Power Resources Technical Appendix C

Power Impact Analysis for the Trinity River SEIR/EIS Central Valley Project Phase 2 Report

<u>Revised Draft dated February 5, 2004</u>

Power Impact Analysis for the Trinity River SEIR/EIS Central Valley Project Phase 2 Report

Prepared for:

CH2M HILL and
United States Bureau of Reclamation

Date Prepared:
February 5, 2004

Prepared by:
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Date Submitted:
October 16, 2003

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1 INTRODUCTION

Henwood Energy Services, Inc. (Henwood) previously provided a Phase 1 report on Power Impact Analysis for the Trinity River SEIR/EIS Central Valley Project. That report was dated October 2, 2002. The Phase 1 Report consisted of two segments. The first segment consisted of a review of the previous power impact analysis and the objections to that prior analysis. The second segment presented a detailed study plan for conducting a Power Impact Analysis for the supplemental environmental impact analysis of the Trinity River Mainstem Fishery Restoration that fully addresses any shortcomings of the previous analysis.

This Phase 2 report presents the results of the revised Power Impact Analysis for the supplemental environmental impact analysis of the Trinity River Mainstem Fishery Restoration that fully addresses any shortcomings of the previous analysis.

2 BACKGROUND - DECEMBER 2000 ROD, RELATED LITIGATION, AND PLAN FOR SUPPLEMENTAL EIS/EIR

In December 2000, the U.S. Department of the Interior (Department) issued its Record of Decision (ROD) on the Trinity River Mainstem Fishery Restoration. In making its decision, the information and analyses contained in the Final Environmental Impact Statement /Environmental Impact Report (FEIS/EIR) dated October 2000 was reviewed and considered in detail. The ROD recommended increasing the flows in the Trinity River thereby decreasing the diversion of Trinity River water to the Central Valley Project (CVP). This ROD has been challenged in court. In response to the court decision, CH2M HILL is preparing a supplemental environmental impact analysis (SEIS/SEIR) for the Trinity River Mainstem Fishery Restoration.

CH2M HILL's objective is to prepare the SEIS/SEIR for the Trinity River Mainstem Fishery Restoration Program by:

- Incorporating basic elements of the October 2000 SEIS/SEIR so that readers and decision makers can gain full understanding of the Project;
- Analyzing and presenting environmental impacts of the Project in the context of biological opinions issued for CVP operations not considered in the October 2000 SEIS/SEIR;
- Analyzing and presenting environmental impacts of the Project in the context of CVPIA 3406(b)(2) water supplies not considered in the October 2000 SEIS/SEIR;
- Analyzing and presenting potential environmental impacts of the Project in the context of changed conditions in the energy industry; and
- Analyzing potential environmental impacts of new alternatives as identified in the scoping proceedings that will be a part of the SEIS/SEIR.

Henwood was retained by CH2M HILL to provide the Power Impact Analysis for this supplemental environmental impact analysis. As a part of the supplemental power impact analysis, several CH2M HILL staff and subcontractors to CH2M HILL ran models and developed model outputs for use in Henwood's Power Impact Analysis.

The following models were replaced for the SEIS/SEIR effort:

- CALSIM II replaces PROSIM
- CALAG replaces CVPM
- Long-TermGen (LTG) replaces PROSIM Power Module
- MARKETSYM replaces PROSYM

3 DESCRIPTION OF EFFORT UNDERTAKEN IN PHASE 2

3.1 INFORMATION DEVELOPED BY OTHERS AS INPUT TO THE POWER IMPACT ANALYSIS PERFORMED BY HENWOOD

Certain adjustments were made to the alternatives to be studied for the SEIR/EIS. A brief description of the alternative studies are:

- Existing Conditions (EC) - 340 thousand acre feet of annual flow (TAF) releases down the Trinity River, 2001 Level of Development (i.e. water demands).
- Maximum Flow (MF) - 463-2,146 TAF (zero exports to Sacramento Valley), 2020 Level of Development.
- Preferred Alternative or Flow Evaluation or ROD Flow (PF) – 369-815 TAF, 2020 Level of Development.
- 70 Percent Inflow (70) - 421-1,732 TAF, 2020 Level of Development
- Modified Percent Inflow (MP) – 369-720 TAF, 2020 Level of Development.
- Revised Mechanical (SMUD) – 340-556 TAF, 2020 Level of Development.
- No Action (NA) – 340 TAF, 2020 Level of Development

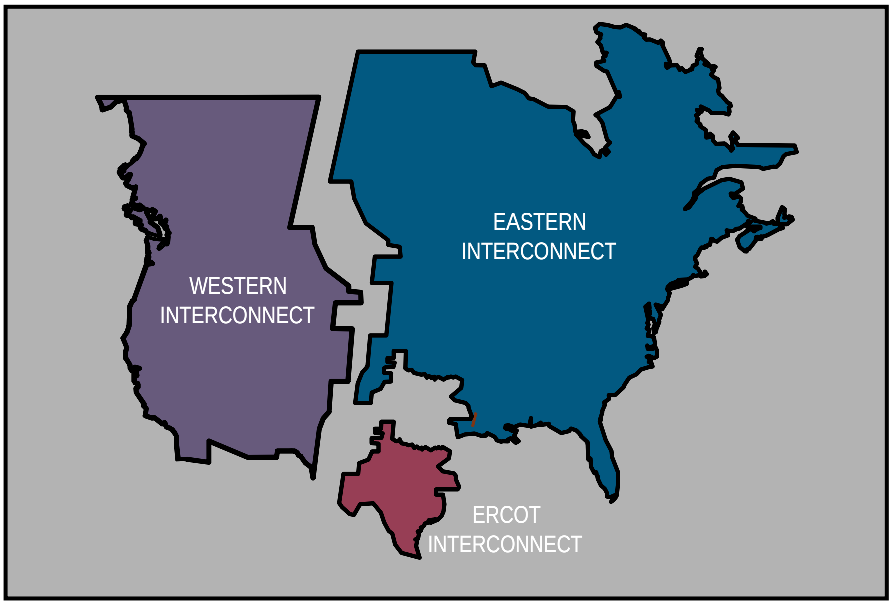
For each of these 7 alternatives, models were run by others to develop data to be used by Henwood in its Power Impact Analysis. The models run by others were the CALSIM II model (which develops monthly water flows) and LTG (which develops monthly generation from those water flows). The data provided to Henwood for each of the 7 alternatives was:

- Monthly generation under each of 73 different historical years of rainfall for each of the CVP hydroelectric generation facilities consisting of the following power plants (which total approximately 2,000 MW of capacity):
  a. Trinity
  b. J.F. Carr
  c. Spring Creek
  d. Shasta
  e. Keswick
  f. Folsom
  g. Nimbus
  h. San Luis
  i. O'Neill
  j. New Melones
- Monthly CVP electric pumping load under each of 73 different historical years of rainfall. The monthly pumping load was divided between pump load during heavy load hours of that month (these hours consist of 16 hours from 6:00AM to 10:00 PM Monday through Saturday) and pump load during the remaining hours of the month.

3.2 ANALYSIS PERFORMED BY HENWOOD

Henwood analysis recognizes that the CVP power plants are a part of the Western Interconnection. The Western Interconnection (sometimes called Western Electricity Coordinating Council or "WECC") is one of three major interconnections in North America.

Figure 3-1
Interconnections



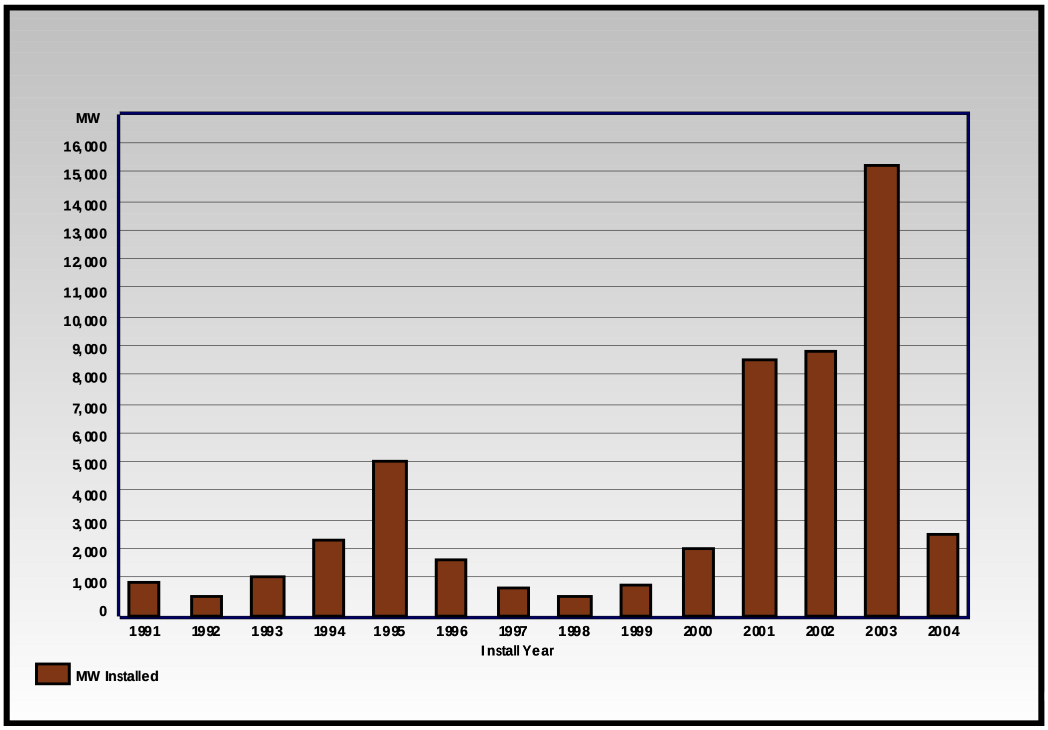
The WECC region extends from Canada to Mexico, including the Canadian provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico and all or portions of fourteen U.S. states.

Data needed for analysis

Because of a strong network of transmission lines across WECC, the value of power associated with generators connected to this network, and the reliability of the electric network, are best determined by analysis that reflects all of the generators and loads in WECC. As of 2003, there is approximately 185,000 MW of generation nameplate capacity in WECC, of which 60,000 MW is hydro nameplate capacity. The single hour highest (peak) load in WECC in 2003 was approximately 135,000 MW. The average hourly load over the year 2003 is expected to be approximately 92,000 aMW (805,920 GWH in the year).

In general it is believed that, with 185,000 MW of generating capacity and 135,000 MW of peak load, there is somewhat of an overbuild of generation in WECC today. This is a much different situation than the one that existed in December of 2000, when the Record of Decision for the Trinity River Mainstream Fishery Restoration was issued. As can be seen from the figure below, a very large amount of new generation has been added in WECC in the years 2001, 2002 and 2003. There was no generation assumed to be added in the year 2005 because of the overbuild that resulted from the large resource additions in WECC in the years 2001-2003.

Figure 3-2
New Generation



Every six months Henwood develops an independent forecast of power prices in WECC. Henwood has used its Spring 2003 price forecast as a starting point to evaluate the power impact of alternatives for Trinity River Mainstem Fishery Restoration. This forecast is a fundamental based forecast that uses Henwood's proprietary MARKETSYM model and updated database to forecast hourly market clearing prices. Over 50 entities have purchased Henwood's Spring 2003 price forecast. These entities include both investor owned and consumer owned utilities, power plant developers, banks, and rating agencies. The forecast is widely accepted as a reasonable forecast.

In developing its forecast of hourly market clearing power prices, Henwood has developed a forecast of hourly loads across the many sub-areas of WECC. A database of generation available for operation in these areas is also developed along with the operating restrictions, heat rates, fuel cost, etc. that need to be reflected in an analysis regarding operation of the plants. It is also necessary to represent some of the key transmission path constraints that may limit the ability to move power from one sub-area of WECC to another from hour to hour.

Choosing a year for analysis

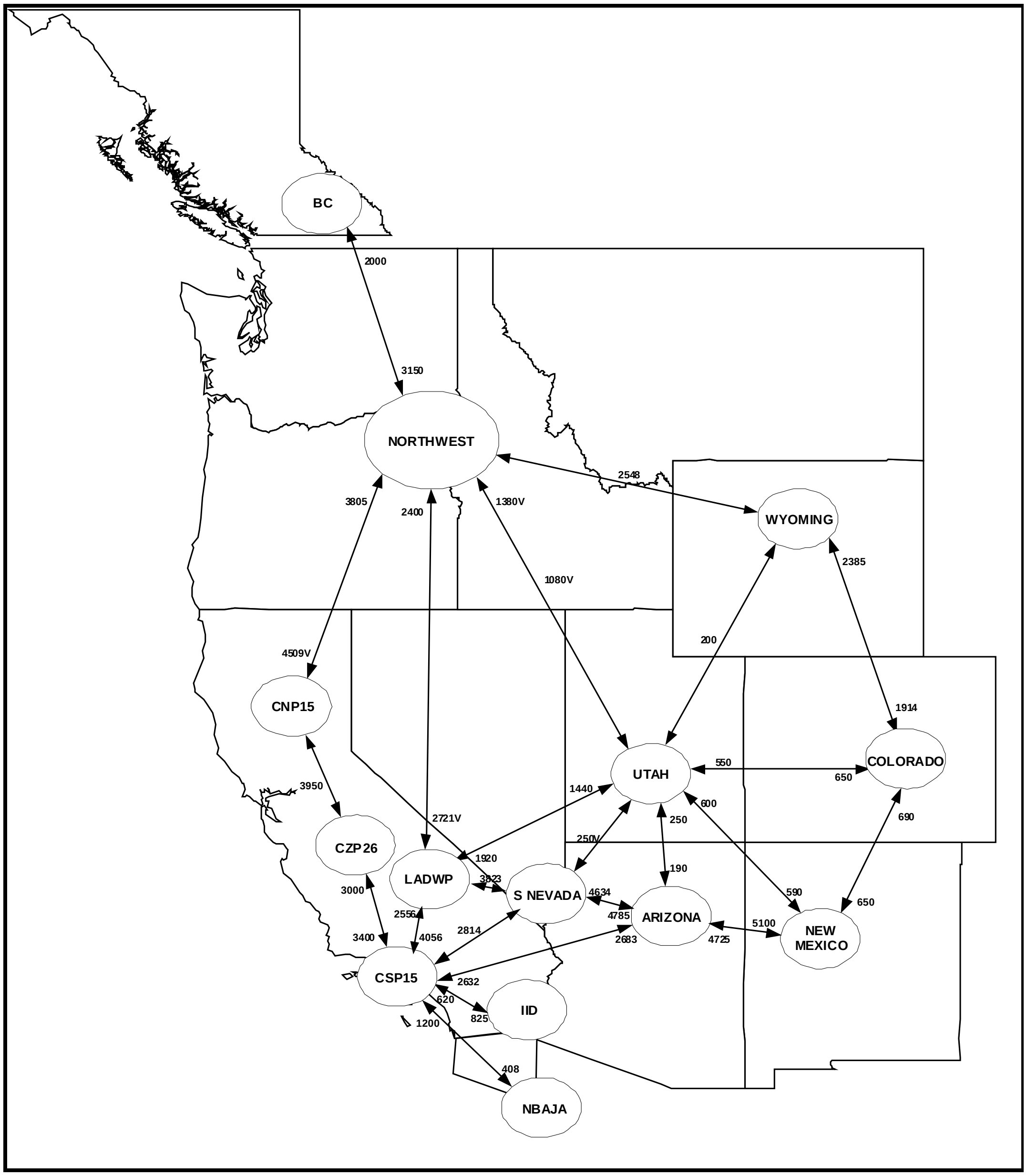
In choosing a year to evaluate the power impact of alternatives for Trinity River Mainstem Fishery Restoration, Henwood believes that 2005 would be a reasonable year for performing the analysis. The generation overbuild situation is forecast to be reduced by that time as loads are forecast to grow and little new generation is assumed to be added after 2003. Beyond 2005 it is more difficult to predict just when and how much new generation will be built.

Choosing a topology for analysis

Having chosen the year 2005 as a reasonably representative year for performing Power Impact analysis, Henwood starts with the extensive database developed for the year 2005 from its Spring 2003 price forecast. Henwood then developed the following transmission topology representation for use in the analysis. As can be seen, WECC is divided into 14 zones. The lines on the topology map reflect the ability of the transmission system to move power between the zones. The numbers on the lines indicate the maximum amount of power, in MW, that such line (path) can move in the indicated direction. With this topology, northern California is represented by the NP-15 zone along with the major links that connect this zone to the balance of the WECC power grid. Peak load occurring at normal temperatures expected on a peak day in the NP-15 zone is approximately 21,000 MW. Generation nameplate capacity located within the NP-15 zone is approximately 23,000 MW. As indicated in the chart below, there is approximately 8,500 MW of transmission capability that could be used to import power from other areas of WECC into northern California.

This 14-zone topology reflects the reality that of the 60,000 MW of hydro nameplate capacity in WECC, approximately 10,000 of this hydro capacity is located in California, primarily northern California. The CVP hydro project nameplate capacity accounts for approximately 2,000 MW of this California hydro.

Figure 3-3
Transfer Capabilities Between WECC Subregions (MW)



This 14-zone topology provides a reasonable representation of major transmission constraints in WECC and can be used for market clearing price formation analysis. Henwood analyze uses the MARKETKSYM model to determine hourly dispatch of generation against load across WECC in the year 2005. The analysis is repeated for each of the 7 alternatives. The difference in the analysis between these 7 cases is the different amount of CVP generation associated with each of the 7 alternatives being studied. As discussed below, the model runs were done several times. One stochastic analysis was run with 73 iterations, and three deterministic analysis were run. Deterministic analysis is done for average hydro conditions, dry hydro conditions in northern California, and wet hydro conditions in northern California.

How the model computes hourly market clearing prices

MARKETKSYM model runs assume that there is no transmission constraint within a zone. In each hour being analyzed, the model first determines the load for the hour in one of the zones, and then determines which generating plants located in that zone must be operated to meet the load. The plants with the lowest bid price[1] are operated first. Once the model determines which resources are needed on the first zone, it then moves on to do the same analysis in each of the remaining zones. Then the model looks to see if a low cost resource is not running in one zone while a higher cost resource is operating in a different zone. If so, the model looks to see if there is transmission capacity to move power between the zones. If the answer is yes, then the model will redispatch these units economically. The model continues to look for these redispatch opportunities until all the zones reflect the same marginal cost or transmission constraints prohibit additional economic redispatch. At this point the model can determine the market clearing price in each zone for that hour. The model then goes on to analyze the next hour in the year.

Modeling can be performed either deterministically or stochastically. In a deterministic analysis, the assumptions used in the modeling are established (generally as “expected” or “central tendency” values) and then a single analysis is performed to show how markets will perform under these fixed assumptions. When doing deterministic analysis, it is also common to run alternative scenarios to see how a change in one or two assumptions might alter how markets will perform. In a stochastic analysis, key parameters are not only given their “expected” or “central tendency” values, but these parameters are also described by statistical parameters that reflect the volatility of the parameter. For example, natural gas prices are entered into the stochastic model as a combination of central tendency prices along with statistical parameters (based on history) of how these prices might vary with abnormal weather conditions. Details of the stochastic analysis are discussed in the following section.

Henwood has performed both deterministic analysis and stochastic analysis to provide the Power Impact Analysis for this supplemental environmental impact analysis. In the deterministic analysis, all inputs driven by weather events were assumed to be normal in

[1] WECC markets are currently bilateral markets. Sellers offer their power at a price they are willing to sell. In general, sellers will need to cover at least their operating cost from a sale or they will simply shut down. Sellers also need to cover additional amounts to cover fixed costs. Competition generally keeps sellers from making excessively high bids. The supply/demand situation in the year 2005 is such that sellers will not be able to charge monopoly prices. Henwood’s bid price algorithm reflects competitive limits on bid prices. In the absence of competition, FERC has indicated they will impose some kind of price mitigation regulation.

the Deterministic Average case. Henwood also ran a deterministic dry case. Note, this dry year is only dry in northern California (all northern California hydro including CVP) while the rest of the hydro in WECC is assumed to be normal. Therefore, the market price for power does not increase substantially since only northern California hydro (i.e., less than 20 percent of WECC hydro) is assumed to experience dry conditions. Henwood also ran a deterministic wet case. Note, this wet year is only wet in northern California (all northern California hydro including CVP) while the rest of the hydro in WECC is assumed to be normal. Therefore, the market price for power does not decrease substantially since only northern California hydro (i.e., less than 20 percent of WECC hydro) is assumed to experience wet conditions.[2]

Taking Volatility into account

There are several key inputs needed in the modeling database that are subject to weather induced volatility. For example, the CVP power plants will generate different amounts of power depending on how much rainfall occurs in any year. The data provided to Henwood showing CVP power generation amounts under each of the 7 alternatives was varied depending on rainfall conditions. Henwood was provided 73 different annual generation levels for each CVP power plant for each of the 7 alternatives. The 73 different levels reflect historical rainfall levels over a 73 year history.

In addition to volatility in CVP power generation levels caused by weather, other key inputs impacted by weather are:

- Hydro generation levels in other parts of WECC
- Loads across WECC
- Natural gas prices which fuel natural gas priced generation

(Note: Loads and natural gas prices are also strongly impacted by economic conditions, but we have not attempted to capture economic condition cycles in this analysis.)

[2] In order to select the wet and dry year, Henwood reviewed its data on historical levels of hydro generation for the Northern California area (less USBR) and picked a reasonable range. For northern California it was 73% of average for Dry and 126% for Wet. These values represented the 6th and 94th percentiles. Henwood then looked at the corresponding USBR generation for that same iteration. For the Dry year, the generation was about 68% of average. In checking the USBR generation level, this translated roughly to the water year for 1935. Henwood also consulted with a hydro experts at CH2M HILL. That expert mentioned several years could be used for the dry year, including 1935. For the wet year, we chose 1958 which, for the USBR, was about the 2nd wettest generation year on record. The main objective was to reflect dry, but not extreme conditions in northern California and the calculation of associated market clearing prices for valuation purposes. For the wet year, the selection was not as precise, nor as critical, since the market clearing prices will tend not to decrease as dramatically between the 95 and 99 percentiles.

In December of 2000 when the Record of Decision for the Trinity River Mainstream Fishery Restoration was issued, WECC was in the midst of a severe drought, especially with regard to hydro generation affected by Pacific Northwest rainfall conditions. It was determined that the Power Impact analysis should reflect the possibility that such conditions could recur.

The Power Impact analysis performed here includes a stochastic analysis. In other words, each of the alternatives analyzed in the year 2005 were run 73 times. Each of the 73 iterations reflected approximately the CVP generation levels for that alternative in one of the 73 hydro years of history. At the same time, Monte-Carlo draws were included to reflect random draws to hourly loads in the 14 zones of WECC. Standard deviation, mean reversion and correlation factors were developed through a process of performing statistical analysis of historical data in varying sub-periods of the year and making test runs to see if resulting distributions of the variables were reasonable. Historical correlation between these zonal load variations were reflected in the analysis. Monte-Carlo draws for Pacific Northwest hydro were also reflected in the 73 iterations based on historic volatility in these generation amounts. Correlation between CVP hydro and Pacific Northwest hydro was reflected in the analysis based on historical correlations of these levels.[3] Monte-Carlo draws of natural gas prices were reflected in the analysis based on historical natural gas price volatility. Finally, Monte-Carlo draws were made on generation unit forced outage based on historical levels of generation forced outage. A total of 73 draws were used in the stochastic analysis.

Determining hourly amounts of CVP generation

Henwood was provided monthly amounts of power generation at each of the CVP projects for each of the alternatives. Determining the expected hourly shape of power generation from monthly data is a complicated undertaking given the complexities of fundamental constraints such as re-regulating downstream reservoirs and subjective human behavior. Henwood has approached the task of determining the hourly shape of power differently in the deterministic analysis than in the stochastic analysis.

In the Deterministic analysis, since there are fewer water conditions being evaluated, it is possible for Henwood to pre-process the hydro generation to develop hourly generation patterns That preprocessing activity is described in a separate work paper.[4]

In the Stochastic analysis of 73 different water conditions and 7 different alternatives, it is not practicable to perform such an elaborate pre-processing analysis for each hydro

[3] Henwood assumes that weather induced changes to CVP power generation are 100% correlated to other Northern California hydro generation levels. Hydro generation amounts in WECC outside of Northern California and the Pacific Northwest are small in comparison to Northern California and Pacific Northwest hydro generation levels. Henwood has included these hydro generation amounts at their average value in all cases.
[4] See June 27, 2003 report entitled “methodology and modeling issues” prepared by Henwood.

condition and alternative. However, reasonable approximations for the hourly shape under these many hydro conditions and alternatives can be determined using computer algorithms available in the MarketSym software. In this stochastic analysis, for each of the projects, Henwood assumed there was a minimum amount of generation that would need to operate in every hour and a maximum capacity that could be operated in any hour. Given a certain quantity of monthly generation, Henwood's analysis first assigned the necessary quantity to meet the minimum generation amount in each hour. The remaining generation was shaped to reflect the hourly shape of loads in the California ISO control area. The maximum generation in any hour could not exceed the maximum capacity of that generator.

Calculating the value of CVP power

The analysis then calculates a value of CVP power under each alternative. For the deterministic analysis there is a base case, a high CVP hydro case and a low CVP hydro case. Value of the CVP power is calculated as CVP power generation levels (net of pumping load requirements) times the market clearing price of power in the Northern California zone.[5] For the Stochastic analysis, the values reported here are the average values calculated for each of the 73 iterations discussed above. In all cases, the value of CVP power has been calculated by adding the Ancillary Services value as discussed in the next section.

Ancillary Services

Power projects such as those owned by CVP have value not only from their ability to produce power, but also from their ability to provide ancillary services. Ancillary services are products needed in order for the power grid to be operated reliably. It is common to talk about five key ancillary services. These five ancillary services are:[6]

- Spinning Reserve - The portion of unloaded synchronized generation capacity that is immediately responsive to system frequency and that is capable of being loaded in ten minutes, and that is capable of running for at least two hours.

[5] In making this calculation, Henwood took the project generation on heavy load hours for each month and valued it at the average of all heavy load market clearing prices for that month. Similarly, Henwood took the project generation on light load hours for each month and valued it at the average of all light load hour market clearing prices for that month. This approach was taken for two reasons. First, much of the power bought and sold in WECC is packaged as "standard products", with a standard product being a flat heavy load hour delivery for a day and a flat light load hour delivery for a day. Henwood is also aware that the hourly load shaping algorithm used here may overstate the amount of power that can be shaped due to issues regarding re-regulating reservoirs that exist on the CVP system. It is not practicable to capture all these limitations in this kind of analysis. The somewhat overly optimistic hourly shaping algorithm is offset by the somewhat pessimistic average pricing approach to reflect a reasonable estimation of the value of project generation.

[6] The definitions below are taken from the California ISO Tariff filed with the Federal Energy Regulatory Commission. Capitalized terms mean that the terms have specific definitions in such Tariff.

- Non-Spinning Reserve - The portion of off-line generating capacity that is capable of being synchronized and ramping to a specified load in ten minutes (or load that is capable of being interrupted in ten minutes) and that is capable of running (or being interrupted) for at least two hours.
- Regulation Up and Regulation Down – The service provided either by Generating Units certified by the ISO as equipped and capable of responding to the ISO's direct digital control signals, or by System Resources that have been certified by the ISO as capable of delivering such service to the ISO Control Area in an upward or downward direction to match, on a real time basis, Demand and resource, consistent with established NERC and WECC operating criteria. Regulation covers both the increase or decrease in output of generation. Regulation Up and Regulation Down are distinct capacity products, with separately stated requirements and Market Clearing Prices in each settlement period.
- Replacement Reserve – Generating capacity that is dedicated to the ISO, capable of starting up if not already operating, being synchronized to the grid, and ramping to a specific load point within a 60 minute period, the output of which can be continuously maintained for a two hour period.

Regulation Up and Regulation Down receive the highest prices of these five ancillary services. However, Henwood assumes that CVP will not allow its generators to be automatically controlled by the ISO's direct digital control signals. Therefore, CVP projects would not be able to realize these prices.

Spinning Reserve is the next highest value of the ancillary services. Henwood assumes that CVP projects could be offered as spinning reserve units to the ISO to the full extent of their capability less the then current operating level. In general, the alternative that results in less hydro generation would result in more sales of spinning reserve.[7] Given the assumption of all unused capacity being sold as spinning reserve, there is nothing else left to sell to the remaining lower value ancillary services markets.

Air Emissions

Henwood modeling can be used to measure SO_2, NO_X and CO_2 emissions by power plant for every hour. CVP project generation does not create air emissions. The existence of more or less generation from CVP projects will results in less or more generation from other fossil fuel generation in WECC. Henwood has calculated the expected levels of total WECC wide SO_2, NO_X and CO_2 emissions for the year 2005 under each of the seven alternatives studied.

[7] The exception is the Maximum Flow alternative which provides no water to the J.F. Carr and Spring Creek projects. With no water, these projects can provide no ancillary services.

Reliability

As a measure of the effect on reliability of power supply in WECC of the 7 alternatives, Henwood has calculated the expected level of load that would not be served under the stochastic analysis in WECC. In other words, generation is expected to be adequate to meet load in all hours of 2005 under “normal” conditions. Normal conditions do not reflect higher than normal loads caused by hotter than normal temperatures. Normal conditions do not reflect drought hydro conditions. Normal conditions do not reflect forced outages of several generating plants at the same time.

Henwood’s Monte-Carlo driven stochastic analysis will result in some situations where load is higher than normal and resource availability is lower than normal. Therefore, it is possible that certain areas of WECC may have difficulty meeting load in all hours of the year. Henwood tracked unserved energy associated with each hour of each iteration for each of the alternatives studied. A comparison of expected levels of unserved energy provided an indication of reliability impacts associated with each alternative.

4 RESULTS

The CVP power values shown in this report are a way to establish a value and determine the change in that value under different operating regimes. The value calculated here is based on the value of power in wholesale power markets in each hour of the year, multiplied by the quantity of power produced by the combined CVP projects under different operating regimes. The differences in value between the operating regimes are relative for comparative purposes. Only these differences are of concern and even these differences do not necessarily reflect in real financial impact to any single or the entire group of Preference Power Customers. The differences merely represent the potential financial impact to the entire group of Preference Power Customers if and only if they had to replace all of the lost power from the NP15 spot market for power.

The values reported are broken out in thee categories. The first category is simply the CVP generation times the spot market value for that generation. The second category shows how much of the CVP generation is needed for pumping load and the value taken up by the pumping load based on the same spot market price. The third category shows the value of unused CVP capacity on any hour in ancillary services markets. The summary table in Section 5 of this report shows CVP Power Value as determined from the gross value of CVP generation less value taken by pumping load plus ancillary service value. Section 5 of the report also separately displays ancillary service value which has been added to the CVP Power Value.

Detailed model outputs:

For purposes of displaying results of this power impact analysis, the following information has been extracted from the modeling:

- Spot market electricity prices in Northern California for each of the three deterministic analysis (normal hydro, dryer than normal, and wetter than normal). Expected (average) spot market prices in Northern California for the stochastic analysis along with the “+2 standard deviation” and “–2 standard deviation” price.[8]
- Monthly generation for the combined CVP project hydro generation, net of CVP pumping load.
- Breakdown of annual net generation as between that net generation occurring during “on-peak” hours and that generation occurring during “off-peak” hours.

[8] The range between the “+2 Standard Deviation” and “-2 Standard Deviation” means that 95% of the expected observations will fall between these two numbers. For example, in the NA alternative, while the expected Market Clearing Price for the NP15 zone in Northern California is 35.09 $/MWh, we know that there is volatility in this price. Analysis indicates that there is a 95% chance that actual Market Clearing Prices for the NP15 zone of Northern California will fall between 27.99 $/MWh and 43.52 $/MWh.

- Average of the annual "on peak" generation and average of the annual "off peak" generation.
- Monthly gross generation for the combined CVP project hydro generation and associated monthly CVP pumping load.
- Monthly "value" of the combined CVP project generation as described in the section above entitled "Calculating the value of CVP power."
- Expected level of unserved energy in Northern California.
- Expected level of unserved energy in WECC.
- Anticipated Value of Ancillary Services that can be provided by the combined CVP Projects.
- Total.

The reported data is displayed as the actual model outputs for the "No Action" alternative and changes in that value for the six other alternatives. The reported detail data is included in the Appendices as follows:

Appendix A. Reports the "expected" value of CVP Power [under each alternative studied] after performing the Monte-Carlo based analysis (e.g. when randomly selecting possible hydro conditions, loads, natural gas prices, etc.).

Appendix B. Reports the value of CVP Power[under each alternative studied] under a single "most probable" set of assumptions about hydro conditions, loads, natural gas prices, etc.

Appendix C. Reports the value of CVP Power [under each alternative studied] under a single "most probable" set of assumptions about hydro conditions, loads, natural gas prices, etc. except that it is assumed that there is a drought in Northern California.[9]

[9] From historical data, we know that there is some correlation between droughts in Northern California and other hydro regions in Western North America. We know that while there is correlation, the correlation is not high. For purposes of this deterministic analysis in this report, we assumed other parts of WECC were normal while Northern California was dry. In the stochastic analysis, the actual correlation parameters from historical data was reflected.

Appendix D. Reports the value of CVP Power [under each alternative studied] under a single "most probable" set of assumptions about hydro conditions, loads, natural gas prices, etc. except that it is assumed that there is a extremely wet condition in Northern California.[10]

[10] From historical data, we know that there is some correlation between droughts in Northern California and other hydro regions in Western North America. We know that while there is correlation, the correlation is not high. For purposes of this deterministic analysis in this report, we assumed other parts of WECC were normal while Northern California was extremely wet. In the stochastic analysis, the actual correlation parameters from historical data was reflected.

5 OBSERVATIONS AND CONCLUSIONS

The table below provides a summary of CVP power value under each of the alternatives. In this table, the power value includes the value of ancillary services of the CVP projects.

Table 5-1
Summary of CVP Power Value

		Alternative						
Year 2005		NA	EC	MF	PF	MP	SMUD	70
Stochastic	MCP - NP15+2STD ($/MWh)	43.53	43.51	43.76	43.56	43.56	43.53	43.63
Stochastic	MCP - NP15 ave ($/MWh)	35.09	35.09	35.24	35.14	35.12	35.12	35.19
Stochastic	MCP - NP15-2STD ($/MWh)	27.99	27.99	28.14	28.03	28.02	28.00	28.10
CVP Power Value	Stochastic Average	$ 153,099,230	$ 150,439,374	$ 108,020,353	$ 145,945,406	$ 146,342,218	$ 149,748,414	$ 133,706,978
	Change from NA	$ -	$ (2,659,855)	$ (45,078,877)	$ (7,153,824)	$ (6,757,011)	$ (3,350,816)	$ (19,392,252)
Deterministic-Wet	MCP - NP15 ($/MWh)	34.84	34.89	35.13	34.93	34.91	34.89	34.99
CVP Power Value	Deterministic Wet	$ 241,055,512	$ 237,013,149	$ 177,656,114	$ 219,533,890	$ 227,348,369	$ 230,830,214	$ 202,954,006
	Change from NA	$ -	$ (4,042,363)	$ (63,399,398)	$ (21,521,622)	$ (13,707,143)	$ (10,225,298)	$ (38,101,506)
Deterministic-Ave	MCP - NP15 ($/MWh)	36.13	36.15	36.26	36.16	36.17	36.16	36.20
CVP Power Value	Deterministic Ave	$ 166,313,646	$ 162,124,027	$ 120,304,472	$ 159,040,607	$ 162,268,750	$ 163,715,496	$ 147,005,119
	Change from NA	$ -	$ (4,189,619)	$ (46,009,173)	$ (7,273,038)	$ (4,044,895)	$ (2,598,150)	$ (19,308,527)
Deterministic-Dry	MCP - NP15 ($/MWh)	37.75	37.74	37.78	37.75	37.76	37.76	37.78
CVP Power Value	Deterministic Dry	$ 96,033,714	$ 89,609,447	$ 67,510,150	$ 88,316,320	$ 91,538,001	$ 91,920,839	$ 69,499,422
	Change from NA	$ -	$ (6,424,267)	$ (28,523,564)	$ (7,717,393)	$ (4,495,713)	$ (4,112,875)	$ (26,534,292)

The table below provides probability ranges on the Value of CVP Power based on the stochastic evaluation.

Table 5-2
Probability Ranges

Year 2005	Alternative						
CVP Generation, MWh	NA	EC	MF	PF	MP	SMUD	70
10th Percentile	3,726,445	3,761,179	2,835,497	3,522,568	3,601,840	3,644,602	3,193,620
30th Percentile	4,219,252	4,259,321	3,300,156	3,963,826	4,059,446	4,121,223	3,633,235
Average	4,657,546	4,697,679	3,632,718	4,378,731	4,487,804	4,549,167	4,025,067
50th Percentile	4,674,544	4,711,697	3,607,223	4,403,352	4,512,146	4,569,477	4,038,204
70th Percentile	5,059,544	5,104,960	3,913,389	4,755,309	4,872,621	4,939,847	4,333,814
90th Percentile	5,733,570	5,785,514	4,565,328	5,420,137	5,537,428	5,595,601	5,022,862
Market-Based Revenues, 2002$							
10th Percentile	$126,246,560	$127,152,094	$96,947,355	$118,196,643	$121,494,816	$123,385,825	$107,745,596
30th Percentile	$145,160,564	$146,591,815	$114,464,628	$136,272,944	$139,961,417	$142,111,372	$125,877,090
Average	$163,624,140	$165,016,943	$127,014,058	$153,817,162	$157,671,799	$159,913,002	$141,018,498
50th Percentile	$160,355,579	$161,302,455	$126,413,190	$150,124,816	$154,300,654	$156,334,608	$139,337,675
70th Percentile	$177,731,763	$179,182,632	$137,008,312	$165,828,279	$170,671,681	$173,306,851	$151,281,552
90th Percentile	$206,823,137	$208,275,018	$158,419,983	$194,727,365	$199,167,332	$201,512,696	$178,650,797
Pump Energy Consumed, MWh							
10th Percentile	1,017,260	1,147,023	850,843	999,739	1,066,134	1,007,761	1,013,155
30th Percentile	1,115,676	1,236,805	976,390	1,093,464	1,173,122	1,119,022	1,084,039
Average	1,166,056	1,304,370	1,061,229	1,142,453	1,239,846	1,182,209	1,138,371
50th Percentile	1,182,355	1,305,914	1,090,985	1,148,254	1,263,255	1,183,992	1,147,434
70th Percentile	1,229,524	1,384,133	1,152,327	1,187,973	1,315,018	1,243,715	1,191,040
90th Percentile	1,282,289	1,482,097	1,248,257	1,288,964	1,387,863	1,323,686	1,245,759
Pump Energy Cost, 2002$							
10th Percentile	$31,659,556	$34,362,157	$26,232,792	$31,792,169	$33,122,085	$31,634,683	$31,876,667
30th Percentile	$36,393,770	$40,667,083	$31,547,647	$36,110,748	$38,367,850	$36,950,805	$35,351,246
Average	$40,822,107	$45,000,080	$36,837,737	$39,844,397	$42,668,692	$41,291,947	$39,920,397
50th Percentile	$40,087,040	$43,640,954	$36,528,274	$38,820,802	$41,194,507	$41,864,319	$39,443,512
70th Percentile	$44,309,283	$48,929,443	$41,669,050	$42,609,602	$47,226,005	$45,190,864	$43,266,692
90th Percentile	$51,868,042	$56,261,469	$47,361,508	$50,373,439	$54,350,293	$52,120,076	$48,838,774
Energy Not Served (E.N.S), MWh							
10th Percentile	0	0	0	0	0	0	0
30th Percentile	0	0	0	0	0	0	0
Average	4,599	4,599	4,599	4,599	4,599	4,599	4,599
50th Percentile	0	0	0	0	0	0	0
70th Percentile	0	0	0	0	0	0	0
90th Percentile	0	0	0	0	0	0	0

The table below shows information on the ancillary service value determined for CVP projects under each of the alternatives.[11]

Table 5-3
Ancillary Service Value

Year 2005	Alternative						
A/S Value	NA	EC	MF	PF	MP	SMUD	70
Wet Hydro	$21,613,785	$21,215,890	$21,340,142	$24,121,890	$23,294,042	$23,761,957	$25,490,629
Average Hydro	$30,297,197	$30,422,512	$17,844,032	$31,972,641	$31,339,111	$31,127,359	$32,608,878
Dry Hydro	$23,850,686	$19,710,695	$12,517,417	$18,315,055	$21,347,972	$21,294,470	$13,212,420

No incidences of inability to serve load showed up in any of the 21 deterministic cases run. In the stochastic analysis, there was no inability to serve load in northern California in any of the iterations. The only inability to serve load was found in the Northwest under draws that resulted in extremely low hydro generation in the Northwest. Of the 73 stochastic iterations run there was one iteration in January with “energy not served” (ENS) in the Northwest and two iterations in February with ENS in the Northwest. The number of hours of ENS occurring did not change as a result of the different alternatives being considered for Trinity diversions. Because there was only one iteration with ENS, the ENS does not show in any of the confidence bands, but does show in the “Average” of all iterations run.

As can be seen from the write-up above and the reported results, the alternatives analyzed here do not make a significant impact on power supply in the WECC as a whole or in northern California. This conclusion is based on the small impact on prices and zero impacts on reliability of power supply in the WECC as a whole or in northern California caused by the alternatives analyzed.

That the alternatives do not make a significant impact on WECC as a whole should not be surprising given the fact there is over 185,000 MW nameplate of generation in WECC and the CVP hydro projects have a total nameplate capacity of 2,000 MW. Comparing the 185,000 MW of WECC capacity to 135,000 MW of WECC peak load, it is clear that excess generation exists in WECC and that some small loss of CVP power would therefore not have a large impact on the WECC in total.

That the alternatives do not make a significant impact on northern California prices and reliability should not be surprising given the fact that (a) northern California peak hour load is more than covered with northern California located generation and (b) northern California is interconnected to the rest of WECC through approximately 8,500 MW of

[11] This value was calculated for the deterministic normal condition case and was assumed not to change in the other cases. While this assumption is not technically correct, our interest is in the change in value between alternatives. It is expected that while the actual level of ancillary service value will change under different environments, the change in ancillary service value between alternatives will not be significantly different than the change in value in the deterministic normal case.

transmission capability, and therefore fairly large imports of power into northern California could be accomplished if the need arises.

Notwithstanding the small impact on WECC and northern California power supply, the customers of CVP power will have different cost impacts depending on the chosen alternative. Power cost increases for these CVP customers on an expected basis will range from $3 million per year to $46 million per year if the decision is to move away from the No Action alternative. The lowest power cost alternative is the SMUD alternative. The highest power cost alternative is the MF alternative.

Under the dry year deterministic case, the value of CVP power is decreased substantially in all alternatives due to the fact that there is generally less hydro generation in all the alternatives. Note, this dry year is only dry in northern California (all northern California hydro including CVP) while the rest of the hydro in WECC is assumed to be normal. Therefore, the market price for power does not increase substantially since only northern California hydro (i.e., less than 20 percent of WECC hydro) is assumed to experience dry conditions.

Under the wet year deterministic case, the value of CVP power is increased substantially in all alternatives due to the fact that there is generally more hydro generation in all the alternatives.. Note, this wet year is only wet in northern California (all northern California hydro including CVP) while the rest of the hydro in WECC is assumed to be normal. Therefore, the market pride for power does not decrease substantially since only northern California hydro (i.e., less than 20 percent of WECC hydro) is assumed to experience wet conditions.

Alternatives being considered regarding Trinity River diversions will generally reduce generation from hydroelectric generators and substitute generation from thermal power plants. As a result, there will be an increase in air emissions. In the modeling done here, generation across WECC is re-dispatched, on an economic basis, to make up for the reduction in CVP hydro generation under each alternative. From hour to hour, the replacement generation may come from different areas of WECC. The table below reports the change in WECC-wide air emissions under each alternative.

Table 5-4
Air Emissions

Year 2005			Alternative						
Stochastic Average			NA	EC	MF	PF	MP	SMUD	70
WECC wide Emissions									
	SO2	(000tons)	408.9	408.9	409.0	409.0	409.0	408.9	409.0
	NOx	(000tons)	497.3	497.3	497.6	497.4	497.4	497.4	497.5
	CO2	(000tons)	341,120.3	341,098.7	341,727.4	341,280.8	341,219.8	341,184.7	341,485.9
Increase in CO2 vs NA		(000tons)	-	(21.6)	607.1	160.5	99.5	64.4	365.6

Since generation on the margin is generally state of the art natural gas fired generation, there is not a large increase in SO_2 emissions or NO_X emissions. While CO_2 emissions are more measurable on the basis of thousand of tons per year, the percentage changes in these emissions is quite small, less than 0.2 percent in all cases.

Economic Impact on Non-CVP Customers

The analytic work done for this report shows that modifications to Trinity River operations of the CVP can change market clearing prices in Northern California by up to 0 to 9 cents per Mwh in the PF alternative and 0 to 5 cents per Mwh in the SMUD case. Under average conditions, prices change by 3 to 5 cents per Mwh in the PF alternative and 3 cents per Mwh in the SMUD alternative. These changes represent a maximum change of 0.3 percent (PF alternative, wet year, deterministic analysis) and an average change of 0.1 percent (both PF and SMUD alternatives, both stochastic and deterministic analyses).

Changes of under 10 cents per Mwh in the price of electricity are well below the standard of significance used in the original Trinity River EIS, 50 cents per Mwh. They are also small compared to the price variation due to hydrological variation in Northern California alone, which is almost $3 per Mwh (difference between deterministic wet and dry analyses). They are even smaller compared to the more than $15/Mwh variation due to the combined effects of hydrology, gas price, and load variations (difference between stochastic analyses).

If the small price impacts calculated by Henwood for Northern California (and the even smaller impacts for other regions) are multiplied times the total regional loads, the result would be an apparent grid-wide impact of $20 million in the PF alternative, and millions of dollars in every case (as compared to the No Action alternative). This might seem like a significant number despite the fact that the rate impact is only a few pennies per Mwh. However, the great majority of electricity in the Western grid is not sold at prices which vary with market conditions. Most generation is either sold at prices based on its cost (e.g., virtually all hydrogeneration and coal and nuclear generation) or is sold at prices pre-determined under long-term contracts (e.g., contracts entered into by the California Department of Water Resources in early 2001 to provide stability to California electricity markets).

The net impact on non-CVP customers of the market price changes quantified by Henwood will thus be a very small fraction of the potential impact.

APPENDIX A "EXPECTED" VALUE OF CVP POWER

Note: All changes are relative to the NA case. For percentage change, the calculation is: (Case value-NA value)/NA value.
For others, the calculation is Case value - NA value. Thus, if a percentage change is positive, it means the Case value is greater than the NA value, and vice versa.

Results of Case:	NA Stoch	EC Stoch	MF Stoch	PF Stoch	MP Stoch	SMUD Stoch	70 Stoch
1 MCPs	**$/MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
+2 SD	43.53	-0.1%	0.5%	0.1%	0.1%	0.0%	0.2%
Mean	35.09	0.0%	0.4%	0.1%	0.1%	0.1%	0.3%
-2 SD	27.99	0.0%	0.5%	0.1%	0.1%	0.0%	0.4%
2 Expected monthly net energy:							
	MWh	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
Jan	142,609	-16.1%	-4.5%	17.8%	-17.4%	-4.3%	-18.3%
Feb	206,674	-3.3%	5.9%	-5.2%	-5.1%	-2.0%	2.1%
Mar	181,222	-9.2%	-1.0%	-2.2%	-10.4%	-2.4%	7.0%
Apr	288,740	-22.2%	-3.1%	-0.5%	-24.5%	0.3%	5.3%
May	471,487	-1.4%	-13.8%	-4.4%	-4.4%	-2.0%	-10.7%
Jun	463,883	0.7%	-24.0%	-10.1%	-3.5%	-5.5%	-15.8%
Jul	554,085	1.1%	-37.7%	-7.0%	-1.2%	-1.3%	-19.4%
Aug	392,956	0.5%	-51.3%	-6.6%	-1.9%	-1.8%	-19.2%
Sep	303,585	3.1%	-43.0%	-14.2%	-8.8%	-2.4%	-34.9%
Oct	225,999	1.4%	-38.9%	-17.3%	-13.3%	-15.8%	-41.0%
Nov	98,160	-2.0%	-57.4%	-36.4%	-19.8%	-10.9%	-31.6%
Dec	162,089	-1.7%	-32.8%	-8.9%	5.5%	-4.8%	-46.4%
	3,491,490	-2.8%	-26.3%	-7.3%	-7.0%	-3.6%	-17.3%
3 Expected Annual net ene	**MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
On-Pk	2,722,291	0.9%	-22.7%	-6.7%	-3.4%	-3.3%	-15.5%
Off-Pk	769,199	-16.0%	-39.2%	-9.5%	-19.6%	-4.6%	-23.9%
Total	3,491,490	-2.8%	-26.3%	-7.3%	-7.0%	-3.6%	-17.3%

4 Expected aMW of July and August Capacity based on USBR Generation

	aMW	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
On-Pk	601	0.0%	-30.0%	-4.9%	-2.5%	-1.5%	-15.3%
Off-Pk	240	-0.2%	-34.4%	-9.6%	-5.4%	-3.3%	-21.5%

5 USBR Expected Monthly and Annual Loads and Resources, MWh

	Generation	Load	HG., MW	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh
Jan	260,007	117,398	3,161	26,080	-23,649	-17,252	-7,595	-33,006	-4,935	19,903	-6,680	-532	-13,237	12,797
Feb	289,404	82,729	1,536	8,319	-3,219	-15,386	-7,734	3,077	-5,822	4,676	-5,111	-955	1,210	-3,154
Mar	305,146	123,925	1,382	18,091	-12,882	-11,025	-7,248	-3,329	-5,031	13,743	-5,613	-1,262	-12,632	-25,236
Apr	344,021	55,281	6,009	70,077	-2,463	6,616	-1,005	405	-1,610	69,055	-3,552	-4,346	9,149	-6,139
May	504,005	32,517	2,777	9,563	-60,213	4,776	-16,257	4,369	-10,928	9,913	-5,815	3,839	-44,825	5,473
Jun	553,318	89,434	6,906	3,671	-98,539	12,792	-28,286	18,627	-17,144	-878	-16,608	9,041	-65,030	8,045
Jul	697,260	143,174	4,403	-1,771	-191,184	17,815	-38,639	69	-21,711	-14,817	-14,879	-7,865	-112,654	-5,285
Aug	554,938	161,982	-4,791	-6,603	-199,732	1,990	-39,586	-13,732	-19,975	-12,439	-10,192	-3,091	-100,904	-25,455
Sep	410,099	106,514	7,645	-1,719	-188,253	-57,742	-53,561	-10,385	-28,340	-1,691	-9,411	-2,169	-130,496	-24,522
Oct	283,365	57,366	5,328	2,181	-121,392	-33,517	-40,993	-1,943	-28,374	1,684	-17,120	18,488	-78,836	13,854
Nov	199,241	101,081	2,890	4,820	-63,336	-7,023	-23,241	12,488	-16,922	2,560	-8,096	2,595	-45,480	-14,452
Dec	256,743	94,655	2,886	5,606	-59,967	-6,871	-14,670	-243	-8,950	-17,919	-5,303	2,411	-38,744	36,391
Annual	4,657,546	1,166,056	40,133	138,315	-1,024,828	-104,826	-278,815	-23,602	-169,742	73,791	-108,378	16,153	-632,479	-27,685

6 USBR Net Value (based on Net Energy), $

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	$5,562,001	-$749,648	-$226,633	$890,565	-$847,350	-$233,068	-$1,024,649
Feb	$6,899,260	-$182,634	$417,018	-$342,469	-$315,441	-$144,548	$130,028
Mar	$6,062,268	-$543,120	-$77,548	-$135,514	-$609,075	-$146,390	$414,949
Apr	$8,828,167	-$1,819,059	-$315,696	-$21,645	-$2,030,507	$57,752	$479,692
May	$14,424,587	-$181,582	-$1,918,174	-$607,091	-$618,232	-$279,535	-$1,491,585
Jun	$15,192,841	$98,237	-$3,516,773	-$1,443,279	-$525,378	-$789,358	-$2,289,950
Jul	$20,509,625	$201,781	-$7,341,958	-$1,370,413	-$250,026	-$236,201	-$3,857,282
Aug	$14,980,450	$58,831	-$7,517,197	-$961,156	-$275,670	-$248,381	-$2,775,407
Sep	$12,322,829	$348,943	-$5,033,749	-$1,672,152	-$991,385	-$278,223	-$4,190,738
Oct	$7,896,463	$107,477	-$2,957,070	-$1,307,584	-$1,028,491	-$1,198,208	-$3,138,980
Nov	$3,746,575	-$52,625	-$2,071,484	-$1,296,423	-$702,382	-$387,282	-$1,107,978
Dec	$6,376,967	-$71,771	-$2,066,448	-$562,109	$395,011	-$297,536	-$2,852,034
Annual	**$122,802,033**	**-$2,785,171**	**-$32,625,713**	**-$8,829,268**	**-$7,798,926**	**-$4,180,978**	**-$21,703,932**

7	Reliability as Measured by E.N.S. in CNP15	**MWh**	**CHG., MWh**	**CHG., MWh**	**CHG., MWh**	**CHG., MWh**	**CHG., MWh**	**CHG., MWh**
	Annual	0	0	0	0	0	0	0
8	Reliability as Measured by E.N.S. in WECC							
	Annual	4,599	0	0	0	0	0	0

9	Revenues, $							
		2003 USD	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**
	Jan	$6,320,215	-$181,706	-$3,666,272	$67,402	$53,844	$99,894	-$1,596,576
	Feb	$1,424,522	-$73,977	-$927,658	$20,539	$12,910	$11,626	$44,022
	Mar	$1,958,821	-$64,979	-$1,124,792	$32,817	$21,453	$26,862	$175,432
	Apr	$3,313,549	-$543,478	-$1,299,576	$18,238	$108,921	$60,751	$206,404
	May	$3,433,259	-$277,162	-$1,006,384	$506,817	$284,511	$237,181	$613,390
	Jun	$2,679,879	$162,005	-$742,553	$442,264	$230,369	$236,850	$792,944
	Jul	$1,745,989	$892,850	-$91,508	$89,725	$30,533	$16,272	$481,984
	Aug	$1,603,633	$702,939	-$74,320	$69,169	$26,668	$6,556	$338,236
	Sep	$926,856	$309,693	$13,052	$102,575	$35,774	$2,856	$438,243
	Oct	$1,569,793	$65,799	-$492,135	$192,336	$119,537	$72,606	$392,783
	Nov	$1,479,126	-$264,260	-$812,219	$88,617	$71,461	$40,781	$205,592
	Dec	$3,841,554	-$602,408	-$2,228,801	$44,945	$45,934	$17,927	$219,226
	Annual	**$30,297,197**	**$125,316**	**-$12,453,164**	**$1,675,444**	**$1,041,915**	**$830,162**	**$2,311,681**

10	(based on Net Energy							
		2003 USD	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**	**CHG, 2003 USD**
	Jan	$11,882,217	-$931,354	-$3,892,905	$957,967	-$793,506	-$133,173	-$2,621,226
	Feb	$8,323,782	-$256,611	-$510,640	-$321,931	-$302,532	-$132,923	$174,050
	Mar	$8,021,089	-$608,099	-$1,202,340	-$102,697	-$587,621	-$119,528	$590,381
	Apr	$12,141,716	-$2,362,537	-$1,615,272	-$3,407	-$1,921,586	$118,502	$686,096
	May	$17,857,846	-$458,745	-$2,924,558	-$100,274	-$333,722	-$42,353	-$878,195
	Jun	$17,872,720	$260,241	-$4,259,326	-$1,001,014	-$295,009	-$552,508	-$1,497,006
	Jul	$22,255,614	$1,094,630	-$7,433,466	-$1,280,687	-$219,493	-$219,930	-$3,375,298
	Aug	$16,584,083	$761,770	-$7,591,517	-$891,986	-$249,001	-$241,824	-$2,437,170
	Sep	$13,249,685	$658,636	-$5,020,697	-$1,569,577	-$955,612	-$275,366	-$3,752,495
	Oct	$9,466,256	$173,276	-$3,449,205	-$1,115,248	-$908,954	-$1,125,602	-$2,746,197
	Nov	$5,225,701	-$316,885	-$2,883,703	-$1,207,806	-$630,921	-$346,501	-$902,385
	Dec	$10,218,521	-$674,179	-$4,295,249	-$517,164	$440,945	-$279,609	-$2,632,807
	Annual	**$153,099,230**	**-$2,659,855**	**-$45,078,877**	**-$7,153,824**	**-$6,757,011**	**-$3,350,816**	**-$19,392,252**

APPENDIX B VALUE OF CVP POWER UNDER "MOST PROBABLE" CONDITIONS

Note: All changes are relative to the NA case. For percentage change, the calculation is: (Case value-NA value)/NA value.
For others, the calculation is Case value - NA value. Thus, if a percentage change is positive, it means the Case value is greater than the NA value, and vice versa.

Results of Case:		NA AvgR	EC	MF	PF	MP	SMUD	70
1 MCPs		**$/MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
	Mean	36.13	0.0%	0.3%	0.1%	0.1%	0.1%	0.2%
2 Expected monthly net energy:								
		MWh	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
	Jan	168,049	-4.5%	-12.1%	-3.4%	-2.0%	-3.4%	-12.1%
	Feb	203,045	-8.0%	4.3%	-4.1%	-2.0%	-1.5%	1.7%
	Mar	219,020	-2.7%	1.0%	-2.9%	-1.3%	-2.5%	-2.8%
	Apr	305,857	-0.6%	2.2%	-0.5%	-0.5%	-2.0%	3.9%
	May	459,960	-1.1%	-10.5%	-1.2%	-1.5%	-1.2%	-8.7%
	Jun	473,495	-2.1%	-18.0%	-5.2%	-3.2%	-3.6%	-12.9%
	Jul	544,344	-2.1%	-29.8%	-5.5%	-2.8%	-1.6%	-17.9%
	Aug	414,643	-2.7%	-42.8%	-8.8%	-4.0%	-2.1%	-22.6%
	Sep	308,216	-0.8%	-57.7%	-16.8%	-9.3%	-2.9%	-40.7%
	Oct	193,883	-0.3%	-60.1%	-19.5%	-13.0%	-8.6%	-36.7%
	Nov	109,089	-11.6%	-50.9%	-19.3%	-13.1%	-6.8%	-36.3%
	Dec	147,220	-7.1%	-32.8%	-7.4%	-4.6%	-2.7%	-22.8%
		3,546,820	-2.7%	-24.6%	-6.8%	-4.0%	-2.7%	-16.2%
3 Expected Annual r		**MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
	On-Pk	3,431,355	-6.7%	-19.6%	-4.6%	-2.8%	-2.0%	-12.0%
	Off-Pk	115,466	117.7%	-173.0%	-70.5%	-39.5%	-26.2%	-138.6%
	Total	3,546,820	-2.7%	-24.6%	-6.8%	-4.0%	-2.7%	-16.2%

POWER IMPACT ANALYSIS FOR THE TRINITY RIVER SEIR/EIS CENTRAL VALLEY PROJECT

4 Expected aMW of July and August Capacity based on USBR Generation

	aMW	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
On-Pk	674	-1.3%	-23.6%	-2.8%	-1.5%	-1.0%	-9.9%
Off-Pk	165	-0.5%	-63.7%	-21.0%	-11.4%	-6.2%	-47.1%

5 USBR Expected Monthly and Annual Loads and Resources, MWh

	Generation	Load	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh
Jan	291,061	123,012	-2,455	5,188	-23,342	-3,006	-8,115	-2,448	-5,040	-1,625	-6,942	-1,187	-17,739	2,632
Feb	313,620	110,575	-14,158	2,165	-1,413	-10,189	-7,941	286	-5,911	-1,781	-5,236	-2,176	1,245	-2,109
Mar	322,289	103,269	-4,779	1,037	-11,884	-14,162	-7,237	-985	-5,104	-2,349	-6,137	-729	-13,168	-6,959
Apr	358,713	52,856	-1,957	-229	2,042	-4,727	-993	482	-1,415	220	-6,288	-163	10,794	-1,277
May	513,016	53,056	-5,885	-854	-56,826	-8,396	-7,846	-2,166	-7,991	-1,155	-6,331	-938	-42,478	-2,310
Jun	563,970	90,476	-6,787	3,012	-98,124	-12,728	-28,317	-3,643	-16,850	-1,842	-18,276	-1,310	-64,737	-3,801
Jul	693,652	149,308	-3,876	7,444	-193,068	-30,999	-39,189	-9,251	-22,194	-6,948	-13,802	-5,163	-112,658	-15,023
Aug	554,911	140,269	-9,845	1,522	-200,127	-22,708	-40,639	-4,284	-21,048	-4,489	-10,878	-2,052	-102,163	-8,532
Sep	416,940	108,724	-1,479	1,009	-188,464	-10,764	-53,600	-1,804	-29,473	-733	-9,490	-546	-131,176	-5,757
Oct	288,485	94,601	-538	46	-123,969	-7,409	-41,130	-3,296	-28,003	-2,829	-17,134	-404	-79,915	-8,831
Nov	214,714	105,625	-12,466	236	-65,014	-9,525	-23,121	-2,035	-16,748	-2,459	-8,003	-628	-47,300	-7,656
Dec	271,033	123,813	-13,733	-3,288	-62,876	-14,516	-15,793	-4,886	-9,670	-2,965	-5,631	-1,698	-41,422	-7,805
Annual	4,802,403	1,255,582	-77,958	17,289	-1,023,063	-149,130	-273,920	-34,030	-169,446	-28,955	-114,149	-16,994	-640,717	-67,428

6 USBR Net Value (based on Net Energy), $

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	$7,271,553	-$405,272	-$836,559	-$218,381	-$125,386	-$226,751	-$842,164
Feb	$7,285,776	-$638,148	$272,977	-$311,855	-$171,585	-$134,144	$124,772
Mar	$8,011,377	-$288,723	$26,154	-$228,312	-$108,099	-$182,822	-$277,780
Apr	$10,002,427	-$104,342	$137,534	-$49,722	-$49,619	-$192,578	$340,351
May	$15,644,974	-$238,387	-$1,561,403	-$197,302	-$157,808	-$125,737	-$1,272,598
Jun	$15,868,478	-$359,336	-$2,766,826	-$850,237	-$486,426	-$547,622	-$1,982,546
Jul	$22,264,122	-$447,338	-$6,050,370	-$954,265	-$496,646	-$261,772	-$3,465,706
Aug	$17,836,131	-$448,479	-$7,084,467	-$1,366,360	-$606,435	-$333,297	-$3,597,288
Sep	$13,063,146	-$153,158	-$7,152,618	-$2,052,524	-$1,093,051	-$348,083	-$4,986,309
Oct	$7,631,739	-$72,859	-$4,262,145	-$1,378,771	-$903,380	-$594,854	-$2,598,713
Nov	$4,805,273	-$600,242	-$2,305,390	-$880,505	-$601,786	-$313,886	-$1,666,429
Dec	$6,331,453	-$558,649	-$1,972,898	-$460,248	-$286,589	-$166,766	-$1,395,798
Annual	**$136,016,449**	**-$4,314,934**	**-$33,556,009**	**-$8,948,482**	**-$5,086,810**	**-$3,428,312**	**-$21,620,208**

9 USBR Net A/S

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	$6,320,215	-181706.0267	-3666271.88	67402.41825	53843.53552	99894.42916	-1596576.474
Feb	$1,424,522	-73976.84529	-927657.5106	20538.53158	12909.56634	11625.53261	44021.91544
Mar	$1,958,821	-64978.67811	-1124791.673	32817.09226	21453.41285	26862.05323	175432.4646
Apr	$3,313,549	-543477.9541	-1299576.35	18237.88453	108920.8507	60750.71003	206403.992
May	$3,433,259	-277162.3629	-1006383.661	506816.7672	284510.5643	237181.2926	613389.8175
Jun	$2,679,879	162004.505	-742552.611	442264.4856	230369.0669	236849.6947	792943.8969
Jul	$1,745,989	892849.6243	-91507.78618	89725.04674	30533.31649	16271.7164	481984.4673
Aug	$1,603,633	702939.2635	-74319.84152	69169.44736	26668.48492	6556.497018	338236.3061
Sep	$926,856	309692.8214	13052.1982	102574.8665	35773.79627	2856.366153	438243.1862
Oct	$1,569,793	65798.7004	-492134.9632	192335.6787	119537.3546	72606.08901	392783.1701
Nov	$1,479,126	-264259.5389	-812219.3179	88616.74823	71460.63742	40780.68343	205592.1995
Dec	$3,841,554	-602407.9552	-2228801.017	44945.01027	45934.05782	17927.34089	219226.0419
Annual	**$30,297,197**	**125,315.55**	**(12,453,164.41)**	**1,675,443.98**	**1,041,914.64**	**830,162.41**	**2,311,680.98**

10 USBR Net Value

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	$13,591,768	-$586,978	-$4,502,830	-$150,978	-$71,543	-$126,857	-$2,438,741
Feb	$8,710,297	-$712,125	-$654,680	-$291,317	-$158,675	-$122,519	$168,794
Mar	$9,970,199	-$353,702	-$1,098,638	-$195,495	-$86,645	-$155,960	-$102,347
Apr	$13,315,976	-$647,820	-$1,162,042	-$31,484	$59,302	-$131,828	$546,755
May	$19,078,234	-$515,550	-$2,567,787	$309,515	$126,703	$111,445	-$659,208
Jun	$18,548,357	-$197,331	-$3,509,378	-$407,973	-$256,057	-$310,772	-$1,189,602
Jul	$24,010,111	$445,511	-$6,141,877	-$864,540	-$466,113	-$245,500	-$2,983,722
Aug	$19,439,764	$254,460	-$7,158,787	-$1,297,190	-$579,766	-$326,741	-$3,259,051
Sep	$13,990,002	$156,535	-$7,139,566	-$1,949,949	-$1,057,278	-$345,227	-$4,548,066
Oct	$9,201,531	-$7,060	-$4,754,280	-$1,186,436	-$783,843	-$522,248	-$2,205,930
Nov	$6,284,399	-$864,501	-$3,117,609	-$791,888	-$530,325	-$273,105	-$1,460,837
Dec	$10,173,007	-$1,161,057	-$4,201,699	-$415,303	-$240,655	-$148,839	-$1,176,572
Annual	**$166,313,646**	**-$4,189,619**	**-$46,009,173**	**-$7,273,038**	**-$4,044,895**	**-$2,598,150**	**-$19,308,527**

APPENDIX C VALUE OF CVP POWER UNDER "DROUGHT" CONDITIONS

Note: All changes are relative to the NA case. For percentage change, the calculation is: (Case value-NA value)/NA value.
For others, the calculation is Case value - NA value. Thus, if a percentage change is positive, it means the Case value is greater than the NA value, and vice versa.

Results of Case:	NA Dry	EC	MF	PF	MP	SMUD	70
1 MCPs	**$/MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
Mean	37.75	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%
2 Expected monthly net energy:							
	MWh	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
Jan	-108,734	1.7%	19.2%	-61.8%	-64.0%	2.4%	21.5%
Feb	23,042	2.1%	-16.2%	-55.8%	-63.2%	-30.6%	-11.0%
Mar	-50,744	3.0%	3.2%	-1.9%	-13.9%	3.9%	-78.5%
Apr	184,093	-10.2%	-2.6%	9.0%	20.0%	12.1%	20.5%
May	315,900	-3.6%	2.2%	6.0%	-3.8%	-0.2%	-1.9%
Jun	342,162	-2.9%	-18.5%	-13.4%	-16.3%	-14.3%	-16.9%
Jul	522,454	-5.0%	-27.6%	-12.2%	-12.1%	0.2%	-30.0%
Aug	289,651	-1.0%	-32.0%	-0.5%	-2.0%	-1.4%	-33.9%
Sep	156,274	-2.8%	-39.5%	-27.6%	-0.9%	-0.7%	-40.4%
Oct	75,813	8.3%	-42.8%	41.0%	7.6%	23.7%	-54.0%
Nov	-26,681	-14.4%	-18.2%	49.9%	73.1%	38.4%	-34.5%
Dec	-27,613	-47.3%	66.0%	37.3%	21.5%	24.9%	105.0%
	1,695,616	-3.1%	-25.5%	-3.3%	-3.5%	-2.5%	-23.1%
3 Expected Annual net ener	**MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
On-Pk	2,243,573	-3.8%	-14.1%	-2.2%	-2.2%	-1.5%	-13.9%
Off-Pk	-547,957	-6.0%	21.2%	1.3%	1.6%	1.6%	14.6%
Total	1,695,616	-3.1%	-25.5%	-3.3%	-3.5%	-2.5%	-23.1%

4 Expected aMW of July and August Capacity based on USBR Generation

	aMW	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
On-Pk	598	-3.3%	-17.8%	-2.8%	-3.2%	0.1%	-18.9%
Off-Pk	102	-0.5%	-53.5%	-26.7%	-27.4%	-0.8%	-58.1%

5 USBR Expected Monthly and Annual Loads and Resources, MWh

	Generation	Load	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh
Jan	82,938	191,672	-5,693	-3,869	-19,533	1,357	-10,415	-77,579	-6,990	-76,569	-971	1,614	-19,504	3,910
Feb	84,857	61,815	1,882	1,390	-5,008	-1,273	-4,779	8,087	-6,209	8,354	-5,969	1,074	-4,662	-2,132
Mar	101,134	151,878	-857	667	-1,638	-10	-142	-1,107	-881	-7,913	-649	1,317	2,716	-37,101
Apr	254,611	70,519	-3,225	15,476	16,269	21,050	7,105	-9,391	12,659	-24,226	3,081	-19,104	9,911	-27,908
May	348,745	32,845	-2,295	9,093	5,770	-1,098	20,404	1,390	-10,695	1,218	349	878	-7,163	-1,027
Jun	426,576	84,414	-1,755	8,063	-54,534	8,612	-44,937	1,003	-56,173	-427	-48,231	531	-60,517	-2,640
Jul	601,668	79,214	-25,619	254	-146,763	-2,432	-63,188	485	-65,176	-1,930	1,246	431	-160,066	-3,333
Aug	439,800	150,149	-4,364	-1,325	-92,935	-278	-1,783	-359	-4,787	1,009	-1,974	1,987	-95,967	2,174
Sep	270,431	114,157	-9,091	-4,766	-61,828	-169	-43,365	-276	-1,039	359	108	1,124	-63,076	26
Oct	105,673	29,861	15,614	9,304	-44,108	-11,659	27,167	-3,922	2,626	-3,129	16,190	-1,777	-46,176	-5,260
Nov	80,747	107,428	-3,981	-7,823	-14,214	-19,076	-9,693	3,621	-10,691	8,812	-6,477	3,771	-14,963	-24,163
Dec	77,337	104,950	920	-12,129	-15,891	2,337	-6,116	4,175	-2,222	3,722	-3,158	3,719	-16,097	12,887
Annual	2,874,518	1,178,902	-38,464	14,335	-434,413	-2,639	-129,742	-73,873	-149,578	-90,722	-46,454	-4,435	-475,565	-84,567

6 USBR Net Value (based on Net Energy), $

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	-$3,568,393	-$94,687	-$888,984	$2,599,370	$2,728,759	-$93,460	-$980,608
Feb	$1,272,383	$22,391	-$152,056	-$487,142	-$550,453	-$278,994	-$106,285
Mar	-$1,328,879	-$64,593	-$63,864	$34,607	$249,954	-$70,441	$1,420,394
Apr	$6,537,390	-$647,328	-$158,842	$542,407	$1,220,641	$737,612	$1,248,878
May	$11,678,529	-$504,603	$194,954	$620,202	-$423,931	-$42,326	-$235,905
Jun	$12,624,758	-$396,556	-$2,160,563	-$1,573,398	-$1,881,031	-$1,657,004	-$1,985,883
Jul	$21,899,095	-$1,018,295	-$5,569,552	-$2,275,054	-$2,254,800	$53,442	-$6,040,463
Aug	$13,373,712	-$193,854	-$3,935,126	-$56,519	-$232,282	-$162,326	-$4,154,396
Sep	$7,216,591	-$205,061	-$2,579,126	-$1,808,946	-$54,490	-$38,380	-$2,634,631
Oct	$3,412,548	$214,542	-$1,269,596	$1,188,768	$214,610	$681,371	-$1,588,071
Nov	-$527,613	$120,441	$127,097	-$550,075	-$784,541	-$416,543	$293,350
Dec	-$407,093	$483,328	-$734,637	-$415,981	-$225,433	-$269,610	-$1,132,406
Annual	**$72,183,028**	**-$2,284,276**	**-$17,190,295**	**-$2,181,762**	**-$1,992,999**	**-$1,556,660**	**-$15,896,026**

9 USBR Net A/S

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	4665069.035	-1058828.173	-3462682.021	-3433457.478	121311.2804	-28540.93888	-3768755.754
Feb	1489841.354	-271648.7201	-436555.788	-407244.1885	-408668.1229	-413202.4612	-560427.804
Mar	909610.9589	-338988.9516	-4456.568026	6924.415215	7839.895777	4031.664889	-120799.621
Apr	1602938.072	10029.56831	65846.42461	-9546.493925	-5486.775149	7280.736869	555089.9559
May	2545065.008	-387750.7039	-1270742.706	-10699.83836	-1237122.029	-1237541.621	-1091884.26
Jun	2854014.934	-423887.742	-1349420.056	-366752.1667	-376736.5968	-369855.1079	-1392551.982
Jul	1519497.155	-186159.9281	-605756.5418	272748.4368	270367.0042	3140.326437	-446665.6399
Aug	1561868.885	-242797.4386	-737638.6032	3924.120696	-848.0594662	-971.9864331	-599299.2888
Sep	1103964.525	-241826.1032	-583993.9459	347656.3945	-7286.168544	-8306.376869	-608625.0991
Oct	1681523.589	-224499.003	-1047590.809	-167217.5164	-38152.89982	-116577.0632	-800657.6253
Nov	1414844.12	-245400.2186	-872779.3534	-804253.9664	-813724.9594	-394532.9242	-785724.9771
Dec	2502448.078	-528233.4408	-1027498.515	-967712.759	-14206.74645	-1139.724938	-1017963.951
Annual	**$23,850,686**	**-$4,139,991**	**-$11,333,268**	**-$5,535,631**	**-$2,502,714**	**-$2,556,215**	**-$10,638,266**

10 USBR Net Value

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	$1,096,676	-$1,153,515	-$4,351,667	-$834,087	$2,850,070	-$122,001	-$4,749,363
Feb	$2,762,224	-$249,258	-$588,611	-$894,386	-$959,122	-$692,196	-$666,712
Mar	-$419,268	-$403,582	-$68,320	$41,532	$257,794	-$66,409	$1,299,595
Apr	$8,140,328	-$637,299	-$92,995	$532,860	$1,215,154	$744,893	$1,803,968
May	$14,223,594	-$892,354	-$1,075,789	$609,502	-$1,661,053	-$1,279,867	-$1,327,789
Jun	$15,478,773	-$820,444	-$3,509,983	-$1,940,151	-$2,257,768	-$2,026,859	-$3,378,435
Jul	$23,418,593	-$1,204,455	-$6,175,308	-$2,002,306	-$1,984,433	$56,582	-$6,487,129
Aug	$14,935,581	-$436,651	-$4,672,765	-$52,595	-$233,130	-$163,298	-$4,753,696
Sep	$8,320,555	-$446,887	-$3,163,120	-$1,461,289	-$61,776	-$46,686	-$3,243,257
Oct	$5,094,072	-$9,957	-$2,317,187	$1,021,550	$176,457	$564,794	-$2,388,728
Nov	$887,231	-$124,960	-$745,682	-$1,354,329	-$1,598,266	-$811,076	-$492,375
Dec	$2,095,355	-$44,906	-$1,762,136	-$1,383,694	-$239,639	-$270,750	-$2,150,370
Annual	**$96,033,714**	**-$6,424,267**	**-$28,523,564**	**-$7,717,393**	**-$4,495,713**	**-$4,112,875**	**-$26,534,292**

APPENDIX D VALUE OF CVP POWER UNDER "WET" CONDITIONS

Note: All changes are relative to the NA case. For percentage change, the calculation is: (Case value-NA value)/NA value.
For others, the calculation is Case value - NA value. Thus, if a percentage change is positive, it means the Case value is greater than the NA value, and vice versa.

Results of Case:	NA Wet	EC	MF	PF	MP	SMUD	70
1 MCPs	**$/MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
Mean	34.84	0.1%	0.8%	0.2%	0.2%	0.1%	0.4%
2 Expected monthly net energy:							
	MWh	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
Jan	463,001	0.1%	-7.7%	-2.7%	-2.8%	-2.7%	-17.5%
Feb	646,226	-8.6%	-7.0%	1.2%	2.1%	0.6%	4.3%
Mar	558,306	5.8%	12.3%	0.0%	0.0%	0.0%	11.7%
Apr	487,219	-11.2%	15.4%	-4.4%	-4.6%	-4.4%	3.6%
May	748,478	-4.0%	-30.9%	-9.6%	-3.9%	-3.8%	-27.8%
Jun	693,143	1.7%	-37.1%	-30.0%	-2.0%	-18.2%	-32.0%
Jul	614,898	1.7%	-47.1%	-5.4%	0.0%	0.1%	-14.4%
Aug	474,607	1.1%	-44.8%	-0.3%	0.4%	0.3%	-4.0%
Sep	495,466	-3.9%	-53.1%	-0.5%	0.1%	0.1%	-0.4%
Oct	428,853	-1.0%	-85.3%	-71.7%	-74.4%	-49.6%	-86.6%
Nov	198,432	-2.5%	-61.7%	-44.7%	-32.6%	0.2%	-79.6%
Dec	345,263	-1.5%	-38.5%	-0.7%	-2.7%	0.2%	-60.4%
	6,153,890	-1.8%	-29.5%	-12.0%	-7.4%	-6.4%	-20.3%
3 Expected Annual net energy	**MWh**	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
On-Pk	4,809,589	-2.2%	-22.7%	-7.7%	-5.4%	-3.6%	-14.3%
Off-Pk	1,344,301	-0.5%	-53.6%	-27.7%	-14.5%	-16.4%	-41.4%
Total	6,153,890	-1.8%	-29.5%	-12.0%	-7.4%	-6.4%	-20.3%

POWER IMPACT ANALYSIS FOR THE TRINITY RIVER SEIR/EIS CENTRAL VALLEY PROJECT

4 Expected aMW of July and August Capacity based on USBR Generation

	aMW	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.	% CHG.
On-Pk	740	1.0%	-22.9%	-0.4%	-0.2%	0.0%	-2.9%
Off-Pk	241	1.1%	-59.4%	-7.7%	-0.3%	0.0%	-19.4%

5 USBR Expected Monthly and Annual Loads and Resources, MWh

	Generation	Load	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh	CHG., MWh
Jan	565,607	102,606	-2,250	-2,601	-110,955	-75,265	-13,807	-1,193	-13,995	-1,226	-13,812	-1,127	-83,534	-2,404
Feb	798,866	152,639	-82,524	-26,718	-137,802	-92,340	-175	-7,664	-179	-13,930	-178	-3,831	-206	-28,021
Mar	722,984	164,679	11,630	-20,755	-31,183	-99,979	0	-162	237	277	-1	-244	42,968	-22,608
Apr	573,329	86,110	-33,108	21,230	50,169	-24,761	1	21,405	-6	22,199	-6	21,224	40,298	22,820
May	793,021	44,544	-17,533	12,753	-215,713	15,202	-58,096	13,945	-15,955	13,472	-14,436	14,077	-195,081	12,859
Jun	807,734	114,591	11,167	-590	-255,560	1,847	-208,692	-709	-15,420	-1,595	-126,817	-440	-224,547	-2,805
Jul	823,543	208,646	8,247	-2,308	-256,449	33,411	-29,281	3,744	-3,056	-3,034	-507	-1,427	-77,952	10,438
Aug	636,657	162,049	6,310	983	-208,863	3,598	-2,351	-1,122	-743	-2,678	603	-737	-23,502	-4,442
Sep	615,996	120,530	-19,159	-30	-262,957	306	-2,596	-105	98	-290	532	-61	-2,599	-579
Oct	537,379	108,526	-5,839	-1,600	-359,834	5,904	-308,489	-1,146	-320,257	-1,236	-214,131	-1,221	-372,261	-1,060
Nov	327,272	128,840	-3,455	1,526	-117,264	5,095	-85,377	3,303	-65,513	-895	-399	-821	-180,011	-22,147
Dec	446,008	100,745	-5,083	-74	-149,812	-16,780	-3,715	-1,389	-10,846	-1,429	-445	-1,284	-175,854	32,559
Annual	7,648,396	1,494,506	-131,596	-18,183	-2,056,223	-243,763	-712,577	28,905	-445,634	9,635	-369,598	24,108	-1,252,282	-5,390

6 USBR Net Value (based on Net Energy), $

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	$17,391,400	$40,016	-$1,309,535	-$396,727	-$403,272	-$399,223	-$2,949,299
Feb	$22,139,149	-$1,875,508	-$1,522,028	$280,886	$493,972	$150,368	$972,111
Mar	$18,786,005	$1,082,019	$2,270,450	$12,611	$9,281	$8,335	$2,142,109
Apr	$15,412,303	-$1,648,179	$2,299,074	-$642,215	-$665,017	-$637,304	$657,140
May	$24,019,405	-$895,857	-$6,753,092	-$2,104,064	-$909,644	-$882,673	-$6,127,600
Jun	$21,834,806	$359,637	-$7,597,498	-$6,100,824	-$355,891	-$3,720,997	-$6,516,349
Jul	$23,879,330	$527,493	-$10,156,872	-$1,042,913	-$14,115	$30,796	-$2,939,160
Aug	$19,714,427	$144,353	-$8,246,186	-$45,395	$76,748	$49,351	-$731,990
Sep	$19,905,726	-$756,996	-$10,147,143	-$88,530	$11,441	$27,967	-$68,495
Oct	$15,061,443	-$131,471	-$12,378,539	-$10,363,660	-$10,767,551	-$7,050,158	-$12,604,508
Nov	$8,264,367	-$285,361	-$4,780,503	-$3,457,413	-$2,507,780	$24,459	-$6,289,346
Dec	$13,033,365	-$204,613	-$4,803,881	-$81,482	-$355,573	$25,610	-$7,522,962
Annual	**$219,441,727**	**-$3,644,468**	**-$63,125,755**	**-$24,029,727**	**-$15,387,400**	**-$12,373,470**	**-$41,978,350**

9 USBR Net A/S

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	5666122.133	-44755.07508	-487474.1632	111292.0749	111488.6086	110572.8586	-544086.5344
Feb	669815.1244	180361.1051	2689.15689	1125.709426	1647.584282	546.2942183	3154.112177
Mar	1262512.45	-45194.01133	28694.07158	79.65553921	-172.8621299	-118.1404616	2686.386214
Apr	1891469.965	128115.0262	1936.031202	-3876.246848	-4300.200523	-4118.21709	-4222.541163
May	1183778.605	11889.08992	1016231.829	973071.7665	-3585.906687	-3684.193542	2307431.859
Jun	1293673.056	-31143.5593	-27121.82647	-25955.45349	795882.3628	1268415.745	-25700.38917
Jul	1112516.05	-240503.6962	-36923.27492	628324.7701	998.6394933	4638.116205	651186.0322
Aug	1865243.181	-227924.8071	-673170.3803	-850.9077481	507.9989293	347.6140869	19984.02965
Sep	958166.0654	50964.81949	-311935.8223	7233.011849	-116.7272973	-1007.270904	7338.767395
Oct	1112112.799	-200387.6128	478094.2524	483946.1567	483707.464	797621.3942	482022.6475
Nov	1305715.386	2072.882834	-39637.60888	350725.5613	246520.9113	-7724.573369	-30341.77984
Dec	3292660.448	18610.30644	-225025.695	-17011.20843	47678.98021	-17318.10652	1007391.133
Annual	**$21,613,785**	**-$397,896**	**-$273,643**	**$2,508,105**	**$1,680,257**	**$2,148,172**	**$3,876,844**

10 USBR Net Value

	2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD	CHG, 2003 USD
Jan	$23,057,522	-$4,739	-$1,797,009	-$285,435	-$291,783	-$288,650	-$3,493,386
Feb	$22,808,965	-$1,695,147	-$1,519,339	$282,012	$495,619	$150,914	$975,265
Mar	$20,048,517	$1,036,825	$2,299,144	$12,691	$9,109	$8,217	$2,144,795
Apr	$17,303,773	-$1,520,064	$2,301,010	-$646,091	-$669,317	-$641,423	$652,917
May	$25,203,183	-$883,967	-$5,736,860	-$1,130,993	-$913,230	-$886,357	-$3,820,168
Jun	$23,128,479	$328,493	-$7,624,620	-$6,126,780	$439,992	-$2,452,582	-$6,542,050
Jul	$24,991,846	$286,989	-$10,193,796	-$414,589	-$13,116	$35,434	-$2,287,974
Aug	$21,579,670	-$83,572	-$8,919,357	-$46,246	$77,256	$49,699	-$712,006
Sep	$20,863,892	-$706,031	-$10,459,079	-$81,297	$11,325	$26,960	-$61,156
Oct	$16,173,556	-$331,859	-$11,900,445	-$9,879,714	-$10,283,844	-$6,252,536	-$12,122,485
Nov	$9,570,083	-$283,288	-$4,820,141	-$3,106,688	-$2,261,259	$16,734	-$6,319,688
Dec	$16,326,026	-$186,003	-$5,028,907	-$98,493	-$307,894	$8,292	-$6,515,571
Annual	**$241,055,512**	**-$4,042,363**	**-$63,399,398**	**-$21,521,622**	**-$13,707,143**	**-$10,225,298**	**-$38,101,506**

Department of Energy March 9, 2004 Letter

Department of Energy
Western Area Power Administration
Sierra Nevada Customer Service Region
114 Parkshore Drive
Folsom, California 95630-4710

MAR - 9 2004

Mr. Kirk Rodgers
Regional Director
Bureau of Reclamation
Mid-Pacific Region
2800 Cottage Way
Sacramento, CA 95825-1898

Dear Mr. Rodgers:

Thank you for the opportunity to provide the Western Area Power Administration's (Western) views on the analytical methods employed and conclusions reached by the Henwood Energy Services, Inc. (Henwood) in their report, "Power Impact Analysis for the Trinity River Supplemental Environmental Impact Report (SEIR)/Environmental Impact Statement (EIS), Central Valley Project, Phase 2 Report, (revised draft October 20, 2003)".

Western provided comments, informally, to Mr. Kim Nguyen of your staff and Mr. Mike Urkov of CH2M-Hill in December 2003. Our initial comments focused on our concern that the scope of the power impact analysis appeared to concentrate primarily on regional cost impacts to the Western Electricity Coordinating Council region under the EIS/EIR alternatives, and did not appear to evaluate the power-related impacts of alternative water operations at the Trinity Dam and Reservoir upon individual authorized beneficiaries. While the aggregated regional impact analysis may quantify the overall regional cost, from an economic impact basis, Western believes that an analysis identifying how these costs will become the responsibility of a more limited group, primarily the Preference Power customers of the Central Valley Project (CVP) is desirable.

We were pleased to see our concerns were addressed when CH2M-Hill developed additional analytical data describing the potential range of impacts CVP Preference Power customers may incur from alternative water operations at the Trinity Dam and Reservoir. I understand that the revised analysis now includes an assessment of financial impacts to two representative CVP customers, with one example summarizing the impacts to an average customer for which 14 percent of its load is served by CVP power, while the other portrays the impacts to a high-allocation customer, for which 85 percent of its load is served using CVP power. I appreciate the commitment to provide further explanation of the methods used to quantify the change in costs per unit of electricity for these representative customers for each alternative in the Trinity SEIS.

Western agrees the "bookends" regional analytical approach undertaken by Henwood and CH2M-Hill in this study provides a range of possible impacts, and accordingly, we believe the revised analysis addresses the requirements established by the Federal District Court in its legal opinion.

Again, thank you for the opportunity to provide comments on this document.

Sincerely,

Thomas R. Boyko
Power Marketing Manager

U.S. Geological Survey Report
Technical Appendix D

Technical review of portions of the Department of Interior's Trinity River Restoration Plan concerning sediment transport and the management of spawning gravels

By E.D. Andrews, K. M. Nolan, and S.M. Wiele

Introduction

Populations of salmon, both adults and their progeny, in the Trinity River of northern California have declined substantially since the completion of the Central Valley Project's Trinity River Division (TRD) in the early 1960s. The streamflow storage and diversion by the TRD has reduced annual runoff of the Trinity River by as much as 90 percent. Numerous investigations and studies have been conducted in the past 20 years as part of an attempt to recover salmon populations. These studies have considered, among other topics, the relation between streamflows, fluvial sediment transport, and river channel features that provide salmon habitat, including gravel substrate suitable for spawning and relatively low velocity areas utilized by young fish. Based on these studies, several alternative flow regimes have been proposed. These alternatives were evaluated in accordance with NEPA, and an Environmental Impact Statement (EIS) was prepared and reviewed. On December 19, 2000, the Secretary of the Interior issued a Record of Decision (ROD). The preferred alternative consists of (1) five annual flow release regimes from Lewiston Dam depending on the expected basin runoff: critically dry, dry, normal, wet, and extremely wet, (2) the introduction (augmentation) of gravel-sized sediment suitable for salmon spawning below Lewiston Dam, and (3) an adaptive management program to evaluate and change, when necessary, the flow regimes and gravel augmentation.

The Sacramento Municipal Utility District (SMUD) and other parties subsequently challenged the ROD. During August 2002, SMUD met with representatives of the Bureau of Reclamation (BOR) to express their views concerning the effect of the ROD flow regimes and the feasibility of the gravel augmentation, and to propose an alternative flow regime. The substance of the SMUD presentation is a digital document containing 96 figures, photographs, and text panels. In late September 2002, the BOR asked the U.S. Geological Survey (USGS) to conduct a partial technical review of SMUD's Trinity River Restoration proposal and consider three specific issues, namely:

1. Evaluate hydrologic and geomorphic components of the ROD plan relative to streambed scour and the configuration of gravel and cobbles in reaches 1,2, and 3. Assess SMUD's assertion of potential gravel mobility problems that may result from ROD flows. Further determine if the alleged mobility of the gravels due to the ROD flows would eliminate the most significant spawning areas in the Trinity River.
2. Assess SMUD's assertion regarding substantial gravel replacement by mechanical means (gravel management plan) as being impractical.
3. Determine if the modified flow rates proposed by SMUD would avoid the assertions made in 1 and 2.

We reported our findings orally to Mr. Kirk Rogers, Mid-Pacific Regional Director, BOR, on October 15, 2002. This report is a record of our findings presented to Mr. Rogers.

Background Information:

Our review relied upon part or all of several reports:

1. The Trinity River Mainstem Fishery Restoration Final EIS/EIR, October 2000,
2. The Record of Decision, December 2000,
3. The SMUD Trinity River Restoration proposal, August 30, 2002,
4. McBain, S., and W. Trush. 1997. *Trinity River Channel Maintenance Flow Study Final Report*. Prepared for the Hoopa Valley Tribe, Trinity River Task Force, and
5. Parker, G. 1979. Hydraulic geometry of active gravel rivers. Journal of the Hydraulic Division, American Society of Civil Engineers, 105(HY9), N85-1201,
6. U.S. Fish and Wildlife Service and the Hoopa Valley Tribe. 1999. Trinity River Flow Evaluation Final Report,
7. Wilcock, P.R., G.M. Kondolf, A.F. Barta, W.V.G. Matthews, and C.C. Shea. 1995. Spawning gravel flushing during trial reservoir releases on the Trinity River. Field observations and recommendations for sediment maintenance flushing flows. Prepared for the U.S. Fish and Wildlife Service, Sacramento, CA., Cooperative Agreements 12-16-0001-91514 and 14-16-0001-91515,

8. Wilcock, P.R., G. M. Kondolf, W. V. G. Matthews, and A. F. Barta. 1996A. Specification of sediment maintenance flows for a large gravel-bed river. Water Resources Research **32**:2911-2921, and
9. Wilcock, P. R., et. al. 1996B. Observations of flow and sediment entrainment on a large gravel-bed river. Water Resources Research **32**:2897-2909.

On October 12, 2002, we met with Drs. Mike Harvey and Robert Mussetter, consultants to SMUD. They presented the SMUD proposal and answered our questions concerning their methods and results. The proposal assertions we were asked to evaluate are summarized in 13 figures from the SMUD presentation. Copies of these figures are attached and we will use them to describe our findings. We will identify each figure by their number within the SMUD presentation.

Streamflow to Maintain Spawning Habitat

Reaches 1 to 3, as shown in figure 5, contain the most important salmon spawning beds on the mainstem of the Trinity River and are the reaches of particular interest identified in the BOR review request. The formation and maintenance of a loose, permeable gravel bed necessary for salmon spawning requires occasional movement and reworking of gravel and the mobilization of relatively fine sediment. Relatively fine sediment deposited in the gravel interstices reduces the exchange and flow of oxygenated river water through the gravel and smothers salmon eggs. Gravel is transported downstream when spawning gravel is reworked and fine sediment is mobilized. In an unregulated, unobstructed river, there is a ready supply of gravel to replace the particles transported downstream. Dams trap the upstream supply of gravel, however, and gravel-bed channels downstream from dams will tend to erode if dam releases are sufficiently high to mobilize the gravel and there is no artificial gravel supplement.

Maintaining suitable spawning gravel downstream of a dam requires a complex balancing of transport and supply of gravel. For some distance below a dam, tributary contributions of gravel may be insufficient to support downstream gravel transport at a rate that will maintain the permeability of the spawning bed. Without a sufficient supply of gravel particles of the sizes suitable for spawning, approximately 15 to 45 mm, spawning beds will, over time, become too coarse. In many instances, suitable spawning beds can be maintained downstream of a dam only by adding gravel to the river.

Each of the three questions posed by the BOR relates to whether the ROD flow regime and the accompanying gravel augmentation plan achieves a proper balance between reworking of the spawning gravels and supply. SMUD's presentation suggests that the ROD flow regimes will cause so much gravel transport, especially of those sizes suitable for spawning, that it will be impractical to add enough gravel to balance the transport. Implicit in this assertion is the possibility that gravel transport by the ROD flow regimes and associated imbalance will be so large that the spawning gravels could be severely eroded before the imbalance becomes apparent and appropriate action could be taken. SMUD's conclusions regarding excessive gravel transport were derived from their model results. In the sections below, we present our review of the SMUD analysis.

SMUD hydraulic model

The basis for much of the SMUD analysis is a one-dimensional step-backwater hydraulic model. Input to the model consists of channel cross-sections referenced to a common vertical datum at specified longitudinal distances, channel roughness, and discharge. The model computes water surface elevation, water surface width, cross-sectional area, and mean flow velocity that would occur at specified discharges at each cross-section along the channel. The quantity of bed-material transported by the river at specified discharges can be calculated at each cross section using hydraulic predictions from the model at that cross section, a specified riverbed sediment particle-size at that cross section, and an appropriate bedload function. These techniques are useful and widely applied, although they are not without significant uncertainties and pitfalls.

The SMUD hydraulic model analysis covered approximately 40 miles of the Trinity River from Lewiston Dam to the confluence of the North Fork Trinity Fork. This 40-mile reach, which is shown in SMUD figure 5, has been subdivided into 12 shorter reaches defined by channel morphology and major tributaries.

Although a flow model provides the best tool for predicting flow properties in the absence of direct measurement, confidence in the SMUD model results is limited by the scarcity of information with which to calibrate or test the model. The accuracy of predictions produced by any hydraulic model depends on the accuracy with which the physical characteristics of the river are represented in the model. Measured water surface elevations at some known discharges permit the modeler to calibrate the flow resistance input to the model so that the calculated water-surface elevations agree with the measured values. The calibrated model can then be used to compute the water surface elevation over a range of discharge. Experience has shown that extensive model calibrations through a river reach and over a wide range of discharge reduces the uncertainty of model results. The SMUD hydraulic model appears to have been calibrated at only one cross-section (see SMUD figure 7). Among the approximately 540 cross-sections used for the SMUD model, the same flow resistance was applied at all except 15 cross-sections for all discharges from 100 to 14,000 ft^3/s. With such limited calibration, the model results are, at best, a rough approximation. Flow resistance varies along a river as a result of differences in channel width, depth, alignment, size of bed-material etc. As noted above, the SMUD analysis divided the 40-miles into 12 subreaches based, in part, on differences in channel morphology. These differences are summarized in several SMUD figures. Given these significant differences in channel morphology of the Trinity River, we believe it is unjustified to assume a constant flow resistance throughout the 40-mile reach. Flow resistance, also, varies with discharge as flow through a river cross-section becomes wider, deeper, and faster. The SMUD presentation does not provide evidence that their hydraulic model was adequately calibrated and accurately represents flow characteristics in the 40-mile reach.

SMUD's Anaylsis of Sediment Transport

Based on the available information concerning flow and sediment transport in the Trinity River, we believe that the ROD flow regimes and the associated gravel augmentation plan are an appropriate approach to restore and maintain gravel beds suitable for salmonid spawning. Assertions made in the SMUD presentation regarding the possibility of excessive gravel transport by the largest ROD flows and the infeasibility of supplying enough gravel to balance losses is not substantiated. Results presented in some figures are inconsistent or conflict with material found in other figures. SMUD's calculated rate of sediment transport in reaches 1 and 3 at a discharge of about 6,000 ft^3/s do not agree with actual measurements made in these reaches. Finally, daily streamflows within the range of magnitude, which SMUD asserts will cause damage to spawning habitat, have actually occurred on 46 days since 1997 and no degradation of the gravel spawning beds has been observed. The basis for our conclusions is described below.

Reach-averaged critical discharge

SMUD's calculations of reach-averaged critical discharge (figure 36) are inconsistent with SMUD's assertions that ROD flows will cause excessive gravel transport. Figure 36 shows the calculated critical discharge, which is the discharge at which bed particles begin to move, for the 12 reaches identified in figure 5. The median bed particle size in each reach is shown on the right-hand ordinate. The median diameter of bed particles in reaches 1 to 3 is about 54mm. The indicated critical discharge for gravel motion in reach 1 is 6,000 ft^3/s. Actual particle movement at the critical discharge is extremely small and would be insufficient to rework spawning gravels and mobilize the relatively fine sediment. Consequently, streamflows somewhat larger than the critical discharge must be sustained for a few days to accomplish the desired reworking of a spawning gravel bed. Therefore, according to figure 36, releases from Lewiston Dam must occasionally exceed 6,000 ft^3/s by an appreciable margin to maintain the suitability of spawning gravels in reach 1, but streamflow releases proposed by SMUD are capped at 6,000 ft^3/s (see SMUD figures 15-19).

Our assessment that releases from Lewiston Dam must occasionally exceed 6,000 ft^3/s by an appreciable margin is based upon the fact that dimensionless grain shear stress, which is the ratio of the fluid forces acting on riverbed particles to the fluid forces required to move the bed particle, and thus, is the single hydraulic characteristic of a stream most indicative of the bed-material transport rate, does not vary linearly with discharge. Rather, shear stress varies with about the 0.4 power of discharge. This relation means, for example, that a discharge 3 times greater than the critical discharge will result in a dimensionless grain shear stress that is only 55 percent greater than critical dimensionless grain shear stress.

Critical discharge indicated for reaches 2 to 3 is approximately 4,000 ft^3/s. In these reaches, dam releases of 6,000 ft^3/s would probably be sufficient to rework spawning gravels. Within reach 4 and 5, the critical discharge is estimated to again be about 6,000 ft^3/s, and dam releases of only 6,000 ft^3/s would be insufficient in these reaches unless tributrary inflows to the mainstem were substantial. SMUD's analysis shown in figure 36 indicates, to us, that the ROD flow regimes which provides streamflows greater than 6,000 ft^3/s for a few days during wet and extremely wet years are reasonable.

Critical shear stress at individual cross sections

Longitudinal profiles of the river bed (the thalweg) and water surface elevations computed by SMUD's hydraulic model at individual cross sections at 6,000 ft^3/s and 10,000 ft^3/s through reach 1 are shown in the lower panel of figure 40. Longitudinal profiles of the dimensionless grain shear stress at 6,000 ft^3/s and 10,000 ft^3/s are shown in the upper panel. A value less than 1.0 indicates that fluid forces at that discharge are insufficient to move bed particles. A value greater than 1.0 indicates that fluid forces at that discharge are sufficient to move bed particles. The horizontal dashed line in the upper panel has a value of 1.0 and identifies channel cross-sections with gravel motion and no gravel motion.

Beginning at the Old Dam near Station 205,000, there appears to be 36 locations where the dimensionless grain shear stress has been computed. We chose to start this analysis below the Old Dam site because bedrock outcrops and remnants of the Old Dam appear to distort the local flow characteristics significantly. This effect is artificial and unrepresentative of the rest of reach 1 downstream.

The model results displayed in the upper panel of figure 40 are physically unreasonable. The computed dimensionless grain shear at six cross sections downstream of the Old Dam site is 3 or greater. Four of these cross-sections are located within riffles, which are relatively steep, high velocity portions of the channel. Within several hundred to perhaps a thousand feet, up and/or downstream of these cross-sections with very large dimensionless grain shear stresses, there are cross-sections where the dimensionless grain shear stress is nearly 1.0 or less.

Relatively small longitudinal variations in bed-material transport, especially during the rising or falling limb of a flood hydrograph, are common and can cause short-term net accumulations or depletions of sediment in a given cross-section. Imbalances that exist during one portion of a flood hydrograph are subsequently reversed, so that when the flood has passed, there is no appreciable accumulation or depletion of bed-material. Very large differences in the bed-material transport, however, can only exist in reality for a very short time without causing major changes in channel shape and slope.

River channels adjust over a period of time so that the sediment supplied to the channel is transported by the available discharge. If more sediment is delivered to a cross section than is transported away from the cross section, the bed must aggrade. Conversely, if less sediment is delivered to the cross section than is transported away, the cross section must scour. Thus, a river with the longitudinal grain shear stress profile shown in figure 40 would rapidly adjust; the cross sections with high grain shear stress that are downstream of cross sections with low grain shear stress would erode and cross sections with low grain shear stress that are downstream from cross sections with high grain shear stress would aggrade. Consequently, significant erosion and, thus, enlargement of the channel would reduce local flow velocity, depth, and/or slope, all of which would tend to reduce the local bed-material transport rate. Because such rapid adjustments have not occurred during flows comparable to the modeled flows, we concluded that the dimensionless grain shear stresses greater than about 2.0 shown in figure 40 for both 6,000 ft^3/s and 10,000 ft^3/s are physically unrealistic.

The justification for our conclusion is, perhaps, best demonstrated at the downstream end of reach 1 between station 185,000 and about 188,000. Rush Creek joins the Trinity River at this point. Since the regulation and diversion of Trinity River flows, large volumes of coarse sediment carried by Rush Creek have accumulated as a debris fan that obstructs the Trinity River. The hydraulic effect of this obstruction is shown by a relatively flat upstream water surface slope and a relatively steep water surface slope downstream from the crest of the debris fan (see figure 40). A photograph of the large Rush Creek debris fan is shown in figure 42 in the SMUD presentation . The dimensionless grain shear stress immediately downstream from the debris fan crest is about 3.5 (see figure 40). The bedload transport rate associated with such a shear stress can be estimated using the Parker-Einstein equation (Parker 1979) and a median bed particle size of 54mm as shown in figure 36. At a discharge of 6,000 ft^3/s, the estimated bedload transport rate would be somewhat more than 25,000 ton per day. With no supply of gravel from upstream, this material would be eroded from the Rush Creek debris fan. A discharge of 6,000 ft^3/s has been recorded on 46 days at the USGS gage, Trinity River near Lewiston, since 1997. During these 46 days, more than 1.1 million tons of sediment would have eroded from the Rush Creek debris fan if the dimensionless grain shear stress shown in figure 40 were correct. Eroding such a quantity of material from the Rush Creek fan would have excavated a new channel approximately 200' wide, 10 feet below the present surface of the debris fan, and over 2 miles long. In short, the Rush Creek debris fan would have been completely removed. In fact, the 46 days of 6,000 ft^3/s have caused little, if any, erosion of the Rush Creek debris fan. SMUD figure 42, is a photograph of the Rush Creek debris fan showing mid-channel gravel bars with established mature vegetation. These gravel bars have existed for years and were not substantially eroded by the extended period of streamflows greater that 6,000 ft^3/s since 1997. SMUD figure 30, proposes that tributary debris fans in reaches 1 to 3, including the Rush Creek debris fan, be removed mechanically; an implicit acknowledgement that streamflows of 6,000 ft^3/s are insufficient to erode these debris fans. For these reasons, we believe that the sharp, local maximums of dimensionless grain shear stress shown in figure 40 are not a correct presentation of hydraulic condition in the Trinity River.

The physically unreasonable result, described above, is largely, if not wholly, a consequence of SMUD's use of the same particle size in the grain shear stress calculation for both the high velocity riffles and for the lower velocity pools. In reality, high velocity zones tend to have larger bed particle sizes than occur in the pools. Grain shear stress is inversely proportional to the particle size. The use of actual bed particle sizes in the computation of grain shear stress would result in a more realistic distribution of grain shear stresses.

Daily and annual rates of sediment transport by reach

SMUD extended their analysis, described above, and estimated the volume of sediment transport within each of the 12 reaches for each of the five flow regimes, critical dry to extremely wet, identified in the ROD and SMUD proposals. Annual sediment fluxes for the 12 reaches during a wet year are shown in figure 56. Annual sediment fluxes for the 12 reaches during an extremely wet year are shown in figure 50. Because Lewiston Dam releases essentially clear water, the reach 1 sediment flux must be composed principally of bed-material. There would be little or no washload entrained from above or within reach 1.

The volumes of sediment shown in SMUD figures 50 and 56 for both the ROD and SMUD flows are extremely large for a river of the size and slope of the Trinity. Based on the following analysis we conclude that the volumes of sediment shown in figures 50 and 56 are incorrect, and moreover, inconsistent with SMUD's other results discussed above.

In figure 36 the critical discharge for reach 1 was shown to be 6,000 ft^3/s. Because the releases would only equal, but not exceed the critical discharge, the quantity of sediment transported by the SMUD proposed flows should be quite small. As shown in figure 56, however, the estimated volume of sediment transported through reach 1 by the SMUD proposed flows during a wet winter is approximately 600,000$(yds)^3$, almost a million tons. The volume of sediment transported through reach 1 reported in figure 56 is inconsistent with the results shown in figure 36

The daily bedload transport rates needed to move the annual volumes of sediment shown in figure 50 and 56 are also inconsistent with bedload transport rates actually measured over a range of streamflows up to 6,000 ft^3/s at two locations within reaches 1-3. Bedload transport rates have been samples in the vicinity of the USGS gage, Trinity River at Lewiston, near the upstream end of reach 1, see figure 8.7, p. 173, of the Trinity River Maintenance Flow Study Final Report dated November 1997, and at Poker Bar near the end of reach 3, (Wilcock et. al., 1996A and 1996B). Figure 8.7 showing measured transport rates for sediment larger than 8mm together with a fitted relation is included in the back of our report. Both investigations sampled the rate of bedload transport at a discharge slightly less than 6,000 ft^3/s and obtained very similar results, approximately 400 tons/day at the Lewiston gage and 330 tons/day at Poker Bar. Furthermore, Wilcock et. al. (1996A) demonstrate that the sampled bedload transport rates at Poker Bar over a range of discharges are in agreement with the Parker Bedload Function; the most widely applied equation to compute gravel transport rates. Although the ROD and SMUD wet year hydrographs different somewhat, daily bedload transport rates in reaches 1-3 at a discharge of 6,000ft^3/s would need to be approximately 50 times greater than the measured values in order to move the annual volumes of sediment shown in figure 56.

An estimate of the quantity of sediment larger than 8mm potentially transported by the 5 hydrographs of daily mean flow releases specified in the ROD was calculated using the fitted relation (dashed curve) shown in figure 8.7. Annual bedload fluxes calculated from the measured transport rates are compared with the SMUD estimated in Table 1.

Table 1. Estimated Annual Bedload Sediment Transport in Trinity River Reach 1 in Tons/Year.

	Bedload Sampling	SMUD Model Calculations[1]
Extremely Wet	97,700	1,460,000
Wet	22,800	1,280,000
Normal	3510	Not given
Dry	212	Not given
Critically Dry	0	Not given

[1] A cubic yard of sediment was estimated to weigh 1.35 tons.

The analysis described above shows that the annual load of sediment estimated by SMUD is much larger than one would obtain using actual bedload transport rates measured in the Trinity River reach 1. The measurement of bedload transport involves significant uncertainties and only 3 measurements were used to define the relation in figure 8.7. The fitted relation, however, has the shape of a typical bedload curve and the measurements were made at discharges within the range of interest[1]. Given the available information at this time, we feel that measured bedload transport rates provide a better estimate of the quantity of bedload transported by the 5 annual hydrographs specified in the ROD. Annual bedload transport calculated by the SMUD model for the annual hydrographs are unreasonably large and inconsistent with other results reported by SMUD.

[1] A bedload transport rate of approximately 10 tons/day of material larger than 8mm was measured in the vicinity of the USGS gage at Lewiston when the river discharge was 4,000 ft^3/s. Given this measurement, we believe that the critical discharge in reach 1 is approximately 4,000 ft^3/s, similar to the critical discharge in reach 2 and 3. In either case, the bedload transport rate in the Trinity River, reach 1, is much smaller than indicated by figures 50 and 56.

Suitability of gravel augmentation

The volumes of sediment needed to augment lost spawning gravels as stated under the flow evaluation alternative in the EIS, (Table 2.9) compare favorably with the volumes of bedload predicted using bedload sampling data (Table 1). Data in Table 2, below, compare those data. Note that bedload sampling data are presented in Table 1 in terms of tons/year, and are presented in Table 2 in terms of yd^3/year.

Table 2. Estimated annual bedload transport in Trinity River Reach 1, in yd^3/yr.

	Bedload Sampling	EIS, Table 2.9
Extremely Wet	72,400	49,100
Wet	16,200	14,200
Normal	2600	2000
Dry	157	200
Critically Dry	0	0

We feel the values in Table 2 compare favorably with one another because not all sediment transported as bedload would need to be replaced artificially. Some sediment will come into the reach from tributaries and local bank erosion. Also, bedload transport will include material that is larger than that needed to develop spawning habitat. This larger material would not need to be replaced. In summary, we believe that the analysis of gravel replacement in the EIS is supported by the available bedload transport information.

Finally, the SMUD presentation argues that the EIS estimates of gravel transport during an extremely wet season would require annual augmentation rates that are not feasible. While it is true that it may be difficult to replace all gravel transported during an extremely wet year, the entire volume of gravel would not need to be replaced immediately. Extremely wet conditions are estimated in the EIS to occur about once in eight years. The gravel budget would not necessarily need to be balanced on an annual basis. A consistent rate of annual augmentation would probably be adequate to maintain the gravel-bed habitat.

Summary

We do not believe that the SMUD proposal demonstrates serious flaws in the hydrologic and geomorphic components of the ROD. This assessment is based upon review of historic streamflow records, theoretical computations of bedload transport, and available bedload data. If detrimental changes do occur in these reaches, those changes should occur over a period of time that will allow appropriate action to be taken during the adaptive management phase of the restoration plan.

We do not believe that SMUD's proposed alternative hydrographs will achieve the objectives of the Trinity River Restoration plan. Some of the bedload computations contained in SMUD's presentation appear to be flawed and local flow characteristics determined from SMUD's hydraulic model were applied incorrectly with reach-averaged bed-material sizes. Consequently, SMUD's analysis of bedload transport in Trinity River reaches 1 to 3 are unreasonably large.

Finally, the amount of gravel augmentation planned under the "Flow Evaluation" alternative of the EIS seems to be in line with the volume of sediment that would be transported out of Reach 1 under the five water-year classes.

Figures Follow

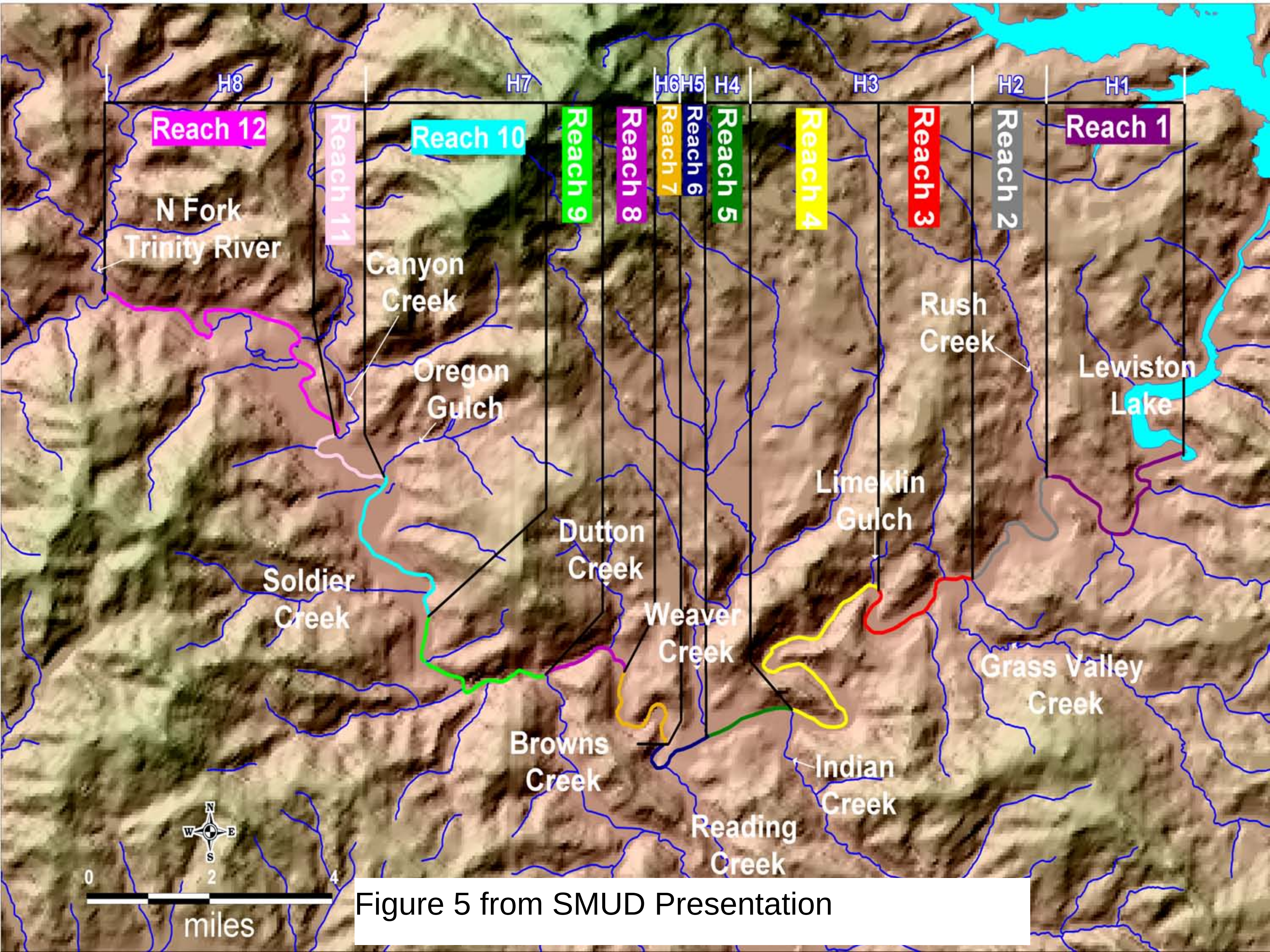


Figure 5 from SMUD Presentation

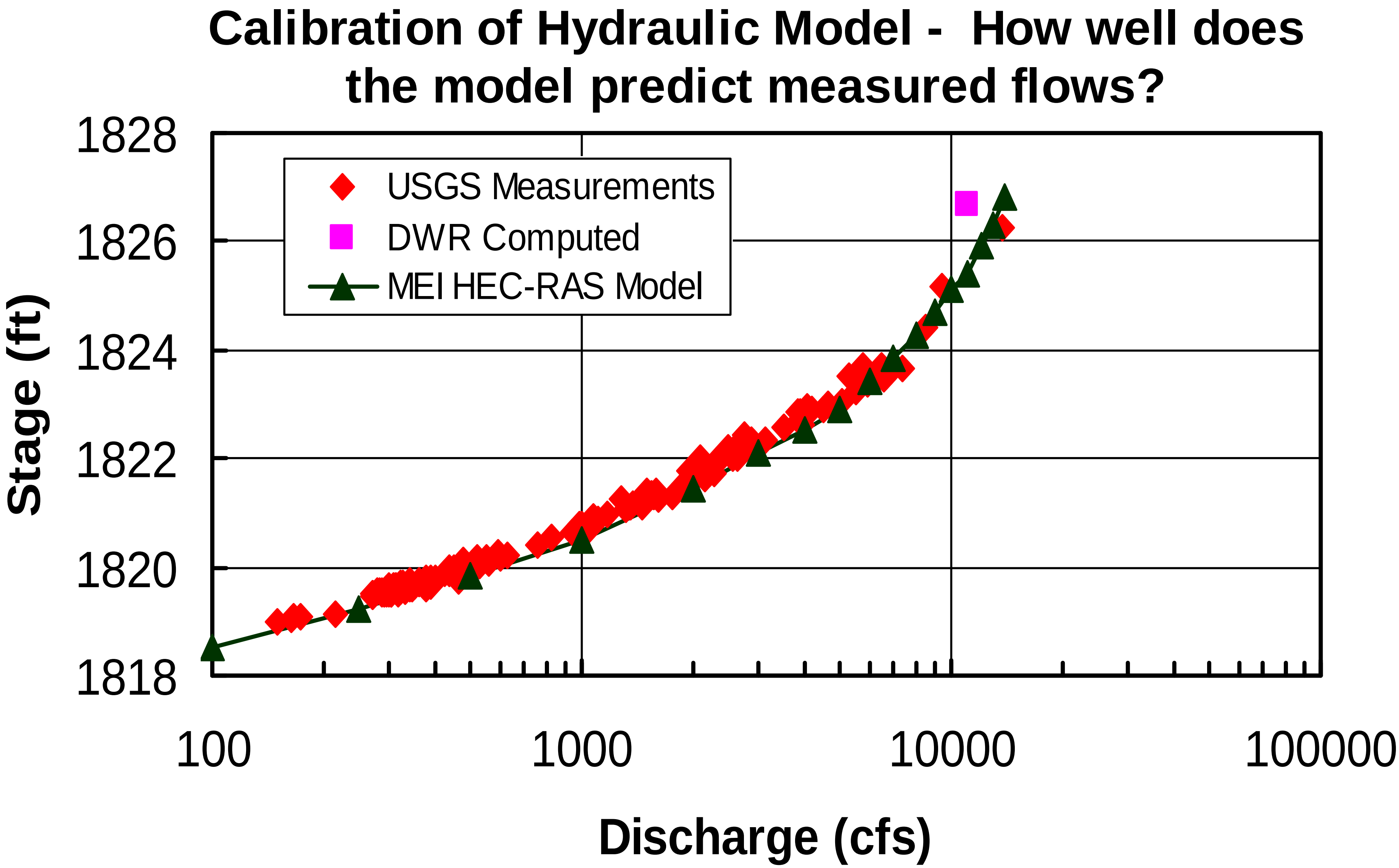


Figure 7 from SMUD Presentation

Proposed Flow Releases for a "Critically Dry" Water Year at Lewiston

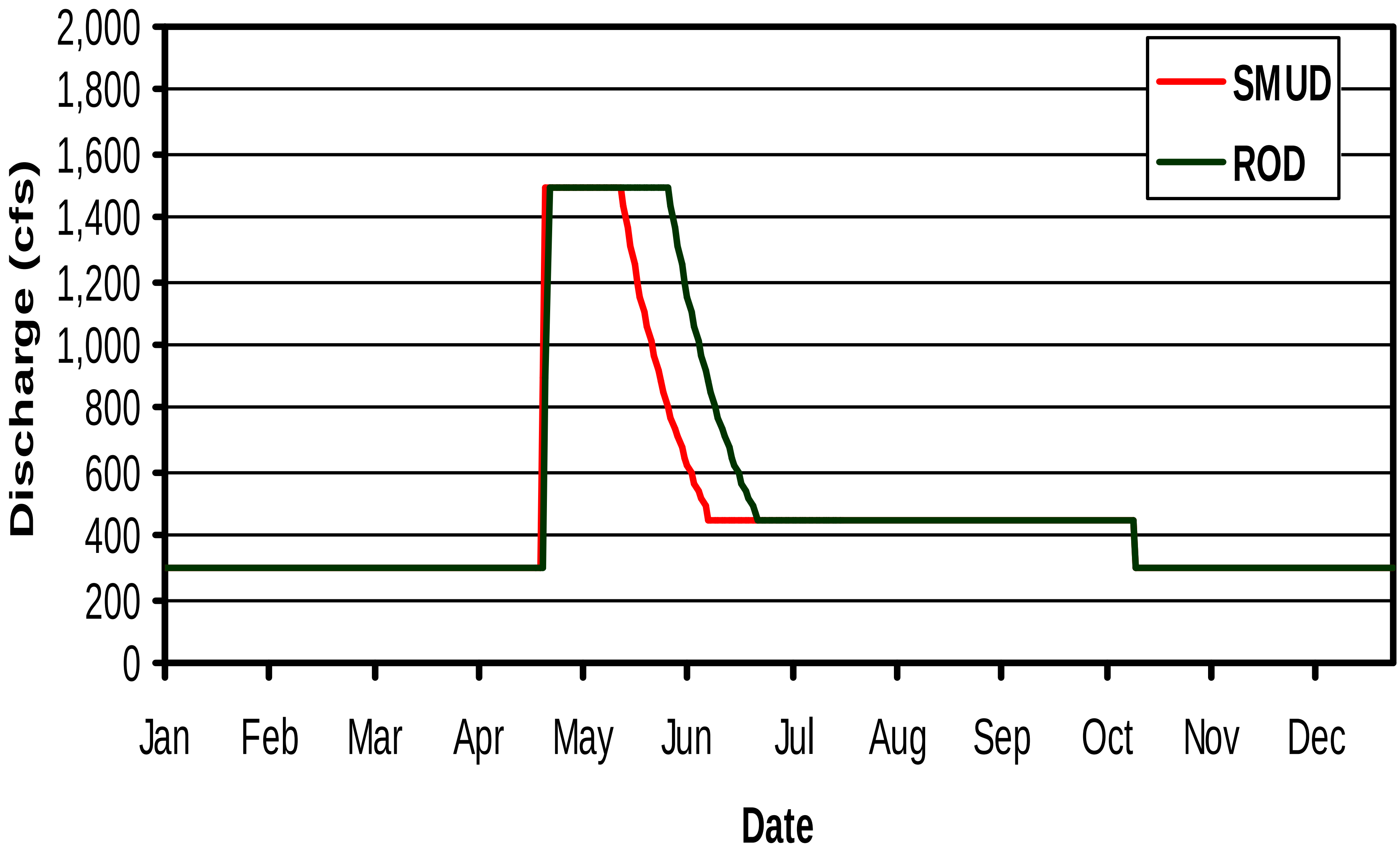


Figure 15 from SMUD Presentation

Proposed Flow Releases for a "Dry" Water Year at Lewiston

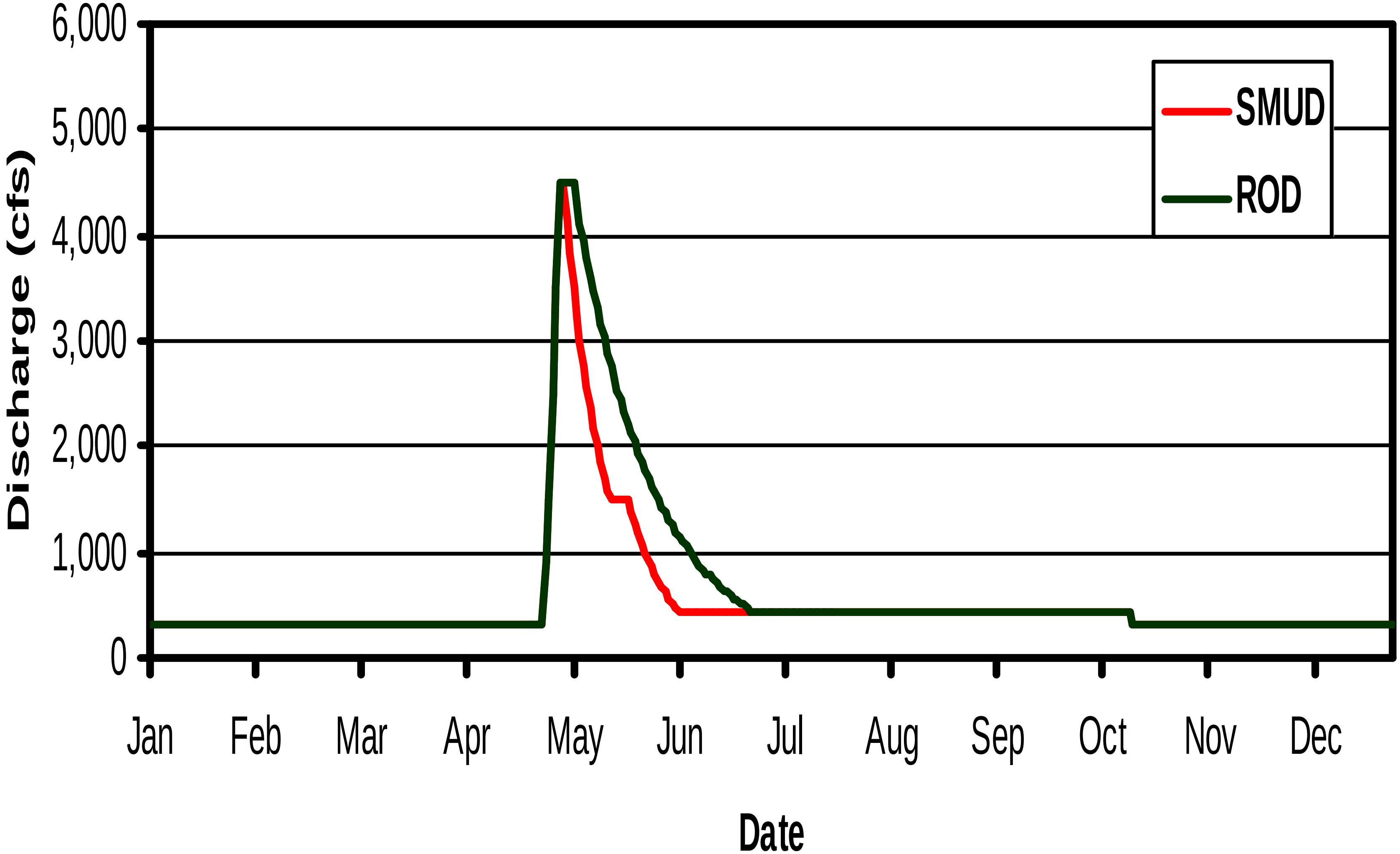


Figure 16 from SMUD Presentation

Proposed Flow Releases for a “Normal” Water Year at Lewiston

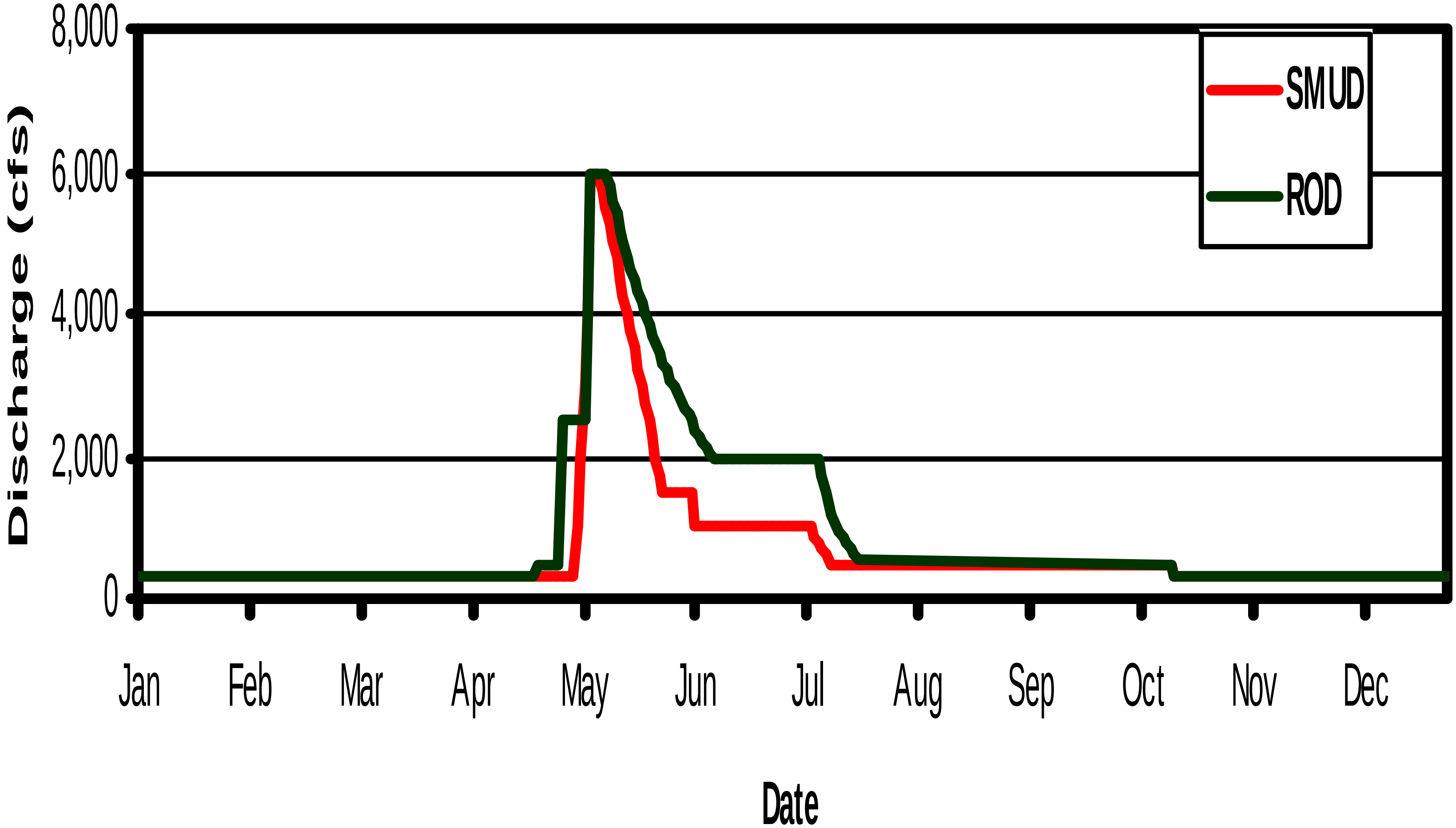


Figure 17 from SMUD Presentation

Proposed Flow Releases for a "Wet" Water Year at Lewiston

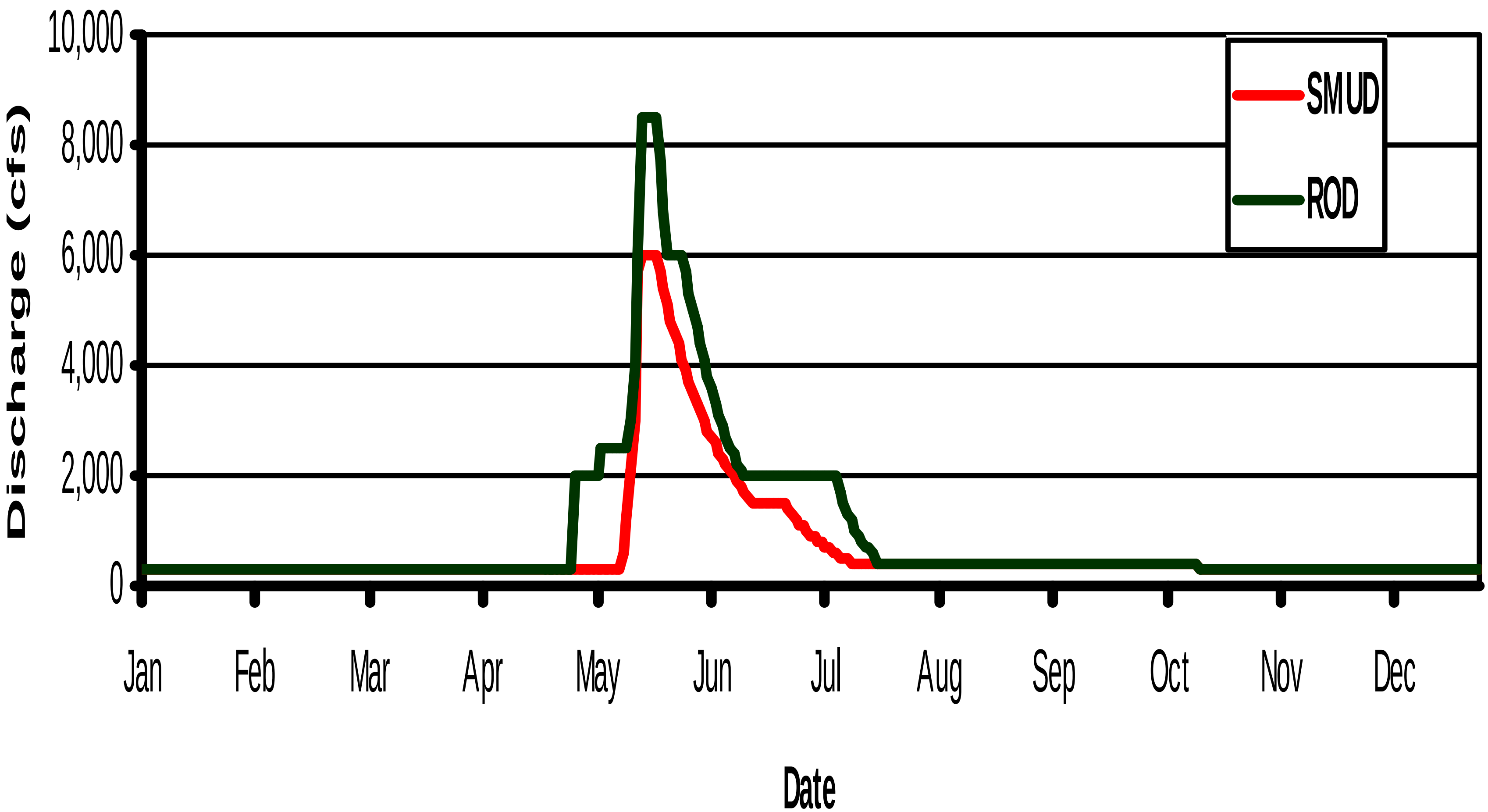


Figure 18 from SMUD Presentation

Proposed Flow Releases for an "Extremely Wet" Water Year at Lewiston

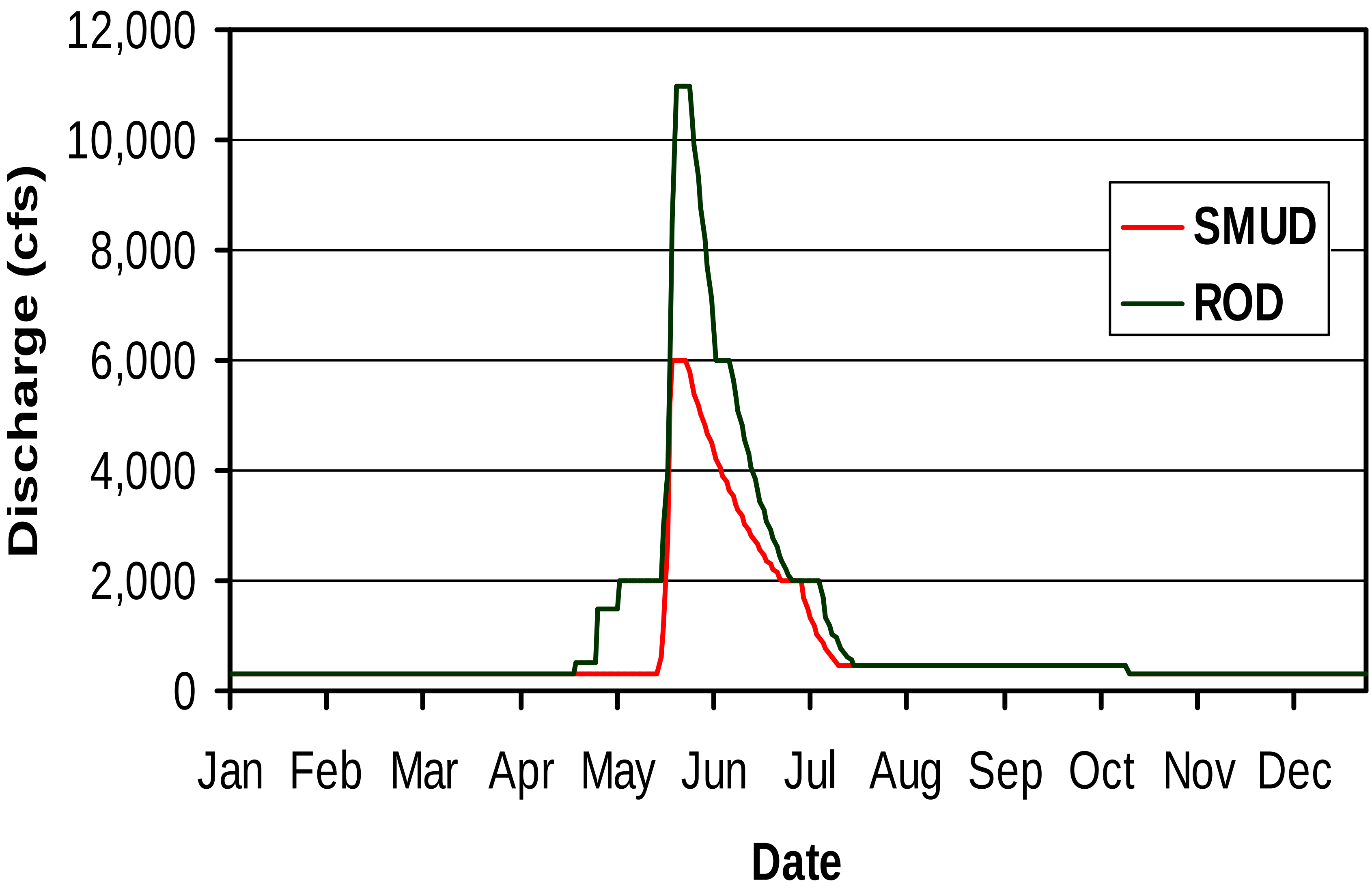


Figure 19 from SMUD Presentation

REACHES 1-3 (ALLUVIAL WITH BEDROCK CONSTRAINTS)

- Existing Condition

  - limited lateral movement
  - low gravel supply
  - high degradation potential
  - high sand supply from Grass Valley Creek and other tributaries

Preferred Upstream Habitat

  - Good spawning, lower temperatures, adult preference

- Alternative Analysis
  - Reach vulnerable to scour of limited gravels by ROD flows
  - Problems with ROD proposed gravel augmentation – source, volume, transport

  SMUD Proposes
  - Reduced flows
  - Mechanical removal of tributary mouth bars – screen and return gravels without sand
  - Pool dredging to remove sand
  - Additional tributary sediment retention structures

Figure 30 from SMUD Presentation

Reach Averaged Critical Discharge

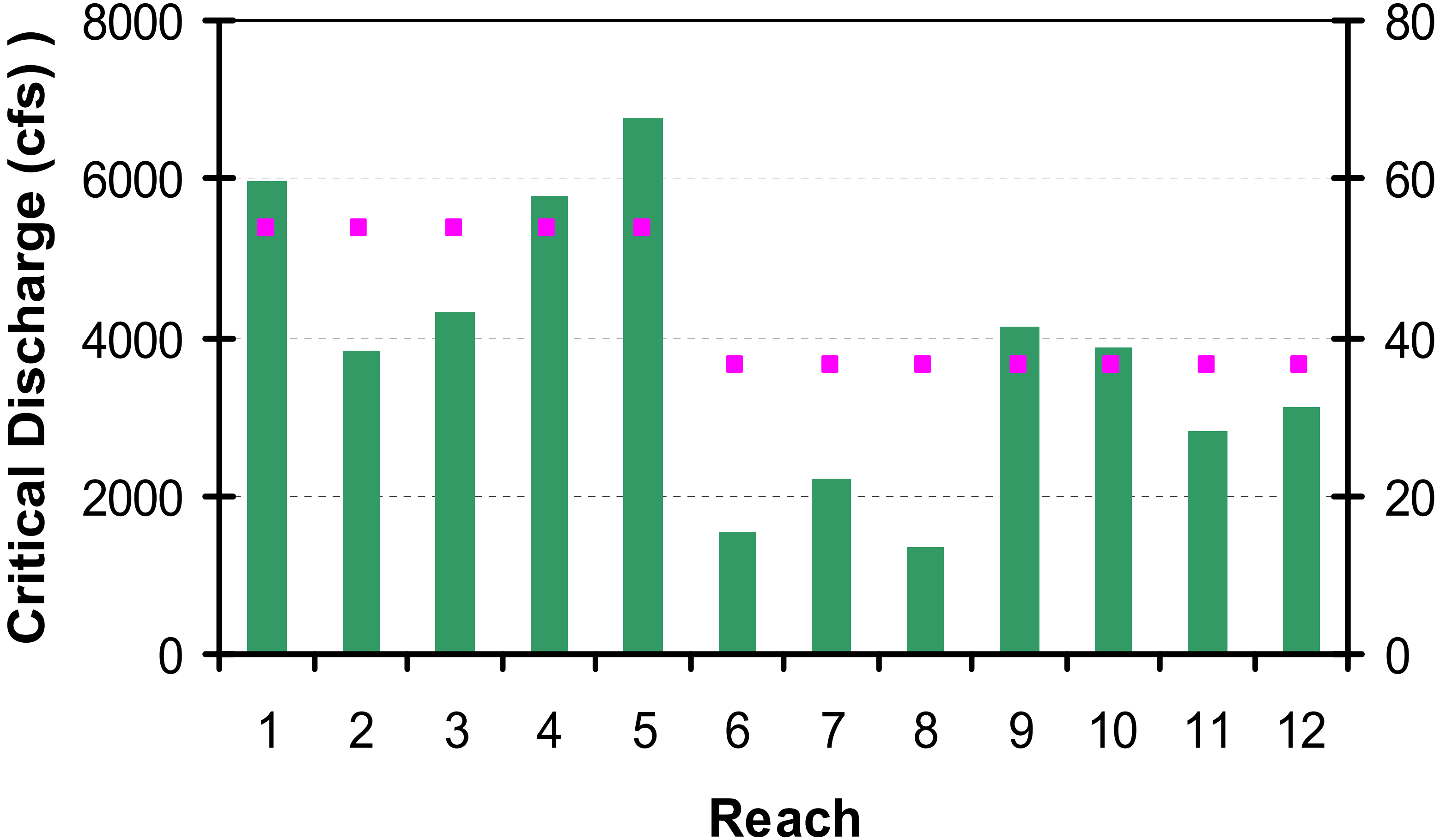


Figure 36 from SMUD Presentation

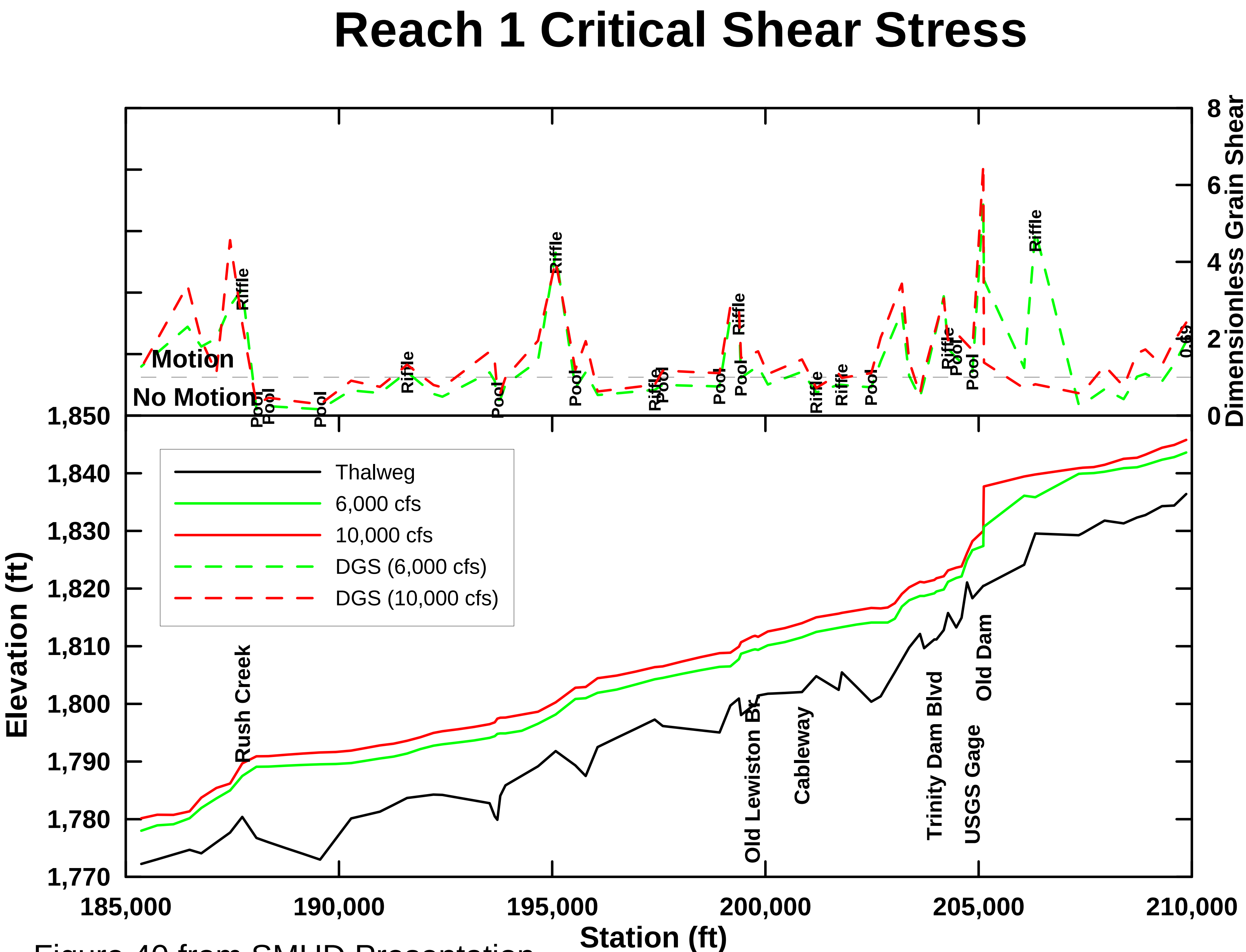


Figure 40 from SMUD Presentation

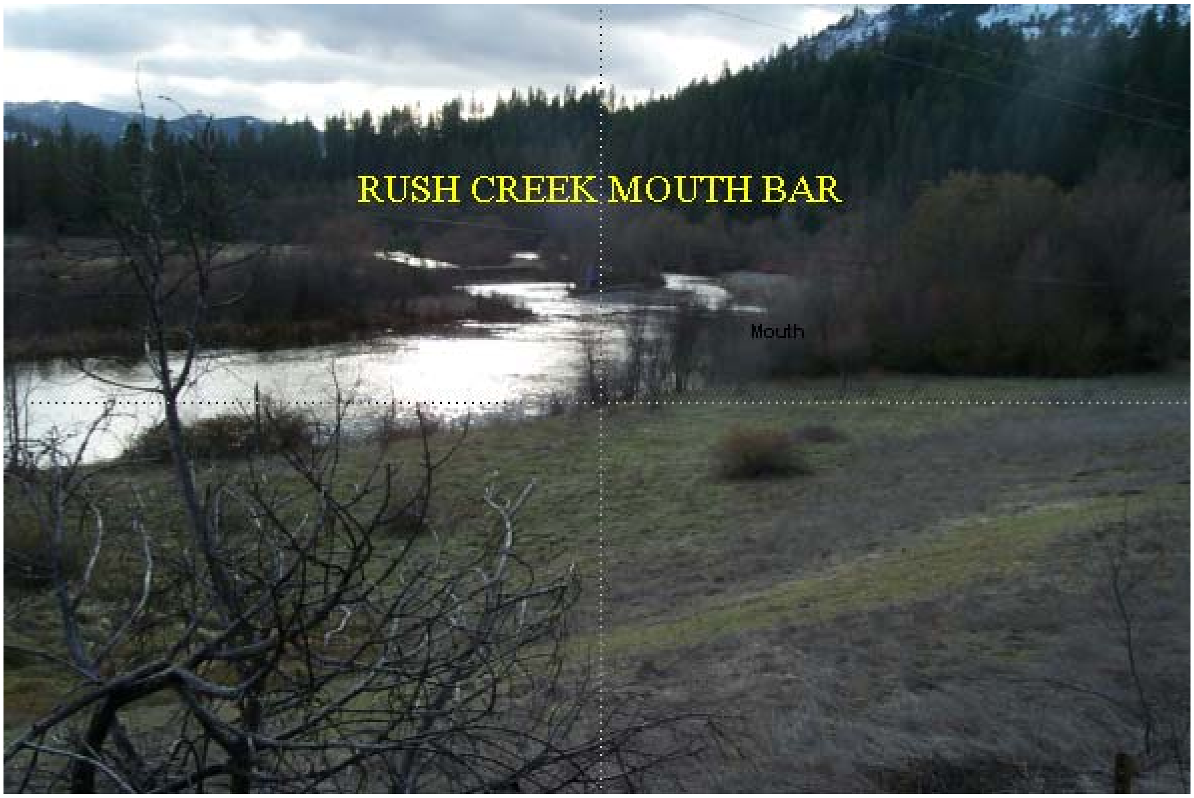


Figure 42 from SMUD Presentation

Sediment Transport Capacity

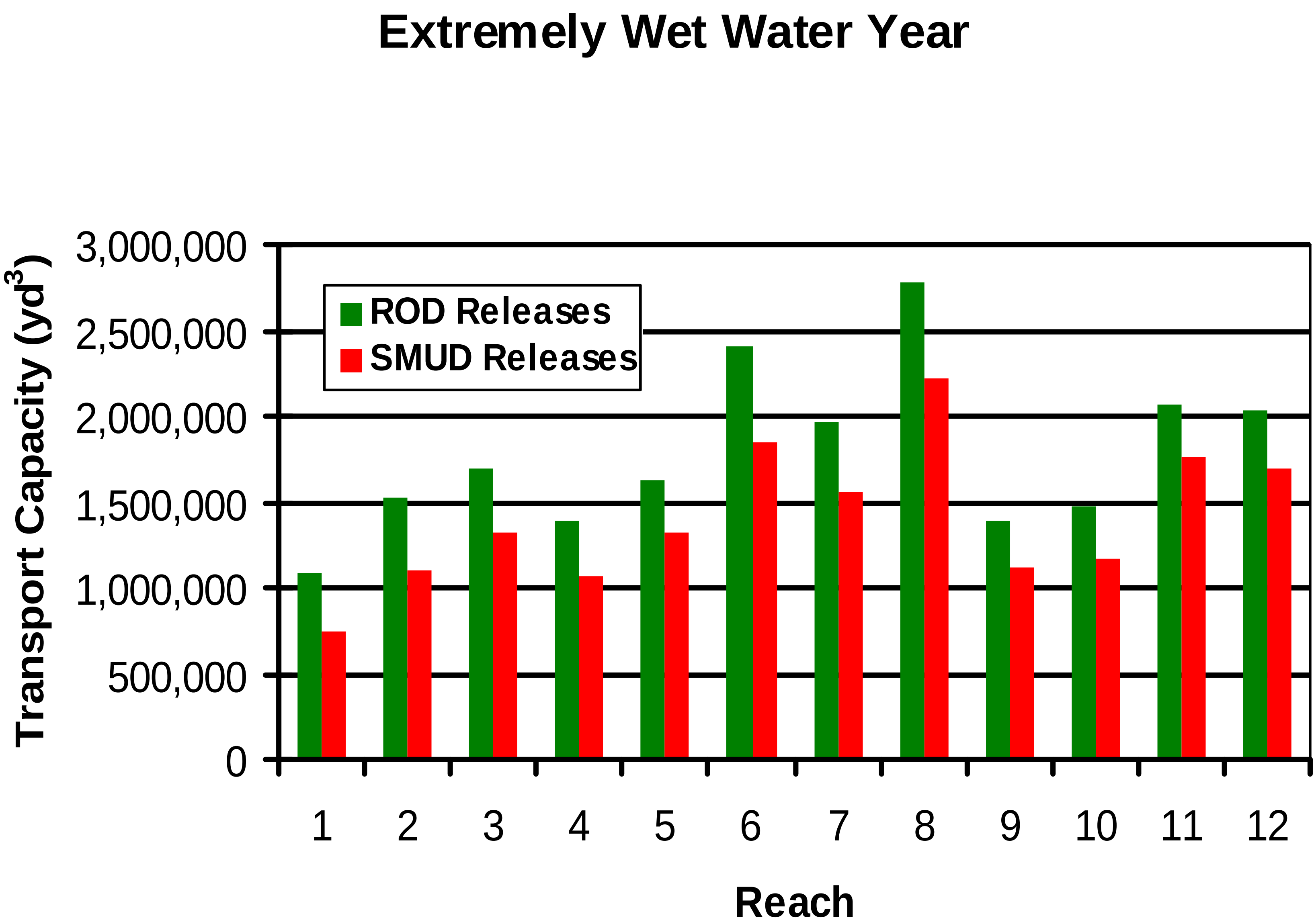


Figure 50 from SMUD Presentation

Sediment Transport Capacity

Wet Water Year

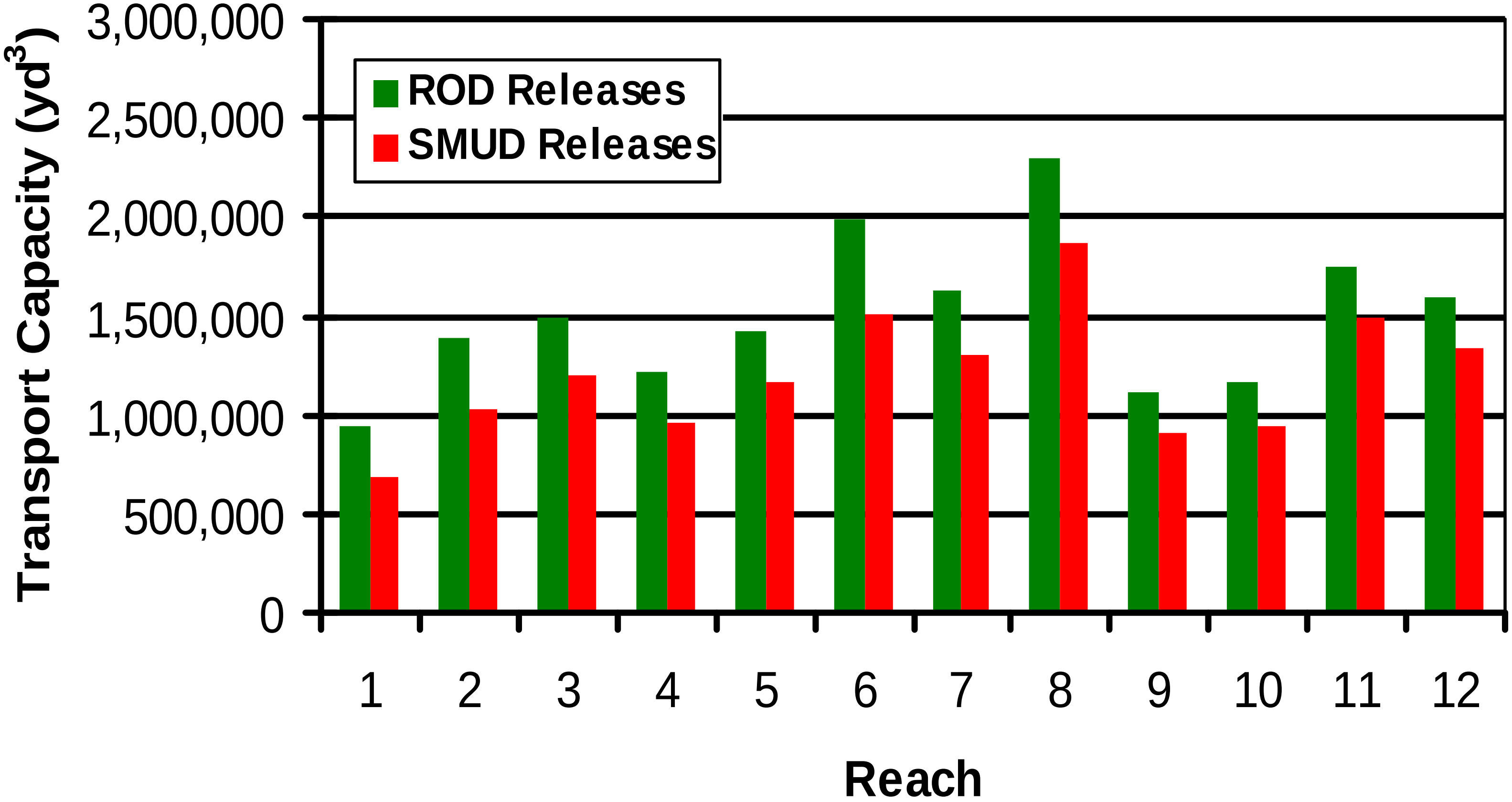


Figure 56 from SMUD Presentation

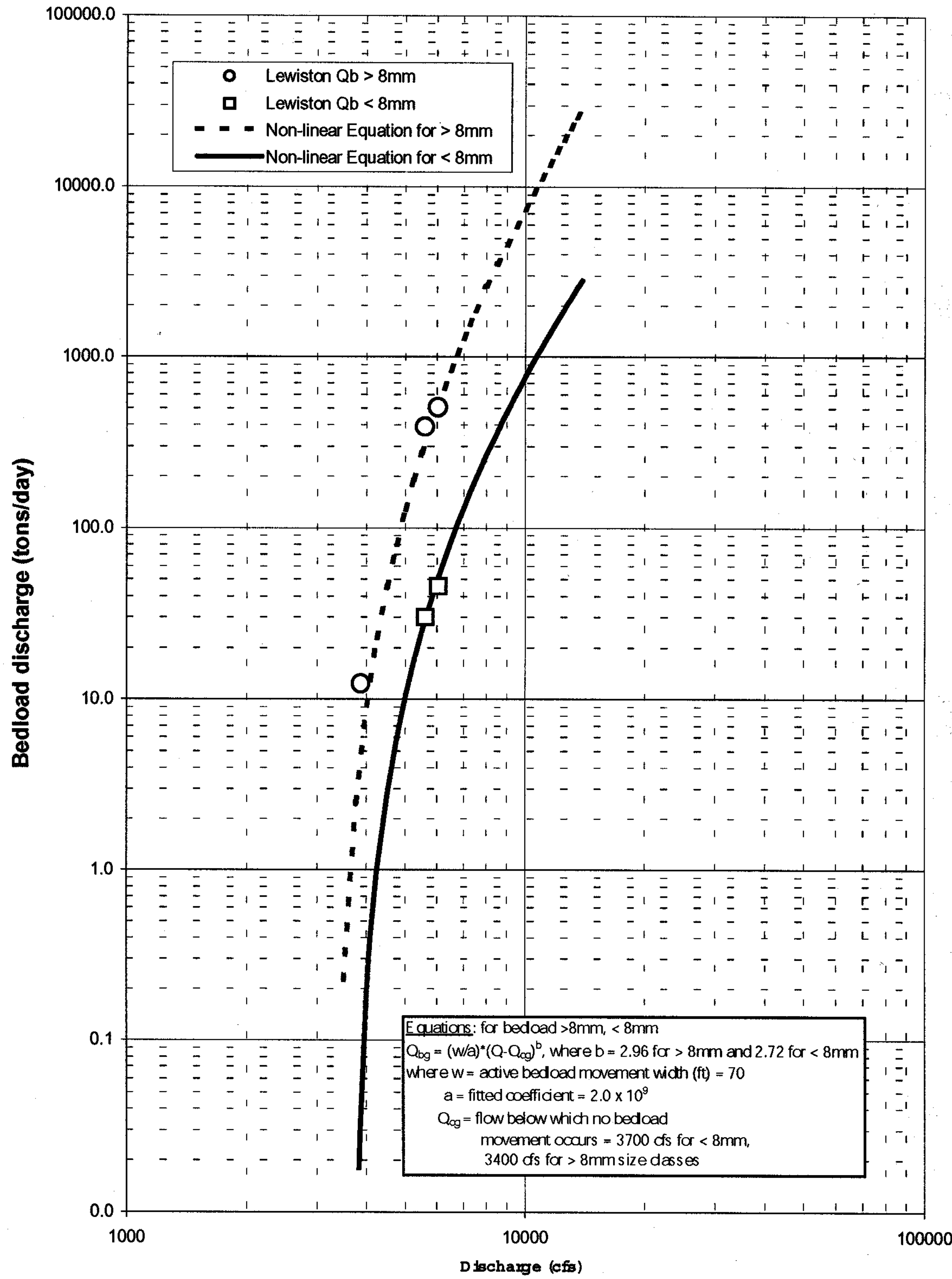


Figure 8.7 Trinity River at Lewiston mainstem bedload transport for > 8mm and < 8mm size classes.

Figure 8.7 from McBain and Trush, 1997

Watershed and Tributary Component of the Flow Evaluation Alternative for the Trinity River Mainstem Fishery Restoration Supplemental EIS/EIR Technical Appendix E

<u>WATERSHED AND TRIBUTARY COMPONENT OF THE FLOW EVALUATION ALTERNATIVE FOR THE TRINITY RIVER MAINSTEM FISHERY RESTORATION SUPPLEMENTAL EIS/EIR (SEIS/EIR)</u>

Summary:
The purpose of the Watershed and Tributary Component is to integrate non-flow measures, such as watershed and tributary restoration, into the Supplemental Environmental Impact Statement/Report for Trinity River Mainstem Fishery Restoration (SEIS/EIR). This component aims to minimize impacts on all other Central Valley Project (CVP) interests, while achieving the statutory goals of Trinity River fishery and basin restoration. The activities described herein are intended to function as a component of the Flow Evaluation alternative addressing the restoration of the Trinity River's fisheries resources.

According to U.S. Environmental Protection Agency's (USEPA) Trinity River Total Maximum Daily Load (TMDL) documentation, a complex restoration program has been implemented on the Trinity River since the late 1970's. *See* "Trinity River Total Maximum Daily Load for Sediment" (USEPA 2001). There is little doubt that the Trinity River Restoration Program and other related efforts have had a beneficial effect on habitat in the river through a combination of watershed restoration, fish passage improvement, sediment detention, riparian improvements, water conservation, land acquisition, increased flows from Lewiston Dam, and mainstem habitat enhancement through pool dredging, side channel construction, and feather edge construction.

Watershed and tributary restoration activities within the basin continue to be implemented by the Trinity River Restoration Program partnering agencies and will continue under each alternative identified in the SEIS/EIR. The majority of projects documented to date include upslope restoration and instream habitat improvement projects within the Upper Middle Trinity and South Fork Trinity Watersheds. The current rate of project implementation is limited due to lack of funding, available staffing and infrastructure, landowner cooperation and other issues. In order to maximize potential benefit from watershed and tributary restoration projects in the Trinity Basin, priority watersheds and restoration types must be identified and re-focused. This component includes the following recommendations:

- Upslope Watershed Restoration Projects are a high priority restoration type. The Upper Middle Reach of the Trinity Watershed (Lewiston Dam to Brown's Creek) is the highest priority in terms of sediment source reduction.
- Emphasis on sediment control should be transferred to the Indian Creek watershed, as it is capable of producing over three times the sediment that the mainstem can transport. Upslope restoration should also be focused in the Browns Creek, Rush Creek, and Weaver Creek watersheds and more generally, on tributaries throughout the Upper Middle Watershed area such as Reading Creek, Hoadley Gulch and Deadwood Creek.

- Prioritization of roads sediment reduction, rehabilitation, and decommissioning projects should be deferred to the implementing agencies that have conducted a systematic road sediment source inventory and/or analysis.
- In the South Fork Trinity River, the Natural Resource Conservation Service (NRCS), the Trinity County Resource Conservation District (TCRCD), and US Forest Service should continue to work towards the 30% reduction of sediment input as recommended in the US EPA's South Fork Trinity River TMDL. Adherence to the Watershed Component of the Trinity ROD should assist in the delegation and prioritization of watersheds and projects to these entities and their current work plans as well as the TMDL implementation plans.
- Fish Passage Improvement Projects are a high priority restoration type throughout the Trinity River Basin, including the South Fork and other tributaries. Fish Passage improvement projects can provide measurable benefits in the restoration of salmon and steelhead populations in the tributaries of the Trinity River Basin. The Implementation Plan for the Trinity River ROD calls for a four fold increase in habitat in the mainstem Trinity River. Current efforts should are focused on those projects which will provide easily accessible habitat from the upper middle mainstem Trinity River (e.g., Soldier Creek, Oregon Gulch, Deadwood Creek).
- Due to limiting factors such as inadequate funding, landowner cooperation, limited staffing, permitting, and low cost-efficiency, the current rate of restoration project implementation for many of the water conservation, land acquisition, instream improvement, and riparian improvement project types cannot be significantly accelerated under existing conditions.
- Projects should be coordinated on a basin-wide scale through the Trinity River Watershed Coordination Effort by TCRCD.
- Upslope sediment reduction and increased instream flows appear to complement each other, but one cannot be traded for the other. The ROD flows are intended to achieve several attributes of a healthy alluvial river system that sediment allocations through the TMDL cannot achieve alone.

Background and Status:
The Final Environmental Impact Study/Report (FEIS/EIR) for The Trinity River Mainstem Fishery Restoration was released in October 2000 by the U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), and the Hoopa Valley Tribe (HVT), as lead agencies under NEPA, and Trinity County (TC), as the lead agency under the California Environmental Quality Act (CEQA). Former Interior Secretary Bruce Babbitt and former Hoopa Valley Tribal Chairman Duane Sherman signed the Record of Decision (ROD) for that document on December 19, 2000. These two documents were the result of nearly 20 years of studies of the Trinity River and its fisheries.

The ROD mandated that the agencies of the Department of Interior (Department) implement the Preferred Alternative and the "reasonable and prudent" measures described in the Biological Opinions (BOs) by the National Marine Fisheries Service (now NOAA Fisheries) and the USFWS. The Preferred Alternative identified in the ROD incorporates the recommendations developed in the Trinity River Flow Evaluation

Report and evaluated under the Flow Evaluation Alternative, as well as additional watershed protection efforts identified in the Mechanical Restoration Alternative of the EIS/EIR.

Immediately following the Interior Secretary's ROD, the Westlands Water District and the San Luis and Delta-Mendota Water Authority filed suit against the federal government in the Eastern Federal District Court in Fresno, on the grounds that the FEIS/EIR did not fully analyze an adequate range of project alternatives, effects on endangered species or potential impacts to water and power users in the Central Valley. Shortly thereafter, the Sacramento Municipal Utilities District and the Northern California Power Agency intervened in the case in support of the plaintiffs.

In several rulings issued between March 2001 (preliminary injunction) and March 2003 (final judgment), Federal District Court Judge Oliver Wanger concluded that the EIS was inadequate in several areas, notably in its stated purpose, the range of alternatives considered, analysis of power supply in light of the California energy crisis of late 2000 and early 2001, and failure to prepare a supplemental EIS to disclose the impacts of reasonable and prudent measures recommended by NMFS and USFWS in their respective BOs, which had been issued after completion of the draft EIS. In December 2002, the court issued an injunction against the implementation of higher flow releases, ruling that a Supplemental EIS be completed in order to address the deficiencies identified with the original EIS. He ordered that the NMFS and USFWS Biological Opinion Reasonable and Prudent Measures be described and evaluated in that draft SEIS. He limited fishery flow releases to 369,000 AF in critically dry years and 453,000 AF in dry, normal, wet and extremely wet years. All non-flow related activities under the ROD were directed to proceed, including mechanical rehabilitation, floodplain infrastructure improvement, gravel placement, watershed restoration, the establishment of the Trinity Management Council and an Adaptive Environmental Management Program.

The activities described herein are directly linked to the district court's conclusion that the EIS process should have considered an alternative that integrates flow with non-flow measures (such as watershed and tributary restoration) and seeks to minimize impacts on all other Central Valley Project (CVP) interests, while achieving the statutory goals of basinwide Trinity River fishery restoration. The court concluded that the lead agencies and the EIS management team intentionally narrowed the scope of the alternatives to "ecological" and "flow-driven" objectives. It stated that the lead agencies avoided addressing, and foreclosed public participation regarding, any alternative that sought to utilize non-flow measures to meet the Congressionally-mandated Fishery Restoration Goals of the Trinity River Restoration Act of 1984 (Public Law 98-541). The court concluded that the document did not adequately consider whether an integrated management alternative would minimize the overall effect on CVP water and power users and listed species in the Central Valley and the Delta.

Per the district court's order, the activities described herein are intended to function as a component of a larger alternative addressing the restoration of the Trinity River mainstem. The component is also directly linked to the fishery restoration goals of the

Trinity River Basin Fish and Wildlife Management Act of 1984 (P.L. 98-541), which authorized the Secretary of the Interior to formulate and implement a management program to restore the fish and wildlife populations in the Trinity River Basin to levels that existed prior to the construction of the Trinity River Division of the Central Valley Project. To that end, the Secretary was then authorized to take appropriate actions to ensure the preservation and propagation of such fish and wildlife.

Purpose:
The development of a Watershed and Tributary Restoration component will better integrate watershed restoration and “non-flow measures” into the overall approach to the restoration of the Trinity River as mandated in the district court’s December 9, 2002, Memorandum Decision and Order. Per that order, implementation of a watershed and tributary component will also help to further meet the Congressionally mandated fishery restoration goals of P.L. 98-541 as follows:

1. Improve the capability of the Trinity River Hatchery to mitigate for salmon and steelhead fishery losses that have occurred above Lewiston Dam;

2. Restore natural (fish spawning in river/stream gravels) salmon and steelhead production in the mainstem and tributaries below Lewiston Dam to pre-dam levels;

3. Contribute to fish harvest management;

4. Compensate for deer and other wildlife losses from flooding of habitat and reduced stream flows as a result of trans-basin water diversions to the Central Valley Project; and

5. Develop and implement land management activities to stabilize watersheds and reduce sediment yield to streams.

Data collection and analysis were conducted in order to establish the current status of watershed and tributary restoration within the basin, to help identify further information needs and priorities, to estimate the costs of increased watershed restoration efforts, and to determine how further watershed and tributary restoration may fit into the current framework of restoration in coordination with higher flow releases from Lewiston Dam.

The Watershed and Tributary Restoration Component may be incorporated into the analysis of one or more of the seven alternatives in the SEISEIR.

Geographic Scope
The Watershed and Tributary Restoration Component includes the Trinity River watershed and tributaries downstream of Lewiston and Trinity Dams, including all Trinity River tributaries such as North Fork, South Fork, New River, etc. It also includes the watershed boundary of the lower Klamath River below its confluence with the Trinity River to the Pacific Ocean for watershed restoration/fine sediment reduction efforts only (See Section 2(a)(1)(A), P.L. 98-541). Watershed restoration efforts to reduce fine

sediment input into the lower Klamath River can improve habitat conditions for migrating Trinity River fish. However, improvement of fish habitat in Lower Klamath River tributaries such as Blue Creek would not improve the production of Trinity River fish, would therefore be inconsistent with the Trinity River fishery restoration goals of P.L. 98-541, and is therefore not considered in this analysis.

Methodology

In order to determine the role of watershed and tributary restoration in the basin, the Tributary/Watershed Alternative Analysis Team categorized restoration projects within the basin into 6 different "restoration types." A restoration type is a conservation treatment or series of conservation treatments aimed at enhancing the natural function of a specific geographic location. In the Trinity River Basin, "restoration types" were categorized into Upslope Watershed Restoration, Instream Habitat Improvement, Riparian Habitat Improvement, Fish Passage Improvement, Water Conservation: Improving Water Supply (Quantity/Quality), and Land Conservation. Restoration project types were then linked to the restoration objectives of the Trinity River Restoration Program, the December 2000 Trinity River Record of Decision, and P.L. 98-541.

The team compiled a database of restoration projects implemented between 1984 (the year the Trinity River Basin Fish and Wildlife Act was signed) and 2000. Project information was obtained from the Bureau of Land Management (BLM), Bureau of Reclamation (BOR), California Conservation Corps, California (CCC), California Department of Fish and Game (CDF&G), Trinity County, California Department of Water Resources (DWR), Five Counties Salmonid Conservation Program (5C), Hoopa Valley Tribe (HVT), North Coast Fisheries Restoration, Trinity Fisheries Improvement Association, Trinity County Resource Conservation District (TCRCD), River Consulting, USDA Forest Service, Lower Trinity Ranger District, Shasta Trinity National Forest, Big Bar Ranger District, Hayfork Ranger District, Shasta Trinity Division, Weaverville Ranger District, Yolla Bolly Ranger District, Six Rivers National Forest, Willow Creek Community Services District, and the Yurok Tribe Watershed Restoration Department/Lower Klamath River Partnership.

Information collected includes each project's implementing agency, watershed, location, land ownership, funding source, contractor, start and end dates, status of completion, average cost, restoration type, specific restoration activity, and cost. When available, appropriate project details were also collected, such as cubic yards of sediment saved, number of stream crossings removed, miles of road decommissioned, miles of instream habitat improved, miles of upslope habitat improved, fish species affected, and materials used. The project team also identified projects currently planned in the basin by different agencies.

In order to identify priorities and further analyze completed projects, the Trinity River watershed was subdivided into 5 planning watersheds, consistent with the Trinity River Total Maximum Daily Load (TMDL). The planning watersheds include the Upper Trinity River, Upper Middle Trinity River, Lower Middle Trinity River, the Lower

Trinity River and the South Fork Trinity River. The five planning watersheds follow the California Watershed Assessment Area (CALWAA) divisions.

Watershed and Tributary Restoration:
In 1994, both the South Fork Trinity River and the Mainstem Trinity River were listed under the Clean Water Act (CWA) Section 303(d) as water quality impaired due to sediment. Sediment levels are currently in excess of the Water Quality Standards (WQS) necessary to protect the beneficial uses of the basin – particularly the cold-water fishery.

According to U.S. Environmental Protection Agency's (USEPA) Trinity River TMDL documentation, a complex restoration program has been implemented on the Trinity River since the late 1970's. *See* "Trinity River Total Maximum Daily Load for Sediment" (USEPA 2001). There is little doubt, based on anecdotal descriptions of the river in that time period, that the Trinity River Restoration Program and other related efforts (such as CDF&G's Fishery Restoration Grants Program) have had a beneficial effect on habitat in the river through a combination of watershed restoration, fish passage improvement, sediment detention, riparian improvements, water conservation, land acquisition, increased flows from Lewiston Dam, and mainstem habitat enhancement through pool dredging, side channel construction, and feather edge construction.

A total of 476 projects were compiled into the database under the six restoration types of upslope restoration, instream habitat improvement, riparian improvement, fish passage improvement, water conservation, and land conservation. The majority of projects documented to date are upslope restoration and instream habitat improvement projects. Most work was completed in the Upper Middle Trinity and South Fork Trinity Watersheds as follows:

Restoration Type	Projects Documented
Upslope Restoration	164
Instream Habitat Improvement	179
Riparian Improvement	49
Fish Passage Improvement	69
Water Conservation	5
Land Conservation	1
Unknown	9

RESTORATION TYPES

Upslope Watershed Restoration

It has been recognized that upslope sediment management and land treatment are integral components in meeting the stated mandate of the 19 December, 2000 Record of Decision (ROD), the goals and objectives of the Trinity River Restoration Program (TRRP), P.L. 98-541 and the Trinity River TMDL for controlling fine sediment. According to the FEIS/EIR, this type of work is identified as critical in restoring salmon and steelhead habitat as part of the ROD on the President's Forest Plan (Final Supplemental EIS on

Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl: U.S. Department of Agriculture and U.S. Department of the Interior, 1994).

Significantly reduced streamflows, combined with accelerated erosion in various sub-watersheds primarily related to land use changes, have resulted in sediment accumulation in the mainstem and South Fork channels. These accumulations have filled pools, covered spawning riffles and over-wintering areas, and impacted rearing areas, thereby greatly reducing salmonid habitat.

The effect of upslope sediment reduction projects and the need for additional releases from Lewiston and Trinity reservoirs into the Trinity River is described on page 65 of the "Trinity River TMDL for Sediment" (U.S. E.P.A, 2001) as follows:

> "*In order for the TMDL to be fully effective in protecting beneficial uses and attaining water quality standards, the ROD flows and restoration program must be implemented.* ***The ROD flows are intended to achieve several attributes of a healthy alluvial river system that sediment allocations through the TMDL cannot achieve alone.*** *For example, the ROD flows include inter- and intraannual flow variations that mimic the natural snowmelt period. These peak flows are critical to support several river functions including the mobilization of channelbed particles, scour pools, create point bars and connect the mainstem to the floodplain. Such conditions are necessary to support habitat elements for spawning, rearing and migration of salmonids. The TMDL sediment allocations will be more effective in supporting beneficial uses if implemented in consort with the ROD flows.* ***Similarly, the ROD flows will be more effective in achieving the river health goals when the TMDL load allocations are implemented****.*" (Emphasis added)

No other data or information exists to contradict the above statement from USEPA's Trinity River TMDL. Thus, it cannot be determined if upslope sediment reduction projects will result in decreased demands for instream flow releases from Trinity River Division reservoirs. To the contrary, it appears that upslope sediment reduction and increased instream flows appear to complement each other, and one cannot be traded for the other. It was that rationale which resulted in the inclusion of the Watershed Component of the Mechanical Restoration Alternative in the Preferred Alternative for the December 2000 Trinity ROD approved by the Interior Secretary and the Hoopa Valley Tribe.

Findings and Prioritizations:
The Upper Middle Reach of the Trinity Watershed (Lewiston Dam to Brown's Creek) was identified as the highest priority in terms of sediment source reduction in the Trinity River TMDL (U.S. E.P.A. 2001). The condition of aquatic habitat in the Upper Middle Reach was identified as being of particular importance for two reasons: (1) biologically, it is utilized more extensively for anadromous fish spawning and rearing than are other basins reaches, and (2) the tributaries and mainstem of this basin have been subjected to a high level of habitat modification, due to the Central Valley Project (CVP) Trinity River Diversion, land management in the watersheds and tributaries, and natural slope

processes. The "Water Quality Control Plan for the North Coast Region" (North Coast Regional Water Quality Control Board) has long identified "flow depletion" from CVP Trinity River diversions as a source of sedimentation in the mainstem Trinity River.

Instream impairment factors relating to sediment reduction and upslope restoration activities within the upper half of the Middle Reach are:

1. Limited Sediment Mobilization Below Lewiston Dam: The mainstem channel bed, since the completion of the CVP Trinity River Diversion, has not been adequately mobilized, increasing sediment accumulation at the deltas of tributaries and resulting in loss-of-habitat characteristics associated with alternate bar sequence. The gravels delivered by the mainstem tributaries below the dam have also not been effectively mobilized or dispersed due to inadequate flood flows and fossilized riparian berms.

2. Reduced Main Stem Pool Depth: After access to the upper basin was eliminated due to dam construction, spring chinook, which formerly migrated upstream of Lewiston Dam, had to "summer-over" in any available deep pools below the dams until spawning began in fall. Fine sediment has reduced the mainstem pool depths, affecting the amount of deep pool habitat important for adult salmonids holding over in the summer. Since many of these pools were historically occupied by summer-run steelhead, chinook were forced to compete for pool habitat below the dam.

3. Excessive Levels of Fine Sediment: The reduction of dam controlled scouring flows in the mainstem has contributed to fine sediment infiltration into spawning gravels. This impact is greatest just below the confluence of Grass Valley Creek. Deposition of sediment on exposed cobble bars and lack of flushing flows has created "fossilized" berms or sediment accumulation around riparian vegetation. This contributes to loss of open, shallow, low-velocity gravel bar habitats for rearing salmonid fry.

The Trinity River TMDL identified Grass Valley and Indian Creeks as the primary producers of fine sediment between Lewiston Dam and the North Fork confluence. Due to the level of disturbance within each watershed, both tributaries provide significant fine sediment loads even in critically dry years. In Water Year 2000, combined loads from these two tributaries were over three times larger than the combined loads of all other tributaries from Lewiston Dam to Brown's Creek (Matthews 2000). Weaver, Rush, Reading, Deadwood and Hoadley Creeks also were also identified as impaired, based on an analysis of stream and watershed condition indicators (Matthews 2000, and De la Fuente et al. 2000). Because of their water quality and channel conditions, Weaver and Rush Creeks were rated as functioning at risk and as having a high watershed hazard condition. The same assessment determined that Brown's Creek was in a moderate condition. In other words, physical and biological conditions in these creeks suggest that aquatic and riparian systems are at risk of being unable to support aquatic & riparian dependent species and retain beneficial uses of water.

Numerous studies have described and evaluated sediment sources in and delivery from the Grass Valley Creek (GVC) watershed (Matthews 2000). The Trinity River TMDL Sediment Source Analysis (SSA) states that since the 1984 passage of P.L. 98-541, the TRRP has addressed this problem through a series of approaches and restoration efforts. In 1990, the Buckhorn Debris Dam was built in order to trap sediments from about 25% of the watershed and in 1994, sediment control ponds, known as the "Hamilton Ponds", were constructed near the confluence of Grass Valley Creek and the Trinity River. Changes in land management were accomplished through the purchase and transfer of 17,000 acres in the watershed from Champion International Corporation to the Bureau of Land Management (BLM) in 1993. Throughout the 1990's, the Trinity County Resource Conservation District (TCRCD) and the Natural Resource Conservation Service (NRCS) implemented a major watershed restoration effort in the Grass Valley Creek Watershed primarily on BLM lands. Between 1992 and 1996, this program treated 10,838 acres, including 858 sites inventoried by NRCS (1992); decommissioned 45 miles of old roads, landings, and skid trails; improved 19 miles of permanent roads; installed sediment basins; and revegetated extensive areas using 1.2 million trees, shrubs, and plugs (TCRCD). More recently, additional sediment control structures have been constructed at almost every draw draining a cut slope along Highway 299 (Matthews 2000).

According to the Trinity River TMDL Sediment Source Analysis, monitoring by the TCRCD since 1995 has shown a decreasing sediment yield at the Hamilton Ponds, which is attributed to the implementation of extensive watershed restoration efforts. Over time, a reduction in the intensity of timber management activities has also reduced GVC fine sediment yields (Matthews 2000).

With the most deleterious portion (sand sized particles) trapped in Hamilton Ponds and extensive upslope restoration efforts coordinated by the TCRCD, Grass Valley does not present the enormous problem that it once did (Matthews 2000). The Trinity TMDL states that emphasis on sediment control should be transferred to the Indian Creek watershed, as it is capable of producing over three times the sediment that the mainstem can transport. With this type of loading, the deposits in the mainstem will continue to grow downstream at a significant rate, as has been observed by local residents. This has contributed to, and will continue to contribute to, downstream habitat degradation (Matthews 2000). Upslope restoration also should also be focused in the Browns Creek, Rush Creek, and Weaver Creek watersheds and more generally, on tributaries throughout the Upper Middle Watershed area such as Reading Creek, Hoadley Gulch and Deadwood Creek. Through funding provided to Trinity County, efforts are ongoing to reduce fine sediment production associated with county roads in the Deadwood Creek and Hoadley Gulch drainages.

The lower middle reach assessment area generally consists of relatively steep gradient (i.e., high sediment transport) stream reaches and rugged terrain, much of which lies within the Trinity Wilderness area. Land management disturbance is minimized in much of the area due to its Wilderness designation. However, according to De la Fuente et al. (2000), Canyon Creek is at risk with regard to several aquatic habitat indicators including water quality, stream vegetation, channel stability, and aquatic integrity. The presently unstable channel conditions in Canyon Creek largely result from intensive historic mining activity and other land use activities for several miles along the lower mainstem that are easily accessible via a primary road (pers. comm. Loren Everest). Conversely, other tributaries in the lower-middle area are relatively difficult to access and have not experienced the same level of disturbance.

For much of the South Fork Basin, unstable and highly erodible terrain as well as land management activities have resulted in high sediment yields from landslides. The greatest source of sediment loading is mass wasting not associated with management sources. Lands west of the South Fork mainstem draining primarily off of the Franciscan Formation soils of South Fork Mountain are particularly susceptible both to natural mass wasting and to accelerated mass wasting from management activities. The rates of sediment loading generated from these areas are significantly greater than that from other locations (South Fork Trinity River (SFTR) TMDL, U.S. E.P.A. 1998).

Based on the analyses conducted for the SFTR TMDL, it is estimated that about two-thirds of sediment loading in the basin is associated with natural sources and about one-third has been associated with various land management activities. Roads generate about twice the levels of sediment loading as timber harvest units, and are the most significant component of management-related sediment production.

The SFTR TMDL states that significant sediment loading reductions appear to be necessary to address the instream problems associated with sediment. Particularly with management activity, load reductions should be more aggressive in the western portion of the South Fork basin, where road/stream interactions are more problematic and terrain is more susceptible to landsliding. Removal of potential road diversions and stream crossing failures, and reductions of road-related sediment throughout the basin, where erosion problems are most significant, will facilitate the continued in-channel improvements.

BLM’s Trinity River Watershed Analysis contains an average annual sediment yield estimate at Hoopa of 1,283 yd^3 per square mile (BLM 1995). Extrapolating this figure to the entire basin (exclusive of the areas upstream of Lewiston Dam and federally designated roadless/wilderness areas), the 2,223-square-mile area in question would produce approximately 2.85 million yd^3 of sediment per year. Full-scale implementation of the watershed protection program identified in the Draft EIS/EIR would result in an approximate reduction of 240,000-480,000 yd3/year, which is approximately 9-17 percent of the average annual sediment produced in the Trinity River Basin. Currently, the Department of Fish and Game recognizes $15 per cubic yard of sediment saved as a reasonable cost in implementing upslope sediment reduction projects. The 1999 Draft Trinity EIS/EIR estimated a cost of $5-10 per cubic yard of sediment saved. However, as projects increase in complexity and associated costs such as permitting are taken into account, costs could typically realistically range from $15 - $30 or more per cubic yard. At this range, implementation of the watershed component of the original EIS/EIR alone would amount to anywhere from $3.6 – $7.2 million (240,000-480,000 yd3/year at $15/yd3) to $7.2 - $14.4 million (240,000-480,000 yd3/year at $30/yd3

Accelerated road decommissioning, road maintenance, and road rehabilitation have primarily been focused on public lands within Trinity National Forest (South Fork Management Unit and Upper Middle Trinity River/Weaverville Ranger District Trinity River Management Unit). This area also includes a small portion of the Six Rivers National Forest-Willow Creek Lower Trinity Ranger District in the lower South Fork and lower mainstem watersheds, as well as the private lands and county roads within the entire Trinity River watershed. The Trinity County RCD has inventoried over 940 miles of Forest Service Roads in the South Fork Basin since 1996. Since that time, the District has completed 72 road upgrade projects, 11 road-decommissioning projects, and 11 road hydro closures in the sub-basin. Trinity County, under the Five Counties Salmonid Conservation Program (5C), has completed a sediment source inventory throughout the Trinity River watershed on County Roads, including the SFTR. Sediment reduction projects on County roads were then prioritized according to treatment immediacy, erosion potential and potential sediment yield as well as by several other management and biological factors. 5C has implemented 4 roads sediment reduction projects and three more are slated for construction in 2004.

Many road rehabilitation and maintenance activities were completed in the Weaverville Ranger District approximately 8-12 years ago (Everest pers. comm.) A Watershed Assessment for the Weaverville watershed (Rush Creek, Little Brown's Creek, Weaver Creek) is in the initial stages and the work identified under that assessment is expected to begin within the next 3-4 years. Road rehabilitation work is also planned for the Oregon Fire Area and is expected to also take place within the next five years. 5C will continue to implement projects at the rate of 2-3 per year on County Roads. Other projects are ongoing by the U.S. Forest Service, TCRCD, the Yurok Tribe and others.

Projects on private roads, which make up the remainder of the watershed, can be done through NRCS and TCRCD, and other limited grant sources; however, because landowner cooperation is a limiting factor, projects on private roads are rarely implemented. For instance, grant funding through CDFG's Fishery Restoration Grant Program requires private landowners to allow CDFG staff unlimited access to the project site for 10 years, which many private landowners, both large and small, are reluctant to allow.

Prioritization of roads sediment reduction, rehabilitation, and decommissioning projects should be deferred to the implementing agencies that have conducted a systematic road sediment source inventory and/or analysis. Consistent with the Trinity River TMDL, further prioritization should be placed on those projects within the Upper Middle Trinity River Watershed. These projects should be implemented and coordinated on a basin-wide scale through the TCRCD currently serving as the Trinity River Watershed Coordinator.

<u>The Action Plan for Restoration of the South Fork Trinity River Watershed and its Fisheries</u> was prepared by Pacific Watershed and Associates in 1994 for the South Fork Trinity River Coordinated Resources Management Plan (SFTR CRMP), with funding by

the TRRP. The SFTR CRMP is a stakeholders' group consisting primarily of representatives of landowners, land managers, conservation groups, local, state, and federal agencies, and other interested members of the public. The U.S. Forest Service (USFS) South Fork Management Unit (SFMU) and the TCRCD have been effectively targeting sediment reduction and upslope restoration projects in the South Fork Watershed under the Action Plan. The USFS SFMU has completed 63 upslope restoration projects in the SFMU and as detailed above; the TCRCD has also completed an impressive program of work in the watershed. NRCS has targeted restoration activities on private lands in the South Fork through its Environmental Quality Incentives Program (EQIP) program. These entities should continue to work towards the 30% reduction of sediment input as recommended in the US EPA's SFTR TMDL. Adherence to the Watershed Component of the Trinity ROD should assist in the delegation and prioritization of watersheds and projects to these entities and their current work plans as well as the TMDL implementation plans.

The current rate of project implementation in the South Fork and other watersheds downstream of the North Fork confluence is limited due to available staffing and infrastructure. There is a reluctance of the Trinity River Restoration Program to fund projects in the SFTR Watershed due to a recent interpretation by the Bureau of Reclamation of a 1998 Interior Solicitor's Opinion on use of TRRP funds. Reclamation's position is that projects in most tributaries and watersheds, particularly those downstream of the North Fork confluence (including, but not limited to, the South Fork), do not have a "causal link" to the Trinity River Division of the CVP, and are therefore ineligible for funding through Reclamation. Trinity County disagrees with Reclamation's interpretation of the Solicitor's Opinion and believes there is a causal linkage to restoration activities in the South Fork and other watersheds and tributaries of the Trinity River, even if they might not be as high of a priority as other similar projects upstream of the North Fork closer to Lewiston Dam (Stokely, 2003).

Nonetheless, the TCRCD was recently awarded a contract through the Trinity River Basin Fish and Wildlife Restoration Grant Program, funded through the Bureau of Reclamation and administered by Trinity County. Under this agreement, TCRCD will provide local expertise to coordinate watershed restoration efforts in the tributaries of the Trinity River Watershed under the framework and direction of the Trinity River ROD. This project includes providing a liaison between the US Forest Service and the Trinity River Restoration Program in the development of a Rush Creek Watershed Analysis, assistance in development of a Trinity River Watershed Restoration Strategic Plan, providing education and outreach to landowners and stakeholders in the watershed about restoration needs and methods in the tributaries, coordinating with public and private landowners in providing technical advice and developing and prioritizing watershed restoration needs, and the ability to track and secure significant matching grant funding to implement these restoration projects, which will improve fishery habitat in the Trinity River downstream of Lewiston Dam.

As discussed in Section 2.1 of the Trinity River Mainstem Fishery Restoration Draft EIS/EIR (1999), the SFTR CRMP, GVC watershed restoration, enforcement of Trinity County's Decomposed Granite Grading Ordinance, and related sediment reduction efforts are ongoing and part of the No Action Alternative. As discussed in Section 4.1 (Cumulative Effects) of the Draft EIS/EIR (1999), the Five Counties Salmonid Conservation Program (5C), the USEPA's Trinity River and SFTR TMDL's, the Lower Klamath River Partnership and changes to California Forest Practice Rules are ongoing related projects to reduce fine sediment inputs to the Trinity River mainstem and its tributaries.

Upslope restoration is a high priority restoration type. Upslope restoration project limiting factors include available funding, staffing and infrastructure. Projects on private lands are limited by access, funding and landowner cooperation. Projects should be coordinated on a basin-wide scale through the Trinity River Watershed Coordination Effort by TCRCD.

Fish Passage Improvement

Fish Passage Improvement restoration types include the removal of structures impeding the migration of anadromous and resident fish species. This restoration type also includes the construction of fish passage structures such as fish ladders and baffles. Restoration is aimed at improving the movement of fish migration to suitable spawning and rearing habitat within the Trinity River and its tributaries. Natural and constructed structures that may impede fish passage include culverts, dams, step-pool systems, large woody debris, and/or waterfalls (Oregon watershed Enhancement Board, 1999; U.S Army Corp of Engineers, 2003).

Permanent barriers to fish movement in the Trinity Basin have resulted in habitat fragmentation and a vast reduction of available habitat for spawning and rearing. Other effects of barriers may include increased levels of sedimentation and predation, alteration of stream flows, degradation of stream channels, depletion of riparian areas, modification of water temperature regimes, and loss of habitat diversity and complexity. Barriers can also impair sediment transport, thereby diminishing the replenishment of beneficial sediment (spawning gravel). The cumulative effects of large numbers of these structures within the watershed pose significant risk to the recovery and long-term viability of salmon and steelhead populations and limit the ability to reach the restoration goals of the P.L. 989-541.

Fish Passage Improvement Projects have mainly been focused in the South Fork Trinity and Upper Middle Trinity River Watersheds. According to the Database of Trinity River restoration activities, 69 fish passage improvements have already been implemented. Many barriers within the basin have been identified, and are cited in the California Coastal Conservancy's recently published report, "Inventory of Barriers to Fish Passage in California's Coastal Watershed". The Five Counties Salmonid Conservation Program (5C) has completed a County road inventory, identifying and prioritizing 58 barriers in Trinity County (46 in the Trinity River watershed). 5C has implemented two of these projects within the watershed, with three more slated for construction in 2004. The 5C Program has restored over 100 miles of salmonid habitat within the entire 5C program area (includes areas outside of the Trinity River basin). The USFS Hayfork Ranger District currently has four projects planned for implementation in the South Fork Basin, and the USFS Weaverville has identified priority projects within its district. In addition, the Trinity County RCD and NRCS continue to work with cooperative landowners to remove barriers to fish passage on private lands**.**

The greatest limiting factors to implementation of these projects are often the extensive, sometimes controversial and lengthy permitting processes, lack of available funding and adequate staffing, landowner cooperation, and high costs associated with full implementation. Costs are in the range of $250,000 per project or more on public roads.

Fish Passage improvement projects can provide measurable benefits in the restoration of salmon and steelhead populations in the tributaries of the Trinity River Basin. The Implementation Plan for the Trinity River ROD calls for a four fold increase in habitat in the mainstem Trinity River. The implementation of fish passage improvement projects on mainstem tributaries can be important in meeting this goal. For example, Trinity County's 3 planned projects for 2004 are all located relatively close to their respective confluences with the mainstem Trinity River. These projects alone will restore access to almost 13 miles of salmonid habitat in tributaries of the Trinity River. However, the combined cost of these projects amounts to approximately $650,000. These projects should be coordinated through an inter-agency effort on a basin-wide scale. **In the context of the Watershed and Tributary Restoration Component of the SEIS/EIR, fish passage improvement projects have a high priority.**

Instream Habitat Improvement

Instream habitat restoration types include activities such as mechanical alterations and coarse sediment augmentations. Restoration is aimed at improving fish habitat. Mechanical restoration includes the removal/improvement/installment of weirs (log, boulder, and/or cement), large woody debris, root wads, boulders, step-pool systems, channel excavation (i.e., dredging) and other alterations that enhance diversity of instream refugia (Oregon watershed Enhancement Board, 1999; U.S Army Corp of Engineers, 2003). Sediment augmentation introduces coarse sediment into the stream channel to create diverse habitats for spawning (Oregon watershed Enhancement Board, 1999). These restoration activities are categorized as Instream Habitat Improvement restoration types based on a common goal of increasing in-channel fish habitat.

Instream restoration projects have primarily been implemented in the South Fork Trinity River and Upper Middle Trinity River Watersheds. Instream habitat improvement projects are often necessary in lower gradient stream systems, many of which have been simplified due to the cumulative effects of historic mining and different land use activities such as logging. Large woody debris and boulder placement can be beneficial at these locations. However, the poor habitat conditions typically warranting instream habitat improvement projects are often a result of excessive sediment input and/or upslope watershed disturbance. In recent years it has often been recognized that upslope restoration projects tend to be more beneficial than instream projects. Instream projects often fail to control the source of the problem in terms of upslope sediment input.

Further, many of the tributaries within the Trinity River Basin are higher gradient streams in which instream habitat improvement projects are inappropriate and ineffective. Due to their failure to treat causative factors, these projects are often short-term and temporary. **These projects will be analyzed as medium priority in the context of the Watershed and Tributary Restoration Component of the SEIS/EIR.**

Riparian Habitat Improvement

Riparian habitat restoration types include streambank stabilization, managing livestock by fencing off portions of the riparian habitat and/or creating a buffer zone between farmland and stream systems (Oregon Watershed Enhancement Board, 1999). Streambank stabilization, which is aimed at improving riparian habitat and water quality, can include using riprap, boulders, cement, vegetation, bio-enhancement, and/or regrading bank slope (U.S Army Corp of Engineers, 2003). Eradication of exotic species, such as scotch broom, can also be a beneficial riparian habitat improvement project. These restoration activities are categorized as Riparian Habitat Improvement based on the common goal of enhancing riparian habitat and water quality.

Stream buffer zone and riparian fencing projects have mainly been implemented by private landowners throughout the South Fork watershed with assistance from TCRCD and NRCS. Further riparian habitat improvement projects of this type are limited by landowner cooperation and available funding. Federal riparian lands are specifically managed for objectives identified under the Northwest Forest Plan, including Riparian Reserve Allocations. Stream bank stabilization projects are not a common need on a basin wide scale; however, they can be very beneficial in discrete locations. Unstable stream banks are often a result of excessive upstream sediment loads or poor adjacent land uses practices (e.g., cattle grazing or roads on steep/unstable streambanks**). As a result of these factors, riparian habitat improvement activities will carry a medium priority for SEIS/EIR analysis purposes.**

Water Conservation: Improving Water Supply (Quantity/Quality)

Water right acquisition and water conservation activities are examples of water supply "restoration types" that can improve water quality. Restoration is aimed at improving water quantity and quality. Water acquisition includes buying instream water rights or senior water rights from private property owners (Oregon Watershed Enhancement Board, 1999). Water conservation includes efficient changes in irrigation methods and domestic water use (ditch lining, pipe replacement, drip system, and/or removal of water diversions) (U.S Army Corp of Engineers, 2003). Acquisition and water conservation activities are categorized under Water Conservation: Improving Water Supply (Quantity/Quality) because of the common goal of improving water quantity and quality.

Through water conservation, water quantity and quality in tributaries can be improved and managed to help provide the elements necessary to support and restore fisheries throughout the basin. During periods of warm weather, salmonids are often found at or in refugia areas created by cold-water flows from various tributaries into larger streams such as the mainstem Trinity River or lower Klamath River. However, it is not expected that improved cold-water flows from tributaries would be able to decrease mainstem water temperatures significantly, except at their immediate confluence with the mainstem.

Most water conservation projects have been implemented by private landowners within the South Fork Trinity River Watershed through the Trinity County RCD and the NRCS. In several of the smaller watersheds, increased instream flows through water right acquisition and water conservation have helped to provide suitable water temperatures, volumes and velocities for fish habitats. In some cases, these projects have also eliminated fish passage barriers by elimination of instream diversion structures. However, most of the feasible, beneficial projects of this type have been completed. Further implementation is limited by landowner cooperation and funding. Because of concerns with water rights, these projects are not easy for some of the local major landowners/diverters to accept. In terms of augmenting water releases from Lewiston Dam, it is not expected that water conservation will have a significant effect because water diversions are considered small in relation to mainstem flows (0.5-15 cfs, compared to 300-11,000 cfs). **In context of the analysis of a Watershed and Tributary Component of the SEIS/EIR, water conservation projects play a small role and are a medium priority**.

Land Conservation

Land conservation "restoration types" include the acquisition of the fee title or conservation easements of private property.

Public ownership and legal access to lands surrounding tributaries allows for management activities consistent with watershed and tributary restoration riparian reserve allocations and Wild and Scenic River Corridor Criteria. Land Conservation restoration types allow implementing agencies to have the ability to better control sediment sources from lands located in tributaries or to increase protection of private lands through incentives. Floodplain-prone lands along the Trinity River mainstem may also be appropriate for acquisition and/or conservation easements to limit further development in the floodplain.

Land acquisition can provide opportunities for restoration. For example, in the late 1980s and early 1990s, the Trinity River Task Force had become convinced that commercial timber harvesting on highly erosive decomposed granite soils, such as those in Grass Valley Creek, was incompatible with the goals of the restoration program. As a result, some 17,000 acres overlying this erosive formation in the GVC watershed was purchased in 1993 from Champion International. The Bureau of Land Management is now managing the land for purposes other than timber harvest. Since the land purchase, NRCS and the Trinity County Resource Conservation District (TCRCD) have implemented a major watershed restoration effort. The change in land use alone resulted in a significant reduction in discharge of decomposed granite into GVC and the Trinity River.

Approximately 1.58 million acres of the Trinity River watershed (83% of area) are already under Tribal, local, state or federal ownership/management. The Six Rivers and Shasta-Trinity National Forests, and the Bureau of Land Management account for the vast majority of public land management. Almost half of the public lands, 700,000 acres (37% of the watershed area), are within federally designated Wilderness areas or inventoried roadless areas. Additional public lands are within the Wild and Scenic River corridor and/or designated Late Seral Reserves with limited road management or development activities. It is not anticipated that significant land or easement acquisitions would be incorporated into an overall restoration plan for the Trinity River, as remaining private lands are not expected to significantly come into public ownership. **As a result of these factors, land conservation programs will carry a low priority for SEIS/EIR analysis purposes.**

Conclusions

Due to limiting factors such as inadequate funding, limited landowner cooperation, limited staffing, permitting, and low cost-efficiency, the current rate of restoration project implementation for many of the water conservation, land acquisition, instream improvement, and riparian improvement project types cannot be significantly accelerated under existing conditions. However, with increased funding and coordination, as well as additional prioritization, upslope restoration and fish passage improvement projects within the watersheds could be accelerated, particularly on public lands. Agencies should continue to focus on these restoration types. Projects should be prioritized and coordinated on a basin-wide scale regardless of the implementation agency.

As stated in the Trinity River TMDL, upslope restoration and sediment reduction projects should be focused in the Upper Middle Trinity River Watershed and specifically in the Indian Creek sub-basin. Rush Creek, Weaver Creek, and Brown’s Creek are also high priority areas in terms of sediment reduction. In the South Fork Basin, load reductions should be more aggressively targeted, particularly with management activity, in the western portion of the South Fork basin, where road/stream interactions are more problematic and terrain is more susceptible to landsliding. Sediment source inventory data should continue to be used in the prioritization of projects.

Fish passage improvement projects are generally prioritized according to habitat quality and quantity, the extent of the barrier, and species diversity. Further prioritization results from factors including cost-effectiveness, permitting complexity, landowner cooperation, and coordination with other capital improvement projects. Although the costs of such projects can sometimes seem prohibitive, cost-effectiveness is generally very high in terms of habitat restored. Project prioritization should defer to implementing agencies but should be coordinated through the Trinity River Watershed coordination effort by TCRCD using TRRP funding.

Fish passage and upslope watershed restoration efforts throughout the Trinity River basin downstream of Lewiston Dam could potentially receive increased funding if interpretation of the 1998 Interior Solicitor's Opinion became less restrictive in terms of spending federal appropriations to the Bureau of Reclamation, including TRRP funds and the Central Valley Project Improvement Act Restoration Fund.

List of Ongoing and Planned Watershed and Tributary Projects:

Trinity County/5C-

Soldier Creek Fish Passage
Roundy Road Fish Passage (Little Browns Creek)
Deadwood Creek Fish Passage
Deadwood Creek sediment reduction
Hoadley Gulch (Lewiston Turnpike Rd) sediment reduction
Big Creek sediment reduction

Trinity County RCD-

-Watershed Coordination (includes small demonstration project for fine sediment, as yet undetermined)
-Watershed Coordination upstream of Trinity Dam (funded by SWRCB) –outside of geographic scope
-Upper Trinity River Basin Road Inventory (USFWS Jobs in the Woods)- outside of geographic scope
-GVC Watershed Restoration- (BLM Jobs in the Woods)
Hamilton Ponds Dredging
-319(H) Sediment Reduction in SFTR ($450,000 over 3 years), mostly implementation, some effectiveness monitoring
-RAC ($55,000) as match for 319H
-Lower Little Creek/SFTR Road Decommissioning (USFS $80,000)
-Road Inventory of all BLM in Trinity River Mainstem Watershed
-Packer's Creek Erosion Control

Natural Resource Conservation District (EQIP)- (disclosure of project location prohibited by federal law (Sec 2004 of the Farm Security and Rural Investment Act of 2002))

One water conservation
Two riparian enhancement
4 Road/sediment reduction

U.S. Forest Service

Tule Creek Fish Passage (3 sites)
Soldier Creek Fish Passage (upstream of Trinity Co. site)
Packers Creek Fish Passage

Sediment Reduction-Road Maintenance/Decommissioning:

Road	Watershed	Area	Rx
28N50 from 30 road Int. to D Spur	Upper So Fork	Wilcox	Maint
28N52	Upper So Fork	Wilcox	Maint
Non System 1	Upper So Fork	Wilcox	Decom
29N62C	East Fork/Smoky		Decom
29N74	East Fork/Smoky		Decom
28N50D	Upper So Fork	Wilcox	Decom
2N37	Butter Creek		Decom
2N37A	Butter Creek		Decom
2N34	Butter Creek		Decom
2N10K	Butter Creek		Decom
32N30A	Lower Hayfork	Lower Little	Decom
32N30B	Lower Hayfork	Lower Little	Decom
4N08A	Lower Hayfork	Lower Little	Decom
28N83	Upper So Fork		Decom

Yurok Tribe/Lower Klamath River Partnership-

-McGarvey Creek Watershed Restoration (road decommissioning)

-Pularvasar Cr. Watershed Restoration (road decommissioning)

-Roach Creek Watershed Assessment

Supplemental 2003 Fall Fishery Flows
Technical Appendix F

Supplemental 2003 Fall Fishery Flows

In a March 5, 2003 court hearing, Judge Oliver Wanger directed the Department of the Interior to determine what actions would be necessary to "assure against the risk of fish losses that occurred late in the season last year." Judge Wanger subsequently issued a ruling on April 4, 2003 allowing Reclamation to use an additional 50,000 af from the Trinity River Division of the Central Valley Project "at its reasonable discretion" to prevent a recurrence of the September 2002 fish die-off.

In fall of 2003 an Action Plan was developed that recommended increased Trinity River flows to reduce the likelihood, and potentially reduce the severity, of a fish die-off occurring during the fall run Chinook salmon migration. The Action Plan provided flows known to be adequate for unimpaired salmon migration through the lower Klamath River. It was expected that increasing flows would reduce or eliminate adverse in-river conditions that contributed to the adult fish die-off of 2002.

An initial presentation of increased late-summer Trinity River dam release options and request for written comments was given at the TMC meeting on June 26, 2003. Written comments were received through July 18, 2003. A technical workgroup of state, federal, and tribal biologists was convened on July 23 and 24, 2003, to consider comments received and evaluate alternatives. That group developed a revised alternative, the Action Plan Flows option, that addresses these concerns. Additional updates were provided to a broadly representative group of stakeholders on July 29, 2003, at a TAMWG meeting in Weaverville, California, and a TMC conference call on

July 30, 2003. A letter of support for the proposed action was forwarded directly to the Secretary of the Interior from the TMC and TAMWG in a letter dated August 8, 2003.

The need for implementing the Action Plan was both biological and legal in nature. In 2002, low flow conditions in the lower Klamath River, warm water temperatures, and an above average fall run Chinook salmon escapement combined to create conditions favorable to an epizootic outbreak resulting in a fish die-off. Biological consequences of a die-off in two consecutive years would substantially impact present efforts to restore the native Trinity River anadromous fish community and fishery. Reductions in the Trinity River fish population would also affect Tribal fishery harvest opportunities, ocean harvest levels, recreational fishing, as well as public perception and recovery mandates. Last year's loss of 3 year-old and a potential loss of 4 year-old fish from the 1999 brood year affect the population structure, and may impede recovery goals authorized by the Trinity River Division Central Valley Project Act of 1955 (P.L. 84-386), the Trinity River Basin Fish and Wildlife Act of 1984 (P.L. 98-541), and the Central Valley Project Improvement Act of 1992 (P.L. 102-575), for naturally produced fall run Chinook salmon.

Projected flow conditions and a large fall run Chinook salmon escapement on the lower Klamath River in 2003 were similar to conditions that existed during the die-off in 2002. The two triggers established for initiating the preventive flow release (low flow and a large return of fall run Chinook salmon) were met as of August 20, 2003. Therefore, Reclamation implemented the release schedule proposed in the Action Plan as a preventative means to reduce the likelihood of another fish die-off in 2003.

Methods

The Action Plan used a conservative risk management approach to avert another fish die-off in 2003. The Action Plan had two flow components. The first component was a preventative flow release, using 33,000 acre-ft (af) of water. The preventative flow was intended to reduce the likelihood of a large scale fish die-off by ensuring adequate conditions for adult upstream migration though the lower Klamath River. The second component was an emergency response flow release, using an additional 17,000 af of water. This flow would be implemented to decrease the severity of a fish die-off if real-time monitoring indicated a rapid spread of the incidence and severity of the disease Ich.

Implementing components of the Action Plan were dependant on separate triggers for initiating preventive and emergency response flow releases. Triggers for initiating the preventive flow release were: (1) a fall run Chinook salmon population size estimate of greater than 110,000 for the Klamath Basin, and (2) a flow of less than 3,000 cfs in the lower Klamath River. Triggers for initiating the emergency response flow release would have been an estimated doubling in less than 7 days of either the incidence (proportion of fish infected) or severity (number of parasites per gill) of Ich. Evaluation of emergency action triggers were based on real-time monitoring of disease incidence conducted by the U.S. Fish & Wildlife Service, Fish Health Center, the Yurok Tribe, the Karuk Tribe and California Department of Fish & Game.

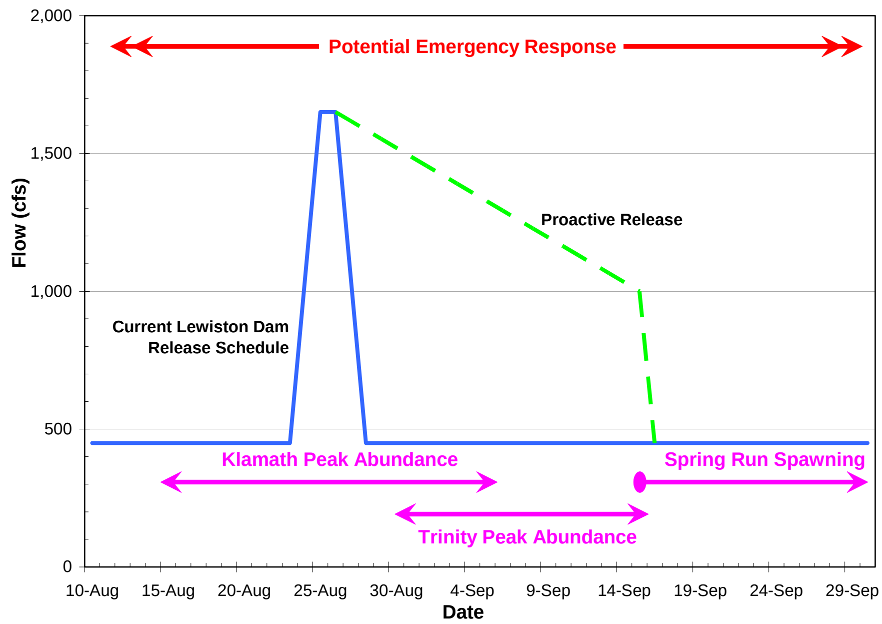


Figure 1. Daily Flow Schedule for Preventative Component of Action Plan.

Existing monitoring programs managed by the U.S. Fish & Wildlife Service, California Department of Fish & Game, the Hoopa Valley Tribe, the Yurok Tribe and the Karuk Tribe assessed the physical and biological effects associated with the Action Plan. Monitoring activities included weir counts, carcass and redd surveys, water temperature, water quality, angler and tribal harvest rates and adult salmon radio tracking, as well as disease incidence and severity from the real-time monitoring used as the trigger for the emergency action component of the Action Plan. Refugia dives and float surveys upstream of the Trinity River confluence were also conducted to evaluate the possibility of unintended effects on Klamath mainstem migrating adults.

Results

Results reported in this memo are preliminary and have not been peer reviewed for consistency with other findings and are subject to revision.

Figures 2, and 3 summarize results of key monitoring to assess effectiveness of the Action Plan release schedule. Additional information on run timing and migration patterns from weir operation, angler and tribal harvest and radio tracking studies is currently being prepared and will be reported in subsequent revisions of this memo.

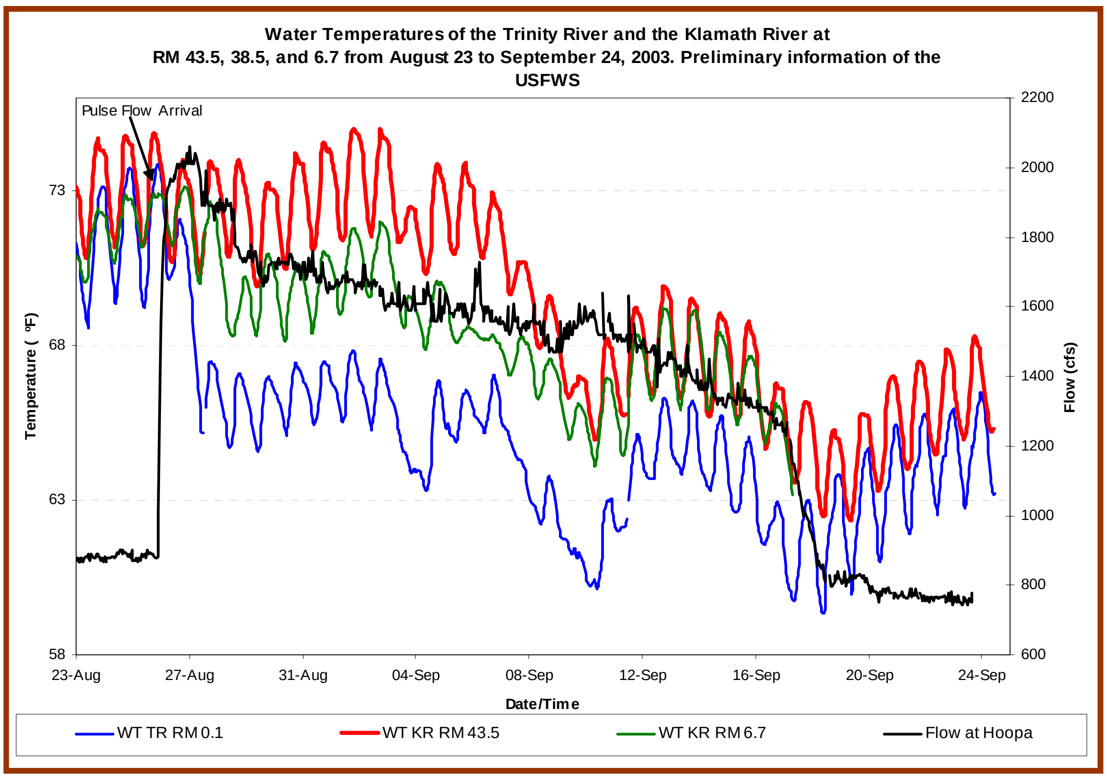


Figure 2. Trinity River flows reduce lower Klamath River water temperatures during the preventative action release schedule. River flow at Hoopa (black) during the fall of 2003, water temperature for the lower Trinity River near Hoopa (blue), Klamath River above Weitchpec (red) and lower Klamath River below the Trinity River confluence (green). Water temperatures above 71.6F inhibit adult Klamath Basin Chinook salmon migration. Preliminary data from Paul Zedonis, Fish & Wildlife Service, Arcata Field Office.

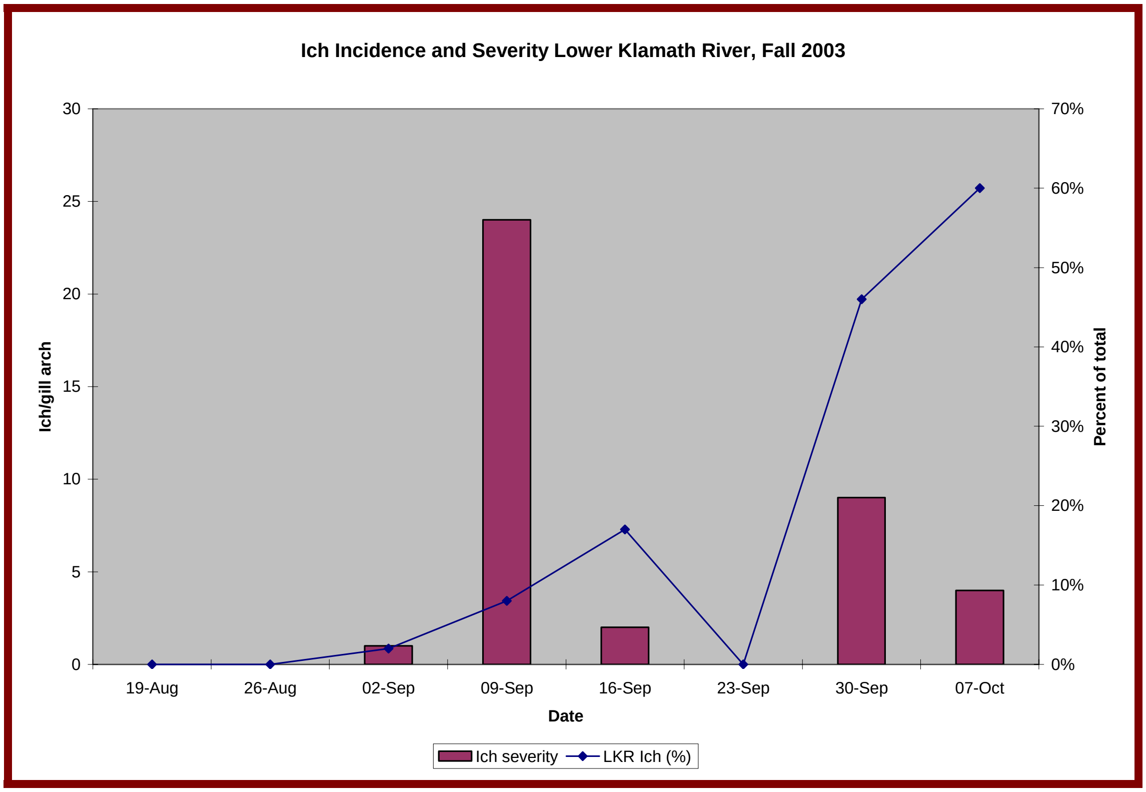


Figure 3. Incidence and severity of Ich (*Ichthyophthirius multifiliis*) on fall run Chinook salmon in the lower Klamath River during the fall of 2003. Disease incidence is reported as proportion of sampled fish with parasites (blue line). Severity is reported as the number of parasites per gill arch (red bars). Standard deviations not reported. Low value for incidence on 23 September is due to low sample size (n=10). Severity values greater than 30 parasites /gill arch is considered to a lower threshold for notable physiological stress. Preliminary data from Scott Foott, Fish & Wildlife Service, Fish Health Center, Red Bluff, Ca.

In addition, two preliminary conclusions from radio tracking studies to understand use of thermal refugia by adult Chinook salmon are relevant to the Trinity River fall flows (Josh Strange, University of Washington pers. com.).

- temperatures above 22C (71.6F) inhibit adult Chinook salmon migration and
- Fish die-off prevention flows from Trinity Dam substantially lowered temperatures in the lower Trinity and Klamath Rivers. During these higher flows thermal refugia use and migration delays were minimal among tagged Chinook salmon.

Conclusions

Monitoring results indicate that implementing the 2003 Trinity River Fall Flows Action Plan was successful in reducing the risk of a major die-off event. No observations of significant adult mortality were noted and the preventative flow schedule maintained water temperatures and flow magnitudes known to provide adequate fish migration in the lower Klamath River, specifically water temperatures were kept below 22C and flows near Klamath, Ca. (Terwar gage) greater than 3000 cfs.

Fall run Chinook salmon migration was unimpeded. Radio tracking of tagged fish demonstrated that migration delays were minimal. Congregations of large numbers of fish at known thermal refugia areas and below critical riffles and rapids were not noted by divers. Observations of fish above the confluence of the Trinity River did not note any negative migration, or health effects to Klamath mainstem Chinook salmon due to these artificially increased flows.

Emergency response flows were not called for although monitoring revealed disease incidence increased throughout the sample period and a doubling did occur. Incidence of Ich did not exceed 20% (10% was assumed to be an acceptable background value) until late September by this time the majority of the fish had migrated out of the lower Klamath and monitoring indicated that disease severity was kept at a low level and therefore did not pose a threat to the physiological health of infected fish.

Spring run Chinook salmon spawning was not affected in the upper Trinity River by the preventative flow schedule. Weekly redd counts in the Trinity River immediately below Lewiston Dam indicate that minimal spawning occurred before September 15, 2003. Lewiston Dam releases returned to the normal (450 cfs) on September 16, 2003. Those redds noted were not threatened by de-watering following flow reductions. Anecdotal reports indicate that fish condition was excellent throughout the run (Loren Everest, Forest Service, Trinity River Management Unit pers. com.).

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