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3.0 GEOLOGY AND SOILS

This section describes the geology and soils in the Middle Fork American River Watershed (Watershed), as they pertain to the Middle Fork American River Project (MFP or Project). The Federal Energy Regulatory Commission's (FERC's) content requirements for this section are specified in Title 18 of the Code of Federal Regulations (CFR) Chapter I § 5.6(d)(3)(ii).

The information presented in this section focuses on those aspects of the existing environment that are pertinent to hydropower facilities and/or may affect stream conditions. For example, the soils information focuses on soil stability and erodibility near Project facilities and bypass streams associated with the MFP. Existing erosion, mass soil movement, slumping or other forms of instability in the Watershed are discussed in Section 8.0, Geomorphology and in the 2005 and 2006 Physical Habitat Characterization Study Reports (PCWA 2006 and 2007, respectively) contained in Supporting Document G (SD G) 1-2 and SD G 2-2. Potential Project-related impacts pertaining to soils and geology will be addressed as the relicensing process proceeds.

3.1 INFORMATION SOURCES

Existing information regarding the geology and soils in the Watershed was collected, reviewed, and evaluated. Relevant information used to prepare this section includes:

- Final 2005 Physical Habitat Characterization Study (PCWA 2006). The information contained in the Final 2005 Physical Habitat Characterization Study Report provided an overview of the geologic conditions and soils in the Watershed.
- Geologic Maps of the Sacramento and Chico Quadrangles, 1:250,000 Scale (California Department of Conservation, 1981 and 1992, respectively). These maps contain generalized information regarding the geologic formations and faults in the Watershed. For the purposes of this section, the geologic map units identified in the official State data were grouped into categories more pertinent to the MFP.
- Digital Database of Faults from the Fault Activity Map of California and Adjacent Areas (California Department of Mines and Geology, 2000). Information from this database was used to identify mapped faults in the Watershed.
- Fault Rupture Hazard Zones in California, Special Publication 42, (California Department of Conservation, Revised 1997, Supplements 1 and 2 added in 1999). This publication contains general information regarding seismic hazards and on Fault Rupture Hazard Zones in California, although none of the Project facilities are located within a mapped zone.
- Seismic-Hazard Issues Associated with the Auburn Dam Project, Sierra Nevada Foothills, California, Open File Report 96-0011 (United States Geological Survey 1996). This report provided information regarding the seismic potential in the Auburn Dam area and provided specific information regarding fault systems in the foothills portion of the Watershed.

- Mineral Resource Potential of the North Fork of the American River Wilderness Study Area, Placer County, California (Miscellaneous Field Studies Map MF-1177-C) and Mineral Resource Potential of the Rubicon Roadless Area, Placer and Eldorado Counties, California (Miscellaneous Field Studies Map MF-1501-B) United States Geological Survey, 1982 and 1983, respectively). These two reports provided information on the mining history and mineral resource potential in the Watershed.
- Gold Districts of California Bulletin 193 (California Division of Mines and Geology, 1970). This report provided historical background regarding gold mining in the Watershed.
- Soil Survey of El Dorado Area, California Soil Survey of Placer County, California Western Part and Soil Survey of the Tahoe Basin Area, California and Nevada (United States Department of Agriculture Forest Service and Soil Conservation Service. Issued April 1974, 1980, and March 1974, respectively). These reports and relevant metadata provided most of the information required for the soil maps and stability review.

3.2 DESCRIPTION OF EXISTING CONDITIONS

The following summarizes the geologic conditions in the Watershed. The general topography of the Watershed is described first, followed by overviews of the geologic setting and history, seismic hazards, mineral resources, and soils.

3.2.1 Topography

The Project facilities are situated in the foothills and mountainous uplands of the western slope of the Sierra Nevada Range. As shown in Map 3-1, the bypass streams associated with the MFP flow southward and then westward, from elevations ranging from a high of approximately 5,100 feet (ft) above mean seal level (msl) at French Meadows Reservoir and Duncan Creek Diversion to approximately 1,100 ft msl at the Ralston Afterbay. The ridges surrounding French Meadows and Hell Hole reservoirs are as high as 7,000 feet msl. The streams and rivers in the Watershed are characterized by steep, deeply incised, and rugged canyons, which are over 3,000 feet deep.

3.2.2 Geologic Setting and History

This section describes the geologic formations present in the Watershed and provides an overview of the geologic history. The primary formations present in the Watershed are identified in Table 3-1 along with corresponding geologic dates and descriptions. A map showing the major geologic formations and mapped faults in the Watershed is provided as Map 3-2.

The Sierra Nevada mountain range is a faulted and westward tilted range consisting of metamorphosed sediments of an inland sea, a number of discrete accreted terranes, volcanic and sedimentary deposits, and plutonic intrusions (USDA-FS 2006). Some of the oldest rocks in the western part of the range are Ordovician to Devonian age (360 million years before present (mybp) to 500 mybp) marine deposits, called the Shoo-fly complex. The Shoo-Fly complex is comprised of sedimentary rocks deposited in a prehistoric inland sea. These marine deposits have since been uplifted, folded, and metamorphosed. With the exception of North and South Fork Long Canyon, all of the bypass streams bisect the Shoo-Fly Complex. The steep exposures of the Shoo-Fly Complex along the stream channels appear to be responsible for significant sediment inputs in the form of rockfalls.

During the same timeframe a collection of discrete island arc and ocean floor terranes were attaching to the western margin of the North American continent as part of the subduction of a large oceanic plate. These accreted terranes are known as the Foothills Suture Zone, which are part of the Western Metamorphic Belt. The oldest rocks in this suture zone include the Calaveras Complex, which occurs throughout the lower elevations of the Watershed, to the north and west of Ralston Afterbay (Map 3-2). The Calaveras Complex is dominated by chert, and is highly contorted and rotated with very steep to near vertical bedding surface planes (CDC 1981, 1992).

This accretion continued into the Mesozoic Era (63 to 240 mybp) with the addition of the Clipper Gap formation of chert and argillite and the Mariposa formation of slates and metagraywacke. The Clipper Gap and Mariposa formations are present in the western-most part of the Watershed, between Canyon Creek and the North Fork American River confluence.

Each of these accreted terranes is separated by large faults. The Foothills Suture Zone contains two large potentially active fault zones; the Melones Fault Zone and the Bear Mountain Fault Zone. These faults are discussed in more detail in Subsection 3.2.3.

During the Mesozoic Era (63 to 240 mybp) the magma generated by the subduction of the oceanic plate came up as isolated plutons in the metamorphic rocks of the Shoo-Fly complex and in the accreted terranes. Gold-bearing veins were formed from the metamorphosis of marine sediments, primarily in the accreted terranes. These gold-bearing deposits were the source of gold mined throughout the region beginning in the mid-1800's. The mineral resources and mining associated with this process are discussed further in Subsection 3.2.4.

A long sequence of volcanism began in the Mesozoic Era, specifically during the Tertiary Period (2 to 63 mybp). Andesitic volcanic deposits of the Mehrten Formation completely buried the bedrock topography of the western slopes of the northern portion of the Sierra Nevada mountain range. As a consequence, the prevolcanic drainage was eliminated and a new drainage evolved (Watson and Humphrey 2002). The Mehrten Formation was deposited mainly as mudflows (lahars) that consist chiefly of volcanic debris, which originated on the flanks of the volcanoes. These deposits occur throughout the Watershed, generally at the ridge tops. The largest area of the Mehrten

Formation extends westerly from the crest between the Middle Fork American River and the Rubicon River through the Long Canyon drainage (Map 3-2). The rhyolite surrounding the French Meadows Reservoir is also associated with this volcanically active period.

This volcanic activity was followed by a long period of erosion in the Cretaceous Period (63 to 138 mybp) that eroded the overlying volcanics, exposed the underlying granitics, and deposited gold into stream channels. The granitics of the Mesozoic plutons and batholiths are exposed along the Middle Fork American River near French Meadows Reservoir and at various locations along the Rubicon River and Long Canyon Creek, and around Hell Hole Reservoir.

During the middle or late Pliocene (2 to 5 mybp), the Sierra Nevada Range was uplifted on its eastern margin and tilted to the west. This progressive uplift and rotation resulted in incised river canyons on the western slopes to depths of 2,000 ft to 4,000 ft or more. These incised stream channels that bisect granitic bedrock tend to be steep and confined, and consist of course bed elements such as boulders.

The Sierra Nevada Range was glaciated several times during the Pleistocene Period (2 my to 10,000 years bp). These events modified the topography of the Watershed by forming wide, U-shaped valleys. Glacial deposits have been mapped in the headwaters of the North Fork American River, Middle Fork American River, Rubicon River, South Fork Rubicon River, and the South Fork Long Canyon Creek, particularly in the upper reaches. All of these glacial deposits are located above Project diversions, with the exceptions of a small area on the Rubicon River below Hell Hole Dam. Erosion of glacial deposits, such as till and moraines tend to contribute gravel-sized sediment to streambeds in the area.

3.2.3 Seismic Hazards

Map 3-2 shows faults mapped in the Watershed and the estimated period of activity. The information presented in the map is based on data contained in the California Division of Mines and Geology (CDMG) digital database. As shown in Map 3-2, the lower elevations of the Watershed are situated in the Foothills Suture Zone that includes the Melones Fault Zone and the Bear Mountain Fault Zone (CDC 1981, 1992).

Most of the faults documented in the Watershed show pre-Quaternary displacement, meaning they were active more than 2 mybp. However, an area of faulting on the North Fork American River in the Melones Fault Zone shows Quaternary displacement and several areas of the Bear Mountain Fault Zone exhibit late Quaternary displacement, meaning activity within the past 10,000 years (CDMG 2000).

Because of this late Quaternary displacement in the Bear Mountain Fault Zone, several seismic hazard studies have been conducted in association with the Auburn Dam Project, a proposed dam and reservoir project unrelated to the MFP. The proposed Auburn Dam Project is located approximately 28 miles downstream of Ralston Afterbay Dam, within the Bear Mountain Fault Zone. The United States Bureau of Reclamation

(USBR) has designated the Bear River Fault Zone as “indeterminate active” (USGS 1996).

In addition to the suture zone fault activity some minor faulting throughout the upper elevation of the Watershed is also shown on Map 3-2. This includes a concentrated area of faulting on Duncan Creek. These faults are all classified by the CDMG database as pre-Quaternary and most likely are inactive.

The California Department of Conservation (CDC) defines an “Active Fault Zone” as an area of related faults that have exhibited surface displacement within the last 11,000 years. According to the CDC, no active fault hazard zones have been identified in the immediate vicinity of the Project. However, the Project is located west of an active fault zone hazard area near Lake Tahoe and south of an active fault zone hazard area in Plumas County (CDC 1999).

3.2.4 Mineral Resources

Gold veins were produced throughout the Western Metamorphic Belt when the marine sediments of the accreted terranes were metamorphosed by the magma, which was produced by the subduction of the oceanic plate. The Mother Lode Gold Belt is an example of this process that produced extensive amounts of lode-gold (CDMG 1970). The MFP is located immediately north of the Mother Lode Gold Belt.

In addition to the potential for lode-gold deposits, the early Tertiary channel of the American River was once a highly productive placer gold mining area (CDMG 1970). The erosional period in the Cretaceous and the uplift and incision of the river channels during the Pleistocene resulted in the deposition of gold deposits in the streams, which are interspersed throughout the Western Metamorphic Belt (CDMG 1970).

Gold, silver, chromium, tungsten, and aggregates are the principal mineral resources in the Watershed. Most of the mineral resources mined in the Watershed are associated with the Melones Fault Zone and the accreted terranes of the Foothills Suture Zone. Therefore, historic mining activity is concentrated around the area to the west and north of the Ralston Afterbay. A map showing current and historical mining operations is provided as Map 3-3.

Based on a USGS study of the mineral resources in the North Fork American River Wilderness, the mineral resource potential for the North Fork American River in the vicinity of the MFP is highly probable, and would include gold, chromite, and silver (USGS 1982). Very little mining has been conducted along the Rubicon River. Studies in the Rubicon Roadless Area indicate a low potential for mineral resources. Only minor amounts of lead, copper, and gold were found in abandoned mines and placer deposits (USGS 1983).

3.2.5 Soils

This subsection provides a brief overview of the primary soil types identified along the stream reaches in the vicinity of the MFP. Table 3-2 provides more specific information

about the soils associations including map code, soil description and slope, taxonomy, parent rock, stability classification and vegetation supported by the soil. Most of the information in Table 3-2 was derived from the Soil Conservation Service (SCS) soil surveys. The parent rock of the soil association is included for those associations where a connection was discernable from the literature reviews or a comparison of the geology and soil maps. Maps 3-4(a), (b), and (c) show the geographic locations of the soil types with its map code and color-coded slope stability designations. For mapping purposes, only those soil units that are adjacent to Project facilities and bypass streams that are likely to contribute sediment were delineated.

In general, the soils surrounding the Project facilities, reservoirs and bypass streams are identified as highly erodible sandy to silty loams with steep unstable slopes. Much of the area is identified as rock outcrop or rock land with only minor amounts of soil. Soils in the upper elevations were formed from weathered volcanic rocks, plutonic rocks, and the Shoo-Fly Complex rocks. Much of the granitic bedrock is barren with no soil or vegetation (NRCS 2006). Soils in the foothills are formed from weathered slates, schists, serpentine rocks, and basic, metabasic, and acid igneous rocks. These soil associations generally consist of well-drained sandy loams (SCS and USDA-FS 1974 and 1980).

The Project reservoirs generally are surrounded by rock outcrops with steep slopes. The banks of the French Meadow Reservoir and Hell Hole Reservoir in the upland areas of the Watershed, consist primarily of granitic and volcanic rock and the soils derived from weathering of those rocks. The banks of the Ralston Afterbay and Middle Fork Interbay in the foothills area of the Watershed consist of vertically tilted schists and slates and soils derived from those rocks. The angle of vertical tilt indicates some drastic uplift and faulting has occurred in the area and may result in unstable steep slopes.

3.3 REFERENCES

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TABLES

Table 3-1. Primary Geologic Formations in the Watershed.

Name	Map Code	Geologic Time	Age (in mybp)	Description
Glacial Deposits	gl	Quaternary	0-2	Glacial Deposit
Talus	td	Quaternary	0-2	Talus
Mehrten	Tma	Tertiary	2-65	Andesite
Mehrten	TMc	Tertiary	2-65	Andesite Conglomerate
Tertiary Volcanic Rhyolite	TVr	Tertiary	2-65	Rhyolite
Sierra Nevada Batholith and Associated Plutons	gr	Mesozoic	63-240	Granitic rocks
Ultramafic	um	Mesozoic	63-240	Serpentine
Clipper Gap Formation	TCs	Jurassic	138-205	Chert and Argillite
Mariposa	JMm	Jurrassic	138-205	Slate, Meta-Graywacke, and Meta-Conglomerate
Undifferentiated Gabbro	gb	Paleozoic to Mesozoic	63-500	Gabbroic Rocks
Shoo-Fly Complex	DSs	Ordivician to Devonian	360-500	Marine Sediments -- Sandstone
Calaveras Complex -- Sedimentary	PCs	Paleozoic	360-500	Marine Sediments -- Chert and Argillite
Calaveras Complex -- Volcanics	PCv	Paleozoic	360-500	Marine Sediments -- Chert and Argillite

Table 3-2. Soil Types, Slope, and Stability Along the Streams and Rivers Associated with the MFP.

Map Code	Association	Soil Description and Slope	Taxonomy	Parent Rock	Stability Designation	Vegetation
Duncan Creek						
CSF	Crozier	CROZIER-COHASSET COMPLEX, 30 TO 50 PERCENT SLOPES	Crozier -- ULTIC HAPLOXERALFS, FINE-LOAMY, MIXED, MESIC Cohasset -- Fine-loamy, mixed, mesic Ultic Haploxeralfs	Mehrten	Severe -- Slope/erodibility	Conifers and hardwoods
CTG	Crozier	CROZIER-MCCARTHY-COHASSET COMPLEX, 30 TO 75 PERCENT SLOPES	Crozier -- ULTIC HAPLOXERALFS, FINE-LOAMY, MIXED, MESIC McCarthy -- Medial-skeletal, mesic Andic Xerumbrepts Cohasset -- Fine-loamy, mixed, mesic Ultic Haploxeralfs	Mehrten	Severe to Very Severe -- Slope/erodibility	Conifers and hardwoods
CUG	Crozier	CROZIER-MARIPOSA-CRYUMBREPTS, WET COMPLEX, 30 TO 75 PERCENT SLOPES	Crozier -- ULTIC HAPLOXERALFS, FINE-LOAMY, MIXED, MESIC Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults	Mehrten	Severe to Very Severe -- Slope/erodibility	Conifers and hardwoods
DDH	Deadwood	ROCK OUTCROP-DEADWOOD ASSOCIATION, 50 TO 100 PERCENT SLOPES	Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts		Severe to Very Severe --	
DEG	Deadwood	DEADWOOD-ROCK OUTCROP-HURLBUT COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/erodibility	
HUE	Hurlbut	HURLBUT-DEADWOOD-MARIPOSA COMPLEX, 2 TO 30 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults		Moderate to Severe -- Slope/erodibiity	
HUG	Hurlbut	HURLBUT-DEADWOOD-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
IMG	Ledmount	LEDMOUNT-MCCARTHY-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Ledmount -- LITHIC XERUMBREPTS, MEDIAL-SKELETAL, FRIGID McCarthy -- Medial-skeletal, mesic Andic Xerumbrepts		Severe to Very Severe -- Slope/Severely eroded	
JZG	Jocal	JOCAL-JOCAL VARIANT-CRYUMBREPTS, WET COMPLEX, 50 TO 75 PERCENT S LOPES	ULTIC HAPLOXERALFS, LOAMY-SKELETAL, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
MAE	Mariposa	MARIPOSA-JOCAL COMPLEX, 2 TO 30 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Jocal -- ULTIC HAPLOXERALFS, LOAMY-SKELETAL, MIXED, MESIC	Mariposa	Moderate to Severe -- Slope/erodibiity	Conifers, hardwoods and brush

Table 3-2. Soil Types, Slope, and Stability Along the Streams and Rivers Associated with the MFP (continued).

Map Code	Association	Soil Description and Slope	Taxonomy		Stability Designation	Vegetation
Duncan Creek (continued)						
MCG	McCarthy	MCCARTHY-LEDMOUNT-CROZIER COMPLEX, 30 TO 75 PERCENT SLOPES	Ledmount -- LITHIC XERUMBREPTS, MEDIAL-SKELETAL, FRIGID McCarthy -- Medial-skeletal, mesic Andic Xerumbrepts Crozier -- ULTIC HAPLOXERALFS, FINE-LOAMY, MIXED, MESIC	Mehrten	Severe to Very Severe -- Slope/Severely eroded	Conifers and hardwoods
SMG	Smokey	SMOKEY-WOODSEYE-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Smokey -- DYSTRIC XEROCHREPTS, LOAMY-SKELETAL, MIXED, FRIGID Woodseye -- Loamy-skeletal, mixed, frigid Lithic Xerumbrepts		Severe to Very Severe -- Slope/erodibilty	
TBE	Tallac	TALLAC-CRYUMBREPTS, WET COMPLEX, 2 TO 30 PERCENT SLOPES	PACHIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID	Glacial	Moderate -- Slope/erodibility	Dense conifers and shrubs
TBF	Tallac	TALLAC-CRYUMBREPTS, WET COMPLEX, 30 TO 50 PERCENT SLOPES	PACHIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID	Glacial	Sever -- Slope/Erodibility	Dense conifers and shrubs
WOG	Woodseye	WOODSEYE-ROCK OUTCROP-SMOKEY COMPLEX, 30 TO 75 PERCENT SLOPES	Smokey -- DYSTRIC XEROCHREPTS, LOAMY-SKELETAL, MIXED, FRIGID Woodseye -- Loamy-skeletal, mixed, frigid Lithic Xerumbrepts		Severe to Very Severe -- Slope/erodibility	
Long Canyon						
114	Cohasset	COHASSET-MCCARTHY ASSOCIATION, RHYOLITIC SUBSTRATUM, 5 TO 30 PERCENT SLOPES	McCarthy -- Medial-skeletal, mesic Andic Xerumbrepts Cohasset -- Fine-loamy, mixed, mesic Ultic Haploxeralfs		Moderate to Severe -- Slope/erodibility	Conifers and hardwoods
115	Cohasset	COHASSET-MCCARTHY ASSOCIATION RHYOLITIC SUBSTRATUM, 30 TO 75 PERCENT SLOPES	McCarthy -- Medial-skeletal, mesic Andic Xerumbrepts Cohasset -- Fine-loamy, mixed, mesic Ultic Haploxeralfs		Very severe to severe - slope/erodibility	Conifers and hardwoods
170	Mariposa	MARIPOSA-JOCAL COMPLEX, 30 TO 75 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Jocal -- ULTIC HAPLOXERALFS, LOAMY-SKELETAL, MIXED, MESIC	Mariposa	Very severe to severe - slope/erodibility	Conifers, hardwoods and brush
172	Mariposa	MARIPOSA-MAYMEN COMPLEX, 30 TO 75 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts	Mariposa/Calaveras	Severe - Slope/erodibility	Conifers, hardwoods and brush
173	Maymen	MAYMEN-ROCK OUTCROP ASSOCIATION, 30 TO 75 PERCENT SLOPES	Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts	Calaveras	Very severe to severe - slope/erodibility	
174	Maymen	MAYMEN-ROCK OUTCROP ASSOCIATION, 75 TO 100 PERCENT SLOPES	Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts	Calaveras	Very severe to severe - slope/erodibility	
196		PITS, BORROW			Not rated	

Table 3-2. Soil Types, Slope, and Stability Along the Streams and Rivers Associated with the MFP (continued).

Map Code	Association	Soil Description and Slope	Taxonomy		Stability Designation	Vegetation
Long Canyon (continued)						
221	Zeibright	ZEIBRIGHT EXTREMELY GRAVELLY COARSE SANDY LOAM, 2 TO 30 PERCENT SLOPE	ENTIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Moderate to Sever -- Slope/Stability	
222	Zeibright	ZEIBRIGHT EXTREMELY GRAVELLY COARSE SANDY LOAM, 30 TO 75 PERCENT SLOPES	ENTIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Very severe to severe - slope/erodibility	
Middle Fork American River -- French Meadows Reservoir to Ralston Afterbay						
154	Jocal	JOCAL-MARIPOSA-UMBREPTS ASSOCIATION, 30 TO 75 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Jocal -- ULTIC HAPLOXERALFS, LOAMY-SKELETAL, MIXED, MESIC	Mariposa	Very severe to severe - slope/erodibility	
170	Mariposa	MARIPOSA-JOCAL COMPLEX, 30 TO 75 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Jocal -- ULTIC HAPLOXERALFS, LOAMY-SKELETAL, MIXED, MESIC	Mariposa	Very severe to severe - slope/erodibility	Conifers, hardwoods and brush
172	Mariposa	MARIPOSA-MAYMEN COMPLEX, 30 TO 75 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts	Mariposa/Calaveras	Severe - Slope/erodibility	Conifers, hardwoods and brush
173	Maymen	MAYMEN-ROCK OUTCROP ASSOCIATION, 30 TO 75 PERCENT SLOPES	Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts	Mariposa	Very severe to severe - slope/erodibility	
ACE	ahart	AHART-WACA, RHYOLITIC SUBSTRATUM, 2 TO 30 PERCENT SLOPES	Ahart -- Medial, frigid Andic Xerumbrepts Waca -- Medial-skeletal, frigid Andic Xerumbrepts		Moderate to Severe -- Slope/erodibiity	Dense conifers
ACF	ahart	AHART-WACA, RHYOLITIC SUBSTRATUM COMPLEX, 30 TO 50 PERCENT SLOPES	Ahart -- Medial, frigid Andic Xerumbrepts Waca -- Medial-skeletal, frigid Andic Xerumbrepts		Severe -- Slope/erodibility	Dense conifers
AEE	Ahart	AHART-ROCK OUTCROP-LEDMOUNT VARIANT COMPLEX, 2 TO 30 PERCENT SLOPES	Ahart -- Medial, frigid Andic Xerumbrepts		Moderate to Severe -- Slope/erodibiity	Sparse Conifers
CUG	Crozier	CROZIER-MARIPOSA-CRYUMBREPTS, WET COMPLEX, 30 TO 75 PERCENT SLOPES	Crozier -- ULTIC HAPLOXERALFS, FINE-LOAMY, MIXED, MESIC Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults		Severe to Very Severe -- Slope/erodibility	Conifers and hardwoods
DDH	deadwood	ROCK OUTCROP-DEADWOOD ASSOCIATION, 50 TO 100 PERCENT SLOPES	Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts		Severe to Very Severe -- Slope/erodibility	
DEG	Deadwood	DEADWOOD-ROCK OUTCROP-HURLBUT COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/erodibility	
FFE	Ponto	PONTO VARIANT-NEER COMPLEX, 2 TO 30 PERCENT SLOPES	Ponto -- ANDIC XEROCHREPTS, MEDIAL, MESIC Neer -- TYPIC VITRIXERANDS, MEDIAL-SKELETAL, MESIC		Moderate to Severe -- Slope/erodibiity	

Table 3-2. Soil Types, Slope, and Stability Along the Streams and Rivers Associated with the MFP (continued).

Map Code	Association	Soil Description and Slope	Taxonomy		Stability Designation	Vegetation
Middle Fork American River -- French Meadows Reservoir to Ralston Afterbay (continued)						
FFF	Ponto	PONTO VARIANT-NEER COMPLEX, 30 TO 50 PERCENT SLOPES	Ponto -- ANDIC XEROCHREPTS, MEDIAL, MESIC Neer -- TYPIC VITRIXERANDS, MEDIAL-SKELETAL, MESIC		Severe -- Slope/erodibility	
FGG3	Ponto	PONTO VARIANT-NEER-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES , SEVERELY ERODED	Ponto -- ANDIC XEROCHREPTS, MEDIAL, MESIC Neer -- TYPIC VITRIXERANDS, MEDIAL-SKELETAL, MESIC		Severe to Very Severe -- Slope/Severely eroded	
HUE	Hurlbut	HURLBUT-DEADWOOD-MARIPOSA COMPLEX, 2 TO 30 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults		Moderate to Severe -- Slope/erodibiity	
HUG	hurlburt	HURLBUT-DEADWOOD-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
HUG	Hurlbut	HURLBUT-DEADWOOD-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
JZG	Jocal	JOCAL-JOCAL VARIANT-CRYUMBREPTS, WET COMPLEX, 50 TO 75 PERCENT S LOPES	ULTIC HAPLOXERALFS, LOAMY-SKELETAL, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
MCE	McCarthy	MCCARTHY-LEDMOUNT-CROZIER COMPLEX, 2 TO 30 PERCENT SLOPES	Ledmount -- LITHIC XERUMBREPTS, MEDIAL-SKELETAL, FRIGID McCarthy -- Medial-skeletal, mesic Andic Xerumbrepts Crozier -- ULTIC HAPLOXERALFS, FINE-LOAMY, MIXED, MESIC		Moderate to Severe -- Slope/erodibiity	Conifers and hardwoods
MmF		METAMORPHIC ROCK LAND			Not Rated	
PTE	Putt	PUTT-ROCK OUTCROP-CRYUMBREPTS, WET COMPLEX, 2 TO 30 PERCENT SLOP ES	ANDIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Moderate -- Slope/erodibility	
PVG	Putt	PUTT-ROCK OUTCROP, GRANITIC-ZEIBRIGHT COMPLEX, 30 TO 75 PERCENT SLOPES	Putt -- ANDIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC Zeibright -- ENTIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Severe to Very Severe -- Slope/erodibility	
R		RIVERWASH			Unrated	
RPG	Putt	ROCK OUTCROP, GRANITIC-PUTT COMPLEX, 30 TO 75 PERCENT SLOPES	ANDIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Severe to Very Severe -- Slope/erodiblity	

Table 3-2. Soil Types, Slope, and Stability Along the Streams and Rivers Associated with the MFP (continued).

Map Code	Association	Soil Description and Slope	Taxonomy		Stability Designation	Vegetation
Middle Fork American River -- French Meadows Reservoir to Ralston Afterbay (continued)						
RVE	Waca	ROCK OUTCROP-WACA, RHYOLITIC SUBSTRATUM-LEDMOUNT VARIANT COMPLEX ,2 TO 30 PERCENT SLOPES	Waca -- Medial-skeletal, frigid Andic Xerumbrepts		Moderate to Severe -- Slope/erodibility	
TAE	Tallac	TALLAC VERY GRAVELLY SANDY LOAM, 2 TO 30 PERCENT SLOPES	PACHIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID		Moderate -- Slope/erodibility	Dense conifers and shrubs
TBE	Tallac	TALLAC-CRYUMBREPTS, WET COMPLEX, 2 TO 30 PERCENT SLOPES	PACHIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID		Moderate -- Slope/erodibility	Dense conifers and shrubs
ZEE	Zeibright	ZEIBRIGHT GRAVELLY FINE SANDY LOAM, 2 TO 30 PERCENT SLOPES	ENTIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Severe -- Slope/erodibility	
Middle Fork American River -- Ralston Afterbay to North Fork Confluence						
170	Maymen	MAYMEN-ROCK OUTCROP COMPLEX, 50 TO 75 PERCENT SLOPES	Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts		Not Rated	Brush and scattered stunted conifer and harwood
178		RIVERWASH			Not Rated	
179		ROCK OUTCROP			Not Rated	Sparse grasses and stunted trees
DDH	Deadwood	ROCK OUTCROP-DEADWOOD ASSOCIATION, 50 TO 100 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts		Severe to Very Severe -- Slope/erodibility	
DEG	Deadwood	DEADWOOD-ROCK OUTCROP-HURLBUT COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/erodibility	
DUF	Dubakella	DUBAKELLA-DUBAKELLA VARIANT-ROCK OUTCROP COMPLEX, 30 TO 50 PERCENT	LITHIC MOLLIC HAPLOXERALFS, LOAMY-SKELETAL, SERPENTINITIC, MESIC		Severe -- Slope/erodibility	
HsE	Horseshoe	HORSESHOE GRAVELLY LOAM, 30 TO 50 PERCENT SLOPES	XERIC HAPLOHUMULTS, FINE-LOAMY, OXIDIC, MESIC		Severe -- Slope/erodibility	Conifers and hardwoods
HUE	Hurlbut	HURLBUT-DEADWOOD-MARIPOSA COMPLEX, 2 TO 30 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults		Moderate to Severe -- Slope/erodibiity	
HUG	Hurlbut	HURLBUT-DEADWOOD-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
HUG3	Hurlbut	HURLBUT, THIN SURFACE-DEADWOOD-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES, SEVERELY ERODED	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
MbF	Mariposa	MARIPOSA VERY ROCKY SILT LOAM, 50 TO 70 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults		Severe to Very Severe -- Slope/erodibility	Conifers, hardwoods and brush

Table 3-2. Soil Types, Slope, and Stability Along the Streams and Rivers Associated with the MFP (continued).

Map Code	Association	Soil Description and Slope	Taxonomy		Stability Designation	Vegetation
Middle Fork American River -- Ralston Afterbay to North Fork Confluence (continued)						
MmF		METAMORPHIC ROCK LAND			Not Rated	
SaF		SERPENTINE ROCK LAND			Not Rated	Chamise, grasses and Digger pines
TaD		TAILINGS			Not Rated	
North Fork American River to Folsom Reservoir						
170	Maymen	MAYMEN-ROCK OUTCROP COMPLEX, 50 TO 75 PERCENT SLOPES	Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts		Not rated	Brush and scattered stunted conifer and harwood
MmF		METAMORPHIC ROCK LAND			Not Rated	
SaF		SERPENTINE ROCK LAND			Not Rated	Chamise, grasses and Digger pines
Rubicon River						
106	Chaix	CHAIX COARSE SANDY LOAM, 30 TO 75 PERCENT SLOPES	DYSTRIC XEROCHREPTS, COARSE-LOAMY, MIXED, FRIGID			
109	Chaix	CHAIX-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	DYSTRIC XEROCHREPTS, COARSE-LOAMY, MIXED, FRIGID		Very severe to severe - slope/erodibility	Conifers and hardwoods
137	Hartless	HARTLESS-MIERUF VERY GRAVELLY LOAMS, 30 TO 50 PERCENT SLOPES	Hartless -- Loamy-skeletal, mixed, mesic Dystric Xerochrepts Mieruf -- Fine-loamy, oxidic, mesic Xeric Haplohumults		Severe - Slope/erodibility'	
138	Hartless	HARTLESS-MIERUF VERY GRAVELLY LOAMS, 50 TO 75 PERCENT SLOPES	Hartless -- Loamy-skeletal, mixed, mesic Dystric Xerochrepts Mieruf -- Fine-loamy, oxidic, mesic Xeric Haplohumults		Very severe to severe - slope/erodibility	
140	Hartless	HARTLESS-NEUNS COMPLEX, 30 TO 75 PERCENT SLOPES	Hartless -- Loamy-skeletal, mixed, mesic Dystric Xerochrepts Neuns -- Loamy-skeletal, mixed, mesic Dystric Xerochrepts		Very severe to severe - slope/erodibility	
145	Holland	HOLLAND-BIGHILL COMPLEX 30 TO 75 PERCENT SLOPES	Holland -- ULTIC HAPLOXERALFS, FINE-LOAMY, MIXED, MESIC Bighill -- Coarse-loamy, mixed, mesic Typic Xerumbrepts		Very severe to severe - slope/erodibility	
164		LITHIC XERUMBREPTS-ROCK OUTCROP COMPLEX, 15 TO 75 PERCENT SLOPES			Not rated	
170	Mariposa	MARIPOSA-JOCAL COMPLEX, 30 TO 75 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Jocal -- ULTIC HAPLOXERALFS, LOAMY-SKELETAL, MIXED, MESIC		Very severe to severe - slope/erodibility	Conifers, hardwoods and brush

Table 3-2. Soil Types, Slope, and Stability Along the Streams and Rivers Associated with the MFP (continued).

Map Code	Association	Soil Description and Slope	Taxonomy		Stability Designation	Vegetation
Rubicon River (continued)						
172	Mariposa	MARIPOSA-MAYMEN COMPLEX, 30 TO 75 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts		Severe - Slope/erodibility	Conifers, hardwoods and brush
173	Maymen	MAYMEN-ROCK OUTCROP ASSOCIATION, 30 TO 75 PERCENT SLOPES	Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts		Very severe to severe - slope/erodibility	
174	Maymen	MAYMEN-ROCK OUTCROP ASSOCIATION, 75 TO 100 PERCENT SLOPES	Maymen -- Loamy, mixed, mesic Dystric Lithic Xerochrepts		Very severe to severe - slope/erodibility	
184	Neuns	NEUNS GRAVELLY LOAM, 50 TO 75 PERCENT SLOPES	Neuns -- Loamy-skeletal, mixed, mesic Dystric Xerochrepts		Very severe to severe - slope/erodibility	
185	Neuns	NEUNS-LITHIC XERUMBREPTS-ROCK OUTCROP ASSOCIATION, 50 TO 100 PERCENT SLOPES	Neuns -- Loamy-skeletal, mixed, mesic Dystric Xerochrepts		Very severe to severe - slope/erodibility	
193	Pilliken	PILLIKEN COARSE SANDY LOAM, 30 TO 50 PERCENT SLOPES	Coarse-loamy, mixed, mesic Entic Xerumbrepts		Severe - Slope/erodibility	
195	Pilliken	PILLIKEN-ROCK OUTCROP COMPLEX, 30 TO 50 PERCENT SLOPES	Coarse-loamy, mixed, mesic Entic Xerumbrepts		Severe - Slope/erodibility	
200	Tinker	ROCK OUTCROP-TINKER ASSOCIATION, 15 TO 75 PERCENT SLOPES	ANDIC HAPLUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID		Severe - Slope/erodibility	
204	Tallac	TALLAC VARIANT-LITHIC XERUMBREPTS-ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES	PACHIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID		Moderate to Severe -- Slope/erodibility, or not rated	Dense conifers and shrubs
207	Tinker	TINKER-TALLAC COMPLEX, 50 TO 75 PERCENT SLOPES	Tallac -- PACHIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID ANDIC HAPLUMBREPTS, LOAMY-SKELETAL, MIXED, FRIGID		Very severe to severe - slope/erodibility	Dense conifers and shrubs
221	Zeibright	ZEIBRIGHT EXTREMELY GRAVELLY COARSE SANDY LOAM, 2 TO 30 PERCENT SLOPES	ENTIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Moderate to Sever -- Slope/Stability	
222	Zeibright	ZEIBRIGHT EXTREMELY GRAVELLY COARSE SANDY LOAM, 30 TO 75 PERCENT SLOPES	ENTIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Very severe to severe - slope/erodibility	
224	Zeibright	ZEIBRIGHT-ROCK OUTCROP ASSOCIATION, 15 TO 75 PERCENT SLOPES	ENTIC XERUMBREPTS, LOAMY-SKELETAL, MIXED, MESIC		Severe -- Slope/erodibility	
DEG	Hurlbut	HURLBUT-DEADWOOD-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/erodibility	
HSE	Horseshoe	HORSESHOE GRAVELLY LOAM, 30 TO 50 PERCENT SLOPES	XERIC HAPLOHUMULTS, FINE-LOAMY, OXIDIC, MESIC		Severe -- Slope/erodibility	Conifers and hardwoods
HUG	Hurlbut	HURLBUT-DEADWOOD-ROCK OUTCROP COMPLEX, 30 TO 75 PERCENT SLOPES	Deadwood -- Loamy-skeletal, mixed, mesic Dystric Lithic Xerochrepts Hurlbut -- DYSTRIC XEROCHREPTS, FINE-LOAMY, MIXED, MESIC		Severe to Very Severe -- Slope/Severely eroded	
Mbf	Mariposa	MARIPOSA VERY ROCKY SILT LOAM, 50 TO 70 PERCENT SLOPES	Mariposa -- Fine-loamy, mixed, mesic Ruptic-Lithic-Xerochreptic Haploxerults		Severe to Very Severe -- Slope/erodibility	Conifers, hardwoods and brush
MMF		METAMORPHIC ROCK LAND			Not Rated	

MAPS