TRANSPORTATION

Affected Environment

Existing Transportation System - Arterial and collector roads within and adjacent to the Kings River Project area include State Highway 168, Fresno County Roads 2440 (Dinkey Creek Road), Fresno County Road 2070 (Peterson Mill Road), and various Level 3, 4 and 5 National Forest System Roads (NFSR). Most Level 3, 4 and 5 roads would only require pre-haul maintenance. Many local roads within the project area vary in degree of condition ranging from good that require pre-haul maintenance to poor that require reconstruction to meet access needs and eliminate resource concerns. None of the road systems are suitable for wet weather use due to rutting; high potential for off-road damage; and degradation of water quality. A summary of the transportation situation for each of the project's eight management units follows.

Bear_fen_6 Management Unit - Access to this management unit is provided by Fresno County Road 2440, Dinkey Creek Road, NFSR 10S024 and NFSR 10S069. These roads provide the primary access route for the management area and are in good condition. NFSR 10S024 and NFSR 10S069 are aggregate. Access for project activities would require approximately 16.5 miles of road reconstruction. No new road construction is planned.

El_o_win_1 Management Unit – Access to this management unit is provided by Fresno County Road 2440 (Dinkey Creek Road), NFSR 10S024, and NFSR 11S040. These roads provide the primary access route for the management area and are in good condition. NFSR 10S024 has an aggregate surface and NFSR 11S040 is paved. Access for project activities would require approximately 12.4 miles of road reconstruction. No new road construction is planned.

Glen_meadow_1 Management Unit - Access to this management unit is provided by Fresno County Road 2440 (Dinkey Creek Road), NFSR 9S009, NFSR 10S007, and NFSR 10S069. These roads provide the primary access route for the management area and are in good condition. NFSR 9S009 and 10S007 are paved. NFSR 10S069 has an aggregate surface. Access for project activities would require approximately 12.2 miles of road reconstruction. No new road construction is planned.

Krew_bul_1 Management Unit - Access to this management unit is provided by Fresno County Road 2440 (Dinkey Creek Road), NFSR 10S024, and NFSR 11S040. These roads provide the primary access route for the management area and are in good condition. NFSR 10S024 has a native surface and NFSR 11S040 is paved. Access for project activities would require approximately 10.8 miles of road reconstruction and 0.2 miles of new construction.

Krew_prv_1 Management Unit - Access to this management unit is provided by Fresno County Road 2440 (Dinkey Creek Road), NFSR 10S017, and NFSR 10S069. These roads provide the primary access route for the management area and are in good condition. NFSR 10S017 is paved. NFSR 10S069 has an aggregate surface. Access for project activities would require approximately 13.0 miles of road reconstruction and 0.9

miles of new construction. Road rights of way would need to be acquired for NFSR 10S010, NFSR 10S012, NFSR 10S017B, NFSR 10S017C, NFSR 10S017D, NFSR 10S017M, NFSR 10S025A and NFSR 10S069.

N_soaproot_2 Management Unit - Access to this management unit is provided by Fresno County Road 2070 (Peterson Mill Road), NFSR 10S002, NFSR 10S043, and NFSR 10S004. These roads provide the primary access route for the management area and are in good condition. NFSR 10S002 is paved. NFSR 10S004 and NFSR 10S043 have an aggregate surface. Access for project activities would require approximately 4.3 miles of road reconstruction. No new road construction is planned. A high water ford would need to be constructed on NFSR 10S004 to cross Rush Creek. No significant change in traffic quantity is expected as a result of the ford.

Providence_1 Management Unit - Access to this management unit is provided by Fresno County Road 2440 (Dinkey Creek Road), County Road 2070 (Peterson Mill Road), NFSR 10S017, NFSR 10S018, and NFSR 10S002. These roads provide the primary access route for the management area and are in good condition. NFSR 10S002 and NFSR 10S017 are paved. NFSR 10S018 has an aggregate surface. Access for project activities would require approximately 7.6 miles of road reconstruction and 0.6 miles of new construction. Road rights of way would need to be acquired for NFSR 10S017A, NFSR 10S017B, and NFSR 10S087.

Providence_4 Management Unit - Access to this management unit is provided by Fresno County Road 2440 (Dinkey Creek Road), and County Road, 2070 (Peterson Mill Road), NFSR 10S017, and NFSR 10S002. These roads provide the primary access route for the management area and are in good condition. NFSR 10S002 and NFSR 10S017 are paved. Access for project activities would require approximately 6.8 miles of road reconstruction. No new road construction is planned. Road rights of way would need to be acquired for NFSR 10S037.

Table 3-18. Road Mileage and Construction Cost Summary

Manage-ment Unit	Year	Miles of Road Maintenance	Miles of Road Reconstruction	Miles of New Road Construction	Project Construction & Maintenance Costs	Costs Borne by Project
Bear_fen	2008	41.5	16.5	0	$265,039	No
El_o_win	2006	23.9	12.4	0	$122,275	Yes**
Glen_mdw	2007	24.2	12.2	0	$237,666	Yes**
Krew_bul	2007	22.2	10.8	0.2	$156,626	Yes
Krew_prv	2006	23.5	14.1	0.9	$436,469	Yes*
N_soapro	2008	12.9	4.3	0	$269,174	No
Prov_1	2007	23.4	7.6	0.6	$188,891	No
Prov_4	2006	19.1	6.8	0	$176,320	No
Totals		190.7	84.7	1.7	$1,852,461	

* Except No for Alternative 3, 4 and 5
** Except No for Alternative 5

Inventoried National Forest System Roads accessing the proposed project area are shown on the Project Area Map and summarized in the Road Data Summary, on file at the High Sierra District Office.

The cost of road reconstruction and new construction for this project would be approximately $2,000,378. Access for log trucks, fire engines, and other work crews would be provided. The cost of construction, reconstruction, and maintenance would be borne by the project to the extent possible. Appropriated funds may be utilized if available.

Effects of Alternative 1, 3, 4 and 5

Direct and Indirect: These alternatives include 84.7 miles of road reconstruction to repair existing substandard road conditions and 1.7 miles of new construction. No temporary roads are planned. Design standards for road reconstruction reflect use during the normal operating season; dry weather access; and repair for roads that are causing resource damage. Reconstruction would reduce erosion from unsurfaced roads. Reconstruction would be especially important in reducing soil sedimentation into streams in sub-watersheds that have the potential for a cumulative watershed effect (See Watershed Section for further details). In addition, a high water ford would be built on NFSR 10S004 across Rush Creek for access to the North_Soaproot_2 Management Unit. Road maintenance such as additional rocking of the road surface, grading, subgrade repair, and subgrade drainage would be needed to support wet weather activities, if project activities take place outside the normal operating season. The Proposed Action does not contemplate wet weather operation.

Water is typically not plentiful enough for extensive dust abatement. Restrictions from use of alternative dust abatement products in riparian conservation areas for specific aquatic species on some roads may limit hauling operations and increase the cost. Limiting hauling operations may delay completion of scheduled treatments. Trip restrictions or speed reductions may be considered in lieu of water.

Approximately three miles of unclassified roads would be decommissioned for the purpose of improving water quality and enhancing wildlife habitat.

All road maintenance, reconstruction, and new construction would follow the Sierra Forest Land Resource Management Plan Standards and Guidelines and Best Management Practices. Roads would be maintained to provide access for equipment access. Roads would not be upgraded beyond the standards consistent with the Land Resource Management Plan and project access requirements.

The current condition includes existing substandard road conditions. The cumulative effect would be reduced erosion and stream sedimentation when the effects of road reconstruction are added to the effects of past actions and natural events.

Effects of Alternative 2

No direct effects would occur. Existing road reconstruction needed to eliminate resource damage and support equipment access would not take place. No new road construction or decommissioning would take place

Cumulative effects include continued soil erosion from unsurfaced roads. The transportation system for the area would not be updated and improved to meet current access management direction.

AIR QUALITY

Affected Environment

Fires are a natural disturbance process in the forest ecosystem (Agee 1993; Graham and McCaffrey 2003). The goal of land managers is to return fire as a process in a healthy forest ecosystem (Blackwell, 2004). The challenge to forest managers is to retain the ability to use prescribed fire as a tool to restore fire as a natural disturbance while reducing the effects of smoke within the airshed. Certain tradeoffs between silvicultural and prescribed fire treatments are needed to improve the resiliency of the forest; reduce the potential for stand replacing fire; and reduce the amount of smoke emissions (Brown and others, 2004).

Air quality in the San Joaquin Valley (Valley) is among the poorest in the state. The Valley experiences about 35 to 40 days when it exceeds federal health-based standards for ground-level ozone and more than 100 days over the state ozone standard. Levels of airborne particulates exceed the federal standard less than fives time annually. The California standard is set at a lower and more protective level. The San Joaquin Valley exceeds the California limit an average of 90-100 days per year (SJVUAPCD, 2003).

Currently the Valley is federally classified as severe non-attainment for the federal ground-level ozone and particulate matter less than 10 microns in diameter (PM_{10}) standard. Additionally, the valley is classified as severe non-attainment for the California ozone standard and non-attainment for the state's PM_{10} standard. Attainment status for PM_{10} was requested from the Environmental Protection Agency (EPA) on April 25, 2006 www.valleyair.org, 2006.

Smoke is a limiting factor in how many acres of natural and activity fuels can be treated per project per year (the Kings River Project Air Conformity Determination Document is incorporated by reference). Limiting the use of prescribed fire to reduce hazardous fuel conditions to areas where other management treatments are not feasible can reintroduce fire as an ecosystem process (Blackwell, 2004) and limit the amount of wildfire and prescribed fire emissions into the San Joaquin Valley.

Environmental Consequences

Alternative 1 – Proposed Action

Direct Effects: Post thinning burn treatments under this alternative would produce 3,667 tons of particulate matter (PM_{10}) and 1,666 tons of nitrous oxide (NO_x) under dry burning conditions, compared to 48,000 tons (PM_{10}) that would be produced in the event of a wildfire of the same acreage. This leads to a reduction of 85 percent. The California State Implementation Plan (SIP) restricts emissions to a maximum 70 tons per project per year for PM_{10} and 25 tons for NO_x for severe non-attainment areas (San Joaquin Valley Unified Air Pollution Control District 2003).

PM_{10} rather than NO_x would be the limiting factor for underburning. NOx would be the limiting factor for pile burning in the Kings River Project. This would restrict the number of treated areas for Kings River Project to 570 acres of underburning and 245 acres of piled slash per management unit per year. Completing burning in the project area would take from 2.7 to 4 years depending on management unit; number of acres; type of prescribed fire treatment; and seasonal burning limits. Treated acres allowed each year would be governed by proposed amounts of slash (0-10 inches in diameter) after thinning. Slash would be removed by prescribed fire, tractor and hand piling. Mechanical treatments of vegetation through the use of logging equipment also produce PM_{10}, exhaust hydrocarbons. Total PM_{10} emissions produced from the use of mechanical equipment would be 5.7 tons; exhaust hydrocarbons emissions would total 4.84 tons; and nitrous oxides would total 72.3 tons.

Indirect Effects - The potential for indirect effects is from exposure to organic hydrocarbons (precursors to smog under high daytime temperatures); large particulate matter; and PM_{10} produced from prescribed fires. These emissions are easily inhaled and can cause respiratory and pulmonary distress.

The Fresno Metropolitan area; the community of Shaver Lake; the Dinkey Creek Recreation Area; recreational residences; and private subdivisions within Providence Creek and Exchecquer are considered smoke sensitive areas. These areas could be affected by smoke if weather patterns prevent smoke from venting into the upper atmosphere. Prescribed burns would be planned during periods which would allow for proper ventilation. However, prescribed underburns could last for several days or weeks and a potential for recurring shifts in air masses exist. The production of PM_{10} is always a consideration and under conditions of poor ventilation could present problems throughout the year. All burning activities would be implemented under optimum conditions using Best Available Control Measures to prevent smoke concentrations from affecting local communities.

Cumulative Effects - Cumulative effects can be expected within the Kings River Project Area from current and foreseeable future projects. Several prescribed underburns within the Kings River Project area would continue as part of the High Sierra Ranger District Program of Work. The Kings River Project includes within its boundaries the Front Country and Turtle Underburn Programs. The combined acres of these underburn programs is 12,000 acres. All underburns are in ponderosa pine or mixed conifer forested areas; have been treated at least once; and are in maintenance status. Typically 2,000 acres per year are burned as part of this program and would continue unaffected by the alternative chosen. An estimate of emissions for the underburn program is based on 2,000 acres treated per year with an average of three tons per acre consumed (APCD Work Plan, 2005).

Table 3-19. Tons of Estimated Pollutants, Underburn Program of Work

PM_{10}	$PM_{2.5}$	NO_x	SO_2	VOCs	CO
73.5	66	10.5	.30	43.5	699.0

PM_{10}: Particulate Matter greater than 10 microns in size. **$PM_{2.5}$**: Particulate Matter greater than 2.5 microns in size, **NO_x :** Nitrous oxide, **SO_2**: Sulpher Dioxide, **VOCs**: Visual Organic Compounds (precursors to smog), **CO**: Carbon Monoxide.

A cumulative effect could also occur when respiratory or pulmonary distress is caused by wildland fire in the area. The 4,132 acre North Fork Fire in 2000 on the Bass Lake Ranger District produced nearly 2,388 tons of PM_{10} emissions. A wildfire occurring in the Kings River Project area of the same size would produce nearly 48,000 tons of PM_{10} emissions (Kings River Project EIS Air Conformity Determination). The San Joaquin Valley is classified in a severe non-attainment status for PM_{10} emissions and ozone. The valley had expected to be elevated to an extreme non-attainment status by the Environmental Protection Agency and the San Joaquin Valley Unified Air Pollution Control District. Emissions from wildfires affect the San Joaquin Valley during stable summer air patterns. Smoke emissions from wildfires can cause air pollution alerts not only in local mountain communities but also in the central valley.

Other past, present and foreseeable future projects within the Kings River Project Area include the Prescribed Burn Program of Work (including the South of Shaver Project); cattle grazing; the district plantation and vegetation management program; off-highway Vehicle (OHV) use; the Helms-Gregg 230 kV Transmission Line Right-of-Way; private land management activities; and timber sales. Cumulative effects to air quality include any vegetation management program (public or private) in which vegetation would be burned, or where vehicle and heavy equipment use contribute to exhaust emissions or fugitive dust. Projects that could and possibly would contribute to air quality cumulative effects from particulate matter PM_{10} include the Southern California Edison (SCE) Company's forestry and prescribed burn program; the High Sierra District plantation and vegetation management program; and vegetation treatments in the Wildflower Subdivision. No burning would take place as part of the Helms-Gregg transmission line project. Cumulative effects to air quality from exhaust emissions and fugitive dust can be expected from the SCE forestry program; the Helms-Gregg transmission line project; OHV use; and vegetation management treatments on private and public lands; and the district plantation management program. The amount of heavy equipment use and or prescribed burning that may take place as part of the SCE program or vegetation management activities on private land is unknown.

Patterson, Deer, Snow Corral and Hall timber sales no longer have air quality direct or indirect effects. These past timber sales no longer have any proposed activities. The Reese and the Indian Rock Timber Sale have on-going underburns and are part of the district's Prescribed Burn Program of Work. The cumulative effects to air quality from these timber sales are included with the discussion above.

Alternative 2 – No Action

Direct and Indirect Effects - No direct or indirect effects occur under Alternative 2. No treatments associated with the proposed action would take place.

Cumulative Effects - Several prescribed underburns within the project area would continue as part of the High Sierra Ranger District Program of Work. The Kings River Project includes the Front Country and Turtle Underburn Programs within its boundaries. The combined acres of these underburn programs is 12,000 acres. All underburns are in ponderosa pine or mixed conifer forested areas; have been treated at least once; and are in maintenance status. Typically 2,000 acres per year are burned as part of this program and would continue unaffected by the alternative chosen. An estimate of emissions for the underburn program is based on 2,000 acres treated per year with an average of three tons per acre consumed (APCD Work Plan, 2005).

Table 3-20. Tons of Estimated Pollutants, Underburn Program of Work

PM_{10}	$PM_{2.5}$	NO_x	SO_2	VOCs	CO
73.5	66	10.5	.30	43.5	699.0

Indirect or cumulative effects could also include the occurrence of respiratory or pulmonary distress when a wildland fire occurs in the area. The North Fork Fire in 2000 on the Bass Lake Ranger District produced nearly 2388 tons of PM_{10} emissions and a wildfire occurring in the Kings River Project area would produce nearly 48,000 tons of PM_{10} emissions. The San Joaquin Valley is classified in a severe non-attainment status for PM_{10} emissions and ozone and is expected to be elevated to an extreme non-attainment status by the Environmental Protection Agency and the San Joaquin Valley Unified Air Pollution Control District. Smoke emissions from wildfires can cause air pollution alerts not only in local mountain communities but also in the central valley.

Other past, present and foreseeable future projects within the Kings River Project Area include the Prescribed Burn Program of Work (including the South of Shaver Project); cattle grazing; district plantation and vegetation management program; off-highway vehicle (OHV) use; the Helms-Gregg 230 kV Transmission Line Right-of-Way; and private land management activities. Cumulative effects to air quality include any vegetation management program (public or private) in which vegetation would be burned, or where vehicle and heavy equipment use contributes to exhaust emissions or fugitive dust. Projects that could and possibly would contribute to air quality cumulative effects from particulate matter PM_{10} include the SCE forestry and prescribed burn program; the High Sierra District plantation and vegetation management program; and vegetation treatments in the Wildflower Subdivision. No burning would take place as part of the Helms-Gregg transmission line project. Cumulative effects to air quality from exhaust emissions and fugitive dust can be expected from the SCE forestry program; the Helms-Gregg transmission line project; OHV use; vegetation management treatments on private and public lands; and the district plantation management program. The amount of heavy equipment use and prescribed burning that may take place as part of the SCE program or vegetation management activities on private land is unknown.

Alternative 3 – Retain Largest Trees, Uneven-aged Strategy

Direct, Indirect and Cumulative Effects - The direct, indirect and cumulative effects of Alternative 3 are the same as those of the Proposed Action. Alternative 3 makes only negligible reductions in the amount of slash that would be treated.

Alternative 4 – Fisher Emphasis

Environmental Consequences

Direct Effects: The direct effects of Alternative 4 (the volume of emissions produced) are increased from Alternative 3. Emissions from mechanical harvesting equipment (PM10, exhaust hydrocarbons, and NOx) would not change because the treatments are similar. Post thinning burn treatments (PM_{10} and NOx) would increase emissions. Increased amounts of dead and down material and live vegetation would likely burn hotter. This increases the overall amount of emissions produced. Refer to Table 3-21 for a comparison of burn emissions by alternative and to Table 3-22 for a comparison of harvesting equipment emissions by alternative.

Table 3-21. Burn Emissions

	Alt 1	Alt 2	Alt 3	Alt 4	Alt5
PM_{10}	3667	0	3667	2177	4316
NOx	1666	0	1666	1221	1360
Time to Burn	2.7-4 years	0	2.7-4 years	2.3- 4 years	2.7-4 years

PM10 = Particulate matter to 10 microns
NOx = Nitrous oxides, a precursor to smog
Time to Burn – is a limiting factor of the time it take to fully complete all burn treatments as related to the state implementation plan, and amount of emissions allowed per project per year. The state implementation plan restricts projects to 70 toms of PM10 and 50 tons of NOx allowed emissions produced per year.

Table 3-22. Mechanical Harvesting Emissions

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
PM_{10}	5.7	0	5.7	3.69	5.7
Exhaust hydrocarbons	4.84	0	4.84	3.26	4.84
NOx	72.3	0	72.3	49.1	72.3

Indirect and Cumulative effects: Indirect and cumulative effects are the same for Alternative 4 as for Alternative 3. Refer to Tables 3-21 and 3-22 above for a comparison of emissions for each alternative. The potential for indirect and cumulative effects are from exposure to organic hydrocarbons (precursors to SMOG under high daytime temperatures); large particulate matter; and PM_{10} produced from prescribed burning. These emissions are easily inhaled and cause respiratory and pulmonary distress.

The dispersion of pollutants (PM_{10}, $PM_{2.5}$, NOx, CO, VOC, SO_2, EH) is affected by local meteorological conditions. Pollutants can stay trapped in one place if no wind and thermal mixing exist. Prescribed burns are conducted on days when atmospheric ventilation transports smoke and pollutants away from the San Joaquin Valley. Pollutants are not normally a problem during prescribed burns. Burns are conducted on authorized burn days, in consultation with the Air Pollution Control District. Poor ventilation occurs during summer and fall months, when the Valley is characterized by relatively stable air masses. Ozone concentrations can reach peak levels on sunny days when temperatures rise above 95 degrees Fahrenheit during periods of poor ventilation. Ozone is not released directly to the atmosphere. Ozone is produced by chemical reactions involving VOCs and NOx. Meteorological factors favorable to significant ozone formation occur only during the summer.

The Fresno Metropolitan area; Shaver Lake, Providence, and Exchequer communities; and the Dinkey Creek Recreation Area are considered smoke-sensitive areas. These areas could be affected by smoke if weather patterns produce a stable air mass and smoke is unable to vent into the upper atmosphere. PM_{10} and O_3 are public health hazards so prescribed burns would be planned during periods of unstable air, which would allow for proper ventilation. Prescribed underburns could last for several days, or weeks and the potential for recurring shifts in air masses toward more stable conditions exists. The production of PM_{10} is always a consideration. Conditions of poor ventilation could present problems throughout the year. All burning activities would be implemented under optimum conditions using Best Available Control Measures to prevent smoke concentrations from affecting local communities.

Cumulative Effects – On-going district projects

Several prescribed underburns in the project area would continue as part of the High Sierra Ranger District Program of Work. The Kings River Project includes within its boundaries the Front Country and Turtle Underburn Programs. Combined acres of these underburn programs include approximately 12,000 acres. All underburns are in ponderosa pine or mixed conifer forested areas; have been treated at least once; and are in maintenance status. Typically 2,000 acres per year are burned as part of this program and would continue, unaffected by the alternative chosen. An estimate of emissions for the underburn program is based on 2,000 acres treated per year with an average of three tons per acre consumed (APCD Work Plan, 2005).

Table 3-23. Tons of Estimated Pollutants – Underburn Program of Work

PM_{10}	$PM_{2.5}$	NO_x	SO_2	VOCs	CO
73.5	66	10.5	.30	43.5	699.0

Indirect or cumulative effects may also include the occurrence of respiratory or pulmonary distress if a wildland fire were to occur in the area. The North Fork Fire produced nearly 2,388 tons of PM_{10} emissions and a wildfire occurring in the Kings River Project area could produce nearly 48,000 tons. The San Joaquin Valley is classified in a severe non-attainment status for PM10 emissions and ozone. The valley is expected to be elevated to an extreme non-attainment status by the Environmental Protection Agency and the San Joaquin Valley Unified Air Pollution Control District. Emissions from wildfires settle into the San Joaquin Valley during stable summer air patterns. Smoke emissions from wildfires cause air pollution alerts not only in local mountain communities but also in the central valley.

Alternative 5 - Thin from Below

Direct, Indirect and Cumulative Effects - This alternative considers a size limit for removal of 20 inches or less, compared to up to 35 inches for the proposed action. The amount of slash material generated under this alternative should be less. Any slash treatments utilizing prescribed burning or pile burning should result in fewer emissions than Alternative 1.

BOTANICAL RESOURCES

Affected Environment

Botanical surveys were conducted during 2004, focusing on areas of suitable habitat for Threatened, Endangered and Sensitive (TES) plants and on disturbed areas likely to be invaded by noxious weeds. Several occurrences of sensitive plants and invasive or noxious weeds are known to occur within the project area. See the Biological Evaluation for further details of sensitive plant field surveys and effects analysis. The Biological Evaluation is on file at the High Sierra Ranger District office and is incorporated by reference. A summary of survey results for each of the eight initial units follows.

Bear fen_6 Management Unit – No sensitive plants are known to occur in this unit. Spanish broom occurs on 10S67 where the road crosses Oak Flat Creek, extending about 100 feet of roadside. Bull thistle, a noxious weed, occurs at the junction of 11S91 and 11S91B; along 11S55; along road 10A45 in about three places; and along 11S91. A few patches of cheatgrass occur on exposed road slopes along 10A45. Klamathweed (*Hypericum perforatum*) is present along 11S61 where it borders the southwestern side of the management unit.

El_o_win_1 Management Unit - No sensitive plants are known to occur in this management unit. Bull thistle, a noxious weed, was found in the vicinity of Dinkey Meadow Creek near the gate of Camp El-O-Win, and in a moist area north of the tributary in T10S, R26E, NW ¼ section 20. An occurrence of common mullein (*Verbascum thapsus*) has been recorded in the El_o_win_1 Management Unit near the Dinkey Creek day ride station.

Glen_meadow_1 Management Unit - No sensitive plants are known to occur within this management unit. Bull thistle, a noxious weed, was found in several patches in this management unit; on the eastern half of the old sawmill site (T10S, R26E, NW ¼ section 17); along some day ride trails used by Clyde Pack Operation (CPO) (T10S, R26E, section 17); about 1.1 miles north on 9S09, west of "Trail's End" picnic area; in a meadow in T10S, R26E, NE ¼ section 13; and in a large gully approximately located on the boundary between private and Forest Service land in T10S, R26E, NE ¼ section 13. An occurrence of lens-podded hoary cress (*Cardaria chalepensis*) was found in front of the CPO horse corrals at the Dinkey day ride station. Cheatgrass is scattered throughout the old sawmill site, as well as on the banks of a large gully approximately located on the boundary between private and Forest Service land in T10S, R26E, NE ¼ section 13.

Krew_bul_1 Management Unit – *Meesia triquetra,* a sensitive plant, is found in a meadow in southern branch of the Bull Creek drainage. The meadow falls partly within and partially outside of the unit. The area of the *Meesia triquetra* occurrence appears to be a fen. No noxious weeds are known to occur within this management unit.

Krew_prv_1 Management Unit – *Meesia triquetra,* a sensitive plant, is found in Glen Meadow and in the meadow east of 10S25, about 1/5 mile north of the Southern California Edison property boundary. Both of the *Meesia triquetra* occurrences are in fen-like areas. Bull thistle was found on the northern end of Glen meadow. Bull thistle is scattered throughout the vicinity of Road 10S11.

N_soaproot_2 Management Unit - Golden annual lupine, a sensitive plant, occurs scattered throughout the gravelly soils of this unit. About 25 percent of rock outcrops in the unit were surveyed. Most rock outcrops were found to support golden annual lupine. A patch of carpenteria is located in the western central part of the management unit. A patch of tocalote (*Centaurea melitensis*) about 60' by 60' in size is present on the roadside and downhill into a draw, west of 10S04. A small patch of foxglove (*Digitalis purpurea*) plants were found along 10S24 near the southern end of the unit. Cheatgrass is present near the plantation in the middle of the unit.

Providence_1 Management Unit - Golden annual lupine, a sensitive plant, *(Lupinus citrinus* var. *citrinus*) is found on two rock outcrops within the unit. Habitat for the California red-legged frog, foothill yellow-legged frog, relictual slender salamander, and the western pond turtle occur within the management unit. Bull thistle (*Cirsium vulgare*), a noxious weed, was found along Road 10S75 near the creek in T10S, R25E, SW ¼ Section 15 near the southern end of road 10S87. Bull thistle is also known to occur along 10S39 in section 9; in two patches along 10S18 in section 16; and on the road that runs along the top of Grand Bluff in section 10. Spanish broom (*Spartium junceum*) is found just to the south of the management unit along 10S18.

Providence_4 Management Unit - Golden annual lupine, a sensitive plant, was found on the edge of plantation units on 10S14 near the southern end of the unit. The southern edge of the unit may contain *Carpenteria californica* habitat. Cheatgrass (*Bromus tectorum*) is scattered in patches through the plantations in this unit, mainly on old skid roads that have not been colonized with bear clover, manzanita, or *Ceanothus* spp. A patch of broom (Scotch and or Spanish) is recorded along 10S02, slightly north of an intersection with 10S55. Bull thistle was found near the broom.

Sensitive Species Known to Occur within the Project Area

Carpenteria californica (carpenteria) is found at elevations between 1500 and 4400 feet. Carpenteria is an evergreen shrub that mostly occurs in chaparral habitat. Some plants are also found in the lower yellow pine belt. The entire distribution of this species is found within a total area of 225 square miles south of the San Joaquin River and north of the Kings River. One occurrence is found just north of the San Joaquin River. Carpenteria shrubs tend to concentrate and grow most vigorously in draws and ravines in well-drained granitic soils where moisture is relatively abundant. The N_soaproot_2 unit has one recorded occurrence of this species.

Lupinus citrinus var. *citrinus* (golden annual lupine) is found at elevations between 1500 and 5500 feet. This annual lupine occurs in the foothills and lower conifer forest of Fresno and Madera Counties. Most of the known populations occur on the Sierra National Forest south of the San Joaquin River. The population is considered robust with approximately 82 occurrences. Dozens of occurrences have over 100 individuals (Clines and Symonds 2006). Typical habitat contains edges and gravelly shelves of granite outcrops; openings in ponderosa pine forest; oak woodland; or chaparral. Several occurrences of this species are known to occur in the N_soaproot_2 and Providence_1 units.

Meesia triquetra (moss) is found at elevations between 6000 and 8000 feet. *Meesia triquetra* is currently found in six Sierra Nevada national forests and Sequoia National Park within California. *Meesia triquetra* is found in approximately 19 meadows in the Sierra National Forest. This species is more common in other parts of its range. Few meadows in the southern Sierra have *Meesia triquetra*. Primary threats include activities that alter meadow hydrology. Changes in land uses have eliminated some populations. This species seems to prefer meadows with high acidity, indicated by the presence of associates such as blueberry (*Vaccinium*), peat moss (*Sphagnum*) and sundew (*Drosera*). Cold spring fed areas in the meadow seem to be preferred. This moss requires permanent saturation and would not occur in meadows that dry out. This species is known to occur in three meadows within the Krew_prv_1 and Krew_bul_1 units.

Peltigera venosa (veined water lichen) is found at elevations between 4000 and 8000 feet. This aquatic lichen (formerly known as *Hydrothyria venosa*) has only a few known occurrences in California. Peltigera venosa is found in cold, unpolluted streams on the west slope of the Sierra Nevada and in mixed conifer forests on the Sequoia, Sierra, and Stanislaus National Forests. This aquatic lichen occurs submerged on rocks in clear, running, mountain streams. The species is intolerant of pollution and sedimentation and grows in clear, cool, moving water. California occurrences are separated from the other U.S. populations (Hale & Cole, 1988). This lichen has been in decline throughout its historic range although populations in the Sierra Nevada appear stable at this time (Sierra National Forest Sensitive Plant Files, Supervisor's Office, Clovis CA, 1998).

A recent survey (6/22/2006) found veined water lichen in Summit Creek at T9S, R25 E, Sections 2 and 3 within the project boundary and less than one mile north of Providence _1. This species may exist within Providence_1. Veined water lichen is known to occur in Teakettle Creek, just east of the Krew_bul_1 unit, and less than one mile north of Krew_bul_1.

Species that may have Suitable Habitat

Botrychium crenulatum (scalloped moonwort) occurs at elevations between 4875 and 8125 feet. Scalloped moonwort has a wide range including both the northern and southern hemispheres, but is rare throughout its range. This fern occurs in meadows and marshes in the central Sierra, although no known occurrences exist in the Sierra National Forest at this time.

Botrychium lineare (slender moonwort) occurs at elevations between 8000 and 9000 feet. Slender moonwort grows in rocky, moist sites in subalpine conifer forests. This species is found sporadically and infrequently throughout the northwestern United States, and is suspected to exist in California (Farrar, 2001). A historic location may exist in Piute Canyon, thought to be approximately seven miles from the Hooper OHV route. Location data for this site is ambiguous; however, and may or may not be on the Sierra National Forest. Slender moonwort habitat is similar to *Botrychium crenulatum* (scalloped moonwort). The very eastern edge of the Krew_bul_1 unit falls between 8,000 and 8,080 feet, within the elevational range of slender moonwort. Meadows do not appear to fall within this strip and the species is not expected to be within the management unit.

Bruchia bolanderi (Bolander's candle moss) occurs at elevations between 5000 and 7500 feet. Fewer than 10 occurrences are known in California. This species grows in meadows in mixed conifer forest from Yosemite National Park southward to the Sequoia National Forest in Tulare County. *Bruchia* tends to grow on vertical soil banks of small streams that meander through meadows. The closest known occurrence to the project area is about 2.4 miles from the Krew_bull_1 Management Unit.

Camissonia sierrae ssp. *alticola* (Mono Hot Springs evening primrose) occurs in gravelly areas associated with rock outcrops at elevations between 4000 and 9500 feet. About 18 occurrences are known in Madera and Fresno Counties. Extensive populations of this plant occur in the vicinity of Florence Lake. The closest occurrence of Mono Hot Springs Evening Primrose to the project's eight management units is approximately 15.7 miles north of the Glen_meadow_1 unit.

Epilobium howellii (subalpine fireweed) occurs at elevations between 6500 and 8800 feet. Approximately five sites are known on the Sierra National Forest in the vicinity of Huntington Lake. The species is thought to range from Sierra County at Yuba Pass to

Fresno County. Potential for this species occurs in the Glen_mdw_1 and Krew_bul_1 units. The nearest known occurrences of subalpine fireweed are 9.7 miles north of Glen_mdw_1 and 17.5 miles north of Krew_bul_1.

Eriogonum prattenianum var. *avium* (kettle dome buckwheat) occurs in gravelly areas associated with rock outcrops at elevations between 4000 and 9500 feet. About 33 occurrences are known, from the Sequoia National Forest up to the Minarets District of the Sierra National Forest (Fresno and Madera Counties only). The nearest known occurrences of this species are 15.3 miles northwest of Providence_1, and 15.8 miles southeast of Krew_bul_1.

Hulsea brevifolia (short-leaved hulsea) occurs at elevations between 5000 and 9000 feet. Short-leaved hulsea is a perennial herb. About 46 occurrences are documented on the Sierra National Forest. Other occurrences are documented on adjacent forests and in Yosemite National Park. Short-leaved hulsea is quite abundant in some occurrences. Four occurrences have over 2,000 individuals. Several occurrences number over a 100 individuals. The population is considered fairly robust overall (Clines, Tuitele-Lewis). This species ranges from Tuolumne County south to Tulare County. Habitat for short-leaved hulsea includes gravelly or sandy exposed areas as well as densely wooded sites in coniferous forest. The nearest known occurrence of short-leaved hulsea is about 1.75 miles from El_o_win_1 Management Unit.

Lewisia congdonii (Congdon's lewisia) occurs at elevations between 1900 and 6900 feet in the Kings and Merced River drainages. This perennial herb occupies separate distributions between the Kings River Canyon and the Merced River Canyon 50 miles to the north. All but one population are in the Merced River drainage. Six occurrences are known. Population estimates range from less than 100 plants to greater than 10,000. Most occurrences consist of at least several hundred plants. Plants are found on rock faces; cracks and ledges in rocky areas; loose rock debris and rocky fragments; steep canyon walls; and spoil piles of an abandoned barium mine. Plant communities range from chaparral to coniferous forest. Potential habitat and elevational range exists for this species within the project's eight units. The six known occurrences of Congdon's lewisia are not located within the project boundaries.

Lewisia disepala (Yosemite bitterroot) occurs at elevations between 4000 and 7500 feet. Yosemite bitterroot occurs on granite domes from about 4400 feet to above 10,000 feet, from Mariposa County in the vicinity of Yosemite Valley, southward to Kern County. Approximately 13 occurrences of this species have been found on the Sierra National Forest. This perennial herb emerges in late winter in gravel flats and pans of granite outcrops and domes. The plant is usually found on imposing geological features, but plants have also been found in small openings in pine forest where rock has entirely become coarse gravel soil. Plants flower and disperse seed, and enter dormancy for the summer by early spring in many cases. Plants that have shriveled are impossible to see, even by an experienced field botanist. This species is found in the South of Shaver unit that is covered under a separate NEPA document. The nearest known Yosemite bitterroot occurrence to the project area is about 0.5 mile north of the N_soaproot_2 Management Unit.

Meesia uliginosa (moss) occurs at elevations between 7500 and 9000 feet. Fewer than 10 occurrences are known in California, in two sites on the Sierra National Forest. This species grows in saturated meadows and fens along buried logs at the upper reaches of the mixed conifer forest up to the subalpine zone. Some potential habitat for this species may occur in the Krew_bull_1 Management Unit. The nearest known occurrence of this moss to the project area is about 10 miles west of the Krew_bull_1 unit.

Mimulus gracilipes (slender-stalked monkeyflower) occurs at elevations between 1500 and 4500 feet. This monkey flower occurs in open gravelly areas in chaparral and ponderosa pine forest, often in burned and disturbed areas. This species is an annual plant known to occur in Mariposa, Tuolumne, and Fresno counties. Fewer than 20 known occurrences are known. The Jose Basin and Blue Canyon areas are known to support vigorous populations of this species. Potential habitat for this species may occur in the Krew_prv_1, Providence_1, Providence_4, and N_soaproot_2 units. The nearest known occurrence of slender-stalked monkeyflower to the project area is 2.9 miles west of N_soaproot_2.

Trifolium bolanderi (Bolander's clover) occurs at elevations between 6800 and 7300 feet. Bolander's clover occurs in montane meadows in coniferous forests, only on the Sierra National Forest and in Yosemite National Park. Potential habitat for this species may occur in the Krew_bull_1 Management Unit. The closest known occurrence to the project area is about 1.3 miles northeast of Krew_bull_1.

Environmental Consequences

Alternative 1 - Proposed Action

<u>Direct, Indirect, and Cumulative Effects to *Calyptridium pulchellum* (Federally Threatened species)</u> - No *Calyptridium pulchellum* occurrences are known within the project area, but potential habitat may occur in up to three management units. Project design criteria are in place to protect the rocky/gravelly habitat for this species by prohibiting equipment and tree falling on rock outcrops or thin, sandy or gravelly soils. Herbicides are not to be used on shallow soils below 3800 feet in elevation without prior approval. Botanical surveys are to take place before new road construction if the botanist determines that a survey in the area is necessary. Heavy equipment is required to be free of soil and plant parts before being brought into a management unit. Tocalote in the N_soaproot_2 unit is to be treated before the adjacent area is disturbed by project activities. These design criteria should prevent the disturbance of *Calyptridium pulchellum* habitat by noxious weeds, which should prevent any indirect effects to the species. No direct or indirect effects are expected to this species. No cumulative effects to the species are expected to occur.

<u>Direct Effects to Sensitive Plants and Noxious Weeds</u> - Sensitive plants within the project area could be damaged or killed during harvesting or prescribed burns. These effects are not expected to occur. Their habitats would be protected through by project design measures for botanical resources, aquatic resources, and watershed.

No effects of any kind are expected for unexpected larkspur, Tulare County bleeding heart, Hall's daisy, monarch golden aster, and Congdon's lewisia, which are outside of the geographical range of the species; for Tehipite Valley jewel-flower which is below the elevational range of the only unit that could be within its geographical range; and for grey-leaved violet for which suitable habitat was not found within the eight initial management units.

Noxious weed species in each unit would be treated, and are expected to diminish over time as a direct result of chemical and manual control treatments. Eradication is likely for lens-podded hoary cress in Glen_mdw_1.

<u>Direct Effects to Sensitive Plant Species in Meadows and Streams</u> - Species that occur in meadows require the maintenance of hydrologic function, and a general absence of noxious weed infestations. Project design measures have been developed to protect these areas. Project activities are not expected to alter hydrologic function, with one possible exception in the Krew_bull_1 Management Unit. The lower end of the meadow in the far southeastern corner of T11S, R26E, Section 12 is currently threatened by active headcuts (land erosion at the head of a stream, creek, or river). Headcuts may continue to the top of this section of meadow, where the meadow narrows to bedrock. Effects of headcuts on the meadow cannot be predicted. They could potentially contribute to quickening the flow of water leading to the drying of the surrounding area and consequently altering vegetation. Mosses and other species could then become less effective in slowing the water flow, and the meadow/fen could cease to function properly. This area has been surveyed for sensitive plants, and none were found. This lower section of meadow appears to be a fen. The lower section is spring-fed and supports sundews, blueberry, and sphagnum moss (these species are indicators of acidic conditions).

Wet meadows, riparian areas, and potential fens have been located and marked within the project's eight units. Fen surveys have not occurred; however, any potential fens would be included in protected areas of wet meadows. The only known conflict with riparian standards and guidelines is with Krew_bull_1 as previously stated, to ensure consistent data collection. No sensitive plants or mosses were found in Krew_bull_1. No project work resulting from Kings River Project would affect this area.

<u>Scalloped moonwort</u>, <u>slender moonwort</u>, <u>Bolander's candle moss</u>, <u>*Meesia triquetra*</u>, <u>*Meesia uligniosa*</u>, and <u>Bolander's clover</u> occur in meadows. Most of these species occur within the project area. Only one of these species (*Meesia triquetra*) is known to occur within the project's eight managment units. Potential habitat for these species is in wet meadows. Meadows are not expected to be impacted by project activities.

<u>Subalpine fireweed</u> could have potential habitat in Glen_mdw_1 and Krew_bull_1 Management Units. Subalpine fireweed can occur in meadows but would not be expected to be affected by project activities. This species can also occur in moist, seepy, grassy areas. These areas tend to be associated with meadows or streams and would probably be protected by buffers around these features, although a slight possibility exists that they could be disturbed. The risk is thought to be negligible, especially as the closest known

occurrences of the species are 9.7 miles to the north of Glen_meadow_1 Management Unit, and 17.5 miles north of Krew_bul_1 Management Unit.

Veined water lichen was found within the project area in the northern portion of Kings River Project, approximately .5 miles north of Providence_1. The Krew_bul_1 Management Unit is another likely unit to have veined water lichen. Krew_bul_1 is close to a known occurrence in Teakettle Creek, just to the east of the unit. This unit received the most comprehensive surveys for the species. The species was looked for in 17 locations within the unit along the three main creeks that flow through the unit. Stream habitat is not expected to be directly disturbed by equipment (Streamcourse and Aquatic Protection, BMP 1-10). Veined water lichen is particularly sensitive to sediment increases (Davis, 1999), and some short term sediment input into creeks would occur. However, the potential for increase in sedimentation as a result of project activities is reduced by BMPs and project design measures described in Chapter 2. Habitat quality for veined water lichen is not expected to diminish. See watershed section in Chapter 3 for more information.

Direct Effects to Sensitive Plant Species in Rocky Outcrops - Mono Hot Springs evening primrose, Kettle Dome buckwheat, and Muir's raillardella probably do not occur within the geographic range of the project area. Potential habitat for these species; however, would be protected from equipment damage and tree felling by project design criteria. Yosemite bitterroot was not found within the project area; however, would be protected by project design criteria, by its inaccessibility, and because its general habitat (large granite domes) does not need to be treated as part of the project.

Golden annual lupine is scattered throughout the N_soaproot_2 Management Unit and is found in isolated patches in Providence_1 and Providence_4 Management Units. Golden annual lupine habitat is protected by project design criteria. The loss of a few individuals is not expected to lead to a trend to listing or a loss in viability of the species, given the relative abundance and vigor of the occurrences (Clines- *pers. com*. 2006; Symonds- *pers. com*. 2006). Fire is a natural component of the golden annual lupine ecosystem. Low intensity, prescribed fire is not expected to have a negative effect on the species.

Potential habitat for slender-stalked monkeyflower may occur in Krew_prv_1, Providence_1, Providence_4, and N_soaproot_2 Management Units. The species occurs on thin soils which are partially protected by design criteria, and partially protected by the soils being too thin to support trees. Fire is a natural component of the slender-stalked monkeyflower ecosystem. The species is thought to follow fire (fire annual) (Region 5 USDA Sensitive Plant Species Evaluation and Documentation Form for *Mimulus gracilipes*, 4/9/1998).

Direct Effects to Sensitive Plant Species in Forest Habitats - Short-leaved hulsea is a species found in forest openings that could be affected by project activities. This species primarily grows in openings in red fir forest, and is likely to have potential habitat only in the Krew_bul_1 Management Unit, although most other units have some ground within the elevational range of the species. No short-leaved hulsea was found during project surveys. Available habitat in Krew_bul_1 is limited to acres of red fir forest that were not surveyed. Disturbance is not expected to lead to a trend to federal listing or a loss in viability for the species should a few individuals be disturbed. The species grows abundantly and robustly in other parts of the forest. Many of the areas where it is known to occur (outside of the project area) have been disturbed in the past (Clines *pers. com*. 2005).

Direct Effects to Sensitive Plant Species in Chaparral Habitat - One occurrence of carpenteria is known to occur in the N_soaproot_2 unit. Potential habitat is present in that unit. Carpenteria is partially protected by project design criteria, as well as by its natural abilities. Carpenteria sprouts back after branches are cut, and fire is highly important for seed germination. Near-by abundance of carpenteria would prevent disturbance leading to a trend to listing or a loss of plant viability if a few individuals were damaged by project activities (Clines *pers. com*. 2005).

Indirect Effects

A possible indirect effect to TES species is the degradation or loss of habitat resulting from the introduction or spread of noxious or invasive weeds. Noxious weeds are plant species that can spread rapidly and compete with native plants for water and other resources, in some cases forming solid stands of plants that may crowd out sensitive plant species. Vehicles can transport noxious weeds when equipment passes through soil in contaminated areas and carries weed seeds to new areas. Risk of noxious weed introduction and spread can be greatly reduced by cleaning all heavy equipment of soil and plant parts before bringing equipment onto project sites, as recommended by the USDA Forest Service “Guide to Noxious Weed Prevention Practices” (2001). Noxious weed mitigation has been incorporated as design criteria for the project.

Noxious weeds may place a higher risk to Forest Service sensitive plants of certain habitats than to those of other habitats. Plant species of riparian and wet meadow habitat **(***Meesia triquetra*, veined water lichen, Bolander’s clover**)** are at less risk from invasive species due to saturated conditions and elevation. Sensitive plants found in rock outcrops and openings **(**orange lupine**,** Yosemite bitterroot**,** slender-stalked monkeyflower**)** are at slightly higher risk due to a lack of canopy cover. Plant species found in forest understory (short-leaved hulsea) are at a low to moderate level of risk from potential invasive plants. A high amount of canopy cover generally deters weedy species, but disturbance of the canopy or forest floor can lead to the establishment of ruderal plants (plants that establish on poor land). Plants of chaparral habitats **(**Carpenteria**)** are perhaps at most risk to invasive plant establishment and competition due to the high availability of light and high disturbance regime that is naturally found in chaparral areas.

Soil disturbance from project activities may allow some spread of weeds. Although undesirable, this weed spread is not expected to significantly negatively affect sensitive plants. Most known rare plant habitats would not be disturbed.

Several invasive species occur within the project area. Two weed occurrences were thought to be spread as a result of project activities, bull thistle at the north end of Glen Meadow and tocalote in the N_soaproot_2 unit. Chemical and mechanical treatment of these weeds would begin before project activities take place as specified in the project design. Both bull thistle and tocalote infestations are to be sprayed with glyphosate unless within 100 ft of a water course, in which case they would be hand pulled. These treatments are intended to control the spread of these weeds or eradicate isolated smaller populations. The intent of chemical and mechanical treatments is to decrease the risk of spread of bull thistle and tocalote, resulting from any project activities.

Lens-podded hoary cress in Glen_meadow_1 is not expected to be disturbed by project activities. This species is found in a relatively open area between Dinkey Creek Road and the corrals for the CPO Dinkey Creek day ride station. No project activities are planned for this area (Rojas, *pers. com*., 2004).

Bull thistle occurs in small, infrequent patches in Providence_1, El_o_win_1, Krew_prv_1, Glen_mdw_1, and Providence_4. Bull thistle has the potential to spread if disturbed, or if adjacent ground is disturbed. Bull thistle is not expected to affect sensitive plants. No sensitive plants were found near Bull thistle.

Bull thistle in the Bear_fen 6 unit is more extensive. This species is found in several of plantation units in the area, along roadsides and on landings. Bull thistle in this management unit is likely to spread with project activities. No sensitive plants have been found in the Bear_fen_6 Management Unit.

A roadside occurrence of Spanish broom was found in the Bear_fen_6 unit. Spanish broom has the potential to spread throughout an area of disturbance if the adjacent ground and canopy cover is removed.

Cheatgrass is present in scattered patches within the project area, but does not seem to be in a position to form dense stands. Cheatgrass generally seems to be out-competed by other species. This is a contrast to the eastern Sierra Nevada where cheatgrass is able to form monocultures covering whole hillsides. Cheatgrass infestations are light within the project area, and have not required control efforts in the past. This species was found scattered in Providence_4 plantations; in Glen_meadow_1 at an old sawmill site in a disturbed meadow/gully; in Bear_fen_6 along NFSR10A45; and in N_soaproot_2 near a plantation in the middle of the unit. Soil disturbance and decreased canopy cover from project activities may cause some increase of cheatgrass in the project area.

A few foxglove plants were found in N_soaproot_2. These grow in moist areas and were not encroaching on the near-by golden lupine habitat.

Cumulative Effects

Cumulative effects are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions” (40 CFR 1508.7).

No significant cumulative effects to sensitive plants are expected from past, present and foreseeable actions that would take place in and near the Kings River Project boundary. A small number of populations (Table 3-24) could be at low to moderate risk from accumulated actions of such projects. None of these populations are expected to disappear because of these accumulated actions but may be reduced in number or health. Certain individual plants that were not marked or overlooked could be directly impacted. Other activities may cause indirect effects, such as removal of canopy or increased sedimentation in streams from equipment.

The boundary for this cumulative effects analysis was considered to be known sensitive plant occurrences located within the larger Kings River Project area and not for any located outside of the boundary. Monitoring of known sensitive plant occurrences within the project's eight units would be done when feasible to ensure that populations are not being affected significantly; if observations reveal that significant impact is taking place, then treatments are expected to be modified to reduce impact and subsequent effects evaluations would take this into account.

Carpenteria is also largely protected by design criteria and natural attributes. Short-leaved hulsea is not specifically protected in this project and habitat is limited. The abundance of the species elsewhere on the Forest ensures that if damage to individuals occurs in this project a trend to listing or loss of viability of the species would not occur. Golden annual lupine is protected through project design measures. Veined water-lichen habitat is protected by Standard and Guidelines associated with Riparian Conservation Objective (RCO) #2 and #5 in the SNFPA ROD (2004). Negative effects to sensitive plants are expected to be minimal for the Kings River Project and should not add to any cumulative effects to sensitive plants in the project area.

Table 3-24. Cumulative Effects on Sensitive Plant Species

Project or Activity	Number of Sensitive plant species affected by project	Past, present, or future	Expected effects
Existing road maintenance in project area	Carpenteria californica (1) Lupinus citrinus ssp. citrinus (1) Mimulus gracilipes (2) Peltigera venosa (1)	Past, present	Low to moderate
Vegetation and plantation maintenance <25 years	Carpenteria californica (1),	Past, present	Low
Vegetation management – Grand Bluffs National Fire Plan	Peltigera venosa (1)	Present	Unknown
Vegetation management - Helms/Gregg transmission line right-of-way	Possibly Trifolium bolanderi (No known occurrences)	Present	Low
Vegetation management - Helms/Gregg brush and small tree removal	Possibly Trifolium bolanderi (No known occurrences)	Past, present	Low
Roadside Hazard Tree Removal - Strawberry, Oak, Glen, and Repeater hazard sales	Possibly Hulsea brevifolia or Epilobium howellii (No known occurrences)	Past, present	Potentially low to moderate
Prescribed fire - Underburning, maintain	Out of season burning- Carpenteria californica (1),	Past, present	Low

Project or Activity	Number of Sensitive plant species affected by project	Past, present, or future	Expected effects
DFPZ maintenance, ground fuel reduction	Hulsea brevifolia (unknown)		
Private Land residential development - Wildflower subdivision (Shaver Lake)	Lewisia disepala (1), Lupinus citrinus ssp. citrinus (4)	Past, present	Moderate
Vegetation management - SCE uneven-aged silvicultural activities	Lupinus citrinus ssp. citrinus (2), Peltigera venosa (1)	Past, present	Unknown
Vegetation management - Grand Bluffs/ Twin Ponds thinning	Peltigera venosa (1)	Past, present	Unknown
Vegetation management - Thinning and brush removal in Bretz and Power 1 &2	Lupinus citrinus ssp. citrinus (1)	Present	Low
Fuels reduction - South of Shaver- thinning, prescribed fire, brush removal	Lupinus citrinus ssp. citrinus (3), Lewisia disepala (2)	Present, future	Low
Motorized recreation - 4x4, OHV, and snowmobile	Unknown but potentially every sensitive species found within project boundaries	Present, future	Unknown
Livestock grazing – Grazing allotments in Blue Canyon, Dinkey, Haslett, Patterson Mt., and Thompson	Bruchia bolanderi (1), Carpenteria californica (2), Meesia triquetra (3), Mimulus gracilipes(2), Trifolium bolanderi (4)	Present, future	Low (moderate for Meesia triquetra and Bruchia bolanderi)
Wildlife Enhancement - Barnes South Wildlife Burn	Mimulus gracilipes (2)	Future	Low

Tables 3-24 and 3-25. Includes the Kings River Project area as a whole (79 units), and only accounts for effects on documented TES plant occurrences known to exist within that boundary. Many sensitive plant occurrences are affected by more than one project, which is reflected in the summation of total occurrences in this column. The total occurrences, therefore, are not strictly additive across the project matrix.

Table 3-25. Occurrences Affected by Activities

Total occurrences affected by activities	Percentage of total occurrences affected	Estimated potential cumulative impact of activities on occurrences (including Kings River Project)
Bruchia bolanderi (1),Carpenteria californica (2), Lupinus citrinus ssp. citrinus (6), Lewisia disepala (1-3), Meesia triquetra (3), Mimulus gracilipes (2),Peltigera venosa (1), Trifolium bolanderi (2-5)	Bruchia bolanderi (25%),Carpenteria californica (24%), Lupinus citrinus ssp. citrinus (8%), Lewisia disepala (23%), Meesia triquetra (9%), Mimulus gracilipes (15%),Peltigera venosa (8%), Trifolium bolanderi (5-13%)	Bruchia bolanderi- moderate, Carpenteria californica- low, Lupinus citrinus ssp. citrinus- low to moderate, Lewisia disepala- low, Meesia triquetra- moderate, Mimulus gracilipes- low to moderate, Peltigera venosa- moderate, Trifolium bolanderi- low

Table 3-26. Determinations for Action Alternatives

<table>
<tr><th>Species</th><th>Status</th><th>Determination for Eight Management Units of the Kings River Project</th></tr>
<tr><td>Calyptridium pulchellum</td><td>Federal Threatened</td><td rowspan="2">no effect</td></tr>
<tr><td>Erigeron aequifolius, Delphinium inopinum, Dicentra nevadensis, Heterotheca monarchensis, Lewisia congdonii, Streptanthus fenestratus, and Viola pinetorum ssp. grisea</td><td>Forest Service Sensitive</td></tr>
<tr><td>Meesia triquetra, Meesia uliginosa, Botrychium crenulatum, Botrychium lineare, Bruchia bolanderi, Peltigera venosa, Epilobium howellii, Trifolium bolanderi, Lupinus citrinus var. citrinus, Camissonia sierrae ssp. alticola, Eriogonum prattenianum var. avium, Carlquistia muirii, Lewisia disepala, Hulsea brevifolia, Carpenteria californica, and Mimulus gracilipes</td><td>Forest Service Sensitive</td><td>May affect individuals but is not likely to cause a trend to federal listing or a loss of viability</td></tr>
</table>

Alternative 2 – No Action

Direct Effects: No Direct effects would occur to threatened, endangered, or Forest Service sensitive plants if the No Action Alternative is chosen. No project activities would take place.

Indirect and Cumulative Effects: Indirect and cumulative effects have the potential to occur to TES plants if the No Action Alternative is chosen. A stand replacing wildfire in the project area is a possible outcome if fuels are not treated effectively. Wildfire has the potential to cause significant disturbance to soil, ground cover, and canopy cover. Sensitive riparian species that normally do not regenerate from high-intensity fires could be at risk. Carpenteria and short-leaved hulsea may be impacted by out-of-season burning. Fires can also allow the opportunity for the spread of invasive weeds, which can affect Forest Service sensitive species through competition of resources.

Alternative 3- Retain Largest Trees, Uneven Aged Strategy

Direct, Indirect, and Cumulative Effects to *Calyptridium pulchellum* (Federally Threatened species) – Direct and cumulative effects would be similar to that of the Proposed Action.

Direct Effects to Sensitive Species - Direct effects would be similar to the Proposed Action, with the following exceptions. Sensitive species of forest habitats (short-leaved hulsea) would benefit from retention of greater than 60 percent canopy cover in fisher habitat outside of the WUI. Plant species of riparian/special aquatic features including *Botrychium* spp., Bolander's candle moss, *Meesia triquetra*, *M. uliginosa*, subalpine fireweed, and veined water lichen would benefit from equipment exclusion within 50 feet of these features.

Indirect and Cumulative Effects to Sensitive Species – Indirect and cumulative effects would be similar to those of the Proposed Action with the following exception. Alteration of prescribed burns to avoid fisher denning season may impact tree anemone and short-leaved hulsea, if not done in the fall.

Determination for the Reduction of Harvest Tree Size Alternative Forest Service Sensitive Plants (BE) – The determination would be similar to that of the Proposed Action.

Alternative 4 – Fisher Emphasis

Direct, Indirect, and Cumulative Effects to *Calyptridium pulchellum* (Federally Threatened species) – Direct and Cumulative effects would be similar to that of the Proposed Action.

Direct Effects to Sensitive Species: Direct effects would be similar to the Proposed Action with the following exceptions. Sensitive species of forest habitats (short-leaved hulsea) would benefit from retention of greater than 60 percent canopy cover in fisher habitat outside of the WUI. Plant species of riparian/special aquatic features including *Botrychium* spp., Bolander's candle moss, *Meesia triquetra*, *M. uliginosa*, subalpine fireweed, and veined water lichen would benefit from equipment exclusion within 50 feet of these features.

Indirect and Cumulative Effects to Sensitive Species - Indirect and cumulative effects would be similar to those of the Proposed Action with the following exception. Alteration of prescribed burn timing or possible inability to burn may impact tree anemone and short-leaved hulsea, if not done in the fall.

Determination for the Reduction of Harvest Tree Size Alternative Forest Service Sensitive Plants (BE) – The determination would be similar to that of the Proposed Action.

Alternative 5 - Thin from Below

Direct, Indirect, and Cumulative Effects to *Calyptridium pulchellum* (Federally Threatened species) – Direct, Indirect, and Cumulative effects would be similar to that of the Proposed Action.

Direct Effects to Sensitive Species - Direct effects would be similar to the Proposed Action with the following exceptions. Sensitive species of forest habitats (short-leaved hulsea) would benefit from retention of greater than 60 percent canopy cover in fisher habitat outside of the WUI. Plant species of riparian/special aquatic features including *Botrychium* spp., Bolander's candle moss, *Meesia triquetra*, *M. uliginosa*, subalpine fireweed, and veined water lichen would benefit from equipment exclusion within 50 feet of these features.

Indirect and Cumulative Effects to Sensitive Species – Indirect and cumulative effects would be similar to those of the Proposed Action with the following exception. Alteration of prescribed burns to avoid fisher denning season may impact tree anemone and short-leaved hulsea, if not done in the fall.

Determination for the Reduction of Harvest Tree Size Alternative Forest Service Sensitive Plants (BE) – The determination would be similar to that of the Proposed Action.

Soil Resources

Affected Environment

The project area has 13 soil types that combine into 25 soil map units. The most dominant soils affected by the project include: Shaver family, Holland family, Chaix family, Gerle family, Cagwin family, Umpa family, Chawanakee family, Sirretta family, Auberry family, Tollhouse family, and Typic Xerumbrepts. Soils in the project area vary in characteristics from shallow to deep; thermic to frigid temperature regimes; and xeric moisture conditions. Soils in the project area have developed in metamorphic and granitic parent materials (Giger, 1993). The soils that have the greatest extent or acreage within the proposed treatment areas are Shaver family, Holland family, Cagwin family and Gerle family. The majority of soil in the project area is moderately deep (20-40 inches) to deep (60 inches). Shaver family and Holland family soils are deep (greater than 40 inches). Some areas of shallow soils (less than 20 inches) and rock outcrop occur in the area and these soils consist of Chawanakee family, Dystric Lithic Xerocrepts, and Tollhouse family soils. See soils report in the project file for more information.
Soil resource concerns for this project include:

- Areas proposed for ground based harvest include soil types that are susceptible to soil compaction from heavy equipment operation when they are moist or wet
- Prescribed fire and tractor piling could reduce soil cover and result in accelerated erosion that could lower soil productivity
- Ground based harvest systems on slopes that are too steep or have shallow soils could displace topsoil and result in accelerated erosion and lower soil productivity

Soils in the proposed project area vary in their sensitivity to management effects. Maximum erosion hazard ratings range from Moderate to Very High depending upon soil type. This general risk rating assumes no cover in order to compare the inherent erosion potential of different soils in the soil survey. The presence of soil cover would lower the potential for erosion to occur. A design measure is to leave at least 50 percent well distributed soil cover. Soils with higher clay content and at high moisture levels have the greatest susceptibility to soil porosity loss (compaction) from heavy equipment operation. Soil compaction can occur down to 12 inches deep. Holland soils have a moderate soil compaction hazard and occur in soil map units 136, 137, 138, 139, and 140. These soil map units occur in the South of Shaver 1 (SOS-1) project area, Providence_1, N_soaproot_2, Bear_fen_6, Providence_4, and Krew_prv_1 Management Units. Areas with high amounts of impervious surfaces such as rock outcrop or shallow soils less than 20 inches deep are susceptible to rapid runoff concentration. Impervious surfaces can cause subsequent erosion of soils downslope. Soil map units with a high rock outcrop component include soil map units 126, 150, 148, 123, 159, 166, 110, 113, 116, 147. Soil map units with inclusions of rock outcrop and or shallow soils include soil map units 139, 135, 138, 140, and 112. Shallow soils are susceptible to productivity loss if the very thin topsoil is physically displaced during ground based operations.

Extensive areas of rock outcrops and associated shallow soils are not part of the proposal and these areas were dropped from proposed treatment. Most areas proposed for ground based harvest systems have slopes less then 35 percent. Some areas exist where slopes exceed 35 percent and tractor logging could result in soil disturbance that mixes or removes soils.

The 1991 Sierra National Forest Land Management Plan provides Standards and Guidelines for the protection of the soil resource. FSH 2509.18 - R5 Supplement No. 2509.18-95-1 provides analysis standards, thresholds and indicators to evaluate soil condition. These guidelines are not a set of mandatory requirements (RF letter, Feb 5, 2007). They were utilized during project planning to describe existing soil condition; describe the expected effects from the proposed actions; and aid the formulation of design measures to protect the soil resource.

Existing Condition General

Soil data was collected in the field for all proposed management units. Numerous soil transects were completed in the Providence-1, N_soaproot_2, Bear_fen_6, Providence_4, Glen_meadow_1, and El_o_win_1 Management Units. Data for soil cover, soil disturbance, soil compaction, and large woody debris was collected and summarized in the 2005 Kings River Project Soils Monitoring Report (Alvarado, 2005), and the 2006 Soil Conditions Report. The 2005 Framework Soil Monitoring Methods Protocol was used in these areas. Soil data for the Krew_prv_1 and Krew_bul_1 Management Units was collected by the PSW Fresno lab as part of their base line data collection for their watershed study. This data includes soil cover, woody debris, and soil bulk density, which was used to evaluate compaction. Visual examination of the soil was also done. All of the soil data was utilized to characterize existing soil condition. This data would serve a baseline to compare soil conditions in the future.

Various data indicates that existing soil cover ranges from about 77 percent to 100 percent with values above 80 percent common. This meets Standards and Guidelines of maintaining at least 50 percent soil cover following management activities. The average area with compacted soil in the project's management units ranges from less then 1 percent to over 12 percent. These pre-project levels meet the project design measure of maintaining 90 percent of the natural soil porosity over 85 percent or more of the activity area. Some particular areas in the Bear_fen_6 Management Unit have excessive levels of soil compaction and do not meet recommended thresholds for soil porosity in the regional soil quality analysis standards. Regional soil quality analysis standards for large woody debris recommend maintaining five logs per acre. The number would be adjusted to account for the ecological type; fuel management objectives; and to take advantage of large woody debris contributions from snags. A discussion of the frequency of historic fire occurrence in the project area is included in the Chapter 3 discussion of fuel and fire behavior. Historic fire frequency was about three to five years based upon fire history and tree ring studies (Drumm 1996, Phillips 1998). Given this frequent occurrence of fire, large woody debris probably did not accumulate in large quantities in this ecological type before fire suppression was widely implemented. The existing level of large woody debris is probably the result of a combination of factors including fire suppression; past management in the area; and the capability of the ecological types in the area. It is unlikely that much large woody debris survived fire long enough to decompose fully in fire regimes that proceeded the fire-suppression era (Skinner, 2002). The likelihood that LWD would be consumed in a prescribed fire is related to the season of burn and the degree of decomposition. Generally, the more decomposed the wood, the more likely it is to be consumed by prescribed fire during the drier portions of the year. During field data collection it was found that large woody debris (LWD) ranged from about 1 to 23 pieces per acre throughout the proposed management units.

Soil Characteristics and Existing Condition Data by Management Unit

El_o_win_1 - Soils in this management unit are mostly Shaver family, Sirretta family, and Umpa family. These soils are deep to very deep; have loamy sand to coarse sandy loam textures; and a low compaction hazard. Nine soil transects were collected in the El_o_win_1 Management Unit. The average soil cover for all nine transects is 86 percent which meets Standards and Guideline of 50 percent. Less then one percent of the area has compacted soils. Large woody debris averages 23 pieces per acre, much more than the five logs per acre threshold recommended in the region's soil quality analysis standards.

Providence_1 - Soils in this management unit are mostly Holland family, Chawanakee family, Dystric Lithic Xerocrepts and rock outcrop. These soils range from deep to shallow and generally have sandy loam surface textures. Holland has a moderate compaction risk and the others are generally low. Eleven soil transects were collected in the Providence_1 Management Unit. The average soil cover was 99 percent. Compaction was detected on only 3 of the 11 transects, for an overall average of 5.36 percent for the area. Three transects where soil compaction was found occur in treatment units 205, 262, and 350. Large woody debris averages of 6.3 pieces per acre.

Providence_4 - Soils in this management unit are mostly Holland family, Chaix family, Chawanakee family, and Shaver family. These soils range from deep to shallow and generally have sandy loam surface textures. Holland has a moderate compaction risk and the others are generally low. Three soil transects were collected in the Providen_4 Management Unit. The average soil cover for three transects is 100 percent. The average area compacted was 3.51 percent. Large woody debris averages of 1.1 pieces per acre, which is less than the threshold in the regional soil quality analysis standards

Bear_fen_6 - Soils in this management unit are mostly Holland family and Shaver family. These soils are deep to very deep and have sandy loam textures in the surface horizon. Holland soil has a moderate compaction risk and Shaver is low. Ten soil transects were collected in the Bear_fen_6 Management Unit. The average soil cover for the 10 transects is 97 percent. Nine transects had between 98 and 5 large wood debris pieces per acre and one had none. Compaction was observed on only one transect, which had five percent compacted soils.

Soil monitoring was conducted for the proposed Bear Meadow Project area in 1996 (Roath, 1996). A total of 144 soil transects were collected that included data to evaluate soil compaction. Based upon these transects the average level of area compacted in the Bear Meadow Area is 12.2 percent. Some individual stands in the Bear Meadow Project Area have excessive levels of compaction and include 7, 8, 20, 21, 23, 24, 25, 26, and 27 (see Bear Meadow Project Area Stand Map). Five of the nine stands occur in the Holland family soil type.

N_soaproot_2 - The N_soaproot_2 Management Unit has soils that are mostly moderately deep to deep. These soils include Auberry family and Holland family which have coarse sandy loam surface soils and sandy clay loam subsoils. They have a moderate soil compaction hazard. Tollhouse family soils are also present in this management unit. These soils are mesic, shallow, and somewhat excessively drained, formed from granitic parent material. These soils have a slow infiltration rate, a high runoff potential and are susceptible to a loss of productivity if the thin topsoil is displaced. Some areas of lost soil productivity have been identified in the Soaproot Watershed Restoration Plan. Seven deteriorated watershed sites identified in the Soaproot Watershed Restoration Plan are outside of the proposed project area. Approximately 13 acres of the area has been treated with mechanical equipment in the last 10 years (Gallegos, 2005b). The area with Auberry and Holland family soils has some soil compaction limited to existing skid trails.

Nine soil transects were collected in the N_soaproot_2 Management Unit. The average soil cover for nine transects is 97 percent. Compacted soils occur on four out of the nine soil transects for an eight percent average in the management unit. Four soil transects where compaction was found occur in treatment units 691, 698, and 591. Large woody debris averages one piece per acre, which is less than the threshold in the regional soil quality analysis standards.

Glen_meadow_1 - Soils in Glen_meadow_1 Management Unit are mostly Gerle family, Cagwin family, Umpa family, and Sirretta family soils. They are coarse textured, moderately deep to deep, and the compaction hazard is low. Six soil transects were collected in the Glen Meadow Management Unit. The average soil cover for the six transects is 87 percent. Compacted soils was observed in three out of six soil transects for an average soil compaction of four percent for the management unit. Three soil transects where compaction was found occur in treatment units 245, 296, and 1037. Large woody debris averages one piece per acre, which is less than the threshold in the regional soil quality analysis standards.

Krew_bul_1 and Krew_prv_1 - Soil data for the Krew_bul_1 and Krew_prv_1 Management Units was collected by the PSW Fresno Lab, as part of their baseline data collection, for their watershed and soils study. This information was analyzed to determine soil condition for these management units.

The protocol used by PSW to collect data on woody debris differed from the Region 5 Method for soil monitoring used in the other six management units. The PSW protocol measured the level of coverage of woody debris larger than three inches diameter in one square meter quadrats, at 2, 7 and 12 m along a 22 meter transect (Hunsaker, personal communication). The Region 5 method calls for counting large woody debris over 10 inches long and at least 12 inches in diameter, within a 37-foot radius, at every 5th point, along a 20 point transect of varying length. Soil bulk density samples were collected at each soil horizon in 44 soil pits that were dug in the Krew_bul_1 and Krew_prv_1 Management Units. Soil cover and large woody debris data were collected along 114 transects in the Krew_bul_1 and Krew_prv_1 Management Units. Soil pits and vegetation transects were distributed throughout the eight sub-watersheds in their study area. The following describes soil properties and condition found individually for Krew_bul_1 and Krew_prv_1.

Krew_prv_1 - The Krew_prov_1 Management Unit has soils that are mostly deep to moderately deep. Surface soil textures for most of the unit's soils are coarse sandy loams. Holland family soils are present in this management unit and they have a moderate soil compaction hazard. Dystric Lithic Xerocrepts are present in this management unit. These soils are mesic, shallow, and somewhat excessively drained soils formed from metasedimentary parent material. These soils have a low soil compaction hazard, slow infiltration rate, a high runoff potential and are susceptible to productivity loss if displacement occurs during ground based activities. Approximately 135 acres of this management area has been treated with mechanical equipment in the last five years (Gallegos, 2005b). The area with Holland family soils has some soil compaction limited to the existing skid trails.

Soil bulk density samples were collected in 19 soil pits in the Krew_prv_1 Management Unit. Six soil pits were excavated in sub-watershed D102. Five soil pits were excavated in sub-watershed P301. Four soil pits were excavated in sub-watershed P303. Four soil pits were excavated in sub-watershed P304. Two out of the 19 soil pits with one in sub-watershed D102 and one in sub-watershed P304 have A soil horizons with soil bulk density samples of 1.37 and 2.17, respectively. These two samples are higher than what is typical for this soil type and could indicate compacted soils. Soil bulk density data indicates 10.53 percent of the soils in the Krew_prv_1 Management Unit are compacted. Fourteen vegetation transects were collected in sub-watershed D102, 13 in sub-watershed

P301, 15 in sub-watershed P303, and 10 in sub-watershed P304 for a total of 52 vegetation transects in the Krew_prv_1 Management Unit. Soil cover ranged from 77 percent to 95 percent and woody debris ranged from 16 to 20 percent for the four sub-watersheds in Krew_prv_1. This data is projected over the entire management unit indicates an average of about 89 percent soil cover and 18 percent woody debris. These values meet the Forest LRMP Standards and Guidelines for soil cover.

Krew_bul_1 - Krew_bul_1 Management Unit has coarse textured, moderately deep to deep soils which include Cagwin, Cannell, and Gerle familes, Typic Xerumbrepts, and rock outcrop. The soils have a low compaction risk. Less than 25 acres have been treated in the last five years. Soil bulk density samples were collected in 25 soil pits in the Krew_bul_1 Management Unit. Six soil pits were excavated in sub-watershed B201. Six soil pits were excavated in sub-watershed B203. Six soil pits were excavated in sub-watershed B204. Seven soil pits were excavated in sub-watershed T003. Three out of the 25 soil pits, with 3 in sub-watershed B201 and one in sub-watershed B203 have A soil horizons with soil bulk density samples of 1.40, 1.42 and 1.39, respectively. These samples are higher than typical density for this soil type and could indicate compacted soils. When all the soil bulk density data is considered together, 12 percent of the soils in the Krew_bul_1 Management Unit are compacted. Ten vegetation transects were collected in sub-watershed B201, 15 in sub-watershed B203, 15 in sub-watershed B204, and 20 in sub-watershed T003 for a total of 62 vegetation transects in the Krew_bul_1 Management Unit. Soil cover ranged from 85 percent to 94 percent and woody debris ranged from 23 to 32 percent for the four sub-watersheds in this management unit. An average of 91 percent soil cover and 27 percent woody debris exists throughout this management unit when all the soil cover and woody debris data is considered. These values meet the Forest LRMP Standards and Guidelines for soil cover.

Riparian Conservation Areas (RCA)

Ground disturbance within RCAs was determined by analyzing areas that would have ground disturbing activities within the project's eight proposed management units. The Sierra Nevada Forest Plan Amendment defines ground disturbing activities as "activities that result in detrimental soil compaction or loss of organic matter beyond the thresholds identified by soil quality standards" (USDA, 2004). These activities include tractor logging or some form of tractor piling or some form of heavy equipment operation off of established roads. Helicopter logging and prescribed fire are not considered ground disturbing activities.

The total acres of RCAs in the project's proposed management units are 11,556 acres or 83 percent of the total project area (13,847 acres). Approximately, 4,743 acres of RCA in the project area either is not included in the project proposal or the areas are proposed for "no treatment" or as a "control" in the case of the Krew_prv_1 and Krew_bul_1 Management Units. An additional 2,628 acres would not be disturbed because these areas are either streamside management zones or are proposed for helicopter logging. Streamside management zones are equipment exclusion zones where ground disturbing activities would not permitted. Zones proposed for helicopter logging would have under burning or gross yarding for fuel treatments, which are also considered non-ground disturbing. Gross yarding would result in removing whole trees with a helicopter to a landing for processing. The resultant RCA that would be disturbed is 4,185 acres or 36.21 percent.

The 4,185 acres of disturbed ground would not be completely disturbed. Design measures for the Kings River Project include maintaining at least 90 percent of the soil porosity over 15 percent of an activity area found under natural conditions. This means that up to 15 percent of an activity area can have disturbed ground. Applying 15 percent disturbance factor to 4,185 acres of potentially disturbs ground in the RCA amounts to 5.43 percent.

Environmental Consequences

Soil resource protection is achieved by following Standards and Guidelines in the 1991 Sierra National Forest Land Management Plan. Analysis standards in FSH 2509.18 - R5 Supplement No. 2509.18-95-1 were utilized during project planning to analyze and describe the existing condition and estimate expected effects from the proposed actions. The project proposal could affect soil productivity by reducing soil porosity, soil cover and large woody debris.

Alternative 1 – Proposed Action

<u>Direct Effects to Soils in General</u> - Mechanical harvest would cause soil disturbance and poses increased risk of soil compaction and erosion. Standard operating procedures such as cross ditching skid trails for erosion control would reduce the risk of erosion and promote surface soil stabilization and re-vegetation. Generally, soils in the proposed treatment areas for this project are highly productive so rapid natural re-vegetation and soil cover recovery is expected. Some of these soils are more susceptible to soil porosity loss, due to compaction from heavy equipment operation when soils are moist or wet. To prevent soil compaction soil moisture needs to be dry enough to reduce the susceptibility to compaction. Monitoring on the Sierra NF has found that the ideal moisture content varies between soils but generally should not be above 12 percent to prevent soil compaction. A soil scientist or other earth scientist would be consulted prior to mechanical equipment operating on soils that have a moderate soil compaction hazard, especially outside of the standard operating season (June 1 to October 15). Soil compaction would be reduced by subsoiling skid trails and landings to ensure that soil project design measures are met in the management units. Design measures for all action alternatives include using light-on-the-land harvest and slash treatment methods, when feasible. These may include cut-to-length and feller buncher harvest methods and grappler piling for slash treatment. These methods would reduce ground disturbance and minimize changes in soil cover.

Implementation of the watershed restoration component of the proposed project would result in increased soil productivity at those sites.

The regional soil standard and guideline of 5 logs/acre would be met in some areas and not in other areas. Some areas that do not meet soil quality standards for large woody debris do not have vegetation that would be treated that meets the criteria for large woody debris. These are areas where trees more then 10” in diameter would not be treated and include brush fields that are proposed for mastication and stands of trees and plantations that would have pre-commercial thinning. Existing large woody debris is expected to decrease in some areas of prescribed burning. These areas include small patches of flare ups where prescribed burning may result in moderate to high burn severity and areas where fuel loads may be high. These areas are expected to be no more then 1% of prescribed fire areas. The more decomposed LWD would probably be consumed, whereas the fresh and hard logs would probably become scorched and intact in prescribed fire. At the same time that prescribed fire consumes some LWD, tree mortality from the prescribed fire would contribute to large woody debris. In addition, trees larger then 30” or 35” depending on the selected alternative are being retained and overtime these trees would drop and become large woody debris. Within the scope of the project and where opportunities exist, large woody debris would be increased in the Providence_4, N_soaproot_2, and Glen_meadow_1 Management Units to meet soil quality standards for large woody debris. This would be done by leaving cull logs on the ground where they lay, rather then tractor piling the logs for later burning of the piles.

A design measure is included in all action alternatives to utilize light on the land harvest systems in the 8 subwatersheds where cumulative watershed effects are a concern.

A normal Forest practice is to leave at least 50 percent well distributed soil cover for erosion protection on slopes under 35 percent in areas where tractor piling of slash is planned. Soil cover should be at least 70% if slopes are greater then 35%. Past observations on the Sierra NF have found that this amount of soil cover generally prevents accelerated erosion. A design feature is to conduct tractor logging and piling when the soil is dry to avoid soil porosity loss (compaction) for tractor logging and piling. A buffer of 100 feet would be provided around rock outcrop to prevent accelerated erosion of the adjacent soils from rapid runoff from rock outcrops. An additional design measure to grapple pile slash rather then to tractor pile slash in the 8 subwatersheds where cumulative watershed effects are a concern would result in less ground disturbance in those areas. Soil productivity is expected to be maintained given these design measures and management requirements.

Direct Effects from Mastication Treatment Areas - Areas planned for mastication pose little risk of causing negative effects to soil. This kind of treatment actually increases soil cover reducing the erosion hazard and the equipment used usually causes only minor levels of soil disturbance and compaction.

Direct Effects from Treatment of Fuels with Prescribed Fire - Areas planned for prescribed fire pose low risk of causing significant effects to soil productivity based on the past performance of the High Sierra District prescribed fire program. Past prescribed fires on the district has resulted in low burn severity where fire has burned in a mosaic leaving patches of unburned vegetation and duff, litter intricately mixed with patches of burned areas. Most trees are left undamaged except for a few small patches that have burned at a moderate burn severity. Monitoring of prescribed fire areas has shown that the Standard and Guideline of leaving at least 50 percent soil cover has been met in the last five years of prescribed fire on the High Sierra District (district files). Retaining at least 50 percent soil cover is expected to be met on slopes less than 35 percent and more cover on steeper slopes.

Direct Effects from Treatment of Brush and Noxious Weeds by use of Glyphosate - According to a review of studies by Ghassemi and others (1981) glyphosate rapidly attaches to soil particles or organic matter on the soil surface or on plant surfaces. Glyphosate mobility is very limited. Glyphosate does not become mobile again with additional precipitation and does not leach through the soil. Glyphosate has very low mobility in soil. The only mechanism for off site movement of glyphosate would be to attach to soil particles that were eroded and transported to another location. Normal hydrolysis in a stream would not break the attachment of glyphosate to soil particles. Even if the combination reached the water, it would not be in a form that can be taken up by plants or released through digestion by animals. Glyphosate would not affect either surface or ground water quality. The only potential impact to the soil resources is from direct disturbance and displacement of soil by applicators walking on the ground.

Glyphosate provides a means of vegetation control that causes little, if any direct soil disturbance. Dead foliage and leaves dropping onto the soil surface continues to provide protection from erosion until seeds present sprout. Glyphosate biodegrades within weeks of application into natural products including: carbon dioxide, nitrogen, phosphate and water. The primary metabolite of glyphosate is aminomethylphosphonate (AMPA). The position taken by U.S. EPA/OPP (2002) is that AMPA is not of toxicological concern regardless of its levels in food appears to be reasonable and is well-supported (SERA 2003; p. 3-25). The half-life of glyphosate can range from 20 to 60 days (SERA 2003). Effects on soil microflora are minimal and not pronounced (Ghassemi, 1981). Very little information exists suggesting that glyphosate would be harmful to soil microorganisms under field conditions and a substantial body of information indicates that glyphosate is likely to enhance or have no effect on soil microorganisms (SERA 2003; p. 4-7). R-11 is also broken down by soil microorganisms.

Alternative 1's significant impacts to soil productivity are expected given the design measures for all action alternatives.

Indirect Effects

No potential indirect effects of the proposed action to soil productivity exist, if soil compaction is kept to less then 15 percent of an activity area and erosion control measures are implemented in a timely manner. Soil cover would be restored through a combination of litter fall from the residual stand and natural vegetative response. An occasional summer storm event could cause accelerated erosion of bare exposed soils. Soil erosion sites may be restored to pre-storm conditions either through contracts or appropriated funds in the event that this should occur.

Cumulative Effects

Alternative 1's cumulative effects to soils are a component of analyzing cumulative watershed effects. Please refer to the watershed effects section for the discussion.

Alternative 2 – No Action

Direct Effects

No direct effects to the soil resource would occur.

Indirect Effects

There is generally a high potential for wildfire to occur in the project area due to the dense forest conditions and fuel loadings. See the Chapter 3 section regarding fuel and fire behavior for a detailed description of existing condition and potential threat of wildfire.

A wildfire would result in accelerated erosion due to a loss of soil cover. Soil cover is likely to be less the 10 percent in areas of high soil burn severity. Some soils could develop hydrophobic conditions which would further increase erosion potential. Soil loss could range from 10 to 60 tons per acre in these areas. Past monitoring of wildfire areas on the nearby Stanislaus National Forest has found that bare ground averaged about 70 percent by spring of the first year. Bare ground averaged 27 percent (Janicki, 2003) by spring of the second year. The low level of soil cover, especially during the first winter, leaves the soil vulnerable to erosion. Large woody debris would probably be consumed in a wildfire. No effect to soil porosity would occur.

Modeling of the No Action alternative with a fire in the year 2015 predicted 52 tn/ha/yr (see Watershed Section). Modeling of the proposed action with a fire in the year 2015 predicted 13 tn/ha/yr. This analysis shows that the No Action Alternative with a fire in the year 2015 would result in 400 percent more erosion then the proposed action. This modeling exercise demonstrates that the No Action Alternative could have a significant effect on erosion and soil productivity if a wildfire occurs.

Cumulative Effects

Alternative 2's cumulative effects to soils are a component of analyzing cumulative watershed effects. Please refer to the watershed effects section for the discussion.

Alternative 3 – Retain Largest Trees, Uneven Aged Strategy

Direct and Indirect Effects

This alternative does not include the creation of 92 acres of new openings for regeneration which reduces slightly the risk of soil disturbance. No other significant difference in expected direct and indirect soil effects between Alternatives 1 and 3. The project's design features for soil and watershed protection are common to all action alternatives. These measures are expected to minimize effects to the soil resource and maintain soil productivity.

<u>Cumulative Effects</u>

Alternative 3's cumulative effects to soils are a component of analyzing cumulative watershed effects, so refer to the watershed effects section for the discussion. Alternative 3's cumulative effects are expected to be similar to Alternative 1.

Alternative 4 – Fisher Emphasis

Direct and Indirect Effects

This alternative does not include the creation of 92 acres of new openings for regeneration which reduces slightly the risk of soil disturbance. No other significant difference in expected direct and indirect soil effects between Alternatives 1 and 4. The project's design features for soil and watershed protection are common to all action alternatives. These measures are expected to minimize effects to the soil resource and maintain soil productivity.

<u>Cumulative Effects</u>

Alternative 4's cumulative effects to soils are a component of analyzing cumulative watershed effects. Please refer to the watershed effects section for the discussion. Alternative 4's cumulative effects are expected to be similar to Alternative 1.

Alternative 5 - Thin from Below

Direct and Indirect Effects

This alternative does not include the creation of 92 acres of new openings for regeneration and the harvest size limit is 20 inches. These differences would lower slightly the potential for soil disturbance compared to Alternative 1, but the overall expects to the soil resource is expected to be similar. The design features for soil and watershed protection are common to all action alternatives. These measures are expected to minimize effects to the soil resource and maintain soil productivity.

<u>Cumulative Effects</u>

Alternative 5's cumulative effects to soils are a component of analyzing cumulative watershed effects. Please refer to the watershed effects section for the discussion. Cumulative effects are expected to be similar to Alternative 1.

Watershed

Affected Environment

This section describes the existing condition and identifies indicators and methods used in the analysis of environmental consequences on watershed resources.

The Kings River Project lies in the Dinkey Creek and Big Creek watersheds (see Watershed Map 1, in Appendix F), comprised of three 6th code Hydrologic Units (HUC6s); two within Dinkey Creek and one within Big Creek. Dinkey Creek is tributary to the North Fork Kings River and Big Creek flows directly into Pine Flat Reservoir. Each of these basins is further divided into HUC7s and HUC8s (smaller areas nested within the HUC6s. The Region 5 Cumulative Watershed Effects (CWE) Analysis is conducted at the HUC8 scale, which ranges from approximately 400 to 2,200 acres in the Kings River Project area. The term 'sub-watershed' is used to refer to HUC8s in this analysis.

The watershed analysis is based on the following factors: stream flow, water quality (including sediment), and cumulative watershed effects.

Table 3-27. Stream Systems, Sub-watersheds, and Miles of Stream

Management Unit	Main Stream System(s)	Sub-watershed	Stream miles			
			Perennial (order 3+)	Intermittent (order 2)	Ephemeral (order 1)	Total
Bear_fen_6	Bear Meadow Cr Oak Flat Cr	520.0053 520.0054 520.1001 520.1002 520.1051 520.1101 520.1151	6	6	22	34
El_o_win_1	Dinkey Cr Dinkey Meadow Cr	520.0014 520.0015 520.0016 520.0056 520.0057 520.4001 520.4051 520.4052	7	5	15	27
Glen_mdw_1	Glen Meadow Cr Rock Cr Dinkey Cr	520.0014 520.0016 520.0017 520.0056 520.0057 520.5051	8	6	18	32
Krew_bull_1	Bull Cr	520.3002 520.3051	2	4	8	14
Krew_prv_1	Duff Cr Providence Cr	519.0005 519.0007 519.0008 519.0011 520.0014 520.0016 520.0017	7	8	24	39
N_soaproot_1	Rush Cr	519.0009 519.3001 519.3002 519.3003 519.3004	7	8	22	37

Management Unit	Main Stream System(s)	Sub-watershed	Stream miles			
			Perennial (order 3+)	Intermittent (order 2)	Ephemeral (order 1)	Total
		519.3052 519.3053				
Providence_1	Providence Cr Summit Cr Big Cr	519.0007 519.0008 519.0011 519.0057 519.4001 519.4051	8	12	26	46
Providence_4	Duff Cr Big Cr	519.0007 519.0008 519.0055 519.0056	7	6	11	24

Table 3-27 summarizes stream systems, sub-watersheds, and miles of stream based on District GIS data. These sub-watersheds are shown on Watershed Maps 2a, 2b, and 2c, in Appendix F.

Stream Flow

Average annual precipitation ranges from 30 inches in the N_soaproot_2 Management Unit to almost 60 inches in Glen_mdw_1 and El_o_win_1. Stream flow parameters include peak flow, base flow, and annual yield. Parameters are used as indicators in the analysis of environmental consequences.

Peak flow is the highest flow for a given time period. A peak flow exists for each precipitation event, spring runoff season, and water year. Peak flow can be discussed in terms of an instantaneous peak (the highest flow reached, regardless of its duration) or an annual peak based on daily mean flows. Less variability in daily mean flows exists. The instantaneous peak is important because of its effects on the stream channel and on infrastructure, particularly culverts and bridges.

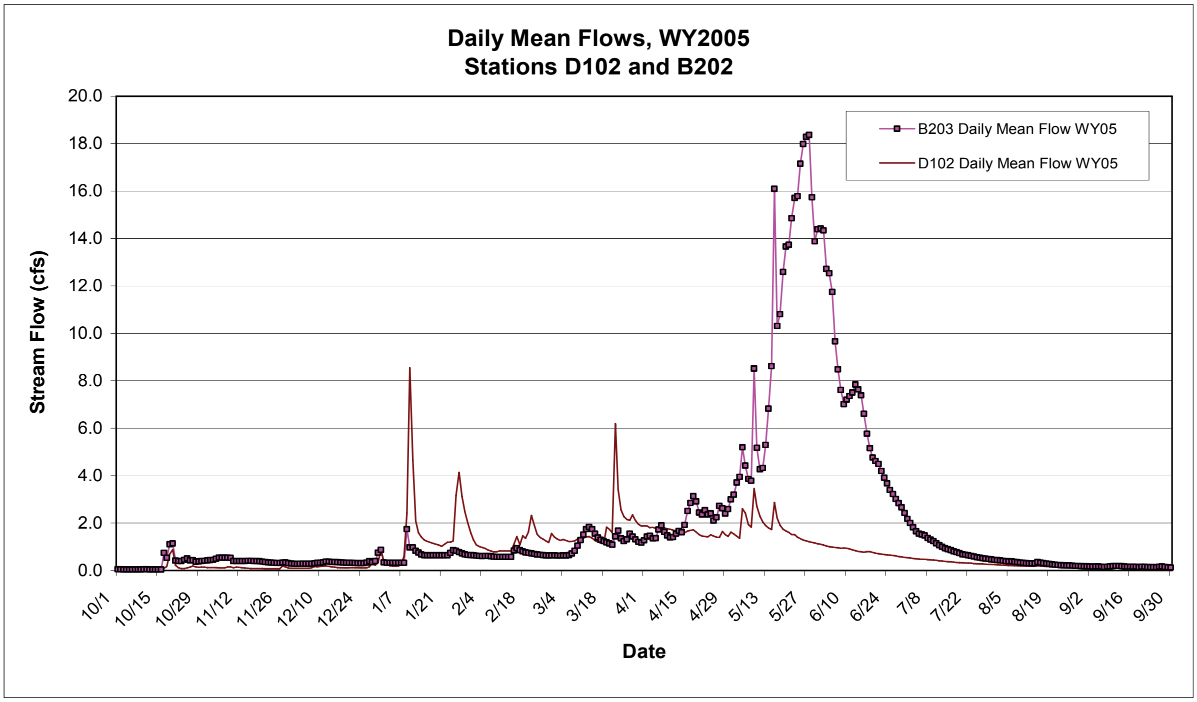
Base flow is the portion of stream flow that comes from sub-surface rather than surface water sources. The level of base flow varies throughout the year. More sub-surface flow is delivered to streams during wet periods with saturated soils, than during dry periods when soil moisture is low. Base flow would be discussed as a contributor to high flows, but changes would only be estimated for the low flow period.

Annual yield is the average amount of water that flows out of an area over a one year period. Annual yield is often reported in acre-feet per year, which is the depth that the total volume of flow would cover a one acre flat surface.

Baseline stream flow data for the KREW Watershed Study has been collected in Providence, Duff, and Bull Creek watersheds, since October 2003. Data collected at these stations is intended to answer specific questions about how flows in these small headwater drainages are affected in response to vegetation treatments. Before and after comparisons are included as well as comparisons between treated areas and ‘control’ areas that receive no treatment. Baseline stream flow data is also helpful in describing the current hydrology of the project area.

Automatic data loggers record stream flow at least once every hour at seven flumes in the project area, shown on Watershed Map 1 (Appendix F). Figure 3-47 shows an example of daily mean flows for selected stations in Water Year 2005. Water Year 2005 includes October 1, 2004 through September 30, 2005, for example. Daily mean flows (the average of all flows recorded each day) are shown for two stations, Duff Creek (D102) and Bull Creek (B203). The project file contains this data and a complete set of hydrographs (maps of water in the project area).

Figure 3-47. Daily Mean Flows



Hydrograph of daily mean flows at stations D102 and B203, KREW Study

A clear difference can be seen between Duff 102 and Bull 203 in Table 3-28. Duff Creek (elevation 4920 ft) responds to winter season precipitation by producing immediate spikes. Bull Creek (elevation 7235) has spikes that are much less dramatic. A sustained peak at B203 is shown in May and June that is absent at the Duff Creek site. The maximum daily mean flow in D102 was 8.6 cfs (cubic feet per second) for example, which occurred on January 10. The matching peak at B203 was 1.7 cfs. Bull Creek's maximum daily mean flow occurred on May 28 and was 18.4 cfs. The largest spring flow at D102 was only 3.4 cfs on May 9. This illustrates that Duff Creek is rain-dominated and Bull Creek is snowmelt-dominated. Peaks in early May that occur at both stations are rain events that in Bull Creek were likely rain-on-snow. Data collected at the stations in Providence Creek resembles the Duff Creek data.

The daily maximum flows at these stations are an average of 10 to 15 percent higher than daily mean flows. The instantaneous peaks from large storms are as much as 3.5 times higher than the daily mean at a given station.

The flow record is too short to support the calculation of flood frequencies, including bankfull flow. Cross section data has been collected at the stations, but bankfull flows have not yet been estimated (personal communication, C. Hunsaker, July 25, 2006). USGS regressions for the Sierra Region (Waananen and Crippen 1977) and regional regressions for the Kern River (Kaplan-Henry and Schoener 2002) were used to estimate various return-interval flows. Flows of various return intervals are denoted by Qx where Q = flow in cubic feet per second (cfs) and x = the return interval in years.

Kern River relationships were used because they include small watersheds and account for the effects of wildfire on small watersheds. The benefit of both of these methods is they can be applied to any size watershed, including sub-watersheds (HUC8s) used for the CWE analysis. Kaplan-Henry and Schoener (2002) found that Sierra Region relationships under-estimated flows at sites with drainage areas less than 10 mi^2 in the Kern River Basin. The project area differs from the Kern River in several ways. Flows in the project area may be more closely approximated by Sierra Regional relationships than Kern River stations; however, both estimates are presented to represent the possible range of flows. Kern River relationships are of particular interest for evaluating the possible effects of a wildfire such as the McNalley Fire.

A complete set of calculated flow estimates is available in the project file. Generally, flows calculated with Kern River relationships are slightly lower than USGS estimates for return intervals up to five years. Results at Q10 are fairly close, but Kern River estimates are slightly higher in smaller watersheds. Kern River relationships at Q50 produce flow estimates that are two orders of magnitude higher than USGS regional relationships. Table 3-28 shows a few examples.

Table 3-28. Subset of Flow Estimates

Station or sub-watershed #	Q2		Q5		Q10		Q25		Q50	
	USGS	Kern	USGS	Kern	USGS	Kern	USGS	Kern	USGS	Kern
D102	10.3	6.8	33.0	13.6	52.3	59.9	90.2	414	178	5580
B203	10.0	7.4	32.8	15.1	52.5	65.0	91.4	442	183	5782
519.0005	37.3	16.5	107	37.5	165	133	278	783	527	7870
520.1001	19.4	10.4	58.4	22.1	91.1	87.9	155	563	299	6580

Subset of flow estimates at various return intervals, calculated with USGS Regional Regressions (Waananen and Crippen 1977) and with Kern River relationships (Kaplan-Henry and Schoener 2002). All flows in cfs (cubic feet per second).

The USGS maintained a stream flow measurement station on Big Creek downstream of the project area from 1953 to 1973. Two stations have been located on Dinkey Creek, one upstream of the project area and another at the mouth of the creek. Another station was operated on Rock Creek, a tributary to Dinkey Creek. These station locations are shown on Watershed Map 1, in Appendix F. Data collected at these stations was used in developing Regional Regressions for the Sierra. A summary of the data at these stations (Waananen and Crippen, 1977) is shown in Table 3-29. Table 3-30 shows a summarization of the data by unit area (flow per square mile of drainage area) for comparison between stations.

Table 3-29. Stream Flow at Gauging Stations

Station	Drainage Area (mi^2)	Elevation (ft)	Average Annual Precip (in)	Q2	Q5	Q10	Q25	Q50
Big Cr	70	961	35	1810	4670	7700	13200	18800
Dinkey Cr	51	5440	38	1050	1780	2350	3170	3850
Dinkey @ mouth	136	1283	35	1940	3190	4140	5500	6620
Rock Cr	7.6	6148	36	404	928	1440	2320	3160

Stream flow at USGS gauging stations at various intervals (from Waananen and Crippen 1977). Flows in cfs.

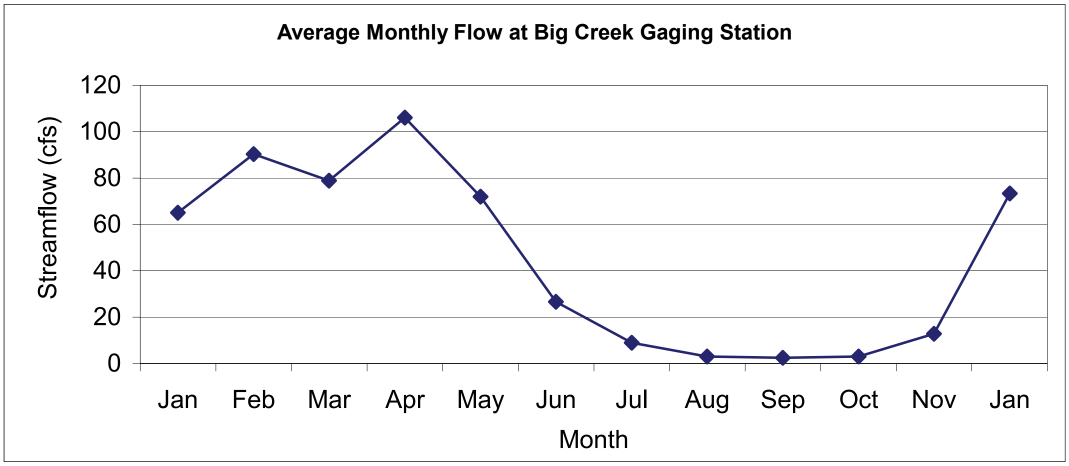
Table 3-30. Selected Stream Flow Information

Station	Mean Annual Flood cfs/mi^2	Largest Rain-on-Snow Flood (cfs/mi^2)	Largest Snowmelt Flood (cfs/mi^2)	Period of Record
Big Cr	45	234	N/A	1953-73
Dinkey Cr*	48	219	50	1921-35; 1977-87
Dinkey @ mouth	2236		2900	1920-37
Rock Cr	110	375	62	1960-70

Selected stream flow information from USGS gaging stations operated in the project area watersheds, presented as absolute value and as normalized value (from Gallegos 2004).
*The 1977-87 data from Dinkey Creek is not reflected in Table, which is based on data published in 1977

Monthly average flows for Big Creek are also displayed in the Big Creek Watershed Analysis, and presented in Figure 3-48. The shape of the tributary Duff Creek at D102 generally fits these monthly average flows in Big Creek.

Figure 3-48. Monthly Average Flows at the Big Creek Gauging Station



From Gallegos 2004

Analysis Methods for Evaluating Changes in Stream Flow - Literature reviewed and summarized in the General Discussion of Environmental Consequences reports the effects of forest management actions on stream flow in terms of the amount of forest cover removed. The percent change in basal area and the percent change in forest canopy were calculated for each vegetation patch modeled in the vegetation and fuels analyses. These changes were then aggregated at the sub-watershed scale as a weighted average. These values are compared to reported studies in order to qualitatively predict the effects of the alternatives on stream flow.

Water Quality - Water quality in the project area is managed under the Water Quality Control Plan for the Tulare Lake Basin (Central Valley Regional Water Quality Control Board (CVRWQCB) 2004). This plan designates beneficial uses to be protected, water quality objectives, and an implementation program for achieving objectives. The project's designated beneficial uses are shown in Table 3-31.

Table 3-31. California Designated Beneficial Uses for Dinkey Creek and Big Creek

Beneficial Use	Dinkey Creek	Big Creek
POW – Hydropower Generation	X	X
REC1 – Water Contact Recreation	X	X
REC2 – Non-Contact Water Recreation	X	X
WARM – Warm Freshwater Habitat (including reproduction and early development)	X	X
COLD – Cold Freshwater Habitat	X	X
WILD – Wildlife Habitat	X	X
RARE – Rare, Threatened, or Endangered Species	X	
SPWN – Spawning, Reproduction, and/or Early Development (cold water)	X	
FRSH – Freshwater Replenishment	X	X

Based on the water quality control plan for the Tulare Lake Basin

Hydropower generation occurs at Pine Flat Dam, downstream of the project area. Recreation occurs in the streams; downstream from the project; and at Pine Flat Reservoir. Aquatic habitat is discussed more comprehensively in the Aquatics section. Some elements of habitat, such as sedimentation, are analyzed in this section.

Section 303(d) of the Clean Water Act requires states to identify bodies of water that are not meeting water quality objectives and are at risk of not fully supporting their designated beneficial uses. These water bodies are called Water Quality Limited Segments (WQLS). The 2002 list is the most recent California list that has been approved by the Environmental Protection Agency (EPA). No water bodies in the Kings River Project area are listed as water quality impaired. The nearest listed segment is the Lower Kings River approximately 50 miles downstream of Pine Flat Dam, which is identified for Electrical Conductivity, Molybdenum, and Toxaphene, all due to agricultural uses.

Water Quality Objectives are narrative or numeric limits designed to protect beneficial uses of water. The parameters with specified objectives in the Tulare Lakes Basin Control Plan include ammonia, bacteria, biostimulatory substances, chemical constituents, color, dissolved oxygen, floating material, oil and grease, pH, pesticides, radioactivity, salinity, sediment, settleable material, tastes and odors, temperature, toxicity, and turbidity. The parameters that this project has the potential to affect are chemical constituents (glyphosate), dissolved oxygen (DO), sediment, temperature, and turbidity.

Limited water quality sampling has been conducted in the analysis area. The Forest collected water chemistry data at established stations on an irregular schedule between 1979 and 1983. Data was collected on dissolved oxygen, temperature, and turbidity at the mouth of Big Creek and the mouth of Dinkey Creek. This data is presented in Table 3-32. Sampling locations are shown in Watershed Map 1 (Appendix F). These locations are well downstream of the project area, but serve as general indicators of the water quality in these watersheds. Water quality data has been collected since 1999 as part of Stream Condition Inventory (SCI) assessments and aquatic species-specific surveys. This information includes macroinvertebrate samples (an indicator of water quality). This data is presented in the Aquatic Species Report (Sanders 2006b). More recent data has also been collected on sediment, which is considered to be the primary threat to water quality in these watersheds. Sediment data is discussed in a separate section below.

Table 3-32. Water quality in Big Creek and Dinkey Creek, 1979-1983

Sample location	Date	Temp (air/water)	DO (mg/l)	Turbidity (NTU)
Big Creek	6/14/79	27 / 22° C	8.3	0.36
	12/22/81	13 / 5°C	9.0	0.34
	7/7/83	21 / 18°C	8.1	2.2
	10/21/82	21 / 11° C	8.4	10
	12/3/83	22 / 12° C	10.6	3.0
	11/1/84	Not recorded	9.1	10
Dinkey Creek	6/14/79	27 / 16° C	9.2	0.6
	12/16/81	22 / 10° C	9.0	3.0
	10/21/82	21 / 11° C	9.0	100
	7/7/83	15 / 4.5°C (water temp suspect)	10.5	0.75
	12/3/83	20 / 10° C	12.5	30
	11/1/84	Not recorded	9.2	20

Includes temperature, dissolved oxygen (DO), and turbidity

The applicable CVRWQCB objective for temperature states, "Natural temperatures of waters shall not be altered unless it can be demonstrated to the Regional Water Board that such alteration in temperature does not affect beneficial uses".

Temperatures are not thought to be a limiting factor for beneficial uses in these watersheds. The temperature recorded in Big Creek in June 1979 (22° C or 72° F) is the highest in this data set, and is similar to the maximum temperatures recorded with continuous data loggers in Big, Providence, and Summit Creeks in the summer of 2005 (Sanders 2006b; Strand 2006). The effects of this project on temperature are analyzed in the Aquatics section.

Dissolved oxygen (DO) is an important water quality parameter because aquatic organisms need oxygen. DO levels can range from 0 to 18 mg/l; levels of 5 to 6 mg/l are stressful for organisms; and lower levels can be fatal (Renn 1970). DO is related to water temperature. Generally, cooler water has higher DO. Turbulence increases DO as oxygen from the air gets mixed into the water. Other factors that exert a control on DO include photosynthesis; respiration; and decomposition of plant material. Photosynthesis only occurs during the day, and increases DO. Respiration and plant decomposition occur around the clock, and deplete DO.

The applicable CVRWQCB water quality objective for dissolved oxygen states, "The DO in surface waters shall always meet or exceed 7.0 mg/l in waters designated COLD or SPWN".

Although the data record is short and sporadic, DO levels in these watersheds do not appear to be at risk of not meeting the objective. Dissolved Oxygen would not be used as an indicator of Environmental Consequences in this analysis.

Turbidity is a measure of the amount of fine material suspended in the water. Water with higher turbidity is cloudier than water with low turbidity. Turbidity varies naturally and is often higher during rainfall runoff, especially during large storms. Turbidity is often higher when stream flow is rising than when stream flow is falling. Chronically increased turbidity can result in increased temperature because solar warming has a greater effect on water carrying fine sediment particles. Fine sediment particles can also be associated with nutrients. More nutrients can increase aquatic production, which in turn depletes DO. Erosion could carry fine sediment to streams and cause an increase in turbidity in the analysis area. Applicable CVRWQCB water quality objective for turbidity states: "Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- Where natural turbidity is between 0 and 5 NTU, increases shall not exceed 1 NTU
- Where natural turbidity is between 5 and 50 NTU, increases shall not exceed 20 percent
- Where natural turbidity is equal to or between 50 and 100 NTU, increases shall not exceed 10 NTU
- Where natural turbidity is greater than 100 NTU, increases shall not exceed 10 percent

In determining compliance with the above limits, the Regional Water Board may prescribe appropriate averaging periods provided that beneficial uses would be fully protected."

The highest measured turbidity in this data set occurred on 10/21/82 in both streams, and likely represents storm runoff although weather conditions were not noted at the time of data collection.

The data presented in Table 3-32 does not allow comparison with water quality objectives. Determining natural background levels is very difficult and requires continuous monitoring because turbidity is highly variable seasonally and in response to runoff events (National Council for Air and Stream Improvement (NCASI) 1999). Turbidity varies with flow levels and tends to be lower in the drier, base flow period (June and July). Turbidity tends to be higher during winters, higher precipitation period (see Table 3-33). Literature shows that turbidity also varies in different locations in the same stream, in different positions both across a single channel cross section and at different positions in the flow profile (i.e., at different depths) (NCASI 1999). Conroy (2003) found that two identical turbidity meters gave different readings for the same sample, and Davies-Colley and Smith (2001) found even greater differences when different types of meters were used, making it difficult to compare data collected by more than a single meter.

Turbidity has not been thoroughly investigated in these watersheds because it is not thought to impair beneficial uses. Turbidity is not used as an indicator of environmental consequences in this analysis.

Glyphosate is an herbicide that would be used in each of the action alternatives. The Tulare Lake Basin Control Plan does not specify objectives for glyphosate, but does note that waters designated MUN (municipal supply) shall comply with water quality objectives in Title 22 of the California Code of Regulations. Waters in the project area are not designated for municipal use. Glyphosate is tracked through the analysis of effects due to public interest in the environmental effects of herbicides.

Routine water quality sampling does not include a test for glyphosate. Surface water samples resulted in no detections in Bakke's (2001) review of studies of glyphosate use on several forests including the Sierra (detection limits ranged from 6 to 25 ppb). Glyphosate is probably not currently present in surface water in the analysis area.

Sediment is the primary threat to water quality in the project area. The indicator used to measure sediment on the Sierra NF is V* ("V-star"), which is the fraction of scoured pool volume that is occupied by fine sediment (Lisle and Hilton 1992, Hilton and Lisle 1993). This is thought to be a good index of variations in fine sediment supply. Lisle and Hilton (1999) show that V* correlates with annual sediment yield in systems with abundant sandy sediment, and that changes in V* correspond to changes in the balance between sediment supply and sediment transport.

V* was collected in 1995, 1996, 1997, 2003, and 2004 in the Big Creek and Dinkey Creek watersheds to quantify existing fine sediment storage. Watershed Maps 2a, 2b, and 2c (Appendix F) show the locations of these V* reaches.

Data collected in the 1990s used a variation of the V* technique, and is not directly comparable to more recent data. Measurement areas were not explicitly identified and cannot be revisited with confidence. Reaches were not selected using criteria recommended by Hilton and Lisle (1993). Far fewer than the recommended 10 pools were sampled in almost every case. Data collection began in 2003 and followed established guidelines for V* measurement closely. This data collection would be used as the baseline for project monitoring. However, older data can be generalized for comparison with desired conditions.

The desired condition for sediment in pools in the Big Creek watershed is a maximum of 30 percent based on watershed potential considering geology, soils, and channel types. V* was measured in twenty stream reaches in the Big Creek watershed in the 1990s. These reaches span from the headwaters of Summit Creek to the lower reaches of Big Creek (see Watershed Map 2a in Appendix F for approximate locations) and include some tributaries. Forty percent of the sampled areas had V* values that exceeded the DC. The 2003-2004 data in Big Creek (see Table 3-33) shows that both sampled reaches in Big Creek are above the desired condition. The reach in Summit Creek just above the confluence with Big Creek meets the desired condition.

The desired condition for sediment in pools in the Dinkey Creek watershed is a maximum of 20 percent based on watershed potential considering geology, soils, and channel types. This is lower than the desired condition in Big Creek due to differences in soils and channel types. Twenty-four stream reaches were measured in Dinkey Creek in the 1990s, from the headwaters of Dinkey Creek and including several tributaries (see Watershed Maps 2b and 2c for approximate locations). Eighty-three percent of these sampled areas met the desired condition. Reaches in upper (520.1002-1) and lower Bear Meadow Creek (520.1051-1 and 520.1051-2) are noteworthy because the measured V* values were approximately 80 percent, far higher than the desired condition. The reach in Oak Flat Creek (520.1151-1) tributary to Bear Meadow Creek slightly exceeded the desired condition.

Table 3-33. V* Reach Data 2003-2004 (after Morales 2004)

Management Units	Creek	Reach #	# Pools	Mean V*
Not in project's eight management units	Big	519.0012-1	10	0.68
Providence_1	Big	519.0057-1	10	0.40
Providence_1	Summit	519.4051-1	10	0.18
Not in project's eight management units	Dinkey	520.0056-1	3	0.04
Glen_mdw_1	Glen Meadow	520.0017-1	10	0.16
Bear_fen_6	Oak Flat	520.1151-1	8	0.45
Bear_fen_6	Oak Flat	520.1151-2	10	0.61

Reaches beginning with 519 are located in the Big Creek watershed. Reaches numbered 520 are in Dinkey Creek

Dinkey Creek data for 2003-2004 shows that surveyed reaches in Dinkey and Glen Meadow Creeks meet the desired condition. Both surveyed reaches in Oak Flat Creek clearly exceed the desired condition. The difference in V* values in Oak Flat Creek between the earlier measurement and recent data cannot be interpreted as a trend because of the limitation of the earlier data.

The analysis method for evaluating changes in sediment relies on literature; the WEPP:Road model (described in the CWE analysis); current V* values; channel types (described below); the expected changes in flows; and the professional judgment of the hydrologist and geologist. Three sources are considered in the analysis of sediment; roads, treatment units, and in-channel erosion. The analysis of effects on sediment levels utilizes five types of information including predicted effects on erosion and sedimentation from the soils analysis; the predicted increases in flows from the analysis; design measures whose purpose is to minimize or mitigate effects; channel type (sensitivity to disturbance); and channel condition (existing bank stability).

Stream condition data has been collected at various locations throughout the project area in addition to V*, (see Watershed Maps 2a, 2b, and 2c) using R5 Stream Condition Inventory (SCI) protocols (Frazier and others 2005). SCI was developed to inventory and monitor stream condition, and to enable comparison of conditions within or between reaches with statistical confidence. A suite of attributes are collected in order to characterize the channel. Baseline SCI reaches would be established and monitored as described in the Adaptive Management Plan, to detect possible changes in these streams.

Baseline data has already been collected for some of the reaches. Bank stability measurements from SCI are used as an indicator of possible channel response to increases in flow that may result from project implementation for this analysis. Rosgen channel type (Rosgen 1996) is also used as an indicator of sensitivity to disturbance. "Disturbance" includes changes in flow and sediment supply coming from upstream. This data represents the reach where it was collected, not the entire stream channel. Table 3-34 presents these attributes from the SCI data collected in the project area in 2005.

Table 3-34 displays selected SCI attributes for sample reaches in the project area. Bank stability ratings are based on 100 data points collected on each bank at 50 locations within the reach. Channel type is an average of three surveyed cross sections within each reach. The interpretation of sensitivity to disturbance comes from Table 8-1 in Rosgen (1996).

Table 3-34. Selected SCI Attributes

Reach	Sub-watershed	Bank Stability			Channel Type	Sensitivity to disturbance
		Stable	Vulnerable	Unstable		
Big Cr 7	519.0056	90%	9%	1%	B4c	moderate
Big Cr 4b	519.0012	37%	38%	25%	B4c	moderate
Big Cr 4a	519.0057	33%	40%	27%	F4	extreme
Big Cr trib	519.0011	71%	20%	9%	B3a*	low
Summit Cr	519.4051	75%	23%	2%	B3c	low
Oak Flat Cr	520.1002 520.1051	32%	39%	29%	B4c	moderate
Laurel Cr	520.4001	66%	23%	11%	B4c	moderate
Bull Cr	520.3002	65%	30%	5%	C3b	moderate

* indicates a transport reach, based on the reach gradient; all others are response reaches

The SCI Technical Guide (Frazier and others 2005) presents a data summary from forests in the northern Sierras collected during pilot development of the program. This data is sorted into 'reference' and 'non-reference' sites, and 'transport' and 'response' stream reaches. Reference response reaches had a mean stability of 75 percent, and non-reference response reaches averaged 53 percent stability in that data set. Stability in transport reaches was slightly higher at 81 percent at reference sites and 56 prcent at non-reference sites. Using these values as general indicators, reaches Big Cr 4a, Big Cr 4b, and Oak Flat Cr have lower channel stability than would be expected. All reaches were in the 30 to 40 percent range. This is especially a concern for reach Big Cr 4a, where the channel type is extremely sensitive to disturbance.

Channel typing has also been done to various levels as part of other data collection efforts since 1989. High sensitivity reaches are listed in Table 3-35. The analysis method for evaluating effects on sensitive channel types is based on consideration of the estimated effects on stream flows and sediment, how those changes would be transmitted downstream and their potential to trigger effects in these locations. The indicator is change in stream bank stability.

Table 3-35. Reaches with Channel Types

Management Unit	Sensitive Channel Reach Locations	Sub-watershed
Bear_fen_6	B5 reach in headwaters of tributary to Bear Meadow Cr, outside of MU B4 reach on Bear Meadow Cr, near downstream end of MU F4/G4 reaches on Oak Flat Creek, at downstream end of MU	520.1051 520.1051 520.1151
El_o_win_1	B4 reach on tributary to Dinkey Creek	520.0017
Glen_mdw_1	B4 reach on tributary to Glen Meadow Creek	520.0057
Krew_bull_1	A4 and B6 reaches in headwater tributaries of Bull Creek	520.3002
Krew_prv_1	None known	-
N_soaproot_2	C4 reaches in Rush Creek and a tributary, upstream of the MU	519.3053
Providence_1	None known	-
Providence_4	B4 reach in Providence Creek, near mouth F5 reach downstream of Providence Creek B4/G4 reach in Big Creek, along edge of MU	519.0008 519.0056 519.0056 and 519.0057

Reaches with channel types characterized as having 'very high' or 'extreme' sensitivity to disturbance (per Rosgen 1996)

Sub-watersheds containing the project's management units also contain a network of system roads that have the potential to contribute water and sediment to streams. The project's action alternatives include road maintenance, reconstruction, and construction. These activities may have the potential to change the effects of roads. Some of the characteristics of the road system are presented in Table 3-36.

Table 3-36. Miles of Road in Riparian Conservation Areas (RCAs) and Number of Stream Crossings

Management Unit	Road density (mi/mi^2)	Miles of road in RCAs	Total Number of Stream Crossings	Number of Perennial Stream Crossings
Bear_fen_6	5.8	10.5	107	7
El_o_win_1	7.9	10.9	110	19
Glen_mdw_1	9.8	16.0	148	28
Krew_bull_1	5.4	4.9	48	2
Krew_prv_1	4.0	8.8	84	11
N_soaproot_2	1.8	3.4	13	4
Providence_1	3.9	8.4	90	11
Providence_4	5.4	7.1	81	18

Based on GIS information
Perennial stream crossings include crossings of roads and trails on order 3 and greater channels.

Not all roads are the same. Some generate very little erosion, while others have widespread problems. More commonly, roads have a few discrete trouble spots where drainage problems or erosion occur. Not all roads within an RCA contribute water or sediment to streams. Road miles within RCAs and the number of stream crossings are presented as indicators of the potential for roads to affect streams.

A measure such as the length of hydrologically connected roads (roads directly connected to streams via a surface flow path) would provide a better indication of the potential for roads to increase peak flows or sediment effects (Gucinski and others 2001). Other factors such as soil types, road grade, effectiveness of road drainage design, road condition, channel condition and channel sensitivity are also important factors to consider when determining this potential. Korte and MacDonald (2005) found that 13 percent of road length in their study areas in Krew_prv_1 and Krew_bul_1 are hydrologically connected. The average length of connected segments is 553 feet on native surface and 385 feet on gravel surfaced roads (Gallegos 2006a).

The current sediment contribution from roads to streams was assessed using Korte and MacDonald's site-specific study (2005) and the WEPP:Road model (described in the CWE analysis later in this section). Stream crossings are by and large the most significant areas along roads that contribute sediment to the stream system. The effect of hydrologically connected portions of roads is they concentrate surface flow from the road bed where sediment is produced and deposit it directly into channels, or near channels where it can eventually make its way to the channel.

Roads/channel crossings were evaluated to determine the average length of road that is hydrologically connected to a channel on native and gravel surfaced roads (Gallegos 2006a). The data set included 38 road/channel crossings, on nine Forest System Roads. Korte and MacDonald (2005) found that the annual sediment production rate was .44 kg/m^2 (1.98 tons/ac) for native surface roads and .06 kg/m^2 (0.27 tons/ac) for gravel surface roads in Krew_prv_1 and Krew_bul_1 Management Units. This sediment production rate is based on the sediment volume collected in silt fences in 2004 (a dry year) and 2005 (a wet year). A similar study conducted between 1999 and 2002 on the El Dorado National Forest determined that annual sediment production rates for native surface roads was .64 kg/m^2 and from gravel surfaced roads was .01 - .03 kg/m^2 (Coe and McDonald 2006). Coe and MacDonald's sediment production rates on the El Dorado National Forest corroborate Korte and MacDonald's findings in Krew_prv_1 and Krew_bul_1.

Korte and MacDonald's sediment production rates; the average length of hydrologically connected road; and the average road width of 14 feet were used to calculate the average volume of sediment produced from each crossing as .35 tons per year for a native surfaced road and .03 tons per year for a gravel surfaced road. A parallel analysis of the same road/channel crossings over a 30 year simulation using the WEPP:Road model estimated that the average sediment delivery rate is 3.44 tons per year for native surfaced roads and .67 tons per year for gravel surfaced roads (USDA 2006). These estimates are compared in Table 3-37.

Table 3-37. Comparison of Estimated Average Annual Sediment Production at Road and Stream Crossings

Road surface type	After Korte and MacDonald (2005)	WEPP:Road Model
Native surface	0.35 tons/yr	3.44 tons/yr
gravel	0.03 tons/yr	0.67 tons/yr

Comparison of these sediment production rates shows that the WEPP model predicts sediment production an order of magnitude greater than predictions based on local data. These estimates represent a potential range of sediment production, with Korte and MacDonald representing short term rates and the WEPP model representing potential long term rates.

Road/channel crossings were determined in GIS by intersecting roads and streams in the project area. Approximately 658 crossings exist in the eight management units. The project area contains approximately 116 crossings on gravel surfaced roads; 132 on native surface roads; 15 on paved roads; and 395 on roads whose surfaces have not been determined in the project area. Sediment production rates on the 395 crossings were determined using both native surface and gravel surface sediment production rates to provide a range. The total estimated sediment production from roads in the project area is 828 to 1890 tons per year based on the WEPP model and 62 to 193 tons per year using Korte and MacDonald's sediment production rates.

Approximately 188 crossings in the eight sub-watersheds are over their lower threshold of concern: 13 on gravel surfaced roads; 105 on native surface roads; and 70 on roads whose surfaces have not been determined. The total amount of predicted sediment production from roads in the eight CWE sub-watersheds is 422 to 630 tons per year based on WEPP predictions, and 39 to 59 tons per year using Korte and MacDonald's sediment production rates.

The analysis method for evaluating the effects of roads includes literature review and the results of WEPP sediment modeling to inform a qualitative assessment.

<u>Cumulative Watershed Effects (CWE) Analysis</u> - The CWE analysis has two components consisting of the R5 Baseline and Detailed CWE Assessments following direction in FSH 2509.22, and a qualitative discussion about how the direct and indirect effects are likely to be transmitted through the stream system.

The Baseline Assessment (Gallegos 2005a) was conducted using the Equivalent Roaded Acres (ERA) model to determine if the ERAs in any sub-watersheds are currently at or over their lower Threshold of Concern (TOC).

The percent in the ERA in a sub-watershed is used as an index of watershed disturbance and the risk of impacts to watershed health. Each acre of activity is multiplied by a coefficient to express its level of disturbance to watershed function. Coefficients for vegetation management activities are determined by silvicultural prescription, logging system, and soil types. ERAs are prorated by their age, assuming a recovery period of 30 years (USDA 1990: Chapter 20).

Major assumptions that were used in the CWE analysis include:

1) The size of the sub-watershed is equivalent to a HUC 8 watershed, which for the Kings River Project ranges from 400 to 2,200 acres.
2) Sub-watersheds vary in their sensitivity to management based on their watershed characteristics that include percent of unstable lands; percent of sensitive soils; and the bifurcation (breaks into two) ratio of the channels in the sub-watershed.
3) An upper limit to tolerance to disturbance exists for each watershed. This limit, or upper TOC, has been estimated to be 14 percent for each watershed measured in terms of ERA. The risk of initiating adverse CWE greatly increases as this upper limit is approached and exceeded.
4) A lower limit to tolerance to disturbance exists for each watershed based on its watershed sensitivity. This limit, or lower Threshold of concern (TOC), has been estimated to be 4 percent for highly sensitive watersheds; 5 percent for moderately sensitive watersheds; and 6 percent for watersheds with a low sensitivity. The purpose of the lower TOC is to identify those watersheds where the risk of CWE could occur to conduct a detailed, field based, cumulative watershed effects analysis. Sub-watersheds currently under the lower TOC have been determined to not have concerns for CWE and are not further analyzed in the detailed CWE analysis.
5) Management activities can be measured in terms of equivalent roaded acres (ERA). This is referred to as the ERA Model.
6) Key indictors of unacceptable degradation can be identified for watershed processes. An indicator of a cumulative watershed effect response could be one or more of the following: filling of channel pools with fine sediment; unstable channel banks; and/or poor aquatic habitat.
7) Land disturbances recover in 30 years.

8) The potential for initiating adverse CWE can be reduced by: dispersing land disturbing activities in time and space; controlling the physical size, shape, location and timing of land disturbing activities; and implementing Best Management Practices to mitigate adverse on-site effects.
9) Watersheds would not reach or exceed the upper TOC of 14 percent.

The Baseline Assessment established that past impacts had raised some sub-watersheds to percent Equivalent Roaded Acres (%ERA) levels that exceeded their lower Threshold of Concern (TOC). Nine sub-watersheds were identified to have a detailed CWE assessment as a result of the baseline assessment. The detailed CWE assessment included field evaluation of channel conditions and aquatic habitat. Field data considered in the detailed analysis includes: channel condition in terms of channel bank stability and pool frequency and size; watershed improvement inventory data in terms of the number of sites found; the amount of erosion and sediment they may be contributing to the fluvial system; and aquatic species observed during aquatic surveys. These findings were documented in a report dated June 10, 2005 by Sanders and Hopson. Review of the data between the draft and final EIS determined that sub-watershed 519.0057 is also over the lower TOC. The detailed assessment for sub-watershed 519.0057 is summarized in a report dated August 8, 2006 by Gott and Sanders. The Detailed Cumulative Watershed Analysis Report for the 2000 Bear Meadow Project was also used to document available data and existing conditions. ERA calculations from the Baseline Assessment are displayed in Table 3-38.

Table 3-38. Summary of ERA by Sub-watershed

Sub-watershed Number	Size (ac)	Natural Sensitivity	TOC	Existing (2006) ERA	2007 ERA	2008 ERA	2009 ERA	2011 ERA	2036 ERA
519.0005	1140	High	4%	3.16%	4.28%			3.79%	2.11%
519.0006	630	Moderate	5%	2.71%		2.59%		2.41%	1.91%
519.0007	1719	High	4%	3.75%	12.72%			13.79%	2.53%
519.0008	1976	Low	6%	3.90%	13.79%			11.57%	2.31%
519.0009	1335	High	4%	7.72%			7.11%	6.50%	3.51%
519.0011	1246	Moderate	5%	3.91%	11.82%			9.76%	1.47%
519.0055	1574	Moderate	5%	3.55%	4.14%			3.59%	2.43%
519.0056	914	Moderate	5%	3.56%	6.55%			5.78%	3.46%
519.0057	1078	Moderate	5%	7.16%	13.73%			11.44%	2.58%
519.2001	2228	Moderate	5%	3.41%		3.38%		3.23%	2.89%
519.2002	2173	Moderate	5%	1.53%				1.43%	1.41%
519.3001	1484	Moderate	5%	2.69%			4.21%	4.05%	2.76%
519.3002	534	Moderate	5%	4.71%			5.11%	5.07%	4.74%
519.3003	716	Moderate	5%	2.08%			7.46%	6.92%	2.41%
519.3004	746	Low	6%	4.66%			11.61%	10.91%	5.12%
519.3052	727	Low	6%	1.97%			10.00%	9.20%	2.51%
519.3053	2083	Moderate	5%	8.85%			9.16%	8.25%	2.31%
519.4001	1828	Moderate	5%	1.13%	1.24%			1.10%	0.85%
519.4051	1402	High	4%	4.69%	10.20%			8.06%	1.74%
520.0013	439	Moderate	5%	3.26%	3.26%			2.58%	2.46%
520.0014	1066	Moderate	5%	5.54%	10.22%	10.81%		9.30%	2.32%
520.0015	2014	Low	6%	2.51%	6.31%			5.33%	1.38%

Sub-watershed Number	Size (ac)	Natural Sensitivity	TOC	Existing (2006) ERA	2007 ERA	2008 ERA	2009 ERA	2011 ERA	2036 ERA
520.0016	591	Low	6%	2.71%	5.60%	12.11%		10.81%	3.03%
520.0017	1952	Moderate	5%	1.99%	3.84%	7.67%		6.80%	1.89%
520.0053	2189	Low	6%	2.34%		2.56%		2.17%	1.51%
520.0054	959	Low	6%	2.62%		2.87%		2.60%	1.67%
520.0055	1757	High	4%	2.26%		2.28%		2.12%	1.75%
520.0056	1209	Moderate	5%	2.98%	13.99%	13.97%		12.39%	3.33%
520.0057	1431	Moderate	5%	4.19%	4.72%	9.75%		8.76%	3.43%
520.1002	1878	High	4%	6.22%		9.80%		8.18%	2.51%
520.1051	1411	High	4%	5.10%		11.72%		9.82%	2.52%
520.1101	1258	High	4%	7.02%		11.53%		10.08%	4.51%
520.1151	837	High	4%	4.33%		8.16%		7.40%	3.76%
520.2001	2010	Moderate	5%	1.70%		1.73%		1.71%	1.67%
520.2051	2020	High	4%	2.34%		2.35%		2.30%	2.18%
520.3002	1661	Moderate	5%	4.87%		10.26%		9.32%	4.43%
520.3052	2206	Low	6%	2.45%		2.47%		2.46%	2.44%
520.3151	1317	Low	6%	2.57%		2.60%		2.49%	2.42%
520.4001	2023	Low	6%	1.81%	1.84%			1.61%	1.48%
520.4051	176	High	4%	1.34%	5.07%			4.27%	1.23%
520.4052	1309	Low	6%	3.10%	3.13%			2.62%	2.09%
520.5051	1582	High	4%	1.77%		2.13%		1.81%	1.34%

Nine of the 42 sub-watersheds found to be over the lower TOC in the Baseline Assessment were evaluated in the CWE Detailed Assessment (Gallegos 2006a). Information on the current condition of these areas was gathered for the Detailed Assessment and is presented in Table 3-39. The following is a summary of physical and biological conditions of the eight sub-watersheds where CWE are a concern.

Table 3-39. Information gathered for the Detailed Cumulative Watershed Effects

Sub-ws ID	Lower TOC	Existing ERA	Proposed ERA	Channel Condition	V*	Aquatic Species Observed	WIN Sites
519.0009	4%	7.72%	7.11%	Mixed Stable & Unstable	25%	WPT/CN/PTF/GS	8
519.0057	5%	7.16%	13.73%	Unstable	20-60%	TRT	10
519.3053	5%	8.85%	9.16%	Mostly Stable	70-90%	WPT/CN/PTF/GS/TRT Poor to moderate aquatic habitat	6
519.4051	4%	4.69%	10.20%	Stable	18%	WPT/RSS/GS/TRT	8
520.0014	5%	5.54%	10.81%	Stable	10%	No Data	7
520.1002	4%	6.22%	9.80%	No Data	58%	No Data	12
520.1051	4%	5.10%	11.72%	Unstable	51% & 49%	No species observed	25
520.1101	4%	7.02%	11.53%	Mixed		GS	
520.1151	4%	4.33%	8.16%	Unstable	45% & 61%	TRT	4

V* value visually estimated, not measured.
Aquatic Species Observed: WPT = Western Pond Turtle; CN = California Newt; PTF = Pacific Tree Frog; GS = Garter Snake; TRT = Trout; RSS= Relictual Slender Salamander

Watershed Improvement Needs (WIN), is an established Forest Service program whose purpose is identifying, tracking, repairing and monitoring watershed erosion problems. Analysis for the nine sub-watersheds identified as over their lower Threshold of Concern.

<u>Sub-watershed 519.0009</u> - Approximately 3.3 acres of treatment stand 553 in the N_soapro_2 Management Unit is located on a ridge top in this sub-watershed. A detailed assessment found a mixture of stable and unstable channel banks in Ackers Creek. V* measured in 1996 met the desired condition. Surveys in 1999 noted that the sub-watershed's channels contain mostly small, shallow pools. A V* reach located at the confluence of this channel and Big Creek found residual pool filling of 25 percent in 1996 (Gallegos 2004). Watershed improvement needs inventories (WINI) collected between 1991 and 2004 indicated eight erosion problems documented in the sub-watershed. Seven of the problems were associated with system and non-system roads and one site is associated with grazing. The small acreage is insignificant and would not add to CWE. Therefore, this sub-watershed is not be discussed further in this analysis.

<u>Sub-watershed 519.0057</u> - This sub-watershed is located in the Providence_1 Management Unit. This sub-watershed includes a reach of Big Creek between Summit Creek and Providence Creek and an unnamed tributary to Big Creek. Channel reaches in Big Creek are unstable, and some channel types are characterized as sensitive to disturbance. A survey performed in an ephemeral tributary suggests that large quantities

of fine sediment are being transported in that channel. The road system in this area (10S75) is badly gullied and crosses drainages in 45 locations. A large proportion of the sediment that has been removed from these roads is likely to have been delivered to tributary channels. V* measurements taken in Big Creek in 1995 indicated that pools were up to 60 percent filled with sediment in the upper portion of the sub-watershed, which exceeds the desired condition. Measurements near the downstream end of the sub-watershed were taken in a transport reach, where the V* was just over the desired condition. Fourteen WIN sites have been documented in this sub-watershed, most of them describing erosion associated with roads or bank erosion in Big Creek. Four of these sites were not found to be problems in 2005, which leaves 10 sites un-addressed. Based on the available data it appears that this sub-watershed is experiencing CWE.

Sub-watershed 519.3053 - This sub-watershed is located in the N_soaproot_2 Management Unit in lower Rush Creek. Existing ERAs are 8.79 percent, which includes 367 acres of treatment in the South of Shaver Project. The CWE analysis for the South of Shaver Project concluded a CWE response is unlikely. However, an additional review of two reaches of Rush Creek for this project indicated that a CWE response may already be occurring. Channel pools are estimated to be filled 70 to 90 percent of their volume with fine sediment. This sub-watershed has mostly stable stream reaches with infrequent small pools. Inventories of watershed improvement needs (WINI) collected between 1991 and 2004 indicate six erosion problems. A 2004 air photo analysis identified thirteen skid trails or roads in the sub-watershed. Some of these trails are currently used by off highway vehicles; however, no resource damage associated with these features has been reported (Morales and others 2004). Ongoing development of the Wildflower Subdivision; timber harvest on private land in the sub-watershed immediately upstream; and OHV use including the annual Mountain Toppers Blue Canyon OHV event are likely to be some of the primary sediment sources. This sub-watershed appears that this sub-watershed is experiencing CWE based on available data.

Sub-Watershed 519.4051 – This watershed is located in the Providence_1 Management Unit. This sub-watershed has mostly stable stream reaches. V* data collected near the mouth of Summit Creek in 1995 indicated that fine sediment in pools was approximately 12 percent, which meets DC (Gallegos 2004). V* in Big Creek is approximately 20 percent upstream and 60 percent downstream of the confluence. The only indication of excessive sediment in this sub-watershed is in the first perennial tributary on the east side of Summit Creek. Pool infilling (V*) was estimated in a 2004 survey to be 50 percent in this channel and could be an effect from past management activities. Watershed improvement needs inventories (WINI) collected between 1995 and 2004 indicate eight erosion sites are present. Each site appears to be channel erosion initiated or influenced by culverts at road/stream crossings. Gully head cuts are located on an unnamed tributary to Summit Creek. This sub-watershed does not appear to be experiencing a CWE based on available data.

Sub-watershed 520.0014 - is located in the El_o_win_1 Management Unit in Dinkey Meadow Creek. Approximately 75 percent of the 1,066 acre watershed is privately owned. Southern California Edison has treated 320 acres of the private land as recently as 1995 and 2005. No evidence of a CWE response or an increased risk of a CWE response to these recent activities exists. Visual observations showed stable stream banks and little sediment in the channel. Large woody debris was common throughout the reach. Measurements of sediment depth in pools suggest that sediment accumulation is on the order of 10 percent, which meets the desired condition. Embeddedness is a measure of fine sediment intrusion into channel substrate (primarily gravels). Embeddedness was low throughout the reach. Aquatic species survey data is not available for this sub-watershed (Hopson 2005). Based on the available data it does not appear that this sub-watershed is experiencing a CWE.

Sub-watershed 520.1002 - is located in the Bear_fen 6 Management Unit in upper Bear Meadow Creek. This sub-watershed has no channel condition data or aquatic species survey data. A V* reach is located at the downstream end of the sub-watershed. Data collected in 1997 indicated that pools had residual pool filling of almost 60 percent (Gallegos 2004), clearly exceeding the desired condition. Watershed improvement needs inventories (WINI) indicate several erosion problems. Twelve sites have been identified between 1989 and 1998. Most erosion problems are associated with roads or old skid trails. Based on the available data it appears that this sub-watershed could be experiencing CWE and may be approaching a threshold for CWE.

Sub-watershed 520.1051 - is located in the Bear_fen 6 Management Unit in lower Bear Meadow Creek. Sub-watershed 520.1051 and sub-watershed 520.1001 have been combined into one sub-watershed. Sub-watershed 520.1001 does not meet watershed size criteria for a cumulative watershed effects analysis. Bear Meadow Creek is the main channel in this watershed. Bear Meadow Creek has a highly sinuous stream with unstable, down-cut banks and very fine particle size stream bottoms. Fence Meadow Creek is also located in sub-watershed. A channel analysis in 1999 indicated that this channel was fairly indistinct. Trample and chisel data collected in 1991 for the Dinkey cattle allotment found 26 percent disturbance of the stream channel from cattle. This disturbance exceeded the desired condition of 20 percent maximum bank disturbance. A channel analysis in 1991indicated that the stream channel was poor, and the area was heavily cut-over from the 1989 to 1990 Fence Green timber sale. Two V* reaches established in 1995 and 1996 indicate that filling of pools was approximately 50 percent. Channel surveys of 1989 also showed the stream in poor condition. No aquatic species have been found in surveys to date in this sub-watershed. Watershed improvement needs inventories (WINI) indicate 25 WIN sites recorded between 1989 and 1998. Nearly all of the problems are associated with roads and skid trails. Only one site was non-road related, documenting heavy accumulation of fine sediment in Bear Meadow Creek.

A CWE analysis was conducted on March 16, 2000 for the Bear Meadow Project. The project proposed to mechanically treat vegetation in this watershed. The analysis concluded that the upper reaches of Bear Meadow Creek contain excessive sediment and have areas of channel down cutting. Extensive gullies and unstable channels are present in the upland watershed areas, upstream from reaches in Bear Meadow Creek containing high sediment loads. Soil compaction was found to occur over approximately 20 percent of past activity areas. Compacted soils located throughout the Bear Meadow project area have sufficiently decreased infiltration to increase runoff. This increases peak flows leading to channel adjustment including down cutting and greater sediment loading.

These changes were concluded to constitute a cumulative watershed effect from past management activity (CWE Team, 2000).

<u>Sub-watershed 520.1101</u> - is located in the Bear_ fen 6 Management Unit and encompasses upper Oak Flat Creek. Channel surveys were conducted in 2004 along the 1,180 meter stream reach in Section 5. The channel was characterized as a steep, deeply entrenched channel with mostly sands with flatter, unstable areas. Only a single garter snake was found during the survey. No Watershed Improvement Needs sites are recorded in District files.

<u>Sub-watershed 520.1151</u> - is located in the Bear_ fen 6 Management Unit and encompasses the lower half of Oak Flat Creek. Surveys between 1990 and 1999 indicate that fines sediments in pools have been high since at least 1990, and may have increased from approximately 30 percent in 1995 to 45 to 60 percent measured in 2004. Surveys in 1999 described an unstable stream channel but some good fish habitat. Watershed improvement needs inventories (WINI) collected between 1989 and 2002 record four erosion sites in this sub-watershed. Three of the locations were related to road conditions. Two of the sites were repaired in 2003.

The conclusions of the Detailed Assessment are described in the Environmental Consequences section describing the Cumulative Effects of the Action Alternatives.

<u>CWE – Erosion and Sediment Delivery Estimates</u> - Sediment production was modeled for the Bear Meadow sub-watershed using GeoWEPP watershed modeling software (GeoWEPP, 2006). This sub-watershed was modeled as an example of the amount of sediment produced under several scenarios including the existing condition (No Action Alternative), the Proposed Action (Alternative 1), the No Action Alternative with a wildfire in the year 2015, and the Proposed Action with a wildfire in the year 2015.

The GeoWEPP software uses ArcView and digital elevation models (DEM) to create a channel network and catchments for a selected outlet point. In addition, the model uses climate data, soil data, slope data and management data to predict erosion and sediment under different scenarios. William Elliot provided assistance in customizing data input files including the soils and management files. Data from Yosemite National Park Climate was used as the climate data for the model. This climate file contains precipitation data similar to conditions in the proposed treatment area. Soils data from the Order 3 Soil Survey (Giger 1993) was used. Erosion and sediment prediction in the GeoWEPP model is sensitive to soil texture. Soil data from the soil survey was grouped into three classes based on soil texture. The Holland family taxonomic description was used to characterize fine textured soils. These soils represented other fine textured soils in the project area. The Shaver family taxonomic description was used to characterize coarse textured soils. The third class in the soils file is actually not a soil, but rock outcrop. Some outcrop exists in the project area and sheds most of its precipitation, creating rapid runoff. Slope files were generated from 30m DEMs acquired from the Geospatial Spatial Data Center (GSDC). These files were processed and prepared in ArcMap. Management files were customized to model the proposed action. The most