3.6 GEOLOGY AND SOILS

3.6.1 Background and Methodology

3.6.1.1 Regulatory Context

Alquist-Priolo Earthquake Fault Zoning Act

California's *Alquist-Priolo Earthquake Fault Zoning Act*, as renamed in 1994, is intended to reduce risks to life and property from surface fault ruptures during earthquakes.[1] The *Alquist-Priolo Act* prohibits most types of structures intended for occupation across the traces of active faults and strictly regulates construction in corridors along active fault zones. The *Alquist-Priolo Act* also established criteria for identifying active faults and established a process for reviewing proposals to build in areas within land adjacent to fault zones.

Seismic Hazards Mapping Act of 1990

Similar to the *Alquist-Priolo Act*, the *Seismic Hazards Mapping Act of 1990* addresses earthquake-related hazards, such as strong ground shaking, liquefaction, and seismic-induced landslides. This Act charged the State with the responsibility for identifying and mapping areas at risk of strong ground shaking, landslides and liquefaction. Permit review under this Act is the primary means of regulation in areas of high risk development. Hazard avoidance under this Act is primarily exercised through the prohibition of development in areas within Seismic Hazard Zones until appropriate geotechnical investigations have been carried out and measures to reduce the risk of damage have been incorporated into development plans.[2]

California Code of Regulations (CCR), California Building Code (CBC) Title 24, Part 2

Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. According to the CBC, all building standards must be incorporated into Title 24 or they are not enforceable by law. The purpose of the CBC is to provide minimum baseline standards for safeguarding the well-being of individuals that would use structures in the State. This is achieved by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within its jurisdiction. The CBC is based on Uniform Building Code (UBC) with necessary California amendments.[3]

Sonoma County General Plan, Seismic Hazards Policies

Groundshaking from earthquakes affects the most people and can cause the most damage of any geologic hazard. Groundshaking hazard areas in Sonoma County are shown in the Sonoma County General Plan Public Safety Element, and are based upon Association of Bay Area Governments (ABAG) data. Groundshaking similar to that which took place in Santa Rosa during the 1969 earthquake can be expected somewhere in Sonoma County once every 20-30 years. The Sonoma County General Plan Public Safety Element contains policies to avoid siting essential service buildings and facilities in areas with Modified Mercalli Index (MMI) Ground

[1] California Public Resource Code, Section 2621.
[2] California Public Resource Code, Sections 2690-2699.6.
[3] California Building Standards Commission, *Code of Regulations Title 24*, available at: http://www.documents.dgs.ca.gov/bsc/Title_24/documents/2010/Part%201/2010_CA_Administration.pdf. Accessed April 21, 2011.

shaking Intensity Levels of Very Violent, Violent, or Very Strong. Where buildings must be located in these areas, they should be constructed to the highest feasible safety standards.[4]

3.6.1.2 Thresholds of Significance

According to *CEQA Guidelines*[5], an impact to soils or the geologic properties of the Airport or properties in the Regional Study Area would be considered significant if it would result in exposure of people or structures to potential substantial adverse effects; notably the risk of loss, injury, or death resulting from:

1. 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;
2. strong seismic shaking that would result in ground failure or liquefaction;
3. substantial erosion or loss of topsoil;
4. landslides;
5. structures located on expansive soil as defined in Table 18-1-B of the Uniform Building Code of 1994;
6. result in or located on soils inadequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available;
7. a project located on an unstable geologic unit, or would become unstable as a result of the project, and potentially result in on or off-site landslides, lateral spreading, subsidence, liquefaction or collapse; and
8. 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.[6]

3.6.1.3 Methodologies

Geologic risks are rarely predictable events whose effects cannot be easily quantified. Therefore, proximity to active faults and historical data regarding the relative frequency of geologic events in the Regional Study Area are used to determine high risk, geologically active areas. Data from the California Soil Resource Lab and the United States Geological Service (USGS) was analyzed for existing soil conditions and geological formations within the Regional Study Area. Meteorological data was also used to predict future soil conditions.

3.6.2 Existing Conditions

3.6.2.1 Geology

Sonoma County is within the complex "Coast Range" geological region of California, which is characterized by valleys and various mountain ranges that are parallel to fault lines. The Airport is situated at an elevation of approximately 128 feet. Two mountain ranges are located in Sonoma County; the Mayacamas Mountains and the Sonoma Mountains. Sonoma County is primarily underlain by a heterogeneous assemblage of rocks referred to as the Franciscan complex.[7] The Franciscan Complex is primarily composed of cherts, greywacke sandstones,

[4] California Building Standards Comission, *Code of Regulations Title 24*, available at: http://www.documents.dgs.ca.gov/bsc/Title_24/documents/2010/Part%201/2010_CA_Administration.pdf. Accessed April 21, 2011.
[5] California Environmental Quality Act, *Appendix G Environmental Checklist Form*, available at: http://ceres.ca.gov/ceqa/guidelines/Appendix_G.html, Accessed: May 5, 2011.
[6] Ibid.
[7] United States Geological Service, *Understanding the "Franciscan Complex,"* available at http://menlocampus.wr.usgs.gov/50years/accomplishments/franciscan.html. Accessed April 21, 2011.

mafic volcanic rocks, shales, limestones, and high pressure metamorphic rock. This data is presented in **Table 3.6-1**.

Table 3.6-1
GEOLOGIC FORMATIONS OF THE SONOMA COUNTY REGION

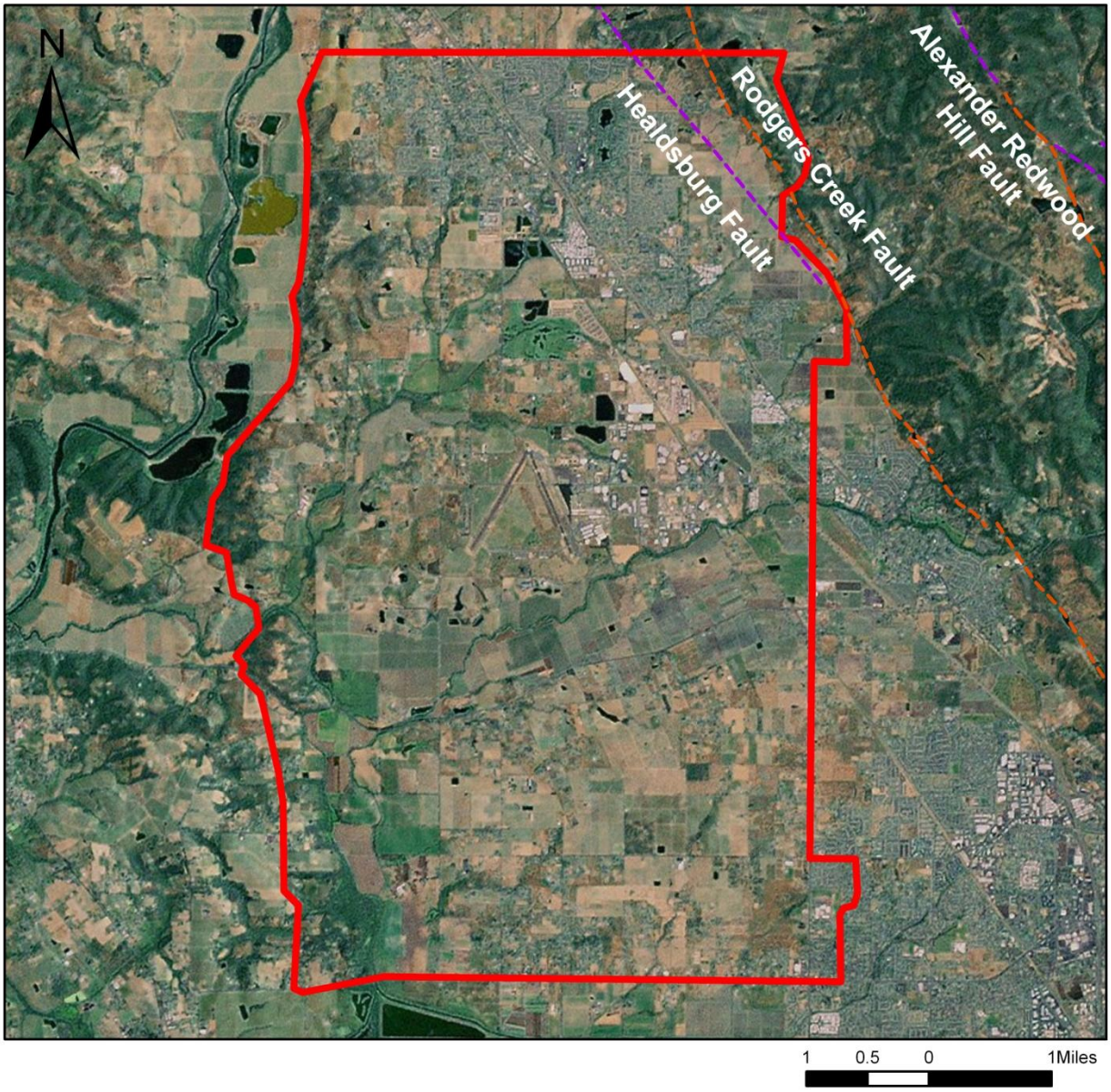
Formation Type	Rock Type	Era Formed/Deposited
Alluvial Surficial Deposits	Sedimentary	Pleistocene
Alluvial Fan and Fluvial Deposits	Sedimentary	Quaternary
Graywacke and Melange	Sedimentary/Metamorphic	Cretaceous and Jurassic
Wilson Grove Formation	Sedimentary	Late Pliocene and Miocene
Petaluma Formation	Sedimentary/Metamorphic	Pliocene and Late Miocene
Alluvial and Marine Terrace Deposits	Sedimentary	Pleistocene

SOURCE: United States Geological Survey, 2011
PREPARED BY: RS&H, 2011

The Airport is not within an Alquist-Priolo Earthquake Fault Zone. However, there are two potentially active fault lines in the Regional Study Area[8]. The Healdsburg-Rodgers Creek Fault is approximately three miles to the east of the Airport[9]. The Maacama fault zone is approximately five miles to the east of the Airport. **Figure 3.6-1** presents the location these fault zones. However, these two fault zones are not close enough to the Airport to justify that the Airport be within an Alquist-Priolo Earthquake Fault Zone. The Airport is not located in a high risk area for landslides or liquefaction.[10] All of the land within the Regional Study Area is located in a Very Strong Groundshaking Zone. Therefore, intense groundshaking could cause damage to strong, modern buildings.

[8] State of California, Department of Conservation. *Alquist-Priolo Earthquake Fault Zone Maps*, available at http://www.consrv.ca.gov/CGS/rghm/ap/Pages/index.aspx. Accessed April 21, 2011.
[9] United States Geological Survey, *Rodgers Creek fault zone*, available at: http://earthquake.usgs.gov/earthquakes/recenteqscanv/fault/201.html. Accessed: April 27, 2011.
[10] United States Geological Survey, Preliminary Maps of Quaternary Deposits and Liquefaction Sustainability, Nine-County San Francisco Bay Region, California (2000) and Summary Distribution of Slides and Earth Flows in the San Francisco Bay Region (1997). Available at: http://pubs.usgs.gov/of/1997/of97-745/sfbr-sef-dbdesc.pdf. Accessed: May 05, 2011.

Figure 3.6-1
FAULT LINES IN REGIONAL STUDY AREA



SOURCE: United States Geological Survey, 2011
PREPARED BY: RS&H, 2011

3.6.2.2 Soils

Table 3.6-2 presents existing soil types, slope and hydric status of soils in the Regional Study Area.

Liquefaction

Poorly drained soils and large grained sands are susceptible to liquefaction. Liquefaction is the process by which soils loose cohesion and flow in a manner similar to liquids. When shaking occurs in poorly drained porous soils they experience a reduction in overall porosity and volume. Reduction in porosity and volume results in increased water pressure between individual grains, and causes water between these spaces to become denser. This density increase promotes the positive buoyancy of individual grains which causes ground instability. The Airport is located on soils and topography considered to be very low risk for liquefaction exposure.[11] This is primarily attributed to the low sand composition of soils at the Airport.

Groundshaking

The Airport, like all of Sonoma County, is subject to groundshaking from earthquakes, which could affect people and cause damage. The amount of groundshaking depends on the magnitude of the earthquake, the distance from the epicenter and the type of earth materials in between groundshaking hazard area. Within the Regional Study Area, there is a 70 percent probability of experiencing ground shaking from at least one major earthquake by 2030. Also, the magnitude of ground shaking would vary on Intensity Levels from Very Violent to Very Strong. Such an event could result in structural failure and collapse or cause of nonstructural building elements to fall, presenting a hazard to occupants and damage to contents.

Expansive Soils

Expansive soils are soils that have the potential to expand when exposed to saturated conditions and contract under dry conditions. The presence of high proportion clay soils is typically indicative of expansive soil risks. Due to the fact that most soils at the Airport are classified as loam; significant expansive soil hazards do not exist. However, site specific geological studies for each individual component of the Proposed Project will determine if soil amending will be necessary to meet the Building Code.

Table 3.6-2
SOILS WITHIN THE AIRPORT STUDY AREA

Soil Name	Map Unit Symbol	Hydric (Y/N/P)	Slope (percent)
Huichica loam, Shallow Ponded	HwB	Partial	0-5 slopes
Huichica loam	HtC	Not	2-9 slopes
Huichica loam, Ponded	HuB	Partial	0-5 slopes
Huichica loam, Shallow	HvC	Partial	0-9 slopes
Zamora silt clay	ZaA	Partial	0-2 slopes

SOURCE: California Soil Resource Lab, 2011
PREPARED BY: RS&H, 2011

[11] United States Geological Survey, *Susceptibility Map of the San Francisco Bay Area*, available at: http://geomaps.wr.usgs.gov/sfgeo/liquefaction/susceptibility.html. Accessed May 5, 2011.

3.6.2.3 Slope

The natural slope of soils at the Airport does not exceed a ten percent slope grade. Additionally, many areas at the Airport have been graded in a manner that has created flat and uniform topography required for Airport infrastructure and safe airport operation.

3.6.3 Environmental Impacts and Mitigation Measures

Impact 3.6.1: Geologic and Seismic Impacts

The primary geologic consideration for the project elements is the use of fill material to accommodate the grading of the RSAs and the soil foundation for the runway extensions. Geotechnical investigations would be completed as necessary for each short-term project element. The location and scope of these studies would be based on detailed site plans for each project element and would evaluate the geotechnical feasibility of these project elements. All foundations and geotechnical recommendations presented in the site-specific geotechnical investigations would be incorporated as part of the Proposed Project and would comply with the most current CBC requirements.

According to the California Geologic Survey, a probabilistic earthquake in the Regional Study Area would produce ground shaking at the Airport that could cause slight damage on modern buildings of "earthquake proof" infrastructure and slight to moderate damage on older buildings.[12]

The major source of seismic hazards at the site would likely be from non-structural building elements. Even though all buildings associated with the long-term project elements could experience damage associated with seismic activity, the buildings would be constructed with the highest feasible safety standard. Potential damage and injuries may be caused by falling objects such as suspended ceilings and light fixtures. Other hazards include toppling furniture; overturned shelving; broken glass; falling plaster, ceiling tiles, and light fixtures; and rupture of overhead water pipes. As part of the Proposed Project construction, all non-structural features would be tied into structural elements of the building. Heavy equipment and other potentially hazardous objects would be secured to floors or walls.

A larger earthquake could potentially cause strong ground shaking that could rupture fuel and natural gas pipelines, resulting in leaks/spills and fire hazards. To reduce the potential for hazardous materials exposure, any new gas lines would be equipped with automatic shut-off valves that would be activated in the event of a major earthquake as part of a CBC requirement.

Landslide potential would be characterized as low given the relatively flat terrain surrounding the Airport. Since the terrain consists of loam soils, there would be no significant expansive soil hazards associated with the Proposed Project. In addition, the topography has a very low risk for liquefaction exposure even with Proposed Project.

Improved CBC requirements in new buildings should further reduce the potential for seismic impacts. The earthquake hazards discussed above currently exist at the Airport and would continue to exist to some degree following implementation of short-term project elements. The effectiveness of measures aimed at reducing earthquake hazards would depend primarily on implementation of safety policies, facility and equipment maintenance, proper training of

[12]California Geological Survey, *Probabilistic Seismic Hazards Assessment*, available at: www.consrv.ca.gov/cgs/rghm/pshamap/pshamap.asp. Accessed May 3, 2011.

workers in safety procedures, and the degree to which facility users respect the need for safe use, storage, and disposal of hazardous materials. Seismic hazards would be mitigated through sound structural design and construction techniques and ongoing inspection and employee training programs. All new facilities would be included in the Airport's earthquake safety inspections. Periodic training concerning earthquake preparedness and seismic hazards reduction would be conducted at all new facilities. The Airport's Emergency Response Plan would continue to be practiced and would be updated as necessary to incorporate the Proposed Action project components as they are completed.

The Proposed Project would comply with all CBC requirements. Thus, potential impacts from geologic and seismic events would be less than significant.

Mitigation Measure 3.6.1

No mitigation is warranted.

Impact 3.6.2: Potential Loss of Topsoil

Grading, excavation, and earthwork associated with construction activities have the potential to directly contribute to topsoil erosion at the Airport. If proper construction and landscaping practices are not maintained throughout the timeframe of the Proposed Project, there could be a significant loss of topsoil in areas where soil would be disturbed. The extent of possible erosion is dependent on several variables such as the slope of soils and weather conditions which are outside the control of the Airport. **Figure 3.6-2** shows the approximate cut and fill volumes by location. It is anticipated that fill generated within the Airport Study Area would be stockpiled in the area north of Airport Creek. However, some imported fill material would be temporarily stored in a designated contractor staging area south of Sanders Road.

There is only one inlet that would be potentially affected as a result of the proposed near-term airfield improvements. The inlet is located south of the run-up apron at the north end of Runway 14/32. However, BMPs included in a construction management and maintenance plan would protect this water feature.

The County shall prepare and implement a construction management and maintenance plan to ensure that the proper Best Management Practices (BMPs) are used throughout the Proposed Project. Such mitigation measures would be seasonally specific as soil conditions will fluctuate based on climatic variables such as wind and precipitation. All proposed infrastructure shall comply with the appropriate California Building Code. Recommended BMPs, which shall be installed on or before October 15 of any construction year, include, but are not limited to:[13]

- protect and establish existing vegetation through reseeding or hydroseeding of disturbed areas;
- stabilize construction entrances and exits to prevent fugitive dust emissions from affecting ambient air and water quality through fencing and sweeping control measures;
- protect exposed slopes from erosion under dry windy conditions or during times of heavy precipitation;
- protect drainage inlets from sediment-laden stormwater through the use of fabric filters, gravel bags, or straw barriers; and

[13] Sonoma County Permit and Resource Management Department, *Construction BMPs*, available at http://www.sonoma-county.org/prmd/sw/sw-bmps.htm. Accessed April 21, 2011.

- check weather forecast for inclement weather, defined as when ¼ inch of rain or more is expected within a 24-hour period that may promote accelerated erosion and be prepared by having necessary materials onsite.

Mitigation Measure 3.6.2

No Mitigation is warranted.

Figure 3.6-2
GRADING AREAS WITHIN THE AIRPORT STUDY AREA

SOURCE: Mead & Hunt, 2011
PREPARED BY: Mead & Hunt, 2011