10. HYDROLOGY AND WATER QUALITY

10.1 Introduction

This section discusses hydrology and water quality issues related to JDSF and its proposed management under the DFMP. It builds on previous sections that discussed related issues, including VII.6.1, Aquatic Resources, and VII.7, Geology and Soils.

10.2 Regional and Project Watershed Setting

Watersheds are organized on a nested, hierarchical structure:

—Region
  —Hydrologic unit
    —Hydrologic area
      —Hydrologic subarea
        —Planning watershed.

JDSF is located in the North Coast hydrologic unit. The North Coast Regional Water Quality Control Board is the lead state agency responsible for the protection of water quality in this hydrologic unit.

This approximately 19,390-square-mile hydrologic unit is comprised of 14 major surface water units, plus a number of smaller drainages (Table VII.10.1). The North Coast region comprises all basins, including Lower Klamath Lake and Lost River Basins, draining into the Pacific Ocean from the California-Oregon state line southerly to the southerly boundary of the watershed of the Estero de San Antonio and Stemple Creek in Marin and Sonoma Counties. The North Coast Region covers all of Del Norte, Humboldt, Trinity, and Mendocino Counties, major portions of Siskiyou and Sonoma Counties, and small portions of Glenn, Lake, and Marin Counties.

The North Coast region is characterized by distinct temperature zones. Along the coast, the climate is moderate and foggy and the temperature variation is not great. For example, at Eureka, the seasonal variation in temperature has not exceeded 63°F for the period of record. Inland, however, seasonal temperature ranges in excess of 100°F have been recorded. Precipitation over the North Coast region is greater than for any other part of California, and there is potential for relatively frequent damaging floods. Particularly devastating floods occurred in the North Coast area in December of 1955, in December of 1964, and in February of 1986.

Ample precipitation in combination with the mild climate found over most of the North Coast Region has provided a wealth of fish, wildlife, and scenic resources. The numerous streams and rivers of the Region contain anadromous fish, and the reservoirs, although few in number, support both coldwater and warmwater fish. Although the North Coast

Region constitutes only about 12 percent of the area of California, it produces about 40 percent of the annual runoff.

Table VII.10.1. Major North Coast Region Water Bodies.

Lost River Hydrologic Area	Smith River Hydrologic Unit
Clear Lake Res. & Upper Lost River	Smith River
Lower Lost River	Lake Earl
Tule Lake	Lake Talawa
Lower Klamath Lake	Crescent City Harbor
Butte Valley Hydrologic Area	Redwood Creek Hydrologic Unit
Meiss Lake	Redwood Creek
Shasta Valley Hydrologic Area	Mad River Hydrologic Unit
Shasta River	Mad River
Lake Shastina	Eureka Plain Hydrologic Units
Scott River Hydrologic Area	Humboldt Bay
Scott River	Eel River Hydrologic Unit
Salmon River Hydrologic Area	Eel River
Salmon River	Van Duzen River
Middle Klamath River Hydrologic Area	South Fork Eel River
Iron Gate and Copco Reservoir	Middle Fork Eel River
Klamath River	Outlet Creek
Applegate River Hydrologic Area	Cape Mendocino Hydrologic Unit
Applegate River	Bear River
Upper Trinity River Hydrologic Area	Mattole River
Clare Engle Lake & Lewiston Res.	Mendocino Coast Hydrologic Unit
Trinity River	Ten Mile River
South Fork Trinity Hydrologic Area	Noyo River
South Fork Trinity River	Jug Handle Creek
Hayfork Creek	Big River
Ewing Reservoir	Albion River
Lower Trinity River Hydrologic Area	Navarro River
Trinity River	Garcia River
Lower Klamath River Hydrologic Area	Gualala River
Klamath River	Russian River Hydrologic Unit
Illinois River Hydrologic Area	Russian River
Illinois River	Laguna de Santa Rosa
Winchuck River Hydrologic Unit	Coastal Waters
Winchuck River	Minor Coastal Streams not Listed Above

A cumulative watershed effects assessment area has been delineated for this EIR, comprised of the Noyo River and Big River watersheds and the Hare Creek, Mitchell Creek, Caspar Creek, and Russian Gulch planning watersheds (presented earlier in Figure V.3). The assessment area is comprised of 32 planning watersheds, as delineated and defined by CALWATER 2.2 (http://www.ca.nrcs.usda.gov/features/calwater/). Sixteen of these planning watersheds are part of the Big River watershed, 12 are part of the Noyo River watershed, and 4 drain directly into the Pacific Ocean. To guide the assessment of cumulative watershed effects, these planning watersheds have been designated according to whether the streams have the potential to receive direct impacts from JDSF management, the potential to contribute impacts to streams on JDSF, or the potential to receive impacts downstream as the result of JDSF management (Figure V.3). Seventeen of the planning watersheds in the assessment area contain portions of JDSF ownership. The percentage of these individual planning watersheds that contain JDSF acreage range from 1 to 99%. Table VII.10.2 displays more detailed information regarding the 32 planning watersheds in the JDSF assessment area.

10.3 Hydrology

The majority of Jackson Demonstration State Forest is less than 2,000 feet above sea level, and the great majority of precipitation falls as rain. Snowfall occurs occasionally in the higher elevations and rarely accumulates. Snow, therefore, is not considered to have any appreciable effect on watershed hydrology at JDSF. Mean annual precipitation ranges from 39 inches on the coast at Fort Bragg (CDWR 1997) to 55 inches east of JDSF at Willits (CDWR 1997) and 70 inches on the eastern edge of JDSF based on isohyetal information in Rantz (1972). The majority of the rainfall occurs between October and April.

10.3.1 Streamflow

A USGS stream gauging station (USGS 11468500) has operated on the Noyo River (drainage area = 67,840 acres) since water year 1952. During this period of operation, large runoff events have occurred in 1955, 1964, 1974, and 1993, with peak flows ranging from 22,000 to 26,600 cubic feet per second (cfs). Streamflow data is available from the USGS at the following web site: http://nwis.waterdata.usgs.gov/nwis/peak/?site_no=11468500. No long-term, continuous stream gaging stations are located in the Big River watershed. Two long-term gaging stations are located within the boundaries of JDSF at the South Fork Caspar Creek (1,047 acres) and the North Fork Caspar Creek (1,168 acres). Streamflow has been measured at these sites by CDF and the U.S. Forest Service since water year 1963, and large runoff events were measured on the North Fork gage in 1964, 1966, 1974, 1993, and 1999, with peak flows ranging from 242 to 305 cfs (USFS Caspar Creek webpage). In 1985, thirteen additional stream gauging stations were constructed in the North Fork Caspar Creek to measure peak flows, flow volumes, and suspended sediment loads in anticipation of the future harvesting in the watershed. Seven North Fork stations were discontinued after water year 1995, following the completion of the North Fork phase of the project. Recently, 10 new stream gauging stations have been installed in the South Fork for pre-project information, with data collection beginning in water year 2001. Currently, there are 10 tributary or mainstem stations operating in SF Caspar Creek in addition to the original SF weir, and seven tributary or mainstem stations operating in the NF Caspar Creek in addition to the original NF weir, for a total of 19 stations. Streamflow data for the Caspar Creek stations are available online at the USFS-PSW website for the Caspar Creek watershed study.

Table VII.10.2. Characteristics of the Planning Watersheds within the JDSF EIR Cumulative Watershed Effects Assessment Area.

Watershed No.	Tributary to	Planning Watershed Name	Planning Watershed Acres	CWE	JDSF ACRES	% JDSF
1113.300402	Big River	Berry Gulch	7,999	DIRECT	5,020	63
1113.300302	Big River	Chamberlain Creek	7,868	DIRECT	7,792	99
1113.300101	Big River	Dark Gulch	7,156	CONTRIBUTING		0
1113.300303	Big River	East Branch NF Big River	5,160	CONTRIBUTING	169	3
1113.300301	Big River	James Creek	4,459	DIRECT	3,208	72
1113.300401	Big River	Laguna Creek	3,246	CONTRIBUTING		0
1113.300104	Big River	Leonaro Lake	5,330	CONTRIBUTING		0
1113.300304	Big River	Lower North Fork Big River	4,953	DIRECT	2,790	56
1113.300201	Big River	Martin Creek	5,945	CONTRIBUTING		0
1113.300103	Big River	Mettick Creek	11,733	CONTRIBUTING		0
1113.300403	Big River	Mouth of Big River	9,549	DOWNSTREAM	1,646	17
1113.300203	Big River	Rice Creek	8,039	CONTRIBUTING		0
1113.300202	Big River	Russell Brook	7,017	CONTRIBUTING		0
1113.300102	Big River	South Daugherty Creek	10,668	CONTRIBUTING		0
1113.300406	Big River	Two Log Creek	11,433	DIRECT	544	5
1113.300305	Big River	Upper North Fork Big River	5,420	DIRECT	1,428	26
1113.200301	Noyo River	Brandon Gulch	6,449	DIRECT	6,244	97
1113.200202	Noyo River	Duffy Gulch	5,737	CONTRIBUTING		0
1113.200103	Noyo River	Hayworth Creek	7,112	CONTRIBUTING		0
1113.200303	Noyo River	Kass Creek	3,533	DIRECT	1,532	43
1113.200201	Noyo River	Little N. Fork	8,437	CONTRIBUTING	12	0
1113.200106	Noyo River	McMullen Creek	7,071	CONTRIBUTING		0
1113.200104	Noyo River	Middle Fork N. Fork Noyo River	4,569	CONTRIBUTING		0
1113.200403	Noyo River	Mouth of Noyo River	5,223	DOWNSTREAM	22	0
1113.200105	Noyo River	North Fork Noyo River	6,521	CONTRIBUTING	175	3
1113.200102	Noyo River	Olds Creek	6,969	CONTRIBUTING	41	1
1113.200302	Noyo River	Parlin Creek	7,578	DIRECT	6,058	80
1113.200101	Noyo River	Redwood Creek	3,363	CONTRIBUTING		0
1113.300404	Pacfic Ocean	Caspar Creek	5,360	DIRECT - COASTAL	4,838	90
1113.300405	Pacfic Ocean	Russian Gulch	7,095	DIRECT - COASTAL	1,311	18
1113.200401	Pacfic Ocean	Hare Creek	6,184	DIRECT - COASTAL	4,078	66
1113.200402	Pacfic Ocean	Mitchell Creek	6,555	DIRECT - COASTAL	1,743	27

10.3.2 Peak Flows

Timber harvesting and road building can increase peak flows of streams during storm events by altering evapotranspiration patterns, changing interception loss due to evaporation, increasing interception of subsurface flows by the road network, and altering snowmelt patterns. Changes in peak flows are perhaps of greatest concern from a cumulative effects perspective, where multiple land management activities affecting flow over space and time may result in a significant cumulative peak flow effect at some common downstream point. Appendix 10, Peak Flow Analysis, provides an extensive discussion of peak flows and presents a cumulative effects analysis of peak flow for the JDSF cumulative watershed effects assessment area.

Studies at Caspar Creek found that the greatest proportionate effect of logging on peak flow is to increase the size of the smallest flows during the driest antecedent conditions, with the percent increase becoming smaller as storm size and watershed wetness increase (Ziemer 1998). More recent studies of the peak flow data from Caspar Creek (Lewis and others 2001) have shown that logging also increases peak flows by reducing rainfall interception and transpiration, with the magnitude of peak flow increases related to the amount of area harvested in a watershed, number of years since harvest, and soil wetness at the beginning of the storm. Other work at Caspar Creek has found that canopy interception can account for about 22% of the annual rainfall in second-growth redwood forests (Reid and Lewis 2004). In combination with transpiration, this interception loss is sufficient to account for the peakflow changes observed after logging. The estimated average peak flow increase for a two-year return period discharge was 27 percent for 100 percent clearcut tributary watersheds (excluding WLPZ areas along streams) and was 9 percent for the 50 percent cut North Fork watershed (Ziemer 1998, Rice and others 2001). Revegetation of an area diminished the effect of peak flow increases at a rate of about nine percent per year, with estimated recovery to pre-harvest conditions in 11 years (J. Lewis, USFS-PSW, personal communication), while recovery of total storm flow volume to pre-harvest levels was complete at 10 years.

Logging operations do not appear to substantially increase peak flows associated with harvesting for large, infrequent floods (i.e., greater than 20-year recurrence interval) (Mount 1995). Forest practices have less influence on large floods because a much higher percentage of the watershed is involved in producing runoff during these events (Mount 1995, Ziemer and Lisle 1998). However, the effect of timber operations on large peak flow events are difficult to detect, particularly as flood size and basin size increases (Beschta and others 2000), because: (1) floods are, by definition, rare events, so statistical samples are small; (2) measurement errors increase as the size of the flood event increases; and (3) the relative effects of management activities decrease as the size of the event increases, so that the proportionate increase, if any, is small (Ziemer and Lisle 1998, Grant and others 1999). A review on this subject stated that “the weight of hydrologic evidence is that the biggest floods are little affected by management, but the jury is still out—there just aren’t enough big floods in the record to get a clear picture of how management might be influencing them” (Grant and others 1999).

In summary, clearcutting small basins, leaving only riparian buffer strips, can increase mid-winter peak flow events that cause overbank flooding (i.e., 2-year recurrence interval floods) by an average of approximately 30 percent in rain-dominated hydrologic regimes (Ziemer 1998). These small headwater basins are generally not anadromous fisheries habitat. When significant percentages of larger fish bearing watersheds have been clearcut in a relatively short time frame (i.e., 30 to 50 percent in less than 10 years), 2-year recurrence interval peak discharges have been increased by about 10 percent or less under average soil moisture conditions. These levels of potential increases are generally thought to be relatively benign in most cases and not capable of substantially modifying the morphology of stream channels (Ziemer 1998), since the magnitude of peak flow changes is substantially less than the within-year and year-to-year streamflow variability. In other words, the changes are within the normal range of streamflow variability (Grant and others 1999).

Appendix 10 provides more detailed information about the Caspar Creek studies mentioned above. It also includes peak flow modeling for the seven alternatives considered in this EIR. This analysis looks back at timber harvests over the past 10 years (the period of "decay" for the flow effects of harvesting) and looks forward through 2009 to estimate future peak flow effects from projected harvesting activity. A summary of the modeling findings is presented below under Impact 4.

10.3.3 Water Yield and Summer Low Flows

The effects of selective logging on low flows have been examined in studies conducted on the Caspar Creek watershed near Fort Bragg, California. In the South Fork watershed, about 60 percent of the second-growth stands of redwood and Douglas-fir were tractor logged from 1971 to 1973. This vegetation removal resulted in statistically significant summer low flow increases for 7 years after logging. Minimum discharges averaged 38 percent larger after the selective harvesting and summer low flow volume increases averaged 29% (Keppeler and Ziemer 1990, Rice and others 2001). The average length of the period when flow in the South Fork was less than 0.2 cfs decreased by 43 days from 1972 to 1978, a 40% reduction.

In the North Fork, approximately 50 percent of the watershed was clearcut harvested over about 7 years from 1985 to 1991. Following harvesting, minimum discharge increases averaged 148 percent and the period of water yield enhancement persisted through hydrologic year 1997, with no recovery trend observed. The larger increases in the North Fork were probably due to wetter soils in the clearcut units where little vegetation was present to deplete the soil moisture (Keppeler 1998). It is also likely that flow volume effects will persist longer after clearcutting than when a similar timber volume is removed from a watershed with selective cutting. These differences in water yield are probably related to changes in rainfall interception and evapotranspiration (Rice and others 2001). As a result of the enhanced summer low flows, aquatic habitat in stream channels and the length of the flowing channel network were increased along logged reaches (Keppeler 1998).

The low flow results reported for Caspar Creek are consistent with findings in other locations. For example, Chamberlin and others (1991) reported that harvested areas contained wetter soils than unlogged areas during periods of evapotranspiration, which led to higher groundwater levels and greater late-summer runoff. This effect also has been documented in other studies (Harr 1972, Hetherington 1987). Long-term effects of logging on summer low flows are likely to depend on vegetation composition before and after harvest (Spence and others 1996). After 10-30 years, base flow may return to normal or decrease below pre-harvest levels due to rapidly growing hardwoods that transpire more water than mature trees (Murphy 1995). In the summary of lessons learned from northwest California, Rice and others (2001) state that increases in water yield and summer low flows diminish over time and will probably be of minimal importance compared to other forest management and production goals.

10.4 Water Quality

Water quality and beneficial uses criteria are primarily based on the physical properties and chemical constituents of water. For JDSF and the JDSF EIR assessment area, the most important water quality parameters are stream water temperature, sediment-related parameters (such as suspended sediment and turbidity), dissolved oxygen, nutrients, and fecal coliform (bacteria). Water temperature, however, is discussed in the Aquatics section and will not be elaborated on in this section.

10.4.1 Total Maximum Daily Load (TMDL)

Section 303(d) of the federal Clean Water Act requires each state to prepare a list of water bodies within its boundaries that do not meet water quality standards with existing management practices and to submit this list to the U.S. Environmental Protection Agency (EPA) for approval. Once a body of water is added to a 303(d) list, a TMDL (total maximum daily load) for that water body is developed to specify the maximum amount of a given pollutant the waterway can absorb from all sources, plus a margin of safety, without violating water quality standards for designated uses (such as drinking water, aquatic life, and recreation). Both the Noyo River and Big River watersheds, which include the bulk of JDSF (see Table VII.10.2) are listed as sediment impaired and have had TMDLs prepared (U.S. EPA 1999 and U.S. EPA 2001, respectively). Big River is also listed for temperature, but development of the temperature TMDL is not yet scheduled.

10.4.2 Sediment and Turbidity

Although erosion rates in the Coast Ranges are naturally high, management-related activities have accelerated sediment production in many areas. Sediment from roads can come from erosion of road surfaces, cuts and fills, or slope failures associated with construction and/or drainage (e.g., blocked culvert inlets). Timber harvesting can lead to surface erosion from roads, landings, skid trails, and other compacted areas (MacDonald and others 1991, Murphy 1995, Chamberlin et al. 1991). Mass wasting can be a very large sediment contributor to streams in areas susceptible to landsliding. For example, Furbish and Rice (1983) found that a high proportion of their sampled landslides occurred near streams and immediately below the major convex break in slope for their sampled sites in northwestern California. They concluded that the high proportion of slides near streams probably reflects oversteepening of hillslopes by stream undercutting, and possibly greater buildup of destabilizing pore water pressures. Increased sediment yields from slope failures and road surface runoff can continue after harvesting operations have been completed. Implementation of the modern Forest Practice Rules (FPR) and Best Management Practices (BMPs) over the last 30 years, however, have significantly decreased sediment input to streams relative to past practices (Rice 1999, Cafferata and Spittler 1998; Lewis 1998; Lewis and others 2001, Ice and others 2004, CDF 1995; SWRCB 1987, Cafferata and Munn 2002).

Research at Caspar Creek in JDSF has shown that the modern FPRs can reduce water quality impacts. Selective tractor logging and streamside road construction in the South Fork completed prior to implementation of contemporary forest practices was shown to produce 2.4 to 3.7 times more suspended sediment than was measured in the North Fork with clearcutting and cable logging operations conducted under the modern FPRs (Lewis 1998, Lewis and others 2001). Numerous landslides were documented after road construction and logging in the South Fork, while the size and number of landslides through 1998 were similar in logged and unlogged units in the North Fork (Cafferata and Spittler 1998).

Further discussion of sediment issues can be found in section VII.7, Soils and Geology, and in Appendix 11, Summary of Existing Road and Sediment Studies.

Characterization and quantification of suspended sediment production was conducted through exploratory analysis and model fitting of the North Fork Caspar Creek data (Lewis and others 2001).

While suspended sediment concentrations (SSC) have been measured in the North and South Forks weirs of Caspar Creek since water year 1963, direct field turbidity measurement did not begin until the mid 1990s. Turbidity is strongly related to SSC [e.g. for the 1998 data, the relation of turbidity (T) to SSC was $T = 1.89 \times SSC^{0.49}$ (Lewis 2000)]. Table VII.10.3 below shows the turbidity frequency of these two paired watersheds between 1996 and 1999 (Lewis 2000).

In general, the North Fork had higher turbidity than the South Fork only in 1996 and 1997. Due to the El Nino water year in 1998, record precipitation (during the life of the Caspar Creek study) increased the suspended sediment in both forks of Caspar Creek, and generated numerous landslides related to the old road network in the South Fork watershed (Cafferata and Spittler 1998). Additionally, several miles of road decommissioning work was conducted the South Fork in the summer of 1998, which is also likely to have contributed to the rise in turbidity. Much of the turbidity increase seen in the North Fork can be attributed to a large landslide located in a tributary just above the North Fork weir (Lewis and others 2001).

Data from the Caspar Creek watershed study shows that over the 1996 to 1999 hydrologic years , the North and South Forks have averaged 17 and 19 days over 40 NTUs each year, respectively (Lewis 2000). Both field and laboratory studies reveal that while the foraging efficiency of juvenile salmonids are decreased by increased turbidities, fish continued to capture prey at turbidity levels in the range of 40-50 NTUs (Hadden and others 2004). Turbidity levels exceeded 100 NTUs in the North and South Forks approximately 3 and 5 days, respectively, each year. It is likely that several of the planning watersheds in the western portion of JDSF have generally similar numbers of days with elevated turbidity levels.

Table VII.10.3. Turbidity Frequency. (Turbidity expressed in # days exceeded, 1996-1999)

Turbidity (NTU)	NF96	SF96	NF97	SF97	NF98	SF98	NF99	SF99
40	7.90	4.56	12.69	12.97	32.12	33.58	14.76	25.88
60	2.77	1.98	8.24	6.49	12.94	20.05	6.79	10.94
80	1.12	1.22	6.98	4.22	6.99	13.02	3.07	7.05
100	0.84	0.62	5.80	3.35	4.69	9.21	1.51	5.14
150	0.40	0.31	2.07	2.17	1.97	5.06	0.69	2.87
200	0.25	0.17	1.51	1.47	0.85	2.94	0.49	1.70
250	0.10	0.03	0.97	0.77	0.38	1.85	0.36	1.10
300	0.08	0.00	0.76	0.48	0.19	1.28	0.28	0.91
400	0.05	0.00	0.61	0.25	0.15	0.72	0.22	0.53
500	0.02	0.00	0.56	0.19	0.11	0.44	0.15	0.42

In a study of logging effects on stream biology in the North Fork Caspar Creek, Bottorff and Knight (1996) found little or no evidence of adverse impacts on benthic macroinvertebrate communities. Significant increases after logging were found in macroinvertebrate density and diversity, *Ephemeroptera-Plecoptera-Trichoptera* (EPT) density and diversity, chiromomid density, and leaf decay rates. None of the observed changes could be attributed to the effects of fine sediment on the stream biota, but many effects resulted from changes in light conditions (or nutrients and/or water temperature). Nakamoto (1998) reported that while variability was high, no dramatic changes in the abundance of coho salmon or steelhead trout were recorded after the North Fork logging occurred.

Some of the main conclusions drawn from the Caspar Creek sediment studies are:

- Much of the increased sediment load was related to increased storm flow volumes that are short-lived (approximately 10-11 years without pre-commercial thinning) due to rapid forest vegetation regrowth. In general, downstream suspended load increases were no greater than would be expected from the proportion of land disturbed, and the effects of multiple disturbances on suspended loads were approximately additive (Lewis 1998, Lewis and others 2001).
- Sediment loads are influenced by deposition at temporary storage sites. Annual sediment loads increased 123 to 269 percent in the tributaries, but increased sediment yields at mainstem stations were detected only in small storms and had

little effect on annual sediment loads. Sediment loads were affected as much by channel conditions (e.g. organic debris, sediment storage sites, channel gradient, and width-to-depth ratio) as by sediment delivery from hillslopes (Lewis and others 2001).

- Sediment increases in North Fork tributaries probably could have been reduced by avoiding activities that denude or reshape the banks of small drainage channels (Lewis and others 2001).

Sediment-related issues associated with geology (surface erosion, mass wasting) are discussed in the Geology and Soils section. Appendix 11 provides a detailed summary of past sediment studies throughout the JDSF EIR assessment area.

10.4.3 Dissolved Oxygen

Dissolved oxygen (DO) is the concentration of oxygen dissolved in water. Adequate DO levels are important for the survival of fish, invertebrates, and other aquatic life. In general, DO concentrations should not be below 5-6 ppm for growth of anadromous fish (Krammes and Burns 1973, Murphy 1995). The capacity of water to hold oxygen in solution is inversely proportional to temperature (e.g., higher stream temperatures result in lower DO). In general, most forest streams have adequate DO because turbulence keeps DO near saturation (about 10 mg/l at 10^{o} C) (Murphy 1995). Forest streams generally have low vulnerability to low DO because fine organic matter is usually minimal and re-aeration of flowing water is more than sufficient to maintain high levels of DO.

Limited dissolved oxygen data has been collected in the JDSF EIR assessment area. In 1967, prior to the implementation of the modern Forest Practice Rules, Krammes and Burns (1973) reported that dissolved oxygen concentrations of as low as 5 ppm were measured in the South Fork of Caspar Creek near road construction activities and in some isolated pools holding decaying slash. Dissolved oxygen was also measured by Kopperdahl and others (1971) in April, August, October, and February 1968-1969 in the unlogged North Fork Caspar Creek and in the recently roaded South Fork Caspar Creek. DO samples ranged from 9.4 to 12.0 ppm on the North Fork and 8.6 to 12.0 ppm on the South Fork (Kopperdahl and others 1971). These DO values are in the range of DO saturation, however decomposition of logging slash was seen as a cause for an increase in the amount of carbon dioxide concentration in the logged SF Caspar Creek basin. Current forest practices prohibit putting slash into streams, so timber operations are not likely to reduce DO through an increase in biological oxygen demand (BOD), except where DO is naturally low (Skaugset and Ice 1989).

10.4.4 Nutrients

Nitrogen and phosphorus are nutrients that stimulate plant growth, and the primary productivity of water bodies is often determined by the nitrogen to phosphorus ratio in the water column. Forest streams in the Pacific Northwest commonly have very low background concentrations of nitrogen compounds, often lower than 0.01 mg/l (MacDonald and others 1991, WDNR 1997). Nitrogen export to the aquatic system also varies greatly during the year, reaching annual maximums in autumn with leaf fall (WDNR 1997). Nitrogen-fixing plants such as alder can increase levels of dissolved nitrogen (nitrate) in stream runoff. Nitrate is the predominant form in unpolluted water, and ammonia may exist as an intermediate breakdown product of organic nitrogen, fertilizers, and animal wastes. Both ammonium and nitrate are readily taken up by aquatic biota, so an increase in nitrate concentrations upstream tends to diminish rapidly downstream. However, biological activity due to increased concentrations of nitrogen can deplete dissolved oxygen, which could affect fish and other aquatic organisms.

Phosphorus is tightly conserved within forest ecosystems (Salminen and Beschta 1991, WDNR 1997). Studies in forested watersheds indicate phosphorus tends to be adsorbed to and carried by fine sediment (Meyer 1979; Holton and others 1988). The adsorbed phosphorus on the fine sediment is contained within the mineral lattice of the sediment where it is not available for dissolution or biological uptake (WDNR 1997). The effect of phosphorus adsorption by stream sediments is to convert dissolved phosphorus to fine-particulate phosphorus, which is suspended during periods of high, turbulent flows, primarily during the winter months. The dependence upon high turbidity and suspended sediment reduces the availability of summertime phosphorus (WDNR 1997). However, the dynamics of phosphorus and sediment in stream systems of western coastal forests have generally received little attention (Salminen and Beschta 1991, WDNR 1997). Reuter and Miller (1999) provide a detailed analysis for the Lake Tahoe basin.

Timber harvesting, burning, and grazing may cause an increase in stream nutrients. Harvesting of forests has been shown to increase nitrate levels as much as three to five times for up to three to five years (WDNR 1997—citing Fredricksen and others 1975; Sollins and McCorison 1981), although severe burning has resulted in changes 10 times higher. Soil erosion and input of organic matter are the primary mechanisms for increasing phosphorous levels in aquatic systems (WDNR 1997, MacDonald and others 1991). Systematic scientific reviews, however, have concluded that forest practices in the wetter Pacific Northwest forests are unlikely to increase phosphate concentrations substantially in aquatic systems (WDNR 1997—citing MacDonald and others 1991; Salminen and Beschta 1991; Wolf 1992). Levels of phosphorus in the North Fork Caspar Creek watershed have been documented by Dahlgren (1998), who found dissolved P fluxes were very low in both the clearcut and reference watershed. Dahgren (1998) reported that there may have been some indication of a small increase in P fluxes in the clearcut prior to the 1993-94 water year.

Water chemistry variables (total alkalinity, hardness, dissolved solids, total phosphate, nitrate, chloride, sulfate, tannin, and pH) measured in the North and South Forks of Caspar Creek in 1968-1969 generally varied between seasons, but conditions in logged and unlogged streams were usually similar (Kopperdahl and others 1971). Dahlgren (1998) studied the effects of clearcutting on nitrate concentration in stream water in the North Fork Caspar Creek watershed and reported that nitrate concentrations in stream water increased after clear-cutting, especially during high-discharge storm events. The elevated nitrate concentrations, however, were substantially reduced downstream and returned to background levels downstream of the experimental watershed. Bottorff and Knight (1996) found that an increase of light, water temperature, and/or nutrients, after logging in the North Fork led to increases in benthic algae and corresponding increases in density, relative abundance, and number of taxa in macroinvertebrate populations.

10.4.5 Fecal Coliform

Fecal coliform bacteria are commonly used for water quality monitoring because they are present in the gut and feces of warm-blooded animals and contribute to gastro-intestinal illness in humans. In forested areas, high levels of coliform bacteria are associated with inadequate waste disposal by recreational users, the presence of livestock or other animals in the stream channel, and poorly maintained septic systems (MacDonald and others 1991).

The day-use areas and campgrounds in JDSF use pit toilets from which wastes are removed and trucked to a wastewater treatment plant. Mendocino Woodlands Camp and the Parlin Fork Conservation Camp use septic tanks and leach fields. Two additional leach fields are planned for the Parlin Camp. A new septic system/leach field was installed at the Chamberlain Creek Conservation Camp during the summer of 2004. There are no data suggesting that contamination by fecal coliform bacteria is a problem in the JDSF assessment area.

10.4.6 Grazing Animals

The New McGuire Ranch currently supports about 80 cattle and 10 horses in an area that is upstream of JDSF lands in the headwaters of the South Fork Noyo River. The South Fork Noyo River is dammed at its headwaters, outside of JDSF, to provide a water source for the cattle (i.e., McGuire's Pond or Camp 19). The Watershed Sanitary Survey prepared for the City of Fort Bragg's Water System (SHN 1995) rates the impact to water quality of grazing animals and other agricultural activities at Camp 19 as low.

Deer and other wild mammals are common on JDSF lands, and can be assumed to have minor water quality impacts, since grazing and wild animals are probable sources for Giardia cysts, viruses, and bacteria that are present at low levels in the water supply of the City of Fort Bragg. Analysis of water samples collected from the Noyo River, Newman, and Simpson (Waterfall Gulch) diversions revealed no problems with general mineral, physical, or inorganic water quality parameters (SHN 1995).

10.4.7 Domestic Water Supplies

The City of Fort Bragg draws about 60 percent of its water from an intake on the Noyo River that is located 2.4 miles downstream from the confluence of the South Fork Noyo River with the main stem (SHN 1995). The city's entitlement at this diversion point is 3 cubic feet per second (cfs) year around, with a maximum volume 1,500 ac-ft/yr, but the actual diversion averages less than 1 cfs because of low-flow and bypass requirements. Summer turbidity levels average approximately 0.8 NTUs, while winter turbidities average about 15 NTUs. Normal winter storms elevate turbidity levels to about 70-80 NTUs, with spikes well into the 100's of NTUs (T. Steinhardt, City of Fort Bragg, Water Plant Manager, per. communication). The diversion is screened with a CDFG-approved fish screen to reduce the potential for fish entrainment (J. Murphy, 1997, pers. comm.).

Fort Bragg also draws water by direct surface diversion from Newman Gulch and Waterfall Gulch, two small streams in the Lower Noyo River (outside of JDSF), and Hare Creek planning watersheds, respectively. These diversions are from non-fish bearing streams, so the intakes are not screened (J. Murphy, 1997, pers. comm.), but water from these streams is stored and treated before it is distributed. Water from Newman Gulch is routed to Newman Reservoir, an earthen dam impoundment with a storage capacity of from 2 to 4 acre feet (0.7 to 1.3 million gallons), before entering the City's water plant. This source is apparently used sporadically, when naturally occurring discoloration from tannins and other organics in the lower Noyo River is unacceptably high (SHN 1995). Water from the Waterfall Gulch diversion is stored in Simpson Reservoir, which has a storage capacity of about 5,000 gallons, prior to treatment. The City of Fort Bragg is entitled to 300 acre-feet/year at Newman Gulch Reservoir and 475 acre-feet /year from at the Waterfall Gulch diversion, with a maximum diversion rate of 0.67 cfs.

Georgia Pacific Corporation (G-P) owns a surface water diversion on the Noyo River with an entitlement of 1.33 cfs. This water right was retained by G-P when its property was sold to Hawthorne Timber Company, but the diversion is currently idle since the G-P mill in Fort Bragg is no longer operational. The G-P diversion uses the same intake point as the City of Fort Bragg (L. Walker, 1997, pers. comm.).

Most of the South Fork Noyo River watershed (which includes the Parlin Creek, Brandon Gulch and Kass Creek planning watersheds) is within the boundaries of JDSF, and impacts to water quality in these watersheds could affect the drinking water supply of Fort Bragg and the G-P water supply.

Parlin Fork Conservation Camp, located at the confluence of Parlin Creek and the South Fork Noyo River, is supplied by water pumped from an infiltration gallery that is 20 feet below the bed of the South Fork Noyo River and just downstream of the confluence with Parlin Creek. During normal operation, this system takes in about 8,000 gallons per day and supplies water for about 115 people. During storms, when the South Fork Noyo River is turbid, water is supplied from storage tanks with a capacity of 40,000 gallons. The Camp is also developing additional wells (F.Yee, CDF,1997, pers. comm.) for alternative supply.

Chamberlain Creek Conservation Camp is located on Chamberlain Creek, just upstream of its confluence with the North Fork of Big River. Until 1997, drinking water for approximately 130 people at Chamberlain Creek Camp and a nearby trailer park was pumped from an intake 15 to 20 feet below the bed of Chamberlain Creek, which took in about 15,000 gallons per day, with a total storage capacity of 60,000 gallons. Since 1997, water for drinking and other consumptive purposes at the Chamberlain Creek has been supplied from a well (B. Dalsky, 1997, pers. comm.). Problems with the sand filtration system of the under-bed intake on Chamberlain Creek necessitated this change in water supply source. Water used for irrigation at the Chamberlain Creek Camp is piped from a natural spring located approximately 0.5 miles north of the Camp.

In addition to these water supplies, there are approximately 27 other listed water rights in or near JDSF (see Table 2.2.4.1 in CDF 1999). These are mostly for domestic use and irrigation, and not all are in active use. The Mendocino Woodlands Camp water supply is from several small headwater streams and horizontal wells on JDSF property.
The California Department Health Service's (DHS's) Division of Drinking Water and Environmental Management is the lead agency for developing and implementing the Drinking Water Source Assessment and Protection (DWSAP) Program. An inventory of both surface and groundwater drinking water supply sources by county is available on-line at the DHS website (http://www.dhs.cahwnet.gov/ps/ddwem/dwsap/DWSAPindex.htm). This site includes an assessment for each drinking water source. The assessments for Mendocino County are 99% completed (L. Walker, DHS, per. communication in 2003). From the inventory list for Mendocino County on the DHS website, two additional surface water sites were identified within the JDSF EIR assessment area. However, since the events of September 11, 2001, DHS requires that the public agencies using the assessments keep the documents and the information that they contain confidential. A complete list of the permitted domestic surface water supplies found within the JDSF EIR assessment area is shown in Table VII.10.4.

The DHS's drinking water source assessment is the first step in the development of a complete drinking water source protection program. The assessment includes: (1) a delineation of the area around a drinking water source through which contaminants might reach that drinking water supply, (2) an inventory of possible contaminating activities (PCAs) that might lead to the release of microbiological or chemical contaminants within the delineated area, and (3) a determination of the PCAs to which the drinking water source is most vulnerable.

Table VII.10.4. Permitted Surface Water Systems located within the JDSF EIR assessment area.

Name	Source No.	Watershed
Sea Rock Inn	2300621	Slaughter House Gulch
City of Fort Bragg	2310001-01	Newman Gulch Intake
City of Fort Bragg	2310001-02	Noyo River Pump Station
City of Fort Bragg	2310001-03	Simpson Creek Intake
Russian Gulch State Park	2310304	Russian Gulch
Parlin Fork Conservation Camp	2310800	South Fork Noyo River
Chamberlain Creek Conservation Camp	2310801	Chamberlain Creek tributary

10.5 Regulatory Framework

Evaluating potential hydrologic and water quality impacts involves consideration of federal, state and local regulations, standards and policies. Actions resulting from the Forest Management Plan may be subject to one or more of the following standards:

Federal Clean Water Act. The Noyo River and Big River have been listed as sediment impaired watercourses by the U.S. Environmental Protection Agency, under Section 303 (d) of the Clean Water Act, and Big River has been listed as temperature impaired. As a result of these listings, technical Total Maximum Daily Load sediment reports have been prepared (U.S. EPA 1999 and 2001). These reports estimate existing sediment loads and sources, and define required reductions in sediment input, including significant reductions in sediment derived from roads.

State Porter-Cologne Water Quality Act. This state law mandates the development of a Water Quality Control Plan (i.e., Basin Plan) for the North Coast Region and other water quality regions in California.

Waste discharge prohibitions pertaining to logging, construction, and associated activities in the North Coast Region include:

1. The discharge of soil, silt, bark, slash, sawdust, or other organic and earthen material from any logging, construction, or associated activity of whatever nature into any stream or watercourse in the basin in quantities deleterious to fish, wildlife, or other beneficial uses is prohibited.
2. The placing or disposal of soil, silt, bark, slash, sawdust, or other organic and earthen material from any logging, construction, or associated activity of whatever nature at locations where such material could pass into any stream or watercourse in the basin in quantities which could be deleterious to fish, wildlife, or other beneficial uses is prohibited.

The following water quality objectives, from Section 3 of the North Coast Region Basin Plan, are considered of particular importance in protecting beneficial uses of water from unreasonable effects due to discharges from logging, construction, or associated activities:

1. Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses.
2. Turbidity shall not be increased more than 20 percent above naturally occurring background levels.
3. Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, which cause nuisance or adversely affect the beneficial uses.
4. Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.
5. Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
6. The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
7. All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.

8. Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

Further discussion of the regulatory framework for state water quality law as implemented by the North Coast Regional Water Quality Control Board is presented in section VII.7, Geology and Soils. That section includes a discussion of General Waste Discharge Requirements (GWDR) for Discharges Related to Timber Harvest Activities on Non-Federal Lands and the Categorical Waiver of Waste Discharge Requirements for Discharges Related to Timber Harvest Activities on Non-Federal Lands. The section also discusses the Water Board's November 29, 2004 Resolution No. R1-2004-0087, which is a policy statement to implement sediment TMDLs throughout the North Coast region for all sediment impaired water bodies. GWDRs also are discussed below under Impact 1.

California Forest Practice Rules (FPRs). The FPRs have numerous requirements regarding soil erosion and water quality impacts. Many of these requirements are summarized in Appendix 8, Pertinent Geology- and Erosion-Related Forest Practice Rules. Examples include:

- Article 4, Harvesting Practices and Erosion Control, section 914.2: Limits tractor operations to minimize soil disturbance.
- Article 4, Harvesting Practices and Erosion Control, Section 914.6: Waterbreak spacing along roads and skid trails relative to the Erosion Hazard Rating;
- Article 6, Watercourse and Lake Protection: "The purpose of this article is to ensure that the beneficial uses of water… are protected from potential significant adverse site-specific and cumulative impacts associated with timber operations." This section includes many provisions for the protection of water quality.
- Article 12, Logging Roads and Landings: "All logging roads and landings in the logging area shall be planned, located, constructed, reconstructed, used and maintained in a manner which… minimizes damage to soil resources and fish and wildlife habitat; and prevents degradation of the quality and beneficial uses of water." This section includes a number of provisions for the protection of water quality.

Z'berg Nejedly Forest Practice Act of 1973. The Z'berg-Nejedly Forest Practice Act was passed in 1973, and new Forest Practice Rules written pursuant to this act went into effect in January 1975. The Act was written to ensure the continued productivity of our forests and protection of non-timber forest resources.

U.S. Endangered Species Act. The ESA provides for conservation of species that are in danger of or threatened with extinction throughout all or a significant portion of their range and for the conservation of ecosystems on which they depend. "Species" is defined by the Act to mean a species, a subspecies, or, for vertebrates only, a distinct population. An individual or organization may petition to have a species considered for listing under the Act as endangered or threatened. The listing of a species qualifies it for increased protective measures. Generally, the U.S. Fish and Wildlife Service (FWS) coordinates

ESA activities for terrestrial and freshwater species, while the National Oceanic and Air Administration (NOAA) Marine Fisheries Service (NOAA Fisheries) is responsible for marine and anadromous species. Within 90 days of the filing of a listing petition, the responsible agency must decide whether the petition includes substantial information that may warrant listing. If so, the agency conducts a status review of the species. NOAA Fisheries or FWS can also initiate a status review without a petition for listing. Once initiated, a status review includes a public solicitation for information and data relevant to the population size and life history of the species proposed for listing.

A species must be listed if it is threatened or endangered due to any of the following five factors:

- present or threatened destruction, modification, or curtailment of its habitat or range;
- over-utilization for commercial, recreational, scientific, or educational purposes;
- disease or predation;
- inadequacy of existing regulatory mechanisms;
- and other natural or manmade factors affecting its continued existence.

The ESA prohibits the consideration of economic impacts in making species listing decisions, and agencies are required to make a listing decision based solely on the best scientific and commercial data available. The decision to propose a species for listing must be made within one year after the receipt of a listing petition. If the agency proposes a listing, public comments are solicited, and a final decision must be made within one year after the issuance of the proposal. Critical habitat necessary for the continued survival of the species is also designated by the agency, and this determination does include consideration of economic impacts. After a species is listed, a recovery plan is prepared which identifies the necessary conservation measures. In addition, Section 7 of the ESA requires all Federal agencies to use their authorities to conduct conservation programs and to consult with NOAA Fisheries (or FWS) concerning the potential effects of their actions on any species listed under the ESA.

Within the JDSF EIR assessment area, the federally listed aquatic species that require properly functioning habitat and adequate water quality are coho and chinook (federal proposed threatened) salmon and steelhead trout.

California Endangered Species Act (CESA). The California Endangered Species Act (CESA) (Fish & Game Code §§ 2050, *et seq.*) is administered by the California Department of Fish and Game (DFG) and generally parallels the main provisions of the Federal Endangered Species Act. Under CESA the term "endangered species" is defined as a species of plant, fish, or wildlife that is "in serious danger of becoming extinct throughout all, or a significant portion of its range" and is limited to species or subspecies native to California.

CESA also establishes a petitioning process for the listing of threatened or endangered species. The California Fish and Game Commission is required to adopt regulations for this process and to establish criteria for determining whether a species is endangered or threatened. The California Code of Regulations, Title 14 §670.1(a) sets forth the required contents for such a petition. CESA prohibits the "taking" of listed species except as otherwise provided in State law. Unlike its Federal counterpart, CESA applies the take prohibitions to species petitioned for listing (state candidates). Section 86 of the Fish and Game Code defines "take" as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." State lead agencies are required to consult with DFG to ensure that any action it undertakes is not likely to jeopardize the continued existence of any endangered or threatened species or result in destruction or adverse modification of essential habitat.

Within the JDSF EIR assessment area, the state listed aquatic species that requires properly functioning habitat and adequate water quality is the coho salmon.

Streambed Alteration Agreements. The Department of Fish and Game uses its authority under Section 1600 et seq. of the Fish and Game Code to regulate drafting of water from streams for forest management purposes such as watering roads for dust abatement. The DFG has developed standard guidelines (Hendrix 2004, pers. com.) that are typically imposed as part of streambed alteration agreements to ensure that drafting does not result in water quality or flow effects that could adversely affect fish and other aquatic species. These guideline address factors such as timing, soil disturbance, impoundments and diversions, intake screening and placement, drafting rates, instream flows, and monitoring and record keeping,

California Environmental Quality Act

CEQA requires the preparation of an Environmental Impact Report (EIR) that must include a description of potentially significant effects, including what effects would be inevitable and those that could be permanent. The EIR must also contain information about measures that could be used to lessen the effects predicted and any alternatives to the project. THPs and the THP review process serve as the “functional equivalent” of an EIR for timber harvesting.

10.6 Proposed JDSF Management Measures

Appendix II of the DFMP contains detailed goals and objectives. Goals #3 (Watershed and Ecological Processes) and #4 (Forest Restoration) contain the following elements that are related to the protection of hydrologic and water quality resources:

- Maintain and recruit structural elements necessary for properly functioning habitats.
- Utilize forestry practices that will maintain hillslope stability and prevent sediment production from accelerated mass wasting and surface erosion (Hillslope Management Guidelines).
- Implement a comprehensive Road Management Plan that will reduce sediment production by upgrading roads in the permanent transportation network and by properly decommissioning high risk riparian roads where feasible.

- Restore and decommission selected roads to minimize WLPZ disturbance and erosion.
- Minimize sediment production from roads.

To achieve hydrologic and water quality goals, the DFMP incorporates the following plans and measures:

- Special Concern Areas (Appendix III of the DFMP), which includes watercourse and inner gorge protections.
- Road Management Plan (Appendix VI of the DFMP).
- Silvicultural Allocation Plan (Chapter 3, DFMP pages 47-49).[1]
- Hillslope Management to Provide for Slope Stability (Chapter 3, DFMP pages 71-72).

These measures (as described in the geology and forestry sections) will effectively address hydrology and water quality concerns by working to reduce sediment, turbidity, and peak flow production related to timber operations.

10.7 Additional Management Measure for an Accelerated Road Management Plan

Since the release of the DFMP, CDF has developed the following Additional Management Measure for application to JDSF to facilitate recovery of water quality impaired by sediment. This Additional Management Measure is proposed for application to alternatives C1 and C2.

The Road Management Plan provided for in the DFMP proposes to take 5 years to complete a survey and evaluation of all roads on the Forest. At that time, priorities would be set for road upgrade and decommissioning projects and the work on these projects would begin. CDF proposes to modify the Road Management Plan in the following way in order to more quickly achieve reductions in road-related sediment inputs into streams. To the extent feasible, accelerate the implementation of the Road Management Plan:

- Complete inventory of roads within 3 years rather than 5.
- Until completion of the road inventory, survey and evaluate all appurtenant roads as a part of each THP; complete the identified needed road upgrades as a part of the THP.
- Feasibility will be determined by availability of JDSF staff and contractors, availability of funding, and by ability to include road upgrade work as a part of timber sale contracts.

[1] Page references to the DFMP refer to the electronic version (PDF) posted at the Board's website: http://www.bof.fire.ca.gov/pdfs/jdsf_mgtplan_master%203b.pdf.

10.8 Thresholds of Significance

Based on policy and guidance provided by CEQA (Public Resources Code (PRC) Section 21001 and the CEQA Guidelines Appendix G), an impact of a proposed project would be considered significant to hydrology or water quality if it results in one or more of the following:

1. Violation of any water quality standards or waste discharge requirements;
2. Substantial depletion of groundwater supplies or interference with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted);
3. Substantial alteration of the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial on- or off-site erosion or siltation;
4. Substantial alteration of the existing drainage pattern of the site or area, including alteration of the course of a stream or river, or substantial increase in the rate or amount of surface runoff in a manner which would result in on- or off-site flooding;
5. Creating or contributing runoff water which would exceed the capacity of existing or planned stormwater drainage systems or would provide substantial additional sources of polluted runoff;
6. Otherwise substantial degradation of water quality;
7. Placing housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map;
8. Placing within a 100-year flood hazard area structures which would impede or redirect flood flows;
9. Exposing people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam; and
10. Inundation by seiche, tsunami, or mudflow.

10.9 Project Impacts

Hydrologic and water quality impacts are considered significant if they exceed targets set by federal, state, or local guidelines. Timber management and harvesting generally affects hydrology and water quality through tree canopy removal, loss of root strength, site disturbance by log skidding, and construction, maintenance, and use of the transportation network needed to access and to manage the property. The JDSF Management Plan does not propose to construct housing or any other buildings, does not contain a levee or dam, and the Forest area is not susceptible to seiche, tsunami, or mudflows. Hence impacts 7 through 10 above are not applicable to this project, and no impacts will occur under any alternative. Therefore, no further evaluation of these factors is necessary.

Impact 1: *Violate any water quality standards or waste discharge requirements*. (Less than Significant)

Surface erosion and mass wasting associated with roads and timber harvesting can potentially violate water quality standards by increasing turbidity levels in watercourses. Appendices 10 and 11 describe results from watershed studies conducted in the Caspar Creek watershed, which have included suspended sediment measurements. In general, suspended sediment and related turbidity were found to be complex and dynamic variables that vary from headwater to mainstem channels. However, increases in suspended sediment loads have been minimized by efforts to reduce management caused sediment inputs to drainage networks.

The DFMP incorporates watercourse protection measures (pages 63-64, and 70-71 DFMP), including several practices in addition to the standard California Forest Practice Rules. The specified watercourse protections will significantly minimize equipment work near stream channels. Vegetation requirements for watercourse protection zones will also minimize sediment delivery to the watercourses. The DFMP also includes a Road Management Plan (Appendix VI of the DFMP) to inventory, prioritize, and address road related erosion problems. Limited new road construction is anticipated, and upgrading and formal decommissioning of roads are goals of the plan. The new Additional Management Measure for an Accelerated Road Management Plan will help the speed up the delivery of the sediment reduction benefits of the Road Management Plan proposed in the DFMP.

As discussed in section VII.7, Geology and Soils, the DFMP proposes Hillslope Management Guidelines to minimize mass movement erosion and sediment production from timber operations. Inner gorge areas and potential unstable features will be identified during THP preparation or road layout, and a Certified Engineering Geologist will be consulted for appropriate measures to avoid or minimize potential impacts. The DFMP proposes to mitigate the potential for management-related landsliding through the identification of unstable areas and the implementation of low-impact management practices in those areas. Guidelines for these management strategies are contained primarily within the Road Management Plan, the Hillslope Management discussion, and the day-to-day guidelines presented in the Operational Implications of Watershed Analysis. Problem areas will be mitigated or avoided, as appropriate, and a Certified Engineering Geologist will be retained when operations or improvements are proposed on or near unstable areas. A Certified Engineering Geologist will review inner gorge slopes during layout of timber sales.

Specific riparian management mitigations include:

- Class I – 150 to 200 foot WLPZ; class II – 50 to 100 foot WLPZ. Zone widths are to be expanded where appropriate (e.g., unstable areas, etc.).
- Timber operations within channel migration zones will not occur (except as allowed in the Forest Practice Rules).

- Class I inner band– 0 to (25 – 200) feet from the watercourse transition line: No-cut (except for harvest of cable corridor trees where needed) or limited entry to improve salmonid habitat through use of selection or commercial thinning silvicultural methods. At least 85 percent overstory canopy (where it exists prior to harvest) is to be retained within 75 feet of the channel.
- Class I outer band– 0 to 125 additional feet: High basal area and canopy retention zone. Basal area retention will remain high through the use of the all-age large tree and single tree selection silvicultural systems. Vertical overstory canopy (measured with sighting tube) at least 70 percent (where it exists prior to harvest) is to be retained in the outer band.
- Class I/II: Ten largest conifers per 330 feet of stream channel retained within 50 feet of the watercourse transition line.
- Class II inner band– 0 to (10 – 100) feet from the watercourse transition line: No-cut (except for harvest of cable corridor trees where needed) or limited entry to improve salmonid habitat through use of selection or commercial thinning silvicultural methods. At least 85 percent overstory canopy (where it exists prior to harvest) is to be retained within 25 feet of the channel.
- Class II outer band – 0 to 90 additional feet: High basal area and canopy retention zone. Basal area retention will remain high through the use of all-age large tree and single tree selection silvicultural systems. Overstory canopy will be retained to prevent water temperature increases and allow for adequate canopy recovery where required.
- Reentry – No more frequently than every 20 years for Class I WLPZs.
- Class III – Equipment Limitation Zones (ELZs) will be at least 25 feet on side slopes less than 30 percent, and 50 feet on slopes greater than 30 percent. These zones will be expanded where site-specific investigations reveal that additional protection is merited for preventing sediment movement into class III channels.
- Class III – Burning will be conducted so that the majority of large woody debris is left within the ELZ. Fuels are not to be ignited within 50 feet of Class III channels.

Specific slope stability assessment techniques to be used as part of the JDSF Management Plan include:

- <u>Office Review of Existing Information</u>. This information includes: (1) SHALSTAB model results (computer model of shallow landslide potential based upon digital elevation information), (2) DMG landslide hazard maps (maps of geomorphic features related to landsliding used to identify likely inner gorge and deep-seated features), (3) aerial photographs, and (4) prior THPs and their geologic reports.
- <u>Field Review</u>. Once office review has been completed, an on-site evaluation will be conducted throughout the project area by a Registered Professional Forester (RPF).
- <u>CEG Input</u>. A CEG is to be consulted as appropriate during the design phase of timber sale preparation work to address slope instability and erosion issues identified during office and field reviews, ensuring that harvest units and road designs are proposed that adequately protect unstable areas and inner gorges.

Specific components of the Road Management Plan include:
- Inventory
- Design and construction
- Use restrictions during wet weather
- Inspection and maintenance
- Decommissioning
- Schedule for road work

Specific operational (day-to-day) guidelines are listed on pages 75-76 of the May 2002 DFMP.

Some short-term impacts to water quality are anticipated when implementing the Road Management Plan. In particular, decommissioning roads near watercourses (including crossing removal work) and upgrading watercourse crossings are known to produce short-term elevations in turbidity and suspended sediment concentrations (Brown 2002, Merrill and Cassaday 2003). Even though road improvement practices will likely result in some initial flush of fine sediment into JDSF watercourses, it is fully expected that the long-term potential sediment delivery in these already sediment impaired waterbodies will be reduced with these practices (Madej 2001, Madej and others 2001, Brown 2002, Klein 2003).

Recent orders from the North Coast Regional Water Quality Control Board (NCRWQCB) will help to ensure that violations of waste discharge requirements do not occur from implementation of the DFMP related to timber harvesting. In particular, on June 23, 2004, the NCRWQCB adopted Order No. R1-2004-0030, General Waste Discharge Requirements (WDRs) for Discharges Related to Timber Activities on Non-Federal Lands in the North Coast Region. General WDRs contain discharge prohibitions, receiving water limitations, a requirement for the submittal of some technical reports, an inspection schedule, and a filing/annual fee. The GWDR program has a two-pronged approach to reduce significant sediment input to watercourses: (1) prevention/minimization of new sediment sources, and (2) development and implementation of a program to mitigate existing sediment source areas through an Erosion Control Plan (ECP). The ECP must contain: (1) an inventory of all controllable sediment discharge sources within the Project area, and (2) a schedule for implementation of prevention and minimization management measures from all controllable sediment discharge sources within the Project area. The implementation of prevention and minimization management measures must be completed during the period of coverage under General WDRs. Controllable sediment discharge sources are defined as sites or locations, both existing and those created by proposed timber harvest activities, within the Project area that meet all the following conditions: (1) is discharging or has the potential to discharge sediment to waters of the state in violation of applicable water quality requirements or other provisions of these General WDRs, (2) was caused or affected by human activity, and (3) may feasibly and reasonably respond to prevention and minimization management measures.

Similarly, it is not anticipated that other management related activities contemplated under the DFMP will violate any water quality standards or waste discharge requirements. There is no cattle-grazing on JDSF. There are approximately 80 head of cattle on the New McGuire Ranch upstream of JDSF in the headwaters of the South Fork of the Noyo, with a dammed water source. The day-use areas and campgrounds in JDSF all use pit toilets. Wastes are removed from these toilets and trucked to a licensed septage receiving facility.

A potential area of concern for water quality impacts is the research activities conducted on the Caspar Creek experimental watershed.[2] Current research and management activities on that watershed are not resulting in any significant water quality impacts. Future research projects will be assessed and, if needed, mitigated to prevent violation of water quality or discharge standards; however, no specific new projects are currently being contemplated that could be considered within this EIR. Independent CEQA analysis will be required for any future research projects on the Caspar Creek experimental watershed.

The North Coast Regional Water Quality Control Board issues a number of types of permits for various discharges to surface waters. Water Board staff provided CDF with a listing of all such permits for Mendocino County (Wright-Shacklett 2004, pers. com.). This list was reviewed to identify those permits that were for discharges within the cumulative watersheds effects assessment area for JDSF. Permits within the assessment area were examined for the types and volumes of discharges and for the potential of these discharges to interact with anthropogenic flow, sediment, or other discharges resulting from past, current, or proposed JDSF management. This exercise identified no potential for significant interactions or resulting significant individual or cumulative impacts.

Potential violations of water quality standards related to water temperature are discussed in section VII.6.1 Aquatic Resources and are not covered here.

Based on conditions described above, no violations of waste discharge requirements are expected from implementation of the DFMP (alternative C1). Any water quality impacts would be less than significant. Reductions in road-related sediment due to implementation of the Road Management Plan should contribute to an increase in water quality over time, a beneficial impact.

Mitigation: None required.

None of the six other alternatives are expected to result in significant impacts to water quality standards. Alternative A would not result in timber harvest and associated potential water quality impacts. However, it would result in sedimentation impacts through deterioration and continued use of existing roads. The primary water quality standards

[2] Turbidity is significantly altered by pond excavation activities at the North and South Forks of Caspar Creek. Pond excavations occur approximately every five years, depending on winter storm magnitudes. During 2004, excavation of the South Fork pond produced turbidity values that exceeded 300 NTUs on several occasions during a few days in late September/early October and peaked at over 650 NTUs. Summer background turbidities are near zero.

associated with JDSF are turbidity, and to a very limited extent, campground facilities. Turbidity is minimized in the harvest management alternatives (B-F) by watercourse protection zones. The road management plan (Alternatives C1-F) also will help to identify and reduce surface erosion and mass wasting from roads, particularly for roads that exist within riparian zones. Alternative A would not have recent harvest-related turbidity, but both alternatives A and B could have more sediment yield and turbidity from roads due to a less aggressive road management program. Recent General Waste Discharge Requirements from the North Coast Regional Water Quality Control Board (NCRWQCB) will help to ensure that violations of waste discharge requirements do not occur from timber harvesting under any of the alternatives. Campground maintenance is unchanged in all alternatives, and is not anticipated to violate any waste discharge requirements. None of these six alternatives are expected to violate water quality standards or waste discharge requirements. None are expected to have a significant impact.

Impact 2: *Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.* (No Impact)

Timber harvesting has had the effect of increasing summer low flows typically by decreasing evapotranspiration and interception by trees so that water remains in the soil (Keppeler 1998; Keppeler and Ziemer 1990). No depletion of groundwater supplies is expected to result from the implementation of the DFMP or any of the other alternatives.

The question of whether harvesting redwoods reduces water supply by eliminating the interception and delivery of fog water to the forest floor has also been addressed by a recent study at the Caspar Creek watershed (Keppeler 2004). Measurements of fog drip were made for two summers under mature redwood Douglas-fir forest canopy and in an open clearcut in the late 1990's. Keppeler (2004) concluded that fog drip makes a highly variable but hydrologically insignificant contribution to groundwater and baseflow processes at Caspar Creek. Following timber harvest, streamflow increases due to reduced interception and transpiration were found to exceed diminishment due to the loss of fog drip.

Mitigation: None required.

Impact 3: *Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.* (Less than Significant)

Neither the DFMP nor any of the other alternatives proposes any drainage pattern alterations. However, heavy equipment operations and road networks can indirectly cause stream course alterations which could possibly result in erosion or siltation on- or off site.

The DFMP incorporates watercourse protection measures (pages 63-64 and 70-71 DFMP), including several practices in addition to standard California Forest Practice Rules (FPRs). FPR 923.2 (h) requires crossings to be constructed to prevent diversion potential of stream overflow down the road. The required watercourse protections will substantially minimize equipment work in or near a stream channel. Vegetation requirements for watercourse protection zones will also minimize sediment delivery to the watercourses or alteration of channel conditions. The DFMP also has an extensive Road Management Plan (Appendix VI of the DFMP) to inventory, prioritize, and address road related erosion problems. Limited new road construction is anticipated in the DFMP, and upgrading and formal decommissioning of roads are goals of the plan.

Mitigation: None required.

Each of the management alternatives (B-F) has watercourse protection measures and road improvements: the relative scope of the protections varies with each alternative (e.g., alternative B maintains the current standard protections under the FPRs, while alternative E has the most sweeping protections). Alternatives A and B could have more road related erosion than the other alternatives due to a less aggressive road management program. However, none of the alternatives are expected to substantially alter drainage patterns or to increase sediment delivery. Thus, alternatives C2 through F would have a less than significant impact.

Impact 4: ***Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site*. (Less than Significant)**

The DFMP does not propose any drainage pattern alterations. However, timber harvesting and road systems can indirectly cause increases in the amount of surface runoff and streamflow. Canopy reduction by timber harvesting can lead to increases in peak flows as a result of decreased interception loss and evapotranspiration. Roads can increase the amount of runoff by decreasing infiltration on compacted surfaces and can alter the runoff patterns in a drainage network by more direct routing of runoff, which has the potential to both increase or decrease peak flows depending on whether runoff is synchronized with flows from other areas.

The DFMP incorporates watercourse protection measures (pages 63-64, and 70-71 DFMP), including several practices in addition to standard California Forest Practice Rules that will minimize the potential for increased flooding as a result of timber operations. The watercourse protections will significantly minimize equipment work near stream channels, and vegetation requirements for watercourse protection zones will minimize runoff delivery to the watercourses. The DFMP also has an extensive Road Management Plan (Appendix VI of the DFMP) to inventory, prioritize, and address road related runoff problems. Limited new road construction is anticipated in the DFMP, and upgrading and formal decommissioning of roads are goals of the plan. Additionally, the Silviculture Allocation Plan (Chapter 3, DFMP pages 47-49) confines evenaged management to approximately one-third of the property, limiting the scope of potential canopy loss from clearcutting.

Modeling of peak flow was conducted for the seven alternatives (Appendix 10). The modeling constitutes a cumulative effects analysis for peak flow. Both historic (back to 1995) and projected future (to 2009) timber harvesting activities across the JDSF cumulative watershed effects assessment area (see Figure V.3) were included. Limited future road construction is anticipated in the project. Other than road construction, timber harvesting has the potential to create or contribute additional streamflow in the area. Current and anticipated project peak flow increases for planning watersheds in the JDSF assessment area are less than 4 percent for the 2-year storm return interval under average watershed moisture conditions. While no threshold standards have been determined for peak flow increases, studies (Lewis and others 2001, Grant and others 1999, Ziemer 1998) have indicated that peak flow increases in this range have been relatively benign, causing no significant adverse effects (see Appendix 10). They are not believed to be capable of substantially modifying the morphology of stream channels (Ziemer 1998), because the magnitude of potential peak flow changes is substantially less than the within-year and year-to-year variability in streamflows [i.e., the changes are within the normal range of variability of streamflows (Grant and others 1999)]. The peak flow analysis indicates that there will not be significant adverse effects related to peak flows as a result of either the proposed project or any of the other alternatives considered in this EIR.

Mitigation: None required.

Alternative A would have no effect on this impact because only very limited land management activities would occur. Alternatives C2 through F share many of the same protection measures as alternative C1. These alternatives were assessed for their peak flow effects (Appendix 10), and all were found to result in only small changes in peak flows that are not indicative of having the potential to cause significant impacts.

Impact 5: ***<u>Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.</u>*** **(No Impact)**

For all alternatives, sediment production from project activities will be limited as described under “Impact 1,” above. In addition, runoff impacts to drainage systems will by minimized as discussed under “Impact 4,” also above. None of the alternatives would result in a significant impact to stormwater drainage systems or provide substantial additional sources of polluted runoff.

Mitigation: None required.

Impact 6: ***<u>Otherwise substantially degrade water quality.</u>*** **(No Impact)**

No other issues were identified as having the potential to substantially degrade water quality for any of the alternatives. However, related issues are discussed in section VII.6.1 Aquatic Resources and section VII.7 Geology and Soils.

10.10 Alternatives

A comparison among the various alternatives regarding hydrology and water quality impacts is provided in Table VII.10.5.

Table VII.10.5. Comparison of Hydrology and Water Quality Related Impacts in Relation to the Various Alternatives.

Alternatives						Discussion
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant–Mitigation Not Feasible**
Impact 1. Violate any water quality standards or waste discharge requirements						
Alt. A			■			Alternative A (No Action) would not result in timber harvest but would result in sedimentation impacts through deterioration and continued use of existing roads. The primary water quality standards associated with JDSF are turbidity, and to a very limited extent, campground facilities. Turbidity is minimized in the harvest management alternatives (B-F) by watercourse protection zones. The Road Management Plan (Alternatives C1-F) will also help to identify and reduce surface erosion and mass wasting from roads, particularly for roads that exist within riparian zones. The new Additional Management Measure for an Accelerated Road Management Plan for alternatives C1 and C2 will help the speed up the delivery of the sediment reduction benefits of the Road Management Plan proposed in the DFMP. Alternative A would not have recent harvest-related turbidity, but both alternatives A and B could have more sediment yield and turbidity from roads due to a less aggressive road management program. Recent orders from the North Coast Regional Water Quality Control Board (NCRWQCB) will help to ensure that violations of waste discharge requirements do not occur from implementation of the alternatives related to timber harvesting, including General Waste Discharge Requirements (WDRs) for Discharges Related to Timber Activities on Non-Federal Lands in the North Coast Region The GWDR program has a two-pronged approach to reduce significant sediment input to watercourses: (1) prevention/minimization of new sediment sources, and (2) development and implementation of a program to mitigate existing sediment source areas through an Erosion Control Plan (ECP). Campground maintenance is unchanged in all alternatives, and is not anticipated to violate any waste discharge requirements. None of the alternatives are expected to violate water quality standards or waste discharge requirements.
Alt. B			■			
Alt. C1 May 2002 DFMP			■			
Alt. C2 Nov. 2002 Plan			■			
Alt. D			■			
Alt. E			■			
Alt. F			■			
Impact 2. Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.						
Alt. A		■				None of the alternatives will result in a depletion of groundwater recharge. On the contrary, timber harvesting has been shown in a number of studies to increase seasonal low flows due to the net loss of evapotranspiration from trees.
Alt. B		■				
Alt. C1 May 2002 DFMP		■				
Alt. C2 Nov. 2002		■				

Table VII.10.5. Comparison of Hydrology and Water Quality Related Impacts in Relation to the Various Alternatives.

Alternatives						Discussion
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant–Mitigation Not Feasible**
Plan		■				
Alt. D		■				
Alt. E		■				
Alt. F		■				
Impact 3. Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site.						
Alt. A			■			None of the alternatives propose any drainage pattern alterations; however, heavy equipment operations and road networks can indirectly cause stream course alterations which could possibly result in erosion or siltation on- or off site. Each of the management alternatives (B-F) has watercourse protection measures and road improvements: the relative scope of the protections varies with each alternative (e.g., alternative B maintains the current standard protections, while alternative E has the most sweeping protections). Alternatives A and B could have more road related erosion than the other alternatives due to a less aggressive road management program. However, none of the alternatives are expected to substantially increase sediment delivery.
Alt. B			■			
Alt. C1 May 2002 DFMP			■			
Alt. C2 Nov. 2002 Plan			■			
Alt. D			■			
Alt. E			■			
Alt. F			■			
Impact 4. Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.						
Alt. A		■				Alternative A has no action associated with it and therefore would have no impact. None of the alternatives propose any drainage pattern alterations; however, timber harvesting and road systems can indirectly cause increases in the amount of surface runoff, which could result in flooding on- or off site. Increases in peak flows from contemporary timber operations have been within the range of expected natural variability. Based on peak flow modeling presented in Appendix 10, none of the alternatives is expected to substantially alter the amount of surface runoff in a manner that would result in a significant increase in flooding.
Alt. B			■			
Alt. C1 May 2002 DFMP			■			
Alt. C2 Nov. 2002 Plan			■			
Alt. D			■			

Table VII.10.5. Comparison of Hydrology and Water Quality Related Impacts in Relation to the Various Alternatives.						
Alternatives						**Discussion**
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant–Mitigation Not Feasible**
Alt. E			■			
Alt. F			■			
Impact 5. Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.						
Alt. A		■				Contemporary increases in peak flows from timber operations have been apparently benign. Based on peak flow modeling presented in Appendix 10, none of the alternatives is expected to substantially alter the amount of surface runoff in a manner that would result in a significant increase in flooding. None of the alternatives is expected to exceed the capacity of stormwater drainage systems or provide substantial additional sources of polluted runoff.
Alt. B		■				
Alt. C1 May 2002 DFMP		■				
Alt. C2 Nov. 2002 DFMP		■				
Alt. D		■				
Alt. E		■				
Alt. F		■				
Impact 6. Otherwise substantially degrade water quality.						
Alt. A		■				No other issues were identified as having the potential to substantially degrade water quality.
Alt. B		■				
Alt. C1 May 2002 DFMP		■				
Alt. C2 Nov. 2002 DFMP		■				
Alt. D		■				
Alt. E		■				
Alt. F		■				