4.5 GEOLOGY AND SOILS

4.5.1 Introduction

This section identifies and evaluates potential impacts that could result from geologic or soil conditions as a result of implementation of the Dry Creek Greenway East Trail. This section is based primarily on the *Dry Creek Greenway Trail Fluvial Audit* (City of Roseville and Psomas 2014) and the *Preliminary Geotechnical Evaluation, Dry Creek Greenway Multi-Use Trail Project, City of Roseville, CA* (Parikh 2015), as well as the *Engineering Design Considerations and Evaluation based on Geomorphology Study* (Psomas 2014).

No comments related to geology and soils were received during public review of the Notice of Preparation.

4.5.2 Environmental Setting

REGIONAL SETTING

The project site is located in the Great Valley geomorphic province, which consists of the central part of California between the Coast Range and the Sierra Nevada. The Great Valley is an alluvial plain that is approximately 50 miles wide and 400 miles long where sediment has been deposited almost continually for roughly 160 million years. The proposed project would be located in the northern part of the Great Valley, which is drained by the Sacramento River (California Geological Survey [CGS] 2002).

LOCAL SETTING

Geology

The geology of the area consists of transitional formations between alluvial deposits of the valley and volcanic material of the Sierra Nevada. The City of Roseville is characterized by flat and rolling terrain, as well as rounded knolls and ridges separated by intermittent streams. Pleasant Grove Creek and its tributaries are the primary surface water drainages in northern Roseville; Dry Creek and its tributaries are the primary surface water drainages in southern Roseville. The area slopes gently westward toward the Sacramento River.

Subsurface conditions are mapped by CGS as alluvium deposited in the Holocene (i.e., between 11,700 years ago and the present time) along Dry Creek and Pleistocene-age (i.e., from about 2,588,000 to 11,700 years ago) alluvial deposits classified in the Modesto Formation and Turlock Lake Formation along Cirby and Linda Creeks. Samples indicate that subsurface soils are generally loose, granular (i.e., sandy or silty) materials within 10 to 20 feet of the surface that increase in density with depth. Groundwater is anticipated to fluctuate, but to generally be at or above creek level (Parikh 2015).

Paleontological Setting

Significant nonrenewable vertebrate and invertebrate fossils and unique geologic units have been documented throughout California. The fossil-yielding potential of a particular area is highly dependent on the geologic age and origin of the underlying rocks (refer to geologic timescale in Table 4.5-1). Paleontological potential refers to the likelihood that a rock unit will yield a unique or significant paleontological resource. All sedimentary rocks, some volcanic rocks, and some low-grade metamorphic rocks have potential to yield paleontological resources. Depending on location, the

paleontological potential of subsurface materials generally increases with depth beneath the surface, as well as with proximity to known fossiliferous deposits.

Table 4.5-1 Divisions of Geologic Time

Era	Period	Time in Millions of Years Ago (approximately)	Epoch
Cenozoic	Quaternary	< 0.01	Holocene
		2.6	Pleistocene
	Tertiary	5.3	Pliocene
		23	Miocene
		34	Oligocene
		56	Eocene
		65	Paleocene
Mesozoic	Cretaceous	145	
	Jurassic	200	
	Triassic	251	
Paleozoic	Permian	299	
	Carboniferous	359	
	Devonian	416	
	Silurian	444	
	Ordovician	488	
	Cambrian	542	
Precambrian		2,500	

Source: U.S. Geological Survey 2010

Pleistocene or older (older than 11,000 years) continental sedimentary deposits are considered as having a high paleontological potential while Holocene-age deposits (less than 10,000 years old) are generally considered to have a low paleontological potential because they are geologically immature and are unlikely to have fossilized the remains of organisms. Metamorphic and igneous rocks have a low paleontological potential, either because they formed beneath the surface of the earth (such as granite), or because they have been altered under high heat and pressures, chaotically mixed or severely fractured. Generally, the processes that form igneous and metamorphic rocks are too destructive to preserve identifiable fossil remains.

The project site is located in the Great Valley geomorphic province, consisting of the central part of California between the Coast Range and the Sierra Nevada. The Great Valley is an alluvial plain that is approximately 50 miles wide and 400 miles long where sediment has been deposited almost continually for roughly 160 million years. The proposed project site is located in the northern part of the Great Valley, which is drained by the Sacramento River (CGS 2002). Geology in the area consists of transitional formations between alluvial deposits of the central valley and volcanic material of the Sierra Nevada.

Subsurface conditions are mapped by CGS as alluvium deposited in the Holocene (i.e., between 11,700 years ago and the present time) along Dry Creek and Pleistocene-age (i.e., from about 2,588,000 to 11,700 years ago) alluvial deposits classified in the Modesto Formation and Turlock Lake Formation along Cirby and Linda Creeks. Recognizing the age of alluvial soils, the potential exists to encounter paleontological resources. Samples indicate that subsurface soils are generally loose,

granular (i.e., sandy or silty) materials within 10 to 20 feet of the surface that increase in density with depth (Parikh 2015).

Faults and Seismicity

Seismically-induced ground rupture, the physical displacement of surface deposits in response to an earthquake's seismic waves, is considered most likely along faults that have a record of displacement sometime in the past 11,000 years (the Holocene Epoch). These faults are considered active. Faults on which an event is believed to have occurred during the Quaternary time (approximately the last 1.6 million years) are considered potentially active. All other faults are considered inactive.

The nearest known active fault is the Cleveland Hill Fault, located approximately 41 miles north of Roseville. The Dunnigan Hills and Midland faults, which both have unknown histories of activity and are located approximately 13 and 19 miles from the City of Roseville, respectively, present the highest potential to produce ground shaking at the project site. Ground shaking could also originate from seismic activity along the larger, but relatively distant Foothill or San Andreas fault systems, the nearest components of which are approximately 20 and 55 miles away from the City of Roseville, respectively (City of Roseville 2010).

There are also three inactive faults located near Roseville: the Volcano Hill fault, the Linda Creek fault, and one unnamed fault. The Volcano Hill fault is located northwest of Volcano Hill and extends northwesterly for approximately 1 mile starting just east of the city limits. The Linda Creek fault, the existence of which is disputed because of lack of recorded activity, is suspected to extend along a portion of Linda Creek through Roseville and a portion of Sacramento County. The unnamed fault extends in an east-west direction between Folsom Lake and the City of Rocklin. Portions of this unnamed fault are concealed, and it is possible that the fault is connected to the Bear Mountain Fault near Folsom Lake (City of Roseville 2010: 12-7).

Ground Shaking

Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions.

There is a 25 percent probability of an earthquake of greater than 5.0 magnitude occurring within the next 50 years on the project site due to nearby faults (U.S. Geological Survey 2009). An earthquake that registers 5.0 on the Richter magnitude scale (which is used to quantify the energy released by an earthquake) is of moderate intensity and would be widely felt but would not cause damage to buildings unless they are poorly constructed. The last nearby seismic event measuring at least 4.0 on the Richter scale occurred between Placerville and Roseville in 1908 on a north-south fault line between Folsom and Auburn (City of Roseville 2010:12-3). No significant seismic event has been recorded since that time within the vicinity of Roseville, and the South Placer area is classified as a low severity earthquake zone. No Alquist-Priolo Earthquake Fault Zones are located in the City of Roseville or in Placer County (CGS 2010).

Liquefaction and Lateral Spreading

Soil liquefaction is caused by pressure waves moving through the ground because of earthquakes. Loose, granular soils and non-plastic silts that are saturated by relatively shallow groundwater (generally less than 50 feet) are susceptible to liquefaction. Liquefaction causes soil to lose strength and "liquefy," triggering structural distress or failure because of the dynamic settlement of the ground or a loss of strength in the soils underneath structures. Liquefaction in a subsurface layer can in turn cause lateral spreading of the ground surface, which usually takes place along weak shear zones that have formed within the liquefiable soil layer.

Seismic Hazard Zones are regulatory zones mapped by CGS that encompass areas prone to liquefaction and earthquake-induced landslides. The CGS has not mapped the project site as a Seismic Hazard Zone; this indicates that the risk for liquefaction is low. However, based on review of the area geology and existing boring data, the preliminary geotechnical evaluation identified the potential for liquefaction in the project area because of the presence of sandy and granular soils, and the expectation of loose sand along the creeks (Parikh 2015:4).

Slope Failure

Slope failures, commonly referred to as landslides, include many phenomena that involve the downslope displacement and movement of material, triggered either by static (i.e., gravity) or dynamic (i.e., earthquake) forces. Soil slopes can experience soil slumps, rapid debris flows, and deep-seated rotational slides. Landslides can occur on slopes of 15 percent or less, but the probability is greater on steeper slopes. Slope stability can depend on a number of complex variables, including the geology, structure, and amount of groundwater, as well as external processes such as climate, topography, slope geometry, and human activity. Overall, the risk of landslides within and adjacent to the project site caused by seismic events or project activities is low.

Soil Characteristics

Soils in the Roseville area are generally associated with stream terraces and alluvial bottoms. These soils are typically deep and well drained, have low permeability, low shrink-swell potential, and low soil strength.

Table 4.5-2 provides a list of the soil map units identified by the Natural Resources Conservation Service (NRCS) as occurring within the project area. As indicated in Exhibit 4.5-1, most of the project site is characterized by xerofluvents (coarse textured stream deposits) that are occasionally or frequently flooded. These soils have moderate shrink-swell potential and low to moderate susceptibility to erosion. Staging areas and access ways are characterized by Cometa-Ramona sandy loams, Fiddyment loam, and cut and fill areas.

Table 4.5-2 Characteristics of Soils on the Project Site

Soil Map Unit Name	Shrink-Swell Potential[1]	Water Erosion Hazard[2]	Wind Erosion Hazard[3]	% of Total Project Site
Cometa-Fiddyment complex, 1 to 5% slopes	1.5	0.49	3	0.1
Cometa-Ramona sandy loams, 1 to 5% slopes	1.5	0.32	3	1.6
Fiddyment loam, 1 to 8% slopes	1.5	0.49	5	5.6
Urban land-Xerarents-Fiddyment complex, 0 to 8% slopes	-	-	-	0.1
Xerofluvents, frequently flooded	4.5	0.32	3	76.9
Xerofluvents, occasionally flooded	4.5	0.32	2	13.2
Xerorthents, cut and fill areas	-	-	-	2.6

Notes:

[1] Based on percentage of linear extensibility (i.e., the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state). Linear extensibility of less than 3 indicates a low shrink-swell potential, 3 to 6 is associated with moderate potential,6 to 9 is associated with high potential, and over 9 is very high potential for shrink-swell conditions. Ratings over 3 are associated with damage buildings, roads, and other structures

[2] Based on the erosion factor "Kw," which indicates the erodibility of the whole soil (i.e., modified for the presence of rock fragments). The K factor is a measurement of relative soil susceptibility to sheet and rill erosion by water. Values range from 0.02 to 0.69; higher values are more susceptible to erosion.

[3] Based on the wind erodibility group designated by NRCS. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

Source: NRCS 2015

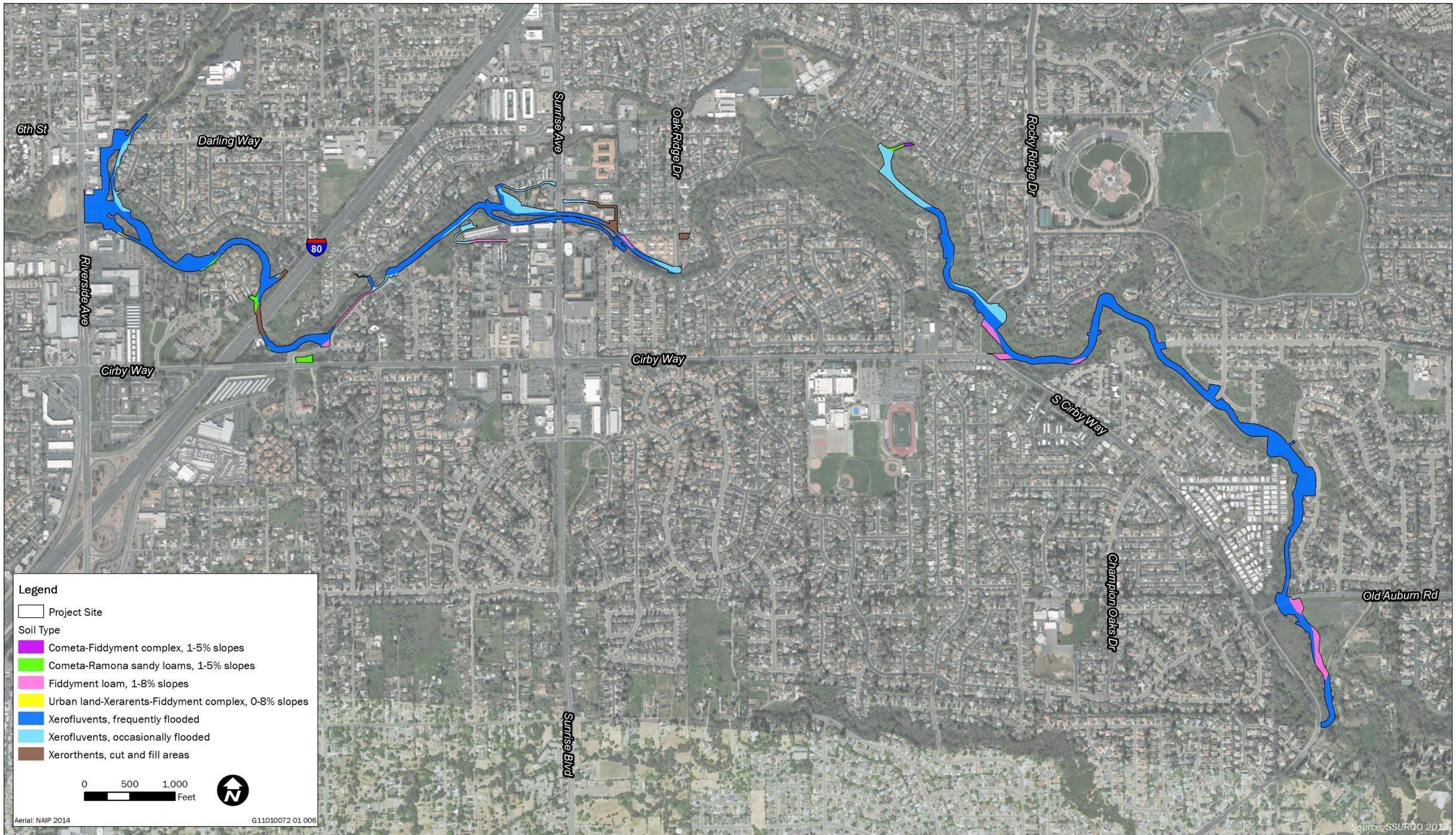

Exhibit 4.5-1

Soils

ASCENT ENVIRONMENTAL

Expansive Soils

Expansive soils contain substantial amounts of clay particles that have the ability to give up water (shrink) or take on water (swell). When these soils swell, the change in volume can exert pressures on loads that are placed on them, such as building and structure foundations or underground utilities, and can result in structural distress and/or damage. Often, grading, site preparations, and backfill operations associated with subsurface structures can eliminate the potential for expansion. Xerofluvents in areas that experience flooding, which comprise approximately 86.9 percent of the project site, are moderately expansive.

Erosion and Runoff

Erosion is a natural process whereby soil and highly-weathered rock materials are worn away and transported, most commonly by wind or water. Natural rates of erosion can vary depending on slope, soil type, and vegetative cover. Soils containing high amounts of silt are typically more easily eroded, while coarse-grained (sand and gravel) soils are generally less susceptible to erosion.

Soil erosion can become problematic when human intervention causes rapid soil loss and the development of erosional features (e.g., incised channels, rills, and gullies) that undermine roads, buildings, or utilities. Vegetation clearing and earth moving reduces soil structure and cohesion, resulting in accelerated erosion. The operation of construction-related heavy machinery and vehicles over access roads, staging areas, and work areas could compact soils and decrease their capacity to absorb runoff, resulting in rills, gullies, and excessive sediment transport.

As indicated in Table 4.5-3, the soils on the project site are generally moderately susceptible to erosion. NRCS also classifies soil according to suitability and limitations for use, including roads and trails. This mapping, which is based on regional data, indicates that approximately 87 percent of the project site has a low erosion hazard when used for roads and trails, another 11 percent has a moderate hazard, and the remaining area is not rated. Additionally, site-specific bank erosion severity has been mapped for the project site. As summarized in Table 4.5-3, below, most of the creek banks have moderately severe bank erosion.

Table 4.5-3 Bank Erosion Severity in Project Site

Bank Erosion Severity	Length (Feet)	% of Total
Minor	284.59	16
Moderate	880.32	50
Moderate-High	361.51	21
High	222.92	13
Total (feet)	**1,749.34**	

Source: City of Roseville and PSOMAS 2014

4.5.3 Regulatory Setting

FEDERAL

National Pollutant Discharge Elimination System Program

Under Section 402 of the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) regulates point sources of pollution of waters of the United States. The California State Water Resources Control Board administers the NPDES permit program in California. Projects that disturb 1 acre or more

of soil must obtain coverage under the state's NPDES General Permit for Discharges of Storm Water Associated with Construction Activity. A stormwater pollution prevention plan (SWPPP) must be developed and implemented that provides specific construction-related best management practices (BMPs) to prevent soil erosion and loss of topsoil. The required components and BMPs commonly included in a SWPPP are described in greater detail in Section 4.8, "Hydrology and Water Quality."

STATE

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. In accordance with this act, the State Geologist established regulatory zones, called "earthquake fault zones," around the surface traces of active faults and published maps showing these zones. The project site is not located in an Alquist-Priolo Earthquake Fault Zone.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking and other hazards caused by earthquakes. This act requires the State Geologist to delineate "zones of required investigation" (i.e., seismic hazard zones) where site investigations are required to determine the need for mitigation of potential liquefaction and/or earthquake-induced landslide. There are no Seismic Hazard Zone maps for Placer County.

LOCAL

City of Roseville General Plan

The General Plan Safety Element includes policies intended to address potential geology, soils, and seismic impacts. These policies are implemented through the Building Permit process (for structures) and the Design and Construction Standards. The specific goals and policies applicable to the proposed project are:

<u>Seismic and Geologic Hazards</u>
GOAL 1: Minimize injury and property damage because of seismic activity and geologic hazards.

- **Policy 3:** Minimize soil erosion and sedimentation by maintaining compatible land uses, suitable building designs, and appropriate construction techniques.
- **Policy 6:** Require contour grading, where feasible, and re-vegetation to mitigate the appearance of engineered slopes and to control erosion.

City of Roseville Design and Construction Standards

The City of Roseville's Design and Construction Standards (last amended in April of 2015) provide a reference to the City's requirements for the design and construction of civil improvement projects, which are to be dedicated to the public and accepted by the City for maintenance or operation, and to provide for coordinated development of those facilities to be used by and for the protection of the public.

City of Roseville Guidance for Stormwater Quality Best Management Practices

Control of construction site stormwater runoff is required by the NPDES stormwater permit that the SWRCB issued the City in 2004. The *Stormwater Quality BMP Guidance Manual for Construction* (City of Roseville 2011) is designed to facilitate compliance with the City's Stormwater Management Plan. See Section 4.8, "Hydrology and Water Quality," for additional discussion of SWPPP requirements and BMPs.

Roseville Multi-Hazard Mitigation Plan

The Roseville Multi-Hazard Mitigation Plan is intended to provide a long-term planning vision to reduce the impacts of future disasters from multiple hazards, including drought, earthquake, flood, landslide, severe weather, and fire hazard.

City of Roseville Emergency Operations Plan

The City of Roseville Emergency Operations Plan is designed to guide users through emergency preparedness, response, recovery, and mitigation in response to extraordinary emergency situations associated with various potential disasters, including earthquakes.

4.5.4 Impacts

METHODS OF ANALYSIS

Potential impacts related to geologic and soil resources resulting from project construction were determined through review of available soil and fault maps for the project area, including the City of Roseville General Plan, U.S. Department of Agriculture NRCS Soil Surveys, and geologic data produced by CGS. The information obtained from these sources was reviewed and summarized to establish existing conditions and to identify potential environmental effects based on the standards of significance presented in this section.

In addition, this analysis incorporates the findings of the *Dry Creek Greenway Trail Fluvial Audit* (City of Roseville and PSOMAS 2014) and the *Preliminary Geotechnical Evaluation, Dry Creek Greenway Multi-Use Trail Project, City of Roseville, CA* (Parikh 2015). These reports were prepared to inform project design. Many of the recommendations of these studies and those contained in the *Engineering Design Considerations and Evaluation based on Geomorphology Study* (PSOMAS 2014), such as bank stabilization elements, have been incorporated into the project, as described in Chapter 3, “Project Description,” of this Draft EIR.

This assessment recognizes that bridge crossings and other areas with slope stability concerns would be designed with input from geotechnical professionals, based on existing data and supplemental geotechnical investigations, as appropriate. Special design features may include retaining walls with tie backs for added support and slope paving to reduce the potential for erosion. These elements would be designed and constructed to meet the California Department of Transportation’s (Caltrans) standard performance specifications.

THRESHOLDS OF SIGNIFICANCE

Based on Appendix G of the CEQA Guidelines, the proposed project was determined to result in a significant impact related to geology and soils resources if it would:

- expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - rupture of a known earthquake fault, as delineated by the most recent Alquist-Priolo Earthquake Faulting Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;
  - strong seismic ground shaking;
  - seismic-related ground failure, including liquefaction;
  - landslides;
- result in substantial soil erosion or the loss of topsoil;

- be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on-or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
- be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating a substantial risk to life or property;
- have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of wastewater; or
- directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

ISSUES OR POTENTIAL IMPACTS NOT DISCUSSED FURTHER

The proposed project would not include the construction or operation of restrooms, and the project would not include infrastructure to connect to the City of Roseville wastewater system, nor result in the need for septic tanks. Therefore, the potential for site soils to support septic tanks or alternative wastewater disposal systems is not evaluated in this section.

IMPACT ANALYSIS

Impact 4.5-1	Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure, or landslides.
Applicable Policies and Regulations	City of Roseville Design and Construction Standards; Roseville Multi-hazard Mitigation Plan; City of Roseville Emergency Operations Plan
Significance with Policies and Regulations	Proposed Project: Less than significant Alignment Option 1A: Less than significant Alignment Option 1C: Less than significant Alignment Option 5A: Less than significant
Mitigation Measures	None required (Proposed Project, Option 1A, Option 1C, Option 5A)
Significance after Mitigation	Less than significant (Proposed Project, Option 1A, Option 1C, Option 5A)

Proposed Trail Alignment

As noted in the environmental setting section above, the project site is not in an area where strong seismic ground shaking is anticipated. In addition, the potential for surface rupture is low because no active faults pass through the site. Geographic conditions, soil conditions, and surface terrain combine to minimize risk of major damage from landslides, subsidence, or other geologic hazards that could result from seismic activity and related natural forces in the City (City of Roseville 2013). Based on available geological and seismic data, the potential for strong ground shaking in the project area is moderate (Parikh 2015:3).

However, the site is predominantly composed of Xerofluvent soils, which could be subject to localized creep, slumping, and small landslides on over-steepened slopes, along incised drainages, and during periods of water saturation. Retaining walls, including gravity walls (reinforced concrete) and anchored walls (soil nail and tie back walls), are proposed at several locations where the proposed trail is located near an exposed bank or an area susceptible to slumping. The type and extent of the proposed retaining walls are shown in Table 3-3 in Chapter 3, “Project Description.”

Complete plans and specifications for the proposed multi-use trail would be submitted to the Public Works Engineering Division for review and approval prior to construction. Pursuant to Section 13 of the City of Roseville Design and Construction Standards, “Bikeways,” these plans would be based on soil tests taken at least every 1,000 feet along the trail alignment, or as directed by the City Engineer. The

structural section of the path would be designed to support a gross vehicular weight of 30,000 pounds where it would be used for access by maintenance or emergency vehicles.

The preliminary geotechnical evaluation indicates that, with information from these site-specific borings, the potential effects of liquefaction could be accommodated with implementation of standard design practices. Any effects of liquefaction potential would be considered in the structural design (Parikh 2015). Project elements, such as retaining walls, may be added or modified in the plans based on further geotechnical investigations.

Construction Impacts

The potential for a seismic event to result in a geologic hazard during construction is low because there is a lack of active faulting close enough to the project area to create a significant hazard. However, construction of the project would require excavation in an area with steep banks and loose, granular soils that could be susceptible to localized areas of slope failure. As discussed above, construction specifications would be developed for the project based on detailed soil testing and site specific geotechnical engineering.

Use-related Impacts

The project would not include any occupied structures, and trail design would include features, such as retaining walls, to provide support where bank cuts would occur below existing structures. This would reduce the exposure of the trail and bridges, along with people recreating on the trail, to loss or injury during a seismic event.

Conclusion

With the adoption of construction practices consistent with the City's Design and Construction Standards, and the incorporation of design features to prevent localized creep, slumping, and small landslides, the potential effects of localized ground failure would be **less than significant**.

Alignment Option 1A

Implementation of this alignment would not substantially change the potential for the project to expose people or structures to substantial adverse effects associated with rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure, or landslides because it is located in the same general area as the Proposed Trail Alignment and would require the same construction techniques, adhere to the same standards, and include the same type of bank stabilization elements. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 1C

Implementation of this alignment would not substantially change the potential for the project to expose people or structures to substantial adverse effects associated with rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure, or landslides because it is located in the same general area as the Proposed Trail Alignment and would require the same construction techniques, adhere to the same standards, and include the same type of bank stabilization elements. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 5A

Implementation of this alignment would not substantially change the potential for the project to expose people or structures to substantial adverse effects associated with rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure, or landslides because it is located in the same general area as the Proposed Trail Alignment and would require the same construction techniques, adhere to the same standards, and include the same type of bank stabilization elements. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Mitigation Measures

None required.

Impact 4.5-2	Result in substantial soil erosion or the loss of topsoil.
Applicable Policies and Regulations	RWQCB NPDES Permit; City of Roseville General Plan; City of Roseville Design and Construction Standards
Significance with Policies and Regulations	Proposed Project: Less than significant Alignment Option 1A: Less than significant Alignment Option 1C: Less than significant Alignment Option 5A: Less than significant
Mitigation Measures	None required (Proposed Project, Option 1A, Option 1C, Option 5A)
Significance after Mitigation	Less than significant (Proposed Project, Option 1A, Option 1C, Option 5A)

Proposed Trail Alignment

The potential for soil erosion is based on soil type and exposure to erosive forces. Table 4.5-4 summarizes the soil map units within the proposed project construction area. As discussed below, during construction the potential for erosion is mostly dependent on the disturbance of soil and loss of vegetation, which can expose soils to the erosive forces of wind and water runoff. During use, key areas of concern would be acceleration of erosion because of travel on the trail, and the potential hazards associated with ongoing streambank erosion.

Table 4.5-4 Acreage of Permanent and Temporary Impacts by Soil Map Unit

Alignment Option	Soil Type							Total (acres)
	Cometa-Fiddyment complex, 1-5% slopes	Cometa-Ramona sandy loams, 1-5% slopes	Fiddyment loam, 1-8% slopes	Urban land-Xerarents-Fiddyment complex, 0-8% slopes	Xerofluvents, frequently flooded	Xerofluvents, occasionally flooded	Xerorthents, cut and fill areas	
Proposed Trail Alignment	**0.07**	**0.60**	**1.47**	**-**	**19.48**	**3.80**	**0.95**	**26.37**
Permanent Impact	-	0.05	0.64	-	9.06	0.92	0.19	10.86
Temporary Impact	0.07	0.55	0.83	-	10.42	2.88	0.76	15.51
Comparison of Other Options Against Proposed Trail Alignment								
Option 1A	**0**	**0**	**0**	**+0.03**	**-0.64**	**-0.08**	**0**	**-0.69**
Permanent Impact	0	0	0	+0.03	-0.28	-0.04	0	-0.29
Temporary Impact	0	0	0	0	-0.36	-0.04	0	-0.40
Option 1C	**0**	**0**	**0**	**0**	**-0.51**	**+0.53**	**0**	**+0.02**
Permanent Impact	0	0	0	0	+0.24	+0.35	0	+0.59
Temporary Impact	0	0	0	0	-0.75	+0.18	0	-0.57

Table 4.5-4 Acreage of Permanent and Temporary Impacts by Soil Map Unit

Alignment Option	Soil Type							Total (acres)
	Cometa-Fiddyment complex, 1-5% slopes	Cometa-Ramona sandy loams, 1-5% slopes	Fiddyment loam, 1-8% slopes	Urban land-Xerarents-Fiddyment complex, 0-8% slopes	Xerofluvents, frequently flooded	Xerofluvents, occasionally flooded	Xerorthents, cut and fill areas	
Option 5A	**0**	**0**	**0**	**0**	**+0.83**	**-0.41**	**-0.07**	**+0.35**
Permanent Impact	0	0	+0.03	0	+0.51	-0.26	-0.06	+0.22
Temporary Impact	0	0	-0.03	0	+0.32	-0.15	-0.01	+0.13

Source: NRCS 2015

Construction Impacts

Construction of the proposed project would involve removing existing vegetation from the project site (i.e., trail footprint and construction zone), excavation and contouring to establish the trail bed, excavation for retaining wall footings and bridge abutments, construction of temporary stream crossings, and temporary stockpiling of soil. These activities would temporarily expose soil to wind and water erosion. An estimated 15.51 acres would be temporarily disturbed by construction activities and 10.86 acres would be permanently impacted by trail development. Soils in the project area generally have a high susceptibility to wind erosion. The potential for water-driven erosion is generally moderate along the trail and higher in the staging and temporary access areas. Where vegetation would be removed from sloped areas or where soils are unconsolidated in newly graded areas, surface water and wind could result in accelerated erosion. The ground disturbance created by construction of a temporary creek crossing and the use of heavy equipment traffic could result in increased erosion.

Compliance with the City's Design and Construction Standards, which prescribe erosion/sediment control and grading requirements addressing erosion, and a SWPPP to comply with the NPDES General Permit administered by the State Water Resources Control Board would be required. The SWPPP would identify structural and nonstructural BMPs to control erosion.

Temporary soils stabilization BMPs may include: scheduling limitations during the rainy season; preservation of existing vegetation; application of hydraulic mulch to disturbed areas outside of the stream channel; use of geotextiles, plastic coves, and erosion control mats; instillation of silt fences; and use of fiber rolls along the slope contour above the high-water level to intercept runoff (Caltrans 2003). Stream flow and soil strength would also inform the design and restoration of temporary stream crossings, which would be approved by a registered engineer. Bridge footings would be cast-in-drilled-hole pilings constructed to Caltrans' standard specifications. Special construction practices (e.g., temporary steel casing) may be necessary because of the granularity of area soils.

As indicated in Table 4.5-2, most soils in the project area are xerofluvents. The xerofluvent and xerorthent soils do not have a developed soil structure or a nutrient rich upper horizon commonly referred to as "topsoil." However, a topsoil layer is found in the Cometa, Fiddyment, and Ramona soils, and grading of these areas could result in a loss of soil productivity, which can make successful revegetation of disturbed areas difficult, leading to chronic erosion and poor soil health in these areas. Topsoil would be excavated and stored during construction operations and respread over disturbed areas after construction activities are complete. Disturbed soil areas would be revegetated through planting of native grasses, shrubs, and trees.

Use-related Impacts

As summarized in Table 4.5-5, most of the soils in the area are classified by the NRCS as posing only a slight erosion hazard when used for roads and trails. Moreover, the pathway would be paved and

adjacent areas would be revegetated. Because the soils on the project site are suitable for trail use and the trail would be paved, there is low potential for use of the trail to result in substantial soil erosion.

Table 4.5-5 Proposed Alignment Erosion Hazard (Road/Trail)

	Erosion Hazard			Total (acres)
	Slight	Moderate	Not Rated	
Preferred Alignment	23.27	2.15	0.95	26.37
Permanent Impact	9.97	0.70	0.19	10.86
Temporary Impact	13.30	1.45	0.76	15.51

Source: NRCS 2015

As discussed in Chapter 3, "Project Description," of this Draft EIR, a geomorphic report was prepared to provide an assessment of the potential future risk to the proposed trail because of erosion associated with the expected future water flows and trajectories of Cirby and Linda Creeks. Most of the Proposed Alignment would be located adjacent to areas with moderate to high bank erosion severity (Table 4.5-6). The report identified six locations along the preferred alignment where there would be extreme or high risk to the trail due to soil conditions and the future water flows and trajectories of the creeks (City of Roseville and Psomas 2014). The recommendations of that report (including trail realignment, bank protection, and channel modifications) in these extreme and high-risk areas have been incorporated into the project design, except where existing constraints required alternative solutions. The areas of moderate risk are generally either near the creek or have existing soil erosion, but are not likely to present a substantial hazard to the use or integrity of the trail and, as such, did not require design modification. Through the design review process established in the City's Design and Construction Standards, the City Engineer would verify that the project has been designed to avoid contributing to soil instability.

Table 4.5-6 Proposed Alignment Bank Erosion Severity

	Bank Erosion Severity				Total (feet)
	Minor	Moderate	Moderate-High	High	
Preferred Alignment	43.08	185.47	159.38	131.12	519.05
Permanent Impact	39.38	-	69.48	34.29	143.15
Temporary Impact	3.70	185.47	89.90	96.83	37.59

Source: City of Roseville and PSOMAS 2014

After construction, disturbed areas of the site would be seeded and mulched to reestablish a vegetation cover in the upland portions of the project site that would resist erosion and increase bank stability by increasing tensile strength in the soil and increasing infiltration (Caltrans 2003).

Conclusion

Although construction would expose erosion-prone soils to the effects of wind and water, the project would implement the City's standards and BMPs identified in the SWPPP. Because the portion of the project site that would be traveled by bicyclists and pedestrians would be paved, open areas would be revegetated, and streambanks would be engineered to remediate existing erosion and prevent ongoing erosion. Therefore, the Dry Creek Greenway East Trail project would have a **less-than-significant** impact on soil erosion.

Alignment Option 1A
Option 1A would reduce the area of temporary and permanent impacts by 0.40 acre and 0.29 acre, respectively. There would be a corresponding 0.72-acre reduction in the area mapped as slight erosion hazard when used for roads and trail, and a 0.03 acre increase in area not rated. There would be no change in the bank erosion severity along the alignment. Because construction activities under Option 1A would be of the same type and magnitude as would occur under the Proposed Trail Alignment, implementation of this alignment would not substantially change the potential for the project to result in soil erosion or the loss of topsoil. The impact would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 1C
Option 1C would decrease temporary impacts by approximately 0.57 acre, while increasing permanent impacts by 0.59 acre. This would result in a net increase of 0.02 acre mapped as slight erosion hazard when used for trails and roads. There would also be an increase in the length of bank affected; an additional 146.29 linear feet of moderately eroded bank would be affected (67.98 feet of temporary impacts and 78.31 acres of permanent impacts).

With implementation of Alignment Option 1C, the trail would be located in an additional area of high risk, as identified in the trail risk assessment (PSOMAS 2014). The section of trail along the east side of Dry Creek downstream of the Darling Way Bridge would be located in proximity to the eroding creek bank in an area where the stream power is high. Key constraints in this area include the distance between the top of the creek bank and the existing fence line of the adjacent private properties, an existing sewer trunk line, and a number of large trees. A reinforced concrete retaining wall would be constructed along the property line, and the trail would be located up against the property line to maximize setback from the creek. Trail width would be reduced to 8 feet, and a post and cable fence would be constructed on the western side of the trail.

Other construction activities under Option 1C would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment. Implementation of this option would not substantially change the potential for the project to result in soil erosion or the loss of topsoil. The impact would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 5A
Option 5A would increase temporary and permanent impacts by 0.13 acre and 0.22 acre, respectively. There would be a corresponding increase of 0.43 acre mapped as slight erosion hazard for roads and trails and a decrease of 0.07 acre not rated. Areas with moderate erosion hazard would be slightly less affected during construction (a reduction of 0.03 acre), but would make up slightly more of the project footprint (an increase of 0.02 acre). There would be no change in the bank erosion severity along the alignment. Because construction activities under Alignment Option 5A would be the same type as would occur under the Proposed Trail Alignment, implementation of this option would not substantially change the potential for the project to result in soil erosion or the loss of topsoil. The impact would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Mitigation Measures

None required.

Impact 4.5-3	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.
Applicable Policies and Regulations	City of Roseville Design and Construction Standards
Significance with Policies and Regulations	Proposed Project: Less than significant Alignment Option 1A: Less than significant Alignment Option 1C: Less than significant Alignment Option 5A: Less than significant
Mitigation Measures	None required (Proposed Project, Option 1A, Option 1C, Option 5A)
Significance after Mitigation	Less than significant (Proposed Project, Option 1A, Option 1C, Option 5A)

Proposed Trail Alignment

The project site is not located in an area of underlying geologic instability. Localized surficial, slope failures could occur within the project site, however, primarily associated with incised and over steepened streambanks. As described above, the City's Design and Construction Standards require soil testing to inform bike path design. Where borings identify loose, sandy soils that have the potential to be subject to liquefaction, standard design practices for foundations and pilings would be incorporated to avoid potential effects on the proposed trail. For example, the standards include specifications regarding the thickness of aggregate base placed under the asphalt concrete based on the ability of soil samples to resist spreading because of an applied vertical load (the R-Value) where vehicles would use the path for maintenance or emergency access.

Raveling or caving is expected during drilling of bridge foundations because of the presence of granular material. Bridge footings would be cast-in-drilled-hole pilings constructed to Caltrans' standard specifications. Tie back walls would be used for excavation support where cuts are required next to existing bridge abutments or in steep terrain that has existing buildings in close proximity to the trail. Caltrans standard performance specifications for tieback systems would be used to attain the required design capacity.

Construction Impacts

Construction of the project would require excavation in an area with steep banks and loose, granular soils. As discussed above, construction specifications would be developed for the project based on detailed soil testing. Special construction practices (e.g., temporary steel casing) may be necessary during construction of bridge footings because of the granularity of area soils. In addition, to avoid failure of shoring walls, excessive settlement in the surrounding areas, and unsafe working conditions, controlled dewatering would be performed (when necessary) to prevent possible piping or blowout at the base of excavations. These construction practices would be consistent with the City's Design and Construction Standards.

Use-related Impacts

As discussed above, a geomorphic assessment of the potential future risk to the proposed trail developed solutions to address the potential for the trail to be located on unstable soils or soils that would become unstable as a result of the project. Through the design review process established in the City's Design and Construction Standards, the City Engineer would verify that the project has been designed to avoid contributing to a condition of soil instability.

Conclusion

With the adoption of construction practices and design features that are consistent with the City's Design and Construction Standards, the potential effects of localized, surficial ground failure would be **less than significant**.

Alignment Option 1A
Construction activities under Alignment Option 1A would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment and would generally occur in the same types of soil as the Proposed Trail Alignment in this area. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 1C
Construction activities under Alignment Option 1C would be generally the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment and would generally occur in the same types of soil as the Proposed Trail Alignment in this area. Because trail design would reduce the hazard to the trail associated with unstable soils, the impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 5A
Construction activities under Alignment Option 5A would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment and would generally occur in the same types of soil as the Proposed Trail Alignment in this area. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Mitigation Measures

None required.

Impact 4.5-4	Be located on expansive soil, creating a substantial risk to life or property.
Applicable Policies and Regulations	City of Roseville Design and Construction Standards
Significance with Policies and Regulations	Proposed Project: Less than significant Alignment Option 1A: Less than significant Alignment Option 1C: Less than significant Alignment Option 5A: Less than significant
Mitigation Measures	None required (Proposed Project, Option 1A, Option 1C, Option 5A)
Significance after Mitigation	Less than significant (Proposed Project, Option 1A, Option 1C, Option 5A)

Proposed Trail Alignment
The trail would be located in an area with moderately expansive soils. Repeated shrinking and swelling of soils could cause damage to the integrity of the trail surface (such as pavement cracking) and to bridge footings. However, grading activities and placement of base materials can effectively reduce or eliminate this potential, as discussed below.

Construction Impacts
Although soils in the project area are moderately expansive, they would not cause a potential for risks to life and property during construction, because the type of damage caused by expansive soils is incremental and generally associated with the built environment.

Use-related Impacts
Soil sampling would be conducted as part of the project, as required by the City's Design and Construction Standards. The potential effect of expansive soils on the trail and bridges would be addressed through this process, and specific design features, such as specialized bridge footings or abutments, would be incorporated into the design and specifications for the project, as appropriate, to avoid or minimize the extent of potential damage. A substantial risk to life or property would not occur.

Conclusion
The impact of locating the project on moderately expansive soils would be **less than significant**.

Alignment Option 1A
Construction activities under Alignment Option 1A would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment and would generally occur in the same types of soil as the Proposed Trail Alignment in this area, although there would be one fewer bridge required with implementation of this option. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 1C
Construction activities under Alignment Option 1C would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment and would generally occur in the same types of soil as the Proposed Trail Alignment in this area, although Option 1C would not require the widening of the Darling Way bridge. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Alignment Option 5A
Construction activities under Alignment Option 5A would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment and would generally occur in the same types of soil as the Proposed Trail Alignment in this area. Implementing Option 5A would change the location of one bridge (#14 rather than #13), but would not change the number of bridges proposed. The impacts would be **less than significant** for the same reasons discussed above for the Proposed Trail Alignment.

Mitigation Measures
None required.

Impact 4.5-5	Destroy a unique paleontological resource.
Applicable Policies and Regulations	California Public Resources Code Section 5097.5
Significance with Policies and Regulations	Proposed Project: Less than significant Alignment Option 1A: Less than significant Alignment Option 1C: Less than significant Alignment Option 5A: Less than significant
Mitigation Measures	None required (Proposed Project, Option 1A, Option 1C, Option 5A)
Significance after Mitigation	Less than significant (Proposed Project, Option 1A, Option 1C, Option 5A)

Proposed Trail Alignment

Construction Impacts
The project site is primarily underlain by alluvial deposits classified in the Modesto Formation and Turlock Lake Formation along Cirby and Linda Creeks. Samples indicate that subsurface soils are generally loose, granular (i.e., sandy or silty) materials within 10 to 20 feet of the surface that increase in density with depth. A search of the University of California Museum of Paleontology's (UCMP) database was conducted on June 19, 2015. The database listed 63 paleontological resources in Placer County, however all resources are located approximately 30 miles northeast of the City of Roseville, in Tahoe National Forest. The database did not list any paleontological resources from the Turlock Lake or Modesto formation (UCMP 2015).

Although no paleontological resources have been recorded near the project site, the soils along Cirby and Linda Creeks are classified as Pleistocene-age (i.e., from about 2,588,000 to 11,700 years ago) alluvial deposits. Pleistocene sedimentary deposits are considered to have a high paleontological sensitivity, while alluvial deposits are generally considered to have low paleontological sensitivity. These alluvial deposits contain vertebrate and invertebrate remains of extant, modern taxa, which are generally not considered paleontologically significant.

Use-related Impacts

The project is a multi-use bike trail and use of the project would not include grading, excavation, or other earth-moving activities that could affect the integrity of a paleontological site.

Conclusion

Because the types of soil formations that underlay the project site have a low sensitivity for important paleontological resources, the development of the proposed project would have a **less-than-significant** impact on paleontological resources.

Alignment Option 1A

Construction activities under Alignment Option 1A would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment. Alignment Option 1A would begin north of Darling Way and would travel on the west side of Dry Creek. At the confluence of Dry Creek and Cirby Creek, this option would cross to the south side of Dry Creek and travel along the south side of Cirby Creek as the trail heads upstream.

As discussed above under the Proposed Trail Alignment, there are no known paleontological sites of any kind near the project site. Because the types of soil formations that underlay the project site are not sensitive for paleontological resources, the development of Alignment Option 1A would have a **less-than-significant** impact on paleontological resources.

Alignment Option 1C

Construction activities under Alignment Option 1C would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment. Alignment Option 1C would begin north of Darling Way and would travel on the east side of Dry Creek before crossing to the south side of Cirby Creek upstream of the confluence with Cirby Creek.

As discussed above under the Proposed Trail Alignment, there are no known paleontological sites of any kind near the project site. Because the types of soil formations that underlay the project site are not sensitive for important paleontological resources, the development of Alignment Option 1A would have a **less-than-significant** impact on paleontological resources.

Alignment Option 5A

Construction activities under Alignment Option 5A would be the same type and magnitude of physical activities and ground disturbance that would occur under the Proposed Trail Alignment. East of Eastwood Park, Alignment Option 5A would remain on the south side of Linda Creek until east of Sunrise Avenue before crossing to the north side of the creek.

As discussed above under the Proposed Trail Alignment, there are no known paleontological sites of any kind near the project site. Because the types of soil formations that underlay the project site are not sensitive for important paleontological resources, the development of Alignment Option 1A would have a **less-than-significant** impact on paleontological resources.

Mitigation Measure

None required.

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