
3.5 - Geology and Soils

3.5.1 - Introduction

This section describes the existing geology, soils, and seismicity setting and potential effects from project implementation on the site and its surrounding area. Descriptions and analysis in this section are based on information from the Vallejo General Plan and the Preliminary Geotechnical Exploration Report prepared by ENGEO in November 2011. The Preliminary Geotechnical Exploration Report is included in this EIR as Appendix E.

3.5.2 - Environmental Setting

Geology and Soils

Regional Setting

The City of Vallejo is located along the western coastal margin of the seismically active Coast Range Geomorphic Province of Northern California. This region is dominated by northwest-southeast trending ranges of low mountains and intervening valleys. The regional structure of the Coast Ranges of northern California consists of northwest trending folds and faults created by the tectonic setting of colliding plate boundaries and subsequent transitional shear along the San Andreas Fault system. The regional folding and faulting of the Mesozoic and Tertiary age rocks of this area have created the foothills north of Carquinez Strait, the outlet of the Sacramento-San Joaquin River system.

Project Site

The project site is located at 900 Fairgrounds Drive in Vallejo, California. The 149.11-acre site is located immediately southwest of the Stated Route 37 and Interstate 80 junction, situated approximately 2 miles southwest of Sulphur Springs Mountain and 2 miles east of the Napa River. Lake Chabot is located directly west of the subject site, divided from the site by Fairgrounds Drive.

The property has elevations ranging from 83 to 106 feet above mean sea level. The site slopes gently towards the southwest. It is currently developed and utilized as the Solano County Fairgrounds, a golf course, a grandstand and horse track, and related improvements.

Soils

The United States Department of Agriculture Natural Resources Conservation Service indicates that majority of the project site is primarily underlain by Clear Lake and Rincon soils. The soil properties are summarized in Table 3.5-1.

Table 3.5-1: Soil Properties Summary

| Soil Name | Surface Texture | Source Material | Hydrologic Group | Drainage Class |
|------------|------------------------|--|---|----------------|
| Clear Lake | Clay, 0–2% slopes | Mixed alluvium | Group D: Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission. | Poorly drained |
| Rincon | Clay loam, 2-9% slopes | Alluvium derived from sedimentary rock | Group C: Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission. | Well drained |

Source: United States Department of Agriculture, Natural Resources Conservation Service, 2011.

Regional Seismicity

The term seismicity describes the effects of seismic waves that are radiated from an earthquake as it ruptures. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves. The probability of one or more earthquakes of magnitude 6.7 (Richter scale) or higher occurring in the project area has been evaluated by the United States Geological Survey (USGS). Based on the results of the USGS evaluation, there is a 62-percent likelihood that such an earthquake event will occur in the Bay Area between 2003 and 2032. The faults with the greater probability of movement with a magnitude of 6.7 or higher earthquake are the Hayward Fault at 27 percent, the San Andreas Fault at 21 percent, and the Calaveras Fault at 11 percent. To understand the implications of seismic events, a discussion of faulting and seismic hazards is provided below.

Faulting

Faults form in rocks when stresses overcome the internal strength of the rock, resulting in a fracture. Large faults develop in response to large, regional stresses operating over a long time, such as those stresses caused by the relative displacement between tectonic plates. According to the elastic rebound theory, these stresses cause strain to build up in the earth's crust until enough strain has built up to exceed the strength along a fault and cause a brittle failure. The slip between the two stuck plates or coherent blocks generates an earthquake. Following an earthquake, strain will build once again until the occurrence of another earthquake. The magnitude of slip is related to the maximum allowable

strain that can be built up along a particular fault segment. The greatest buildup in strain that is due to the largest relative motion between tectonic plates or fault blocks over the longest period of time will generally produce the largest earthquakes. The distribution of these earthquakes is a study of much interest for both hazard prediction and the study of active deformation of the earth’s crust.

Deformation is a complex process, and strain caused by tectonic forces is not only accommodated through faulting but also by folding, uplift, and subsidence, which can be gradual or in direct response to earthquakes.

Faults are mapped to determine earthquake hazards, since they occur where earthquakes tend to recur. A historic plane of weakness is more likely to fail under stress and strain than a previously unbroken block of crust. Faults are, therefore, a prime indicator of past seismic activity, and faults with recent activity are presumed to be the best candidates for future earthquakes. However, since slip is not always accommodated by faults that intersect the surface along traces, and since the orientation of stresses and strain in the crust can shift, predicting the location of future earthquakes is complicated. Earthquakes sometimes occur in areas with previously undetected faults or along faults previously thought inactive.

The San Francisco Bay Area contains numerous active faults. The site is not located within a currently designated Alquist-Priolo Earthquake Fault Zone, and no known active faults exist within the site. According to the Alquist-Priolo map for the Cordelia Quadrangle the late Pleistocene to Holocene active West Napa Fault is located approximately 1.8 miles northwest of the project area. According to geologic mapping by Crane (1995), the West Napa Fault is shown trending northwest through the project site. Additionally, the Green Valley Fault is mapped approximately 5 miles east of the site, and the North Hayward Section of the Hayward Fault is mapped approximately 11.4 miles southwest of the site. An active fault is defined by the State Mining and Geology Board as one that has had surface displacement within Holocene time (about the last 11,000 years) (Hart, 1997). These faults and their characteristics are summarized in Table 3.5-2.

Table 3.5-2: Fault Summary

| Fault | Distance from Project Site (miles) |
|---------------------|------------------------------------|
| West Napa | 1.8 |
| Green Valley | 5.0 |
| Hayward | 11.4 |
| Source: ENGEO, 2011 | |

Seismic Hazards

Seismicity describes the effects of seismic waves that are radiated from an earthquake as it ruptures. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves.

To understand the implications of seismic events, a discussion of faulting and seismic hazards is provided below.

Seismic hazards pose a substantial danger to property and human safety and are present because of the risk of naturally occurring geologic events and processes impacting human development. Therefore, the hazard is influenced as much by the conditions of human development as by the frequency and distribution of major geologic events. Seismic hazards present in California include ground rupture along faults, strong seismic shaking, liquefaction, ground failure, landsliding, and slope failure.

Fault Rupture

Fault rupture is a seismic hazard that affects structures sited above an active fault. The hazard from fault rupture is the movement of the ground surface along a fault during an earthquake. Typically, this movement takes place during the short time of an earthquake, but it also can occur slowly over many years in a process known as creep. Most structures and underground utilities cannot accommodate the surface displacements of several inches to several feet commonly associated with fault rupture or creep.

Ground Shaking

The severity of ground shaking depends on several variables such as earthquake magnitude, epicenter distance, local geology, thickness, seismic wave-propagation properties of unconsolidated materials, groundwater conditions, and topographic setting. Ground shaking hazards are most pronounced in areas near faults or with unconsolidated alluvium.

Based on observations of damage from recent earthquakes in California (San Fernando 1971, Whittier-Narrows 1987, Landers 1992, Northridge 1994), ground shaking is responsible for 70 to 100 percent of all earthquake damage. The most common type of damage from ground shaking is structural damage to buildings, which can range from cosmetic stucco cracks to total collapse. The overall level of structural damage from a nearby large earthquake would likely be moderate to heavy, depending on the characteristics of the earthquake, the type of ground, and the condition of the building. Besides damage to buildings, strong ground shaking can cause severe damage from falling objects or broken utility lines. Fire and explosions are also hazards associated with strong ground shaking.

While Richter magnitude provides a useful measure of comparison between earthquakes, the moment magnitude is more widely used for scientific comparison since it accounts for the actual slip that generated the earthquake. Actual damage is due to the propagation of seismic or ground waves as a result of initial failure, and the intensity of shaking is as much related to earthquake magnitude as is the condition of underlying materials. Loose materials tend to amplify ground waves, while hard rock can quickly attenuate them, causing little damage to overlying structures. For this reason, the Modified Mercalli Intensity (MMI) Scale provides a useful qualitative assessment of ground shaking.

The MMI Scale is a 12-point scale of earthquake intensity based on local effects experienced by people, structures, and earth materials. Each succeeding step on the scale describes a progressively greater amount of damage at a given point of observation. The MMI Scale is shown in Table 3.5-3, along with relative ground velocity and acceleration.

Table 3.5-3: Modified Mercalli Intensity Scale

| Richter Magnitude | Modified Mercalli Intensity | Effects | Average Peak Ground Velocity (centimeters/seconds) | Average Peak Acceleration |
|-------------------|-----------------------------|--|--|---------------------------|
| 0.1–0.9 | I | Not felt. Marginal and long-period effects of large earthquakes | — | — |
| 1.0–2.9 | II | Felt by only a few persons at rest, especially on upper floors of building. Delicately suspended objects may swing. | — | — |
| 3.0–3.9 | III | Felt quite noticeable in doors, especially on upper floors of building, but many people do not recognize it as an earthquake. Standing cars may rock slightly. Vibration like passing a truck. Duration estimated. | — | 0.0035–0.007 g |
| 4.0–4.5 | IV | During the day, felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensations like heavy truck striking building. Standing cars rocked noticeably. | 1–3 | 0.015–0.035 g |
| 4.6–4.9 | V | Felt by nearly everyone, many awakened. Some dishes, windows, broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. | 3–7 | 0.035–0.07 g |
| 5.0–5.5 | VI | Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of falling plaster and damaged chimneys. Damage slight. | 7–20 | 0.07–0.15 g |
| 5.6–6.4 | VII | Everyone runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built, ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars. | 20–60 | 0.15–0.35 g |

Table 3.5-3 (cont.): Modified Mercalli Intensity Scale

| Richter Magnitude | Modified Mercalli Intensity | Effects | Average Peak Ground Velocity (centimeters/seconds) | Average Peak Acceleration |
|-------------------|-----------------------------|---|--|---------------------------|
| 6.5–6.9 | VIII | Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monument walls, and heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving in cars disturbed. | 60–200 | 0.35–0.7 g |
| 7.0–7.4 | IX | Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. | 200–500 | 0.7–1.2 g |
| 7.5–7.9 | X | Some well-built structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Railway lines bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks. | ≥ 500 | >1.2 g |
| 8.0–8.4 | XI | Few, if any masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly. | — | — |
| ≥ 8.5 | XII | Total damage. Waves seen on ground. Lines of sight and level distorted. Objects thrown into the air. | — | — |

Source: United States Geologic Survey.

Ground Failure

Ground failure includes liquefaction and the liquefaction-induced phenomena of lateral spreading, and lurching.

Liquefaction is a process by which sediments below the water table temporarily lose strength during an earthquake and behave as a viscous liquid rather than a solid. Liquefaction is restricted to certain geologic and hydrologic environments, primarily recently deposited sand and silt in areas with high groundwater levels. The process of liquefaction involves seismic waves passing through saturated granular layers, distorting the granular structure, and causing the particles to collapse. This causes the granular layer to behave temporarily as a viscous liquid, resulting in liquefaction.

Liquefaction can cause the soil beneath a structure to lose strength, which may result in the loss of foundation-bearing capacity. This loss of strength commonly causes the structure to settle or tip. Loss of bearing strength can also cause light buildings with basements, buried tanks, and foundation piles to rise buoyantly through the liquefied soil.

Lateral spreading is lateral ground movement, with some vertical component, caused by liquefaction. In effect, the soil rides on top of the liquefied layer. Lateral spreading can occur on relatively flat sites with slopes less than 2 percent, under certain circumstances, and can cause ground cracking and settlement.

Lurching is the movement of the ground surface toward an open face when the soil liquefies. An open face could be a graded slope, stream bank, canal face, gully, or other similar feature.

Landslides and Slope Failure

Landslides and other forms of slope failure form in response to the long-term geologic cycle of uplift, mass wasting, and disturbance of slopes. Mass wasting refers to a variety of erosional processes from gradual downhill soil creep to mudslides, debris flows, landslides and rock fall—processes that are commonly triggered by intense precipitation, which varies according to climactic shifts. Often, various forms of mass wasting are grouped together as landslides, which are generally used to describe the downhill movement of rock and soil.

Geologists classify landslides into several different types that reflect differences in the type of material and type of movement. The four most common types of landslides are translational, rotational, earth flow, and rock fall. Debris flows are another common type of landslide similar to earth flows, except that the soil and rock particles are coarser. Mudslide is a term that appears in non-technical literature to describe a variety of shallow, rapidly moving earth flows.

Subsurface Conditions

A field investigation was conducted at the project site on April 2, 2009. The field investigation consisted of drilling four exploratory borings carried to depths of 31.5 feet below the existing ground surface. The findings of these investigations are summarized below.

Project Site Conditions

The exploratory borings encountered deposits of existing, “man-made” fills. Along the western and central areas of the site, in areas coinciding with the previous lake area, the borings encountered fills

of overly soft, recent natural alluvial deposits consisting of silts, clays and sands. The combined thickness of man-made fills and soft natural sediments varied from about 23 to 24 feet. Along the eastern side of the site, existing fills combined with soft sediments varied from 10 to 14 feet.

Interbedded claystone and siltstone was encountered at depths of 23 feet, 24 feet, and 29 feet.

Groundwater

During drilling, groundwater was initially encountered at 14 feet, 14.5 feet, 18 feet, and 19 feet. Several groundwater measurements were taken subsequent to drilling. Table 1 of the Preliminary Geotechnical Exploration Report displays stabilized groundwater measurements and corresponding elevations.

Ground Rupture

Because there are no known active faults crossing the property and the site is not located within an Earthquake Fault Special Study Zone, the Preliminary Geotechnical Exploration Report concluded that ground rupture is unlikely at the subject property.

Ground Shaking

According to the Preliminary Geotechnical Exploration Report, an earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking at the site, similar to that which has occurred in the past. To mitigate the shaking effects, all structures should be designed using sound engineering judgment and the 2010 California Building Code (CBC) requirements, as a minimum. Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead-and-live loads. The code-prescribed lateral forces are generally considered to be substantially smaller than the comparable forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage but with some nonstructural damage, and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

Liquefaction

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded fine-grained sands. Loose sands were encountered in one of the exploratory borings extending from 18 to 24 feet below ground surface. Based on the subsurface exploration and published liquefaction susceptibility maps the site is considered to have a moderate liquefaction potential (ENGE0, 2011).

Lateral Spreading

Lateral spreading is a failure within a nearly horizontal soil zone (possibly due to liquefaction), which causes the weaker soils to move toward a free face such as a channel, or down a gentle slope. Based on the soils at the site and proposed development the potential for lateral spreading at the site is considered low (ENGEO, 2011).

Ground Lurching

Ground lurching is a result of the rolling motion imparted to the ground surface during energy released by an earthquake. This rolling motion can cause ground cracks to form in weaker soils. The potential for the formation of these cracks is considered greater at contacts between deep alluvium and bedrock. Such an occurrence is possible at the site as in other locations in the Bay Area Region, but based on the site location, the offset is expected to be very low (ENGEO, 2011).

3.5.3 - Regulatory Framework

Federal

Federal Earthquake Hazards Reduction Act

In 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program. The act established the National Earthquake Hazards Reduction Program (NEHRP). The National Earthquake Hazards Reduction Program Act (NEHRPA) significantly amended this program in 1990 by refining the description of the agency responsibilities, program goals, and objectives.

NEHRP's mission includes improved understanding, characterization, and prediction of hazards and vulnerabilities; improved building codes and land use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improved mitigation capacity; and accelerated application of research results. The NEHRPA designates the Federal Emergency Management Agency (FEMA) as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, National Science Foundation and the USGS.

State

California Building Standards Code

The California Building Standards Code establishes building requirements for construction and renovation. The most recent version of the California Building Standards Code was adopted in 2010 by the California Building Standards Commission and is based on the International Code Council's Building and Fire Codes. Included in the California Building Standards Code are the Electrical Code, Mechanical Code, Plumbing Code, Energy Code, and Fire Code.

The State of California provides minimum standards for building design through the California Building Standards Code (California Code of Regulations, Title 24). Where no other building codes apply, Chapter 29 regulates excavation, foundations, and retaining walls. Finally, the 2010 California Building Standards Code regulates grading activities, including drainage and erosion control and construction on unstable soils, such as expansive soils and areas subject to liquefaction.

California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code Section 1690-2699.6) addresses seismic hazards other than surface rupture, such as liquefaction and induced landslides. The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

Alquist-Priolo Earthquake Fault Zoning Act

In response to the severe fault rupture damage of structures by the 1971 San Fernando earthquake, the State of California enacted the Alquist-Priolo Earthquake Fault Zoning Act in 1972. This act required the State Geologist to delineate Earthquake Fault Zones along known active faults that have a relatively high potential for ground rupture. Faults that are zoned under the Alquist-Priolo Act must meet the strict definition of being “sufficiently active” and “well-defined” for inclusion as an Earthquake Fault Zones. The Earthquake Fault Zones are revised periodically, and they extend 200 to 500 feet on either side of identified fault traces. No structures for human occupancy may be built across an identified active fault trace. An area of 50 feet on either side of an active fault trace is assumed to be underlain by the fault, unless proven otherwise. Proposed construction in an Earthquake Fault Zone is permitted only following the completion of a fault location report prepared by a California Registered Geologist.

National Pollutant Discharge Elimination System Permit

In California, the State Water Resources Control Board (SWRCB) administers the federal Environmental Protection Agency’s promulgated regulations (55 Code of Federal Regulations 47990) requiring the permitting of stormwater-generated pollution under the National Pollutant Discharge Eliminations System (NPDES). In turn, the SWRCB’s jurisdiction is administered through Regional Water Quality Control Boards. Pursuant to these federal regulations, an operator must obtain a General Permit under the NPDES Stormwater Program for all construction activities with ground disturbance of one acre or greater. The General Permit requires the implementation of best management practices (BMPs) to reduce pollutant loads into the waters of the State and measures to reduce sediment and erosion control. In addition, a Stormwater Pollution Protection Plan (SWPPP) must be prepared. The SWPPP addresses water pollution control during construction. SWPPPs require that all stormwater discharges associated with construction activity, where clearing, grading, and excavating results in soil disturbances, must by law be free of site pollutants.

Local

City of Vallejo

General Plan

The City of Vallejo General Plan establishes the following goals and policies related to geology and soils that are applicable to the proposed project:

Seismic Hazards

- **Goal:** To protect life, property, and public well-being from seismic, floodplain, and other environmental hazards and to reduce or avoid adverse economic, social, and physical impacts caused by existing environmental conditions.
- **Policy 1:** Adopt, maintain, review (whenever necessary), and enforce adequate standards and criteria to reduce or avoid all levels of seismic or other geologic risk, whether it be unacceptable, tolerated or avoidable risk.
- **Policy 2:** Evaluate all new development for potential seismic hazards using the Geotechnical Hazards Map (Plate 1 in Appendix 1) as a guide for determining the need for additional geologic investigation.
- **Policy 3:** Evaluate the compatibility of existing zoning as well as future land use allocation, with known geologic risk zones, or those that may be identified in the future.
- **Policy 5:** Prohibit development of important or critical use structures in any active or potentially active fault zones, unless no other more suitable site can be located, and the site is shown to be safe for the intended use.
- **Policy 7:** Improve inter-jurisdictional cooperation and communication; especially in regard to seismic safety aspects related to dams, reservoirs, state highway, and freeway structures, regional fault studies, legislative matters, and disaster response or emergency plans.
- **Policy 9:** Existing and prospective property owners should be made aware of the potential hazards and their implications.
- **Policy 10:** Seismic shaking:
 - a) A systematic survey should be conducted to identify those older structures most vulnerable to earthquake damage. Recommended guidelines for determining priorities are included in Appendix 1 of the General Plan.
 - b) There should be continued compliance with Chapter 12.07, Seismic Hazard Identification and Mitigation Program for Un-reinforced Masonry Buildings, of the Vallejo Municipal Code.
 - c) Existing medium- and high-rise buildings (over three stories) should be evaluated in terms of evacuation procedures and fire control.
 - d) Vital facilities, including fire and police stations, hospitals and communication centers within the high-risk (C or D on Plate 2, Land Use Capability Map, in Appendix 1 of the General Plan) zones should be evaluated regarding their compliance with current structural standards for a seismic design. Emergency power generators at these facilities should also be evaluated for seismic safety.

- e) At the discretion of the Building Official, certain of the more important or critical use structures in Groups I, II and III (such as hospitals, schools, high-rise buildings and fire stations, etc.) should be specified as requiring more conservative seismic design parameters utilizing the maximum credible earthquake (rather than the maximum probable earthquake). Other less important uses in Groups I, /I, and 11/ (such as certain utilities, roads, and small isolated dams) could be designed utilizing the maximum probable earthquake, as are the ordinary types of construction in Groups IV and V.
- f) Future detailed study of the Southampton Fault should be undertaken, including subsurface exploration between the Garthe Ranch and Blue Rock Springs Creek, geophysical profiling of Southampton Bay and Carquinez Strait to confirm the continuity of the fault zone; microseismic monitoring along the fault, and a triangulation survey of the fault trace to detect possible fault creep.

Slope Stability

- **Goal:** To protect life, property, and public well-being from seismic, floodplain, and other environmental hazards and to reduce or avoid adverse economic, social, and physical impacts caused by existing environmental conditions.
- **Policy 1:** Require special engineering studies in areas of known slope instability.
- **Policy 2:** Avoid development on known unstable slopes where engineering design cannot ensure a safe living condition.
- **Policy 3:** Identify and appropriately zone areas of unstable soils and/or geologic formations in areas identified as having slopes of over 20% and regulate density and siting in accordance with the natural carrying capacity of the land.

Soil Related Problems

- **Goal:** To protect life, property, and public well-being from seismic, floodplain, and other environmental hazards and to reduce or avoid adverse economic, social, and physical impacts caused by existing environmental conditions.
- **Policy 1:** Special engineering studies should be required for areas underlain by un-engineered fill. Some of these areas are shown on Plate 1 in Appendix 1 of the General Plan.
- **Policy 2:** Special foundation design, including pile foundations, may be required in the area underlain by bay mud.
- **Policy 3:** Soil studies required for new development should include a discussion of and methods for reducing groundwater hazards.

Floodplain Hazards

- **Goal:** To protect life, property, and public well-being from seismic, floodplain, and other environmental hazards and to reduce or avoid adverse economic, social, and physical impacts caused by existing environmental conditions.

- **Policy 1:** Require strict compliance with the Flood Damage Protection Ordinance of the City of Vallejo.
- **Policy 3:** Evaluate all new developments to determine how peak runoff can be delayed using such measures as detention or retention basins, permanent greenbelt areas, temporary underground storage, permeable paving and roof top ponding.

3.5.4 - Methodology

ENGEO prepared a Preliminary Geotechnical Exploration Report, dated November 4, 2011, to provide preliminary geotechnical recommendations for the site development and initial building design. The report summarized the findings of a field investigation. The field investigation consisted of site reconnaissance and the drilling of borings. Four borings were drilled at the site to a maximum depth of approximately 30.5 feet below ground surface. Additionally, soil samples were recovered during drilling. Boring logs are provided in Appendix E.

3.5.5 - Thresholds of Significance

According to the CEQA Guidelines' Appendix G Environmental Checklist, to determine whether impacts to geology and soils are significant environmental effects, the following questions are analyzed and evaluated. Would the project:

- a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:
 - i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.
 - ii. Strong seismic ground shaking?
 - iii. Seismic-related ground failure, including liquefaction?
 - iv. Landslides?
- b) Result in substantial soil erosion or the loss of topsoil?
- c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?
- d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?
- e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater? (Refer to Section 7, Effects Found Not To Be Significant.)

3.5.6 - Project Impacts and Mitigation Measures

Earthquakes Impact Analysis

| | |
|----------------------|--|
| Impact GEO-1: | <p>The project would expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:</p> <ul style="list-style-type: none"> i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42. ii) Strong seismic ground shaking? iii) Seismic-related ground failure, including liquefaction? iv) Landslides? |
|----------------------|--|

Impact Analysis

This impact analysis evaluates potential exposure of the proposed project area to seismic hazards, including fault rupture, strong ground shaking, ground failure and liquefaction, and landslides.

Entertainment Area and Fairgrounds

Fault Rupture

There are no Alquist-Priolo Earthquake Fault Zones within the project site boundaries. In addition, the Preliminary Geotechnical Exploration Report indicated that there are no faults within the project site boundaries. This condition precludes the possibility of the proposed project being exposed to fault rupture. No impacts would occur.

Strong Ground Shaking

As discussed above, the San Francisco Bay Area contains numerous active faults. The Working Group on California Earthquake Probabilities (WGCEP, 2007) has evaluated the Bay Area seismicity. In their study, the WGCEP evaluated the probability that a magnitude 6.7 or greater earthquake will occur in the Bay Area within 30 years of the publish date (2007–2037). The Hayward-Rogers Creek Fault and North San Andreas Fault systems are estimated to have a 30-year probability of 31 percent and 21 percent, respectively. It should be expected that the site will experience one or more episodes of strong ground shaking during the design life of the proposed redevelopment. An earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking at the site, similar to that which has occurred in the past.

The proposed project area may be exposed to strong ground shaking during an earthquake in the general region. The proposed project would implement all applicable requirements of the most recent California Building Standards Code, which provides criteria for the seismic design of buildings. Seismic design criteria account for peak ground acceleration, soil profile, and other site conditions, and they establish corresponding design standards intended primarily to protect public safety and secondly to minimize property damage. Mitigation is proposed that would require the project applicant to submit site plans to City of Vallejo for review and approval that demonstrate that proposed project's plans incorporate all applicable seismic design criteria of the most recent

California Building Standards Code. Accordingly, potential ground shaking impacts would be reduced to a level of less than significant.

Ground Failure and Liquefaction

As described above, soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, fine-grained sands. Loose sands were encountered in one of the exploratory borings extending from 18 to 24 feet below ground surface. Based on the subsurface exploration and published liquefaction susceptibility maps, the site is considered to have a moderate liquefaction potential (ENGEO 2011). Liquefiable soils can be mitigated through standard grading techniques, such as removal and replacement, and/or ground improvement methods to densify these soils in place to reduce the risk for future development. Alternatively, foundation design practices can reduce the impacts of potentially liquefiable soils. However, this would be addressed in the design-level geotechnical study.

As discussed earlier, the proposed project would implement all applicable requirements of the most recent California Building Standards Code, which provides criteria for the seismic design of buildings. Seismic design criteria account for peak ground acceleration, soil profile, and other site conditions, and they establish corresponding design standards intended primarily to protect public safety and secondly to minimize property damage. Mitigation is proposed that would require the project applicant to submit site plans to City of Vallejo for review and approval that demonstrate that proposed project's plans incorporate all applicable seismic design criteria of the most recent California Building Standards Code.

Landslides

There are no substantial slopes on or near the project site. This condition precludes the possibility of landslides inundating the project site. No impacts would occur.

Level of Significance Prior to Mitigation

Potentially significant impact.

Mitigation Measures

MM GEO-1a Entertainment Area. Prior to issuance of building permits, the project applicant shall submit a design-level geotechnical study and building plans to the City of Vallejo for review and approval. The building plans shall demonstrate that they incorporate all applicable recommendations of the design-level geotechnical study and comply with all applicable requirements of the most recent version of the California Building Standards Code. Recommendations from the design-level geotechnical study may include standard grading techniques such as removal and replacement and/or ground improvement methods to densify these soils in place to reduce the risk for future development. Alternatively, foundation design practices can reduce the impacts of

potentially liquefiable soils. A licensed professional engineer shall prepare the plans, including those that pertain to soil engineering, structural foundations, pipeline excavation, and installation. The approved plans shall be incorporated into the proposed project. All onsite soil engineering activities shall be conducted under the supervision of a licensed Geotechnical Engineer or Certified Engineering Geologist.

MM GEO-1b Fairgrounds. Prior to commencement of site grading, the project applicant shall complete a design-level geotechnical study and building plans. The building plans shall demonstrate that they incorporate all applicable recommendations of the design-level geotechnical study and comply with all applicable requirements of the most recent version of the California Building Standards Code. Recommendations from the design-level geotechnical study may include standard grading techniques such as removal and replacement and/or ground improvement methods to densify these soils in place to reduce the risk for future development. Alternatively, foundation design practices can reduce the impacts of potentially liquefiable soils. A licensed professional engineer shall prepare the plans, including those that pertain to soil engineering, structural foundations, pipeline excavation, and installation. The approved plans shall be incorporated into the proposed project. All onsite soil engineering activities shall be conducted under the supervision of a licensed Geotechnical Engineer or Certified Engineering Geologist.

Level of Significance After Mitigation

Less than significant impact.

Soil Erosion or Topsoil Loss

Impact GEO-2: The project would result in substantial soil erosion or the loss of topsoil.

Impact Analysis

This impact analysis evaluates the project’s potential to create erosion and sedimentation.

Entertainment Area and Fairgrounds

Construction activities associated with the proposed project would involve vegetation removal, grading, and excavation activities that could expose barren soils to sources of wind or water, resulting in the potential for erosion and sedimentation. NPDES stormwater permitting programs regulate stormwater quality from construction sites, which includes erosion and sedimentation. Under the NPDES permitting program, the preparation and implementation of an SWPPP is required for construction activities that would disturb an area of 1 acre or more. The SWPPP must identify potential sources of erosion or sedimentation that may be reasonably expected to affect the quality of stormwater discharges as well as identify and implement Best Management Practices (BMPs) that ensure the reduction of these pollutants during stormwater discharges. Typical BMPs intended to

control erosion include sand bags, detention basins, silt fencing, storm drain inlet protection, street sweeping, and monitoring of water bodies.

These requirements have been incorporated into the proposed project as mitigation. The implementation of an SWPPP and its associated BMPs would reduce potential erosion impacts to a level of less than significant.

Level of Significance Prior to Mitigation

Potentially significant impact.

Mitigation Measures

Entertainment Area

MM GEO-2a Implement Mitigation Measure HYD-1a.

Fairgrounds

MM GEO-2b Implement Mitigation Measure HYD-1b.

Level of Significance After Mitigation

Less than significant impact.

Unstable Geologic Location

Impact GEO-3: The project 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 Analysis

This impact analysis evaluates the proposed project’s potential to expose persons or structures to hazards associated with unstable geologic units or soils.

Entertainment Area and Fairgrounds

As stated in the Preliminary Geotechnical Exploration Report, exploration borings encountered existing, man-made undocumented fills, and the thickness of fills generally increases along the western limits of the site, where Lake Chabot was buried. Significant portions of the site are underlain by existing undocumented fills of variable thickness. Existing undocumented fill was encountered at the site in all of our borings, with the thickest portions encountered extending to depths of about 15 feet. Undocumented fills may contain debris that is unsuitable for use as engineered fill and may be loosely placed and inadequate for foundation support. In addition, the undocumented fills are considered susceptible to seismic densification, liquefaction, and excessive total and differential settlement that could adversely impact support of planned structures and site improvements. As discussed earlier, areas of uncontrolled existing fills were mapped on the site. Depths and extent of these fills may vary at the site. In general, uncontrolled fills are considered susceptible to excessive total and differential settlements. To reduce settlements resulting from unsuitable fills, where these fills will be located below structures or improvements, they should be

completely over-excavated and replaced with engineered fill. The actual extent of the existing unsuitable fills should be determined during grading. This would be addressed in the design-level geotechnical study.

In general, from a geotechnical standpoint, if existing fills are cleared of unsuitable debris and rubble, oversized-rock fragments, and any hazardous or deleterious materials (if encountered), these materials are anticipated to be suitable for reuse as engineered fill (ENGE0 2011).

As determined in the Preliminary Geotechnical Exploration Report, underlying the fills are natural soil deposits of variable consistency, and these deposits directly overlie bedrock units. The upper zones of natural soils deposits appear soft, loose, and highly compressible; the soft and loose zones coincide with historic lake areas. Depending on specific variations in fine content, thickness of layers, *in situ* densities, and groundwater levels, the sandy layers may be considered marginally susceptible to seismically induced deformations such as liquefaction and even possible lateral spreading. Potential settlements and related hazards of liquefiable soils could impact foundation support of overlying structures, result in excessive settlement, and cause damage to other related site improvements if the onsite soils are liquefiable, depending on their occurrence and level of severity. As such, it is recommended that design-level geotechnical exploration further characterize liquefaction potential for the proposed development and potential related, seismically induced deformations. Such studies should include appropriate exploratory methods such as rotary wash drilling methods and/or cone penetrometer testing (CPT) to address potential liquefaction to provide appropriate design features, as deemed necessary, for the proposed project.

As part of the proposed project, the project site would be graded, and the area underlying the building pads would be soil-engineered in accordance the recommendations of a design-level geotechnical study and the requirements of the California Building Standards Code. This requirement is established by Mitigation Measure GEO-1. This process would involve removal of unsuitable soils, placement of engineered fill, and compaction in order to ensure that the proposed structure is adequately supported. These practices would ensure that the proposed project is located on stable soils and geologic units and that it would not be susceptible to settlement or ground failure. Therefore, the implementation of Mitigation Measures GEO-1a and GEO-1b would reduce impacts to a level of less than significant.

Level of Significance Prior to Mitigation

Potentially significant impact.

Mitigation Measures

Entertainment Area

MM GEO-3a Implement Mitigation Measure GEO-1a.

Fairgrounds

MM GEO-3b Implement Mitigation Measure GEO-1b.

Level of Significance After Mitigation

Less than significant impact.

Expansive Soil

Impact GEO-4: **The project would be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.**

Impact Analysis

This impact analysis evaluates the project's potential to expose persons or structures to hazards associated with expansive soils.

Entertainment Area and Fairgrounds

According to the Preliminary Geotechnical Exploration Report, expansive soils are present within the proposed development area. Expansive soils shrink and swell as a result of seasonal fluctuation in moisture content. This can cause heaving and cracking of slabs on grade, pavements and structures founded on shallow foundations. Suggested design measures include keeping exposed subgrade materials moist at all times during construction to prevent shrinkage, and replacing existing expansive soils with non-expansive select fill below constructed slabs. Alternatively, slabs can be designed by the structural engineer to allow for construction on expansive soils. In addition, proper moisture conditioning of expansive soils below slabs prior to placement will reduce the effects of expansion. The structural engineer would provide final design thickness and additional reinforcement, if necessary, for the intended structural loads. This issue would be addressed in the design-level geotechnical study.

Shallow groundwater may be encountered at this site. Shallow groundwater can potentially impact building and site improvements if not mitigated in design. Suggested design measures within the Preliminary Geotechnical Exploration Report include waterproofing underdrainage and dewatering systems, as necessary. Temporary dewatering during construction can allow work to be conducted in a relatively dry environment so that the work can be completed to design specifications. Proposed structures extending below the groundwater table can be designed to accommodate permanent dewatering operations. As noted above, this issue would be addressed in the design-level geotechnical study. Impacts would be less than significant with the implementation of Mitigation Measures GEO-1a and GEO-1b.

Level of Significance Prior to Mitigation

Potentially significant impact.

Mitigation Measures

Entertainment Area

MM GEO-4a Implement Mitigation Measure GEO-1a.

Fairgrounds

MM GEO-4b Implement Mitigation Measure GEO-1b.

Level of Significance After Mitigation

Less than significant impact.

3.5.7 - Residual Significant Impacts

None identified.