5.5 Geology and Soils

5.5 GEOLOGY AND SOILS

This section evaluates the geologic and seismic conditions within the Project area and the potential for geologic hazard impacts associated with implementation of the proposed Project. Information in this section is based primarily upon the *Geology, Soils, and Seismicity Report, Lincoln Specific Plan* (Geology Report) prepared by D. Scott Magorien, February 28, 2014 and the *Preliminary Geotechnical Evaluation Report Proposed Development, Fred C. Nelles Site* (LGC Report) prepared by LGC Geotechnical, Inc., April 26, 2013; refer to Appendix 11.7, *Geology and Soils Reports*.

5.5.1 EXISTING ENVIRONMENTAL SETTING

GEOLOGIC SETTING

Regionally, the Project site is located within the northeastern edge of the Los Angeles Coastal Plain on the La Habra Piedmont slope, an alluvial slope located near the foot of Puente Hills. This alluviated basin lies within an area west and northwest of the Peninsular Ranges and southeast of the Transverse Ranges geomorphic provinces. The region surrounding the Project is characterized by a broad, southerly sloping basin with intervening, low-lying hills (i.e., Coyote Hills), and several major rivers, namely, the San Gabriel and Santa Ana, that drain from the San Gabriel and San Bernardino Mountains, respectively. Exhibit 5.5-1, *Geologic Map*, illustrates the Project site's geologic setting.

The greater Los Angeles Basin began forming approximately 18 million years ago, during which time was represented by a number of intervening basins, which over time, had become infilled with 1,000's of feet of marine and non marine sedimentary and volcanic rocks. Beginning approximately 7 to 8 million years ago, the Los Angeles basin and surrounding environs were subjected to north-south compression associated with the onset of San Andreas transform fault system; see Faulting and Seismicity Section below. The resulting San Andreas tectonic framework created most of the currently seismically active, northwest-southeast trending right-lateral strike slip faults of the Peninsular Ranges, as well as east-west-trending left-lateral and oblique slip faults of the western Transverse Ranges.

The nearby Whittier fault, which is located approximately one mile north of the Project site, displays faulting characteristics of both the Peninsular and Transverse Ranges provinces. Although there are no documented active or potentially active faults within or projecting towards the site, a seismically active blind thrust fault known as the Puente Hills Blind Thrust fault underlies the Project site at a depth of approximately 4.5 miles.

This portion of the Los Angeles Basin is mantled by approximately 3,000 feet of Quaternary age (0 to 1.6 million years old) alluvial and fluvial sediment derived from eroded bedrock materials from the nearby Puente Hills and deposits laid down as floodplain deposits. These Holocene and late Pleistocene age sediments comprise the main groundwater-bearing strata in this portion of the eastern Los Angeles Basin. Beneath these non-marine deposits are Pliocene to late Miocene age (1.6 to approximately 12 million years old) marine deposits, which include the Pico, Repetto, Modelo and Topanga formations attain a combined thickness in excess of 4,000 feet.

SITE CONDITIONS

According to the latest U.S. Geological Survey (USGS) topographic map for the Whittier 7.5' Quadrangle, the Project site lies near the confluence of the eastern edge of the San Gabriel River floodplain and the distal portions of a broad alluvial fan emanating from nearby Puente Hills. The topography of the Project site has an overall southwesterly-sloping surface with elevations ranging from approximately 230 feet above mean sea level (msl) along the northern margin to approximately 185 feet above msl along the southern margin. The overall ground surface gradient is approximately 0.025.

GEOLOGIC MATERIALS

The latest (i.e., 2010) geological mapping by the California Geological Survey (CGS) characterizes the native soils underlying the Project site as young alluvial fan deposits. Prior mapping by the USGS in cooperation with the CGS also mapped these deposits as Holocene age alluvial fan and valley fill (i.e., floodplain) sediments. LGC collected substantial subsurface data from their exploratory borings and test pits conducted in 2013. Specifically, the LGC field investigation consisted of 14 hollow stem auger borings drilled to depths of approximately 26.5 to 51.5 feet, 9 cone penetration test (CPT) soundings advanced to depths of approximately 50 feet, and 12 backhoe test trenches excavated to depths of approximately 2 to 11 feet. The subsurface data collected by LGC indicate the geologic materials that underlie the Project site to the depths explored include a surficial veneer of typically fine-grained topsoil and/or undocumented artificial fill soils, which are underlain fine-grained, native alluvial sediments.

Topsoil

Based on test pit and boring logs in the LGC Report, the majority of the Project site appears to be mantled with topsoil, which is characterized primarily as silty clay that is dark brown in color, moist to very moist, soft, and porous and contains scattered roots and rootlets. These deposits reportedly vary in thickness from approximately 2.0 to 5.0 feet thick, and are considered unsuitable for foundation support for new roadways and structures (i.e., buildings and walls). If not removed/replaced with properly engineered/compacted fill beneath buildings, foundations/ structural elements could experience moderate to significant distress.

Undocumented Artificial Fill

Undocumented artificial fill soils occur along a narrow, north-south-trending strip near the eastern margin of the Project site. These man-made deposits are reported to consist mainly of silty and clayey soils that are mottled brown and dark brown, moist to very moist, soft, and contain scattered brick and concrete debris. These soils are considered "undocumented," because there apparently was no observation or density testing by a qualified geotechnical engineering firm when they were placed, and are likely derived from native topsoil materials. Due to the lack of adequate documentation, as well as direct observations by LGC, these soils are considered to be compressible, and therefore subject to consolidation. If not removed/replaced with properly engineered/compacted fill beneath buildings, foundations/ structural elements could experience moderate to significant distress.

0 2500 5000

Approximate Scale in Feet

SYMBOL EXPLANATION

[For geologic line symbols: lines are solid where location is accurate, long-dashed where location is approximate, short-dashed where location is inferred, dotted where location is concealed. Queries added where identity or existence may be questionable.]

Contacts

Contact

Reference contact -- Used to delineate geologic units that were mapped as separate units on the original source map, but are consolidated on this map.

Fault -- Includes strike-slip, normal, reverse, oblique, and unspecified slip

Folds -- Showing direction of plunge where appropriate

Anticline

Syncline

Stream

Wet area

Road

County boundary

MAP UNITS

- All units may not apply -

Late Holocene (Surficial Deposits)

af — **Artificial Fill** - deposits of fill resulting from human construction, mining, or quarrying activities; includes engineered fill for buildings, roads, dams, airport runways, harbor facilities, and waste landfills

Qls — **Landslide Deposits** - may include debris flows and older landslides of various earth material and movement types; unconsolidated to moderately well-consolidated

Qb — **Beach Deposits** - unconsolidated marine beach sediments consisting mostly of fine- and medium-grained, well-sorted sand

Qw — **Alluvial Wash Deposits** - unconsolidated sandy and gravelly sediment deposited in recently active channels of streams and rivers; may contain loose to moderately loose sand and silty sand

Qa — **Alluvial Valley Deposits** - unconsolidated clay, silt, sand, and gravel recently deposited parallel to localized stream valleys and/or spread more regionally onto alluvial flats of larger river valleys; sandy sediment generally more dominant than gravelly sediment

Ql — **Lacustrine, Playa, and Estuarine (Paralic) Deposits** - mostly unconsolidated fine-grained sand, silt, mud, and clay from fresh water (lacustrine) lakes, saline (playa) dry lakes that are periodically flooded, and estuaries; deposits may contain salt and other evaporites

Qe — **Eolian and Dune Deposits** - unconsolidated, generally well-sorted wind-blown sand; may occur as dune forms or sheet sand

Holocene to Late Pleistocene (Surficial Deposits)

Qyf — **Young Alluvial Fan Deposits** - unconsolidated to slightly consolidated, undissected to slightly dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon

Qya — **Young Alluvial Valley Deposits** - unconsolidated to slightly consolidated, undissected to slightly dissected clay, silt, sand, and gravel along stream valleys and alluvial flats of larger rivers

Qyl — **Young Lacustrine, Playa, and Estuarine (Paralic) Deposits** - unconsolidated to slightly consolidated, undissected to slightly dissected fine-grained sand, silt, mud and clay from lake, playa, and estuarine deposits of various types

Qye — **Young Eolian and Dune Deposits** - unconsolidated to slightly consolidated, undissected to slightly dissected wind-blown sands

Late to Middle Pleistocene (Surficial Deposits)

Qof — **Old Alluvial Fan Deposits** - slightly to moderately consolidated, moderately dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon

Qoa — **Old Alluvial Valley Deposits** - slightly to moderately consolidated, moderately dissected clay, silt, sand, and gravel along stream valleys and alluvial flats of larger rivers

Qol — **Old Lacustrine, Playa, and Estuarine (Paralic) Deposits** - slightly to moderately consolidated, moderately dissected fine-grained sand, silt, mud, and clay from lake, playa, and estuarine deposits of various types

Qoe — **Old Eolian and Dune Deposits** - slightly to moderately consolidated, moderately dissected wind-blown sands

Middle to Early Pleistocene (Surficial Deposits)

Qvof — **Very Old Alluvial Fan Deposits** - moderately to well-consolidated, highly dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon

Quaternary (Bedrock)

Qss — **Coarse-grained formations of Pleistocene age and younger** - primarily sandstone and conglomerate

Qsh — **Fine-grained formations of Pleistocene age and younger** - includes fine-grained sandstone, siltstone, mudstone, shale, siliceous and calcareous sediments

Tertiary (Bedrock)

Tss — **Coarse-grained Tertiary age formations** - primarily sandstone and conglomerate

Tsh — **Fine-grained Tertiary age formations** - includes fine-grained sandstone, siltstone, mudstone, shale, siliceous and calcareous sediments

Tv — **Tertiary age formations of volcanic origin**

Mesozoic and Older (Bedrock)

pKm — **Cretaceous and pre-Cretaceous metamorphic formations of sedimentary and volcanic origin**

Basemap modified from "Geologic Compilation of Quaternary Surficial Deposits in Southern California Onshore Portion of the Long Beach 30' x 60' Quadrangle", July 2010, www.conservation.ca.gov/cgs

Source: D. Scott Magorien, CEG; February 28, 2014.

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Holocene-Age Alluvial Deposits

Holocene age alluvial, and likely fluvial (i.e., floodplain) sediments directly underlie the surficial topsoil and undocumented fill soils beneath the entire Project site. These natural soils consist of layers and lenses of fine-grained mixtures of silt, sand, and clay with lesser amounts of gravel. In general, these silty sand layers are dusky brown to brown in color, moisture varying from dry to damp, generally medium dense, slightly porous to porous, contain scattered gravel, and occasional white-colored stringers of undetermined composition. Limited laboratory testing of these particular soils indicate they are normally consolidated, not susceptible to hydroconsolidation, and therefore suitable for foundation support for roadways and lightly loaded structures.

Layers of silty clay and clayey silt soils are generally light brown to reddish brown in color, moist to very moist, soft to firm, non-porous to porous, contain scattered small pebbles and some caliche (i.e., calcium carbonate) and medium-grained sand, occasional white-colored stringers of undetermined composition. Laboratory testing of these soils indicate they are normally consolidated and not susceptible to collapse/hydroconsolidation, but are classified by California Building Codes (Table 18-I-B) (2001) as having a medium expansion potential. Expansive soils are soils that shrink or swell as the moisture content decreases or increases. Structures built on these soils without mitigation may experience shifting, cracking, and tilting damage as the soils shrink or expand. Limited corrosion testing of these silty clay and clayey silt soils also indicated they are very to extremely corrosive. Corrosive soils have the potential to damage metal/concrete. Overall, these soils are suitable for foundation support for roadways and light loaded structures; additional reinforcement appropriate with the expansive nature of these soils is necessary.

From a geotechnical perspective, the Holocene-age, and older, alluvial soils have sufficient soil engineering strengths to provide foundation support. Given the relatively dense nature of these deposits, and the absence of any significant slopes, there are no significant constraints associated with seismically-induced landsliding, lurching, or lateral spread. However, laboratory testing and analyses by LGC indicates that some isolated sandy layers are subject to seismically-induced liquefaction; see *Liquefaction* Section below.

GROUNDWATER

The uppermost 80 to 90 feet of the alluvium that underlies the Project site is composed primarily of fine-grained sediments, similar to those encountered by LGC in their exploratory borings, which correlate to the Bellflower Aquitard. An aquitard is defined as a layer of rock or soil, which can be fully or partially saturated with groundwater, but has such low permeability they do not readily transmit water to wells, springs, or adjacent aquifers. Below depths of 80 to 90 feet below ground surface, groundwater is typically encountered within layers of water-bearing clayey silts, sandy silts, or fine-grained sands. In the immediate Project site vicinity, moderately to high permeability sands and gravelly sands have been reported from well data below depths of 100 feet below the ground surface, which are correlative with either the Gage or Jefferson Aquifer. Historic high groundwater levels beneath the Project site vary from approximately 30 feet below ground surface (bgs) in the western most portion of the site, to approximately 60 feet bgs along the eastern margin of the site. However, more recent groundwater level data in the vicinity indicates depth to groundwater varies between 70 and 80 feet bgs. No evidence of springs or seeps has been documented within or adjacent to the Project site.

MINERAL RESOURCES

There are no documented metallic or non-metallic mineral deposits, oil or gas prospects, or significant paleontological (i.e., fossils) sites within the Project site. The nearest oil fields are the Santa Fe Springs and Whittier fields that lie approximately 1.5 miles and 1.8 miles northeast of the Project site, respectively. According to a State of California Division of Oil, Gas, and Geothermal Resources (DOGGR) District 1 map, the closest plugged/abandoned "dry" exploratory oil well is located approximately 700 feet east of the Project site. This well is identified as Humble Oil and Refining Co, Whittier Operation, Unit One - 1 (#141).

GEOLOGIC HAZARDS AND GEOTECHNICAL CONSTRAINTS

The analysis provided below addresses the potential for geologic hazards and geotechnical constraints to exist at the Project site. Hazards associated with earthquakes include primary seismic hazards, such as strong ground shaking and surface rupture, and secondary seismic hazards, such as liquefaction, lateral spreading, seismically-induced settlement and landsliding, tsunamis, and seiche. The potential geotechnical constraints addressed below include landslides, land subsidence, corrosive soils, expansive soils, subsidence, sloughing or caving of excavations, slope stability, and soil erosion.

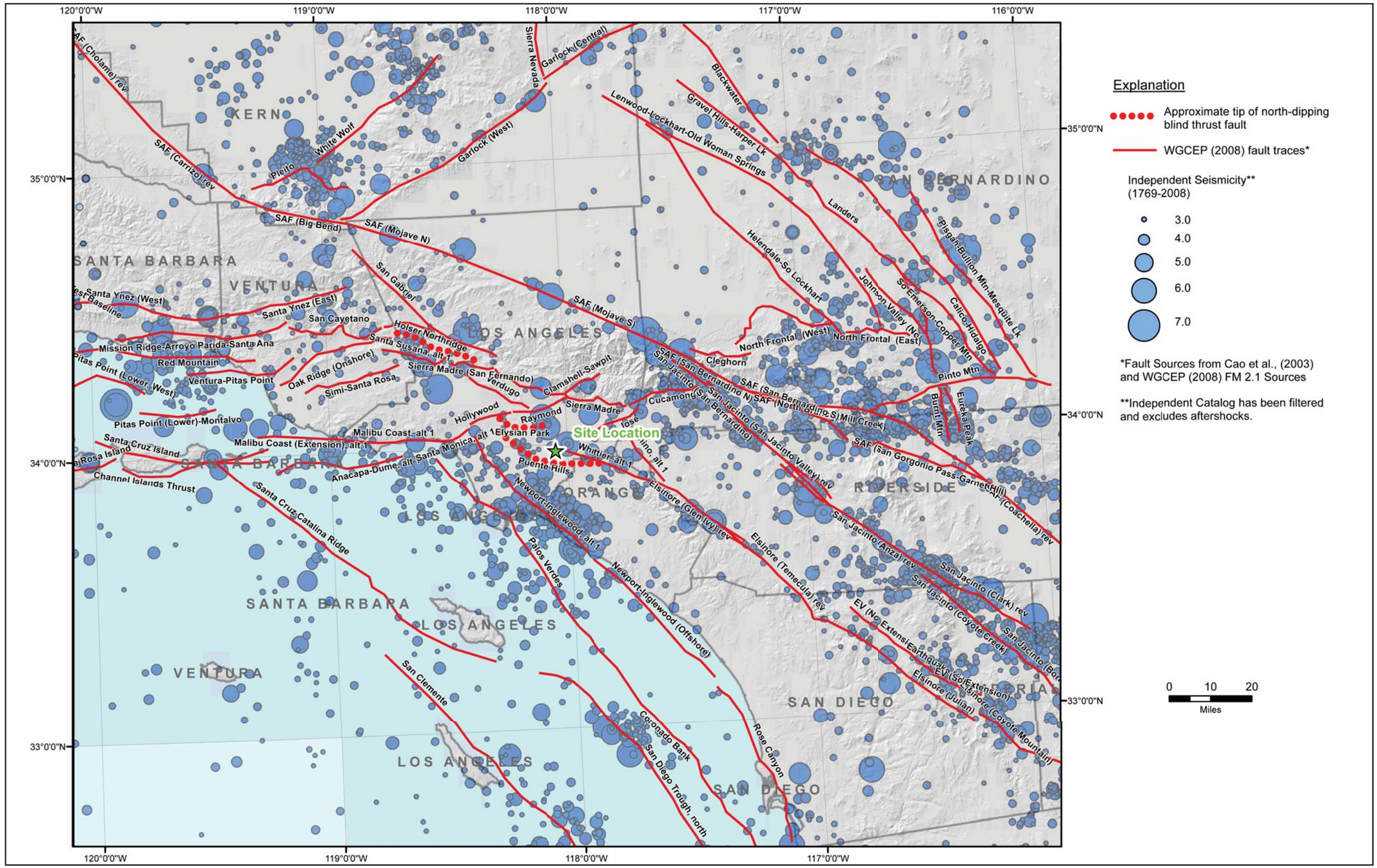
Seismicity and Faulting

As shown in Exhibit 5.5-2, *Fault Location and Seismicity Map*, the Project area is situated within a highly seismically active area of southern California referred to as the Los Angeles Basin. In accordance with the CGS, a fault is defined as a fracture in the crust of the earth along which rocks on one side have moved relative to those on the other side. Most faults are the result of repeated displacements over a long period of time. An inactive fault is a fault that has not experienced earthquake activity within the last three million years. In comparison, an active fault is one that has experienced earthquake activity in the past 11,000 years. A fault that has moved within the last two to three million years, but has not been proven by direct evidence to have moved within the last 11,000 years, is considered potentially active.

Primary Seismic Hazards

STRONG SEISMICALLY-INDUCED GROUND MOTION

The Modified Mercalli Intensity (MMI) scale was developed in 1931 and measures the intensity of an earthquake's effects in a given locality, and is perhaps much more meaningful to the layman because it is based on actual observations of earthquake effects at specific places. On the MMI scale, values range from I to XII. The most commonly used adaptation covers the range of intensity from the conditions of: "I - not felt except by very few, favorably situated, to XII – damage total, lines of sight disturbed, and objects thrown into the air." While an earthquake has only one magnitude, it can have multiple intensities, which decrease with distance from the epicenter. In the case of the 1994 Northridge earthquake, the Santa Clarita/Newhall area experienced MMIs between VII and VIII. Ground motions, on the other hand, are often measured in percentage of gravity (percent g), where g = 32 feet per second per second (980 cm/sec^2) on the earth.



Source: D. Scott Magorien, CEG; February 28, 2014.

LINCOLN SPECIFIC PLAN
ENVIRONMENTAL IMPACT REPORT

Fault Locations and Seismicity Map

Exhibit 5.5-2

RBF CONSULTING A Baker Company

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Based on the CGS Seismic Hazard Zone Report for the Whittier 7.5-Minute Quadrangle that applies peak ground acceleration (PGA) for 10 percent exceedance in 50 years for alluvial-type soils, the level of ground motion at the Project site is expected to be approximately 0.46 g. However, based on site-specific studies presented in the LGC Report that follow the guidelines in Chapter 16 Section 1613 of the 2010 California Building Code (CBC), the design PGA for the Project site is somewhat higher, 0.53g.

A listing of active faults considered capable of producing moderate to strong ground motion at the Project site, their closest distances to the site, and the maximum expected earthquake (M) along each fault, as well as fault characteristics are presented in Table 5.5-1, *List of Active Faults*.

Table 5.5-1
Summary of Active Faults and Generalized Earthquake Information

Name	Closest Distance (km)	Site Lies	Moment Magnitude (Mw)	Fault Mechanism
Whittier	1.69	SW	7.849	Oblique SS
Puente Hills (Santa Fe Springs)	5.36	N	6.7	Reverse
Puente Hills	6.62	Above	7.1	Reverse
Puente Hills (Coyote Hills)	7.29	NW	6.9	Reverse
Puente Hills (LA)	7.31	E	7.0	Reverse
Elysian Park (Upper)	11.28	SE	6.7	Reverse
Raymond	16.90	S	6.8	Reverse
San Jose	17.19	SW	6.7	Strike Slip
Verdugo	19.36	SE	6.9	Reverse
Newport-Inglewood	20.88	NE	7.5	Strike Slip
Sierra Madre	21.11	S	7.2	Reverse
Sierra Madre Connected	21.11	S	7.3	Reverse
Clamshell-Sawpit	22.57	S	6.7	Reverse
Hollywood	22.68	SE	6.7	Strike Slip
Chino	23.25	W	6.8	Strike Slip
Santa Monica	25.87	E	7.4	Strike Slip/Reverse
Palos Verdes	31.87	NE	7.3	Strike Slip
Palos Verdes Connected	31.87	NE	7.0	Strike Slip
San Joaquin Hills	33.47	N	7.1	Reverse
Cucamonga	33.82	SW	6.7	Reverse
Sierra Madre (San Fernando)	40.11	SE	6.7	Reverse
San Gabriel	43.13	SE	7.3	Strike Slip
Malibu Coast	44.02	E	7.0	Strike Slip
Anacapa-Dume	46.40	E	7.2	Reverse
Northridge	46.54	SE	6.9	Reverse
Southern San Andreas	54.35	SW	8.2	Strike Slip
Santa Susana, alt 1	56.05	SE	6.9	Reverse
San Jacinto	56.74	NW	7.875	Strike Slip
Holser, alt 1	65.13	SE	6.8	Reverse
Cleghorn	65.37	SW	6.8	Strike Slip
Simi-Santa Rosa	69.44	SE	6.9	Strike Slip
Oak Ridge Connected	73.71	SE	7.4	Reverse

Source: D. Scott Magorien C.E.G., *Geology, Soils, and Seismicity Report Lincoln Specific Plan*, February 28, 2014.

Ground shaking accompanying earthquakes on nearby faults can be expected to produce the potential for strong ground motion at the Project site. The greatest amount of ground shaking at the Project site would be expected to accompany large earthquakes on the nearby Whittier Fault, the Puente Hills (Santa Fe Springs or Coyote Hills segments) Blind Thrust Faults, Newport-Inglewood Fault, or the Sierra Madre Fault. Earthquake magnitudes in the range of M6.5 to M7.3 could produce MMI in the range of VIII to XI within the property.

SURFACE RUPTURE

Although the Project area is located within a highly seismically active portion of the State, there are no documented active or potentially active faults transecting or projecting towards the site.

A seismically active blind thrust fault known as the Puente Hills Blind Thrust Fault underlies the site at a depth of approximately 4.5 miles. The closest distance from the Site to this blind thrust fault is based on a vertical projection of the rupture surface along the subsurface trace of the fault. These faults are termed "blind thrust faults," because they have no surface exposure, and, therefore, do not create a potential for direct ground surface rupture. However, a significant earthquake on the Puente Hills Blind Thrust Fault, such as the January 17, 1994, M6.7 Northridge earthquake that occurred on a blind thrust fault in the San Fernando Valley, can produce significant vibratory ground motion at the Project site, as discussed above.

The Project area is not located within an Alquist-Priolo Earthquake Fault Zone, according to the CGS; see the *Alquist-Priolo Earthquake Fault Zoning Act* Section below.

Secondary Seismic Hazards

LIQUEFACTION

Seismic ground shaking of relatively loose, granular soils that are saturated or submerged can cause the soils to liquefy and temporarily behave as a dense fluid. Liquefaction is caused by a sudden temporary increase in pore water pressure due to seismic densification or other displacement of submerged granular soils. Liquefaction more often occurs in earthquake-prone areas underlain by young (i.e., Holocene age) alluvium where the groundwater table is less than 50 feet below ground surface.

The CGS has designated certain areas within California as potential liquefaction hazard zones. As shown on the State of California's Seismic Hazard Zone Map for the Whittier 7.5' Quadrangle, the southern and southwestern portions of the Project site lie within an area that is considered to be potentially susceptible to earthquake-induced liquefaction; see the *Liquefaction Hazard* Section below. Further, site-specific liquefaction analyses performed by LGC for the site indicate that isolated sandy layers in the underlying Holocene-age alluvium are subject to liquefaction during a significant earthquake. However, the results of their analyses, using the historic high groundwater level of 30 feet below the existing ground surface, indicates that the total seismic-related soil settlements would be approximately 0.5 inches within the upper 50 feet of the alluvium. Given this very limited amount of potential settlement that would be spread over a soil thickness of 50 feet, the potential for this liquefaction hazards at the Project site is negligible.

LATERAL SPREADING

Lateral spreading involves the dislocation of near surface soils generally along a near-surface liquefiable layer. In many cases, this phenomenon of shallow landsliding occurs on relatively flat or gently sloping ground adjacent to a "free face," such as a river embankment. Given the site conditions, the likelihood for lateral spread beneath the Project site during a major earthquake in the area is nonexistent.

SEISMICALLY-INDUCED LANDSLIDING

Based on the essentially flat nature of the Project site, and the absence of any adversely-oriented, weak clay beds, the potential for seismically-induced landsliding within the site is considered nil.

SEISMICALLY-INDUCED SOIL SETTLEMENT

Strong ground shaking can cause settlement by allowing sediment particles to become more tightly packed, thereby reducing pore space. Unconsolidated, loosely packed sediments, such as native topsoil and young alluvial are especially susceptible to this phenomenon. Poorly compacted (i.e., non-engineered) artificial fills may also experience seismically-induced settlement. Based on the subsurface data obtained by LGC, the Project site is mantled with topsoil and in certain places by non-engineered (i.e., loose) fill soils that are likely subject to seismically-induced settlement and/ or development of ground cracking.

FLOODING/TSUNAMI RUN-UP

Flood hazards include storm-induced flooding, and those caused by earthquakes, namely tsunami and dam failure. According to the latest (September 26, 2008) Flood Insurance Rate Map (FIRM) prepared by Federal Emergency Management Agency (FEMA), the site does not lie within either a 100-year or 500-year flood area, or within a dam inundation area.

A tsunami is a sea wave generated by an earthquake, landslide, volcanic eruption, or even by a large meteor hitting the ocean. An event such as an earthquake creates a large displacement of water resulting in a rise or mounding at the ocean surface that moves away from this center as a sea wave. Tsunamis generally affect coastal communities and low-lying (low-elevation) river valleys in the vicinity of the coast. Buildings closest to the ocean and near sea level are most at jeopardy. According to the CGS, the site and surrounding neighborhood lie outside a tsunami inundation area; see the *Tsunami* Section below.

GROUND LURCHING

Lurching is a phenomenon in which loose to poorly consolidated deposits move laterally as a response to strong ground shaking during an earthquake. Lurching is typically associated with soil deposits on or adjacent to steep slopes.

Certain soils have been observed to move in a wave-like manner in response to intense seismic ground shaking, forming ridges or cracks on the ground surface. Areas underlain by thick accumulations of young alluvium appear to be more susceptible to ground lurching than bedrock. Under strong seismic ground motion conditions, lurching can be expected within loose, cohesionless soils, or in clay-rich soils with high moisture content. Generally, only lightly-loaded structures such as pavement, fences, pipelines and walkways are damaged by ground lurching; more heavily loaded structures appear to resist such deformation. Based on the

proposed grading, and the relatively dense nature of the alluvial soils, the likelihood that lurching would affect the Project site is considered remote.

SEICHING

Seiching involves an enclosed body of water oscillating due to ground shaking, usually following an earthquake. Lakes and water towers are typical bodies of water affected by seiching. Given that there are no large, enclosed open bodies of water or reservoirs upgradient of the Project area, there is no potential for seiching at the Project site.

CONCLUSION

Given the generally dense nature of the alluvial sediments, elevation, and distance from the Pacific Ocean, and depth to groundwater, secondary seismic hazards due to moderate to strong earthquake ground motions from future earthquakes in the region (such as liquefaction, lateral spreading, seismically-induced landsliding, flooding/tsunami run-up, ground lurching, and seiching) are not potentially hazardous to the Project site. However, given the Project site is mantled with topsoil and in certain places by non-engineered (i.e., loose) fill soils, the Project site is likely subject to seismically-induced settlement and/or development of ground cracking.

Other Geotechnical Constraints

LANDSLIDES

There are no documented landslides within or adjacent to the Project area. Therefore, no potential hazard exists in this regard.

CORROSIVE SOILS

Corrosive soils contain chemical constituents that can react with construction materials, such as concrete and ferrous metals, that may cause damage to foundations and buried pipelines. One such constituent is water-soluble sulfate which, if in high enough concentration, can react with and damage concrete. Electrical resistivity and pH levels are indicators of the soil's tendency to corrode ferrous metals. According to limited laboratory testing by LGC, near-surface native alluvial soils have a neutral to relatively mildly alkaline pH value (7.1 to 7.6), and minimum resistivity values ranging from 650 to 1.500 ohm-cm, indicating these soils are considered severely corrosive to ferrous metals in contact with these soils. Thus, LGC concludes that onsite soils are corrosive to ferrous metals.

Laboratory tests by LGC (2013) also indicate water soluble sulfate contents of less than 0.02 percent, which is an indication of negligible sulfate exposure. As such, no particular recommendations for cement type or water ratio were deemed necessary by LGC to provide sulfate resistance.

EXPANSIVE SOILS

Expansive soils are clay-rich soils that can undergo significant increase in volume with increased water content and significant decrease in volume with a decrease in water content. Significant changes in moisture content within moderately to highly expansive soil can produce cracking, differential heave, and other adverse impacts to structures constructed on such soils. Based on the results of laboratory testing performed by LGC on seven clayey soil samples, the

native soils exhibit a “moderate expansion potential.” Therefore, the soils that are present on the Project site are expansive and pose a significant development constraint.

SUBSIDENCE

The extraction of groundwater or oil from sedimentary source rocks can cause the permanent collapse of pore space that was previously occupied by the removed fluid. The compaction of subsurface sediments resulting from fluid withdrawal can and has caused the ground surface overlying fluid reservoirs to subside. If sufficiently great, the subsidence can cause significant damage to nearby engineered structures. Land subsidence has in the past been associated with withdrawals of oil from a number of oil and gas fields in southern California (i.e., Wilmington, Inglewood, Buena Vista Hills, Santa Fe Springs, and Huntington Beach).

The nearest oil fields to the Project site are the Santa Fe Springs and Whittier fields that lie approximately 1.5 miles and 1.8 miles northeast of the Project site, respectively. Land subsidence has not been identified within these nearby oil and gas fields. No significant subsidence associated with fluid withdrawal (groundwater or petroleum), peat oxidation, or hydrocompaction has occurred in the City of Whittier, and none is expected on the Project site.

SOIL EROSION

Soil erosion is most prevalent in more weakly consolidated (i.e., highly weathered) surficial soils, which are prone to downcutting during and after heavy rainstorms. Strong wind forces can also produce varying amounts of soil erosion of the more weakly consolidated surficial soils.

The short-term effects of soil erosion during rough grading for the Project are not considered significant given that the Project site is essentially flat and does not possess site conditions necessarily conducive to soil erosion.

SLOUGHING OR CAVING OF EXCAVATIONS

Excavations on the Project site would encounter topsoil and existing artificial fill soils, which may be subject to sloughing and caving, if unsupported. These conditions have the potential to create short-term hazards to construction workers and equipment.

5.5.2 EXISTING REGULATORY SETTING

FEDERAL AND STATE

Soil and Water Resources Conservation Act

The purpose of the Soil and Water Resources Conservation Act of 1977 is to protect or restore the functions of the soil on a permanent sustainable basis. Protection and restoration activities include prevention of harmful soil changes, rehabilitation of the soil of contaminated sites and of water contaminated by such sites, and precautions against negative soil impacts. If impacts are made on the soil, disruptions of its natural functions and of its function as an archive of natural and cultural history should be avoided, as far as practicable. In addition, the requirements of the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) through the National Pollution Discharge Elimination System (NPDES) permit) provide guidance for protection of geologic and soil resources.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code 2621-2624, Division 2 Chapter 7.5) was passed to mitigate the hazard of surface faulting to structures for human occupancy. The Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Act requires the State Geologist to establish regulatory zones, known as "Earthquake Fault Zones," around the surface traces of active faults and to issue appropriate maps. Local agencies must regulate most development projects within these zones. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults. An evaluation and written report of a specific site must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (typically 50 feet set backs are required). According to the Alquist-Priolo Earthquake Fault Zone Map – Whittier Quadrangle, the Project site is not affected by a State-designated AP Earthquake Fault Zone.[1] The closest Earthquake Fault Zone to the Project site is the Whittier Fault Zone (WFZ) located approximately one mile to the north.

Effective June 1, 1998, the Natural Hazards Disclosure Act requires that sellers of real property and their agents provide prospective buyers with a "Natural Hazard Disclosure Statement" when the property is being sold lies within one or more State-mapped hazard areas, including Earthquake Fault Zones.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (SHMA) of 1990 directs the Department of Conservation, California Geological Survey to identify and map areas prone to liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the SHMA is to minimize loss of life and property through the identification, evaluation, and mitigation of seismic hazards. Staff geologists in the Seismic Hazard Zonation Program gather existing geological, geophysical, and geotechnical data from numerous sources to produce the Seismic Hazard Zone Maps. They integrate and interpret these data regionally in order to evaluate the severity of the seismic hazards and designate as Zones of Required Investigation (ZORI) those areas prone to liquefaction and earthquake–induced landslides. Cities and counties are then required to use the Seismic Hazard Zone Maps in their land use planning and building permit processes.

The Seismic Hazards Mapping Act requires site-specific geotechnical investigations be conducted within the ZORI to identify and evaluate seismic hazards (i.e., liquefaction and earthquake induced landslides) and formulate mitigation measures prior to permitting most developments designed for human occupancy.

LIQUEFACTION HAZARD

Liquefaction occurs when loose, water-saturated sediments lose strength and fail during strong ground shaking. Liquefaction is defined as the transformation of granular material from a solid state into a liquefied state as a consequence of increased pore-water pressure. The process of zonation for liquefaction combines Quaternary geologic mapping, historical ground-water information and subsurface geotechnical data. The liquefaction hazard ZORI boundaries are

[1] State of California Department of Conservation, California Geological Survey, Alquist-Priolo Earthquake Fault Zone Maps, http://www.quake.ca.gov/gmaps/ap/ap_maps.htm, Accessed March 7, 2014.

based on the presence of shallow (less than 40 feet depth) historic groundwater in uncompacted sands and silts deposited during the last 15,000 years and sufficiently strong levels of earthquake shaking expected during the next 50 years. According to the Seismic Hazards Zones Map for the Whittier Quadrangle (Released March 25, 1999), the western portion of the Project site is located within a ZORI for liquefaction hazard.[2] The Map further explains the ZORI for liquefaction hazard as "areas where historic occurrence of liquefaction, or local geological, geotechnical, and groundwater conditions indicate a potential for permanent ground displacements such that mitigation, as defined in Public Resources Code Section 2693(c) would be required." Refer also to the *Liquefaction* Section above.

EARTHQUAKE-INDUCED LANDSLIDES

Landslides tend to occur in weak soil and rock on sloping terrain. The ZORI for earthquake-induced landslides generally indicate areas characterized by steep slopes composed of weak materials that may fail when shaken by an earthquake. The process for zonation of earthquake-induced landslides incorporates expected levels of future earthquake shaking, evidence of existing landslides, slope gradient, and strength of hillslope materials. According to the Seismic Hazards Zones Map for the Whittier Quadrangle (Released March 25, 1999), the Project site is not located within a ZORI for earthquake-induced landslide hazard.[3]

TSUNAMIS

According to the CGS Los Angeles County Tsunami Inundation Maps,[4] the Project site is not located within a tsunami inundation area. Additionally, based on the distance of the Project site from large bodies of open water, the possibility of seiches and/or tsunamis affecting the site is considered remote.[5]

International Building Code

Development standards require projects to comply with appropriate seismic design criteria in the International Building Code (IBC) (with California Amendments), adequate drainage facility design, and preconstruction soils and grading studies. Seismic design standards have been established to reduce many of the structural problems occurring because of major earthquakes. In 1998, the IBC was revised, as follows:

- Upgrade the level of ground motion used in the seismic design of buildings;
- Add site amplification factors based on local soils conditions; and
- Improve the way ground motion is applied in detailed design.

California Building Code

California building standards are published in the California Code of Regulations, Title 24, also known as the CBC. The recently published 2013 CBC took effect July 1, 2014. The CBC, which applies to all applications for building permits, consists of 12 parts, including among others Part 2 - California Building Code and Part 11 - California Green Building Standards Code

[2] State of California Department of Conservation, California Geological Survey, Regional Geologic Hazards and Mapping Program, http://www.quake.ca.gov/gmaps/ap/ap_maps.htm, Accessed March 7, 2014.

[3] Ibid.

[4] State of California, Department of Conservation Website, *Los Angeles County Tsunami Inundation Maps*, http://www.quake.ca.gov/gmaps/tsunami/tsunami_maps.htm, Accessed March 7, 2014.

[5] Lawson & Associates Geotechnical Consulting, Inc., Geotechnical Feasibility Study, Proposed Development, Fred C. Nelles Site, 11850 East Whittier Boulevard, City of Whittier, California, February 25, 2005.

(CALGreen Code). CBC Part 2 is based upon the 2009 International Building Code. Local agencies must ensure that all development complies with the CBC guidelines. Cities and counties have the ability to adopt additional building standards beyond the CBC.

California Historical Building Code

The 2010 California Historical Building Code (CHBC) (California Code of Regulations, Title 24, Part 8) requires city building departments to apply the provisions of alternative building standards and building regulations adopted by the CHBC Board in permitting repairs, alterations, and additions necessary for the preservation, restoration, rehabilitation, moving, or continued use of an historical building or structure. The purpose of the CHBC is to provide such regulations for buildings or properties designated as qualified historical buildings or properties. The intent of the CHBC is to facilitate the preservation and continuing use of qualified historical buildings or properties while providing reasonable safety for the building occupants and access for persons with disabilities.

CITY OF WHITTIER MUNICIPAL CODE

WMC Chapter 12.28, Excavations and Grade Changes

The purpose of this Chapter of the Whittier Municipal Code (WMC) is to safeguard life, limb, health, property, and the public welfare by regulating and controlling the design, construction, quality of materials, the location and maintenance of buildings and structures, and the grading and filling of land within the City.

WMC Section 12.28.020, Applicability. According to this Section, no person shall commence or make any excavation or fill upon any lot, parcel, street or alley without complying with all applicable provisions of this Chapter and all other City regulations relating to excavations, earth removal, compaction, hauling, or protection of slopes. This Chapter applies also to all persons dividing land pursuant to the subdivision regulations of this Code (Title 17). The Grading Plan shall be submitted to the City Engineer for approval prior to the approval of the Final Tract Map.

WMC Section 12.28.030 Permit – Required. This Section specifies that no person is allowed to raise or lower the existing grade of any lot or make excavation or fill, which changes the grade of the natural slope of the surface of any lot, unless a Grading Permit is obtained.

WMC Chapter 15.04, Building Codes

According to this Chapter, the 2010 Edition of the California Administrative Code was adopted with no amendments, as the City's building administrative code to regulate the site preparation, erection, construction, alteration, demolition, and occupancy, among other actions, of all buildings and/or structures in the City. Additionally, except as provided in WMC Chapter 15.04, the California Building Code, 2010 Edition, Volumes 1 and 2 including Appendix Chapters A, C, D, F, G, H, I, and J with all errata, was adopted with amendments for the purpose of regulating the erection, construction, alteration, demolition, and occupancy, among other actions, of all buildings and/or structures in the City.

WMC Chapter 17.06, Tentative Map Filing Procedures

This Chapter establishes requirements for the preparation and filing of Tentative Maps, consistent with the requirements of the Subdivision Map Act. According to WMC Section 17.06.030, *Filing and Processing Requirements*, the Tentative Map must be accompanied by a Geological/Geotechnical Report (if required by the City Engineer, prepared by a licensed geologist, registered civil engineer and/or geotechnical engineer, stating the effect of geological or soil conditions on the proposed development.

WMC Chapter 17.08, Final Tract Maps and Parcel Maps

This Chapter establishes requirements for the preparation, filing, processing, approval, conditional approval or denial, and recordation of Final Tract and Parcel Maps, consistent with the requirements of the Subdivision Map Act.

WMC Section 17.08.020, Final Tract and Parcel Map Form and Content. According to this Section, a preliminary Geotechnical Report, prepared by a state-registered civil or geotechnical engineer in compliance with Building Code requirements, and based upon test borings and prepared, is required for all tract maps and for those parcel maps, which involve commercial or industrial development.

WMC Chapter 17.12, Subdivision Design and Improvement Requirements

This Chapter establishes standards for the design and layout of subdivisions, and the design, construction and installation of public improvements within subdivisions. As specified in WMC Section 17.12.160, *Geotechnical Report Required*, a Geotechnical Report is required for each subdivision or other division of land contemplated by the Subdivision Map Act or Title 17. Notwithstanding the provisions of this Section, the City Council may waive the requirement of a Preliminary Soils Report if it finds that due to staff knowledge concerning the quality of soils included within the subdivision or other division of land no such preliminary analysis is necessary. Where geotechnical reports are required, and the same disclose an unstable condition, the City shall require appropriate steps to be taken to correct such condition; or if such unstable condition cannot be eliminated, the subdivision or other division of land shall be disapproved.

5.5.3 IMPACT THRESHOLDS AND SIGNIFICANCE CRITERIA

The environmental analysis in this section is patterned after the Initial Study Checklist recommended by Appendix G of the *CEQA Guidelines*, as amended, and used by the City of Whittier in its environmental review process. The Initial Study Checklist includes questions relating to geology and soils. The issues presented in the Initial Study Checklist have been utilized as thresholds of significance in this section. Accordingly, a project may create a significant environmental impact if it would:

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

- Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42 (refer to Section 8.0, *Effects Found Not to be Significant*).

- Strong seismic ground shaking.

- Seismic-related ground failure, including liquefaction.

- Landslides (refer to Section 8.0, *Effects Found Not to be Significant*).

- Result in substantial soil erosion or the loss of topsoil.

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

- Be located on expansive soil, as defined in Table 18-1-B of the California Building Code (1994), creating substantial risks to life or property.

- 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 (refer to Section 8.0, *Effects Found Not to be Significant*).

Earth resource and/or topographic impacts resulting from the proposed Project could be considered significant if any of the following occur:

- Exposure of people or property to substantial geological hazards, such as flooding due to dam or reservoir failure, landslides, mudslides, ground failure or similar hazards; or soil and/or seismic conditions so unfavorable that they could not be overcome by design using reasonable construction and/or maintenance practices;

- Location of a structure within a mapped hazard area or within a structural setback zone;

- Location of a structure within an Alquist-Priolo Fault-Rupture Hazard Zone, or an area characterized by surface rupture that might be related to a fault;

- Triggering or acceleration of geologic processes, such as landslides or erosion that could result in slope or embankment/levee failures;

- Substantial irreversible disturbance of the soil materials at the Project site or adjacent sites, such that their use is compromised;

- Modification of the surface soils such that abnormal amounts of windborne or waterborne soils are removed from the Project site;

- Earthquake-induced ground shaking capable of causing ground rupture, liquefaction, soil settlement, landsliding resulting in substantial damage to people and/or property;

- Deformation of foundations by expansive soils (those characterized by shrink/swell potential) or collapsible soils; and/or

- Modification of the on-site topography (i.e., grading) in a manner that results in decreased stability for adjacent residential, commercial or industrial enclaves.

Based on these standards, the Project's effects have been categorized as either a "less than significant impact" or a "potentially significant impact." Mitigation measures are recommended for potentially significant impacts. If a potentially significant impact cannot be reduced to a less than significant level through the application of mitigation, it is categorized as a significant unavoidable impact.

5.5.4 IMPACTS AND MITIGATION MEASURES

STRONG SEISMIC GROUND SHAKING

- **THE PROJECT COULD EXPOSE PEOPLE OR STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS INVOLVING STRONG SEISMIC GROUND SHAKING.**

Impact Analysis: The Project would result in the development of 750 DU, 20,017 square feet of commercial uses within two existing structures to be adaptively reused, and 188,333 square feet of commercial uses within new structures; refer to Table 3-1. A moderate to large magnitude earthquake on a regional fault could cause moderate to severe seismic shaking in the City, thus exposing people or structures on the Project site to potential substantial adverse effects, including the risk of loss, injury, or death. The possibility of moderate to high ground acceleration in the City may be considered as approximately similar to the entire Southern California region, as a whole. Ground shaking accompanying earthquakes on nearby faults can be expected to produce the potential for strong ground motion during the design life of the proposed Project. The intensity of ground shaking on the Project site would depend upon the magnitude of the earthquake, distance to the epicenter, and the geology of the area between the epicenter and the Project site.

Given the proximity to major active faults, severe ground motion should be expected at the Project site. In general, the City regulates development (and reduces potential seismic and geologic impacts) under the requirements of the CBC, WMC, and Project-specific mitigation measures. Numerous controls would be imposed on future development through the permitting process that would lessen potential risks involving strong seismic ground shaking. The design, construction, and engineering of structures within the Specific Plan area would be subject to compliance with the City's Building Code, which adopted the 2010 CBC; see WMC Chapter 15.04. The City's Building Code provides minimum standards to safeguard property and public welfare from potential seismic and geologic hazards by regulating the design, construction, quality of materials, use and occupancy, location and maintenance of buildings, equipment, and structures. All structures associated with the proposed development must be designed to withstand the "design-level" earthquake, as set forth in the latest edition of the CBC. The potential adverse effects to people and new structures from strong, seismically-induced, vibratory ground motion would be sufficiently mitigated through proper seismic design and conformance with the City's Building Code. Additionally, Mitigation Measure GEO-1 requires compliance with the design recommendations set forth in the Geology Report and LGC Report. The exposure of people and new structures to potential adverse impacts involving strong, seismically-induced, vibratory ground motion would be reduced to less than significant through compliance with the CBC, WMC, and Mitigation Measure GEO-1.

The Project proposes to adaptively reuse two buildings (i.e., the Superintendent's Residence and Administration Building) and integrate them into the Heritage Court commercial area. Mitigation incorporated into this EIR (refer to Section 5.4, *Cultural Resources*) would also require preservation and adaptive reuse of the Chapels Building and Assistant Superintendent's Residence. As discussed in Section 5.4, these buildings are qualified historical buildings. As such, they are required to comply with the SHBC, which provides alternative building standards and building regulations intended to facilitate the preservation and continuing use of qualified historical buildings, while providing reasonable safety for the building occupants and access for persons with disabilities. The exposure of people and existing structures to potential adverse impacts involving strong, seismically-induced, vibratory ground motion would be reduced to less than significant through compliance with the SHBC and Mitigation Measure GEO-1.

Mitigation Measures:

GEO-1 Prior to Grading or Building Permit issuance, the Grading and Building Plans shall demonstrate compliance with the recommendations that pertain to seismic ground shaking set forth in the *Geology, Soils, and Seismicity Report Lincoln Specific Plan* (D. Scott Magorien C.E.G., February 28, 2014) and *Preliminary Geotechnical Evaluation Report Proposed Development, Fred C. Nelles Site* (LGC Geotechnical, Inc., April 26, 2013). These recommendations pertain to site earthwork recommendations, preliminary foundation design parameters, soil bearing and lateral resistance, lateral earth pressures for retaining walls, non-structural concrete flatwork, preliminary pavement design, geotechnical observation and testing. The geotechnical reports are included in Appendix 11.7, *Geology and Soils Reports* of this EIR and are incorporated by reference into this mitigation measure.

Level of Significance: Less Than Significant With Mitigation Incorporated.

SEISMIC-RELATED GROUND FAILURE

- **THE PROJECT COULD EXPOSE PEOPLE OR STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS INVOLVING SEISMIC-RELATED GROUND FAILURE.**

Impact Analysis: As part of the Project's Tentative Map Filing Procedures, WMC Section 17.08.020 requires preparation of a preliminary Geotechnical Report, which complies with Building Code requirements and is based upon test borings, for all tract maps and for those parcel maps that involve commercial development. Should the Geotechnical Report disclose an unstable condition, the City requires that appropriate steps be taken to correct such condition (WMC Section 17.12.160). In compliance with these Code provisions, Geological Report and LGC Report were prepared in support of the Project.

Given the historic land use, current site soil conditions, physiographic setting, and nature of the proposed site grading and structures, Project implementation would not expose additional people and structures to potential substantial adverse effects involving liquefaction, lateral spreading, seismically-induced landsliding, flooding/tsunami run-up, ground lurching, and seiching. Therefore, a less than significant impact would occur in this regard. However, given the Project site is mantled with topsoil and in certain places by non-engineered (i.e., loose) fill soils, Project implementation could expose additional people and structures to potential substantial adverse effects involving seismically-induced settlement and/or ground cracking.

The susceptibility of topsoil and undocumented fill soils to seismically-induced settlement presents a potentially significant impact to people and structures on the Project site. As noted above, numerous controls would be imposed on future development through the permitting process that would lessen potential risks involving seismically-induced settlement and/or ground cracking. According to WMC Chapter 12.28, the Grading Plan must be submitted to the City Engineer for approval prior to approval of the Final Tract Map. WMC Chapter 12.28 also specifies that no person is allowed to raise or lower the existing grade of any lot or make excavation or fill, which changes the grade of the natural slope of the surface of any lot, unless a Grading Permit is obtained and the proposed excavation or fill complies with all applicable provisions of Chapter 12.28 and all other City regulations relating to excavations, earth removal, and compaction. Moreover, to mitigate seismically-induced soil settlement and/or ground cracking, the Geology Report recommends removal and replacement of these soils with properly engineered fill. Thus, remedial grading during Project site development would remove these settlement-prone soils and replace them with properly compacted engineered fill. Once the Project site is graded, the potential for seismically-induced settlement and ground cracking is considered low. Mitigation Measure GEO-1 requires compliance with the building and grading design recommendations set forth in the Geology Report and LGC Report. Therefore, the exposure of people and structures to potential adverse impacts involving seismically-induced settlement and/or ground cracking would be reduced to less than significant through compliance with the WMC and remedial grading, as recommended in the Geology Report (see Mitigation Measure GEO-1).

Mitigation Measures: Refer to Mitigation Measure GEO-1.

Level of Significance: Less Than Significant With Mitigation Incorporated.

SOIL EROSION

- **THE PROJECT WOULD NOT RESULT IN SUBSTANTIAL SOIL EROSION OR THE LOSS OF TOPSOIL.**

Impact Analysis: Project implementation would result in ground-disrupting activities such as excavation and trenching for foundations and utilities, soil compaction and site grading, and the erection of new structures, all of which would temporarily disturb soils. However, the short-term effects of soil erosion during rough grading for the Project are not considered significant, given the site is essentially flat and does not possess site conditions necessarily conducive to soil erosion. Therefore, Project implementation would result in a less than significant impact involving soil erosion or the loss of topsoil. Moreover, as concluded in Section 5.8, *Hydrology and Water Quality*, the Project is subject to compliance with the National Pollutant Discharge Elimination System (NPDES) permitting process, since one or more acres of soil would be disturbed. Before Grading Permit issuance, the Applicant would be required to prepare a Stormwater Pollution Prevention Plan (SWPPP), in order to control common pollutants such as suspended soil in stormwater runoff from leaving the Project area. The SWPPP would include an Erosion Control Plan and appropriate Best Management Practices (BMPs). Following compliance with the established NPDES regulatory requirements, Project implementation would result in a less than significant impact involving soil erosion or the loss of topsoil.

Mitigation Measures: No mitigation measures are required.

Level of Significance: Less Than Significant Impact.

UNSTABLE GEOLOGIC UNIT OR SOILS

- **THE PROPOSED DEVELOPMENT COULD BE LOCATED ON A GEOLOGIC UNIT OR SOIL THAT IS UNSTABLE, OR THAT WOULD BECOME UNSTABLE AS A RESULT OF THE PROJECT, EXPOSING PEOPLE OR STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS.**

Impact Analysis: As concluded above, conditions conducive to sloughing or caving of excavations and slope instability exist at the Project site. During Project construction, excavations associated with remedial grading would encounter topsoil and existing artificial fill soils. If unsupported, these soils may be subject to sloughing and caving, hence creating a short-term hazard to construction workers and equipment. Additionally, the Preliminary Grading Plan (Fuscoe Engineering, November 22, 2013) indicates construction of a number of proposed 2:1 (horizontal to vertical), 6- to 16-foot-high fill slopes associated with construction of a number of large pads, and 3- to 5-foot-high 2:1 fill slopes along the margins of the Project site. No slope stability analyses have been performed for these slopes. Therefore, Mitigation Measure GEO-2 requires preparation of a 40-scale Geotechnical Review Report for the Grading Plan that addresses both the long-term surficial and gross stability of the slopes, together with grading recommendations to provide an adequate factor of safety against either form of instability. The exposure of people and structures to potential adverse impacts involving unstable geologic units/soils would be reduced to less than significant through compliance with the Mitigation Measure GEO-2, which requires compliance with the geotechnical reports recommendations and preparation of a 40-scale Geotechnical Review Report for the Grading Plan.

Mitigation Measures:

GEO-2 Prior to Grading or Building Permit issuance, a 40-scale Geotechnical Review Report shall be prepared for the Grading Plan that addresses both the long-term surficial and gross stability of the slopes, and makes grading recommendations to provide an adequate factor of safety against both sloughing or caving of excavations and slope instability. Recommendations are expected to pertain to site earthwork recommendations (including fill material, fill placement and compaction, trench and retaining wall backfill and compaction, and soil shrinkage), slab underlayment guidelines, and preliminary pavement design. The geotechnical reports are included in Appendix 11.7, *Geology and Soils Reports,* of this EIR and are incorporated by reference into this mitigation measure.

Level of Significance: Less Than Significant With Mitigation Incorporated.

EXPANSIVE SOILS

- **THE PROPOSED DEVELOPMENT COULD BE LOCATED ON EXPANSIVE SOIL CREATING SUBSTANTIAL RISKS TO LIFE OR PROPERTY.**

Impact Analysis: Expansive soils are types of soil that shrink or swell as the moisture content decreases or increases. Structures built on these soils without mitigation may experience shifting, cracking, and tilting damage as the soils shrink or expand. Based on the results of the laboratory test performed by LGC, both native and undocumented clay soils are anticipated to exhibit a moderate expansion potential and, therefore, the potential for expansive

soils to impact new development is considered high. As concluded by LGC, clayey soils would not be suitable for backfill behind any proposed retaining walls, and import of sandy soils meeting Project specifications would be required. For footings, foundations, and slab-on-grade floors for new structures, the Geology Report recommends corrective measures, such as post tensioned slabs, additional reinforcement of footings, etc. Mitigation Measure GEO-1 requires compliance with the site earthwork, building and foundation design recommendations set forth in the Geology Report and LGC Report. Therefore, the Project would create a less than significant impact involving risks to life or property resulting from development on expansive soils through implementation of corrective measures, as recommended in the Geology Report (see Mitigation Measure GEO-1).

Mitigation Measures: Refer to Mitigation Measure GEO-1.

Level of Significance: Less Than Significant With Mitigation Incorporated.

CORROSIVE SOILS

- **THE PROPOSED DEVELOPMENT COULD BE LOCATED ON CORROSIVE SOIL CREATING DAMAGE TO PROPERTY.**

Impact Analysis: Corrosive soils contain chemical constituents that can react with construction materials, such as concrete and ferrous metals, and cause damage to foundations and buried pipelines. The near surface soils are considered severely corrosive to ferrous metals in contact with these soils. Therefore, the Geology Report recommends that lot-specific Soils Investigations be conducted to evaluate the nature and extent of these soil types. The recommendations also involve requiring a corrosion specialist to develop a Corrosion Mitigation Plan upon completion of rough grading, and that such Plan at a minimum require, that buried metal piping be protected with suitable coatings, wrapping, or seals. Potential impacts involving corrosive soils that could create damage to property would be reduced to less than significant through compliance with Mitigation Measure GEO-3, which requires lot-specific Soils Investigations and development of a Corrosion Mitigation Plan.

Mitigation Measures:

GEO-3 Upon completion of rough grading, lot-specific Soils Investigations shall be conducted to evaluate the nature and extent of the onsite soil types. Additionally, a corrosion specialist shall develop a Corrosion Mitigation Plan that, at a minimum, requires that buried metal piping be protected with suitable coatings, wrapping, or seals. The geotechnical reports are included in Appendix 11.7, *Geology and Soils Reports,* of this EIR and are incorporated by reference into this mitigation measure.

Level of Significance: Less Than Significant With Mitigation Incorporated.

5.5.5 CUMULATIVE IMPACTS

- **THE PROPOSED PROJECT, COMBINED WITH OTHER RELATED CUMULATIVE PROJECTS, WOULD NOT EXPOSE PEOPLE OR STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS INVOLVING GEOLOGY AND SOILS.**

Impact Analysis: As concluded above, compliance with the CBC and WMC, and the recommended mitigation measures would ensure that Project implementation would result in less than significant impacts involving strong seismic ground shaking, seismic-related ground failure, unstable geologic units/soils, and expansive and corrosive soils. Therefore, given the Project's potential impacts would be less than significant, and since the potential impacts would be contained to the Project site, the Project's incremental effects involving geology and soils are not cumulatively considerable. Moreover, the geotechnical and soil characteristics of each cumulative project site would be evaluated on a project-by-project basis, and appropriate mitigation measures would be required, as necessary to reduce potential impacts to a less than significant level. Further, all development would be required to comply with the CBC, the Municipal Code of each respective jurisdiction, and the recommendations of the site-specific geotechnical and soils investigations, if required.

As concluded above, Project implementation would result in a less than significant impact involving soil erosion or the loss of topsoil, following compliance with NPDES requirements. Therefore, the Project's incremental effects involving erosion and loss of topsoil are not cumulatively considerable. Although, cumulative development would result in ground-disrupting activities that would temporarily disturb soils, all construction activities would be subject to compliance with the established regulatory requirements (i.e., NPDES and respective municipal codes), which would ensure a less than significant impact involving soil erosion or the loss of topsoil would occur.

Mitigation Measures: No mitigation measures are required.

Level of Significance: Less Than Significant Impact.

5.5.6 SIGNIFICANT UNAVOIDABLE IMPACTS

No significant unavoidable impacts related to geology and soils have been identified following implementation of the recommended mitigation measures.

5.5.7 SOURCES CITED

City of Whittier, *City of Whittier General Plan*, Comprehensively Adopted 1993.

City of Whittier, *City of Whittier Municipal Code*, Passed July 8, 2014, Codified through Ordinance No. 3023.

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