5.2 GEOLOGY AND SOILS

1. INTRODUCTION

This section describes existing geologic conditions at the project site and applicable regulations related to geology and soils. The evaluation describes geologic hazards such as liquefaction, unstable soils, lateral spreading, soil erosion, water table conditions and activities associated with the implementation of the RAP with respect to such hazards. The analysis in this section is based on information provided in the City of Carson General Plan, Los Angeles County Building Code, and studies prepared for the Former Kast Site, including the Final Phase I Site Characterization Report, Excavation Pilot Tests, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slabs, Plume Delineation Report, and a Subsurface Drainage Study. These reports are referenced in Chapter 9 of this EIR and on file with the Regional Board.

2. ENVIRONMENTAL SETTING

Regulatory Framework

Federal Regulations

There are no applicable federal regulations. Geological conditions and soils-related effects, such as liquefaction, ground shaking, settlement, and earth movement are addressed through regulations set forth in State of California, Los Angeles County, and City of Carson codes and adopted plans.

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code Section 2621) was enacted by the State of California in 1972 to reduce the risk to life and property from surface fault rupture during earthquakes.[1] The Alquist-Priolo Earthquake Fault Zoning Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults. The act requires that development permits for projects in "Earthquake Fault Zones" be withheld until geologic investigations demonstrate that the sites are not threatened by surface displacement from future fault rupture. To be zoned under the Alquist-Priolo Earthquake Fault Zoning Act, a fault must be considered active, or both sufficiently active and well-defined. The California Geological Survey (CGS) defines an active fault as one that has had surface displacement within Holocene time (about the last 11,000 years); and a sufficiently active fault as one that has evidence of Holocene surface displacement along one or more of its segments or branches. The CGS considers a fault to be well defined if its trace is clearly detectable as a physical feature at or just below the ground surface.[2] The site is developed with residential uses and while no new habitable

[1] *The Act was originally entitled the Alquist-Priolo Geologic Hazards Zone Act.*

[2] *California Department of Conservation, California Geological Survey, Special Publication 42, Fault-Rupture Hazard Zones in California, Alquist-Priolo Special Studies Zone Act of 1972 with Index to Special Studies Zones Maps, 2007.*

structures are proposed by the project, the "Earthquake Fault Zones" maps help identify areas in the site vicinity where potential surface fault rupture hazards may exist.

Seismic Hazards Mapping Act

In order to address the effects of strong ground shaking, liquefaction, landslides, and other ground failures due to seismic events, the State of California passed the Seismic Hazards Mapping Act of 1990 (Public Resources Code Section 2690-2699). Under the Seismic Hazards Mapping Act, the State Geologist is required to delineate "seismic hazard zones." Cities and counties must regulate certain development projects within these zones until the geologic and soil conditions are investigated and appropriate mitigation measures, if any, are incorporated into development plans. The State Mining and Geology Board provides additional regulations and policies to assist municipalities in preparing the Safety Element of their General Plan and encourages land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety. Under Public Resources Code Section 2697, cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard. Each city or county shall submit one copy of each geotechnical report, including mitigation measures, to the State Geologist within 30 days of its approval. Under Public Resources Code Section 2698, nothing is intended to prevent cities and counties from establishing policies and criteria which are stricter than those established by the Mining and Geology Board.

State publications supporting the requirements of the Seismic Hazards Mapping Act include the California Geological Survey SP 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, and SP 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California*. The objectives of SP 117 are to assist in the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations and to promote uniform and effective statewide implementation of the evaluation and mitigation elements of the Seismic Hazards Mapping Act. SP 118 implements the requirements of the Seismic Hazards Mapping Act in the production of Probabilistic Seismic Hazard Maps for the State.

The California Geological Survey (CGS) is responsible for geologic hazard characterization, public education, the development of partnerships aimed at reducing risk, and exceptions (based on science-based refinement of tsunami inundation zone delineation) to state mandated tsunami zone restrictions. In California, each earthquake is followed by revisions and improvements in the Building Codes. The 1933 Long Beach Earthquake resulted in the Field Act, affecting school construction. The 1971 Sylmar Earthquake brought another set of increased structural standards. Similar re-evaluations occurred after the 1989 Loma Prieta Earthquake and 1994 Northridge Earthquake. These code changes have resulted in stronger and more earthquake resistant structures statewide.

In addition to the CGS, the State's Seismic Safety Commission, the Applied Technology Council, California Emergency Management Agency, United States Geological Survey, Cal Tech, the California Geological Survey as well as a number of universities and private foundations have undertaken a rigorous program to identify seismic hazards and risks including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Seismic hazard maps have been published and are available for many communities in California through the CGS.

Regional Regulations

Los Angeles County Manual for Preparation of Geotechnical Reports

The Los Angeles County Department of Public Works (LACDPW) Manual for Preparation of Geotechnical Reports ("Manual") (July 1, 2013) presents the requirements for geotechnical work within the County. Geotechnical reports that are required for grading plans must be coordinated with the LACDPW. The purpose of the Manual is to provide geotechnical consultants with the information necessary to prepare adequate and acceptable reports consistent with the County Code. Geotechnical reports must include recommendations and conclusions based on soil data, records, geologic conditions, and analysis of geotechnical hazards in relation to site development or remediation.

It is the responsibility of the soils engineer to review the project and determine what items must be covered (e.g. slope stability, collapsible soils, liquefaction, pile design, construction constraints, mitigation of effects to offsite property, etcetera) in the preparation of a geotechnical report. The report must demonstrate that property and public welfare will be safeguarded in accordance with current County Codes and policies. Provisions of the County Building Code Section 110.2 requires that the building site will be free of geotechnical hazards, such as landslide, settlement, or slippage, and that the proposed work will not adversely affect offsite property. County Building Code Section 111 requires the report contain a finding to show compliance with County Building Code Section 110.2. The County Building Code Section 111 statement must clearly make a finding regarding the safety of the site against hazard from landslide, settlement or slippage and a finding regarding the effect that the proposed work will have on the geotechnical stability of the area outside of the proposed work. The finding must be substantiated by appropriate data and analyses.

The County Building Code Section 111 statement is mandatory for all geotechnical reports except for reports prepared for tentative subdivisions and environmental impact reports. Although the 111 Statement is optional for these specific types of reports, there must be sufficient supporting information that demonstrates to the satisfaction of the Building Official or Public Works Land Development Division Subdivision Mapping Section (Subdivision Mapping Section) that the sites will be developable and that the required Building Code Section 111 Statement can be provided at a later stage of development.

Section 3.3.1.2 of the Manual specifically applies to geotechnical reports prepared for EIR's. According to this section, if a proposed development is identified to have potentially significant impacts and an EIR is required, impacts due to soils or geology issues must be addressed in an appropriate report (engineering geology, soils engineering, or geotechnical report). The report must be prepared to address all geotechnical issues that may affect the proposed development and its surroundings, including those identified in the Initial Study. The soils report must have sufficient data and analyses to support the recommendations provided by the soils engineer.

The findings in soils engineering and geotechnical reports submitted to the LACDPW must be based on the boring logs, trenches, pits, cone penetration test soundings (CPTs) and other subsurface explorations utilized to characterize the soil data, soil properties, and subsurface conditions. Descriptions of the subsurface conditions should be clear and consistent with the subsurface exploration and soil data collected. The logs of all subsurface explorations and subsurface data should be included within or appended to the report.

Los Angeles County Grading Guidelines

The Los Angeles County Grading Guidelines ("Guidelines") (January 1, 2008) provide information for the preparation and processing of grading permit applications. Portions of the grading code that are commonly encountered during the planning, permitting, and construction of grading work are presented therein in order to reduce unnecessary plan review time and construction delays. Also provided are referrals to other governmental agencies that may have an influence on the design and approval of a project. The information presented in the Guidelines does not presume to cover all the possible Code and ordinance requirements. The prospective owner and contractor may find it necessary to confer directly with the staff of Building and Safety Division or Land Development Division, of the LACDPW, for a specific project.

Los Angeles County Building Code

The Los Angeles County Building Code (LACBC) (Code of Ordinances Title 26), Appendix J, which is incorporated by reference in the City of Carson Municipal Code, sets forth regulations specific to grading. Section J101.5, Protection of Utilities, requires protection of utilities and Section J101.6, Protection of Adjacent Property, requires protection of adjacent property during excavation. Under this provision, no person shall excavate on land sufficiently close to the property line to endanger any public or private property without taking measures to support such property from settling, cracking, or other damage. Section J101.7, Storm Water Control Measures, requires that all precautionary measures necessary to protect adjacent water courses and public or private property from damage by erosion, flooding, and deposition of mud, debris, and construction-related pollutants originating from the site during grading and related construction activities shall be put into effect and maintained.

Under Section J103.1, Permits Required, no grading shall be performed without a permit from the Building Official. A separate permit shall be obtained for each site and may cover both excavations and fills and may cover both excavations and fills. Regular grading less than 5,000 cubic yards (CY) may require a licensed contractor if the Building Official determines that special conditions or hazards exist. Under Section J103.2, Exemptions, a grading permit is not required for excavations that do not exceed 2 feet in depth or 50 CY. Section J104.1, Submittal Requirements, requires that the grading plan show existing and finished grades, limits and depths of cut and fill, location of any buildings or structures within 15 feet of the proposed grading, contours, flow areas, and storm water provisions.

.Section J104.2.1 requires that grading in excess of 5,000 cubic yards (CY) shall be designated as "engineered grading." All engineered grading shall be performed in accordance with an approved grading plan and specifications prepared by a civil engineer, unless otherwise required by the Building Official. Section J104.1, Submittal Requirements, requires that the grading plan show existing and finished grades, limits and depths of cut and fill, location of any buildings or structures within 15 feet of the proposed grading, contours, flow areas, and storm water provisions.

Under Section J104.4, Liquefaction Study, a liquefaction study is not required where the Building Official determines from established local data that the liquefaction potential is low.

Sections J105.3, Field Engineer Inspection, and J105.4, Soils Engineer Inspection, require that the field engineer or soils engineer, respectively, provide on-site inspection of those parts of the grading within the engineer's area of technical specialty, which include setting of stakes, observation during grading, testing for required compaction and safety of structures due to any slippage or settlement of the completed grading, and ensure that conditions in approved engineering reports are implemented. Under Section J106.1, Maximum Cut Slope, the slope of cut surfaces shall be no steeper than safe for the intended use, and shall be no steeper than 2 units horizontal to 1 unit vertical (50 percent) unless the applicant furnishes a soils engineering report justifying a steeper report. The report must contain a statement by the soils engineer that the site was investigated and an opinion that a steeper slope will be stable and will not cause a hazard to public or private property, in conformance with the requirements of Section J111. Exceptions include a cut surface of 67 percent provided it is not intended to support structures, it is adequately protected against erosion, it is no more than 8 feet in height, and it is approved by the Building Official.

Section J107.4, Fill Material, provides standards for fill material and requires that fill shall not contain organic, frozen, or other deleterious materials. Section 107.5, Compaction, requires that all fill materials must be compacted to a maximum of 90 percent maximum density as determined by American Society for Testing and Materials (ASTM) D-1557, Modified Proctor, unless a lower relative compaction (not less than 90 percent of maximum dry density) is justified by the soils engineer and approved by the Building Official. Where ASTM D-1557, Modified Proctor, is not applicable, a test acceptable to the Building Official shall be used. Not less than 10 percent of the required density tests, uniformly distributed, shall be obtained by the Sand Code Method.

Section J108.1, Setbacks, requires that cut and fill slopes be set back from the property lines , a minimum of 2 feet and maximum of 20 feet unless substantiating data is submitted justifying reduced setbacks and if recommended in a soils engineering report approved by the Building Official. Under Section J108.4, Alternate Setbacks, the Building Official may approve alternate setbacks if it is determined that no hazard to life or property will be created or increased.

Under Section J111, National Pollution Discharge Elimination System (NPDES) Compliance, plans for all best management practices (BMPs) shall be provided and BMPs shall be installed before grading begins. As grading progresses, all best management practices shall be updated as necessary to prevent erosion and to control construction related pollutants from discharging from the site. Section J111.2, Storm Water Pollution Prevention Plan (SWPPP), if required, this plan details best management practices, including temporary drainage or control measures, or both, as necessary to control construction-related pollutants. Section J111.3, Wet Weather Erosion Control Plans (WWECP) is required if grading is not completed prior to November 1. The WWECP shall include specific best management practices to minimize the transport of sediment and protect public and private property from the effects of erosion, flooding, or the deposition of mud, debris or construction-related pollutants.

Section 1805.3.2, Footing Setback from Descending Slope Surface, requires that footings on or adjacent to slope surfaces shall be founded in firm materials with an embedment or setback from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Footing shall be places into firm natural material and located a minimum of 5 feet from the slope surface. Section 1805.3.5, Alternate Setback and Clearance, allows the Building Official to approve alternate setbacks and clearances if safety consistent with the Code is demonstrated by a soils engineer. Such investigation shall include the type of material, height of slope, slope-gradient, load intensity, and erosion characteristics of the slope materials. Where adverse geological, soil, and drainage conditions exist, the Building Official may require increases in setbacks and clearances.

Local Regulations

City of Carson Natural Hazards Mitigation Plan

The City of Carson Natural Hazards Mitigation Plan (adopted July 5, 2012) includes resources and information to assist City residents, public and private sector organizations, and others interested in participating in planning for natural, man-made, and technological hazards. The Mitigation Plan provides a list of activities that may assist the City of Carson in reducing risk and preventing loss from future hazard events.

The action items address multi-hazard issues, as well as activities for Earthquake, Flood, and Windstorm. The mission of the City of Carson Mitigation Plan is to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the City in creating a more sustainable community. Policies applicable to geologic hazards include EQ-1 and EQ-12, which are to integrate mapping of existing and new earthquake hazards to and improve technical analysis of earthquake hazards.

Implementation through existing programs: The City of Carson addresses statewide planning goals and legislative requirements through its General Plan, Capital Improvement Plans, and City Building and Safety Codes. The Natural Hazards Mitigation Plan provides a series of recommendations, many of which are closely related to the goals and objectives of existing planning programs. The City of Carson will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

Some of the goals and action items in the Mitigation Plan may be achieved through activities recommended in the City's Capital Improvement Program (CIP). Various city departments develop the CIP and review it on an annual basis. Upon annual review of the CIP, the Public Safety Commission will work with the city departments to identify areas that the Mitigation Plan action items are consistent with CIP goals and integrate them where appropriate.

City of Carson General Plan Safety Element

City of Carson General Plan Safety Element (adopted October 11, 2004) evaluates natural and man-made hazards that have the potential to endanger the welfare and safety of the general public and aims to reduce the potential risk of death, injuries, property damage and the economic and social dislocation resulting from them. The potential threat from natural and man-made hazards can pose significant danger to a community. The Safety Element identifies flooding, seismic activity, geology, soils and wind as natural hazards for the City. Man-made hazards involve hazardous materials, transportation, oil production facilities, civil unrest, national security emergencies and terrorism. The concerns identified in the Safety Element are subsequently incorporated into goals, policies and implementation actions to reduce the impacts of hazards. The Safety Element addresses the existing conditions of these hazards and programs currently in place to address them (Safety Element, page 4).

Goal SAF-1: Minimize the risk of injury, loss of life, and property damage caused by earthquake hazards.

- Policy SAF-1.1 Continue to require all new development to comply with the most recent City Building Code seismic design standards.
- Policy SAF-1.2 Work with the City's Public Information Office and Public Safety Division to:
  - Educate residents in earthquake safety at home,
  - Educate the public in self-sufficiency practices necessary after a major earthquake (e.g., alternative water sources, food storage, first aid, family disaster plans, and the like), and
  - Identify locations where information is available to the public for planning self-sufficiency.
- Policy SAF-1.3 Examine the potential to create a commercial loan program to subsidize the cost of retro-fitting buildings to meet seismic safety regulations. To this end, pursue all sources of state and federal funding in order to retro-fit buildings to meet seismic requirements.

Implementation Measure SAF-IM-1.1: Apply City Building Code consistently to all development. *(Implements SAF-1.1)*

City of Carson Municipal Code

The City of Carson Municipal Code (CMC) primarily incorporates by reference the building requirements of the Los Angeles County Code (Title 26, Appendix J) regarding grading, soils, and geologic issues. However, additions to Title 26, Appendix J under the Municipal Code are also applicable to grading operations. These include Division 6, Project Grading, Sections 9166.1 and 9166.2. Under these code sections, a project requiring the removal of more than 10,000 CY of soil and if more than 20 occupied dwelling units are located within a parallel corridor 300 feet wide on each side from the edge of a transport route, grading shall not be permitted unless either of the following is provided:

A. A Conditional Use Permit is obtained, or

B. A plot plan is submitted to the director, who shall approve the plan upon finding that the proposed project grading will comply with the requirements of this Division.

Section 9166.2 sets forth specific conditions for grading, including the following:

A. A grading permit, when required, shall first be obtained as provided in the Building Code before the commencement of any project grading.

B. The application to the Director or for a Conditional Use Permit, as the case may be, shall contain statements setting forth the following information:

1. The names and addresses of all persons owning all or any part of the property from which such material is proposed to be removed and to which such material is proposed to be transported.

2. The names and addresses of the person or persons who will be conducting the operations proposed.

3. The proposed ultimate use of the lot.

4. Such other information as the Director finds necessary in order to determine whether the application should be granted.

5. In the case of an application for a Conditional Use Permit, the information required pursuant to CMC 9172.21(A) and 9173.1.

C. The applicant shall submit a map showing in sufficient detail the location of the site from which such material is proposed to be removed, the proposed route over streets, and the location to which such material is to be imported.

D. All hauling as approved under this Section shall be restricted to a route approved by the Director of Public Works.

E. Compliance shall be made with all applicable requirements of the City and other governmental agencies.

F. If any condition of this Section is violated, or if any law, statute or ordinance is violated, the privileges granted herein shall lapse and such approval shall be suspended.

G. Neither the provisions of this Section nor the granting of any permit provided for in this Division authorizes or legalizes the maintenance of a public or private nuisance.

Existing Conditions

Regional Geological Setting

The City of Carson is situated in the northern part of the physiographic basin known as the Los Angeles Basin, or the Coastal Plain of Los Angeles and is located within the northerly end of the Peninsular Ranges geomorphic province. The Peninsular Ranges province extends from the Los Angeles Basin south of the Santa Monica Mountains to the tip of Baja California.

Geologically, the Basin consists of a very thick sequence of unconsolidated marine and continental sediments overlying consolidated sedimentary rocks that range in age from a few thousand years to tens of million years. Geologic units of the northern Peninsula Ranges province consist of Jurassic and Cretaceous age basement rocks overlain by as much as 32,000 feet of marine and non-marine sedimentary strata ranging in age from the late Cretaceous to Holocene epochs. The north, west, and southern portions of Carson is underlain by stream Quaternary Non-marine Terrace Deposits (Qt). The central and southeastern portion of the City of Carson is directly underlain by Holocene age alluvial (Qal) deposits of the Downey Plain and Dominguez Gap. The alluvial deposits are composed of poorly consolidated sand, silt, clay, and gravel.

This geomorphic province is characterized by elongated northwest trending mountain ranges separated by straight-sided sediment floored valleys. The most prominent landforms features within the City are the Dominguez Hills, which represents the central portion of the Newport-Inglewood fault zone (or uplift), and the Dominguez Gap, which characterize the area's northwest-trending faults and folds. The latter include the Newport-Inglewood fault zone, the Paramount syncline, the Dominguez anticline, the Gardena syncline, the Wilmington anticline, and the Wilmington syncline.

Earthquake Fault Zones

Several major faults that could affect the greater Los Angeles region and the Carson area are identified in the City of Carson General Plan Safety Element and Natural Hazards Mitigation Plan. Fault zones in the region are illustrated in **Figure 5.2-1,** *Southern California Earthquake Faults.* These include the following fault zones that are identified in the Safety Element and Natural Hazards Mitigation Plan as having the greatest potential effect on the City of Carson:

- Avalon-Compton/ Newport Inglewood Fault Zone
- San Andreas Fault Zone
- Palos Verdes Fault Zone
- Whittier Fault Zone
- Santa Monica Fault Zone

The Avalon-Compton Fault Zone, which is part of the Newport-Inglewood Fault Zone, is the only active fault in the City of Carson. The Avalon-Compton fault is located immediately east of Avalon Boulevard and north of the Artesia Freeway (SR-91), approximately five miles to the north of the site. Historically, the Avalon-Compton fault and regional shear zone has moderate to high seismic activity with numerous earthquakes greater than Richter magnitude four. The Newport-Inglewood fault extends from the southern edge of the Santa Monica Mountains southeastward to an area offshore of Newport Beach. This zone commonly referred to as the Newport-Inglewood uplift zone, can be traced at the surface by following a line of geomorphically young anticlinal hills and mesas. These hills and mesas include the Baldwin Hills, Dominguez Hills, Signal Hill, Huntington Beach Mesa and Newport Mesa.

Earthquake focal mechanisms (seismic locaters) for 39 small earthquakes (1977 to 1985) show faulting along the north segment (north of Dominguez Hills) and along the south segment (south of Dominguez Hills to Newport Beach). The 1933 Long Beach earthquake has been attributed to movement on the Newport-Inglewood fault zone. Based on historic earthquakes, the fault zone is considered active. The Newport-Inglewood fault zone (outside of the Avalon-Compton Fault Zone) is considered capable of generating a maximum credible earthquake of a magnitude 7.0 on the Richter Scale.

The San Andreas Fault Zone is California's most prominent structural feature, trending in a general northwest direction for almost the entire length of the state. The southern segment is approximately 280 miles long. It extends from the Mexican border into the transverse ranges west of Tejon Pass. Along this segment, there is no single traceable fault line; rather, the fault is composed of several branches. The fault is considered capable of generating a maximum credible earthquake of magnitude 8.25 on the Richter Scale.

The Palos Verdes Fault Zone is located southwest of the City of Carson and is traceable in the subsurface along the northern front of the Palos Verdes Hills. Offshore data, consisting of acoustic and reflection profiles, suggests very recent movement along the Palos Verdes Fault.

The Whittier Fault Zone (Elysian Park Structure) is the source of the 1987 Whittier Narrows earthquake (Richter magnitude 5.9). The earthquake has been attributed to subsurface thrust faults (a low angle reverse fault) that are reflected at the earth's surface by a west-northwest trending anticline known as the Elysian Park Anticline, or the Elysian Park structure. The subsurface faults that create the structure are not exposed at the surface, and do not present a potential surface rupture hazard. However, as demonstrated by the 1987 earthquake and two smaller earthquakes on June 12, 1989, the faults are a source of future seismic activity. As such, the structure should be considered an active feature capable of generating future earthquakes.

The Santa Monica Fault Zone is an east-west trending left reverse fault that extends approximately 24 kilometers within the immediate vicinity of Pacific Palisades, Westwood, Beverly Hills and Santa Monica. Annual slip rate is estimated between 0.27 mm and 0.39 mm per year along the fault. The fault is considered capable of generating an earthquake between a 6.0 to 7.0 on the Richter scale.

The Uniform California Earthquake Rupture Forecast (UCERF) published in 2007 estimated that California has a 99.7 percent chance of having a magnitude 6.7 or larger earthquake during the next 30 years.[3] The likelihood of an even more powerful quake of magnitude 7.5 or greater in the next 30 years is 46 percent. Based on the UCERF, the probability of a magnitude 6.7 or larger earthquake over the next 30 years striking the greater Los Angeles area is 67 percent. For the entire California region, the fault with the highest probability of generating at least one magnitude 6.7 quake or larger is the southern San Andreas Fault.

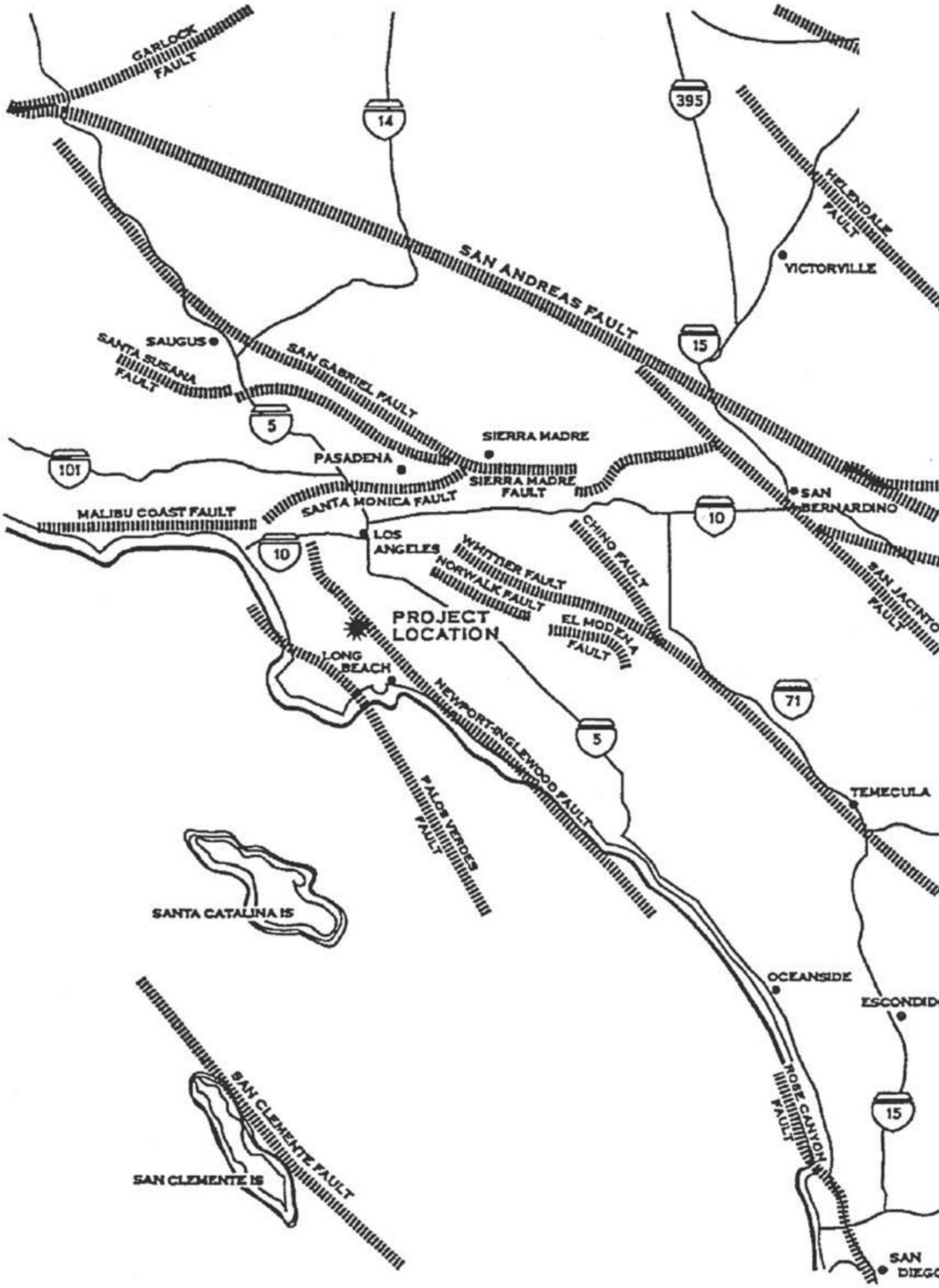
Secondary Seismic Hazards

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake. Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake and the primary cause of earthquake damage. Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Many communities in Southern California have a high likelihood of encountering such risks, especially in areas with steep slopes.

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures. Basic conditions necessary for liquefaction are soil conditions conducive to liquefaction, saturation of these materials by water, and a source of shaking. The Newport-Inglewood fault zone is a potential source of

3 *United States Geological Survey, Uniform California Earthquake Rupture Forecast (UCERF) II, 2007.*



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Southern California Earthquake Faults

Former Kast Property Tank Farm Site Remediation Project

Source: General Plan Safety Element, SAF-3, 2002.

FIGURE

5.2-1

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ground stress, and liquefaction could occur in the City of Carson if the groundwater table were high enough during an earthquake. Due to existing conditions in the City, particularly in the alluvial and former slough areas, there is the possibility that liquefaction could impact buildings and other structures in the event of an earthquake. **Figure 5.2-2,** *Liquefaction Areas - City of Carson,* shows the areas in the City which have shown historical occurrence of liquefaction, or areas in which local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements. Liquefaction can result in the shifting of foundations, settling of roadways and rupture of underground pipelines and cables. Buildings and other objects on the ground surface can settle, tilt and collapse as the foundations beneath them lose support, and lightweight buried structures may float to the surface. A significant portion of the City has been designated as potential liquefaction area and geotechnical investigation reports are required as part of the environmental and building permit processes for most development within these areas.

Ground cracking, ground lurching and lateral spreading are secondary features resulting from strong to moderately strong ground shaking and may be associated with liquefaction. Ground cracking usually occurs in near-surface materials, reflecting differential compaction or liquefaction of underlying materials. The potential for ground cracking exists especially in those areas of the City that have a moderate to high potential for liquefaction. Ground lurching results when soft, water-saturated surface soils are thrown into undulatory motion. Lateral spreading (a form of landsliding) is referred to as limited displacement ground failure, often associated with liquefaction. Compact surface materials may slide on a liquefied or low shear strength layer at a shallow depth, moving laterally several feet down slopes of less than two degrees. Such a condition may be present where conditions conductive to shallow liquefaction exist. Because liquefaction has a low potential of occurrence at the project site, these conditions are not anticipated.

Amplification can occur when soils and soft sedimentary rocks near the earth's surface modify ground shaking caused by earthquakes. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk. Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

The historic withdrawal of oil has been known to cause subsidence in portions of the Wilmington oil field, which is located within the City of Carson. Subsidence extended along the Newport-Inglewood structural zone between Signal Hill and the Port of San Pedro on the south and Redondo Beach on the north. Total subsidence reached a maximum of 29 feet over the crest of the Wilmington anticline, where most of the oil had been withdrawn. There is no documented ground subsidence associated with the Dominguez oil field, also located in the City. By the early 1980s, water injection halted subsidence at the oil fields and, subsequently, no further subsidence has been documented.

Soil Characteristics

Other geologic hazards that have the potential to occur in and around the City of Carson include differential settlement, subsidence, and shrink/swell potential. Differential settlement occurs in loose, cohesionless sediments where differences in densities in adjacent materials lead to different degrees of compaction during ground shaking. In the case of saturated cohesionless sediments, post-earthquake settlement may occur when excess pore-water pressures generated by the earthquake dissipate. Given the lateral and vertical variation of the alluvial soils underlying Carson, differential settlement could occur as a result of an earthquake in areas thought to have a low susceptibility to settlement. According to the EIR prepared for the

City of Carson General Plan, the unstable sub-base of sandy soil in the alluvial deposits underlying the central and southeastern portions of the City, and Quaternary non-marine terrace deposits underlying the northern, western and southern portions of the City, Carson (as well as the entire South Bay area) is regarded as one of the most severe shock areas in the Los Angeles area.[4] The significance of the hazard at any particular site would be determined by soils investigations. Differential compaction resulting from earthquake ground shaking is potentially damaging to structures and buried utilities and services.[5]

The shrink/swell characteristics of soils in the City of Carson are another geotechnical constraint. Soils with a high clay content typically have high shrink/swell characteristics. Shrinking and swelling of soil can cause overlying concrete to crack and settle. In addition, soils with high percentages of sand have a moderate to high potential for erosion. **Table 5.2-1**, *General Physical Characteristics of Soils in the Carson Area*, describes the various soils types within the Carson area.

Table 5.2-1

General Physical Characteristics of Soils in the Carson Area

Soil Association	Soil Type	Depth	Slope	Erosion Potential	Shrink-Swell Potential
Oceano	Sand	60 inches	2-5 percent	Mod-High	Low
Netz-Cortina	Fine sand and fine sandy loam	60 inches	0-5 percent	Lo-Mod	Low
Hanford	Sandy loam	60 inches	2-5 percent	Low	Low
Yolo	Silty loam	60 inches	0 percent	Low-Mod	Mod
Chino (in inclusions of the Forster and Grangeville Associations)	Clay loam	60 inches	0 percent	Low	Mod
Ramona-Placenta	Sandy loam	18-60 inches	2-5 percent	Low-Mod	High

Source: City of Caron General Plan Safety Element, Table SAF-1.

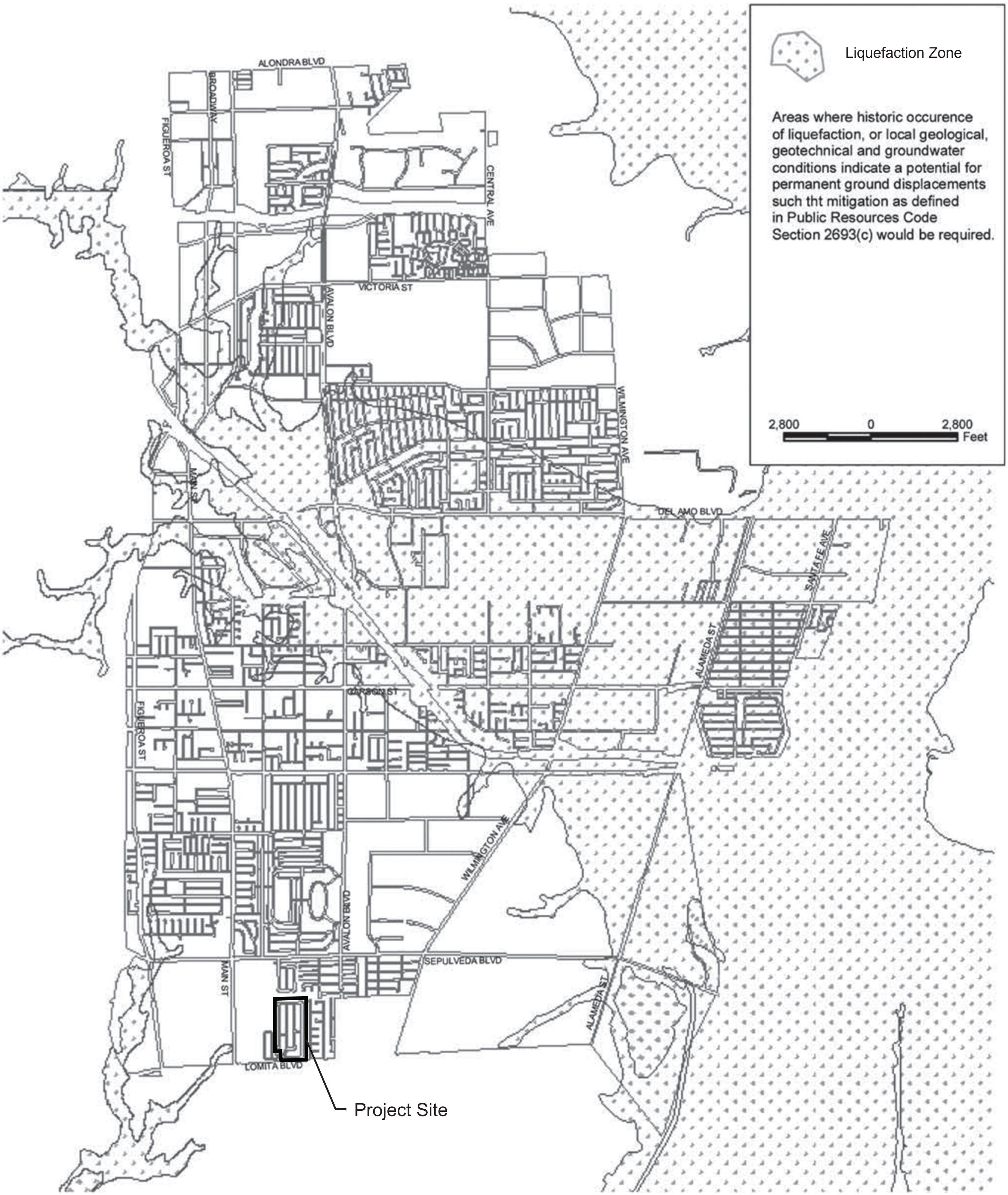
On-Site Geologic Setting

Historical Setting

Based on historical records, the former Kast Tank Farm that occupied the site consisted of three crude oil reservoirs. Oil was pumped into the reservoirs and withdrawn from the reservoirs via pipelines that ran north-south along the western site property line and east-west along what is now Lomita Boulevard.

4 *City of Carson General Plan Environmental Impact Report, Chapter 4.6, Geologic and Seismic Hazards, October 30, 2002, page 4.6-6.*

5 *Ibid.*



Liquefaction Areas - City of Carson

FIGURE **5.2-2**

Former Kast Property Tank Farm Site Remediation Project

Source: General Plan Safety Element, SAF-3, 2002.

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Pipelines are believed to have entered the property from Lomita Boulevard near what is now Neptune Avenue in a northward direction and ran to the pump house.

The reservoirs had reinforced concrete-lined floors with reinforced concrete-lined earthen berms forming sloped side walls and wood frame roofs supported by wooden posts and/or concrete pedestals. The concrete floors of the reservoirs were approximately 7 to 10 feet below current site grade, and the surrounding earthen walls were described as "generally about fifteen feet in height."[6] The reservoirs had depths of approximately 20 to 25 feet from the top of the berms. The sloped side walls of the reservoir berms were approximately 1.5:1 horizontal to vertical. The bottom and sides of the reservoirs were reportedly lined with a 4 to 5-inch thick reinforced concrete slab and there were also 1- to 15-foot high containment berms surrounding the property.

The concrete bases of the reservoirs were either partially removed from the site or abandoned in place. Following the removal of residual fluids from the reservoirs, trenches were cut into the concrete reservoir bases so that the reservoirs would not pond water and adversely affect drainage/infiltration for the subsequent residential lots. According to soils reports,[7,8] trenches approximately 8 inches wide were cut or punched into the concrete reservoir bases in concentric rings radiating from the center at 15-foot intervals. According to the geotechnical report for the southeastern reservoir (Reservoir No. 6), "nearly 6,000 lineal feet of trench were punched through the concrete floor using a truck mounted rig."[9] Concrete from the trenches was reportedly removed to promote infiltration and mitigate ponding of water. However, other documentation exists that indicate trenches in the reservoir bases were ripped in parallel lines rather than concentric rings.[10] The concrete from the reservoir side walls was reportedly mixed with soil before being placed in a single layer within the lower 1 foot of fill upon the base of the reservoirs where it was watered and compacted in place.[11] As discussed in the 1966 geotechnical report prepared for Lomita Development by Pacific Soils Engineering, the Los Angeles County Building and Safety Code required a minimum of 7 feet of fill soil to be placed over the concrete. The report recommended that "no concrete shall be placed within 7 feet of finished grade."[12]

The Pacific Soils Engineering geotechnical report for Reservoir No. 5 indicates that the westernmost portion of the concrete reservoir base in Tract 24836 along Marbella Avenue was entirely removed from the Site during demolition. Because the eastern edge of Tract 24836 is along the back property line of properties on the east side of Marbella Avenue, the concrete reservoir base for Reservoir No. 5 would have been removed from beneath lots on the east side of Marbella Avenue but not beneath properties on the eastern half of the

6 *Pacific Soils Engineering, Inc, 1966, quoted in URS Corporation, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slab, Former Kast Property, Carson, CA, June 28, 2013, page 2-1.*

7 *Ibid.*

8 *Pacific Soils Engineering, Inc, July 31,1967. Re: Tract No. 28441, Lots 7-10 inclusive in the County of Los Angeles, California*

9 *URS Corporation, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slab, Former Kast Property, Carson, CA, June 28, 2013, page 2-4.*

10 *Ibid.*

11 *Ibid.*

12 *Ibid.*

block that front on Neptune Avenue. Trenches were cut in the remaining portion of the concrete base of Reservoir No. 5, similar to the other reservoirs.[13]

Testimony received from a prior project engineer indicated "there was enough soil in the berms to cover all of the reservoirs and bring the Property surface up to street level without importing any soil. Therefore, no soil was brought on to the property to cover the three reservoirs."[14]

Existing Geologic Setting

Geophysical and Soils Conditions

The Avalon-Compton Fault Zone, which is part of the Newport-Inglewood Fault Zone, is located approximately 5 miles to the north of the project site, is the only active fault in the City of Carson and the nearest fault zone to the project site. As illustrated in Figure 5.2-2, the areas designated as having high liquefaction potential in the City are located to the east of the site, to the east of Wilmington Avenue and to the west of the site to the west of Main Street and do not underlie the project site.

The current site ground surface elevation ranges from approximately 44.5 feet above mean sea level (amsl) at the intersection of Panama Avenue and 249th Street in the southeast corner of the Carousel Tract to 32.5 feet amsl near the intersection of Marbella Avenue and 244th Street near the northwest corner of the tract. The site was graded to slope to the northwest to promote drainage during rough grading after demolition of the reservoirs.

Based on site investigations, the upper 10 feet of soil beneath the site is dominantly fine grained and consists of silt with layers or lenses of silty fine sand. Soils between 10 and 15 feet bgs consist primarily of silt and silty fine sand. From 15 to 85 feet bgs site soils consist of fine sands to silty fine sand. Soils encountered between 85 and approximately 180 feet bgs consist of silt, silty sand, and fine to medium sand. The shallowest groundwater encountered beneath the site occurs within the Bellflower aquitard, an overall fine-grained unit that locally has sandy intervals. First groundwater occurs at a depth of approximately 53 feet beneath the site, with a groundwater flow direction to the northeast.

Field investigation and borings performed on the site in the 1960s determined that the site is underlain by relatively uniform soils. All soils were found to be in a dense state and suitable to receive fill. Generally, the first 3 feet of soils tended to be silty and clayey sands. Underlying soils ranged from fine to medium sands. [15] The geotechnical report determined that surface soils in all borings except Borings 1 and 2 were in a dense state and suitable for foundation purposes. The surface soils encountered in Borings 1 and 2 were lean sands in a soft, saturated state and the geotechnical report stated that "similar soils can be expected to exist in the northwest corner of the site due to the presence of an old watercourse as disclosed by aerial

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[13] *Pacific Soils Engineering quoted in URS Corporation, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slab, Former Kast Property, Carson, CA, June 28, 2013, page 2-4.*

[14] *Leroy H. Vollmer (Vollmer Engineering) signed Declaration September 9, 2011, quoted in URS Corporation, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slab, Former Kast Property, Carson, CA, June 28, 2013, page 2-4.*

[15] *Pacific Soils Engineering, Inc, Work Order 6164, March 11, 1966, page 2.*

photographs taken prior to the construction of the reservoirs."[16] In their former state, these soils were unsuitable for foundation purposes. The geotechnical report required that soft, compressible materials, such as those encountered in Borings 1 and 2, be processed and compacted to a depth of four feet. According to the 1966 Pacific Soils geotechnical report, the resulting material would have a minimum relative capacity of 90 percent in accordance with the County Building Code[17]

Soils underlying the lean sands at a depth ranging from 10 to 15 feet were clean, dense to fine to medium sands. The moisture content decreased with depth and no groundwater was observed. The soils encountered on the tract were found to be non-expansive by both Los Angeles County and (Federal Housing Administration (FHA) criteria. A boring capacity of 1500 lbs/sq. ft. was recommended for structures founded in compacted fill or firm natural ground to a depth of one foot.[18]

Because no new soils were brought to the site when it was mass graded in 1966 (subsequent to the 1966 geotechnical report), it is likely that soils present in 1966 were spread over the property and are present in existing boring examples. According to 2009 borings, the upper 5 feet of soil encountered in the explorations was generally uniform, consisting of dark gray to dark grayish brown silt which was moist and generally included shell fragments. Much of the upper 5 feet of soil was observed to have hydrocarbon odor and staining. From 5 to 10 feet bgs, soils consisted primarily of silt, with occasional layers or lenses of silty fine sand. Hydrocarbon staining and odor were also generally observed at this depth interval. Based on a review of the boring logs and cone penetrometer test (CPT) logs, soils between 10 and 15 feet bgs consisted primarily of light olive to olive silts and silty fine sand. Lithology from 15 to 85 feet bgs consisted primarily of alternating fine sands to silty fine sand. The estimated percentage of fine soils varied from less than 5 percent to greater than 30 percent. Occasional silty deposits were encountered, approximately 1 to 8 feet thick. Groundwater was encountered between 53 and 64 feet bgs. Hydrocarbon staining and/or odor were noted in ten of the 20 locations drilled to depths beyond 15 feet bgs. The deepest staining observed was at approximately 65 feet bgs in the boring drilled for monitoring well MW-2.[19]

In the 2009 study, soil samples were recovered at approximately 3 feet, and every 2.5 to 5 feet thereafter with a Modified California split-spoon soil sampler. Bulk samples were taken from the upper 5 feet of each boring. Representative samples were placed in sealed containers and transported for testing. In boring logs for the 24612 Neptune Avenue site, Boring N24612G1, the subsurface soils consist of silty sand and very stiff sandy clay fill soils to a depth of 8.5 feet. Concrete slabs approximately 6-inches thick were encountered at depths of 7 and 8.5 feet bgs. A layer of very stiff lean clay was present between the slabs. The concrete slab at a depth of 8.5 feet was underlain by loose to very dense silty sand alluvium to a depth of approximately 17.5 feet. This layer is underlain by hard lean clay to approximately 22.5 feet. A layer of dense, silty sand is present from 22.5 feet to the maximum explored depth of 25.5 feet. In Boring N24612G2, the subsurface soils consist of medium dense clayey sand fills to a depth of 7.5 feet. A concrete slab approximately 6 inches thick was encountered at 7.5 feet. A layer of medium dense silty sands and poorly graded sand with silt (alluvium) was encountered below the concrete slab to a depth of 16 feet, underlain by hard lean clay to a depth of 22.5 feet. A layer of dense, silty sand is present from 22.5 feet to the maximum explored depth of

[16] *Pacific Soils Engineering, Inc, Work Order 6164, January 7, 1966, page 2.*

[17] *Pacific Soils Engineering, Inc, Work Order 6164, January 7, 1966, page 3.*

[18] *Pacific Soils Engineering, Inc, Work Order 6164, January 7, 1966, page 2.*

[19] *URS Corporation, Final Phase I Characterization Report, Former Kast Property, Carson, CA, October 15, 2009, page 4-1.*

25.5 feet. Groundwater was not encountered in any of the borings drilled to the maximum depth of 25.5 feet.[20]

Based on the review of environmental boring logs for the 24533 Ravenna Avenue site, the geotechnical report concluded that subsurface soils consist of sandy silt and silty sand to the explored depth of 10 feet. Groundwater was not encountered in the environmental borings drilled to the depth of 10 feet. Groundwater table monitoring from October through December 2011 at the site indicated that groundwater was at an elevation of 20 feet which corresponds to approximately 63 feet bgs.[21]

Subsurface Concrete Slabs

In order to locate concrete slabs buried on site, more than 2,400 soil borings were performed at 265 of the 285 properties in the Carousel Tract, with an average of approximately nine borings per property. The target completion depth for these borings is 10 feet bgs, which is the approximate upper end of the depth of burial range of the concrete reservoir slabs.

Figure 5.2-3, *Boring Refusal Map***,** outlines properties where "refusal"[22] was not encountered and shows refusal depths in increments for locations where borings were terminated due to an encountered object. Front and back yards are shown individually where refusal conditions differed between front and back yards. This figure shows a strong correspondence between boring refusal at depths ranging from 7.1 and 10 feet bgs and the outlines of the reservoir bases.[23]

Boring refusal at depths ranging from 0.1 to 5 feet (shaded green and yellow on Figure 5.2-3) is interpreted to be due to encountering rocks or other debris and not the reservoir base. Locations where refusal was encountered at depths ranging from 5.1 to 7 feet bgs are highlighted in orange on Figure 5.2-3, and locations where refusal occurred at depths of 7.1 to 10 feet bgs are shown in light blue. At a small number of locations, refusal was encountered at depths of greater than 10 feet bgs; these are shown in purple. At 133 of the 265 properties that have had residential soil sampling, borings were advanced to the target depth of 10 feet bgs and refusal was not encountered. This means that refusal was encountered at 132 properties in one or more borings at depths ranging from less than 1 foot to 12 feet bgs.[24]

In the area of northern Reservoir No. 7, refusal was encountered in borings at more than half of the properties located partially or completely within the inner ring interpreted to indicate the margins of the base of the reservoir. Refusal was more frequent in the western one-third of the reservoir and less frequent in the eastern one-third of the reservoir, consistent with site grade sloping to the northwest corner of the site and lower elevations in this area resulting in shallower depth of burial. At the majority of lots within the

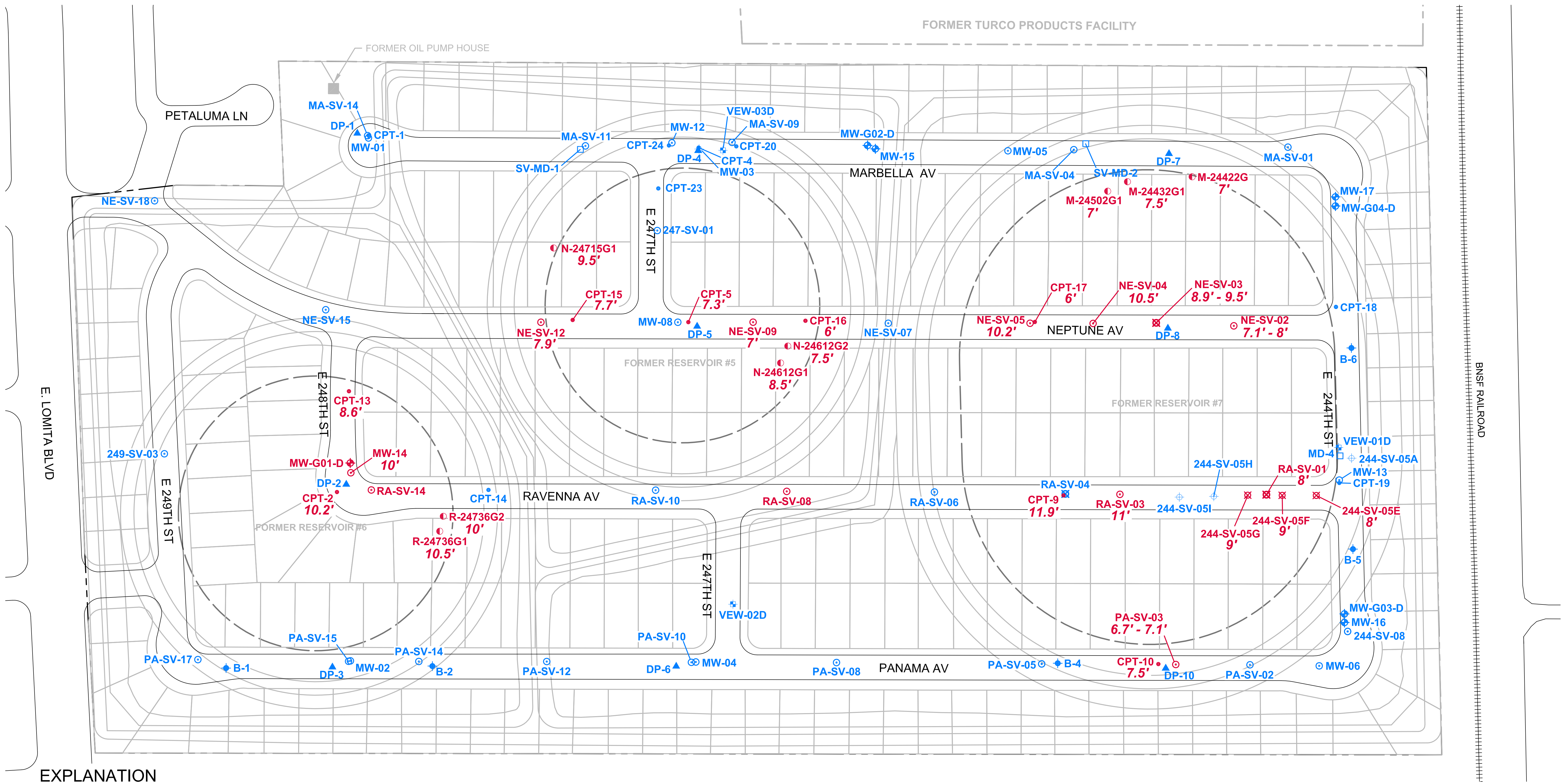
[20] *URS Corporation, Geotechnical Report, Planned Pilot Test for Remedial Excavation and Backfill Placement, 24612 Neptune Avenue, Carson, CA, March 29, 2012, page 4-1.*

[21] *URS Corporation, Geotechnical Report, Planned Pilot Test for Remedial Excavation and Backfill Placement, 24533 Ravenna Avenue, Carson, CA, April 13, 2012, page 2-1.*

[22] *"Refusal" is an obstruction of a boring, which may be caused by concrete slabs or other features, such as stones or other rubble.*

[23] *URS Corporation, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slab, Former Kast Property, Carson, CA, June 28, 2013, page 2-5.*

[24] *URS Corporation, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slab, Former Kast Property, Carson, CA, June 28, 2013, page 2-6.*



EXPLANATION

- LOCATION OF GROUNDWATER MONITORING WELL
- LOCATION OF CPT/UVOST SOUNDING
- LOCATION OF 10-FT BGS SOIL VAPOR PROBE
- LOCATION OF 15-FT AND 20-FT BGS SOIL VAPOR PROBE
- LOCATION OF DIRECT-PUSH BORING
- LOCATION OF MULTI-DEPTH SOIL VAPOR PROBE
- APPROXIMATE LOCATION OF PILOT TEST GEOTECHNICAL BORING
- LOCATION OF SVE EXTRACTION WELL
- ADVANCED TO ≥10' BGS WITHOUT REFUSAL NOTED ON BORING LOGS OR IN FIELD NOTES
- REFUSAL AT ≤10' BGS NOTED ON BORING LOGS OR IN FIELD NOTES WITH DEPTH OF REFUSAL NOTED
- APPROXIMATE PROPERTY LINE

N 0 140 Feet

PCR

Boring Refusal Map

Former Kast Property Tank Farm Site Remediation Project

Source: URS Corporation, Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slabs, 2013.

FIGURE 5.2-3

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area of the footprint of the northern reservoir base, refusal was encountered at depths of 7.1 to 10 feet bgs. Refusals at the upper end of this depth range are interpreted to be due to the reservoir slab; refusals at shallower depths are potentially the result of encountering buried concrete rubble or concrete pedestals that were placed within the lower part of the fill section in this part of the site during grading by the developer.[25]

All of the properties investigated that are within the footprint of the base of Reservoir No. 5, the central reservoir, encountered refusal at depths of 10 feet or less. Refusal was encountered at properties along the eastern side of Marbella Avenue. At properties along Neptune Avenue, refusal was encountered at depths of 10 feet or less in all borings located within the footprint of the former reservoir based on historical drawings. Boring refusal was encountered less frequently in the area of southern Reservoir No. 6, and where refusal was encountered it occurred in a fraction of the borings at individual properties. This is not unexpected, as the site elevation is highest in this portion of the Tract due to rising topography to the northwest.[26]

The results of the site assessment suggest that concrete slabs are present within the soil profile. Due to the potential adverse effects of the impact of the remaining concrete slabs on waste migration where the concrete floors might still be present, the RAP proposes removal of some or all of the residual concrete slabs if encountered during the implementation of the remedial excavation.

3. METHODOLOGY AND THRESHOLDS

Methodology

The determination of impacts is based on the evaluation of the potential geologic hazards that are identified at the project site under existing condition and the evaluation of any hazards caused by proposed excavation or backfill activities. The determination of existing and potential hazards is based on background studies, including soils analyses, excavation pilot testing, and mapping of seismic or other geologic hazards in the area. These are compared to the activities needed to remove COC-containing soils around residential buildings to the extent feasible and the controls on excavation imposed under existing regulations. Seismic and other geologic hazards are identified according to the location of the site with respect to active earthquake faults, designated (state-mapped) liquefaction areas, and the effect of excavation on soils underlying building foundations that would remain in place.

Thresholds of Significance

Appendix G of the State CEQA Guidelines provides a set of screening questions that address impacts with regard to geology and soils. These questions are as follows:

Would the project:

a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

[25] *Ibid.*

[26] *Ibid.*

i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area based on other substantial evidence of a known fault;

ii. Strong seismic ground shaking;

iii. Seismic-related ground failure, including liquefaction; or

iv. Landslides?

b) Result in substantial soil erosion or the loss of topsoil?

c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

Be located on expansive soils, as defined by Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?

d) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

As determined in the Initial Study, which is contained in Appendix A of this EIR, the RP's Proposed Remedy would not result in landslides. As the project is the implementation of the RAP in an urban residential area serviced by the municipal sewer system, the use of septic tanks is not applicable. As such, no further analysis of these topics is necessary.

For purposes of this analysis, the project would have a significant impact on geology and soils if it would:

GEO-1 Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death, involving:

- Strong seismic ground shaking, or
- Seismic-related ground failure, including liquefaction;

GEO-2 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;

GEO-3 Result in substantial soil erosion or loss of topsoil; or

GEO-4 Be located on expansive soil creating substantial risks to life or property.

4. PROJECT ANALYSIS

Project Design Features

Project Design Features (PDFs) to be implemented as part of the RP's Proposed Remedy would include general provisions for grading and design measures that anticipate the preparation of a geotechnical report and remedial excavation grading plans prior to the initiation of grading activities. The geotechnical report and remedial excavation grading plans would be subject to review and approval by the LACDPW, which represents the City of Carson. The proposed PDFs include, but are not limited to the following:

PDF GEO-1 Prior to issuance of a grading permit, a final geotechnical investigation and remedial excavation grading plan with final design recommendations applicable to every excavated area will be prepared by a California-registered geotechnical and civil engineer and submitted to the LACDPW and City of Carson for review. The geotechnical report will describe the characteristics of underlying natural or fill soils, including expansive soils, potential differential settlement and varying soils strength and the placement of backfill. The geotechnical report will contain recommendations for any needed cut slopes or compaction of fill materials. The remedial excavation grading plan will detail the excavation and backfill design details based on the findings and recommendations of the geotechnical report.

PDF GEO-2 The geotechnical report and remedial excavation grading plans will include site-specific design criteria related to the excavation activities in proximity to foundations and footings.

PDF GEO-3 Pre-excavation and post-excavation surveys of the existing structures and improvements at the site and at adjacent properties that have granted access will be conducted to document pre-excavation conditions and any changes in those conditions following excavation. Documentation will consist of written notes, digital photographs, and videos. Existing cracks or other distress present in structures or concrete will be documented and measured. Cracks will be monitored by direct measurement using a dial caliper capable of measuring distances to approximately ±0.001 inch, or using commercially available crack monitoring devices installed on the existing cracks, such that any potential change of crack size during implementation of the RAP can be monitored and documented.

PDF GEO-4 Full time observation should be provided by a licensed engineer during the excavation of the vertical slot cuts. Any conditions encountered within the field that are different than those anticipated (i.e. irrigation water seepage, localized loose soils, clean sand, etc.) will be brought to the immediate attention of the geotechnical engineer for corrective measures.

PDF GEO-5 Clean soil will be imported for backfill of excavations from an offsite source. Before importing the backfill soil to the site, samples of the proposed import soil will be submitted for laboratory geotechnical and chemical characterization analysis. Geotechnical tests include gradation, plasticity index (PI), maximum density and optimum moisture, and corrosivity tests. The geotechnical engineer will approve the backfill soil prior to its import, placement, and compaction at the site.

PDF GEO-6 Upon completion of excavation, concrete removal and environmental sampling (as appropriate), excavated areas will be backfilled as soon as possible. Backfill soils would be moisture conditioned to near optimal moisture content and compacted to at least 90 percent relative compaction, or as determined by the Geotechnical Engineer and approved by Los Angeles County Department of Public Works (LACDPW) and the City of Carson. Borings from auger excavation would be backfilled with controlled low strength material (CLSM, also referred to as flowable fill or sand/cement slurry) the same day they are excavated. Where slot trenching is used for 5-foot excavations or for targeted deeper excavations to 10 feet, the lower part of the slot trenches would also be backfilled with CLSM. The upper 3 feet of excavations would be backfilled with certified clean imported soil. Backfill soil would be free of deleterious organic matter (i.e., vegetation) and cobbles larger than four inches in diameter, and would be approved by the Geotechnical Engineer. The upper foot of soil backfill would be topsoil suitable for vegetation growth and would be compacted to not more than 85 percent relative compaction.

PDF GEO-7 Landscaping of backfilled properties would be restored to "like conditions" or as agreed to with the homeowners.

Analysis of Project Impacts

Threshold GEO-1: The project would have a significant impact on geology and soils if it would expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death, involving strong seismic ground shaking or seismic-related ground failure, including liquefaction.

Short-term Impacts

Impact Statement GEO-1: *The project site is not located within a liquefaction-prone area and underlying soils are in a dense state or sufficiently compacted to reduce acceleration effects. Excavations would be setback from buildings and would not affect underlying geologic structures or soils beneath building foundations. Protective support would be provided for any encountered utility lines. Thus, the project would not increase the exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death, involving strong seismic ground shaking or seismic-related ground failure, including liquefaction. The impact of the RP's Proposed Remedy with respect to these geologic hazards would be less than significant. The Expedited Implementation Option, which would increase the intensity of activity on the site, would also result in a less than significant impact with respect to these geologic hazards.*

Fault Rupture

No known active or potentially active faults underlie the site, and the site is not located within a designated earthquake fault zone. Thus, the potential for surface ground rupture is considered low. Therefore, impacts regarding fault rupture would be less than significant, and no mitigation measures would be necessary.

Seismic Ground Shaking

The site is located within a seismically active region of Southern California. The most likely sources for ground motion are known faults (e.g., Newport-Inglewood Fault, Avalon Compton Fault), which are within a few miles of the site. Moderate to strong ground motion (acceleration) could be caused by an earthquake at these, or any of the local or regional faults. The level of ground shaking that would be experienced at the site from active, potentially active or blind thrust faults in the region would be a function of several factors including earthquake magnitude, type of faulting, rupture propagation path, distance from the epicenter, earthquake depth, duration of shaking, project site topography, and project site geology. The site is not located within a liquefaction area and, thus, accelerated ground shaking, differential settlement, ground cracking, ground lurching and lateral spreading associated with liquefaction would not occur. In addition, the relative firmness and stability of on-site soils and distance to groundwater would not specifically amplify ground motion or settlement during a seismic event. Existing concrete slabs within the site are considered to be a dense material residing within the soil profile and do not cause instability or geologic hazards.

Project design features, including PDFs Geo-1 through Geo-3, which apply to the required geotechnical report, would ensure that final grading designs would incorporate adequate support of cuts (if needed), excavation methods, or setbacks from building foundations during excavation to avoid adverse effects of seismic ground shaking on adjacent buildings during the site remediation. With adequate structural protection during excavation, as determined by the geotechnical engineer, the project would not cause a seismic event to result in substantial damage to structures or cause or accelerate geologic hazards that would expose people to substantial risk of injury. Excavation activities would not affect soils and materials below 5 or 10 feet bgs or underlying geologic units. The implementation of required setbacks from habitable structures would avoid soils that support existing building foundations. It is anticipated that utility lines would be located within the excavation depth. Lines encountered would be protected in place or removed and replaced. [27] This would avoid additional stress during a ground-shaking event. In accordance with PDF-Geo-6, borings from auger excavation would be backfilled with CLSM the same day they are excavated. Where slot trenching is used for 5-foot excavations or for targeted deeper excavations to 10 feet, the lower part of the slot trenches would also be backfilled with CLSM. The upper 3 feet of excavations would be backfilled with certified clean imported soil. Backfill soil would be free of deleterious organic matter (i.e., vegetation) and cobbles larger than four inches in diameter, and would be approved by the Geotechnical Engineer. Backfill soils would be compacted to at least 90 percent relative compaction, or as determined by the Geotechnical Engineer and approved by Los Angeles County Department of Public Works (LACDPW) and the City of Carson in the Grading Permit. Because existing stable soils removed during excavation would be replaced by stable compacted soils, excavation and backfill activities would not cause ground shaking or other seismic hazards to be accelerated compared to existing conditions at the site. Thus, with the implementation of project design features, the RP's Proposed Remedy would not increase the exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death, involving strong seismic ground shaking or seismic-related ground failure, including liquefaction. The short-term impact of the project with respect to these geologic hazards would be less than significant.

Long-term Impacts

Any potential long-term impacts would be associated with changes that would result in increased ground shaking during a seismic event. The replacement of existing stable soils with unconsolidated or poor quality soils could increase amplification or other geologic hazards. The implementation of PDF-Geo-6 provides that, upon completion of excavation, excavated areas would be backfilled as soon as possible with moisture conditioned soils and compacted to a relative compaction of at least 90 percent, for soils placed from 3 feet bgs to one foot bgs. Adequate compaction of backfill would ensure that the site would be returned to its existing stable condition and would not present a potential geologic hazard resulting from ground shaking. In addition, the implementation PDF-Geo-6 would require that clean soil would be imported for backfill of excavations and that, prior to importation of soil, samples of the proposed soil would be submitted for laboratory geotechnical and chemical characterization analysis. Geotechnical tests include gradation, PI,

[27] *Transite water supply lines located in the front and side yards of properties would be avoided. Overhead power lines may require removal and replacement for safety considerations.*

maximum density and optimum moisture, and corrosivity testing, as well as inspection and approval by the geotechnical engineer would ensure that stable soil conditions would be achieved and maintained.

The substantial withdrawal of groundwater over a period of time has the potential to result in local or regional subsidence. In the Carson area historical subsidence has been remedied through a regional seawater injection system. The RAP requires the removal of LNAPL if it is present at a measureable thickness on the groundwater surface.accumulates to a thickness of 0.5 feet on the surface of the Bellflower aquitard, which underlies the site. The removal of LNAPL has been ongoing for three years where it has accumulates in a few monitoring wells. Because of the localized character of the LNAPL and relatively small volume of LNAPL compared to the volume of the aquitard, the removal of LNAPL does not affect the surface level of the water table, which has remained stable (between 52-68 feet bgs) over a period of observation since 2009. Therefore, the ongoing removal of LNAPL is not expected to result in localized or general subsidence.

Other project design features including PDF-Geo-3 would provide a data baseline against which future structural changes could be measured. PDF-Geo-3 requires an evaluation of pre-excavation building conditions and post-excavation conditions of buildings as well as evaluation of any structural changes. This project design feature would provide for the detection of changes in structures from grading and excavation activities. Existing cracks or other distress present in structures or concrete would be documented and measured. Cracks would be monitored by direct measurement using a dial caliper capable of measuring distances to approximately ±0.001 inch, or using commercially available crack monitoring devices installed on the existing cracks, such that any potential change of crack size during the pilot tests can be monitored and documented. Thus, with the implementation of project design features, the project would not increase the exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death, involving strong seismic ground shaking or seismic-related ground failure, including liquefaction. The long-term impact of the RP's Proposed Remedy with respect to seismic hazards would be less than significant.

Expedited Implementation Option

Under the Expedited Implementation Option, the number of properties being remediated at one time could increase from the proposed cluster of up to 8 properties up to 16 properties active at one time. The remediation contractor could implement this option only when the configuration of lots and other conditions are conducive to proceeding in this expedited manner safely. The Option would result in a greater level of activity on the site at one time but would not change the activity at an individual property or the total activity (number of lots remediated, amount of soil and other materials removed from the site, etc.). Project design features would be the same under the Expedited Implementation Option as under the RP's Proposed Remedy. Because the Expedited Implementation Option would comply with Code requirements related to excavation stability (shoring, etc.), monitoring of cuts, and maintaining baseline data to detect any damage or instability at adjacent structures, and would adhere to project design features which further ensure stability of excavations, the Expedited Implementation Option would not cause adverse impacts related to seismic hazards, such as ground shaking, ground failure, and liquefaction. Therefore, impacts regarding seismic hazards would be less than significant.

Threshold GEO-2: The project would have a significant impact on geology and soils if it would 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 Statement GEO-2: *The excavation of the project site would not expose or alter underlying geologic units. Surface soil would be removed to 5 to 10 feet bgs and would be replaced with appropriately compacted backfill. Observation during grading and testing for required compaction and safety of structures due to any slippage or settlement of the completed grading, would ensure that conditions in approved engineering reports are implemented. With implementation of Building Code requirements and project design features the project would not cause on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. Therefore, the impact of the RP's Proposed Remedy with respect to these geologic hazards would be less than significant. The Expedited Implementation Option would also result in a less than significant impact with respect to these geologic hazards.*

Short-term Impacts

The implementation of the RAP would require temporary modifications to the existing grades of the site. Soil would be excavated to a depth of 5 to 10 feet bgs from both landscaped areas and areas currently covered by hardscape, including walkways, driveways, patio areas, and hardscape associated with landscaping. Approximately 177,870 CY of soil would be removed from the residential properties on the site. In addition to the residential soil excavation, there would be approximately 8,100 CY of soil excavated for SVE piping installation in the public rights-of-way and 725 CY excavated for well installation. Total excavation would be approximately 186,945 CY. Final recommendations, including vertical and lateral capacities of soils, would be developed during final design as required under PDF-Geo-1. Soil would be excavated from 219 residential properties where results of the previous site assessments indicate that RAOs are not met under existing conditions. Residual concrete slabs that formed a portion of the former reservoirs would be removed from excavation areas, where encountered. If encountered, concrete extending laterally beneath a structure or beneath the sidewalk would be cut at the edge of the structure or inner edge of the sidewalk and the remaining concrete would be left in place. Existing concrete slabs within the site are considered to be a dense material residing within the soil profile and do not cause instability or geologic hazards.

Hardscape and landscaping would be removed during the initial stage of excavation and restored to like conditions following completion of excavation in consultation with the homeowner. It may be necessary to remove fences and block walls between yards and ornamental or partitioning walls on individual properties, as the depth of excavation likely would exceed fence post and footing depths. As with other hardscape, fences and walls would be restored following completion of excavation and prior to restoration of landscaping. Exceptions to excavation beneath hardscape include patios covered by structures and roofs, swimming pools and pool decking surrounding swimming pools. These hardscape areas would not be excavated to avoid structural demolition and potential damage to swimming pools and appurtenant equipment. No excavation for the purposes of direct soil removal remediation would occur beneath City streets and sidewalks or beneath houses. However, excavation within City streets would be needed for trenching as part of the SVE conveyance piping installation process. In addition to treatment by the SVE/bioventing system discussed below, remaining soil in these non-excavated areas would be addressed in the SMP and by existing City regulatory requirements.

Excavation would be conducted using rubber track-mounted excavators or rubber-tired backhoes. An approximately 15,000 to 18,000 pound medium-sized excavator would be used for work in front yards and back yards where sufficient access is available, and an approximately 3,500-pound rubber track-mounted mini-excavator would be used in back yards with narrow access via side yards. Excavation would be conducted using a front-end loader and/or Bobcat skid-steer mini-loader to move soil from back yards to front yards and vice versa to bring in clean fill soil.

In areas where access for equipment is severely limited, hand tools and wheelbarrows would be used to conduct excavations.

Excavations would be made with side slopes at the horizontal to vertical ratio recommended by the geotechnical engineer and approved by the LACDPW and City of Carson in the grading permit for the particular property being excavated.[28] The basic excavation protocols would be altered as needed as excavations are conducted and to address any previously unknown utilities, concrete debris or foundations unearthed. If possible, and approved by the LACDPW and the City, excavations would have vertical sidewalls to maximize removal of impacted soil to the full depth of excavation.[29]

Geotechnical reports were prepared for the 24612 Neptune Avenue and 24533 Ravenna Avenue properties prior to the pilot test for trenching and excavations. Based on the properties of on-site soil, the report concluded that any construction work within the site would not be subjected to geologic hazards from landslides, settlement, or slippage. They also concluded that implementation of the remedial activities would not adversely affect the geologic stability of surrounding properties. The reports further concluded that, because groundwater was not observed in exploratory borings to a depth of 25.5 feet bgs at the 24612 Neptune Avenue site and to a depth of 10 feet bgs at the Ravenna Avenue site, the potential for groundwater-related impacts during excavation activities, including the potential for perched groundwater intrusion into the near-surface zones during construction, is not anticipated.[30]

Excavations to 5 bgs or deeper would require shoring of the cut area, setbacks from structures, sloped excavation sidewalls, and/or slot trenching in accordance the requirements of the geotechnical report for engineered grading. Placement of clean fill would need to meet compaction requirements under the Code. Because of the shallow depth of excavation (5 to 10 feet) and setbacks from building foundations, the excavation of soil would not alter underlying geologic units or the character of existing soil beneath existing foundations. Surface soil would be replaced by appropriately placed backfill that would meet County Building Code Section J107.4 to prevent fill material containing organic, frozen, or other deleterious materials that could contribute to instability. Implementation of PDF-Geo-5 requires that imported clean soil would be tested for suitability (stability, non-corrosive properties, etc.) as fill materials. Under PDF-Geo-6, backfill would begin upon completion of excavation and installation of other remedial elements. Borings from auger excavation would be backfilled with CLSM the same day they are excavated. Where slot trenching is used for 5-foot excavations or for targeted deeper excavations to 10 feet, the lower part of the slot trenches would also be backfilled with CLSM. The upper 3 feet of excavations would be backfilled with

[28] *The City of Carson follows the LACDPW Grading Guidelines and is a contract city, meaning that the LACDPW provides plan check services for the City.*

[29] *The LACDPW and City could require setbacks from structures in accordance with appropriate elements of Sections J101, J104, J106, and J108 of the County Grading Code as amended by the City of Carson.*

[30] *URS Corporation, Geotechnical Report, Planned Pilot Test for Remedial Excavation and Backfill Placement, 24612 Neptune Avenue, Carson, CA, March 29, 2012, page 4-1.*

certified clean imported soil. Backfill soil would be free of deleterious organic matter (i.e., vegetation) and cobbles larger than four inches in diameter, and would be approved by the Geotechnical Engineer. Backfill soils would be moisture conditioned to near optimal moisture content and compacted to at least 90 percent relative compaction, or as determined by the Geotechnical Engineer and approved by LACDPW and the City of Carson in the Grading Permit. The upper foot of soil backfill would be topsoil suitable for vegetation growth and would be compacted to not more than 85 percent relative compaction.

Los Angeles County Building Code Sections J105.3, Field Engineer Inspection, and J105.4, Soils Engineer Inspection, as well as PDF-Geo-6, require observation during grading, testing for required compaction and safety of structures due to any slippage or settlement of the completed grading, and to ensure that conditions in approved engineering reports are implemented. With implementation of County Building Code requirements and project design features, the RP's Proposed Remedy would avoid lateral spreading, subsidence, liquefaction, or collapse during construction. The project site is essentially level and no land sliding is anticipated. Therefore, the short-term impact of the project with respect to landslide, lateral spreading, subsidence, liquefaction, or collapse would be less than significant.

Expedited Implementation Option

Under the Expedited Implementation Option, the total amount of excavated soil and implementation of Code requirements, such as protection of adjoining properties, setbacks, and stability of cuts would be the same as under the RP's Proposed Remedy. The Option would result in a greater level of activity on the site at one time but would not change the activity at an individual property or the total activity (number of lots remediated, amount of soil and other materials removed from the site, etc.). Project design features would be the same under the Expedited Implementation Option as under the RP's Proposed Remedy. Because the Expedited Implementation Option would comply with Code requirements related to excavation stability (shoring, etc.), monitoring of cuts, and maintaining baseline data to detect any damage or instability at adjacent structures, and would adhere to project design features which further ensure stability of excavations, the Expedited Implementation Option would not cause adverse impacts related to geologic hazards. Therefore, impacts regarding geologic hazards, such as landslide, lateral spreading, subsidence, liquefaction, or collapse would be less than significant.

Long-term Impacts

Any potential long-term impacts would be associated with changes that would cause or increase instability and potentially result in lateral spreading, subsidence, liquefaction, or collapse. The replacement of existing stable soils with unconsolidated or poor quality soils could result in long-term lateral spreading or other geologic hazards. As described under "Short-term Impacts," above the implementation of PDF-Geo-5 and PDF-Geo-6 would provide for the use of clean soils that meet appropriate geotechnical and chemical characterization analysis and for compaction of soils to least 90 percent. Adequate compaction of backfill would ensure that the site would be returned to its existing stable condition and would not present a potential long-term geologic hazard resulting from ground shaking. In addition, project design features would ensure that stable soil conditions would be achieved and maintained.

Other project design features including PDF-Geo-3 would provide a data baseline against which future structural changes could be measured. PDF-Geo-3 requires an evaluation of pre-excavation building and foundation conditions and post-excavation conditions of buildings and foundations and evaluation of any structural changes. Existing cracks or other distress present in structures or concrete would be documented and measured. Cracks would be monitored by direct measurement using a dial caliper capable of measuring distances to approximately ±0.001 inch, or using commercially available crack monitoring devices installed on the existing cracks, such that any potential change of crack size during the pilot test can be monitored and documented. This data baseline would indicate any geologic instability and, thus, provide a means by which potential geologic hazards could be addressed. Thus, with the implementation of project design features, the project would avoid or address adverse geologic conditions, such as poor soil consolidation that could cause lateral spreading, subsidence, liquefaction, or collapse. The impact of the RP's Proposed Remedy with respect to landslide, lateral spreading, subsidence, liquefaction, or collapse would be less than significant.

Threshold GEO-3: The project would have a significant impact on geology and soils if it would result in substantial soil erosion or loss of topsoil.

Impact Statement GEO-3: *With the implementation of Code-required best management practices for excavation and backfill activities, and immediate loading and covering of cut materials, the RP's Proposed Remedy would not result in substantial soil erosion. In addition, the removal of COC-containing soil would not constitute the substantial loss of top soil. Therefore, the impact with respect to erosion and loss of top soil would be less than significant. The Expedited Implementation Option would also result in a less than significant impact with respect to erosion and loss of top soil.*

Short-term Impacts

A function of the RP's Proposed Remedy is to remove approximately 177,870 CY of soil from residential sites (including a 10 percent contingency), approximately 8,100 CY from street excavations, and 725 CY for well preparation, for a total of approximately 186,945 CY. The soil would be replaced by backfill, which would be required to comply with project design features and Building Code requirements regarding absence of organic materials or other deleterious materials. PDF-Geo-6 requires that clean soil would be imported for backfill would be tested for gradation, plasticity, maximum density and optimum moisture, and corrosivity. Under existing conditions, petroleum hydrocarbons and related VOCs and SVOCs occur in shallow and deep soils on the site. Because of potential hydrocarbons present in existing soil, under existing conditions these soils are not suitable for beneficial uses typically associated with topsoil. Although surface soils would be removed from the residential properties, the removal of these materials would not constitute a substantial loss of topsoil. Topsoil in landscaped areas would be replaced in like condition so there would be no significant loss of top soil associated with the RP's Proposed Remedy.

Grading activities have the potential to increase erosion, including erosion of soils during excavation. The SWPPP and WWECP, which would be prepared in accordance with the County Building Code, Appendix J, would require best management practices for the control of runoff and potential transport of sediment or soil erosion during excavation and backfill operations. As described in Chapter 2, Project Description, of this EIR, generally excavated soil would be loaded directly into an awaiting transport vehicle (i.e., end-dump truck, dump truck, or covered soil bin) using the excavator, front-end loader or skid-steer mini-loader, for transport to the appropriate recycling or disposal facility. In the unlikely event that it is necessary to temporarily stockpile soil onsite before loading, soil either would be placed upon plastic sheeting and covered with plastic, or they would be temporarily placed in a covered bin. With the implementation of Code-required best management practices for excavations and backfill, and immediate loading and covering of cut materials, as needed, the project would not result in substantial soil erosion. In addition, the removal of COC-containing soil would not constitute the substantial loss of top soil. Therefore, the short-term impact of the RP's Proposed Remedy with respect to erosion and loss of top soil would be less than significant.

Long-term Impacts

Long-term erosion has the potential to occur in areas of exposed backfill soils. Under PDF-Geo-7, landscape restoration, including the reconstruction of removed fencing or block walls, would be performed to "like conditions" or as agreed to with the homeowners. PDF-Geo-7 requires that properties be restored to like condition, including topsoil in landscaped and softscape areas. With the restoration of landscaping and any removed hardscape, backfill soils would be covered and the potential for erosion would be substantially reduced. With the implementation of project design features, the site would be returned to like condition and the long-term impact of the RP's Proposed Remedy with respect to erosion and loss of top soil would be less than significant.

Expedited Implementation Option

Under the Expedited Implementation Option, the total amount of excavated soil would be the same as under the RP's Proposed Remedy. However, because overall activity at any one time would be increased, the quantity of soil exposed to potential erosion forces would be greater. The PDFs and BMPs in the RP's Proposed Remedy would be applicable to all areas where soil is exposed under the Expedited Implementation Option thereby minimizing soil erosion. The discussion above of impacts associated with loss of top soil is the same as under the RP's Proposed Remedy because no additional surface area would be disturbed. Therefore, impacts regarding erosion and loss of top soil would be less than significant.

Threshold GEO-4: The project would have a significant impact on geology and soils if it would be located on expansive soil creating substantial risks to life or property.

Impact Statement GEO-4: *The project would not remove existing soils under residential buildings or garages and, thus, would not change existing conditions with respect to soils currently supporting habitable structures. Expansive soils do not naturally occur on the project site and expansive soils would not be imported to the project site. Because the RP's Proposed Remedy and the Expedited Implementation Option would not change the existing soils under habitable structures, it would not cause a change in expansiveness of existing materials that would increase risks to life or property. The impact of the RP's Proposed Remedy and the Expedited Implementation Option with respect to expansive soils would be less than significant.*

Short-term Impacts

Prior geotechnical investigations of the site determined that naturally-occurring on-site soils were non-expansive by both Los Angeles County and FHA criteria. The RP's Proposed Remedy would result in the removal of up to approximately 186,945 CY of soil from the site. Excavated soils would be backfilled with imported materials that must comply with County Building Code Section J107.4 to prevent fill material containing organic, frozen, or other deleterious materials that could contribute to instability. Under PDF-Geo-5, imported backfill soil to the site would be tested for gradation and plasticity, which would ensure that high levels of clay that could contribute to shrinking and swelling are considered deleterious and would not be allowed. Because expansive soils would not be imported to the site, any replaced fencing and hardscape would not be located in imported expansive soils. The RP's Proposed Remedy would not remove existing soils under residential buildings or garages and, thus, would not change existing conditions with respect to existing non-expansive soils that currently support habitable structures. Because on-site soils are non-expansive, and imported soils would be tested to ensure that expansive soils would not be used in backfill, the short-term impact of the project with respect to expansive soils would be less than significant.

Long-term Impacts

Expansive soils do not naturally occur on the project site. With the implementation of County Building Code regulations that require that fill material not contain deleterious materials that could contribute to instability and PDF-Geo-5, which requires that imported backfill soil to the site would be tested for gradation and plasticity, soils that contain high levels of clay that could contribute to shrinking and swelling would not be allowed. The RP's Proposed Remedy would not remove existing soils under residential buildings or garages and, thus, would not change existing conditions with respect to existing non-expansive soils that currently support habitable structures. Because on-site soils are non-expansive, and imported soils would be tested to ensure that expansive soils would not be used in backfill, the long-term impact of the RP's Proposed Remedy with respect to expansive soils would be less than significant.

Expedited Implementation Option

Under the Expedited Implementation Option, the total amount of excavated soils would be the same as under the RP's Proposed Remedy. The Expedited Implementation Option would adhere to all project design features, such as PDF-Geo-5, which requires testing of imported backfill soil for gradation and plasticity. This would ensure that high levels of clay that could contribute to shrinking and swelling would not be allowed. Because expansive soils do not occur on the site or would be imported to the site, any replaced fencing and hardscape would not be located in imported expansive soils. The Expedited Implementation Option would not remove existing soils under residential buildings or garages and, thus, would not change existing conditions with respect to existing non-expansive soils that currently support habitable structures. Because on-site soils are non-expansive, and imported soils would be tested to ensure that expansive soils would not be used in backfill, the short-term impact of the Expedited Implementation Option with respect to expansive soils would be less than significant.

5. ALTERNATIVES ANALYSIS

Analysis of Impacts Associated with Alternative 1 (No Project Alternative)

The No Project Alternative would not involve any excavation of soils or change to existing ground conditions that would require grading permits or geotechnical analysis of activities at the site. The No Project Alternative would avoid any potential excavation-related impacts associated with sedimentation or erosion, which were determined to be less than significant under the RAP with the implementation of project design features. Although the No Project Alternative, which would not result in any geologic effects, would avoid the RAP's less than significant geological effects. However, this Alternative would not meet the statutory requirements of the RAP.

Analysis of Impacts Associated with Alternative 2 (Excavation Beneath Landscape and Hardscape to 10 Feet Alternative)

Seismic Hazards

As indicated previously, the site is not located within a designated earthquake fault zone and surface ground rupture is considered low. Because the site is located within a seismically active region, moderate to strong ground motion could be caused by an earthquake. As with the RP's Proposed Remedy, project design features, such as PDFs Geo-1 through Geo-3, would apply. These require a geotechnical report to ensure that final grading designs would incorporate adequate support of cuts (if needed) and setbacks from building foundations during excavation to avoid adverse effects of seismic ground shaking on adjacent buildings during the site remediation. It is expected that 10-foot-deep cuts would be shored and/or slot trenched to ensure stable cuts. With adequate structural protection during excavation, Alternative 2 would not cause a seismic event to result in substantial damage to structures or cause or accelerate geologic hazards that would expose people to substantial risk of injury. Excavation activities would not affect soils and materials below 10 feet bgs or underlying geologic units that could affect seismic activity. Design features would require backfill materials from the base of the cut to one foot bgs to be re-compacted to at least 90 percent, or as required under the grading permit for specific properties. The implementation of project design features, such as PDF-Geo-6, would provide that, upon completion of excavation, excavated areas would be backfilled as soon as possible with CLSM in the lower areas of cuts or borings and backfilled with certified clean imported soil in the upper 3 feet. Thus, with the implementation of project design features and existing grading regulations pertinent to engineered grading, Alternative 2 would not increase the exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death, involving strong seismic ground shaking or seismic-related ground failure, including liquefaction. Impacts with respect to seismic hazards would be less than significant.

Geologic Hazards

Under Alternative 2, all affected properties (241 residential properties) would be excavated to a depth of 10 feet bgs. Total excavated quantities would be approximately 274,700 CY from the residential properties and approximately 43,900 CY of impacted soils from other areas on the site (total approximately 318,600 CY). This Alternative would entail, on average, excavation of 1,222 CY of soil per property.

As with the RP's Proposed Remedy, excavation would be conducted using excavators or backhoes. A limited access bucket auger drilling rig would be used in conjunction with conventional excavation equipment for cuts. Conventional excavation using slot-trenching as necessary to protect structures or other features and open bulk excavation with appropriate sloping, setbacks, and/or shoring would be used where possible. Auger excavation using a limited access rig would allow excavation to be conducted in relatively tight spaces adjacent to structures to remove a column of soil. However, use of auger excavation would be slow and would therefore be used in limited application in favor of conventional excavation wherever possible.

Excavations to 10 feet bgs would require shoring of the cut area, setbacks from structures, sloped excavation sidewalls, and/or slot trenching according to the requirements of the geotechnical report for engineered grading. Placement of clean fill would need to meet compaction requirements under the Code. Geotechnical reports at two locations within the site concluded that any construction work within the site would not be subjected to geologic hazards from landslides, settlement, or slippage. The reports also concluded that implementation of the remedial activities would not adversely affect the geologic stability of surrounding properties.[31]

Los Angeles County Building Code Sections J105.3, Field Engineer Inspection, and J105.4, Soils Engineer Inspection, which are implemented for all engineered grading, as well as implementation of project design features, such as PDF-Geo-6, require observation during grading, testing for required compaction and safety of structures due to any slippage or settlement of the completed grading, and ensure that conditions in approved engineering reports are implemented. With implementation of County Building Code requirements and project design features, Alternative 2 would avoid lateral spreading, subsidence, liquefaction, or collapse during construction. The site is essentially level and no land sliding is anticipated. Therefore, the short-term impact of the Alternative 2 with respect to landslide, lateral spreading, subsidence, liquefaction, or collapse would be less than significant.

Erosion Hazards

Alternative 2 would remove approximately 274,700 CY of impacted soils from the residential properties and approximately 43,900 CY of impacted soils from other areas on the site for a total of 318,600 CY. These soils would be replaced by equivalent volumes of clean backfill. Because the quantity of excavated soil would be greater under this Alternative, potential exposure to natural forces could increase erosion potential. Erosion would be addressed by the SWPPP and WWECP, which would be prepared in accordance with the County Building Code, Appendix J. These programs require best management practices for the control of runoff and potential transport of sediment or soil erosion during excavation and backfill operations. As with the RP's Proposed Remedy, excavated soils would be loaded directly into a transport vehicle (i.e., end-dump truck, dump truck, or covered soil bin). In the event that it is necessary to temporarily stockpile soil on site before loading, soils either would be placed upon Visqueen plastic sheeting and covered with plastic, or they would be temporarily placed in a covered bin. Project design features, such as PDF-Geo-5, which requires that topsoil suitable for plant growth in the upper 6 inches and underlain by 6-inch-thick backfills compacted to a relative compaction of 80 to 85 percent, would also be implemented. The inclusion of topsoil in the backfill materials and compacted underlying soil within the upper one-foot would promote the growth of vegetation, as well as reduce deep erosion. With the implementation of Code-required best management practices for excavations and backfill and project design features, Alternative 2 would not result in substantial soil erosion. The removal of existing COC-containing soils would not constitute useful top soil and, therefore, the impact of Alternative 2 with respect to loss of top soil would be less than significant.

Expansive Soils Hazards

Prior geotechnical investigations of the site determined that naturally-occurring on-site soils were non-expansive by both Los Angeles County and FHA criteria. Design features, such as PDF-Geo-5, would be implemented, which require that soils with high levels of clay that could contribute to shrinking and swelling would not be allowed as backfill material. Because expansive soils would not be imported to the site, any replaced fencing and hardscape would not be located in imported expansive soils. Alternative 2 would not remove existing soils under residential buildings or garages and, thus, would not change existing conditions with respect to existing non-expansive soils that currently support habitable structures. Because on-site

[31] *URS Corporation, Geotechnical Report, Planned Pilot Test for Remedial Excavation and Backfill Placement, 24612 Neptune Avenue, Carson, CA, March 29, 2012, page 4-1 and Planned Pilot Test for Remedial Excavation and Backfill Placement, 24533 Ravenna Avenue, Carson, CA, April 13, 2012, page 2-1.*

soils are non-expansive, and imported soils would be tested to ensure that expansive soils would not be used in backfill, the impact of Alternative 2 with respect to expansive soils would be less than significant.

Analysis of Impacts Associated with Alternative 3 (No Excavation Beneath Hardscape - 5 Feet to Targeted 10-Feet Alternative)

Seismic Hazards

As indicated previously, the site is not located within a designated earthquake fault zone. Although surface ground rupture is considered low, moderate to strong ground motion could be caused by an earthquake. Project design features, such as PDFs Geo-1 through Geo-3, would apply, which would ensure that final grading designs would incorporate adequate support of cuts and setbacks from building foundations during excavation to avoid adverse effects of seismic ground shaking on adjacent buildings during remediation. It is expected that cuts deeper than 5 feet would be shored and/or slot trenched to ensure stability. With adequate structural protection during excavation, Alternative 3 would not cause a seismic event to result in substantial damage to structures or cause or accelerate geologic hazards that would expose people to substantial risk of injury. Excavation activities would not affect soils and materials deeper than 10 feet bgs or underlying geologic units that could affect seismic activity. PDF-Geo-6 would provide that excavated areas would be backfilled as soon as possible. Thus, with the implementation of project design features and existing grading regulations pertinent to engineered grading, Alternative 3 would not increase the exposure of people or structures to potential substantial adverse seismic, including ground failure or liquefaction. Impacts with respect to seismic hazards would be less than significant.

Geologic Hazards

Based on the conclusions of geotechnical reports for two locations within the site, construction work within the site is not considered subject to geologic hazards from landslides, settlement, or slippage. The reports also concluded that implementation of the remedial activities would not adversely affect the geologic stability of surrounding properties.[32]

As with the RP's Proposed Remedy, all affected properties (219 residential properties) would be excavated to a depth of 5 feet, with targeted areas to 10 feet bgs. However, because hardscape (sidewalks, concrete patios, masonry walls, etc.) and soils beneath hardscape would not be removed, total excavated soils would be reduced. It is estimated that approximately 92,755 CY of soil would be exported from the site.

Conventional excavation using slot-trenching as necessary to protect structures or other features and open bulk excavation with appropriate sloping, setbacks, and/or shoring would be used where possible. As with the RP's Proposed Remedy, mini-excavators, hand tools, or wheelbarrows, which are limited to 5-foot-deep cuts, could be used to conduct the 5-foot-deep excavations.

Los Angeles County Building Code Sections J105.3, Field Engineer Inspection, and J105.4, Soils Engineer Inspection, which are implemented for all engineered grading, as well as implementation of project design

32 *URS Corporation, Geotechnical Report, Planned Pilot Test for Remedial Excavation and Backfill Placement, 24612 Neptune Avenue, Carson, CA, March 29, 2012, page 4-1 and Planned Pilot Test for Remedial Excavation and Backfill Placement, 24533 Ravenna Avenue, Carson, CA, April 13, 2012, page 2-1.*

features, such as PDF-Geo-6, require observation during grading, testing for required compaction and safety of structures due to any slippage or settlement of the completed grading, and ensure that conditions in approved engineering reports are implemented. With implementation of County Building Code requirements and project design features, Alternative 3 would avoid lateral spreading, subsidence, liquefaction, or collapse during construction. The site is essentially level and no landsliding is anticipated. Therefore, the impact of the Alternative 3 with respect to landslide, lateral spreading, subsidence, liquefaction, or collapse would be less than significant.

Erosion Hazards

Alternative 3 would remove approximately 83,930 CY of impacted soils from the residential properties, including a 10 percent contingency. In addition, 8,100 CY of soil from street trenching and 725 CY from well preparation would be excavated, for a total of 92,755 CY. These soils would be replaced by equivalent volumes of clean backfill. Because the quantity of excavated soil would be less under this Alternative than under the RP's Proposed Remedy, potential exposure to natural forces could decrease erosion potential. Project design features, such as PDF-Geo-5, which requires that topsoil suitable for plant growth in the upper 6 inches and underlain by 6-inch-thick backfills compacted to a relative compaction of 80 to 85 percent, would also be implemented. The inclusion of topsoil in the backfill materials and compacted underlying soil within the upper one-foot would promote the growth of vegetation, as well as reduce deep erosion. With the implementation of Code-required best management practices for excavations and backfill and project design features, Alternative 3 would not result in substantial soil erosion. The removal of existing COC-containing soils would not constitute useful top soil and, therefore, the impact of Alternative 3 with respect to loss of top soil would be less than significant.

Expansive Soils Hazards

Prior geotechnical investigations of the site determined that naturally-occurring on-site soils were non-expansive by both Los Angeles County and FHA criteria. Design features, such as PDF-Geo-5, would be implemented, which require that soils with high levels of clay that could contribute to shrinking and swelling would not be allowed as backfill material. Alternative 3 would not remove existing soils under residential buildings, garages, or hardscape and, thus, would not change conditions with respect to existing non-expansive soils that currently support habitable structures. Because on-site soils are non-expansive, and imported soils would be tested to ensure that expansive soils would not be used in backfill, the impact of Alternative 3 with respect to expansive soils would be less than significant.

6. CUMULATIVE IMPACTS

The study area considered for the cumulative geologic impacts includes (1) the area that could be affected by the RAP and (2) the areas affected by other projects whose activities could directly or indirectly affect the geology and soils of the project site. Geologic and soil impacts are generally site-specific and there is little, if any, cumulative relationship between development or remediation projects. Adherence to all relevant plans, codes, and regulations with respect to project design and construction would reduce project-specific and cumulative geologic impacts to a less-than significant level. Therefore, since geologic hazards are site-specific, the RAP, in combination with other past, present, and reasonably foreseeable future projects, would not create a potentially significant cumulative impact on geological resources.

Impacts from erosion and loss of topsoil from site development and operation can be cumulative in effect within a watershed. The West Coast Basin of the Los Angeles Coastal Plain encompasses the immediate watershed region and forms the geographic context for cumulative erosion impacts. Development throughout the watershed would be subject to State and local runoff and erosion prevention requirements, including the applicable provisions of the general construction permit, BMPs, and Phases I and II of NPDES, as well as implementation of fugitive dust control measures of SCAQMD Rule 403. These measures are implemented as conditions of approval of project development and subject to continuing enforcement. As a result, it is anticipated that cumulative impacts on the West Coast Basin due to runoff and erosion from cumulative development activity would be less than significant.

7. MITIGATION MEASURES

With the implementation of existing regulations and project design features described above, the RP's Proposed Remedy nor the Expedited Implementation Option would result in significant impacts with respect to geologic hazards, such as ground shaking, slope stability, settlement, liquefaction, erosion, or expansive soils. Therefore, no mitigation measures would be necessary for the RP's Proposed Remedy or the Expedited Implementation Option.

With regard to alternatives, the No Project Alternative would not involve any excavation or other physical activity and would not result in any geologic hazards. Therefore, mitigation measures would also not be required for this Alternative. Alternatives 2 and 3 would not result in significant impacts with respect to geologic hazards, such as ground shaking, slope stability, settlement, liquefaction, erosion, or expansive soils. Therefore, no mitigation measures would be necessary for Alternatives 2 and 3.

8. LEVEL OF SIGNIFICANCE AFTER MITIGATION

No potentially significant impact with respect to seismic risk or other geologic hazards, such as ground shaking, slope stability, settlement, liquefaction, erosion, or expansive soils have been identified. No mitigation measures would be necessary. Because the RP's Proposed Remedy,Alternative 2, and Alternative 3 would be consistent with the existing regulatory framework relative to seismic hazards, grading, foundations, soils, erosion, and other geological concerns, mitigation measures would not be required. No significant impacts with respect to geology and soils would occur. Alternative 1, the No Project Alternative, would not involve any physical activity or cause any geologic effects. Therefore, no impacts are associated with this Alternative.

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