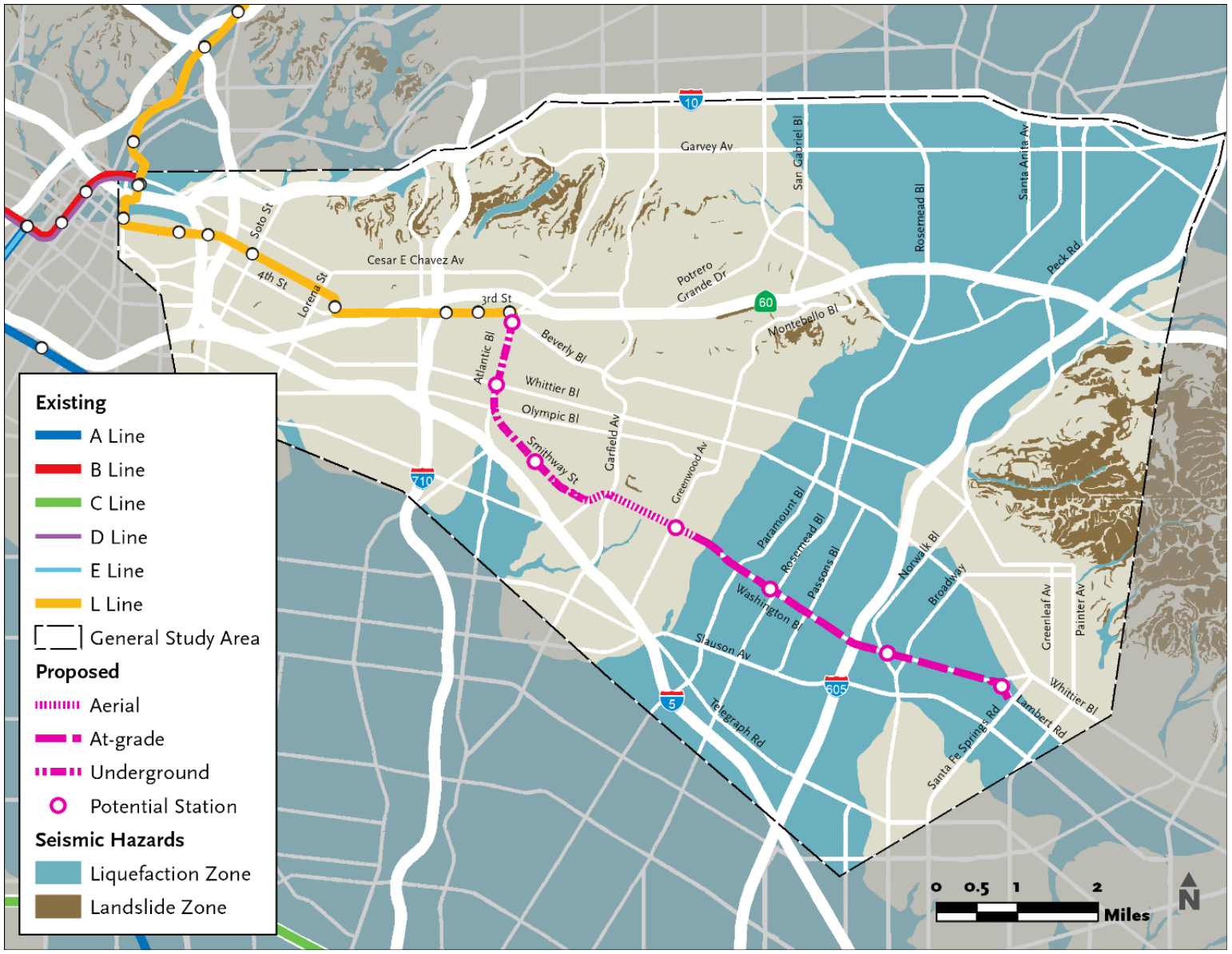
Settlement

Seismically-induced settlement consists of compression of the dry soils above groundwater and liquefaction-induced settlement of the liquefiable soils below groundwater. These settlements occur primarily within the loose to moderately dense sandy soils due to volume reduction during or shortly after an earthquake event. Such settlement can result in structural distress as the ground settles. The portion of Alternative 1 that is mapped within the liquefiable zone and underlain by wash deposits and the young alluvial fan deposits has the potential to experience seismically-induced settlement.

Additionally, the upper soils along the at-grade segment of Alternative 1 consist of predominately young alluvial fan deposits, which could be subject to settlement. Alternative 2 and Alternative 3 are not located in the area mapped to have the potential to experience liquefaction and seismically-induced settlement.

Landslides

The Build Alternatives are not located within a mapped earthquake-induced landslide zone as shown on **Figure 3.6.4.** In general, the Build Alternatives are located on relatively level ground and the potential for landslides to affect the Build Alternatives is low. However, for Alternative 1, the potential for lateral spread landslide may exist within the liquefaction-susceptible area nearby the Rio Hondo and San Gabriel River, as ground surfaces consist of gentle slopes at these two locations. Lateral spreading of the ground surface can occur during a seismic activity when potentially liquefiable soil is present in conjunction with a sloping ground surface and a “free” face (i.e., retaining wall, slope, or channel). When the soil undergoes a temporary loss of strength, and if the liquefiable soil is not contained laterally, it may result in deformation or translation of the slope. Lateral spread potential may also exist in the vicinity of open faces.



Source: Source: CDMG, Seismic Hazard Zone Maps for El Monte, Los Angeles, South Gate, and Whittier 7.5 Minute Quadrangles, Details below.

Figure 3.6.4. Liquefaction and Landslide Hazard Zone Map

3.6.5.3 Paleontological Resources

3.6.5.3.1 Paleontological Potential

Paleontological potential is defined by the Society of Vertebrate Paleontology (SVP) Uniform Guidelines rank geologic units according to Paleontological Potential (SVP 2010). Rock units are described as having (a) high, (b) undetermined, (c) low, or (d) no potential for containing significant paleontological resources.

Only three geologic units occur along the Build Alternatives (**Figure 3.6.1**). These are old alluvial fan deposits (Qof), the young alluvial fan deposits (Qyf), and wash deposits (Qw).

3.6.5.3.2 Paleontological Records Search

A paleontological records search was solicited from the Natural History Museum of Los Angeles County. Of the three most pertinent localities from that report, two are west and northwest of the Build Alternatives between Atlantic station (relocated/reconfigured) and Commerce/Citadel station. These are at a depth of 20 to 35 feet. Two localities are in the Qof. They produced mastodon, horse, deer, sabretooth cat, and turkey fossils. The third locality is south-southwest of the Build Alternatives and lies in the Qyf. At a level of 30 feet bgs, it produced fish, snake, rodent, and rabbit fossils. All fossils from these localities are of Pleistocene age.

3.6.5.3.3 Paleontological Literature Search

A search of paleontological literature yielded no published records of localities near the Build Alternatives. However, there was one recent unpublished report of a fossil bison just north of Beverly Boulevard on the west bank of the San Gabriel River (ESA 2020). It was found at 18 feet bgs within the Qyf, north of the proposed Norwalk station.

3.6.5.3.4 Assignment of Paleontological Potential to Units

There have been relatively few projects in the GSA that were monitored for paleontological resources. One of the fossil localities in the Qyf produced microbertebrate fossils as a result of sediment screening. The sparse localities which can be demonstrated to have produced significant paleontological resource in the GSA do not necessarily indicate that fossils are rare in the GSA.

Paleontological Potential by Geologic Unit

Alluvial wash deposits (Qw) are encountered where Washington Boulevard crosses the Rio Hondo and San Gabriel River. There is no evidence of significant paleontological resources having been found in alluvial wash deposits. Therefore, this area represents a low paleontological potential.

Young alluvial fan deposits (Qyf) (Holocene and late Pleistocene) include all soils in the project vicinity east of the Rio Hondo (with the exception of Qw sediments in the San Gabriel River). Paleontological potential would increase with depth (as depth approaches Pleistocene levels). This unit is assigned a low paleontological potential near the surface, but a high potential below 10 feet.

Old alluvial fan sediments (Qof) (late to middle Pleistocene) are anticipated along Garfield Avenue (including the tunnel section) and along Washington Boulevard extending from Garfield Avenue to

South Bluff Road. Even the near-surface sediments are of Pleistocene age and the entire unit, including undisturbed sediments near the surface, should be assigned a high paleontological potential.

Potential by Project Section

The following describes the paleontological potential by sections of the Build Alternatives.

Atlantic to Citadel Section: This section is entirely within Qof and is ranked high sensitivity. The tunnel location is likely to be entirely within previously undisturbed sediments.

Citadel to Greenwood Avenue: This section is entirely within Qof and is ranked high sensitivity.

Greenwood Avenue to Santa Fe Springs Road: The western portion of this section (from Greenwood Avenue to the Rio Hondo) lies within Qof which has high potential for paleontological resources. The remainder of this section, from the west bank of Rio Hondo to Santa Fe Springs Road, lies within Qyf sediments, and has low paleontological potential near the surface, increasing to high potential below a depth of 10 feet.

3.6.6 Impact Evaluation

3.6.6.1 Impact GEO-1: Exposure to Seismic Hazards

Impact GEO-1: Would a Build Alternative directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:

- **Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (refer to Division of Mines and Geology Special Publication 42)**
- **Strong seismic ground shaking**
- **Seismic-related ground failure, including liquefaction**
- **Landslides**

3.6.6.1.1 Alternative 1 Washington

Operational Impacts

Rupture of a Known Earthquake Fault and Seismic Shaking

Alternative 1 would not cross any known Holocene active faults. As discussed in **Section 3.6.5**, the Whittier fault is closest Holocene active fault with surface expression; it is approximately 2.8 miles northwest of the eastern terminus of the Alternative 1. Because there are no known active faults capable of ground rupture under the alignment, fault rupture would not present a risk, including the risk of loss, injury, or death. Alternative 1 is located in a seismically active area, thus, operation of Alternative 1 would potentially be subject to seismic ground shaking. Seismic shaking could result in

damage to structures or human injury or death. For Alternative 1, this could include damage to aerial structures and stations, at-grade guideway and stations, and underground tunnel guideway sections and stations. Seismic shaking could also injure humans using the system from falls to the ground or structural collapse. The potential to experience substantial seismic ground shaking is a common hazard for every project in Southern California. Structures have been and continue to be successfully designed and constructed based on mandatory design criteria as described below.

To address potential seismic hazards, including development of site-specific design parameters to account for seismic shaking, Alternative 1 would be designed and constructed in conformance with the MRDC as set forth in project measure PM GEO-1, identified in **Section 3.6.7**. Additionally, Alternative 1 would be designed and constructed in conformance with applicable portions of building and seismic code requirements including the most recent edition of the CBC, Metro's standard specifications, and industry standards. Consistent with MRDC requirements, Project structures would be designed to perform in accordance with the two-level seismic evaluation approach based on the MDE and ODE. Aerial, at-grade, and underground structures would be designed and would perform in accordance with federal, state, and local thresholds for seismicity. Compliance with the latest earthquake-resistant building design standards and other seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events.

Structural engineering standards to address geological conditions are part of standard construction requirements and standard construction practices. Additionally, PM GEO-1 sets forth project compliance with MRDC Section 5, Structural, which dictates that during final design, a geotechnical investigation must be conducted, including a detailed and site-specific evaluation of geotechnical hazards. The resulting final geotechnical engineering recommendations and any additional recommendations that come out of the review process would be incorporated into the final design plans consistent with MRDC requirements and standard practice to address any unstable geologic and related conditions present along the alignment. The Project would be designed to perform in accordance with the MDE and ODE thresholds as described in **Section 3.6.2**. As described, the seismic design criteria (MRDC, Caltrans Seismic Design Criteria, LA County Building Code/CBC) provide the design framework, including to address the average return period and shaking intensity. Compliance with these requirements and industry standards would ensure that strong seismic ground shaking would not cause potential substantial adverse effects, including the risk of loss, injury, or death.

Seismic-Related Ground Failure, Liquefaction, and Landslides

Seismic-related ground failure, liquefaction, and landslides could result in damage to structures and human injuries where the soil undergoes a temporary loss of strength. Ground instability could impact structural stability which in turn could damage structures or injure humans occupying structures on unstable ground. The aerial portion and the underground portion of the alignment are predominately in the old alluvium where the potential for adverse impact due to liquefaction is considered low. Further, the aerial portion of the alignment would be supported on a deep foundation system to minimize risk. There would be potential for adverse effects from liquefaction and seismically-induced settlement along the at-grade configuration and stations underlain by young alluvial fan deposits from South Bluff Road to the eastern terminus of the alignment.

Project measure PM GEO-1, identified in **Section 3.6.7**, would be implemented. This project measure identifies that the Project would be designed in accordance with design standards specific to ground stability. As set forth in PM GEO-1, a geotechnical investigation would be performed during final design in compliance with the MRDC; the required design-level geotechnical investigation would

provide information pertaining to the depths and areal extents of potential liquefaction, lateral spread, and seismically induced settlement. During the design process, if it is determined that these hazards could result in an unacceptable soil or structural response, ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting or deep foundation support to account for liquefaction, lateral spread, or seismically induced settlement potential would be implemented, consistent with the recommendations contained in the geotechnical investigation and design standards.

While Alternative 1 is on relatively level ground with a low potential for landslides, lateral spread landslide potential may exist near the Rio Hondo and San Gabriel River where ground surfaces consist of gentle slopes. Lateral spreading would be further investigated during the design phase when site-specific data and final geometry of improvements are available consistent with local requirements. The preliminary geotechnical design report has identified that shallow foundations would likely not be suitable at the site for the replacement of the Rio Hondo and San Gabriel River Bridges, and that similar to the existing bridges, the bridges would be supported on deep foundations (Diaz-Yourman & Associates 2021). The foundation types would be determined as part of the required geotechnical investigation conducted during the final design phase and would ensure that the potential for lateral spread landslide would not cause potential for substantial adverse effects, including the risk of loss, injury, or death. Foundation types may include deep foundation cast-in-drilled-hold (CIDH) concrete piles for drilled foundations and steel H-piles for driven piles for aerial structures, steel driven H-piles or CIDH piles for bridge supports, mat foundations with a 50- to 60-foot excavation for underground stations, embedded track on structure slab for track work, and CIDH concrete piles or other shallow foundation designs specific to the structure type for other miscellaneous structures.

Summary

Alternative 1 would be designed in compliance with regulatory requirements, industry standards, and the MRDC as identified in PM GEO-1; compliance with these regulatory and design requirements would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards. Operation of Alternative 1 would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Design Options

Atlantic/Pomona Station Option

Alternative 1 with the Atlantic/Pomona Station Option would not have seismic risks that differ from the base Alternative 1. The Atlantic/Pomona Station Option would potentially be subject to seismic ground shaking, but it is not located within a liquefaction zone. As identified in PM GEO-1, the Atlantic/Pomona Station Option would be designed in compliance with regulatory requirements and the MRDC and would be the subject of a site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Because of compliance with these regulatory and design requirements and engineering standards, operation of Alternative 1 with the Atlantic/Pomona Station Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Montebello At-Grade Option

Alternative 1 with the Montebello At-Grade Option would not have seismic risks that differ from the base Alternative 1. Alternative 1 with the Montebello At-Grade Option would be potentially subject to seismic ground shaking, but it is not located within a liquefaction zone. As identified in PM GEO-1, the Montebello At-Grade Option would be designed in compliance with regulatory requirements and the MRDC and would be the subject of a site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Because of compliance with these regulatory and design requirements and engineering standards, operation of Alternative 1 with the Montebello At-Grade Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Construction Impacts

Rupture of a Known Earthquake Fault and Seismic Shaking

Construction activities for Alternative 1 would involve temporary excavation shoring, foundation support installation and earthwork along the alignment. Additionally, cut-and-cover excavation, roadway decking, temporary shoring, mass excavation, and underground construction would occur along Smithway Street at the Tunnel Boring Machine (TBM) launching pit and then the TBM receiving pit west of Atlantic Boulevard and south of Pomona Boulevard. Alternative 1 would not cross any known active faults. As discussed in **Section 3.6.5**, the Whittier fault is the Holocene active fault with surface expression that is closest to the Build Alternatives; it is approximately 2.8 miles northwest of the eastern terminus of the Alternative 1.

Alternative 1 is located in a seismically active area, thus, construction of Alternative 1 would potentially be subject to seismic ground shaking which could result in damage to structures and human injury. To address potential seismic hazards, Alternative 1 would be constructed in compliance with the MRCD as identified in project measure PM GEO-1 (see **Section 3.6.7**), applicable portions of building and seismic code requirements including the most recent edition of the CBC, Metro's standard specifications, and industry standards. These requirements include development of site-specific design parameters to account for seismic shaking. Adherence with the latest seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events.

Seismic-Related Ground Failure, Liquefaction, and Landslides

In the portion of the proposed alignment within a mapped liquefiable zone, including the proposed stations at Rosemead Boulevard, Norwalk Boulevard, and Lambert Road, there would be potential for adverse effects from liquefaction and seismically-induced settlement. Additionally, lateral spread landslide potential may exist nearby the Rio Hondo and San Gabriel River where ground surfaces consist of gentle slopes. Consequently, construction of the Build Alternatives could subject people and structures to unstable ground where the soil undergoes a temporary loss of strength which would result in damage to structures or human injury.

Project measure PM GEO-1 identifies that the Build Alternatives would be designed and constructed in accordance with design standards and regulatory requirements, including state regulations and the

MRDC, to account for the potential effects of liquefaction and seismic settlement. As identified in PM GEO-1, a geotechnical investigation would be performed during final design in compliance with the MRDC; the geotechnical investigation would include structural engineering standards and recommendations for temporary construction activities to address geological conditions, including recommendations on sloping or shoring to ensure stability of temporary excavations. The investigation would provide information pertaining to the depths and extent of liquefaction and an estimate of the anticipated ground deformation associated with liquefaction, lateral spread, and induced settlement. Depending on the findings of the investigation, various ground improvements would be implemented to minimize risks consistent with design standards, including dynamic compaction, stone columns, jet grouting, cement deep-soil mixing, and compaction grouting. The results of the geotechnical investigation would inform the design parameters for structural integrity and ground stability and thereby minimize risks associated seismic-related ground failure, liquefaction, and landslides.

Summary

Compliance with requirements and industry standards as described in PM GEO-1 would ensure that Alternative 1 would not cause potential substantial adverse effects, including the risk of loss, injury, or death during construction. Construction of Alternative 1 would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Design Options

Atlantic/Pomona Station Option

Alternative 1 with the Atlantic/Pomona Station Option would not have seismic risks that differ from the base Alternative 1. The Atlantic/Pomona Station Option would be potentially subject to seismic ground shaking, but it is not located within a liquefaction zone. The Atlantic/Pomona Station Option would be designed and constructed in compliance with regulatory requirements, industry standards and the MRDC, and would be the subject of a site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Compliance with regulatory and design requirements as identified in PM GEO-1 and described under the base Alternative 1 would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards. Construction of Alternative 1 with the Atlantic/Pomona Station Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Montebello At-Grade Option

Alternative 1 with the Montebello At-Grade Option would not have seismic risks that differ from the base Alternative 1. Alternative 1 with the Montebello At-Grade Option would be potentially subject to seismic ground shaking, but it is not located within a liquefaction zone. The Montebello At-Grade Option would be designed and constructed in compliance with regulatory requirements, industry standards and the MRDC, and would be the subject of a site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Compliance with regulatory and design requirements as identified in PM GEO-1 and described under

the Alternative 1 would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards. Construction of Alternative 1 with the Montebello At-Grade Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

3.6.6.1.2 Alternative 2 Atlantic to Commerce/Citadel IOS

Operational Impacts

Base Alternative and Design Option

Rupture of a Known Earthquake Fault and Seismic Shaking

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would not cross any known faults capable of ground rupture. Thus, there is no potential for ground rupture due to known active faulting.

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option is located in a seismically active area; thus, operation would potentially be subject to seismic ground shaking that could result in damage to structures or human injury or death. As described in greater detail in **Section 3.6.6.1.1** and identified in project measure PM GEO-1, to address potential risks associated with seismic hazards, the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would be designed and constructed in conformance with the MRDC**,** applicable portions of building and seismic code requirements including the most recent edition of the CBC, Metro's standard specifications, and industry standards. Additionally, as further identified in PM GEO-1, during final design, a geotechnical investigation would be conducted, including detailed and site-specific evaluation of geotechnical hazards. The resulting final geotechnical engineering recommendations would be incorporated into the final design plans consistent with standard practice to address any unstable geologic and related conditions present along the alignment. Compliance with these requirements and industry standards would ensure that strong seismic ground shaking would not cause potential substantial adverse effects, including the risk of loss, injury, or death.

Seismic-Related Ground Failure, Liquefaction, and Landslides

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option is not within in a liquefaction zone and is located in an area of generally flat topography and on stable soils. Thus, operations would not result in exposure to seismic-related ground failure, including liquefaction, or landslides. While these conditions are not expected to occur, the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would be designed in compliance with regulatory requirements, industry standards, and the MRDC, as described in greater detail in **Section 3.6.6.1.1** and identified in project measure PM GEO-1. Compliance with these regulatory and design requirements would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards.

Summary

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would be designed in compliance with regulatory requirements, industry standards, and the MRDC as identified in PM GEO-1; compliance with these regulatory and design requirements would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards. Operation of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Construction Impacts

Base Alternative and Design Option

Rupture of a Known Earthquake Fault and Seismic Shaking

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would not cross any known active faults.

Like Alternative 1, the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option is located in a seismically active area, thus, construction of Alternative 1 would potentially be subject to seismic ground shaking which could result in damage to structures and human injury. To address potential seismic hazards, Alternative 2 would be constructed in compliance with the MRCD as identified in project measure PM GEO-1 (see **Section 3.6.7**), applicable portions of building and seismic code requirements including the most recent edition of the CBC, Metro's standard specifications, and industry standards. These requirements include development of site-specific design parameters to account for seismic shaking. Adherence with the latest seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events.

Seismic-Related Ground Failure, Liquefaction, and Landslides

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option is not within in a liquefaction zone and is located in an area of generally flat topography and on stable soils. Thus, construction would not result in exposure to seismic-related ground failure, including liquefaction, or landslides. While these conditions are not expected to occur, the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would be designed and constructed in accordance with regulatory requirements, industry standards, and the MRDC, as described in project measure PM GEO-1. As identified in the PM GEO-1, in compliance with the MRDC, a geotechnical investigation would be performed during final design; the geotechnical investigation would include structural engineering standards and recommendations for temporary construction activities to address geological conditions, including recommendations on sloping or shoring to ensure stability of temporary excavations. The results of the geotechnical investigation will inform the design parameters for structural integrity and ground stability, and ensure impacts associated seismic-related ground failure, liquefaction, and landslides would be less than significant.

Summary

Compliance with requirements and industry standards as identified in PM GEO-1 would ensure that the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death associated with seismic hazards during construction. Construction of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

3.6.6.1.3 Alternative 3 Atlantic to Greenwood IOS

Operational Impacts

Base Alternative and Design Options

Rupture of a Known Earthquake Fault and Seismic Shaking

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would not cross any known faults capable of ground rupture. Thus, there is no potential for ground rupture due to known active faulting.

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option is located in a seismically active area, thus, operation would potentially be subject to seismic ground shaking that could result in damage to structures or human injury or death. As described in greater detail in **Section 3.6.6.1.1** and identified in project measure PM GEO-1, to address potential risks associated with seismic hazards, the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would be designed and constructed in conformance with the MRDC**,** applicable portions of building and seismic code requirements including the most recent edition of the CBC, Metro's standard specifications, and industry standards. Consistent with MRDC requirements, Project structures would be designed to perform in accordance with the two-level seismic evaluation approach based on the MDE and ODE. At-grade and underground structures would be designed and would perform in accordance with federal, state, and local thresholds for seismicity.

Additionally, as further identified in PM GEO-1 and in compliance with the MRDC, a geotechnical investigation would be conducted, including detailed and site-specific evaluation of geotechnical hazards. The resulting final geotechnical engineering recommendations and any additional recommendations that come out of the review process would be incorporated into the final design plans consistent with standard practice to address any unstable geologic and related conditions present along the alignment. Compliance with these requirements and industry standards would ensure that strong seismic ground shaking would not cause potential substantial adverse effects, including the risk of loss, injury, or death.

Seismic-Related Ground Failure, Liquefaction, and Landslides

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option is not within a liquefaction zone and is located in an area of generally flat topography

and on stable soils. Operations would not result in exposure to seismic-related ground failure, including liquefaction, or landslides. While these conditions are not expected to occur, as with Alternative 1, the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option would be designed in compliance with regulatory requirements, industry standards, and the MRDC, as identified in project measure PM GEO-1. Compliance with these regulatory and design requirements would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards.

Summary

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option would be designed in compliance with regulatory requirements, industry standards, and the MRDC as described in PM GEO-1; compliance with these regulatory and design requirements would reduce impacts by ensuring that development is designed to withstand seismic or other geologic hazards. Operation of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Construction Impacts

Base Alternative and Design Options

Rupture of a Known Earthquake Fault and Seismic Shaking

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option would not cross any known active faults.

Like Alternative 1, the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option is located in a seismically active area, thus, construction of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option would potentially be subject to seismic ground shaking which could result in damage to structures and human injury. To address potential seismic hazards, Alternative 3 would be constructed in compliance with the MRCD as identified in project measure PM GEO-1 (see **Section 3.6.7**), applicable portions of building and seismic code requirements including the most recent edition of the CBC, Metro's standard specifications, and industry standards. These requirements include development of site-specific design parameters to account for seismic shaking. Adherence with the latest seismic safety parameters would substantially reduce potential structural damage and the risk to public safety from seismic events.

Seismic-Related Ground Failure, Liquefaction, and Landslides

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option is not within in a liquefaction zone and is located in an area of generally flat topography and on stable soils. Thus, construction would not result in exposure to seismic-related ground failure, including liquefaction, or landslides. While these conditions are not expected to occur, the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade

Option would be designed and constructed in accordance with regulatory requirements, industry standards, and the MRDC, as described in project measure PM GEO-1. As identified in the PM GEO-1, in compliance with the MRDC, a geotechnical investigation would be performed during final design; the geotechnical investigation would include structural engineering standards and recommendations for temporary construction activities to address geological conditions, including recommendations on sloping or shoring to ensure stability of temporary excavations. The results of the geotechnical investigation will inform the design parameters for structural integrity and ground stability, and ensure impacts associated seismic-related ground failure, liquefaction, and landslides would be less than significant.

Summary

Compliance with requirements and industry standards as described in PM GEO-1 would ensure that the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from seismic hazards during construction. Construction of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or Montebello At-Grade Option would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

3.6.6.1.4 Maintenance and Storage Facilities

Operational Impacts

MSF Site Options and Design Option

The Commerce MSF site option, Montebello MSF site option, and the Montebello MSF At-Grade Option are not located on any known faults capable of ground rupture. Because there are no known active faults capable of ground rupture under the MSF site options, there is no potential for ground rupture due to known active faulting. The proposed MSF site options are not within a liquefaction zone and are located in an area of generally flat topography and on stable soils. Operations would not result in exposure to seismic-related ground failure, including liquefaction, or landslides.

The MSF site options would be designed in compliance with regulatory requirements, industry standards and the MRDC, as identified in project measure PM GEO-1, and would be the subject of a site-specific geotechnical evaluation during the final design phase that would include structural engineering recommendations. Compliance with these regulatory and design requirements would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards. Operation of the MSF site options would not cause substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure including liquefaction, and landslides. Therefore, the impact would be less than significant.

Construction Impacts

MSF Site Options and Design Options

The Commerce MSF site option, Montebello MSF site option, and the Montebello MSF At-Grade Option are not located on any known faults capable of ground rupture. Because there are no known active faults capable of ground rupture under the MSF site options, there is no potential for ground rupture due to known active faulting. The proposed MSF site options are not within a liquefaction zone and are located in an area of generally flat topography and on stable soils. Construction would not cause potential substantial adverse effects related to seismic-related ground failure, including liquefaction, or landslides.

The potential to experience substantial seismic ground shaking is a common hazard for projects in Southern California. The proposed MSF site options would be designed and constructed in compliance with regulatory requirements, industry standards and the MRDC, as identified in project measure PM GEO-1, and would be the subject of a site-specific geotechnical evaluation during the final design phase that would include specific structural engineering recommendations. Compliance with these regulatory and design requirements would reduce potential impacts by ensuring that development is designed to withstand seismic or other geologic hazards. The proposed MSF site options would not cause potential substantial adverse effects, including the risk of loss, injury, or death from known earthquake fault rupture, strong seismic ground shaking, seismic-related ground failure, including liquefaction, and landslides. Therefore, the impact would be less than significant.

3.6.6.2 Impact GEO-2: Soil Erosion

Impact GEO-2: Would a Build Alternative result in substantial soil erosion or the loss of topsoil?

3.6.6.2.1 Alternative 1 Washington

Operational Impacts

Alternative 1 is located in an urbanized area that is primarily impervious with no exposed soil. There are some areas of pervious surfaces associated with the Rio Hondo Spreading Grounds and San Gabriel River and to a minimal extent, landscaped medians and setbacks, parks, and residential yards within the DSA. Operation of Alternative 1 would not result in ground disturbance or an increase in the amount of exposed soil as compared to existing conditions. Furthermore, operations would not change the amount of erosion in the Rio Hondo and spreading grounds or the San Gabriel River compared to existing conditions. Alternative 1 would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. NPDES Permits and LID standards are discussed in more detail in Appendix J of this EIR. Thus, operation of Alternative 1 would not result in substantial soil erosion or the loss of topsoil and impacts would be less than significant.

Design Options

Atlantic/Pomona Station Option

Operation of Alternative 1 with the Atlantic/Pomona Station Option would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions. Furthermore, operations would not change the amount of erosion in the Rio Hondo and spreading grounds or the San Gabriel River as compared to existing conditions. Alternative 1 with the Atlantic/Pomona Station Option would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. Thus, operation of Alternative 1 with the Atlantic/Pomona Station Option would not result in substantial soil erosion, or the loss of topsoil and impacts would be less than significant.

Montebello At-Grade Option

Operation of Alternative 1 with the Montebello At-Grade Option would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions. Furthermore, operations would not change the amount of erosion in the Rio Hondo and spreading grounds or the San Gabriel River as compared to existing conditions. Alternative 1 with the Montebello At-Grade Option would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. Thus, operation of Alternative 1 with the Montebello At-Grade Option would not result in substantial soil erosion or the loss of topsoil and impacts would be less than significant.

Construction Impacts

Ground disturbing activities occurring during construction would temporarily expose surficial soils to wind and water erosion, increasing the potential for soil erosion and loss of topsoil compared to existing conditions. During a storm event, soil erosion and loss of topsoil could occur at an accelerated rate. However, construction activities would be required to comply with existing regulatory requirements, including implementation of BMPs and other erosion and sedimentation control measures that would ensure grading, excavation, and other earth-moving activities would avoid a significant impact. For example, a SWPPP and erosion and sediment control plan would be prepared in compliance with applicable NPDES Permits. The implementation of erosion control BMPs would help to keep exposed soils in place and reduce the occurrence of substantial soil erosion or the loss of topsoil, including within the Rio Hondo Spreading Grounds and San Gabriel River have soft, dirt bottoms with more potential for erosion. Erosion control BMPs may include, but would not be limited to, use of detention ponds or infiltration pits to collect and reduce erosion, using barriers to slow the rate of runoff, or controlling the use of water irrigation. These and other potential BMPs are discussed and identified as project measure PM HWQ-2 in Section 3.9, Hydrology and Water Quality.

At the close of construction, areas of exposed soil that were previously paved would be restored to a paved condition. Construction of Alternative 1 would result in the localized and temporary movement of soils during construction; however, given compliance with regulatory requirements, substantial erosion of soils or loss of topsoil is not expected. Therefore, the impact would be less than significant.

Design Options

Atlantic/Pomona Station Option

Because ground disturbing construction activities have the potential to increase erosion and loss of topsoil, a SWPPP and erosion and sediment control plan would be prepared in compliance with applicable NPDES Permits. Compliance with these requirements, including the implementation of erosion control BMPs, would help to keep exposed soils in place and reduce the occurrence of substantial soil erosion or the loss of topsoil as discussed further in Section 3.9, Hydrology and Water Quality. At the close of construction, areas of exposed soil that were previously paved would be restored to a paved condition. Construction of Alternative 1 with the Atlantic/Pomona Station Option would result in the localized and temporary movement of soils during construction; however, given compliance with regulatory requirements, substantial erosion of soils or loss of topsoil is not expected. Therefore, the impact would be less than significant.

Montebello At-Grade Option

Because ground disturbing construction activities have the potential to increase erosion and loss of topsoil, a SWPPP and erosion and sediment control plan would be prepared in compliance with applicable NPDES Permits. Compliance with these requirements, including the implementation of erosion control BMPs, would help to keep exposed soils in place and reduce the occurrence of substantial soil erosion or the loss of topsoil as discussed further in Section 3.9, Hydrology and Water Quality. At the close of construction, areas of exposed soil that were previously paved would be restored to a paved condition. Construction of Alternative 1 with the Montebello At-Grade Option would result in the localized and temporary movement of soils during construction; however, given compliance with regulatory requirements, substantial erosion of soils or loss of topsoil is not expected. Therefore, the impact would be less than significant.

3.6.6.2.2 Alternative 2 Atlantic to Commerce/Citadel IOS

Operational Impacts

Base Alternative and Design Option

The base Alternative 2 and Alternative 2 with the Atlantic/Pomona Station Option are in an urbanized area that is primarily impervious with no exposed soil. Operations would not result in ground disturbance or an increase in the amount of exposed soil as compared to existing conditions. The base Alternative 2 and Alternative 2 with the Atlantic/Pomona Station Option would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. Thus, operation of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would not result in substantial soil erosion or the loss of topsoil and impacts would be less than significant.

Construction Impacts

Base Alternative and Design Option

Ground disturbing activities occurring during construction of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. However, construction activities would be required to comply with existing regulatory requirements, including implementation of BMPs and other erosion and sedimentation control measures that would ensure grading, excavation, and other earth-moving activities would avoid a significant impact. Compliance with these requirements would help to keep exposed soils in place and reduce the occurrence of substantial soil erosion or the loss of topsoil as discussed further in Section 3.9, Hydrology and Water Quality. At the close of construction, areas of exposed soil that were previously paved would be restored to a paved condition. Construction of the base Alternative 2 of Alternative 2 with the Atlantic/Pomona Station Option would result in the localized and temporary movement of soils during construction; however, given compliance with regulatory requirements, substantial erosion of soils or loss of topsoil is not expected. Therefore, the impact would be less than significant.

3.6.6.2.3 Alternative 3 Atlantic to Greenwood IOS

Operational Impacts

Base Alternative and Design Options

The base Alternative 3 and Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option are located in an urbanized area that is primarily impervious with no exposed soil. Operations would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions. The base Alternative 3 and Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and other local jurisdictions, which aim to minimize erosion impacts from development projects. Thus, operation of base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would not result in substantial soil erosion or the loss of topsoil and impacts would be less than significant.

Construction Impacts

Base Alternative and Design Options

Ground disturbing activities occurring during construction of base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. However, construction activities would be required to comply with existing regulatory requirements, including implementation of BMPs and other erosion and sedimentation control measures that would ensure grading, excavation, and other earth-moving activities would avoid a significant impact. Compliance with these requirements would help to keep exposed soils in place and reduce the occurrence of substantial soil erosion or the loss of topsoil as discussed further in Section 3.9, Hydrology and Water Quality. At the close of construction, areas of exposed soil that

were previously paved would be restored to a paved condition. Construction of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would result in the localized and temporary movement of soils during construction; however, given compliance with regulatory requirements, substantial erosion of soils or loss of topsoil is not expected. Therefore, the impact would be less than significant.

3.6.6.2.4 Maintenance and Storage Facilities

Operational Impacts

MSF Site Options and Design Options

The Commerce MSF site option, Montebello MSF site option, and the Montebello At-Grade Option are in an urbanized area that is primarily impervious with no exposed soil. Operation of the proposed MSF site options would not result in ground disturbance or a change in the amount of exposed soil as compared to existing conditions. The MSF site options would comply with post-construction measures in applicable NPDES permits and LID standards required by Los Angeles County and the cities of Commerce and Montebello that aim to minimize erosion impacts from development projects. Thus, operation of the proposed MSF site options would not result in substantial soil erosion or the loss of topsoil and impacts would be less than significant.

Construction Impacts

MSF Site Options and Design Options

Ground disturbing activities occurring during construction would temporarily expose surficial soils to wind and water erosion and have the potential to temporarily increase erosion and loss of topsoil. However, construction activities would be required to comply with existing regulatory requirements, including implementation of BMPs and other erosion and sedimentation control measures that would ensure grading, excavation, and other earth-moving activities would avoid a significant impact. Compliance with these requirements would help to keep exposed soils in place and reduce the occurrence of substantial soil erosion or the loss of topsoil as discussed further in Section 3.9, Hydrology and Water Quality. At the close of construction, areas of exposed soil that were previously paved would be restored to a paved condition. Construction of the Commerce MSF site option, Montebello MSF site option, or the Montebello At-Grade Option would result in the localized and temporary movement of soils during construction; however, given compliance with regulatory requirements, substantial erosion of soils or loss of topsoil is not expected. Therefore, the impact would be less than significant.

3.6.6.3 Impact GEO-3: Soil Stability

Impact GEO-3: Would a Build Alternative 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?

3.6.6.3.1 Alternative 1 Washington

Operational Impacts

The underground and aerial segments of Alternative 1 are located on stable soils and not in an area mapped to have the potential to experience liquefaction and settlement. Operations of the underground and aerial segments would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of Alternative 1.

Conversely, the at-grade segment of Alternative 1 is underlain by young alluvial fan deposits from South Bluff Road to the eastern terminus of the alignment. These soils are potentially loose and compressible and thus have the potential to settle due to traffic loading from the at-grade track, which could affect the overlying operation of the track. Further, this segment of the alignment is within a mapped liquefiable zone. Thus, the at-grade alignment, the proposed stations at Rosemead Boulevard, Norwalk Boulevard, and Lambert Road, and the associated parking facilities have the potential to be adversely affected by liquefaction and seismically-induced settlement. Additionally, existing lateral spread landslide potential may exist nearby the Rio Hondo and San Gabriel River due to the liquefiable soils and gentle slope topography. Ground shaking leading to liquefaction of saturated soil could result in lateral spreading where the soil undergoes a temporary loss of strength, and if the liquefied soil is not contained laterally, it may result in deformation or translation of the slope.

Structural engineering standards to address geological conditions are part of standard construction requirements and standard construction practices. Alternative 1 would be designed in accordance with MRDC Section 5, Structural; Metro's Supplemental Seismic Design Criteria (2017); and the California Seismic Hazards Mapping Act. Further, as identified in PM GEO-1, Alternative 1 would be designed in accordance with recommendations developed in a detailed geotechnical report prepared during final design, which would provide site-specific information pertaining to the depths and areal extents of liquefaction, lateral spread, and settlement. During the design process, if it is determined that these conditions identified in the geotechnical report could result in an unacceptable soil or structural response (to be defined during final design and dependent on the type of structure), the resulting final geotechnical engineering would include recommendations that would be incorporated into the final design plans consistent with standard practice to address any unstable geologic and related conditions present along the alignment. This may include deep foundations and/or ground improvements such as dynamic compaction, stone columns, jet grouting, and cement deep soil mixing and compaction grouting that would be implemented consistent with the design standards provided in **Section 3.6.2.4**.

Alternative 1 would be designed in compliance with MRDC, the California Seismic Hazards Mapping Act, industry standards and recommendations contained in the design level geotechnical report as described in PM GEO-1. Given compliance with these regulatory and design requirements, operation of Alternative 1 would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Design Options

Atlantic/Pomona Station Option

The Atlantic/Pomona Station Option portion of the alignment is located on stable soils and is not within a liquefaction zone. Further, as described in PM GEO-1, Alternative 1 with the Atlantic/Pomona

Station Option would be designed in compliance with MRDC, the California Seismic Hazards Mapping Act, industry standards and recommendations contained in the design level geotechnical report. Given compliance with these regulatory and design requirements, operation of Alternative 1 with the Atlantic/Pomona Station Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Montebello At-Grade Option

The Montebello At-Grade Option portion of the alignment is located on stable soils and is not within a liquefaction zone. Further, as described in PM GEO-1, Alternative 1 with the Montebello At-Grade Option would be designed in compliance with MRDC, the California Seismic Hazards Mapping Act, industry standards and recommendations contained in the design level geotechnical report. Given compliance with these regulatory and design requirements, operation of Alternative 1 with the Montebello At-Grade Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Construction Impacts

Construction activities for Alternative 1, such as ground excavation, tunneling, and dewatering, could affect soil stability leading to ground movements (both lateral movements and settlements) or subsidence. Excavation and tunneling could impact soil stability by reducing lateral support for soil that is not excavated. Dewatering could affect soil stability by causing subsurface soil compaction and, consequently, sinking or settling of the ground above. Excavation for construction of underground structures, such as station boxes, tunnels, and tunnel portals would be reinforced by shoring systems to protect abutting buildings, utilities and other infrastructure. Tunneling using a TBM would result in ground volume loss and potential ground movements. Dewatering, when performed to create a dry work condition for construction of the underground structures, would result in compaction or consolidation of the subsurface soils and thus result in surface settlements. Without compliance with regulatory and design requirements, these activities described above could result in subsidence or collapse of the ground.

However, as with impact GEO-1: Exposure to Seismic Hazards, discussed under **Section 3.6.6.1** and identified in GEO PM-1, Alternative 1 would be designed in accordance with MRDC Section 5, Structural; Metro's SDC (Metro 2017); and the California Seismic Hazards Mapping Act. These design standards dictate that during final design, a geotechnical investigation be conducted, including detailed evaluation of hazards. The investigation would be part of Metro's comprehensive geologic/geotechnical field investigation program that is being currently developed and would include a detailed evaluation of these hazards and would also include structural engineering standards and recommendations for temporary construction activities as well as project design and engineering to address geological conditions. The design-level geotechnical investigations and evaluations would provide information pertaining to the depths and areal extents of liquefaction, lateral spread, and seismically induced settlement. During the design process, if it is determined that these hazards could result in an unacceptable soil or structural response (to be defined during final design and dependent on the type of structure), the resulting final geotechnical engineering would include recommendations that would be incorporated into the Project's final design plans consistent with standard practice to address any unstable geologic and related conditions present along the alignment during construction. This would include recommendations for foundation construction, groundwater management (groundwater cutoff and/or dewatering), excavation and shoring, consistent with the design standards provided in **Section 3.6.2**.

Alternative 1 would be designed and constructed in compliance with regulatory requirements and the MRDC as identified in PM GEO-1 and as discussed under Impact GEO-1 and in **Section 3.6.2.4**. Given compliance with these regulatory and design requirements, construction of Alternative 1 would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Design Options

Atlantic/Pomona Station Option

Alternative 1 with the Atlantic/Pomona Station Option would not have soil stability risks that differ from the base Alternative 1. The Atlantic/Pomona Station Option would be designed and constructed in compliance with regulatory requirements, the MRDC, and recommendations contained in the design level geotechnical report as described for the base Alternative 1 and identified in PM GEO-1. Given compliance with these regulatory and design requirements, construction of Alternative 1 with the Atlantic/Pomona Station Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Montebello At-Grade Option

Alternative 1 with the Montebello At-Grade Option would not have soil stability risks that differ from the base Alternative 1. Alternative 1 with the Montebello At-Grade Option would be designed and constructed in compliance with regulatory requirements, the MRDC, and recommendations contained in the design level geotechnical report as described for the base Alternative 1 and identified in PM GEO-1. Given compliance with these regulatory and design requirements, construction of Alternative 1 with the Montebello At-Grade Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

3.6.6.3.2 Alternative 2 Atlantic to Commerce/Citadel IOS

Operational Impacts

Base Alternative and Design Option

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would be located on stable soils where no liquefaction zones are present. Operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. Further, the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would be designed in compliance with MRDC, the California Seismic Hazards Mapping Act, industry standards and recommendations contained in the design level geotechnical report as described in **Section 3.6.6.3.1** and identified in PM GEO-1. Given compliance with these regulatory and design requirements, operation of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Construction Impacts

Base Alternative and Design Option

The base Alternative 2 and Alternative 2 with the Atlantic/Pomona Station Option are located on stable soils and not present in a liquefaction zone. However, construction activities, such as ground excavation, tunneling, and dewatering, could affect soil stability leading to ground movements (both lateral movements and settlements) or subsidence. Excavation and tunneling could impact soil stability by reducing lateral support for soil that is not excavated. Dewatering could affect soil stability by causing subsurface soil compaction and, consequently, sinking or settling of the ground above. Excavation for construction of underground structures, such as station boxes, tunnels, and tunnel portals would be reinforced by shoring systems to protect abutting buildings, utilities and other infrastructure. Tunneling using a TBM would result in ground volume loss and potential ground movements. Dewatering, when performed to create a dry work condition for construction of the underground structures, would result in compaction or consolidation of the subsurface soils and thus result in surface settlements. Without compliance with regulatory and design requirements, these activities described above could result in subsidence or collapse of the ground.

However, as described in **Section 3.6.6.3.1** and identified in PM GEO-1, the base Alternative 2 and Alternative 2 with the Atlantic/Pomona Station Option would be designed and constructed in compliance with regulatory requirements, the MRDC, and recommendations contained in the design level geotechnical report. This would include incorporating recommendations on engineering and design considerations identified in the geotechnical report to ensure soil stability during construction. Thus, given compliance with design requirements as identified in PM GEO-1, construction of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

3.6.6.3.3 Alternative 3 Atlantic to Greenwood IOS

Operational Impacts

Base Alternative and Design Options

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would be located on stable soils where no liquefaction zones are present. Operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would be designed in compliance with MRDC, the California Seismic Hazards Mapping Act, industry standards and recommendations contained in the design level geotechnical report as described in **Section 3.6.6.3.1** and identified in PM GEO-1. Given compliance with these regulatory and design requirements, operation of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Construction Impacts

Base Alternative and Design Options

The base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option are located on stable soils and not in a liquefaction zone. However, construction activities, such as ground excavation, tunneling, and dewatering, could affect soil stability leading to ground movements (both lateral movements and settlements) or subsidence. Excavation and tunneling could impact soil stability by reducing lateral support for soil that is not excavated. Dewatering could affect soil stability by causing subsurface soil compaction and, consequently, sinking or settling of the ground above. Excavation for construction of underground structures, such as station boxes, tunnels, and tunnel portals would be reinforced by shoring systems to protect abutting buildings, utilities and other infrastructure. Tunneling using a TBM would result in ground volume loss and potential ground movements. Dewatering, when performed to create a dry work condition for construction of the underground structures, would result in compaction or consolidation of the subsurface soils and thus result in surface settlements. Without compliance with regulatory and design requirements, these activities described above could result in subsidence or collapse of the ground.

However, as described in **Section 3.6.6.3.1** and identified in PM GEO-1, the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would be designed and constructed in compliance with regulatory requirements, the MRDC, and recommendations contained in the design level geotechnical report. This would include incorporating recommendations on engineering and design considerations identified in the geotechnical report to ensure soil stability during construction. Thus, given compliance with design requirements as identified in PM GEO-1, construction of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

3.6.6.3.4 Maintenance and Storage Facilities

Operational Impacts

MSF Site Options and Design Option

The Commerce MSF site option, the Montebello MSF site option, and the Montebello MSF At-Grade Option would be located on stable soils where no liquefaction zones are present. Operations would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the MSF site options, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. As with the Build Alternatives, the MSF site options would be designed in compliance with regulatory requirements, the MRDC, and recommendations contained in the design level geotechnical report, including recommendations on engineering and design considerations as described in in **Section 3.6.6.3.1** and identified in PM GEO-1. Thus, operation of the MSF site options would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

Construction Impacts

MSF Site Options and Design Option

The Commerce MSF site option, Montebello MSF site option, and the Montebello MSF At-Grade Option are located on stable soil and not within a mapped liquefiable zone. Construction would not occur on a geologic unit or soil that is unstable, or that would become unstable as a result of the MSF site options, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. The MSF site options would be designed and constructed in compliance with regulatory requirements, the MRDC, and recommendations contained in the design level geotechnical report as described in **Section 3.6.6.3.1** and identified in PM GEO-1. This includes incorporating recommendations on engineering and design considerations in the geotechnical report to ensure soil stability during construction. Thus, construction of the MSF site options would have less than significant impacts related to soil stability that could potentially result in landslides, lateral spreading, subsidence, liquefaction, or collapse.

3.6.6.4 Impact GEO-4: Expansive Soils

Impact GEO-4: Would a Build Alternative be located on expansive soil, as defined in Section 1803.5.3 of the CBC, creating substantial direct or indirect risks to life or property?

3.6.6.4.1 Alternative 1 Washington

Operational and Construction Impacts

Clay-rich soils may exist locally within alluvial soils present along Alternative 1 that could swell and shrink with wetting and drying. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. Expansive soils could have an impact on project components, including the stations, guideway, tunnel, and other fixed structures; expansive soils do not have distinct construction or operational impacts and are addressed through project design. Alternative 1 would be designed and constructed in accordance with the MRDC, Los Angeles County and other applicable local building codes, CBC, and other applicable design specifications as described in **Section 3.6.2** and identified in PM GEO-1. This includes compliance with MRDC Section 5.6.2 that requires preparation of a geotechnical investigation (MRDC Section 5.6.2) during final design. This design-level geotechnical investigation must include a detailed evaluation of hazards and provide information pertaining to the depths and areal extents of liquefaction, soil expansiveness, lateral spread, and seismically induced settlement. This includes obtaining soil samples and performing tests to assess the potentials for corrosion, consolidation, expansion and collapse. Based on the investigation and test results, design recommendations would address any of these issues, if they exist. Alternative 1 would be designed and constructed in accordance with the recommendations contained in the final design geotechnical investigation, including remediation of expansive soils if required. Expansive soil remediation could include soil removal and replacement, chemical treatment, or structural enhancements. Compliance with regulatory requirements, including compliance with the MRDC and adherence to recommendations identified in the geotechnical investigation as set forth in PM GEO-1, would ensure that construction and operation of Alternative 1 would not create a substantial direct or indirect risk associated with being located on expansive soils. Compliance with

these regulatory and design requirements would ensure that impacts associated with expansive soils would be less than significant.

Design Options

Atlantic/Pomona Station Option

Alternative 1 with the Atlantic/Pomona Station Option would not have risks associated with expansive soils that differ from the base Alternative 1. The Atlantic/Pomona Station Option would be designed and constructed in compliance with regulatory requirements discussed in **Section 3.6.2**, including compliance with the MRDC and adherence to recommendations identified in the geotechnical investigation as set forth in PM GEO-1. Compliance with these regulatory and design requirements would ensure that operation and construction of Alternative 1 with the Atlantic/Pomona Station Option would not create a substantial direct or indirect risk associated with being located on expansive soil and the impact would be less than significant.

Montebello At-Grade Option

Alternative 1 with the Montebello At-Grade Option would not have risks associated with expansive soils that differ from the base Alternative 1. Alternative 1 with the Montebello At-Grade Option would be designed and constructed in compliance with regulatory requirements as discussed in **Section 3.6.2**, including compliance with the MRDC and adherence to recommendations identified in the geotechnical investigation as set forth in PM GEO-1. Compliance with these regulatory and design requirements would ensure that operation and construction of Alternative 1 with the Montebello At-Grade Option would not create a substantial direct or indirect risk associated with being located on expansive soil and the impact would be less than significant.

3.6.6.4.2 Alternative 2 Atlantic to Commerce/Citadel IOS

Operational and Construction Impacts

Base Alternative and Design Option

Clay-rich soils that could swell and shrink with wetting and drying may exist locally within alluvial soils present along the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. Expansive soils could have an impact on project components, including the stations, guideway, tunnel, and other fixed structures; expansive soils do not have distinct construction or operational impacts and are addressed through project design. As with Alternative 1 discussed in **Section 3.6.6.4.1**, the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would be designed and constructed in compliance with regulatory requirements described in **Section 3.6.2** and identified in PM GEO-1. This includes the MRDC and recommendations contained in the design level geotechnical report. Compliance with these regulatory and design requirements would ensure that operation and construction of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would not create a substantial direct or indirect risk associated with being located on expansive soil and the impact would be less than significant.

3.6.6.4.3 Alternative 3 Atlantic to Greenwood IOS

Operational and Construction Impacts

Base Alternative and Design Options

Clay-rich soils that could swell and shrink with wetting and drying may exist locally within alluvial soils present along the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option. The change in soil volume is capable of exerting enough force on structures to damage foundations, structures, and underground utilities. Damage can also occur as these soils dry out and contract. Expansive soils could have an impact on project components, including the stations, guideway, tunnel, and other fixed structures; expansive soils do not have distinct construction or operational impacts and are addressed through project design. As with Alternative 1 discussed in **Section 3.6.6.4.1**, the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would be designed and constructed in compliance with regulatory requirements described in **Section 3.6.2** and identified in PM GEO-1. This includes the MRDC and recommendations contained in the design level geotechnical report as described in PM GEO-1. Compliance with these regulatory and design requirements would ensure that operation and construction of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would not create a substantial direct or indirect risk associated with being located on expansive soil and the impact would be less than significant impact.

3.6.6.4.4 Maintenance and Storage Facilities

Operational and Construction Impacts

MSF Site Options and Design Option

Clay-rich soils that could swell and shrink with wetting and drying may exist locally within the Commerce MSF site option, Montebello MSF site option, or the Montebello MSF At-Grade Option. The placement of the MSF structures or other facilities on such soils could result in structural damage or distress. The MSF site options would be designed and constructed in compliance with regulatory requirements described in **Section 3.6.2** and identified in PM GEO-1. This includes the MRDC and recommendations contained in the design level geotechnical report. Compliance with these requirements would ensure that operation and construction of the MSF site options would not create a substantial direct or indirect risk associated with being located on expansive soil and the impact would be less than significant impact.

3.6.6.5 Impact GEO-5: Paleontological Resources

Impact GEO-5: Would a Build Alternative directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

3.6.6.5.1 Alternative 1 Washington

Operational Impacts

Operation of Alternative 1 would consist of LRT and would not involve any additional ground disturbance that could have a substantial adverse effect on a paleontological resources. Therefore, no impacts would occur.

Design Options

Atlantic/Pomona Station Option

Operation of Alternative 1 with the Atlantic/Pomona Station Option would consist of LRT and would not involve any additional ground disturbance that could have a substantial adverse effect on a paleontological resources. Therefore, no impacts would occur.

Montebello At-Grade Option

Operation of Alternative 1 with the Montebello At/Grade Option would consist of LRT and would not involve any additional ground disturbance that could have a substantial adverse effect on a paleontological resources. Therefore, no impacts would occur.

Construction Impacts

As described in **Section 3.6.5.3**, while few fossil localities have been identified in the GSA, this is not an indication that fossils are rare and several soil types underlying Alternative 1 have a high paleontological potential. Most of Alternative 1 is located in area of high sensitivity for paleontological resources, which means that paleontological resources are likely to be present, and loss of paleontological resources could occur during construction. Construction of Alternative 1 where resources are likely to be present would result in a direct impact to paleontological resources from soil disturbance including excavation, tunneling, and construction of underground stations. Additionally, the aerial and at-grade features would be located in areas that have a high sensitivity for paleontological resources, including undisturbed sediments near the surface. Thus, there would also be direct impacts to paleontological resources associated with installation of supports for the aerial station and aerial guideways, ground disturbance for construction of the at-grade stations and installation of posts to support catenary systems for the at-grade alignment. The direct impacts to paleontological resources would include the loss of significant paleontological specimens and their pertinent stratigraphic and geographic data and would be significant without mitigation measures.

Implementation of MM GEO-1 through MM GEO-4 would reduce the potential impact on paleontological resources from some manual and mechanical construction activities. MM GEO-1 would provide for a qualified paleontologist and paleontological monitor to monitor excavation areas where paleontological resources are likely to occur during construction activities. MM GEO-2 would permit sampling, empower the paleontologist and monitor to temporarily halt construction or modify construction techniques if resources are discovered, and record and preserve any recovered specimens. MM GEO-3 and MM GEO-4 require that any recovered specimens will be prepared, catalogued, and submitted to a professional accredited museum repository. Together, these mitigation measures would reduce the potential impact from construction activities where monitoring is feasible.

Monitoring is feasible during excavation where the excavation site is reasonably accessible and visible, where soil spoils can be reasonably observed, and where construction methods do not completely destroy any potential specimen. Because of the nature of how the TBM operates, monitoring of tunnel boring is not feasible. Consequently, while any ground disturbance in previously undisturbed sediments could encounter resources, the primary construction impact would result from boring the underground section from South La Verne Avenue to Smithway Street.

Given the boring technologies employed in recent Metro projects, there is no known way to monitor or mitigate boring impacts on paleontological resources because the TBM grinds the material as it moves forward, making it impossible to preserve fossils or bones. There is no fossil record for the area in which the TBM would operate that would provide a basis for determining how many paleontological resources could be impacted or the magnitude of the impact. The conclusion that there would be a significant impact is based on the sediment type alone and evidence that this sediment type has a high sensitivity for paleontological resources. Thus, construction using TBM would result in significant direct impacts on paleontological resources.

As described above, ground disturbance associated with construction of Alternative 1 would result in significant impacts on paleontological resources. MM GEO-1 through MM GEO-4 as identified in **Section 3.6.7** would be implemented to reduce impacts; however, because monitoring of tunnel boring is not feasible, unique paleontological resources may be destroyed and impacts would be significant and unavoidable.

Design Options

Atlantic/Pomona Station Option

Alternative 1 with the Atlantic/Pomona Station Option would have similar paleontological impacts as the base Alternative 1. The Atlantic/Pomona Station Option is located within old alluvial fan deposits which have a high sensitivity for paleontological resources, including undisturbed sediments near the surface. Therefore, construction of Alternative 1 with the Atlantic/Pomona Station Option could disturb significant paleontological resources. Significant impacts on paleontological resources would occur. MM GEO-1 through MM GEO-4 which require monitoring for resources and cataloging any finds as described under the base Alternative 1 above and identified in **Section 3.6.7** would be implemented to reduce impacts; however, because monitoring TBM operations is not feasible, unique paleontological resources may be destroyed and impacts would be significant and unavoidable.

Montebello At-Grade Option

Alternative 1 with the Montebello At-Grade Option would have similar paleontological impacts as the base Alternative 1. The Montebello At-Grade Option is located within old alluvial fan deposits which have a high sensitivity for paleontological resources, including undisturbed sediments near the surface. Therefore, construction of Alternative 1 with an at-grade guideway and an at-grade station at this location could disturb significant paleontological resources. Significant impacts on paleontological resources would occur. MM GEO-1 through MM GEO-4 which require monitoring for resources and cataloging any finds as described under the base Alternative 1 above and identified in **Section 3.6.7** would be implemented to reduce impacts; however, because monitoring TBM operations is not feasible, unique paleontological resources may be destroyed and impacts would be significant and unavoidable.

3.6.6.5.2 Alternative 2 Atlantic to Commerce/Citadel IOS

Operational Impacts

Base Alternative and Design Option

Operation of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would consist of LRT and would not involve any additional ground-disturbance that could have a substantial adverse effect on paleontological resources. Therefore, no impacts would occur.

Construction Impacts

Base Alternative and Design Option

The base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option are located in area of high sensitivity for paleontological resources and loss of paleontological resources would occur during construction. Construction of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would result in an impact to paleontological resources from excavation and soil disturbance where resources are likely to be present. Operation of the TBM and construction requiring excavation or other ground disturbance would result in direct impacts to paleontological resources. Implementation of MM GEO-1 through MM GEO-4 which require monitoring for resources and cataloging any finds as described in **Section 3.6.6.5.1** and identified in **Section 3.6.7** would reduce the potential impact on paleontological resources from some manual and mechanical construction activities. Together, these mitigation measures would reduce the potential impact from construction activities where monitoring is feasible.

Monitoring is feasible during excavation where the excavation site is reasonably accessible and visible, where soil spoils can be reasonably observed, and where construction methods do not completely destroy any potential specimen. Because of the nature of how the TBM operates, monitoring of tunnel boring is not feasible. Consequently, while any ground disturbance in previously undisturbed sediments could encounter resources, the primary construction impact would result from operation of the TBM to bore the underground section from South La Verne Avenue to Smithway Street. There is no known way to monitor or mitigate boring impacts on paleontological resources because the TBM grinds the material as it moves forward, making it impossible to preserve fossils or bones. Because tunnel boring would occur in sediments with a high sensitivity for paleontological resources, construction using TBM would result in significant direct impacts on paleontological resources.

As described above, ground disturbance associated with construction of the base Alternative 2 or Alternative 2 with the Atlantic/Pomona Station Option would result in significant impacts on paleontological resources. MM GEO-1 through MM GEO-4 as described in **Section 3.6.6.5.1** and identified in **Section 3.6.7** would be implemented to reduce impacts; however, because monitoring of tunnel boring is not feasible, unique paleontological resources may be destroyed and impacts would be significant and unavoidable.

3.6.6.5.3 Alternative 3 Atlantic to Greenwood IOS

Operational Impacts

Base Alternative and Design Options

Operation of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would consist of LRT and would not involve any additional ground-disturbance that could have a substantial adverse effect on paleontological resources. Therefore, no impacts would occur.

Construction Impacts

Base Alternative and Design Options

The base Alternative 3 and Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option are located in an area of high sensitivity for paleontological resources and loss of paleontological resources would occur during construction.

Construction of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option where resources are likely to be present would result in a direct impact to paleontological resources from soil disturbance including excavation, tunneling, and construction of underground stations. Additionally, the aerial features would be located in areas that have a high sensitivity for paleontological resources, including undisturbed sediments near the surface. Thus, there would be direct impacts to paleontological resources associated with installation of supports for the aerial station and aerial guideway. Implementation of MM GEO-1 through MM GEO-4 which require monitoring for resources and cataloging any finds as described in **Section 3.6.6.5.1** and identified in **Section 3.6.7** would reduce the potential impact on paleontological resources from some manual and mechanical construction activities.

Monitoring is feasible during excavation where the excavation site is reasonably accessible and visible, where soil spoils can be reasonably observed, and where construction methods do not completely destroy any potential specimen. Because of the nature of how the TBM operates, monitoring of tunnel boring is not feasible. Consequently, while any ground disturbance in previously undisturbed sediments could encounter resources, the primary construction impact would result from operation of the TBM to bore the underground section from South La Verne Avenue to Smithway Street.

Given the boring technologies employed in recent Metro projects, there is no known way to monitor or mitigate boring impacts on paleontological resources because the TBM grinds the material as it moves forward, making it impossible to preserve fossils or bones. There is no fossil record for the area in which the TBM would operate that would provide a basis for determining how many paleontological resources could be impacted or the magnitude of the impact. The conclusion that there would be a significant impact is based on the sediment type alone and evidence that this sediment type has a high sensitivity for paleontological resources. Thus, construction using TBM would result in significant direct impacts on paleontological resources.

As described above, construction of the base Alternative 3 or Alternative 3 with the Atlantic/Pomona Station Option and/or the Montebello At-Grade Option would result in significant impacts on paleontological resources. MM GEO-1 through MM GEO-4 as discussed in **Section 3.6.7** would be

implemented to reduce impacts; however, because monitoring of tunnel boring is not feasible, unique paleontological resources may be destroyed and impacts would be significant and unavoidable.

3.6.6.5.4 Maintenance and Storage Facilities

Operational Impacts

MSF Site Options and Design Option

The Commerce MSF site option, Montebello MSF site option, and the Montebello MSF At-Grade Option are within sediments mapped as older alluvial fan deposits. However, operations would not involve additional ground disturbance that could result in direct or indirect destruction of paleontological resources. Therefore, no impacts would occur.

Construction Impacts

MSF Site Options and Design Option

The Commerce MSF site option, Montebello site option, and the Montebello MSF At-Grade Option are within sediments mapped as older alluvial fan deposits which have a high potential for paleontological resources, including undisturbed sediments near the surface. Construction would have a significant impact on paleontological resources. Implementation of MM GEO-1 through MM GEO-4 which require monitoring for resources and cataloging any finds as described in **Section 3.6.6.5.1** and identified in **Section 3.6.7** would reduce the potential impact on paleontological resources from some manual and mechanical construction activities. Together, these mitigation measures would reduce the potential impact from construction activities at the MSF site options where monitoring of ground disturbance activities is feasible. Implementation of MM GEO-1 through MM GEO-4 as discussed in **Section 3.6.7** would reduce impacts to less than significant.

3.6.7 Project Measures and Mitigation Measures

3.6.7.1 Project Measures

Project measure are design features, best management practices, or other measures required by law and/or permit approvals. These measures are components of the Project and are applicable to all Build Alternatives, design options, and MSF site options and MSF design option.

PM GEO-1: The Build Alternatives shall be designed and constructed per the 2018 Metro Rail Design Criteria (MRDC). The MRDC incorporates various design specifications from the Federal Highway Administration (FHWA), California Department of Transportation (Caltrans), the State of California, the County of Los Angeles, and other sources by reference. Key compliance sections of the MRDC relative to geology and soils are Section 5.3, Section 5.4, Section 5.6, and MRDC Section 5 Appendix, Metro Supplemental Seismic Design Criteria. Section 5.6 of the MRDC provides detailed requirements for planning and conducting a geotechnical investigation, geotechnical design methodologies, and reporting. In addition, Caltrans and the County of Los Angeles Building Code (based on the California Building Code [CBC]) have

independent design criteria for bridges and aerial structures (Caltrans) and building structures (County of Los Angeles) that are also required. In accordance with the MRDC, geotechnical report recommendations shall be incorporated into the project plans and specifications. These recommendations shall be a product of final design and shall address potential subsurface hazards. Without these report recommendations, the project plans and specifications shall not be approved and the Build Alternatives will not be allowed to advance into the final design stage or into construction.

3.6.7.2 Mitigation Measures

As identified in **Section 3.6.6**, the Build Alternatives and Build Alternatives with the design option(s) would have less than significant impacts on geology and soils under Impact GEO-1 (Exposure to Seismic Hazards), Impact GEO-2 (Soil Erosion), Impact GEO-3 (Soil Stability), and Impact GEO-4 (Expansive Soils). The Build Alternatives and Build Alternatives with design option(s) would have a significant impact on paleontological resources under Impact GEO-5 (Paleontological Resources). Mitigation measures to reduce the impacts are presented herein. MM-GEO-1 through MM GEO 4 apply to all Build Alternatives and Build Alternatives with the design option(s). However, impacts from boring cannot be mitigated. Therefore, impacts on paleontological resources would be significant and unavoidable.

Following the mitigation measures, **Table 3.6-1** identifies applicable measures and the combined impact after mitigation of the base alternatives with the associated MSF site option(s), and the alternatives with one or both design options (as applicable) with the associated MSF site option(s).

MM GEO-1: Metro shall retain a qualified paleontologist and a qualified paleontological monitor to carry out the following tasks: The qualified paleontologist shall supervise the qualified paleontological monitor to monitor excavation in areas identified as likely to contain paleontological resources. These areas are defined as all areas within the Older alluvium in the project site where planned excavation will exceed three feet below the surface or three feet into undisturbed sediments and all areas within the Younger alluvium in the project site where planned excavation will exceed 10 feet below the surface or 10 feet into undisturbed sediments. The qualified paleontologist shall retain the option to reduce monitoring if, in his or her professional opinion, sediments being monitored are previously disturbed. Monitoring may also be reduced if the potentially fossiliferous units are determined to have low potential to contain fossil resources.

MM GEO-2: Metro shall make sure that the qualified paleontologist and the qualified paleontological monitor are equipped to salvage fossils and samples of sediment as they are unearthed to avoid construction delays and empowered to temporarily halt or divert equipment to allow removal of abundant or large specimens. Since Older alluvium yields small fossil specimens (microvertebrate fossils) likely to go unnoticed during typical large-scale paleontological monitoring, matrix samples shall be collected and processed to determine the potential for small fossils to be recovered prior to substantial excavations in those sediments. If this sampling indicates that these units do possess small fossils, a matrix sample of 6,000 pounds shall be collected at various locations, to be specified by the paleontologist, within the construction area. These matrix samples shall also be processed for small fossils.

MM GEO-3: The qualified paleontologist shall make certain that recovered specimens be prepared to a point of identification and permanent preservation, including washing of sediments to recover small invertebrate and vertebrate fossils.

MM GEO-4: Metro shall make certain that specimens shall be curated into a professional accredited museum repository with permanent retrievable storage. A report of findings, with an appended itemized inventory of specimens, shall be prepared. The report and inventory, when submitted to the professional accredited museum repository, shall signify completion of the program to mitigate impacts to paleontological resources

3.6.8 Significance After Mitigation

As identified in **Table 3.6-1**, **with implementation of mitigation measures MM GEO-1 through MM GEO-4 impacts on Paleontological Resources (Impact GEO-5) would be reduced; however impacts on paleontological resources would remain significant and unavoidable** for all Build Alternatives and the Build Alternatives with the design option(s) and the MSF site options.

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Table 3.6-1. Summary of Impact Determinations for Build Alternatives and MSF Options

CEQA Impact Topic		Alternative 1: Washington Boulevard								Alternative 2: Commerce/Citadel IOS		Alternative 3: Washington/Greenwood IOS							
		Base Alternative 1[1]		Alternative 1 + Atlantic/Pomona Station Option		Alternative 1 + Montebello At-Grade Option		Alternative 1 + Atlantic/Pomona Station Option + Montebello At-Grade Option		Base Alternative 2[2]	Alternative 2 + Atlantic/ Pomona Station Option	Base Alternative 3[3]		Alternative 3 + Atlantic/Pomona Station Option		Alternative 3 + Montebello At-Grade Option		Alternative 3 + Atlantic/Pomona Station Option + Montebello At-Grade Option	
		Commerce MSF	Montebello MSF	Commerce MSF	Montebello MSF	Commerce MSF	Montebello MSF At-Grade Option	Commerce MSF	Montebello MSF At-Grade Option	Commerce MSF		Commerce MSF	Montebello MSF	Commerce MSF	Montebello MSF	Commerce MSF	Montebello MSF At-Grade Option	Commerce MSF	Montebello MSF At-Grade Option
GEO-1 Exposure to Seismic Hazards	Applicable Mitigation	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
	Impacts After Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
GEO-2 Soil Erosion	Applicable Mitigation	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
	Impacts After Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
GEO-3 Soil Stability	Applicable Mitigation	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
	Impacts After Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
GEO-4 Expansive Soils	Applicable Mitigation	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
	Impacts After Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS
GEO-5 Paleonto-logical Resources	Applicable Mitigation	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1	MM GEO-1
		MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2	MM GEO-2
		MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3	MM GEO-3
		MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4	MM GEO-4
	Impacts After Mitigation	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU	SU

Source: CDM Smith/AECOM JV, 2022.
Notes:
The Base Alternatives are shaded in light yellow. Design options are not shaded.
1 The Base Alternative 1 includes the Atlantic station (reconfigured/relocated) and aerial Greenwood station
2 The Base Alternative 2 includes the Atlantic station (reconfigured/relocated)
3 The Base Alternative 3 includes the Atlantic station (reconfigured/relocated) and aerial Greenwood station
Key:
NI = No Impact LTS = Less Than Significant SU = Significant and Unavoidable

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