3.11 Geology, Soils, Seismicity, and Paleontology

The analysis of geology, soils, seismicity, topography, and paleontology is based on a review of the California Geological Survey (CGS) regional mapping, Solano County General Plan, local general plans, and a reconnaissance-level survey to provide an overview of the rock types, seismicity, potential soil constraints, and geologic formations that may contain paleontological resources. No geotechnical or paleontological reports have been prepared at this time.

3.11.1 Regulatory Setting

For geologic and topographic features, the key federal law is the Historic Sites Act of 1935, which establishes a national registry of natural landmarks and protects "outstanding examples of major geological features."

This section discusses geology, soils, and seismic concerns as they relate to public safety and project design. Earthquakes are prime considerations in the design and retrofit of structures. The current policy is to use the anticipated Maximum Credible Earthquake (MCE), from young faults in and near California. The MCE is defined as the largest earthquake that can be expected to occur on a fault over a particular period of time.

Paleontology, which is also addressed in this section, is the study of life in past geologic time based on fossil plants and animals. A number of federal statutes specifically address paleontological resources, their treatment, and funding for mitigation as a part of federally authorized or funded projects. (e.g., Antiquities Act of 1906 [16 USC 431-433], Federal-Aid Highway Act of 1935 [20 USC 78]).

The following acts, regulations, and codes pertain to the project:

- Seismic Hazards Mapping Regulations (14 CCR 3720–3725)
- Caltrans Regulations: The major State regulations protecting public roadways and bridges from geo seismic hazards are contained in Caltrans' *Seismic Design Criteria Version 1.2* (December 2001) and Caltrans' *Highway Design Manual*, Section 110.6, Earthquake Consideration (November 2001). Bridge design is required to be in accordance with Caltrans' *Bridge Design Specifications*, *Bridge Memos to Designers*, *Bridge Design Practices Manual*, and *Bridge Design Aids Manual*. Bridge design is required to be based on the "Load Factor Design methodology with HS20-44 live loading". Seismic design is required to conform to the Bridge Design Specifications, and Section 20 of the memos to Designers, including the Caltrans Seismic Design Criteria.
- California Public Resources Code: PRC 5097.5 prohibits "knowing and willful" excavation, removal, destruction, injury, and defacement of any paleontologic feature on public lands (lands under the jurisdiction of a state, county, city, district, or public authority or under the jurisdiction of a public corporation), except where the agency with jurisdiction has granted express permission. PRC 30244 requires reasonable mitigation for impacts on paleontological resources that occur as a result of development on public lands.

3.11.2 Affected Environment

Geology

Regional Geology

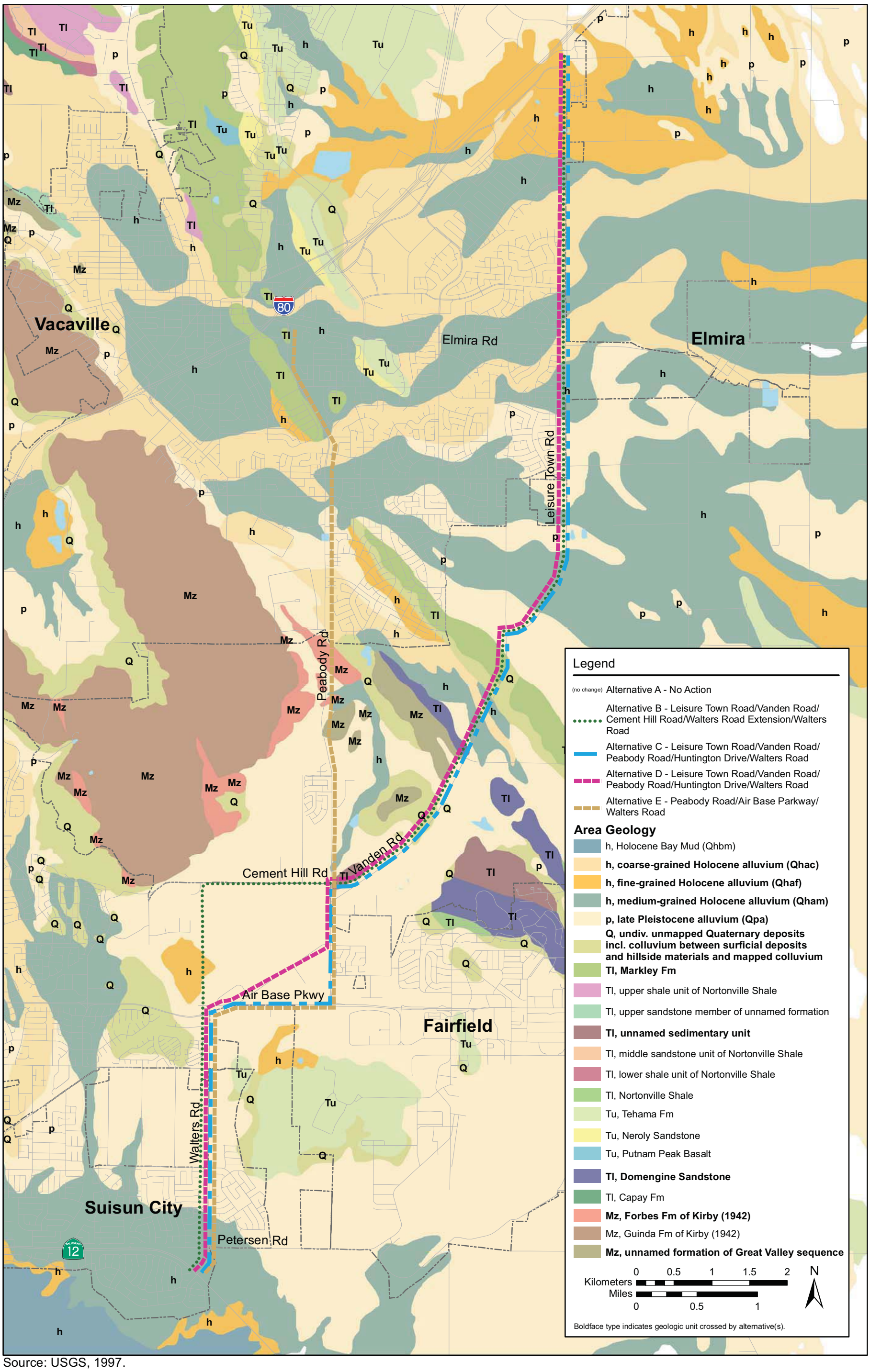
Solano County's diverse geological setting spans 144 million years, from the early Jurassic Period through today. Geologically, the western portion of the county is made up of the north-south trending Sacramento and San Joaquin Valleys, as well as a small portion of the Northern California Coast Ranges. The Northern California Coast Range in Solano County is known as the Vaca Mountains, which consist of Cretaceous and Tertiary strata that has been uplifted and tilted eastward. A large predominantly Quaternary plain lies to the east of the Vaca Mountains. In the southwestern portion of the county, Pliocene and late Miocene volcanic deposits are common. The Pleistocene Montezuma Hills lie just north of the confluence of the Sacramento and San Joaquin Rivers, where they drain to Suisun Bay. Suisun and Montezuma Sloughs mark a large tidal wetland that enters Grizzly Bay along the southern border of the county.

The east-central and northeastern parts of Solano County that the project corridor traverses are relatively flat and are characterized by a Holocene and Pleistocene alluvial plain. Sporadic exposures of northwest-trending sedimentary rocks associated with the development of the Coast Ranges form rolling hills that separate the northern part of the corridor (generally, along Leisure Town Road) from the southern part (Peabody Road/Air Base Parkway/Walters Road). Figure 3.11-1 (Geologic Map) shows the geology in the general area between I-80 and SR-12. The geologic units crossed by the alternatives are indicated in boldface type. Table 3.11-1 lists the geologic formations, the age of the formations and their general composition, and approximate location of each unit relative to each alternative's proposed alignment.

Soils

Solano County soils were mapped and described by the U.S. Soil Conservation Service. The general soil map produced from this effort indicates that there are 17 soil associations in the County. Each association comprises one or more major soil components, which typically characterize the association, and at least one minor soil component. The U.S. Soil Conservation Service categorized each association as one of four groups (described below) based on the changes in slope, drainage class, and landscape position:[1]

[1] Bates, L. A. 1977. Soil Survey of Solano County, California. U.S. Department of Agriculture Soil Conservation Service, in cooperation with the University of California Agricultural Experiment Station. Washington, DC.



Source: USGS, 1997.

Figure 3.11-1

Geologic Map

Table 3.11-1
Geologic Unit Summary

Geologic Unit (abbreviation corresponding to Figure 3.11-1)	Age	Composition	General Location
Holocene Alluvium (Qhaf, Qham, Qhac)	Recent -10,000 years	fine-, medium, and coarse-grained sand, silt, and gravel deposited in alluvial fan, valley fill, terrace, or basin environments	Leisure Town Road between Fry Road and I-80 (Alternatives B, C, and D) Qham northern part of Peabody Road (Alternative E)
Pleistocene Alluvium (Qpa)	Pleistocene: 10,000 to 1.8 million years	less permeable sediments in basin, landslide intertidal, terrace, or riverbank environments	Leisure Town Road between Fry Road and I-80 (Alternatives B, C, and D) Peabody Road, Air Base Parkway, Walters Road (Alternative E)
undivided unmapped Quaternary deposits (Q)	Quaternary: <1.6 million years	Primarily unconsolidated non-marine alluvium, lake, playa, and terrace deposits as colluviums between surface deposits and hillside materials	isolated sections along Vanden Road (Alternatives B, C, and D)
Markley Shale and an unnamed sedimentary unit (Tl)	Eocene: 35 to 55 million years	light gray to white shale	Vanden Road south of Leisure Town Road (Alternatives B, C, and D) northern section of Peabody Road (Alternative E)
Domengine Sandstone (Tl)	Eocene: 35 to 55 million years	cross-bedded white sandstone	small area approximately midway along Vanden Road (Alternatives, B, C, and D)
Forbes Formation (Mz)	Late Cretaceous: 65 to 100 million years	massive beds of fine- to coarse-grained wacke (sandstone) with shell fragments grading into interbedded siltstone and shale	small areas along Vanden and Peabody roads (Alternatives, B, C, D, and E)
unnamed formation of Great Valley sequence (Mz)	Late Cretaceous: 65 to 100 million years	sandstone, shale, conglomerate	small area approximately midway along Peabody Road (Alternative E)

Source:
Solano County, 2008 Draft General Plan EIR, Section 4.7 (Geology and Soils); California Geological Survey, 2010 Geologic Map of California.

- **Soils on Nearly Level to Moderately Sloping Alluvial Fans:**[2] This group of soils comprises the Yolo-Brentwood, Yolo-Sycamore, and Rincon-Yolo soil associations, which occur throughout Solano County. The dominant soil components are typically very deep, well drained to somewhat poorly drained loams[3] to silty clay loams formed from mixed alluvium.[4] Slopes typically range in steepness from 0 to 9 percent. Runoff is typically slow to medium. The erosion hazard is slight, largely because of the low slope gradients that prevail in these areas. The shrink-swell potential (expansive) associated with the dominant soil components typically ranges from moderate to high.
- **Soils on Nearly Level to Gently Sloping Basin Rims, Alluvial Fans, and Deltas, and in Basins, Dredge Spoil Areas, and Salt Water Marshes:** This group of soils comprises the Capay-Clear Lake, Sacramento, Egbert-Ryde, Valdez, Joice-Suisun, and Reyes-Tamba soil associations, which occur primarily in and adjacent to the Delta. The dominant soil components are fine-textured mineral soils and organic soils formed from mixed alluvium or wetland vegetation remains. Slopes typically range from 0 to 5 percent. Runoff is typically slow. The erosion hazard ranges from nonexistent to slight, largely because of the low slopes that prevail in these areas. Except for some organic soils, the shrink-swell potential associated with the dominant soil components typically ranges from moderate to high.
- **Soils on Nearly Level to Moderately Steep Alluvial Terraces and in Basins:** This group of soils comprises the San Ysidro-Antioch, Corning, and Solano-Pescadero soil associations, which occur primarily in the central and north-central portions of Solano County. The dominant soil components are typically somewhat poorly drained to well-drained gravelly loams to clays formed from alluvium derived mostly from sedimentary rocks. Slopes typically range from 0 to 30 percent. Runoff ranges from very slow to medium. The erosion hazard ranges from nonexistent to moderate. The shrink-swell potential associated with the dominant soil components typically ranges from low to high.
- **Soils on Gently Sloping to Very Steep Alluvial Terraces and Mountainous Uplands:** This group of soils comprises the Altamont-Diablo, Dibble-Los Osos, Millsholm, Maymen-Los Gatos, and Hambright-Toomes soil associations, which occur primarily in the westernmost and southernmost portions of Solano County. The dominant soil components of these soil associations are typically somewhat excessively drained to well-drained stony loams to clays formed from weakly consolidated sediments, sandstone, and basic igneous rocks. Slopes range from 2 to 75 percent. Runoff ranges from slow to very rapid. The erosion hazard ranges from slight to very high. The shrink-swell potential associated with the dominant soil components in these soil associations typically ranges from low to high.

The corridor passes through areas containing each of the four soil groups identified above. Although each of the four identified groups is represented in the corridor, the corridor is largely dominated by two of the four soil groups. The southern portion of the corridor primarily includes the Capay-Clear

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[2] An alluvial fan is a fan-shaped pile of sediment that forms where a rapidly flowing mountain stream enters a relatively flat valley. As water slows down, it deposits sediment (alluvium) that gradually builds a fan.

[3] Loam is soil composed of sand, silt, humus, and clay in relatively even concentration.

[4] Alluvium is soil or sediments deposited by a river or other running water. Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel.

Lake, Sacramento, Egber-Ryde, Valdez, Joice-Suisun, and Reyes-Tamba associations, and the northern portion of the corridor primarily includes the San Ysidro-Antioch, Corning, and Solano-Pescadero associations.[5]

Geologic and Seismic Hazards

The known geologic and seismic hazards in Solano County, as identified in the Health and Safety Element of the Solano County General Plan, are discussed below.[6] Additional detail is provided from local general plans, where applicable.

Slope Instability

Slope stability is a function of many factors, including rainfall, how steep the slopes are, rock and soil type, slope orientation, vegetation, seismic conditions, and human activities. The Health and Safety Element of the Solano County General Plan contains a map showing portions of the County where slope failures (landslides, debris flows, and mudslides) are most likely to occur based on available geologic information on geologic units, the location and extent of past slope failures, and mapping criteria developed by the U.S. Geologic Survey (USGS). In general, areas rated as potentially unstable, unstable, and highly unstable (slope instability categories 3, 4, and 5, respectively) are located on geologic units that are known to be susceptible to landsliding or have slopes more than 15 percent. These areas are located almost entirely in the uplands that compose the western third of the County (e.g., the Vaca Mountains) and in the Montezuma and Potrero Hills. The remaining portions of the County have slopes that are less than 15 percent and show no evidence of landslide activity. Accordingly, these areas are considered to have greater relative stability. These findings are generally consistent with a more recent slope stability analysis conducted by USGS.[7] The majority of the corridor is in an area of the County with slopes of less than 15 percent. A small portion of the Alternative E alignment on Peabody Road, near the Vacaville city limits, briefly crosses through the eastern edge of the Vaca Mountains, an area with slopes in excess of 15 percent.[8]

Land Subsidence and Settlement

Land subsidence is the gradual lowering or downward sinking of the ground surface. It can be induced by natural processes or certain human activities. The most common causes of subsidence are groundwater withdrawal, oil and natural gas withdrawal, and oxidation of peat soils. The peat soils of the Delta are generally susceptible to subsidence and represent a potential hazard for road construction and development in southern Solano County.

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5 EDAW. 2006. Solano County General Plan Geology and Soils Background Report. August 28, 2006. Prepared for Solano County Resource Management Department. Fairfield, CA.

6 Sedway/Cook. 1977. Solano County General Plan. Adopted April 21, 1977. Prepared for the Solano County Planning Commission. Fairfield, CA.

7 Ellen, S. D., R. K. Mark, G. F. Wieczorek, C. F. Wentworth, D. W. Ramsey, and T.E. May. 1997. Map showing principal debris-flow source areas in Solano County, California. Scale 1:125,000. In U.S. Geological Survey Open File Report 97-745. Washington, DC.

8 EDAW. 2006. Solano County General Plan Geology and Soils Background Report. August 28, 2006. Prepared for Solano County Resource Management Department. Fairfield, CA.

Land settlement is a gradual lowering of the ground surface that results from the compression or consolidation of soft, poorly consolidated fine-textured deposits (clays and silts). Settlement can be induced by dewatering and placing heavy loads on potentially compressible soils and sediments. Many of the fine-textured bay mud deposits that exist in and adjacent to the Delta are susceptible to settlement and present a potential hazard for road construction and development in southern Solano County.[9] The bay mud deposits susceptible to settlement are generally south of the corridor.

Expansive Soils and Sediments

Soils with high shrink-swell potential (expansive) typically contain a high percentage of expansive phyllosilicate clay minerals (e.g., montmorillonite).[10] Expansive soils swell when wet and shrink when dry. In the process, they can cause substantial damage to structures and roadways. However, most damage resulting from expansive soils and sediments can be avoided through proper foundation and roadway design.

As described above, soils with moderate to high shrink-swell potential occur throughout Solano County. The Solano County General Plan indicates that perhaps as much as 20 to 30 percent of the flat land in the County is underlain by soils that have high shrink-swell potential.[11] Similarly, the City of Fairfield General Plan identifies expansive soils as a common on both the hillsides and valleys of Fairfield.[12] Soils with a high shrink-swell potential are present throughout the majority of corridor.[13]

Surface Fault Rupture

The California State Geology and Mining Board has established policies and criteria for the classification of known earthquake faults in California based on the presence or absence of a detectable fault trace and the recency of fault displacement.[14] The categories are described below:

- **Active Faults:** Detectable fault traces that show evidence of displacement during the last 10,000 to 11,000 years (i.e., Holocene faults) are defined as "active" and are considered to have the greatest potential for surface rupture.
- **Potentially Active Faults:** Detectable fault traces that show evidence of displacement 10,000 to 1.6 million years ago (i.e., Quaternary faults) are defined as "potentially active" and are considered to have less potential for surface rupture.

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9 Sedway/Cook. 1977. Solano County General Plan. Adopted April 21, 1977. Prepared for the Solano County Planning Commission. Fairfield, CA.

10 Phyllosilicates occur when the silica tetrahedra join together to form flat sheets. These sheets are held together by weak bonding between the free oxygen on the tetrahedra and so cleave easily. Phyllosilicates include both micas (biotite & muscovite), talc, and clay minerals.

11 Sedway/Cook. 1977. Solano County General Plan. Adopted April 21, 1977. Prepared for the Solano County Planning Commission. Fairfield, CA.

12 City of Fairfield, Fairfield General Plan, February 2004.

13 EDAW. 2006. Solano County General Plan Geology and Soils Background Report. August 28, 2006. Prepared for Solano County Resource Management Department. Fairfield, CA.

14 Hart, E. W. and W. A. Bryant. 1997. Fault-rupture hazard zones in California: Alquist-Priolo Earthquake Fault Zoning Act with index to earthquake fault zone maps. Special Publication 42. California Division of Mines and Geology. Sacramento, CA.

- **Other Faults:** The board has not established an official category for faults that show no evidence of displacement during the last 1.6 million years (i.e., pre-Quaternary faults). Although such faults are not deemed "inactive," they are considered to have a relatively low potential for surface rupture.

Solano County contains several known faults. Currently, segments of only two faults, the Green Valley fault and the Cordelia fault are known to be active. Both faults have each been zoned under the Alquist-Priolo Act, meaning that development in the immediate vicinity of the fault trace must be preceded by detailed fault investigations.[15] The Green Valley fault and the Cordelia fault are in western Solano County, and do not present any risk of surface fault rupture in the corridor. The corridor crosses the Vaca-Kirby Hills fault; however, this fault is not identified as an active fault.

Seismic Groundshaking

In 1996, the California Department of Mines and Geology (CDMG) (now referred to as the California Geological Survey [CGS]) released a probabilistic seismic hazard assessment for California to aid in the assessment of seismic groundshaking hazards in the State.[16] The report suggests that the groundshaking hazard in the County ranges from very low to severe. The most severe groundshaking hazards are located in the western half of the County. The findings of the report are generally consistent with the findings of the shaking hazard assessment conducted by the Association of Bay Area Governments (ABAG), which also indicated that the most intense seismic groundshaking in Solano County is likely to result from an earthquake on the Green Valley fault.[17] The corridor is just east of the area identified as having the highest potential for earthquake damage.[18]

Liquefaction

Liquefaction is a process by which soils and sediments lose shear strength and fail during episodes of intense seismic groundshaking. As a consequence of liquefaction, soils act like fluids rather than solids. The most recent seismic hazard maps published by ABAG indicate that the susceptibility of soils and sediments in Solano County to liquefaction ranges from very low in areas such as the Montezuma Hills, which are underlain by clayey sand, to very high in areas such as the Delta and the large alluvial plain south of Dixon, which are underlain by unconsolidated sediments of variable composition or shallow groundwater. The corridor crosses through areas with very low, low, and moderate liquefaction potential.[19]

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[15] EDAW. 2006. Solano County General Plan Geology and Soils Background Report. August 28, 2006. Prepared for Solano County Resource Management Department. Fairfield, CA.

[16] Peterson, M. D., W. A. Bryant, C. H. Cramer, T. Cao, and M. Reichle. 1996. Probabilistic seismic hazard assessment for the state of California. (Open-File Report 96-706.) U.S. Geological Survey. Washington, DC.

[17] Association of Bay Area Governments (ABAG). 1995. The San Francisco Bay Area—on shaky ground. Publication P95001EQK. Oakland, CA.

[18] EDAW. 2006. Solano County General Plan Geology and Soils Background Report. August 28, 2006. Prepared for Solano County Resource Management Department. Fairfield, CA.

[19] EDAW. 2006. Solano County General Plan Geology and Soils Background Report. August 28, 2006. Prepared for Solano County Resource Management Department. Fairfield, CA.

Paleontological Resources

Paleontology is the study of life in past geologic time based on fossil plants and animals. A number of federal statutes specifically address paleontological resources, their treatment, and funding for mitigation as a part of federally authorized or funded projects. (e.g., Antiquities Act of 1906 [16 USC 431-433], Federal-Aid Highway Act of 1956 [23 USC 305]).

3.11.3 Impacts (including Permanent, Temporary, Direct, Indirect, and Cumulative)

Methodology

The determination of effects of the proposed action on geology, soils, seismicity, topography, and paleontological resources was based on a review of relevant publications and a reconnaissance-level survey of the corridor.

Summary of Geologic Impacts

Each of the build alternatives has similar potential to encounter geologic hazards associated with seismic activity, expansive soils, and/or unique geologic features. Existing regulations would prevent adverse geologic impacts from occurring with implementation of any of the alternatives. Details regarding these impacts are provided below.

Impact GEO-1: Would the Alternatives Expose People to Injury or Structures to Damage from Potential Rupture of a Known Earthquake Fault, Strong Groundshaking, Seismic-Related Ground Failure, Liquefaction, or Landslides?

Alternative A. Under this alternative, the project would not be constructed. Therefore, there would be no potential for impacts.

Alternatives B, C, D, and E. For Alternatives B, C, D, and E, impacts related to exposure of people to injury or structures to damage from potential rupture of a known earthquake fault, strong groundshaking, seismic-related ground failure, liquefaction, or landslides would be similar because the alternative alignments generally travel along the same geographic area with the same geologic features.

Groundshaking caused by an earthquake on the Green Valley fault or other active and potentially active faults in the region could damage project facilities and result in injury to people using these facilities. Although the corridor is not in the portion of Solano County identified as at risk for severe groundshaking, substantial and damaging groundshaking could still occur along the alternative alignments. Slope failures caused by project construction or operation, earthquakes, high rainfall, human activities, or other means, could cause damage to project facilities and result in injury to people using these facilities.

Table 3.11-2
Preliminary Summary of Paleontological Resource Sensitivity for Geologic Units in the Jepson Parkway Project

Geologic Unit	Fossil Content	General Location in Project Corridor	Sensitivity
Holocene Alluvium (Qhaf, Qham, Qhac)	generally contain vertebrate and invertebrate fossils of extant, modern taxa	Leisure Town Road between Fry Road and I-80 (Alternatives B, C, and D) Qham: northern part of Peabody Road (Alternative E)	Low; however, may form only a thin veneer over sensitive Pleistocene sediments
Pleistocene Alluvium (Qpa)	diverse vertebrate faunas collected from other similar alluvial units in northern California	Leisure Town Road between Fry Road and I-80 (Alternatives B, C, and D) Peabody Road, Air Base Parkway, Walters Road (Alternative E)	High
undivided unmapped Quaternary deposits (Q)	NA	isolated sections along Vanden Road (Alternatives B, C, and D)	NA
Markley Shale and an unnamed sedimentary unit (Tl)	carbonized plant remains and microfossils such as foraminifer and diatoms. Bony fishes recorded in adjacent Contra Costa County	Vanden Road south of Leisure Town Road (Alternatives B, C, and D) northern section of Peabody Road (Alternative E)	High
Domengine Sandstone (Tl)	invertebrate shells, including the highest diversity of mollusks reported from the Pacific Coast.	small area approximately midway along Vanden Road (Alternatives, B, C, and D)	High
Forbes Formation (Mz)	contains shell fragments; foraminifera and may contain significant invertebrate marine fossils	small areas along Vanden and Peabody roads (Alternatives, B, C, D, and E)	High
unnamed formation of Great Valley sequence (Mz)	strata of Great Valley complex in other areas known to contain marine fossils, including invertebrates and marine reptiles	small area approximately midway along Peabody Road (Alternative E)	High

Sources:

Solano County, 2008 Draft General Plan EIR, Section 4.10 (Cultural and Paleontological Resources); Caltrans. 2010. Draft EIR/EIS I-80/I-680/SR-12 Interchange Project, Section 3.2.4 (Paleontology).

Note:

NA = Not available, not identified in readily available literature or UCMP records.

The USGS and CGS identify a design earthquake and the associated peak horizontal ground accelerations (or "shaking") for the project area based on an earthquake on the Green Valley fault. The amount of ground disturbance from an earthquake on the Green Valley fault could cause damage to roads and infrastructure (primary effects), and could cause ground failures in alluvium and poorly compacted fill, as well as seismically induced landslides on steep slopes (secondary effects).

The amount of surface alteration necessary to accommodate the construction of any of the build alternatives is not considered a substantial geologic change in itself. However, the alteration of topography for construction of the roadways raises issues of slope and soil instability in the corridor. Substantial amounts of material would be needed to fill low areas along the alternative alignments, and deep cuts are proposed through the bedrock ridges of the foothills, depending on the alternative selected. The creation of cuts in alluvium, and the placement of fill under new or widened roadways in the corridor would have the potential to create unstable slopes if the cuts and fills are not specifically designed for stability.

Impact GEO-2: Would the Alternatives Result in Damage to Facilities and Injury to the Public from Presence of Expansive Soils?

Alternative A. Under this alternative, the project would not be constructed. Therefore, there would be no potential for impacts.

Alternatives B, C, D, and E. The Soil Survey of Solano County indicates that soils with high shrink-swell potential (i.e., potentially expansive soils) are present in the corridor, for all alternative alignments. The existence of soils with high shrink-swell potential throughout the corridor makes it necessary to ensure the soils used for road base or trench support are sound. The creation of road base in unsuitable soils would have the potential to create future problems of settlement and utility line disruption if the soils were not specifically engineered for stability. The presence of expansive soils could result in damage to project facilities and injury to people using these facilities. Avoidance and minimization measures have been identified to ensure that project facilities are designed to avoid or minimize the potential for damage or injury associated with expansive soils.

Impact GEO-3: Would the Alternatives Result in Cumulative Geology Effects?

Construction in the corridor could lead to an increase in the potential for seismic or expansive soil related hazards. Compliance with existing laws and regulations, however, would avoid or minimize this potential effect. Implementation of Mitigation Measure GEO-1 would minimize the potential for the project alternatives to destroy paleontological resources or geologic features by ensuring the resources are evaluated, recovered, and documented in accordance with Caltrans guidelines and professional standards. Therefore, the project is not anticipated to have a cumulatively considerable contribution to these impacts.

3.11.4 Avoidance, Minimization, and/or Mitigation Measures

As discussed in Impacts GEO-1 and GEO-2, avoidance and minimization measures have been identified to address the potential for adverse effects associated with seismic and slope stability hazards, as well as the presences of expansive soils in the corridor. The local lead agency is required to conduct the necessary site-specific studies, in compliance with the Uniform Building Code and Caltrans Standards seismic design criteria and bridge standards, to ensure that project facilities avoid alignments on active fault zones and areas with expansive soils.

The implementing local agency would be required to design the roadway and associated improvements in conformance with the applicable jurisdiction's *Design and Construction Standards*. For bridges or other concrete structures, structural design shall be in accordance with Caltrans' *Bridge Design Specifications, Bridge Memos to Designers, Bridge Design Practices Manual*, and *Bridge Design Aids Manual*. Bridge design shall be based on the "Load Factor Design" methodology with HS20-44 live loading. Seismic design shall conform to the *Bridge Design Specifications*, and Section 20 of the *Memos to Designers* including "*Caltrans Seismic Design Criteria*".

Prior to approval of the project design, the appropriate local agency would require a completed report of soil and/or rock conditions along the alignment that evaluates potential slope instability conditions. The evaluations would be conducted in accordance with the applicable jurisdiction's Design and Construction Standards. The evaluations must be conducted by registered professionals, and measures to reduce or eliminate slope instability be applied, depending on the soil and/or rock conditions. At a minimum, the investigations must describe the characteristics of the soil and/or materials at the location of the cut or fill; the most appropriate type of support systems for the proposed slopes; the design criteria for the recommended support system, including the estimated ground settlement rate beneath the support system; the necessary subgrade preparation; the lateral pressures for retaining walls; the drainage conditions; the design slopes for cut and fill sections; and, the suitability of on-site soils for use as backfill. The recommendations of the slope and/or structural reports are required to be incorporated in the Plans and Specifications for the design of the project.

An acceptable degree of cut-slope or fill-slope stability along the various alignments can be achieved by designing the project to site-specific geologic conditions. Site-specific stability analysis would be the basis for slope design in areas where instability is suspected. Such slope stability analyses contain recommendations for ground preparation, earthwork, foundation design, etc., specific to the location that become an integral part the construction design.

Site-specific treatments to eliminate expansion of soils include, but are not limited to, grouting, recompaction and replacement with non-expansive material. Site-specific analysis is the mainstay of road base design in areas where unsuitable conditions are suspected. Such analyses contain recommendations for ground preparation and earthwork specific to the site, which become an integral part the construction design. The selected alignment would be evaluated to determine the particular treatment that would be most appropriate.

3.11.4.1 Mitigation Measure Regarding Paleontological Resources

Paleontological resources or unique geologic features may be discovered during construction under Alternatives B, C, D, and E. Activities such as excavation and grading into native soils, trenching for drainage systems, and pile driving for elevated structures or any type of piling or footing could damage such resources.

Avoidance would not be possible in paleontologically sensitive units for Alternatives B, C, D, or E because the geologic units cover a broad area relative to each alternative's alignment. Any improvements involving excavation for footings and trenching, in particular, would need to be placed in specific locations to ensure design criteria are met.

Mitigation Measure GEO-1: *Prepare and Implement Paleontological Mitigation Plan.* STA shall ensure a Paleontological Mitigation Plan is prepared by a qualified paleontologist (M.S. or PhD in paleontology or geology familiar with paleontological procedures and techniques) that addresses, at a minimum the following: pre-excavation survey, literature review, repository review; training for construction personnel; monitoring and data recover; recovery; specimen curation; and documentation requirements. In conjunction with project construction activities, the following shall be implemented.

- STA will retain a qualified paleontologist to conduct preconstruction studies to ensure that paleontological materials exposed at the surface are recovered and properly prepared and curated, or protected from damage using exclusion fencing or other appropriate means, and to further assess potential for impacts.
- A qualified principal paleontologist experienced in teaching non-specialists will be retained to be present at pre-grading meetings to consult with grading and excavation contractors. STA will ensure that all construction personnel receive training provided by the qualified professional paleontologist, to ensure that they can recognize fossil materials in the event any are discovered during construction.
- In accordance with the Department's recommended mitigation procedures for construction in units with the potential to contain fossils, STA will retain a qualified professional paleontologist, working under the direction of the qualified principal paleontologist, to monitor activities with the potential to disturb units sensitive for paleontological resources. Data gathered during preconstruction surveys for paleontological resources, and detailed project design, will be used to identify potential activities that will require the presence of a monitor. In general, these activities include any ground-disturbing activities involving excavation in areas with high potential to contain fossils or excavation deeper than three feet in areas with low or unknown potential to contain fossils.
- In accordance with the Department's recommended mitigation procedures for construction in units with the potential to contain fossils, when requested by the paleontological monitor, earth-disturbing activities will be stopped in an area or diverted to allow for the safe recovery of fossil specimens. Additionally, if construction personnel observe fossils in an area where paleontological resources were not anticipated, and paleontological monitors are, therefore, not present, earth-

disturbing activities within a 100-foot radius will be stopped until the material can be evaluated by a monitor and appropriate treatment taken.

- When fossils are discovered, the paleontologist (or paleontological monitor) will recover them. Construction work in these areas will be halted or diverted to allow recovery of fossil remains in a timely manner. Fossil remains collected during the monitoring and salvage portion of the mitigation program will be cleaned, repaired, sorted, and cataloged. Prepared fossils, along with copies of all pertinent field notes, photos, and maps, will then be deposited in a scientific institution with paleontological collections. A final Paleontological Mitigation Plan Report will be prepared that outlines the results of the mitigation program. STA will be responsible for ensuring that monitor's recommendations regarding treatment and reporting are implemented.

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