Appendix E: Desktop Geotechnical and Geologic Hazard Evaluation

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Revised Desktop Geotechnical and Geologic Hazard Evaluation Mission Valley Community Plan Update
San Diego, California

PREPARED FOR:
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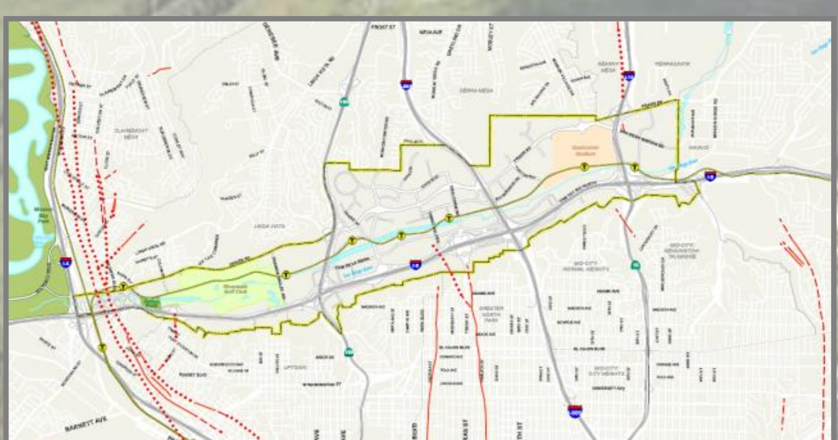

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January 8, 2019
Project No. 9091004

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Subject: Revised Desktop Geotechnical and Geologic Hazard Evaluation
Mission Valley Community Plan Update
San Diego, California

Dear Mr. Bhatia,

We are pleased to submit our Geotechnical and Geologic Hazard Study report. The report was prepared in support of the Mission Valley Community Plan Update and includes identification of geotechnical and geologic hazards within the Study Area and the significance of these hazards to existing and future land uses of the Study Area. Our original report prepared in July 2017, has been revised herein to include review of the most recent Mission Valley Community Plan Update and to incorporate comments from the City of San Diego.

Respectfully submitted,

THE BODHI GROUP, INC.

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EXECUTIVE SUMMARY

This Geotechnical and Geologic Hazard Evaluation (Study) identifies geotechnical and geologic hazards that could have potential adverse effects on the area of the Mission Valley Community Plan Update (Study Area). For this study, we reviewed relevant geologic maps and guidelines published by the City of San Diego Guidelines, State of California, and the United States Geologic Survey. In-house resources were also reviewed. A summary of the geology and geologic hazards is provided below.

- In increasing order of age, soils in the Study Area consist of artificial fill (both documented and undocumented), young alluvium, young colluvium, old alluvium, Old paralic deposits (Unit 6), and formational soils of the San Diego and Mission Valley Formations, Stadium Conglomerate, and the Friars and Scripps Formations. Undocumented fill, young alluvium, and young colluvium are not considered suitable in their current state for support of improvements. To mitigate the potential for future settlement, these soils may need to be removed and replaced as compacted fill, if future structures are planned in these areas. The formational materials contain layers of cemented gravel and cobbles which may be difficult to excavate and may impact trenching operations.
- The closest known active fault is the Rose Canyon Fault, strands of which are located within and near the western end of the Study Area. The Study Area, like the rest of San Diego, is in a region of active faults and will be subject to strong ground motion in the event of an earthquake on these faults. Surface rupture caused by faulting can be mitigated by setting back structures for human occupancy away from the surface trace of clearly-defined active fault traces. Adverse effects of ground shaking can be mitigated through ground improvement and/or the use of proper engineering design.
- According to City of San Diego maps, most of the lower elevation portions of the Study Area (areas close to San Diego River) are defined as having a high potential for liquefaction (Geologic Hazard Category 31). Mitigation may include removal of loose soils and replacement with compacted fill, supporting structures on deep foundations which extend through the liquefiable materials, or suitable ground improvement techniques such as stone columns or deep dynamic compaction.
- Landslide hazards are mapped both by the State of California and the City of San Diego. The State of California and City of San Diego use differing systems to indicate the severity of the landslide hazard and the categories used by the two systems are not coincident. According to the State of California (Tan, 1995), most the Study Area is classified as being marginally susceptible to landsliding (Designation 2). Some portions of the Study Area are classified as being generally susceptible or most susceptible to landsliding (Designations 3-1, 3-2, 4-1 and 4-2). These generally susceptible or most susceptible areas occur on the slopes on both the north and south sides of Mission Valley. Per Tan (1995) a mapped landslide occurs on the southern slope of the valley on a side canyon just west of Texas Street (Figure 3). Per Tan and Kennedy (2008) a landslide is mapped south of the western end of the study area on the slopes south of Mission Valley (Figure 3). According to the City of San Diego Seismic Safety Study most sloping portions of the Study Area are mapped as being at low to moderate risk for landsliding (Hazard Categories 51, 52, and 53). Some areas (dominantly on the eastern side of the Study Area) are mapped as being underlain by the potentially slide-prone Friars Formation. Mitigating this designation though these areas of the Friars Formation lie in zones with neutral or favorable geologic structure (Geologic Hazard Category 23). Mitigation of landslides can be accomplished through avoidance, removal of the deposits, or geotechnical and/or structural engineering.

- Most the Study Area consists of soils that are not expansive in nature. But some expansive, clayey soils may be found in areas underlain by the Friars Formation and in areas underlain by soils of the Olivenhain and Huerhuero Soil Series (UC Davis, 2017). In areas of potential expansive soils, measures including capping or replacement, special grading techniques, or chemical treatment of expansive soils can mitigate these problems for new construction.
- Most the Study Area consists of soils that are not anticipated to be corrosive in nature. However, per available soil maps (UC Davis, 2017) potentially corrosive soils may be present in some localized areas underlain by former marine terrace deposits and in areas near the San Diego River. Mitigation measures may include the use of specialized concrete and consultation with a corrosion engineer.

1. INTRODUCTION

The Bodhi Group has completed a Geotechnical and Geologic Hazards Study (Study) of the Mission Valley Community Plan Update area (Study Area). The Study was performed at a California Environmental Quality Act (CEQA) level for the Study Area. This report presents the results of our "desktop" evaluation of the geotechnical and geologic hazards potentially affecting the Study Area. The purpose of our evaluation was to identify geotechnical and geologic conditions or hazards that might affect future development and/or redevelopment within the Study Area. The following services were provided.

- Reviewed the Mission Valley Community Plan Update (2018).
- Reviewed relevant published geologic maps, State of California-issued geologic hazard maps, the City of San Diego Seismic Safety Study Geologic Hazards and Faults maps, and the City of San Diego Guidelines for Geotechnical Reports
- Reviewed and summarized regional and local geology and identified potential geotechnical and geologic hazards.
- Researched and identified relevant geologic hazards listed in the "Guidelines for Geologic/Seismic Consideration in Environmental Impact Reports," California Geological Survey (California Division of Mines and Geology) Note 46 and "Guidelines for Preparing Geologic Reports for Regional-Scale Environmental and Resource Management Planning," California Geological Survey (California Division of Mines and Geology) Note 52, as amended or updated.
- Researched other City and County resources, and our in-house library of geotechnical and geological hazards such as faulting, seismicity, liquefiable soils, etc.
- Prepared this technical report that identifies geotechnical and geologic hazards. Included in this report is a map of the regional and Study Area geology showing distribution of surficial deposits and geologic units (Figure 1); a map of the faults in the Study Area vicinity (Figure 2); and a geohazards map (Figure 3) identifying areas susceptible to the potential geologic hazards described in this report.

1.1. Significant Assumptions

Documentation and data provided by the client or from the public domain, and referred to in the preparation of this study, are assumed to be complete and correct and have been used and referenced with the understanding that the Bodhi Group assumes no responsibility or liability for their accuracy. The conclusions contained herein are based upon such information and documentation. Because conditions may change, and additional data may become available, data reported, and conclusions drawn in this report are limited to current conditions and may not be relied upon on a significantly later date or if changes have occurred at the Study Area.

Reasonable CEQA-level efforts were made during the Study to identify geologic hazards. "Reasonable efforts" are limited to information gained from information readily-accessible to the public. Such methods may not identify Study Area geologic or geotechnical issues that are not listed in these sources. In the preparation of this report, the Bodhi Group has used the degree of care and skill ordinarily exercised by a reasonably prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. No other warranties are made to any third party, either expressed or implied.

2. PROJECT LOCATION AND DESCRIPTION

The Study Area comprises approximately 3,216 acres and is near the geographic center of the City of San Diego. It encompasses a portion of the San Diego River floodplain, it is generally bounded by Friars Road and the northern slopes of the valley on the north, the eastern banks of the San Diego River on the east, the southern slopes of the valley on the south, and Interstate 5 on the west (City of San Diego, 1985).

The current Mission Valley Community Plan Update was approved in 1985 and last amended in 2013. The community is now a regional center of office, hotels, retail sales, and a growing residential population. Public transportation within the area is provided by the Metropolitan Transit System and includes buses and the San Diego Trolley Green Line. Major thoroughfares include Interstate Highway 8 and Friars Road and Camino del Rio (running east-west through the area) and Interstate Highways 805 and 15 and California Route 163 (running north-south through the area).

The current Mission Valley Community Plan provides the detailed framework to guide development in Mission Valley. Originally adopted in 1985, the plan has undergone over 20 amendments in the intervening years. According to the City of San Diego website (2017), the Community Plan update seeks to bring the plan up-to-date by: analyzing current land use, development, and environmental characteristics; evaluating changes in demographics that may affect land use needs; understanding demand for housing and commercial development; working with community members and stakeholders to determine key issues of concern, desires, and preferences to establish a vision and objectives for the plan update; evaluating the “fit” of current Community Plan policies to achieve community goals and regulatory requirements; and ensuring that policies and recommendations remain in harmony with the General Plan and citywide policies, as well as regional policies.

3. HISTORY

Throughout the history of Mission Valley, the San Diego River has been a primary attraction, first as a source of fresh water and later as a scenic recreational asset. After the Kumeyaay Indians, came the Spaniards, who first named the area La Canada de San Diego. The Spaniards founded the Mission San Diego de Alcala on Presidio Hill in 1769 (City of San Diego, 1985); however, in 1774 it was moved to its present location on San Diego Mission Road in Mission Valley.

In 1870, the name of the area was changed to Mission Valley. Truck farming, sheep herding, and bee keeping were introduced into the valley. By 1880, 20 dairies had been established in the valley. Sand and gravel extraction was introduced in 1913 and began in earnest about 1923. The Mission Valley Oil Enterprise Company unsuccessfully explored for oil at the foot of Texas Street in 1930.

Residential development was approved for Mission Valley in 1940 by local authorities. The Mission Valley Golf Club was established in 1947. In 1953-1954 the Town and Country Hotel and Mission Valley Country Club (now the Handlery Hotel) opened.

In 1958, the Planning Department issued a preliminary study for the valley favoring hotels over dense residential and commercial uses. The construction of U.S. 80 (now Interstate 8) provided an impetus for commercial development in Mission Valley, and for displacement of the agricultural economy. Other significant projects include San Diego Stadium (now Qualcomm Stadium) which was completed in 1967. Major urban development followed, primarily because of improvements in the regional highway network (City of San Diego, 1985).

4. GEOLOGY

San Diego is located within the western (coastal) portion of the Peninsular Ranges Geomorphic Province of California. The Peninsular Ranges encompass an area that roughly extends from the Transverse Ranges and the Los Angeles Basin, south to the Mexican border, and beyond another approximately 800 miles to the tip of Baja California (Norris and Webb, 1990; Harden, 1998). The geomorphic province varies in width from approximately 30 to 100 miles, most of which is characterized by northwest-trending mountain ranges separated by subparallel fault zones. In general, the Peninsular Ranges are underlain by Jurassic-age metavolcanic and metasedimentary rocks and by Cretaceous-age igneous rocks of the southern California batholith. Geologic cover over the basement rocks in the westernmost portion of the province in San Diego County generally consists of Upper Cretaceous-, Tertiary-, and Quaternary-age sedimentary rocks

Structurally, the Peninsular Ranges are traversed by several major active faults. The Elsinore, San Jacinto, and the San Andreas faults are major active fault systems located northeast of San Diego and the Rose Canyon, San Diego Trough, Coronado Bank and San Clemente faults are major active faults located within or west-southwest of San Diego. Major tectonic activity associated with these and other faults within this regional tectonic framework is generally right-lateral strike-slip movement. These faults, as well as other faults in the region, have the potential for generating strong ground motions in the project area. Further discussion of faulting relative to the Study Area is provided in following sections of this report.

Figure 1, modified from Kennedy and Tan (2008), shows the regional geology. Figure 2 shows the proximity of the Study Area to nearby mapped Quaternary faults. A Quaternary fault is defined by the State of California (2007) as a fault that shows evidence of movement in the last 1.6 million years. Quaternary (Holocene and Pleistocene) faults can be classified as either active or potentially active faults. Active faults are those Quaternary Holocene faults which have been shown to have ruptured in the last 11,000 years. Potentially active faults are those Quaternary Pleistocene faults which have been shown to have ruptured during the 1.6 million years but not within the last 11,000 years.

4.1. Local Geology

In increasing order of age, soils in the Study Area consist of artificial fill (both documented and undocumented), young alluvium, young colluvium, old alluvium, Old paralic deposits (Unit 6), and formational soils of the San Diego and Mission Valley Formations, Stadium Conglomerate, and the Friars and Scripps Formations. Descriptions of the general characteristics of these units are presented below.

- Af Artificial fill (late Holocene). These consist of fill deposits resulting from human construction, mining, or quarrying activities. These include both documented and undocumented and/or non-engineered fill. Large areas of Artificial Fill deposits are shown on the map but, although present, some areas of artificial fill are not large enough to be shown at the scale of the map. The mapped areas of Artificial Fill are coincident with the route of Interstate Highway I-8 and its interchanges with State Highway CA-163 and Qualcomm Way within the Study Area. A mapped Artificial Fill Area is also shown to underlie the area where Interstate Highway I-805 traverses the Study Area.
- Qya – Young alluvial flood-plain deposits (Holocene and late Pleistocene). Young alluvial flood-plain deposits are characterized as poorly consolidated, poorly sorted, permeable floodplain deposits of sandy, silty, or clay-bearing alluvium. These deposits occur along the floodplain of the San Diego River down the central axis of Mission Valley.

- Qyc – Young colluvial deposits (Holocene and late Pleistocene). These consist of young poorly consolidated and poorly sorted sand and silt slopewash deposits and are mapped throughout the Study Area (dominantly on the south side of the valley).
- Qoa – Old alluvial flood-plain deposits (late to middle Pleistocene). These are dominantly fluvial sediments deposited on canyon floors consisting of moderately well consolidated, poorly sorted, permeable, commonly slightly dissected gravel, sand, silt, and clay-bearing alluvium. Per the referenced map these deposits are present in portions of the eastern side of the valley (near Qualcomm Stadium).
- Qop6 – Old paralic deposits, Unit 6 (late to middle Pleistocene). Unit 6 of the old paralic deposits is characterized as poorly sorted, moderately permeable, reddish-brown, interfingered strandline, beach, estuarine, and colluvial deposits composed of siltstone, sandstone, and conglomerate. Per the referenced map these deposits are restricted to small areas on the north side of the Study Area.
- Tsd – San Diego Formation, undivided (early Pleistocene and late Pliocene). The San Diego Formation is characterized as predominantly yellowish-brown and gray, fine- to medium-grained, poorly indurated fossiliferous marine sandstone and reddish-brown transitional marine and non-marine pebble and cobble conglomerate, both divided and undivided. Undivided portions of the formation are exposed on the southern slopes of Mission Valley.
- Tmv – Mission Valley Formation (middle Eocene). The Mission Valley Formation is present throughout the Study Area but it is most exposed on the northern flank of Mission Valley. It consists predominantly of light olive-gray, soft and friable, fine- to medium-grained marine and non-marine sandstone containing cobble conglomerate tongues. The Mission Valley Formation has a maximum thickness of nearly 200 feet.
- Tst – Stadium Conglomerate (middle Eocene). The Stadium Conglomerate is present throughout the Mission Valley area but it most exposed on the northern flank of the valley. It consists of massive cobble conglomerate with a dark-yellowish brown, coarse-grained sandstone matrix. The conglomerate contains slightly metamorphosed volcanic and volcaniclastic rocks and quartzite. The Stadium Conglomerate is approximately 150 feet thick at its type section, located near Qualcomm Stadium (Kennedy and Tan, 2008; after Kennedy and Moore, 1971).
- Tf – Friars Formation (middle Eocene). This formation consists of yellowish-gray, medium-grained, massive, poorly indurated non-marine and lagoonal sandstone and claystone with tongues of cobble conglomerate. Within the Study Area it is exposed on the north side of Mission Valley at its eastern end.
- Tsc – Scripps Formation (middle Eocene). The Scripps Formation is present throughout the Study Area but is most exposed on the northern flank of the valley. It consists of pale-yellowish-brown, medium-grained sandstone with some interbedded cobble-conglomerate.

5. HYDROGEOLOGY

Based on a review of available hydrogeologic data from the California Regional Water Quality Control Board San Diego Region (RWQCB, 1994), the Study Area is located in the Mission San Diego Hydrologic Subarea within the Lower San Diego Hydrologic Area (907.11) of the San Diego Hydrologic Unit (907.00). The existing beneficial uses of groundwater in the Study Area include agricultural supply, industrial service supply, and industrial process supply (RWQCB, 1994). Municipal supply is identified in the basin plan as a potential beneficial use (RWQCB, 1994).

The San Diego County Water Authority has classified the Mission Valley portion of the San Diego River to be a principal alluvial aquifer (referred to as the Mission Valley Aquifer). Presently, the City of San

Diego, the local water purveyor, is not using this alluvial aquifer for municipal water supply; however, in the future the City may evaluate potential groundwater use from this aquifer. The details of future groundwater development are not known at this time. Golf courses in the Study Area are the principal users of groundwater for irrigation.

Per information available on the State of California, Department of Water Resources, Water Data Library (2017) and the Geotracker (2017) website there are few public wells located within the Study Area. However, numerous groundwater wells have been installed throughout the Study Area for environmental evaluations conducted to assess contaminated soil and groundwater. Based on that research groundwater is present at relatively shallow depths (less than 10 feet below the adjacent surface) in areas within the Study Area.

6. GEOLOGIC HAZARDS

This section identifies geologic hazards that may affect proposed policies and programs of the Mission Valley Community Plan Update and proposed land use. The proposed land uses were not available at the time of preparation of this report. These hazards include surface fault rupture; seismicity and ground motion; liquefaction; seismically-induced settlement and lateral spread; tsunamis, seiches, and dam failure; slope instability; and expansive and corrosive soils. These hazards, with the possible exception of dam failure, can be mitigated through administrative controls (e.g., avoiding building in hazard-prone areas or structure setback) and/or engineering improvements (e.g., ground improvement, ground restraints, or appropriate structure foundation). Site-specific and hazard-specific geotechnical investigations would be required to evaluate the appropriate mitigation measure or combination of measures.

The City of San Diego Seismic Safety Study summarizes the city's known and suspected geologic hazards and faults to "comply with California regulations requiring cities to adopt a Seismic Safety Element within their general plan" (City of San Diego 2008). The intent of the study was to categorize areas in the city by hazard type (shown on maps) and to assign levels of risk to development. The maps can be used to identify possible or likely types and risk of geologic hazards for a site. The Explanation for the map was updated in 2018. The Study Area encompasses all or portions of map Sheets 21, 22, 26, and 27 of the City of San Diego Seismic Safety. Identified hazards are described below.

6.1. Surface Fault Rupture

Surface fault rupture is the result of movement on an active fault reaching the surface. Figure 2 shows the Study Area in relation to nearby known active faults, of which the Rose Canyon Fault is the most significant. The Rose Canyon Fault is capable of producing a magnitude 7.2 earthquake (Cao et al, 2003). Active portions of the Rose Canyon Fault, some of which are concealed, are located within and near the western end of the Study Area. In addition, as shown on the City of San Diego Seismic Safety map sheets there are several faults noted as being "Potentially Active, Inactive, Presumed Inactive, or Activity Unknown" (Geologic Hazard Category 12; City of San Diego, 2008) that lie within the Study Area. Similar faults are also shown on the web accessible maps available from SANDAG (SANDAG, 2017). Newer fault discoveries have been plotted based on maps available online at the San Diego Association of Geologists (2018). Areas underlain by north-south trending faults in this category are located at locations on the south side of Mission Valley near Texas Street and between Mission Center Road and Interstate Highway 805; and on the north side of Mission Valley near the intersection of Interstate Highway 15 and

Friars Road. The postulated Mission Gorge fault has been mapped paralleling the axis of Mission Valley (Figure 2). The "fault" was postulated to exist due to changes in stratigraphy on either side of Mission Valley. Richard Threet (1973) showed conclusively that the apparent differences in stratigraphy were the result of a shallow southerly regional dip and the presence of the edges of depositional basins (San Diego Formation).

Although the Study Area is not within a State of California Earthquake Fault Zone (State of California, 2003) or the City of San Diego- designated "Downtown Special Fault Zone," strands of the active Rose Canyon fault underlie the western end of the Study Area. The area is currently planned for use as a passive park or open space. No construction is planned in the area underlain by the Rose Canyon fault zone. Should plans change, the City of San Diego will require site-specific fault investigations for construction of any type. The fault investigations will evaluate whether the development overlies an active fault strand capable of surface rupture and will provide recommendations to avoid the hazard or mitigate its effects.

6.2. Seismicity and Ground Motion

An active fault is defined by the State Mining and Geology Board as one that has experienced surface displacement within the Holocene epoch, i.e., during the last 11,000 years (California Geological Survey, 2007). The Study Area is subject to potential ground shaking caused by activity along faults located within and near the Study Area.

The Rose Canyon Fault can produce a magnitude 7.2 earthquake (Cao et al, 2003). Portions of the Elsinore and San Jacinto Fault zones, located east of San Diego, have the capacity to produce earthquakes at maximum magnitudes from 6.4 to 7.2 (Cao et al, 2003).

Ground shaking during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and the type of geologic material underlying the area. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments such as artificial fill or unconsolidated alluvial fill.

As noted, the Study Area is subject to ground shaking hazards caused by earthquakes on regional active faults. Based on a Probabilistic Seismic Hazards Ground Motion Interpolator provided by the California Department of Conservation (2008), the Study Area is located in a zone where the horizontal peak ground acceleration having a 10 percent probability of exceedance in 50 years ranges from 0.450g (where g represents the acceleration of gravity) to 0.582g. Within the Study Area the higher value occurs at the west end and the lower value occurs at the east end.

6.3. Liquefaction, Seismically Induced Settlement, and Lateral Spread

Liquefaction is a phenomenon whereby unconsolidated and/or near-saturated soils lose cohesion as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in temporary, fluid-like behavior of the soil. Soil liquefaction causes ground failure that can damage roads, pipelines, underground cables, and buildings with shallow foundations. Research and historical data indicate that loose granular soils and non-plastic silts that are saturated by a relatively shallow groundwater table are susceptible to liquefaction.

Among the potential hazards related to liquefaction are seismically induced settlement and lateral spread. Seismically induced settlement is caused by the reduction of shear strength due to loss of grain-to-grain contact during liquefaction and may result in dynamic settlement on the order of several inches to several feet. Lateral spreading of the ground surface during an earthquake usually takes place along weak shear zones that have formed within a liquefiable soil layer. Lateral spreading has generally been observed to take place in the direction of a free-face (i.e., retaining wall, slope, channel, etc.) but has also been observed to a lesser extent on ground surfaces with gentle slopes. An empirical model developed by Bartlett and Youd (1995, revised 1999) is typically used to predict the amount of horizontal ground displacement within a site. For sites located in proximity to a free-face, the amount of lateral ground displacement is strongly correlated with the distance of the site from the free-face. Other factors such as earthquake magnitude, distance from the earthquake epicenter, thickness of the liquefiable layers, and the fines content and particle sizes of the liquefiable layers will also affect the amount of settlement or lateral ground displacement.

Large portions of the low-lying areas adjacent to the San Diego River lie within City of San Diego-designated liquefaction hazard zones (Geologic Hazard Map Symbol 31; City of San Diego, 2008) as shown on Figure 3. As noted, liquefiable soils can settle or spread as a result of earthquake energy.

6.4. Tsunamis, Seiches, and Dam Failure

A tsunami is a sea wave generated by a submarine earthquake, landslide, or volcanic action. Submarine earthquakes are common along the edge of the Pacific Ocean, thus exposing all Pacific coastal areas to the potential hazard of tsunamis. However, no portion of the Study Area lies within a mapped tsunami inundation zone. A seiche is an earthquake-induced wave in a confined body of water, such as a lake, reservoir, or bay. However, no portion of the Study Area lies near a confined body of water on which a seiche could be expected to occur.

An earthquake-induced dam failure can result in a severe flood event. When a dam fails, a large quantity of water is suddenly released with a great potential to cause human casualties, economic loss, lifeline disruption, and environmental damage. Based on review of the 2010 San Diego County Multi-Jurisdictional Hazard Mitigation Plan Dam Failure map, the Study Area may be subject to dam inundation as it is downstream of dams and reservoirs that were constructed on the San Diego River. These include Lake Murray, Santee Lakes, El Capitan Reservoir, and other smaller impoundments.

6.5. Slope Instability

Slopes steeper than 2:1 (horizontal:vertical) are susceptible to landslides or slope failure. Slope failure is dependent on topography and underlying geologic materials, as well as factors such as rainfall, excavation, or seismic activities that can precipitate slope instability. Earthquake motions can induce significant horizontal and vertical dynamic stresses along potential failure surfaces within a slope.

Landslide hazards are mapped both by the State of California and the City of San Diego. The State of California and City of San Diego use differing systems to indicate the severity of the landslide hazard and the categories used by the two systems are not coincident. According to the State of California (Tan, 1995), most the Study Area is classified as being marginally susceptible to landsliding (Designation 2). However, some portions of the Study Area are classified as being generally susceptible or most susceptible to landsliding (Designations 3-1, 3-2, 4-1 and 4-2). These generally susceptible or most susceptible areas occur on the slopes on both the north and south sides of Mission Valley. Per Tan (1995) a mapped landslide occurs on the southern slope of the valley on a side canyon just west of Park Boulevard and south of Interstate 8. Per Tan and Kennedy, 2008, there is a mapped landslide at the western end of the Study Area on the southern slopes just east of Interstate Highway 5 and south of Interstate 8 (Figure 3). It should be noted that neither of these landslides are shown on the City of San Diego Seismic Safety Study maps.

According to the City of San Diego Seismic Safety Study most sloping portions of the Study Area are mapped as being at low to moderate risk for landsliding (Hazard Categories 51, 52, and 53). However, some areas (dominantly on the eastern side of the Study Area) are mapped as being underlain by the potentially slide-prone Friars Formation.

6.6. Subsidence

Subsidence typically occurs when extraction of fluids (water or oil) cause the reservoir rock to consolidate. Water extraction is minimal in the Study Area and the geologic materials area well consolidated. Subsidence is not a hazard in the Study Area.

Settlement of unconsolidated soil (fill or alluvium) may occur locally where new loads are imposed on previously uncompacted fill, compacted fill on unconsolidated alluvium, or unconsolidated alluvium.

6.7. Expansive or Corrosive Soils

Other potential geological hazards include expansive or corrosive soils. Expansion of the soil may result in unacceptable settlement or heave of structures or concrete slabs supported on grade. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors. Soils with a relatively high fines content (clays dominantly) are generally considered expansive or potentially expansive.

7. IMPACT MITIGATION

The impacts summarized above may be mitigated through administrative controls (e.g., avoiding building in hazard-prone areas or structural setback areas) and/or engineering improvements (e.g., ground improvement, ground restraints, remedial grading or foundation design). Site specific geotechnical investigations are required to recommend the appropriate mitigation measure(s).

7.1. Seismicity and Ground Motion

The entire Study Area will be affected by seismicity and ground motion. Mitigation can be accomplished by geotechnical and structural engineering design. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports and State of California requirements. Most mitigation measures will involve foundation design and or ground improvement.

7.2. Liquefaction, Seismically Induced Settlement

Predicted liquefaction will occur near the existing San Diego River Channel Mitigation can be accomplished by ground improvement and or foundation design. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports and State of California requirements.

7.3. Tsunamis, Seiches, and Dam Failures

A dam failure would be difficult to mitigate. Future developments may be constructed at higher elevations to avoid flooding from dam failure; however, such administrative controls would have to be consistent with proposed policies, programs, and land use in the Mission Valley Community Plan Update.

7.4. Slope Instability

Mitigation may be achieved by avoidance of development on slopes or stabilizing the slopes through grading or using specially designed foundations. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports with an emphasis on slope stability. Additions to existing structures or development of ancillary structures to existing development will need independent geotechnical investigations if located within 25 feet of slopes in excess of 10 feet high, and on undocumented fills. The investigations should be applied in Hazard Categories 23 and 53.

Mitigation of landslides can be accomplished through avoidance, removal of the deposits, or geotechnical and/or structural engineering. Geotechnical studies specific to a future development will evaluate the risk of slope instability and landslides and provide recommendations to avoid the risk or identify measures for slope stabilization, if such a risk is present.

7.5. Subsidence

Construction of improvements in areas underlain by young colluvium, alluvium or fill should be designed to withstand settlement of unconsolidated soil. Geotechnical investigations for design of settlement resistant structures should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports. Mitigation measures typically include ground improvement and/or foundation design.

7.6. Expansive or Corrosive Soil

Expansive soil measures include specially reinforce foundations or removal and replacement of expansive soil with less expansive material. Roadways may need heavier pavement sections. Geotechnical investigations should be conducted in accordance with City of San Diego Guidelines for Geotechnical Reports to provide appropriate recommendations. Corrosive soil should be evaluated by a Corrosion Engineer for recommendations for soil replacement or cathodic protection.

7.7. Impermeable Soil

Infiltration potential should be evaluated in accordance with City of San Diego Storm Water Standards, Part 1, 2017 Edition (City of San Diego, 2017).

7.8. Groundwater

The effects of potential groundwater on construction should be evaluated by geotechnical investigations in accordance with City of San Diego Guidelines for Geotechnical Report. Recommendations for dewatering, temporary and permanent slope stabilization, and subsurface drainage should be discussed.

8. THRESHOLDS OF SIGNIFICANCE

In accordance with Appendix G of the CEQA Guidelines, the project will have significant effect on the environment if:

<u>**G-1**</u>: Expose people to potential substantial adverse effects, including the risk of loss, injury or death involving: a) fault rupture, b) seismic shaking, c) seismic ground failure, d) landsliding.

<u>**G-2**</u>: Result in substantial soil erosion or loss of top soil.

<u>**G-3**</u> Be located in a geologic unit or soil that is unstable (landsliding, settlement, lateral spreading) or that would become unstable as a result of the project.

<u>**G-4**</u>: Be located on expansive soil causing substantial risk to life or property.

<u>**G-5**</u>: Having soils incapable of supporting the use of septic tanks where sewers are not available

8.1. Threshold G-1 a) Fault Rupture

No significant effect. There are no active or potentially active faults in the proposed development areas shown on the Mission Valley Community Plan Update maps.

8.2. Threshold G-1 b) Strong Seismic Ground Shaking

Less than significant effect. Construction of buildings and other civil works will be required to use seismic resistant designs in accordance with California and City standards and codes. If not constructed to these standards, the impact would be significant.

8.3. Threshold G-1 c) Seismic Ground Failure

Less than significant effect. Design of buildings or other civil works in areas where liquefaction is anticipated should be analyzed by geotechnical investigations performed in accordance with City of San Diego and State of California guidelines. The effects of liquefaction and seismic ground failure can be mitigated through foundation and structural design and or through ground improvement.

8.4. Threshold G-1 d) Seismic Induced Landsliding

Less than significant effect. Planned development will be within areas previously developed. Slopes within developed areas have been constructed in accordance with City of San Diego standards and codes and are assumed to be stable under static and pseudostatic conditions.

8.5. Threshold G-2 Substantial Soil Erosion and Loss of Topsoil

Less than significant effect. The Study Area is almost fully developed with landscaping, buildings, and paving. Areas not developed are dedicated open space areas that are well covered with natural vegetation. As a result, the potential for erosion is very low. Since construction will be required to follow City of San Diego standards and code that stipulate protection against temporary and permanent erosion, the impact of erosion and loss of topsoil is less than significant.

8.6. Threshold G-3 Unstable Soil (Landslide, Settlement, Lateral Spreading)

<u>**Landslide**</u>: Less than Significant. The Mission Valley Community Plan Update (MVCPU) shows planned development only in areas previously developed and are not in landslide prone formation.

<u>**Settlement**</u>: Less than Significant. Settlement prone soil within the MVCPU consists of young colluvium, alluvium, undocumented fills, and fills placed on settlement prone soil. The impact of these settlement prone soils will occur when additions or new fills place new loads on settlement prone soil. Geotechnical reports performed in accordance the City of San Diego Guidelines should be required for ANY new development that would add additional loads on undocumented fills, fills placed on settlement prone soil.

Without changing the requirements for geotechnical investigation for minor additions or fills, the effects of Settlement Prone Soil on the planned development could be significant.

Lateral Spreading: Less than Significant. Lateral Spreading occurs in sloping liquefaction prone soil or liquefaction prone soil with an open face (slope). Liquefaction prone soil in the Study Area is overlain be fill or is confined to stream channel bottoms. The potential for lateral spreading in the Study Area is insignificant.

8.7. Threshold G-4 Expansive Soil

Less than Significant. Expansive soil is present on the mesa portions of the Study Area. This area has been heavily modified by previous development, so the distribution of the expansive soil will be site dependent. Geotechnical investigations as required by the City of San Diego will identify the effects of expansive soil on the planned development. Typical remediation measures include removal of unsuitable soil and replacement with non-expansive soil, chemical treatment of expansive clay, or specially designed and reinforced foundations.

8.8. Threshold G-5 Soil Unsuitable for Onsite Sewage Disposal Systems

Less than Significant. Soil and geologic formations with poor percolation characteristics are widespread in the Study Area. The Study Area is currently well served by existing sewer systems. The use of onsite sewage disposal systems is not anticipated.

9. CONCLUSIONS

Conclusions of this Study are listed below.

- There are no geologic hazards that cannot be avoided or mitigated
- There are no policies or recommendations of the MVCPU which will have a direct or indirect significant environmental effect with regard to geologic hazards.
- The proposed land uses are compatible with the known geologic hazards.
- There are no potential impacts related to geologic hazards from the implementation of the MVCPU that can’t be avoided, reduced to an acceptable level of risk, or reduced below a level of significance through mandatory conformance with applicable regulatory requirements or the recommendations of this technical report.
- The draft EIR and MVCPU plan (January 7, 2019) are in general conformance with the findings and conclusions of this Study.

10. LIMITATIONS

This report was prepared in general accordance with current guidelines and the standard-of-care exercised by professionals preparing similar documents near the Study Area. No warranty, expressed or implied, is made regarding the professional opinions presented in this document. As this report represents a review of existing documentation on geotechnical conditions of the planning areas rather than in-depth on-site investigation, it cannot account for variations in individual site conditions or changes to existing conditions. Please also note that this document did not include an evaluation of environmental hazards.

The conclusions, opinions, and recommendations as presented in this document, are based on a desktop analysis of data, some of which were obtained by others. It is our opinion that the data, as a whole, support the conclusions and recommendations presented in the report.

The purpose of this study was to evaluate geologic and geotechnical conditions within the planning areas to assist in the preparation of environmental impact documents for the project. Comprehensive geotechnical evaluations, including subsurface exploration and laboratory testing, should be performed prior to design and construction of structural improvements. Any future projects on individual sites in the planning areas will require site-specific geotechnical studies as required by State and City regulations.

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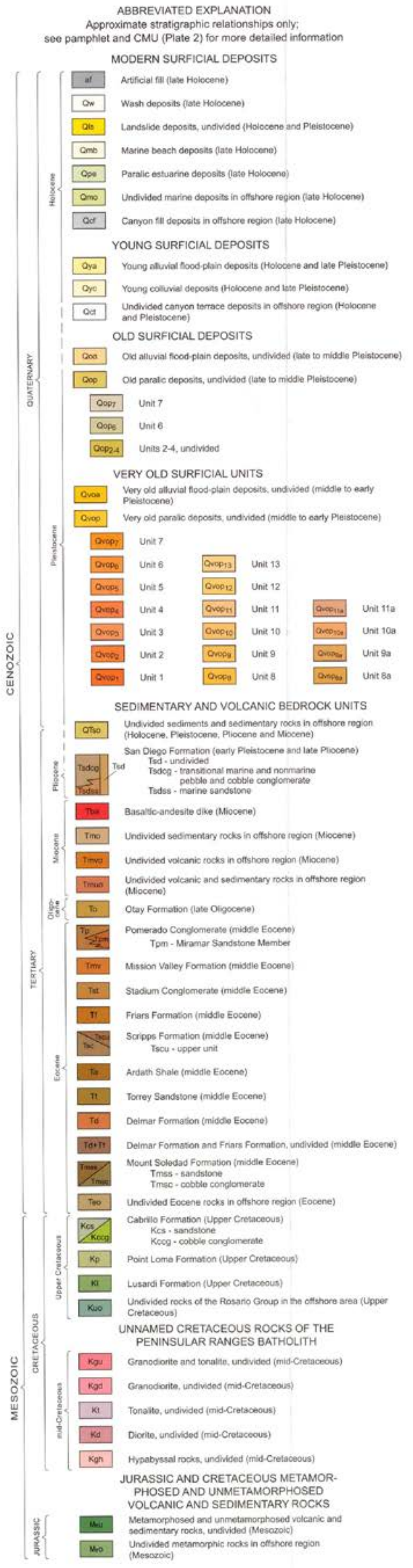
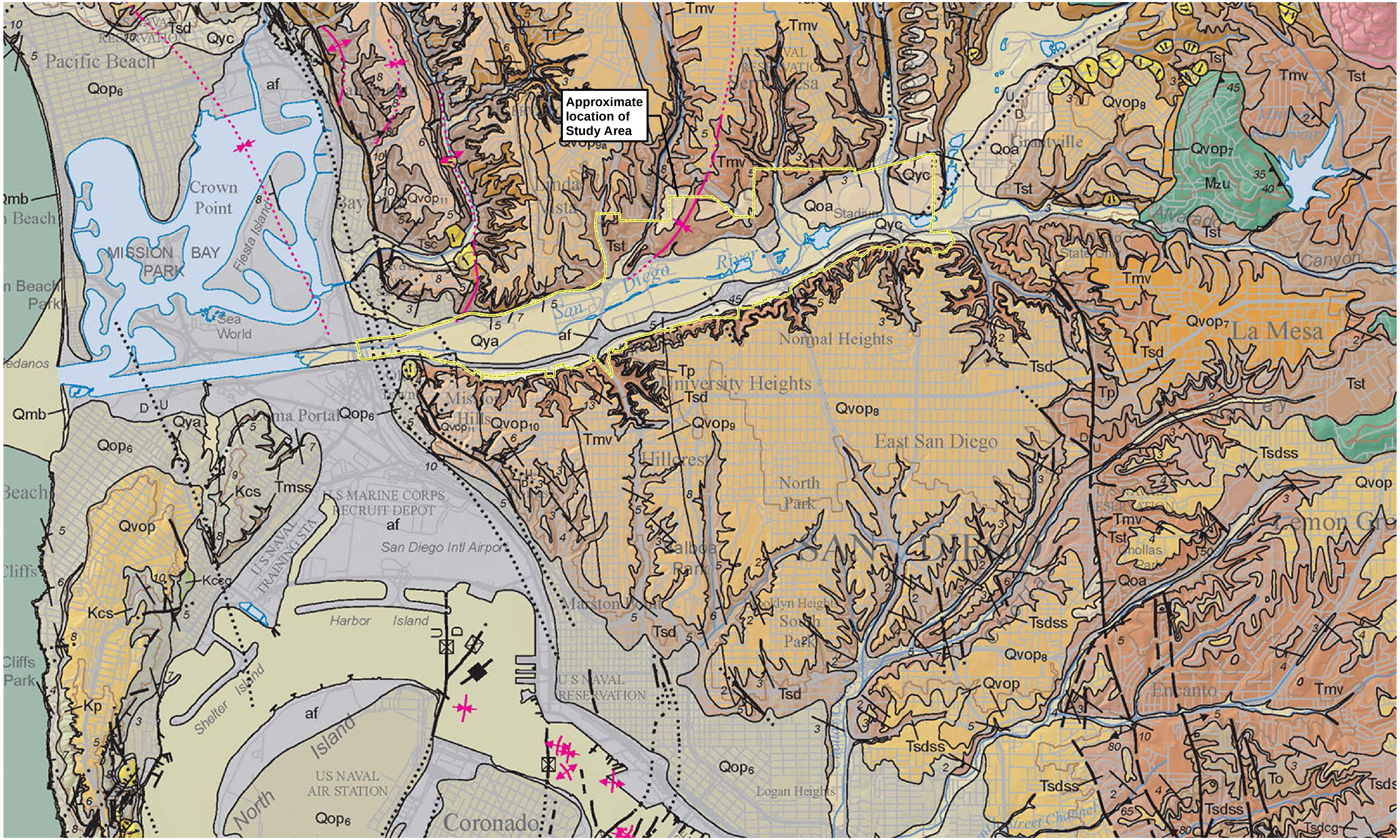
FIGURES

Regional Geology





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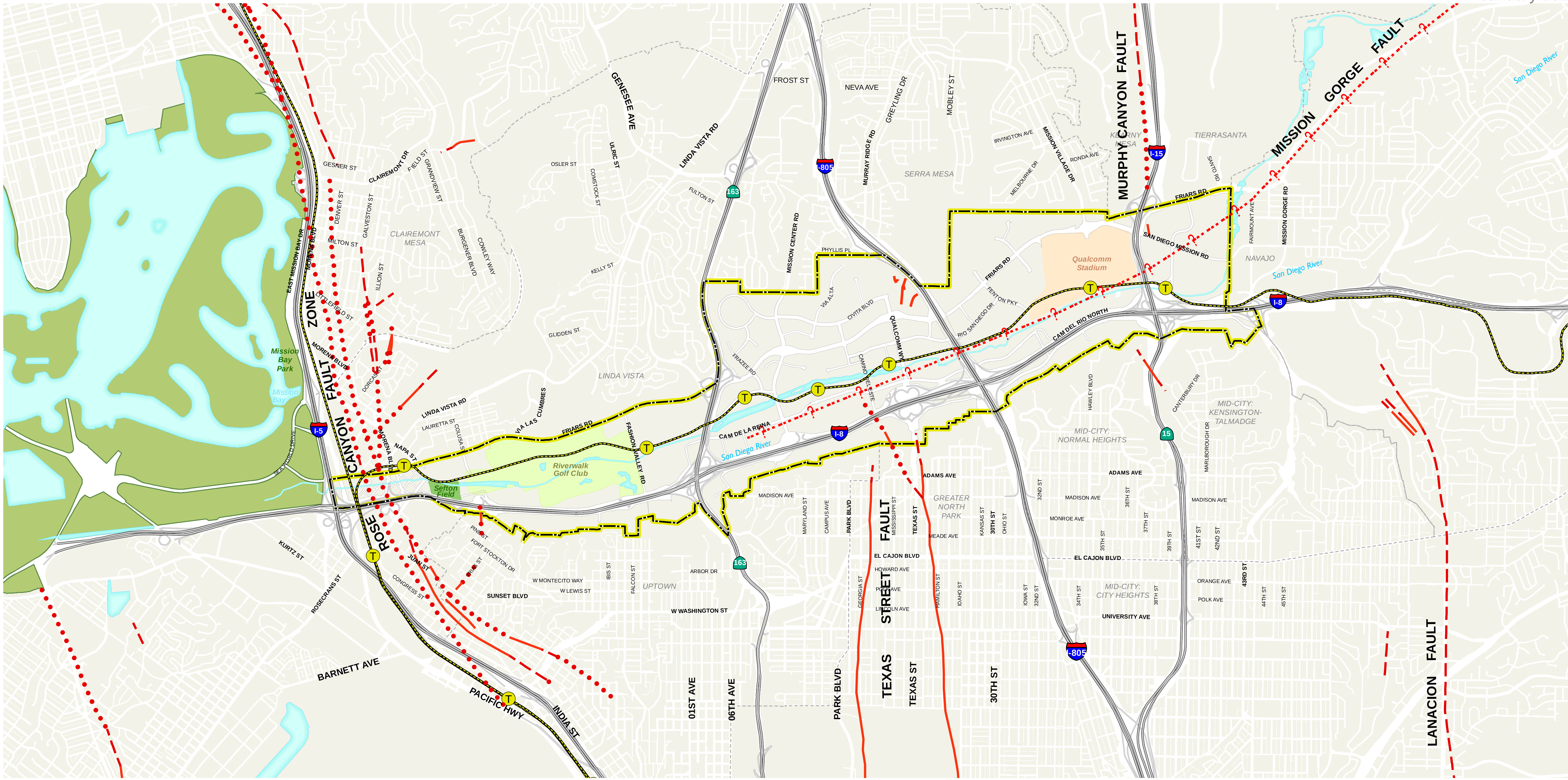
Data Source: City of San Diego, 2015; SANGIS Regional GIS Data Warehouse, 2015. (www.sangis.org)
Dyett & Bhatia, 2015

0 2,000 4,000 8,000 Feet

Fault Map

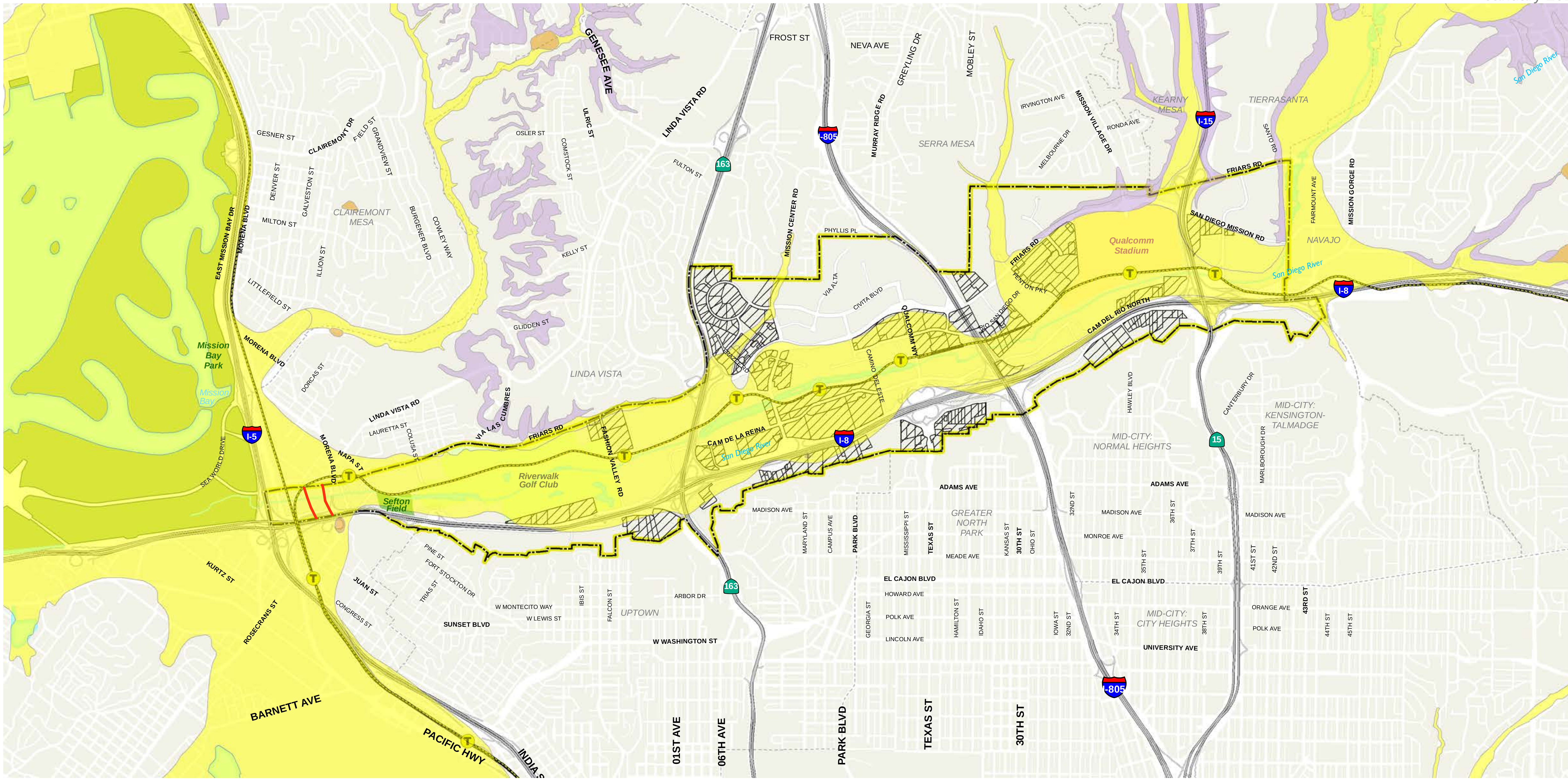


Trolley Stops
Ramps Bottomline
Streams/Creeks
Lakes/Ponds
Mission Valley Community Plan Boundary
Community Planning Areas
Fault
Inferred Fault
Concealed Fault
Uncertain Fault (queried as existence not conclusively established)

0 | 2,300 | 4,600 | 9,200 FEET

Data Source: City of San Diego, 2015; SANGIS Regional GIS Data Warehouse, 2015. (www.sangis.org)
Dyett & Bhatia, 2015

Geohazards Map



Trolley Stops

Ramps Bottomline

Streams/Creeks

Lakes/Ponds

Mission Valley Community Plan Boundary

Community Planning Areas

Active Fault

Landslides

Slide Prone Formations

Liquefaction

Areas with potential new construction and/or subject to new loads

0 2,000 4,000 8,000 FEET

Data Source: City of San Diego, 2015; SANGIS Regional GIS Data Warehouse, 2015. (www.sangis.org)
Dyett & Bhatia, 2015

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