Final

Middle Main Eel River and Tributaries
(from Dos Rios to the South Fork)

Total Maximum Daily Loads
for
Temperature and Sediment

U.S. Environmental Protection Agency
Region IX

Approved by date

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CHAPTER 1: INTRODUCTION

1.1 OVERVIEW OF THE TMDL PROGRAM

The purpose of the Clean Water Act's Total Maximum Daily Load (TMDL) program is to assure that water quality standards are attained and maintained. The water quality problems addressed in this report - increases to natural sediment and temperature patterns - are connected to the decline of salmon populations. While many factors are implicated in the decline of west coast salmonids, these TMDLs solely address the State water quality standards for sediment and temperature that protect cold water fish (e.g. salmon).

The TMDL program is composed of both a list of "impaired" or polluted waterbodies, and the subsequent TMDL. These TMDLs for the Middle Main Eel River are being established under Section 303(d) of the Clean Water Act subsequent to their listing by the State of California. Under Section 303(d), the State of California periodically identifies *"those waters within its boundaries for which the effluent limitations... are not stringent enough to implement any water quality standard applicable to such waters."* In 1992, EPA added the Middle Main Eel river to California's 303(d) impaired water list due to elevated sedimentation and temperature. The North Coast Regional Water Quality Control Board (Regional Board) has continued to identify the Middle Main Eel river as impaired in subsequent listing cycles, the latest in 2002.

In accordance with a consent decree (*Pacific Coast Federation of Fishermen's Associations, et al. v. Marcus, No. 95-4474 MHP, 11 March 1997*), December 31, 2005 is the deadline for establishment of these TMDLs. Because the State of California will not complete adoption of TMDLs for the Middle Main Eel river by this deadline, EPA is establishing these TMDLs.

Under EPA regulations, the Middle Main Eel river TMDLs identify the total amount (or load) of sediment and heat that can be delivered to the Middle Main Eel river and tributaries without exceeding water quality standards. The total amount is allocated among the sources of sediment or heat in the watershed. The TMDLs, when implemented, are expected to result in achieving the applicable water quality standards for sediment and temperature for the Middle Main Eel river and its tributaries. EPA expects the Regional Board to develop an implementation strategy that results in implementing the TMDLs in accordance with the requirements of 40 CFR 130.6.

These TMDLs apply to the portions of the Middle Main Eel river watershed governed by California water quality standards. They do not apply to Indian Country. A portion of the watershed is part of the Round Valley Indian Country.

Pursuant to the consent decree, EPA is not required to establish a TMDL if EPA determines that a TMDL for a listed water is not necessary, consistent with the provisions of Section 303(d) (see consent decree Sec. IV, para I.) Based on EPA's analysis of conditions in the main channel of the Middle Main Eel River, EPA has concluded that the applicable water quality standards for temperature are being attained in the main channel (see Section 2.3.) Therefore, EPA has concluded that a temperature TMDL for the main channel is not needed. However, EPA has concluded that the applicable water quality standards for temperature are not being attained in the tributaries of the Middle Main Eel River TMDL area and temperature TMDLs are established in these tributaries by EPA. EPA is establishing a sediment TMDL that applies to both the main channel and tributaries of the Middle Main Eel.

1.2 WATERSHED CHARACTERISTICS

The Middle Main Eel river watershed area is located primarily in Mendocino, Trinity and Humboldt Counties in Northwestern California. It is east of Highway 101, approximately 150 miles northeast from San Francisco, and includes the towns of Alderpoint and Fort Seward. The watershed, as defined by this TMDL, is the area from Dos Rios to where the Eel meets the South Fork Eel. All of the smaller tributaries are included (see Figure 1). However, the larger tributaries of the North Fork and Middle Fork Eel are not included, as TMDLs were previously completed for these waterbodies in 2002 and 2003 respectively. The Middle Main Eel river TMDL area is 521 square miles. There is no commonly used name of the area as a whole and often this area is called the Lower Eel river or the Main Eel. It is a portion of the USGS 18010105 Lower Eel. The State hydrologic area naming convention is 11.41 Sequoia and 11.42 Spy Rock.

The watershed is rural and remote. This portion of the Eel is inaccessible for most of its length. Public roads cross near Dos Rios and then not until Alderpoint 65 miles downstream. The steep topography and privacy afforded by private lands and private dirt roads make the area unknown to most Californians. Sixty percent of the natural vegetation is shrub, grassland and oak woodlands. Conifers dominate only 14% of the landscape, while the rest is mixed conifer and hardwood. The land use pattern consists of large ranches many of which are increasingly divided into smaller parcels. Many small pockets of dispersed rural residences exist with a larger rural community around the Alderpoint area. The industrial timber company Pacific Lumber owns a small area downstream of Eel Rock where conifers thrive in the influence of the coastal fog.

The area's geology is underlain by the Franciscan terrain that dominates most of California's North Coast. Naturally unstable and prone to landslides, this type of geology is sensitive to human disturbance. All but the very downstream portion of the watershed is dry and warm in the summer, away from the influence of coastal fog. Almost all of the estimated 40 inches of annual rainfall occurs between November and April. Many smaller tributaries dry up in late summer.

The flow of the Main Eel is altered by the Potter Valley Project upstream of the Middle Fork Eel. The major tributaries of the Middle Fork and North Fork Eel have no dams or major diversions. The Potter Valley Project has two dams - the larger Scott Dam and associated Lake Pillsbury and 12 miles downstream the small Cape Horn Dam and Van Arsdale reservoir, where water is diverted adding water supplies to the Potter Valley Irrigation District and Sonoma County through Lake Mendocino and the Russian river. However the diverted water is thought to be greater than the natural summer flow of the Eel as these flows are from the dam at Lake Pillsbury. The Potter

Valley Project has been in operation for approximately 90 years and is licensed by the Federal Energy Regulatory Commission (FERC). Pacific Gas and Electric (PG&E) was issued a new hydro power license in 1983, which contained certain flow requirements on the Eel. These flow requirements were increased with the most recent FERC order amending the license (FERC, Jan 2004) generally consistent with the National Marine Fisheries Service (NMFS) Biological Opinion under the Endangered Species Act. A June 2004 FERC order required PG&E to implement the new flow regime. The new flow regime has been in effect since the June 2004 order.

1.3 ORGANIZATION

This report is divided into 6 chapters. Chapter 2 (Problem Statement) describes the nature of the environmental problems addressed by the TMDLs - fish population, stream temperature problems, sediment problems and water quality standards. Chapter 3 (Temperature TMDL) describes the modeling used to evaluate the temperature changes from differing amounts of shade and stream flow, and identifies the TMDL and allocations. Chapter 4 (Sediment TMDL) describes the sediment source analysis used to evaluate the proportion of human caused sources of sediment and sets the TMDL and allocations. Water Quality indicators for sediment are also identified. Chapter 5 (Implementation and Monitoring Recommendations) contains recommendations to the State regarding implementation and monitoring of the TMDLs. Chapter 6 (Public Participation) describes public participation in the development of the TMDLs.

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Figure 1. Map of major features of Middle Main Eel river TMDL area

CHAPTER 2: PROBLEM STATEMENT

This chapter includes a description of the water quality standards and the effects of stream temperature and sediment conditions on salmonids. In summary, salmon populations have declined; summer stream temperatures are often so warm that they are nearly lethal or stressful to salmon and there are large sediment inputs into the Eel. These stream temperature and sediment conditions are related to both natural conditions and human related activities.

2.1 WATER QUALITY STANDARDS

In accordance with the Clean Water Act, TMDLs are set at levels necessary to achieve the applicable water quality standards. Under the federal Clean Water Act, water quality standards consist of designated uses, water quality criteria to protect the uses, and an antidegradation policy. The State of California uses slightly different language (i.e., beneficial uses, water quality objectives, and a non-degradation policy). This section describes the State water quality standards applicable to the Middle Main Eel river TMDL using the State's terminology. The remainder of this document simply refers to water quality standards.

The beneficial uses and water quality objectives for the Middle Main Eel river are contained in the Water Quality Control Plan for the North Coast Region (Basin Plan), as amended (NCRWQCB, 2005). The Basin Plan identifies the beneficial uses for the Middle Main Eel River specifically: Municipal and Domestic Supply; Agricultural Supply; Industrial Process Supply; Groundwater Recharge; Freshwater replenishment; Navigation; Water Contact Recreation; Non-contact Water Recreation; Commercial and Sport Fishing; Warm Freshwater Habitat; Cold Freshwater Habitat; Wildlife Habitat; Rare, Threatened or Endangered Species; Migration of Aquatic Organisms; and Spawning, Reproduction and/or Early Development.

The water quality objectives pertinent to the temperature and sediment TMDLs are listed in Table 1.

In addition to water quality objectives, the Basin Plan includes two prohibitions specifically applicable to logging, construction, and other associated sediment- producing nonpoint source activities:

- *the discharge of soil, silt, bark, 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; and*
- *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.*

Table 1. Water Quality Objectives

Parameter	Water Quality Objectives
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affects beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface water shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Temperature	The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such an alteration in temperature does not adversely affect beneficial uses.
	At no time or place shall the temperature of any COLD (water with a beneficial use of cold freshwater habitat) water be increased by more than 5 ˚F above natural receiving water temperature.
Turbidity	Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.

These narrative water quality standards refer to "adversely affect" and "quantities deleterious" to beneficial uses. These TMDLs for sediment and temperature are being established to protect the cold water beneficial use from adverse effects as the most sensitive beneficial use. The cold freshwater habitat is the "*uses of water that support cold water ecosystems including, but not limited to the preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates* (NCRWQCB, 2004a)." In addition, the narrative standards above allow for a focus on increases to natural conditions. Thus the TMDLs focus on the human influenced portion of temperature and sediment conditions.

2.2 FISH POPULATION CONCERNS

The primary beneficial use of concern for these TMDLs is the cold freshwater habitat which provides for the "preservation or enhancement" of fish, etc. This TMDL focuses on salmon as the aquatic species that is most sensitive to elevated sediment and temperature conditions. Evidence of salmon population declines is contained in the listing of all the major species under the Endangered Species Act by NOAA fisheries. Salmon populations are listed under their geographic area. The Endangered Species Act listing that applies to the Middle Main Eel is as follows:

Southern Oregon/Northern California Coast Coho Salmon ESU

California Coastal Chinook Salmon ESU

Northern California Steelhead ESU

NOAA fisheries recent review (NMFS, 2005) reconfirmed the "threatened" status of all three ESUs.

Coho

Historically, the entire Eel River basin was thought to have around 14,000 adult coho. Readers should note that most of the coho in the Eel are in the South Fork Eel in the cooler fog and redwood areas. The Middle Main Eel did not have anything but scattered, isolated creeks used by coho year-round. Presently, coho are only known to rear in Thompson and Kapple creeks downstream of McCann. Additionally, coho use the Middle Main Eel as part of their migration route to spawning and rearing tributaries in Outlet Creek. In the Eel in general, the decline of coho was recently reconfirmed (NMFS, 2005): "Coho populations continued to be depressed relative to historical numbers, and we have strong indications that breeding groups have been lost from a significant percentage of streams within their historical range."

Chinook

The entire Eel basin is thought to have produced a significant number of chinook salmon. Estimates reported by NOAA Fisheries range from 55,000 - 17,000 adults (NMFS, 2005). No separate estimates are available for the specific TMDL area. NOAA Fisheries' assessment of the TMDL area (CALWATER Spy Rock and Sequoia) is that the conservation value for chinook is high. An estimated 123 stream miles were estimated to be currently used by chinook (NOAA Fisheries, 2005).

Steelhead

Historical estimates of steelhead in the entire Eel Basin is 82,000 adults (NMFS, 2005). The adult steelhead data is sparse, but steelhead populations upstream were known to be at least 4000 during the 1930s - 1950s. No data on either adult population estimates or juvenile density exists for the Middle Main Eel area.

The distribution of juvenile steelhead is of special interest as summer temperatures are an important facet of their distribution and abundance. In the TMDL study area, juvenile steelhead are widely distributed in the tributaries but not in the main channel. However, due to the inaccessible nature of the watershed, isolated groups may exist near cool water tributaries or seeps. NOAA Fisheries summarized the conservation value of the Middle Main Eel (e.g. Spy Rock and Sequoia HSAs) as medium. That review designated 157 miles of 658 miles as critical habitat for steelhead (NOAA Fisheries, 2005).

Kubicek (1973) reported that salmonids were almost non-existent in the main channel from the Middle Fork to the North Fork. He reported several places where individual salmonids were seen and noted cool spring flow. Two locations had 100 salmonids. One location was a pool near River Garden and the second on Blue Rock Creek. The edge of Shell Rock Creek also had 50 or so salmonids. These areas are believed to be spring fed. Suckers and roach were abundant throughout this section of the river. No salmonids were observed in the rest of the 51 miles of the

Eel, downstream to the South Fork. Kubicek noted that North Fork Dobbyn Creek contained salmon and that during some years the area near the South Fork contained salmon. Kubicek also referenced the heat related death and disease conditions reported by Wales in 1938.

During the 1990's DFG's Stream Inventory reports continued to report individual or small numbers of juvenile steelhead in Bell Spring Creek, Sequoia and Sonoma Creeks in 1998. Thompson Creek was the only area where DFG noted areas of "numerous" steelhead. A few creeks in the watershed have monitoring results from the DFG bioinventory program. On Sonoma Creek one site was electrofished with 42 juvenile steelhead counted. Two sites on South Dobbyn creek inventoried with 75 and 63 steelhead. Sites on Dobbyn Creek and North Dobbyn creeks inventoried with 13 and 4 steelhead, respectively.

Several streams have fish population monitoring data from 1989, 1992 and 1993 in Mud Creek and Dobbyn Creek (near the Mud Creek confluence.) The data was reviewed by FERC and DFG. The reports indicate that steelhead were present throughout the streams downstream of Middle Creek. Dobbyn and Mud Creeks had many fry and juveniles during both mid-July and the late fall.

In summary, information indicates that the cold water beneficial use (e.g. salmon) overall has evidence of adverse effects. Recent reviews under the Endangered Species Act reconfirmed the populations of coho, chinook and steelhead in the area as "threatened." This inaccessible watershed has sparse information limited to the observation of chinook and more widely steelhead. Only a few creeks are used by coho. However, certain areas of Dobbyn Creek have evidence of a sustainable population of steelhead.

Salmonid populations are affected by a number of factors during their life cycle in freshwater and the ocean. These TMDLs focus only on the achievement of the water quality standards related to sediment and temperature. The salmon population declines can also be affected by fishing, ocean conditions and other factors. Additional freshwater stream conditions such as the presence of large woody debris and possibly pike minnow predation may also be factors. Thus the achievement of water quality standards for sediment and temperature will facilitate, but not guarantee, population recovery.

2.3 STREAM TEMPERATURE PROBLEMS

Stream temperatures in the Middle Main Eel watershed are primarily stressful to lethal to juvenile salmonids. Measurement of stream temperatures is available for the entire main channel and some tributary streams. A comparison of the literature on temperature effects on salmon with existing stream temperatures is presented in this section.

Stream temperature directly governs almost every aspect of the survival of Pacific Salmon (Berman, 1998). Temperature is such an important requirement that coho, steelhead, chinook and rainbow trout are known as Acold water fish. Metabolism, food requirements, growth rates, timing of adult migration upstream, timing of juvenile migration downstream, sensitivity to disease and direct lethal effects are affected by stream temperatures (Spence et al, 1996). The TMDL focuses on stream temperatures during the summer as the most sensitive period. Juvenile steelhead and coho rear in freshwater for one or more summers before migrating to the ocean; chinook are not present during the summer.

This TMDL provides an evaluation of stream temperatures in the Middle Main Eel for salmon habitat.[1] Table 2 provides a summary of the literature and stream temperature ranges. EPA relied primarily on previously compiled literature reviews. These stream temperature evaluations (adequate, lethal etc) are not precise in the stream or in the literature, because salmonids are affected by many factors, including the degree of fluctuation in temperature, presence of competition and disease, food availability and access to cool water refugia areas.

Recent stream temperatures are available from the Humboldt County RCD database (HCRCD, 1996-2003). These locations have been monitored for multiple years from 1996-2003. The main channel has lethal temperature conditions from below the Middle Fork (26˚C max7daat) to Eel Rock (24.6˚C). In contrast, the stream temperatures monitored in the main channel range from lethal when sustained to acutely lethal to steelhead. Additional data collection was funded by EPA for the TMDL. A airborne Thermal Infrared Remote Sensing study of the main channel was undertaken during the summer of 2005 (Watershed Sciences, Inc., 2005). This monitoring technique gathers one-time surface water temperatures over the entire length of the main channel Eel. (The report is available as Appendix C). The result of that monitoring is provided in Figure 2. From the Middle Fork Eel (river mile 119) to near Dobbyn Creek most of the main channel is warmer than 26˚C. The biological literature indicates that the main channel is several degrees warmer than streams associated with the presence of steelhead. In addition, much of the river may be acutely lethal (i.e. lethal to steelhead within hours of exposure.) Note that these temperatures represent instantaneous conditions and not the max7daat as reported in the HCRCD data above. The river cools markedly between river mile 62 and river mile 40 where it meets the South Fork Eel.

The tributaries that have been monitored showed a variety of conditions from good to stressful conditions. Temperatures at the mouth of tributaries were also measured by FLIR. The stream temperatures ranged from 25˚C - 28˚C indicating lethal conditions. Exceptions were Kapple and Cameron Creek at river miles 50 and 45. Stressful conditions were monitored at 22˚C. Other downstream locations in tributaries indicate stressful conditions (Burger Creek at 23.2˚C, Chamise Creek at 23.2˚C and Dobbyn Creek 22.6˚C. The North Fork Dobbyn Creek had the coolest conditions monitored (21.6˚C). The only stream temperatures monitored upstream in the tributaries were Mud Creek, Middle Creek and Rock Creek. These tributary locations did not have a comparable temperature recording record but the maximum daily temperatures in 1991 were 18˚C, 20˚C and 21˚C respectively. (Note that a

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[1] In order to summarize stream temperatures, which are often monitored hourly or more and fluctuate daily and seasonally, this TMDL uses the maximum value of the 7-day running average of all recorded temperatures. Although the term MWAT (maximum weekly average temperature) is used often in the literature, it is an inexact term and used inconsistently. The abbreviation max7daat is used herein for the 7day running average of all recorded temperatures.

maximum stream temperature can range from 1.5 - 2.9˚C higher than the max7daat.) Comparing these temperatures to the biological information in Table 2, the lower portions of the tributaries have stressful conditions. Mud, Middle and Rock Creek have fair to optimal conditions. The fish abundance data does indicate that some of these areas are associated with sustainable rearing populations of juvenile steelhead.

Table 2. Evaluation of Effects of Stream Temperatures on Juvenile Steelhead

Stream temperature evaluation	**Stream temperature monitoring period (Max7daat)** ***maximum 7 day average of all monitored temperatures***	**References/Notes** **(a) USEPA (2001a, b)** **(b) Sullivan et al, 2000** **(c) Myrick & Cech (2001)** **(d) Washington DOE, 2002** **(e) Neilsen, et al 1994**
GOOD	13-15E C (59E F)	maximum growth - food limitation (a) 13-15° C protective threshold for summer rearing in the Pacific NW, adjusted from daily max to daily mean. 13°C applicable in Oregon at >3000 foot elevation (a)
FAIR	15- 17˚C (59-63E F)	16.5˚C growth enhanced under optimal conditions (a)
MARGINAL	17 - 19EC	17.2˚- 19˚C growth maximized under optimal conditions (d) 17C maintenance of population abundance within 10% (b)
STRESSFUL	19 - 20˚C	
STRESSFUL	20 - 22˚C	
STRESSFUL	22 - 24˚C	22-24°C maximum temperature, juvenile density declines to zero (a) 22 - 24˚C temperature range which eliminates salmonids from an area (d)
LETHAL (within days)	24 - 25EC (75E F)	Lethal -chronic conditions - upper incipient (7day LD50) within days (a, b, c) steelhead presence noted in water with temperatures >24C when cool water refugia areas are present (e) *Acontinuous exposure of 3-30 hours is necessary to cause mortality at temperatures between 24EC to 26EC (b)*
LETHAL	25 - 26˚C	*"The duration of time necessary to cause mortality decreases sharply with small increments of temperature above approximately 26EC. Short duration excursions (less than 2 hours) above 27EC are very likely to cause mortality of some individuals..." (b)* Lethal - 6 hour LT10 (a)
LETHAL (within hours)	> 26˚C	Lethal - 26.5˚C 1 hour LT10 (a) Critical thermal max (28 - 32C) instantaneous loss of equilibrium (b) "*With cautious acclimation...rainbow trout may not experience LT50 (50% mortality) until a week at 26°C. Even with careful acclimation, 27°C results in high or complete mortality in less than 24 hours... and temperatures of 29-30°C result in 50% mortality in 1-2 hours. (a)*

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Figure 2. TIR Results – Median sampled temperatures by river mile for the Eel River.

The only other temperature monitoring information for the Eel was during 1973 (Kubicek, 1977), but this was conducted after much of the shade and flow alterations had already taken place. In general, Kubicek reports the same patterns noted by the Humboldt County RCD database - stressful and lethal temperatures in the main channel, with limited cool water refugia noted.

Sources of stream temperature

Stream temperature is the result of many physical factors, such as air temperature, solar radiation, shade, surface and groundwater water flow. Many of these factors can be altered by human activities and result in increases to stream temperature. However, the magnitude of the change to stream temperature varies by stream and by the magnitude of the change to shade, flow or other factors. In this watershed both changes to shade and flow were examined. EPA's review found no other sources of stream temperature change in the watershed.

Channel changes from sediment problems can also decrease stream shade. Channel widening or debris torrents that remove vegetation both can be factors in reduced shade. In the Middle Main Eel TMDL area, an EPA funded analysis of air photographs by PWA reported an increase over time in the area of the active channel with a corresponding decrease to the flood plain. However, the distance to the valley wall was estimated to be essentially unchanged.

In the Middle Main Eel TMDL area, tributaries can have shade reduced by debris flows and/or large landslides that remove riparian vegetation and widen tributaries during storms. An analysis by PWA (see Appendix B) found that a large percentage (75%) of the channels that were disturbed in the 1966 photos had recovered. In addition, 95% of the landslides showed a decrease in channel disturbance area. Therefore, the impact of sediment on tributaries through channel disturbance has not been a significant source of reduced shade in the recent past.

EPA concludes tributary streams do not meet water quality standards due to temperature alterations and a TMDL is established in Chapter 3. In addition, EPA concludes a TMDL for temperature is not needed in the main channel Eel (from Dos Rios to the South Fork). EPA reached this conclusion after analyzing shade and flow effects on this area. EPA found that neither human caused changes to flow nor shade are resulting in an alteration of stream temperatures; therefore water quality standards are being attained in the main channel. Pursuant to Section IV.I of the 1997 consent decree, EPA is making the determination that temperature TMDLs are not needed for the main channel of the Eel River from Dos Rios to the South Fork.

Main Channel Eel - Dos Rios to the South Fork

This section describes the analysis for the main channel of the Eel between Dos Rios and the South Fork. The results led to EPA's conclusion that neither flow nor shade is altering natural stream temperatures. In the upstream area of the main channel (Outlet Creek past the Middle Fork to past Cherry Creek, near Nashmead), EPA compared the two most recent flow requirements on the Eel to a range of natural flow and temperature conditions using the Q2Eshade model. In addition, the entire length of the main channel was analyzed for possible shade alterations using the SHADE model. Comparing the modeled results to the water quality standard “natural stream temperatures shall not be altered”, EPA concluded that a TMDL is not needed for this area because the analysis indicated that there were no alterations of natural stream temperatures in the main channel. Appendix A provides the details of the modeling for both flow and shade. A summary of the analysis is provided here.

Given that flow is diverted from the Eel at Van Arsdale, EPA investigated the significance of this diversion to water temperature. EPA compared both the pre-2004 flow requirements of 7 cubic feet per second (cfs) and the current 2004 flow requirements in very wet years of 30 cfs to a range of natural conditions. EPA only compared very wet year requirements because previous modeling concluded that stream temperatures at Outlet Creek were not altered in drier years (USEPA, 2004.)

The water quality standard’s goal of “natural stream temperatures” is challenging because stream temperatures were not monitored before 1914 when the diversions began. In addition, the Potter Valley Project’s influence on stream temperature and cold water habitat is complex. Temperatures upstream of Lake Pillsbury are warmer (approximately 22.5EC at the Rice Fork and inlet at Lake Pillsbury) than those below Lake Pillsbury (18E-20EC), because Lake Pillsbury stratifies and cool bottom water is released into the Eel during the summer. The 12 mile area between Lake Pillsbury and Van Arsdale has significant summer flow (100 cfs on average) and this large block of water resists heating and remains approximately 20EC max7daat. After the diversion, where approximately 7 cfs was released at Van Arsdale until the summer of 2004, the stream quickly heats and was measured to be 24EC as a max7daat around Tomki and 27EC by Outlet Creek.

A variety of assumptions about natural flow and natural stream temperatures upstream were modeled. EPA modeled a range of natural flow conditions on the Main Eel (50-60 cfs) in various combinations with a range (50 & 80 cfs) of natural conditions on the Middle Fork Eel. These were combined with 2 possible natural stream temperature assumptions. As the project has been in existence for nearly a century, no record exists of natural stream temperatures. EPA chose to model two assumptions - warmer v. cooler upstream temperatures - to provide a context for meeting the water quality standard of “natural stream temperatures”.

The cooler (lower bound) assumption is 22.5EC natural stream temperature at Van Arsdale. This is the average of the max7daat of the 2 primary tributaries above Lake Pillsbury - Eel at the inlet of Lake Pillsbury and Soda Creek. This lower (coolest) bound scenario assumes that the stream does not heat during its approximate 20 mile flow from the Eel above Lake Pillsbury to Van Arsdale. EPA considers a lack of downstream heating possible, but only as a lower bound. The area between Lake Pillsbury and Van Arsdale does have both topographic and vegetation shading and cooler subsurface water appears to be present (Jahne, personal communications). It is also possible that the area of Hullville and Gravelly Valley (now Lake Pillsbury) was significantly influenced by subsurface flow. These types of valley settings often create conditions where a significant volume of ground water enters the stream channel draining the valley (McFadin, personal communication). Natural stream temperatures cooler than this were extremely unlikely.

The upper bound (warmest) possible “natural” stream temperature scenario was developed to reflect some downstream stream heating as follows. EPA used the modeled reach between Tomki Creek and Outlet creek as a surrogate of the upstream channel. The current channel morphology between Lake Pillsbury and Van Arsdale has been changed by the hydrological modification and sediment filling around Van Arsdale, thus the temperatures associated with this portion of the channel are not representative of the natural condition. The upper bound scenario accounts for the resistance to heating of increases in the bulk of water (10 cfs, 20 cfs and 50 cfs) with a stream in a similar climate and geography. The distance used was 20 miles (the approximate amount of stream inundated by Lake Pillsbury plus the distance from Lake Pillsbury to Van Arsdale). The rate of stream heating is characteristic of a less shaded stream than would likely exist, plus the river flows generally north/south in the modeled reach, whereas the “natural” channel generally flows east/west. EPA believes this to be the warmest natural stream temperatures likely for the Eel near Van Arsdale.

Using the information in the table above, the resultant temperatures in the reach between Outlet Creek and downstream of Cherry Creek were predicted.

Figure 3 summarizes the results of EPA’s comparison of natural stream temperatures to the current flow requirements and the pre-2004 flow requirements. EPA concludes based on the results presented in Figure 3 that stream temperatures have not been altered significantly. A comparison of altered flows and the estimated natural stream temperatures indicates that there is no alteration of natural stream temperatures for most of the river modeled. Small increases in natural stream temperatures were estimated for a portion of the reach; however, this section of the Main Eel is projected to be warmer than 28˚C naturally as a max7daat.

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Figure 3. Comparison of natural stream temperatures to current flow requirements

The potential effects of shade on the main channel were also examined by EPA. Riparian vegetation can be reduced by timber harvest, grazing or road building. All these factors are present in the Middle Main Eel. For the entire length of the main channel, EPA examined the potential for shade reductions through the reduction of riparian vegetation (Figure 4). Tetra Tech, Inc. used the SHADE model (see Appendix A) to vary the amount of shade that could potentially be reduced to the main channel. The results of the modeling indicated that changes in riparian vegetation would not result in significant changes in shade. Figure 4 illustrates the estimated increase in shade from current conditions to natural shade conditions. As Figure 4 indicates only 6% of the modeled segments improved shade more than 2%. EPA considers this shade improvement to be insignificant in magnitude and geographic extent. Any resultant stream temperature alteration would have a magnitude smaller than the shade alteration.

This analysis supports EPA's conclusion that natural stream temperatures have not been altered in the main channel of the Eel between Dos Rios and the South Fork. Analysis indicates that natural stream temperatures are essentially the same as estimated natural stream temperatures. In addition, alterations of riparian vegetation are not currently altering shade - a important determinant of stream temperature. Moreover, the temperature conditions predicted under natural flow conditions are in the acutely lethal range for salmonids. Thus adverse effects on this beneficial use are not expected under any insignificant shade increases in the main channel.

In contrast, EPA modeled the alterations in natural stream temperatures expected in two tributaries - Dobbyn Creek and Chamise Creek. Changes to shade were examined and found to be significant. Chapter 3 details the modeling and TMDL and allocations.

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Figure 4. Difference in shading
between natural vegetation and current conditions

2.4 SEDIMENT PROBLEMS

Salmon can be adversely affected by many different stream conditions related to sediment. The known effects of sediment on the Middle Main Eel is the changes in the river morphology after the 1964 flood. Like most of the Eel, the Middle Main Eel's sediment loading is very high and a portion of this loading is thought to be exacerbated by human activities.

Salmon requirements related to stream sediment

Salmonids have a variety of requirements related to sediment. Excessive fine sediment can reduce egg and embryo survival and juvenile salmonid development. Tappel and Bjornn (1983) found that embryo survival decreases as the amount of fine sediment increases. Excess fine sediment can prevent adequate water flow through salmon redds (i.e. salmon nests), which is critical for maintaining adequate oxygen levels and removing metabolic wastes. Deposits of these finer sediments can also prevent the hatching fry from emerging from the redd, resulting in smothering. Excess fine sediment can cause gravels in the water body to become embedded (i.e., the fine sediment surrounds and packs in against the gravels), which effectively cements them into the channel bottom. Embeddedness can also prevent the spawning salmon from building redds.

The morphology of a stream can be adversely affected by imbalances in fine or coarse sediment supply and transport. It can reduce overall stream depth and the availability of shelter, and it can reduce the frequency, volume, and depth of pools. Pools provide salmon a resting location and protection from predators.

Excessive sediment can affect other factors important to salmonids. Stream temperatures can increase as a result of stream widening and pool filling. The abundance of invertebrates, a primary food source for juvenile salmonids, can be reduced by excessive fine sediment. Large woody debris, which provides shelter and supports food sources, can be buried. Increases in turbidity or suspended sediment can impair growth by reducing availability or visibility of food sources, and the suspended sediment can cause direct damage to the fish by clogging gills.

Sediment conditions in the Middle Main Eel

The high sediment loading in the Eel has been noted since the 1960's. A USGS study of sediment loading rates (Brown and Ritter, 1971) estimated that the Eel River had the highest average suspended sediment yield for any basin in the United States. Furthermore, USGS noted (Brown and Ritter, 1971) that the major part of the suspended sediment discharge from the basin originates upstream from Eel Rock. These estimates were made directly after the 1964 flood.

In this particular stretch of the Eel, the December flood of 1964 resulted in large scale destruction of the Pacific Northwestern Railroad. The Northwest Pacific RR parallels the Eel for miles along the main channel. The railroad sustained significant damage from erosion, landslides and flooding. For example, north of Alderpoint the tracks were covered with sediment as high as 10-12 feet and huge mudslides wiped out and covered tracks and houses at McCann (WRC, 1965).

Studies of the Eel River, including the Middle Main TMDL area, were undertaken by various agencies in response to a search for additional dam sites in California. A 1972 Study (CDWR, 1972) noted that landsliding dominated the sediment input in the basin and changes in 30 cross sections between Outlet Creek and Island Mountain showed aggraded and degraded sections with the greatest channel changes occurring near tributary streams. The report noted, "improved watershed management practices will be necessary to help restore Eel River salmon and steelhead populations."

Erosion and sediment delivery to streams result from a combination of natural factors combined with human disturbance and rainfall patterns. In general, the factors related to human activities that can increase erosion and sediment delivery include roads, grazing and timber harvest. The sediment source analysis for the TMDL accounted for the significant sources of natural and human related sediment delivery. In addition, EPA collected additional information on the contribution of the railroad to sediment delivery.

Current sediment conditions in the main channel are difficult to determine due to the inaccessibility of the Middle Main Eel river. EPA funded TT/PWA to review historic air photos to document channel changes.

Channel changes on the main channel of the Eel were investigated for EPA by PWA. 25 cross sections on air photographs in Humboldt and Mendocino Counties were analyzed. The distance of the active channel width, the floodplain width and the Valley wall were measured on the 1966 and 2000 air photos. The analysis estimated that the changes in the main channel of the Middle Main Eel consisted of an increase in the active channel width, a decrease in the floodplain width and very little change in the combined width. The width of the confined channel was estimated at 497 feet, however, in the downstream area widths increase substantially to 2070 - 2300 feet.

Channel changes in the tributaries were also investigated for EPA by PWA. PWA found that debris flows and large landslides had resulted in channel disturbance. However, since 1966 a large degree of channel recovery has taken place. The average disturbed channel area has decreased by 12% in the 1984 photos and 65% in the 2000 air photo's.

The California Department of Fish and Game Stream Inventory Reports provide the only available information on stream conditions for salmonids (CDFG Stream Inventory Reports 1991-1998). Using pool embeddedness (estimated visually) as an indicator, variable conditions for salmonids were found by DFG in the Middle Main Eel TMDL area. Four streams in the Dobbyn Creek area were found to have embeddedness conditions that rated 2-4 on a scale where 1 is the highest quality of habitat for salmonids and 4 is the poorest. In the five streams in the westernmost area, downstream of Eel Rock, a better distribution of conditions was found with stream segments ranging from the best conditions (1 rating) to 4. Upstream of Alderpoint only 2 streams have been inventoried - Bell Springs Creek and Burger Creek and these streams show mixed conditions.

In summary, salmonids have particular biological needs related to stream sediment. The notable sediment delivery loads and erosion in the Eel, including the

Middle Main Eel TMDL area, result in sediment conditions that reduce the spawning and rearing success of salmonids. DFG found that tributary stream sediment conditions for salmonids are variable in the Middle Main Eel TMDL area.

CHAPTER 3: TEMPERATURE TMDL

This chapter describes the analytical basis for the temperature TMDL, along with the TMDL and allocations. The analysis of temperature alterations for the Middle Main Eel is divided into two parts. The first part examined the effects of flow and shade on the main channel from Dos Rios to the South Fork. The results of that analysis were described in Chapter 2 - Problem Statement. EPA concludes stream temperatures have not been altered in the main channel. Pursuant to the 1997 consent decree, EPA has determined that a TMDL is not necessary for the main channel.

Chapter 3 discusses the effects of shade on representative tributaries - Dobbyn Creek and Chamise Creek. The analysis of shade in tributaries indicates that stream temperatures have been altered and sets a TMDL based on natural shade. While this conclusion is the same as the draft TMDL, in response to public comments EPA revised assumptions regarding the amount and temperature of groundwater in both tributaries. The final results estimate cooler temperatures than the draft TMDL. However, the conclusion of the TMDL has not changed - current stream temperatures are estimated to be warmer than estimated natural stream temperatures. EPA notes that other information, especially site specific information, should be used during implementation discussions with the Regional Board.

This chapter first describes EPA's interpretation of the narrative water quality standard for temperature. The chapter then describes the temperature modeling for solar radiation and shade for all stream reaches and sets a TMDL for solar radiation (in terms of langleys/day) and allocations in terms of shade for all tributary stream reaches.

3.1 INTERPRETING THE EXISTING WATER QUALITY STANDARDS FOR TEMPERATURE

This temperature TMDL is calculated to attain the applicable water quality standards. The Basin Plan identifies the following two temperature objectives for surface water:

> "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such an alteration in temperature does not adversely affect beneficial uses."

> "At no time or place shall the temperature of any COLD <i.e. water with a beneficial use of cold freshwater habitat> water be increased by more than 5E degree F above natural receiving water temperature."

EPA interpreted the above standards for the TMDL as follows. EPA used a model to compare "natural stream temperatures" with both current stream temperatures and temperatures under a variety of management practices. In considering the first objective, EPA then examined whether these alterations (changes in stream temperatures) would adversely affect the most sensitive beneficial use - that is, cold water fish during the summer rearing period. EPA's evaluation of "adverse" effects is based on the scientific literature on steelhead temperature tolerances (summarized in Table 2). (Chinook do not rear in the summer in the watershed and coho are found only in a few streams in the western part of the watershed.) EPA evaluated whether or not the changes in stream temperature also negatively affected the quality of habitat from stream temperatures. In general, any increase (warming) of natural summer stream temperatures is adverse to rearing steelhead in temperatures between 15 - 26˚C.

The second objective (i.e., not increasing the stream temperature more than 5 degrees F) was evaluated by comparing every modeled point on the stream for exceedance of the 5 degree objective.

3.2 TEMPERATURE MODELING

Stream temperature has been widely studied and the physics of heat transfer is one of the better understood processes in natural watershed systems (TFW, 2000). Many factors affect stream temperature including solar radiation, air temperature, local shading, climate, stream flow and depth, channel morphology, groundwater inflow and upstream temperatures. Modeling of stream temperature is a well developed area of inquiry and many models are available to assist policymakers in understanding the factors controlling stream temperatures.

EPA funded Tetra Tech Inc. to develop and run the Q2ESHADE model to evaluate both the influences of different flow scenarios and different shade scenarios. The Q2ESHADE, a peer reviewed publicly available model, allows EPA to examine how stream temperatures change in relation to different assumptions on flow, upstream temperatures, and shade (as influenced by the size of riparian vegetation, specifically conifers). Appendix A provides a more complete discussion of the model components, assumptions and data. The Q2ESHADE combines elements of two models (Qual2E and SHADE) to examine cumulative effects on stream temperature throughout all modeled areas in a stream network. Qual2E, the first model, is a publicly available model and is widely used in analyzing many water quality problems. The Tetra Tech version of SHADE is a simplification of certain components of the Chen model (see Appendix A). Chen, et al (1998) originally developed and published a model called SHADE that when linked to other models, can provide basinwide (e.g. cumulative effects) information regarding streamside vegetation changes. Inputs from the SHADE model are linked to Qual2E to provide routing of local stream heating or cooling (from vegetation, flow changes, tributary cooling, etc.) downstream through the stream network. The models' performance was determined to be very good; details are available in Appendix A. In response to public comment on the draft TMDL, Tetra Tech revised assumptions regarding groundwater temperatures.

In response to public comments that the model's assumptions on groundwater in Dobbyn Creek needed revision, EPA used the same shade information combined with cooler groundwater temperatures and additional groundwater flow, especially in Mud Creek. The performance of the model improved slightly with these revisions.

3.2.1 Temperature and Solar Radiation Modeling

Dobbyn Creek and Chamise Creek were selected as representative of all tributaries based their vegetation characteristics. The modeling compared the changes in stream temperature that result from several different conditions of riparian vegetation. Altering riparian vegetation is the only significant source of stream temperature changes as large surface water or ground water diversions or impoundments are not found in this sparsely populated area. The diversion associated with the Three Forks Hydroelectric Project was evaluated under a FERC monitoring program. This monitoring did not indicate any temperature or fisheries impacts.

Streamside vegetation can be removed or altered by grazing, vineyard development, housing development, roads or timber harvest. Timber harvest is regulated under the State's Forest Practices Rules. The Forest Practice Rules specify an 85% canopy retention and the retention of the 10 largest conifers per 330 feet of stream, if the stream is anadromous fish bearing. Canopy retention for other streams is 50%. However, the canopy retention can be met while harvesting the tallest trees and depending upon stream width and other site conditions shade can be altered when the canopy retention requirement is met. Therefore, the Forest Practice rules do not directly protect shade over the stream channel.

The analysis conducted for the TMDL was designed to answer whether or not current practices and conditions are altering natural stream temperatures. EPA made the assumption that the current vegetation type is natural. This means that the type of vegetation is not changed by the modeling, only the size and height of the vegetation. In addition, when modeling the results of the Forest Practice Rules, EPA modeled the entire watershed with the same size class because no readily available information was available on the rate of THP approvals in a watershed. Thus scenarios #3 and #4 analyze effects of this type of timber management when in practice the THP approval process may not allow so many THPs to be approved during the same decade. In response to public comments, EPA evaluated the available evidence that riparian species such as alder and willow are presently providing shade. EPA found conflicting evidence regarding riparian species recovery. DFG reports document problems with canopy in Dobbyn Creek, while landowners stated that recovery is evident. EPA thus eliminated the influence of riparian species in the model. The final scenarios vary only conifer size.

EPA evaluated the following five riparian management scenarios with the Q2ESHADE model described above for the Dobbyn Creek and Chamise Creek tributary stream networks.

1 - Current condition (baseline). This scenario is developed using the size of the vegetation as provided by the data and assumptions detailed in Appendix A.

2 - Topographical shading only. This scenario was developed to determine the general importance of vegetation shade in the watershed; it is not meant to reflect current or future conditions. In this scenario, the only shade over the stream is from unvegetated topography such as adjacent hillslopes. All shade from trees (both conifer and hardwood) was eliminated from the model for the purposes of this scenario.

3 - 18 inch diameter at breast height (dbh) conifer- private timber management. This scenario was developed to illustrate the result under the State's Forest Practice Rules. The rules have a requirement for 50-85% canopy retention, however it cannot be generalized what size tree is left in the riparian zone given this minimum requirement. Theoretically, an owner can harvest all trees as small as 12 inch dbh under the Forest Practice Rules, but generally it is not economical to do so. In addition, silvicultural management styles vary amongst different private landowners. This scenario represents the result if the entire watershed was harvested at the same time resulting in 18" dbh conifer trees after harvest. The results indicate that temperature changes are estimated throughout the stream network and occur even in stream segments as small as two kilometers. The actual stream temperature effects watershed wide will be a combination of both the type of riparian management, the proportion of landowners choosing different types of riparian management and the timing and frequency of riparian management.

4 - 24 inch dbh conifer-alternative private timber management. Given the variety of private timberland management styles, EPA also modeled a stand of 24 inch dbh conifers as another possible representation of the temperature effects of private timber management.

5 – Natural (full growth conifer is on average 48" dbh.) While it is difficult to generalize on the natural size of conifers given the range of site conditions, 48 inch dbh conifers were chosen to represent natural conditions. Appendix A provides more details on conifer size data. Riparian vegetation species were not modeled as part of this scenario in response to public comment that in some areas of the watershed riparian species has recovered in recent years. Given that EPA did not have any overall data for the watershed on alder recovery, the final TMDL uses estimates for shade and temperature based solely on conifer changes.

Table 3 and Table 4 provide the results of the modeling. The modeling results indicate that current stream temperatures are likely an alteration (warming) of natural stream temperatures. Additionally, the stream temperature alteration is adverse because all the scenarios show an increase in the percentage of the stream miles that are in warmer (worse) condition than the natural vegetation scenario.

Table 3 demonstrates that natural stream temperatures are estimated to be cooler than the temperatures estimated under current conditions. For example, in Dobbyn Creek the model estimates that under current conditions 34% of stream miles is cooler than 19˚C. Under the stream temperatures estimated to be natural, this proportion increases to 43%. Having a larger proportion of the watershed in cooler conditions is beneficial to salmonids. This overall decrease in stream temperatures, EPA concludes, is beneficial to salmonids. Table 4 shows the same information for Chamise Creek. In Chamise Creek currently 27% of stream miles is cooler than 19˚C. Under the conditions estimated to be natural, the percentage improves to 37% of stream miles.

EPA also examined the geographic extent and magnitude of the temperature changes. In Dobbyn Creek, modeling estimated that 62% of the modeled stream segments could cool by more than 0.5˚C under natural conditions; 14% would cool more than 1.0˚C. For Chamise Creek, 51% of modeled stream segments would cool by more than 0.5˚C under natural conditions; 17% would cool more than 1.0˚C. Figure 5 provides details on the magnitude and extent of the modeled improvements in conditions on Dobbyn Creek. Appendix A provides the same information for Chamise Creek, as well as additional scenarios.

Table 3. Stream Miles by Temperature Category for Dobbyn Creek

Temperature Category	Baseline Conditions		Topo. Shading	18 Inch DBH	24 Inch DBH	48 Inch DBH	
	Stream Miles	% of Total	Stream Miles	Stream Miles	Stream Miles	Stream Miles	% of Total
Good (max7daat < 15°C)	3.1	5%	0.0	2.2	2.2	3.1	5%
Fair (15°C < max7daat < 17°C)	5.0	8%	1.9	3.4	5.0	7.8	12%
Marginal (17°C < max7daat < 19°C)	13.0	21%	2.8	14.0	14.3	16.5	26%
Stressful (19.1°C < max7daat < 20°C)	8.4	13%	2.5	5.0	6.2	8.1	13%
Stressful (20.1°C < max7daat < 21°C)	8.4	13%	5.0	10.6	9.0	9.0	14%
Stressful (21.1°C < max7daat < 22°C)	6.8	11%	5.9	7.5	7.1	3.7	6%
Stressful (22.1°C < max7daat < 23°C)	5.6	9%	1.6	4.7	5.0	6.2	10%
Stressful (23.1°C < max7daat < 24°C)	4.7	7%	5.3	5.3	5.9	3.7	6%
Lethal (max7daat > 24°C)	7.8	12%	37.9	10.3	8.1	4.7	7%
TOTAL	62.8	100%	62.9	63.0	62.8	62.8	100%
Solar Radiation (Langley/day)	299.8		607.9	322.1	308.5	265.0	
% Shade	58.4%		16.1%	55.4%	57.3%	63.2%	

Table 4. Stream Miles by Temperature Category for Chamise Creek

Temperature Category	Baseline Conditions		Topo. Shading	18 Inch DBH	24 Inch DBH	48 Inch DBH	
	Stream Miles	% of Total	Stream Miles	Stream Miles	Stream Miles	Stream Miles	% of Total
Good (max7daat < 15°C)	0.3	0%	0.0	0.3	0.3	0.3	0.3
Fair (15°C < max7daat < 17°C)	2.8	4%	0.0	1.2	1.6	6.5	2.8
Marginal (17°C < max7daat < 19°C)	16.5	23%	0.6	11.8	14.6	19.9	16.5
Stressful (19.1°C < max7daat < 20°C)	10.9	15%	2.8	8.4	11.2	8.1	10.9
Stressful (20.1°C < max7daat < 21°C)	8.1	11%	0.9	11.8	9.3	10.6	8.1
Stressful (21.1°C < max7daat < 22°C)	7.8	11%	0.6	8.4	8.1	7.8	7.8
Stressful (22.1°C < max7daat < 23°C)	9.0	12%	0.9	9.0	9.9	4.0	9.0
Stressful (23.1°C < max7daat < 24°C)	4.3	6%	2.8	7.5	4.0	5.0	4.3
Lethal (max7daat > 24°C)	12.4	17%	63.4	13.7	13.0	9.9	12.4
TOTAL	72.1	100%	72.0	72.1	72.0	72.1	72.1
Solar Radiation (Langley/day)	221.9		499.1	240.1	229.7	201.7	
% Shade	65.1%		22.1%	62.3%	63.9%	68.2%	

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Figure 5. Temperature change between natural and current conditions

Table 3 and Table 4 also demonstrate that the current conditions are slightly better than if the entire watershed had 18 - 24 inch conifers - the approximate size that exists after harvesting under the Forest Practice Rules.

3.2.2 Selection of Scenario Corresponding to Water Quality Standards

The narrative water quality standard states “the natural receiving water temperature ...shall not be altered unless it can be demonstrated...that such an alteration in temperature does not adversely affect beneficial uses.”

EPA concludes that the natural scenario (scenario 5) corresponds best to the “natural stream temperatures shall not be altered” phrase in the State’s Water quality standard. EPA concludes that the estimated magnitude and extent of increased stream temperatures in the tributaries is an alteration of stream temperatures. Furthermore, EPA finds that based on the biological literature this warming is adverse to salmonids. EPA recognizes that natural conditions do not provide optimal summer temperatures for salmonids.

3.3 SOLAR RADIATION TMDL FOR TRIBUTARIES IN THE MIDDLE MAIN EEL TMDL

Because our analysis indicates that water quality standards for temperature are not being attained in the tributaries, EPA is establishing a TMDL for the tributary streams as required by Section 303(d) of the Clean Water Act and EPA regulations. As described in Chapter 2, a TMDL is not needed for the main channel of the Eel from Dos Rios to the South Fork.

3.3.1 Loading Capacity and TMDL – Solar Radiation for All Tributary Stream Reaches

The TMDL is the total loading of a pollutant that the river can assimilate and still attain water quality standards for temperature. In this TMDL, the pollutant is heat, measured in Langleys/day (ly/day). Langleys are a measure of heat energy per surface area per time unit (or gram calories per cubic centimeters) and can be converted to metric units such as joules (1 ly = 41,850 joules/m^2) or watts or BTUs. We are setting the TMDL equal to the amount of heat the waterbody would receive under the natural scenario (e.g. scenario #5).

The TMDL is calculated using the natural scenario as described previously. The modeled calculations are used to express the TMDL. These calculations are the result of several modeling steps. Global solar radiation over each stream segment - i.e., the solar radiation that exists above the vegetation at this latitude, is calculated. Then the model calculates the actual amount of radiation/heat in langleys that would reach each stream segment after accounting for topographical shading, stream orientation, stream width and the potential height of the riparian vegetation. While the model calculates the amount of heat for each stream sampling point, the TMDL is expressed as an average of all stream sampling points for summary purposes.

The **TMDL** for the Middle Main Eel tributaries is set as an

average of **233 langleys/day**.

This is based on an average of the modeled calculations for Dobbyn and Chamise Creek. These tributaries were selected as representative of the vegetation characteristics of the entire watershed. The TMDL number is a mathematical average of the amount of heat that would reach the stream surface for each stream segment modeled after accounting for natural size of conifers and hardwood.

This is the loading capacity of the stream, and will allow water quality standards for temperature to be achieved.

3.3.2 Shade Allocations

EPA regulations define a TMDL as the sum of wasteload allocations for point sources + the sum of the load allocations for nonpoint sources + the sum of load allocations for background sources + a margin of safety. As there are no point sources, the wasteload allocation in the watershed is zero. This TMDL has an implicit margin of safety that is provided by assumptions rather than a explicit margin of safety. Therefore, the TMDL is set equal to the loading capacity and the load allocations are sufficient to result in the attainment of the TMDL. The TMDL is set in langleys and the load allocations are expressed in shade.

While it is theoretically possible to measure langleys/day for streams in practice, shade is a more widely understood concept. Readers should note that the percentage shade used in the TMDL uses a time component in the calculations. (The model calculates the accumulated heat as the sun's path moves throughout the day). The shade values expressed here are the calculation of the accumulated reduction in solar radiation over time. Various measurement devices can approximate this value, such as a solar pathfinder. We have calculated the allocations using the model by translating the TMDL in langleys/day into an average shade allocation for the watershed.

(For all tributary stream reaches in the Middle Main Eel TMDL area)

TMDL = 66% shade (the average shade calculated for all tributary stream segments.)

The load allocations are expressed as percent shade. Percent shade is calculated in the model as the amount of solar radiation reaching the stream surface divided by the potential solar radiation. This is after shading provided by natural vegetation. This will be an average of 66% shade for all stream segments.

Figure 6 and Figure 7 provide the geographic distribution of the expected natural shade (the load allocations) for all stream reaches modeled in Dobbyn Creek and Chamise Creek.

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Figure 6. Percent average shading for natural vegetation in Dobbyn Creek

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Figure 7. Percent average shading for natural vegetation in Chamise Creek

Appendix A provides information on the geographic distribution for all modeled scenarios. In addition, the magnitude of the changes to shade is also provided.

Instream Indicators

The stream temperatures expected to meet the narrative water quality standard "natural stream temperatures shall not be altered" are displayed in Figure 8 and Figure 9 for the representative tributary stream networks. The figures indicate that when the narrative water quality standard is attained, the measured stream temperatures will be variable. EPA recommends that given the wide range of natural stream temperatures that attainment of the TMDL be monitored based on the progress toward natural shade.   In addition, EPA recommends that the Regional Board continue with their practice to take into account site specific conditions during implementation. This is consistent with the Regional Boards action plans for the Scott and Salmon Temperature TMDLs.

3.3.3 Margin of Safety

Under EPA regulations, a margin of safety may be provided explicitly by not allocating a portion of the available TMDL or implicitly through use of using conservative analytical assumptions. In this TMDL, an implicit margin of safety is provided through some conservative analytical assumptions. First, refugia from groundwater sources and springs may be providing the crucial refugia for salmonids in these areas and incremental increases in ambient stream temperatures may not be as detrimental as assumed. Second, the salmonid response to temperature differences in streams may be mitigated by the presence of habitat diversity given that salmonids move to areas where conditions are more optimal for growth. Thus the adverse effects of stream temperature increases will be less than predicted. These assumptions provide an implicit margin of safety as required by 303(d) of the Clean Water Act.

3.3.4 Seasonal Variation and Critical Conditions

In accordance with EPA regulations, the TMDL must account for seasonal variations and critical conditions. In the Middle Main Eel watershed, the summer period defines the critical period when stream temperatures are most likely to have adverse impacts on salmon. To account for seasonal variations and critical conditions, the analysis is based on the max7daat (i.e., the maximum weekly average of the 7 day running average of all monitored temperatures).

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Figure 8. Natural stream temperatures in Dobbyn Creek

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Figure 9. Natural stream temperatures in Chamise Creek

CHAPTER 4: SEDIMENT TMDL

This chapter presents the sediment TMDL for the Middle Main Eel River, along with the technical analysis. The first section summarizes the results of the sediment source analysis. The second section presents the calculations of the TMDL. The TMDL is the total loading of sediment that the Middle Main Eel River and its tributaries can receive without exceeding water quality standards. The third section identifies water quality indicators, which are interpretations of the narrative water quality standards. These indicators can also be used to evaluate stream conditions and progress toward or achievement of the TMDL.

The sediment source analysis for the Middle Main Eel River was conducted by Pacific Watershed Associates (PWA) under subcontract to Tetra Tech, Inc. for EPA. The analysis concluded that past sediment loading is 146% of natural loading. This is in excess of the TMDL, which is set at 125% of the natural sediment load (averaged over time to account for large storms). Sediment delivery and erosion from human disturbance is related primarily to roads and to a lesser extent timber harvest. Landslides dominate both the natural and human related sediment production in the Middle Main Eel River area. Landslides both large (e.g. visible on air photos) and small were the most significant erosion processes in the watershed.

4.1 SEDIMENT SOURCE ANALYSIS

This section summarizes the results of the sediment source analysis. The purpose of the sediment source analysis was to identify and estimate the relative amounts of sediment from the various sediment delivery processes and sources in the watershed. This section is a summary of the methodology, results, and interpretation of the PWA sediment source analysis. Appendix B contains additional details on the results by geology, subwatershed and type of erosional feature.

4.1.1 Sediment Source Analysis Methodology

The sediment source analysis for the Middle Main Eel River and tributaries was conducted to identify the relative contribution of sediment delivered to stream channels. The sediment source analysis covers the period of 1960 - 2003 in order to capture the sediment delivered during large storms. There were two general components to the sediment source analysis: the quantification of “large” (sources greater than 3,000 cubic yards [yds^3]) using air photo analysis and the quantification of smaller sources (sources smaller than 3,000 yds^3). The smaller sources were estimated using a stratified random sampling field study. In addition, surface erosion from roads was estimated by the SEDMODL computer model, a widely used computer model.

All erosional features mapped on the aerial photos or within the random sample plots had the same suite of data collected. These data include: 1) whether the feature was road-, skid trail- or hillslope-related, 2) terrain type (stratum) and dominant vegetation type, 3) type of sediment source, 4) volume of erosion, 5) an estimate of the volume of sediment delivered to streams, 6) hillslope location and average hillslope steepness where the erosion occurred, 7) any apparent land use/management associations, and 8) geomorphic association.

PWA analyzed 1960, 1965, 1966, 1980, 1984, 1985, 2000 and 2003 air photos. These years were selected to allow analysis of major features under two different management conditions, specifically pre-1970 and post-1970. During this general time period, there were both formal shifts in management and changes instigated by the legal system. The formal shifts include the implementation of the Forest Practice Rules (FPR) on private lands in the 1970s and the Northwest Forest Plan on public lands in the early 1990s. In addition, there were several lawsuits filed in the early 1970s regarding timber harvesting and the Endangered Species Act that appear to have resulted in informal changes in management practices. In addition, the aerial photos include the 1964 and the 1997 storms.

Aerial photographs for the entire watershed were analyzed to identify all visible large sediment sources. The following sediment sources were quantified if they exceeded 3,000 yds^3 of past erosion: shallow debris slides, debris flow sources, debris torrent tracks, active earthflows, gullies, and streambank erosion. This analysis estimated the sediment volume delivered to the stream system and then assigned a management association (road-related, harvest-related, etc.) to sources when there was a management activity visible above the feature in the photo. Sources with no management association were assumed due to natural causes. This information was verified at some locations if they were near plots sampled during the field study to identify small sources of sediment.

Sources of erosion and sediment delivery that are too small to be identified from air photos were quantified as well. Both a stratified random sampling (STRS) field study was performed and a model (SEDMODL) used to estimate small sediment sources (USEPA, 1999b, 2002). For the field study, small sediment sources (less than 3,000 yds^3) were placed in the following source categories: debris slide, debris torrent track, bank erosion, road related gully, non-road related gully, stream crossing, channel incision, surface erosion, debris flow source, and active earthflow. In addition to mapping these small sources, the volume of erosion was quantified and the sediment delivered to streams was estimated before assigning a management association to the source. For all erosional features identified within the sample plots or on aerial photographs, PWA attempted to identify the decade in which the erosion was initiated and whether the feature was still actively eroding in 2004. The age of vegetation on or adjacent to an erosional feature provides the most useful information in deriving the origination age and activity level. SEDMODL estimates the surface erosion from roads and well as sediment from the cutbank retreat. EPA considers this methodology to result in the estimation of all significant sources of sediment. In response to comments, EPA revised the SEDMODL estimates to account for the most detailed roads information available.

To estimate the contribution from small sources the watershed was stratified into terrain type. Geology is a major determinant of erosion thus the extrapolation of field measured features to the entire watershed was based on geology. PWA stratified the Middle Main Eel River watershed into six strata or geologies by reviewing maps of bedrock and lumping similar rock types together. These six strata are identified in Table 5 along with their total area and the number of sample plots within each stratum.

To select the location of the sample plots, a grid was developed for the entire basin area with each grid cell equal to 41.8 acres. The sample grid was overlain with the six terrain types to create a layer that identified the dominant terrain type for each grid cell. Landowner permission for access was requested for private domain plots and those plots within the public domain that had some private ownership. When landowner permission could not be obtained, the next sequential cell on the list for the appropriate stratum was selected. In addition, if a cell was randomly selected, but contained a large sediment source (>3,000 yds^3), it was eliminated and another grid cell was systematically selected. 39 field plots were visited in the field during the summer of 2005 where the size of erosional features was measured.

Table 5. Strata Identified in the Upper Eel River Watershed

Strata Area Number and Description	Area (mi^2)	Percent of Basin	Number of Grid Cells	Proposed Number of Sample Plots	Number of Plots Sampled
1. Old and Strong	118	23	1808	9	9
2. Franciscan Melange	317	61	4862	16	17
3. Alluvium	10	2	152	3	2
4. Argillite	14	3	216	4	5
5. Young and Weak	30	6	456	4	4
6. Resistant Blocks	31	6	477	4	2
Totals	**521**	**100%**	**7976**	**40**	**39**

The results of the STRS study were extrapolated to estimate small source sediment yield for the entire basin. After the large and small sources were quantified, the estimated basin-wide small source and aerial photo data were combined to determine the total Middle Main Eel river sediment delivery and rates of erosion for different management associations, time periods, and strata, which are presented in the following section.

4.1.2 Results

Table 6 and Figure 10 summarize the results of the sediment source analysis. Natural landslides - both large features identified on air photos and field measured debris slides - are the dominant (68%) erosional and sediment source in the watershed. An estimated 32% of the total sediment delivered to streams was attributed to smaller natural sources, primarily debris slides. An additional 34% of the total sediment delivered to streams was attributed to larger natural features, primarily landslides visible on air photos. An estimated 32% of the total sediment was attributed to human activity (Table 6). Thus the sediment loading in the watershed is 146% over the natural loading (753 tons/square mile/year total loading divided by 516 tons/square mile/year natural sediment loading.)

EPA also investigated differences in the two major subwatersheds and the portion of the watershed directly loading into the main channel. EPA does not find any notable results using this finer level of detail (see Appendix B). In addition, Appendix B also provides details on the results by geology. Again, EPA did not find the results provided any guidance in setting the TMDL, load allocations or suggested implementation based on geology.

Table 6. Sediment Loading in the Entire Middle Main Eel River Study Area (1940-2005)

Sediment Source	Tons/mi^2/year (65 year average)	Total tons/mi 2/year	Percent of total
Natural-small features (debris slides and bank erosion)	233		
Natural-landslides and other large features	237		
Natural - Earthflows	46		
Total - Natural		**516**	**68%**
Roads - landslides	80		11%
Roads – small features (SEDMODL results, gullies, stream crossing failures)	104		14%
Timber Harvest (landslides and other large features)	36		5%
Timber Harvest-small features	12		2%
Grazing/Homestead	5		0
Total - Human and Land Management Related		**237**	**32%**
Total – All Sources		**753**	**100%**

Source: Appendix B, Table B-4

The time period of sediment delivery was also investigated. Figure 10 identifies all the management- and non-management-associated sediment delivery features that PWA estimated were initiated prior to 1970 and those that were initiated after 1970. The data was separated around 1970 due to improvements in timber management from the Forest Practices Act.

Figure 10 indicates that considerably less natural and human related sediment was produced in the post 1970 period. This likely reflects both differences in the frequency and magnitude of storms, which trigger widespread landslides, road failures and washouts; but could also be attributed to the improvement in land management practices. Figure 10 was derived from appendix B Table 6, plus the sedmodl results.

PWA also investigated the railroad as a source of sediment for EPA. Results indicate that a minimum of 51,000 yds has been delivered to the Middle Main Eel by the railroad's alignment. These estimates are a minimum because they could not account for past erosion that had been obscured by maintenance activities. EPA concludes that the railroad is not a significant source of sediment.

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Figure 10. Percent sediment delivery
by management association and time period

4.2 TMDL AND ALLOCATIONS

4.2.1 Loading Capacity and TMDL

This TMDL is set equal to the loading capacity of the Middle Main Eel River. The TMDL is the estimate of the total amount of sediment, from both natural and human-caused sources, that can be delivered to streams in the watershed without exceeding applicable water quality standards. EPA is using 125% of natural sediment loading for this watershed. This approach to setting sediment TMDLs has been used in most of the watersheds in the north coast of California. The approach taken focuses on sediment delivery rather than a more direct measure of salmonid habitat (i.e. instream conditions). Sediment delivery can be subject to direct management by landowners (i.e. roads can be well-maintained), whereas instream conditions (pool depth, percent fines) are subject to upstream management that may not be under the control of local landowners. While it would be desirable to mathematically model the relationship between salmon habitat and sediment delivery, these tools are not readily available for watersheds with landslides and road failure hazards.

EPA is using a method of setting the TMDL and allocations similar to that employed in other basins (e.g., South Fork Eel, Noyo, Big, Albion Rivers, North Fork Eel, Middle Fork Eel, and Upper Main Eel [USEPA, 1998, 1999a, 2000, 2001c, 2002, 2003 and 2004]). It is based on the assumption that a certain amount of loading greater than what is natural is acceptable, and will still result in meeting water quality standards. Prior TMDL studies of the relationship between sediment loading rates and fish habitat effects found that many North Coast waters supported healthy fish habitat conditions during periods in which sediment loads were up to 125% of natural loading rates. Thus EPA is using this sediment loading rate as the level that meets the water quality standards in Table 1. Those narrative standards are set at levels that "shall not contain" sediment at levels that "adversely affect beneficial uses." Thus the natural sediment loading that is not adverse to beneficial uses (i.e. the cold water use related to salmon) is interpreted to be 125% of natural sediment loading. EPA is calculating the loading capacity and TMDL on a calculation of 125% of natural loading.

EPA is using a long term, watershed wide loading rate because sediment movement in streams is complex both spatially and temporally. Sediment found in some downstream locations can be the result of sediment sources far upstream. Instream sedimentation can also be the result of land management from decades past. While the instream habitat for salmonids (percent fines, embeddedness, pool filling, channel morphology changes) is the adverse affect on salmonids, the sediment delivery rate is linked overall with these factors. The approach also assumes that salmon can be supported in streams even with the yearly variation of natural rates of erosion observed in the 20th century. Although sediment delivered to the streams has varied over time, salmon have adjusted to the natural variability by using the habitat complexity created by the stream's adjustments to the varying sediment loads.

While EPA is calculating the TMDL based on the loading estimates for the entire period analyzed, EPA expects progress toward the TMDL to be analyzed using the percent over natural formula, not the measurement of tons/mi2/year. In addition, Figure 10 suggests that the watershed is making significant progress toward meeting the TMDL.

TMDL = Loading Capacity = 125% x (516 tons/mi^2/year) = **645 tons/mi^2/year**

4.2.2 Allocations

In accordance with EPA regulations, the loading capacity (i.e. TMDL) is allocated to the various sources of sediment in the watershed, with a margin of safety. That is:

TMDL = sum of “wasteload allocations” for individual point sources,

\+ sum of the “load allocations” for nonpoint sources, and

\+ sum of the “load allocations” for background sources

Although nonpoint sources appear to be responsible for all sediment loading in the watershed, there is a potential for limited point source discharge of sediment in the watershed if there were construction sites discharging pursuant to California’s NPDES general permit for construction site runoff. EPA has no evidence that development that would be covered by general NPDES permits is planned for the watershed. Therefore, EPA determined that this source is not significant and is setting the allocation at zero. There are no other wasteload allocations, as there are no other individual point sources of sediment in the basin.

The load allocations for the Middle Main Eel River Sediment TMDL are presented in Table 7. The allocations clarify the relative emphasis and magnitude of erosion control programs that need to be developed during implementation planning. The load allocations are expressed in terms of yearly averages (tons/mi^2/yr). They can be divided by 365 to derive daily loading rates (tons/mi^2/day), but EPA is expressing them as yearly averages because sediment delivery to streams is highly variable on a daily and yearly basis. In fact, EPA expects the load allocations to be evaluated on a ten-year rolling average, because of the natural variability in sediment delivery rates. In addition, EPA does not expect each square mile within a particular source category throughout the watershed to necessarily meet the load allocation; rather, EPA expects the watershed average for the entire source category to meet the load allocation for that category. The load allocations were based on 50% reduction in landslides based on the timeperiod analysis that showed that this type of reduction may be already taking place. No reductions were allocated to homestead and grazing activities given they are a small source. The remaining load is to road surface erosion and small features.

Table 7. Sediment Load Allocations for the Middle Main Eel River

Sediment Source		1960 - 2003	Load Allocation	Percent of 1960-2003
Natural		516	516	100%
Road	Large features	80	40	50%
	Small features	104	60	58%
Timber Harvest	Large features	36	18	50%
	Small features	12	6	50%
Other		5	5	100%
Total Human-related		188	129	
Total - Natural and Human Related Sources		704	645	

4.3 WATER QUALITY INDICATORS AND TARGETS

Indicators and targets can be used to represent attainment of water quality standards. This section identifies numeric water quality indicators and targets specific to the Middle Main Eel River. For each indicator, a numeric or qualitative target value is identified to define the desired condition for that indicator.

Because of the inherent variability associated with stream channel conditions, and because no single indicator applies at all points in the stream system, attainment of the targets is intended to be evaluated using a weight-of-evidence approach. That is, when considered together, the indicators are expected to provide good evidence of the condition of the stream and attainment of water quality standards.

Instream indicators reflect sediment conditions that support healthy salmonid habitat. They relate to instream sediment supply and deposition and are important because they are direct measures of stream "health." In addition to instream indicators, previous TMDLs included watershed indicators such as targets for stream crossing failures. However, EPA is not setting watershed indicators in this TMDL because the Regional Board's more recent review of habitat targets does not include watershed indicators (NCRWCB, 2004). In addition, the Middle Main Eel river watershed is making progress toward the overall TMDL goal and EPA wants to emphasize instream indicators.

4.3.1 Summary of Indicators and Targets

This section describes several sediment indicators for the Middle Main Eel River TMDL. Table 8 summarizes the indicators along with their target, description and purpose. The background on these indicators is contained in the Regional Board's "Salmonid Freshwater Habitat Targets for Sediment-related Parameter" (NCRWQCB, 2004b) that has been developed as part of the basin planning process. EPA notes that that guidance document is intended to be updated as scientific information becomes available. Details on the applicability to different sizes and types of streams, along with monitoring and sampling notes and background literatures is available in that document (NCRWQCB, 2002). EPA expects that future monitoring of these indicators will provide additional information to assess whether the water quality standards are being attained and whether the TMDL is effective in meeting water quality standards.

Table 8. Sediment Indicators and Targets

INDICATOR	TARGET	PURPOSE
Instream		
Substrate Composition - Percent fines	<14% < 0.85 mm ≤30% < 6.4 mm;	Indirect measure of fine sediment content relative to incubation and fry emergence from the redd. Indirect measure of ability of salmonids to construct redds
Turbidity and Suspended Sediment	Turbidity ≤ 20% above naturally occurring background (also included in Basin Plan)	Indirect measure of fish feeding/growth ability related to sediment, and impacts from management activities
Riffle Embeddedness	≤25% or improving (decreasing) trend toward 25%	Indirect measure of spawning support; improved quality & size distribution of spawning gravel
V*	≤0.21	Estimate of sediment filling of pools from disturbance
Macroinvertebrate community composition	Improving trends	Estimate of salmonid food availability, indirect estimate of sediment quality.
Thalweg profile	Increasing variation from the mean	Estimate of improving habitat complexity & availability
Pools	Increasing trend in the number of backwater, lateral scour pools. Increasing trend in the number of stream reaches where the length of the reach is composed of ≥40% in primary pools	Estimates improving habitat availability

4.4 MARGIN OF SAFETY

The margin of safety must be included in a TMDL to account for uncertainties concerning the relationship between pollutant loads and instream water quality and other uncertainties in the analysis. The margin of safety can be incorporated into conservative assumptions used to develop the TMDL, or added as an explicit, separate component of the TMDL. This TMDL incorporates a margin of safety through use of conservative assumptions.

There is uncertainty concerning the interpretation of the amount of sediment delivery associated with management activities versus natural background sources. PWA generally attributed most or all of the sediment load of any landslide occurring within a recent harvest unit as being harvest or road related. This is a conservative assumption because some slides may have occurred naturally even if the land had not been harvested recently. Because the TMDL is calculated based on the amount of natural loading, this results in a more conservative TMDL calculation.

4.5 SEASONAL VARIATION AND CRITICAL CONDITIONS

The TMDL must describe how seasonal variations were considered. Sediment delivery in the Middle Main Eel River watershed has considerable annual and seasonal variability. The magnitudes, timing, duration, and frequencies of sediment delivery fluctuate naturally depending on intra- and inter-annual storm patterns. The analysis accounted for this seasonal and yearly variability by calculating the sediment delivery over the long term (1940 - 2003). This accounts for both the seasonal variation (winter producing the most sediment) and the critical conditions (large storms producing a large percentage of sediment.) Adverse effects on instream conditions and salmonid habitat is the result of the accumulation of sediment, including the impacts from infrequent and large storms. Thus this TMDL is to be evaluated on a ten-year rolling average or longer term average that accounts for the influence of large storms.

CHAPTER 5: IMPLEMENTATION AND MONITORING MEASURES

The main responsibility for water quality management and monitoring resides with the State. EPA fully expects the State to develop and submit implementation measures to EPA as part of revisions to the State water quality management plan, as provided by EPA regulations at 40 C.F.R. Sec. 130.6. The State implementation measures should contain provisions for ensuring that the allocations in the TMDL will in fact be achieved. These provisions may be non-regulatory, regulatory, or incentive-based, consistent with applicable laws and programs, including the State's recently upgraded nonpoint source control program.

For the Temperature TMDL, EPA recommends that timber harvest permits on private lands be evaluated to assure that natural shade is protected or restored in order to assure compliance with the TMDL and thus water quality standards. The State should also assure that the THP process is protecting natural shade. As a practical matter and one that accounts for site-specific information, the TMDL calculation can be simplified during implementation as setting the TMDL equal to no allowable changes to natural shade.

Current standards and guidelines under the North West Forest Plan may be sufficient to attain riparian vegetation characteristics consistent with the temperature load allocations for shade on USFS lands.

For the Sediment TMDL, EPA specifically recommends that more in-stream information be gathered in tributaries throughout the basin. Collecting this information, using a random sampling approach, would assist the Regional Board in determining if the reduced human related sediment loading seen in the recent past is confirmed by instream conditions.

EPA also recommends that the Regional Board use the information developed from the sediment source analysis in setting priorities for any new sediment reduction programs. The Regional Board is currently investigating how to set priorities to addressing sediment waste discharges on a watershed scale. EPA recommends that the Regional Board consider the relative progress and threats of different watersheds when setting priorities. In addition, landslides are the dominant process than produces sediment and reducing this risk may be the most cost-effective approach.

CHAPTER 6: PUBLIC PARTICIPATION

EPA provided public notice of the draft Middle Main Eel River Temperature and Sediment TMDLs by placing a notice in the *Willits News* and *Eureka Times-Standard*, papers of general circulation in Mendocino and Humboldt counties. EPA and the Regional Board also held an informational meeting in April 2005 in Alderpoint at the beginning of collecting data for the TMDL and again in November 2005 to discuss the results of the TMDL. The public notice regarding availability of the draft Middle Main Eel TMDLs was posted on EPA's web site, along with the document. The public notice was also mailed or emailed to additional parties. EPA received 3 comments on the draft TMDL and made revisions based upon those comments. The responsiveness summary is available as a separate document.

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