YUROK TRIBE

Water Year 2004 (WY04) Report
October 1, 2003– September 30, 2004
FINAL

December 2005

Yurok Tribe Environmental Program
PO Box 1027, Klamath, California 95548

Kevin McKernan, Director
Lori McKinnon, Assistant Director
Ken Fetcho, Assistant Director
Eric Brunton, Hydrologist
Laura Mayo, Jessica Hackman, Monica Hiner, Environmental Coordinators
Micah Gibson, Environmental Technician
Seafha Blount, Environmental Intern

Acknowledgements

YTEP would like to acknowledge those who assisted in the collection of water quality data in 2004. Funding was provided by United States Environmental Protection Agency. Technical assistance was provided by the Yurok Tribe Fisheries Program. Technical and logistical support was provided by the United States Fish and Wildlife Service. In particular, Paul Zedonis and Randy Turner were extremely helpful in sampling protocol development, data collection and database management. Others that were imperative to the success of the 2004 monitoring project include North Coast Regional Water Quality Control Board staff Matt St. John, Rich Fadness, and Bruce Gwynn. Appreciation is also extended to Mike Deas and staff from Watercourse Engineering Inc. who coordinated with YTEP on an algae sampling event in August and graciously shared data from the Weitchpec site.

1 Table of Contents

Acknowledgements *2*

1 Table of Contents *3*

2 Table of Figures *8*

3 Table of Tables *10*

4 Introduction *12*

5 Background *13*

5.1 Klamath River **13**

5.2 The Yurok Indian Reservation **13**

5.3 The Klamath River Watershed **15**

6 Yurok Tribe Water Monitoring Division *17*

7 Quality Assurance *18*

8 Site Selection *23*

8.1 Water Quality **26**

8.1.1 Mainstem 26

8.1.2 Tributaries 27

8.2 Hydrologic Monitoring **27**

8.3 Macroinvertebrate Sampling **28**

8.3.1 Mainstem 28

8.3.2 Tributaries 28

8.4 Herbicide Monitoring **29**

8.5 Notchko Remote Automated Weather Station **30**

9 Methods *60*

9.1 Water Quality Monitoring **60**

9.1.1 Mainstem 60

9.1.2 Tributaries 63

9.2 Hydrologic Monitoring **65**

9.3 Macroinvertebrate Sampling **65**

9.4 Herbicide Monitoring **67**

9.5 Notchko Remote Automated Weather Station **68**

10 Results *69*

10.1 Water Quality (Mainstem) **69**

10.1.1 Klamath River above Trinity River (Weitchpec) 69

10.1.1.1 Temperature 69

10.1.1.2 Dissolved Oxygen 71

10.1.1.3 pH 72

10.1.1.4 Specific Conductivity 72

10.1.2 Trinity River above Klamath River 73

10.1.2.1 Temperature 73
10.1.2.2 Dissolved Oxygen 75
10.1.2.3 pH 76
10.1.2.4 Specific Conductivity 76
10.1.3 Klamath River above Tully Creek 77
10.1.3.1 Temperature 77
10.1.3.2 Dissolved Oxygen 79
10.1.3.3 pH 80
10.1.3.4 Specific Conductivity 80
10.1.4 Klamath River above Blue Creek – 7 Meters Deep 81
10.1.4.1 Temperature 81
10.1.4.2 Dissolved Oxygen 83
10.1.4.3 pH 84
10.1.4.4 Specific Conductivity 84
10.1.5 Klamath River at Turwar Gage 85
10.1.5.1 Temperature 85
10.1.5.2 Dissolved Oxygen 87
10.1.5.3 pH 88
10.1.5.4 Specific Conductivity 88
10.1.6 Multi-Site Comparisons 89
10.1.6.1 Comparison: Daily Maximum Water Temperatures across All Riverine Sites Sampled for WY04 89
10.1.6.2 Comparison: Impacts of the Trinity River on Temperature in the Mainstem Klamath River: Klamath River Above the Trinity River as compared with Klamath River Above Tully Creek 90
10.1.6.3 Comparison: Impacts of the Trinity River on Dissolved Oxygen in the Mainstem Klamath River: Klamath River Above the Trinity River as compared with Klamath River Above Tully Creek 91
10.1.7 Special Studies – 92
10.1.7.1 Klamath River Macroinvertebrate Sampling August 2004 92
10.1.7.2 Klamath River Benthic Algae Sampling June – September 96
10.1.7.3 Klamath River Estuary Water Quality Monitoring June - September 102
10.1.7.3.1 Klamath River Upper Estuary 102
10.1.7.3.2 Klamath River Middle Estuary 104
10.1.7.3.3 Klamath River Lower Estuary 106
10.1.8 Mainstem Grab Samples 108
10.1.8.1 Nutrients 108
10.1.8.2 Other Analytes 110
10.1.8.3 Bacteria Analytes 113

10.2 Water Quality and Hydrology (Tributaries) 114
10.2.1 McGarvey Creek 114
10.2.1.1 Discharge 115
10.2.1.2 Turbidity and Specific Conductivity 118
10.2.1.3 Water Temperature 118
10.2.1.4 Suspended Sediment 119
10.2.2 Den Creek 119
10.2.2.1 Discharge 119
10.2.3 Blue Creek 119
10.2.3.1 Discharge 120

10.2.3.2 Turbidity and Specific Conductivity 124
10.2.3.3 Water Temperature 125
10.2.3.4 Suspended Sediment 125
10.2.4 Turwar Creek 125
10.2.4.1 Discharge 126
10.2.4.2 Turbidity 130
10.2.4.3 Water Temperature 130
10.2.4.4 Suspended Sediment 131

10.3 Macroinvertebrate Sampling 131

10.4 Herbicide Monitoring 134

10.5 Notchko RAWS Rainfall Data 135

11 Discussion 138

11.1 Water Quality (Mainstem) 138
11.1.1 Temperature 138
11.1.1.1 Water Temperature – All Riverine Sites 138
11.1.1.2 Klamath River above Trinity River (WE) 138
11.1.1.3 Trinity River above Klamath River (TR) 139
11.1.1.4 Klamath River above Tully Creek 140
11.1.1.5 Klamath River above Blue Creek – 7 meters deep 140
11.1.1.6 Klamath River at Turwar Gage 141
11.1.2 Dissolved Oxygen 141
11.1.2.1 Dissolved Oxygen – All Riverine Sites 141
11.1.2.2 Klamath River above Trinity River 142
11.1.2.3 Trinity River above Klamath River 142
11.1.2.4 Klamath River above Tully Creek 143
11.1.2.5 Klamath River above Blue Creek- 7 meters Deep 143
11.1.2.6 Klamath River at Turwar Gage 143
11.1.3 pH 144
11.1.3.1 Klamath River above Trinity River 144
11.1.3.2 Trinity River above Klamath River 144
11.1.3.3 Klamath River above Tully Creek 144
11.1.3.4 Klamath River above Blue Creek – 7 meters Deep 144
11.1.3.5 Klamath River at Turwar Gage 145
11.1.4 Specific Conductivity 145
11.1.4.1 Specific Conductivity – All Sites 145
11.1.4.2 Klamath River above Trinity River 146
11.1.4.3 Trinity River above Klamath River 146
11.1.4.4 Klamath River above Tully Creek 146
11.1.4.5 Klamath River above Blue Creek 147
11.1.4.6 Klamath River at Turwar Gage 147
11.1.5 Multi-Site Comparisons 148
11.1.5.1 Maximum Water Temperatures – All Riverine Sites 148
11.1.5.2 Impacts of the Trinity River on Temperature in the Mainstem Klamath River 148
11.1.5.3 Impacts of the Trinity River on Dissolved Oxygen in the Mainstem Klamath River 149
11.1.6 Special Studies 149
11.1.6.1 Mainstem Macroinvertebrate Sampling – August 149

11.1.6.2 Klamath River Benthic Algae Sampling June – September 150
11.1.6.3 Klamath River Estuary Water Quality Monitoring June – September, 2004 153
11.1.6.3.1 Water Temperature - Klamath River Upper Estuary 153
11.1.6.3.2 Dissolved Oxygen - Klamath River Upper Estuary 153
11.1.6.3.3 pH - Klamath River Upper Estuary 154
11.1.6.3.4 Salinity - Klamath River Upper Estuary 154
11.1.6.3.5 Water Temperature - Klamath River Middle Estuary Surface and Depth 154
11.1.6.3.6 Dissolved Oxygen - Klamath River Middle Estuary Surface and Depth 155
11.1.6.3.7 pH - Klamath River Middle Estuary Surface and Depth 155
11.1.6.3.8 Salinity - Klamath River Middle Estuary Surface and Depth 156
11.1.6.3.9 Water Temperature - Klamath River Lower Estuary Surface and Depth 157
11.1.6.3.10 Dissolved Oxygen - Klamath River Lower Estuary Surface and Depth 157
11.1.6.3.11 pH - Klamath River Lower Estuary Surface and depth 158
11.1.6.3.12 Salinity - Klamath River Lower Estuary Surface and Depth 158
11.1.7 Grab Samples 159
11.1.7.1 Mainstem Grab Samples 159
11.1.7.1.1 Nutrient Grab Samples-All Sites 159
11.1.7.1.2 Minerals-All Sites 161
11.1.7.1.3 Bacteria-All sites 161
11.1.7.1.4 Other Analytes-All Sites 161

11.2 Water Quality and Hydrology (Tributaries) 162
11.2.1 McGarvey Creek 162
11.2.1.1 Discharge 162
11.2.1.2 Turbidity 163
11.2.1.3 Water Temperature 163
11.2.1.4 Specific Conductivity 164
11.2.1.5 Suspended Sediment 164
11.2.2 Blue Creek 164
11.2.2.1 Discharge 164
11.2.2.2 Turbidity 165
11.2.2.3 Water Temperature 165
11.2.2.4 Specific Conductivity 165
11.2.2.5 Suspended Sediment 165
11.2.3 Turwar Creek 166
11.2.3.1 Discharge 166
11.2.3.2 Turbidity 166
11.2.3.3 Water Temperature 167
11.2.3.4 Suspended Sediment 167

11.3 Macroinvertebrate Sampling 167
11.3.1 **Metric rankings** 169
11.3.1.1 West Fork Pecwan Creek 170
11.3.1.2 Roaches Creek 170
11.3.1.3 East Fork Pecwan Creek 170
11.3.1.4 Mettah Creek 171
11.3.1.5 McGarvey Creek 171
11.3.1.6 Tully Creek 171
11.3.1.7 Turwar Creek 171
11.3.1.8 Blue Creek 171

11.4 Herbicide Monitoring **172**
11.5 Notchko Weather Station **172**
12 Cooperation with Outside Agencies ***173***
13 References ***174***
Arcata Fish and Wildlife Service's 2004 Multiprobe Maintenance and Deployment Protocol. **178**
Grab Samples ***187***
Attaching the Flow Meter to the Wading Rod ***199***
Attaching the AquaCalc to the Wading Rod ***199***
Field Testing the Instrumentation ***199***
Spin Testing the Flow Meter **199**
Meter Normal Spin Minimum Spin ***199***
Measuring stream discharge across a transect ***200***

2 Table of Figures

Figure 5-1 The Yurok Indian Reservation and Yurok Ancestral Territory 14
Figure 5-2 Klamath River Basin Map illustrating major tributaries and dam locations....16
Figure 8-1 YTEP lower Klamath Basin Monitoring Locations, Active and Inactive 25
Figure 8-2 Klamath River above Trinity River (WE) and Trinity River above Klamath River (TR1) Monitoring Locations WY04 31
Figure 8-3 Klamath River/Trinity River Confluence 10/22/2004 32
Figure 8-4 Klamath River above Tully Creek (TC), and Tully Creek (Ty1) Monitoring Locations WY04....33
Figure 8-5 Klamath River above Tully Creek (TC) Looking Upstream June 1, 2004 34
Figure 8-6 Tully Creek (TY1) Looking Downstream 4/29/2004 35
Figure 8-7 Roaches (Ro1)and Mettah (Me1) Creek Macroinvertebrate Monitoring Locations and Notchko Remote Automated Weather Station Monitoring Location WY04 36
Figure 8-8 Roaches Creek (Ro1) Looking Downstream April 29, 2004....37
Figure 8-9 Mettah Creek (Me1) Looking Downstream April 29, 2004 38
Figure 8-10 Notchko RAWS WY04 39
Figure 8-11 East and West Fork Pecwan Creek (EP1 and WP1) Macroinvertebrate Monitoring Locations WY04 40
Figure 8-12 East Fork Pecwan Creek (EP1) May 6, 2004 41
Figure 8-13 West Fork Pecwan Creek (WP1) May 6, 2004....42
Figure 8-14 Klamath River at Johnsons (KJ1) Macroinvertebrate Monitoring Location WY04....43
Figure 8-15 Klamath River at Johnsons (KJ1) August 18, 2004....44
Figure 8-16 Tectah Creek (TeP) Herbicide Monitoring Location WY04 45
Figure 8-17 Klamath River at Ah Pah Riffle (AP1) Macroinvertebrate Monitoring Location WY04....46
Figure 8-18 Klamath River at Ah Pah riffle (AP1) August 18, 2004....47
Figure 8-19 Klamath River above Blue Creek (BC) and Blue Creek Monitoring Locations (Lb1and 2) WY04 48
Figure 8-20 Klamath River above Blue Creek (BC) June 15, 2004....49
Figure 8-21 Blue Creek (Lb1) Staff Plate at Gaging Station WY04....50
Figure 8-22 Blue Creek (Lb2) Macroinvertebrate Sampling Riffle May 26, 2004....51
Figure 8-23 McGarvey Creek Gage Station and Macroinvertebrate Monitoring Location WY04....52
Figure 8-24 McGarvey Creek (Mc1) at Gaging Station WY04 53
Figure 8-25 Klamath at Turwar Gage Water Quality Monitoring Location WY04....54
Figure 8-26 Klamath River at Turwar Gage (TG) Looking Downstream October 2004 55
Figure 8-27 Turwar Creek Gage Station and Macroinvertebrate Monitoring Location WY04 56
Figure 8-28 Turwar Creek (Tu2) Looking Upstream April 27, 2004....57
Figure 8-29 Klamath River Estuary Water Quality and Bacteria Monitoring Locations WY04 58
Figure 8-30 Klamath River Estuary near the mouth September 2004....59
Figure 9-1 Wadable Stream Flow Measurement in Blue Creek on 5/26/2004, YTEP Assistant Director Ken Fetcho and Intern Seafha Blount 66
Figure 10-1 Water Temperature values for the Klamath River above Trinity River WY04....69
Figure 10-2 7-Day Moving Average Water Temperature for the Klamath River above Trinity River WY04....69
Figure 10-3 Air and Water Temperature and Flow Values for the Klamath River above Trinity River WY04....70
Figure 10-4 Klamath River above Trinity River Water Temperature Percent Exceedance WY04....71
Figure 10-5 Dissolved Oxygen Values for the Klamath River above Trinity River WY04....71
Figure 10-6 pH Values for the Klamath River above Trinity River WY04 72
Figure 10-7 Specific Conductivity Values for the Klamath River above Trinity River WY04 72
Figure 10-8 Water Temperature Values for the Trinity River above Klamath River WY04....73
Figure 10-9 7-Day Moving Average Water Temperature for the Trinity River above Klamath River WY04....73
Figure 10-10 Water Temperature and Flow Values for the Trinity River above Klamath River WY04....74
Figure 10-11 Water Temperature Percent Exceedance for Trinity River above Klamath River WY04....75
Figure 10-12 Dissolved Oxygen Values for the Trinity River above Klamath River WY04 75
Figure 10-13 pH Values for the Trinity River above Klamath River WY04 76
Figure 10-14 Specific Conductivity Values for the Trinity River above Klamath River WY04 76

Figure 10-15 Water Temperature Values for the Klamath River above Tully Creek WY04 77
Figure 10-16 7-Day Moving Average Water Temperature for the Klamath River above Tully Creek WY04 77
Figure 10-17 Water Temperature and Flow Values for the Klamath River above Tully Creek WY04 78
Figure 10-18 Percent Exceedance of Daily Maximum and Half-Hourly Water Temperatures for Klamath River above Tully Creek WY04 79
Figure 10-19 Dissolved Oxygen Values for the Klamath River above Tully Creek WY04 79
Figure 10-20 pH Values for the Klamath River above Tully Creek WY04 80
Figure 10-21 Specific Conductivity Values for the Klamath River above Tully Creek WY04 80
Figure 10-22 Water Temperature Values for the Klamath River above Blue Creek – 7 Meters Deep WY04 81
Figure 10-23 7-Day Moving Average Water Temperature for the Klamath River above Blue Creek – 7 Meters Deep WY04 81
Figure 10-24 Air and Water Temperatures and Flow Values for the Klamath River above Blue Creek – 7 Meters Deep WY04 82
Figure 10-25 Percent Exceedance of Daily Maximum and Half-Hourly Water Temperatures for Klamath River above Blue Creek 7 Meters Deep WY04 83
Figure 10-26 Dissolved Oxygen Values for the Klamath River above Blue Creek – 7 Meters Deep WY04 83
Figure 10-27 pH Values for the Klamath River above Blue Creek – 7 Meters Deep WY04 84
Figure 10-28 Specific Conductivity Values for the Klamath River above Blue Creek - 7 Meters Deep WY04 84
Figure 10-29 Water Temperature Values for the Klamath River at Turwar Gage WY04 85
Figure 10-30 7-Day Moving Average Water Temperature the Klamath River at Turwar Gage WY04 85
Figure 10-31 Daily Air and Water Temperature and Flow Values for the Klamath River at Turwar Gage WY0486
Figure 10-32 Klamath River at Turwar Gauge Water Temperature Percent Exceedance WY04 87
Figure 10-33 Daily DO Values for the Klamath River at Turwar Gage WY04 87
Figure 10-34 Daily pH Values for the Klamath River at Turwar Gage WY04 88
Figure 10-35 Specific Conductivity Values for the Klamath River at Turwar Gage WY04 88
Figure 10-36 Comparison of Maximum Water Temperatures across All Sites for WY04 89
Figure 10-37 Comparison of Temperature Values in the Klamath River prior to the introduction of Trinity River Flow (Klamath River Above Trinity River) with Values Subsequent to the introduction of Trinity River Flow (Klamath River Above Tully Creek) 90
Figure 10-38 Comparison of Dissolved Oxygen Values in the Klamath River prior to the introduction of Trinity River Flow (Klamath River Above Trinity River) with Values Subsequent to the introduction of Trinity River Flow (Klamath River Above Tully Creek) 91
Figure 10-39 Macroinvertebrate Taxa Richness and EPT Taxa Richness 92
Figure 10-40 Macroinvertebrate Sensitive EPT Index 93
Figure 10-41 Macroinvertebrate Percent Dominant Taxon 93
Figure 10-42 Macroinvertebrate Tolerance Value 94
Figure 10-43 Macroinvertebrate Shannon Diversity Index 94
Figure 10-44 Macroinvertebrate Summed Sensitive EPT 95
Figure 10-45 Water Temperature, pH, DO and Salinity Values for the Klamath River Upper Estuary WY04 102
Figure 10-46 Cross Section Surface Measurements in the Klamath River Upper Estuary WY04 103
Figure 10-47 Cross Section Bottom Measurements in the Klamath River Upper Estuary WY04 103
Figure 10-48 Water Temperature, pH, DO and Salinity Values for the Klamath River Middle Estuary Surface WY04 104
Figure 10-49 Water Temperature, pH, DO and Salinity Values for the Klamath River Middle Estuary Depth WY04 104
Figure 10-50 Cross Section Surface Measurements in the Klamath River Middle Estuary WY04 105
Figure 10-51 Cross Section Bottom Measurements in the Klamath River Middle Estuary WY04 105
Figure 10-52 Water Temperature, pH, DO and Salinity Values for the Klamath River Lower Estuary Surface WY04 106
Figure 10-53 Water Temperature, pH, DO and Salinity Values for the Klamath River Lower Estuary Depth WY04 106
Figure 10-54 Cross Section Surface Measurements in the Klamath River Lower Estuary WY04 107
Figure 10-55 Cross Section Bottom Measurements in the Klamath River Lower Estuary WY04 107
Figure 10-56 Mean, Minimum, and Maximum Daily Discharge Estimates for McGarvey Creek WY04 116

Figure 10-57 Discharge Rating Curve Values for McGarvey Creek Gaging Station WY04 117
Figure 10-58 McGarvey Creek Stage Height, Hydrograph, and Flow Measurements for WY04 117
Figure 10-59 Fifteen Minute Turbidity and Specific Conductivity Data for McGarvey Creek WY04 118
Figure 10-60 Fifteen Minute Water Temperature Data for McGarvey Creek WY04 118
Figure 10-61 Mean, minimum, and maximum discharges recorded at Blue Creek gaging site from October 1, 2003 through September 30, 2004 123
Figure 10-62 Discharge Rating Curve Values for Blue Creek Gaging Station for WY02 - WY04 and WY04 ...123
Figure 10-63 Blue Creek Hydrograph and Flow Measurements for WY04 124
Figure 10-64 Fifteen Minute Turbidity and Specific Conductivity Data for Blue Creek WY04 124
Figure 10-65 Fifteen Minute Water Temperature and Dissolved Oxygen Data for Blue Creek WY04 125
Figure 10-66 Mean, Minimum, and Maximum Daily Discharge Estimates for Turwar Creek WY04 128
Figure 10-67 Turwar Creek Rating Curve WY04 129
Figure 10-68 Turwar Creek Hydrograph and Flow Measurements for WY04 129
Figure 10-69 Fifteen Minute Turbidity Data for Turwar Creek WY04 130
Figure 10-70 Fifteen Minute Water Temperature Data for Turwar Creek WY04 130
Figure 10-71 Macroinvertebrate Taxa Richness and EPT Taxa Richness WY04 131
Figure 10-72 Macroinvertebrate Sensitive EPT Index 132
Figure 10-73 Macroinvertebrate Percent Dominant Taxon 132
Figure 10-74 Macroinvertebrate Tolerance Value 133
Figure 10-75 Macroinvertebrate Shannon Diversity Index 133
Figure 10-76 Summed Sensitive EPT 134
Figure 10-77 Notchko RAWS One-Hour Rainfall Intensity Greater than 0.25 inches/hour WY04 135
Figure 10-78 Notchko RAWS Daily Rainfall Intensity Equal and Greater than 1 inch/hour WY04 136
Figure 10-79 Notchko RAWS Effective Rainfall (represents 100% annual precipitation) WY04 136
Figure 10-80 Notchko RAWS Cumulative Annual Precipitation WY04 137
Figure 10-81 Notchko RAWS Monthly Cumulative Precipitation WY04 137

3 Table of Tables

Table 7-1 Data Quality Ratings Reference Table 19
Table 7-2 Raw Data Grades for Klamath River above Trinity River (WE) 19
Table 7-3 Raw Data Grades for Trinity River above Klamath River (TR) 20
Table 7-4 Raw Data Grades for Klamath River above Tully Creek (TC) 20
Table 7-5 Raw Data Grades for Klamath River above Blue Creek (BC) 20
Table 7-6 Raw Data Grades for Klamath River at Turwar Gage (TG) 21
Table 8-1 Sampling sites WY04 and their respective parameters in the lower Klamath River Basin 23
Table 8-2 Dates of Deployment* at Continuous Monitoring Locations WY04 24
Table 8-3 Selection criteria priority matrix for macroinvertebrate sampling 29
Table 9-1 Parameters measured in the Klamath River Water Quality Study 62
Table 9-2 Location, deployment dates, turbidity probe type, & parameters monitored in tributaries WY04 64
Table 10-1 Macroinvertebrate Results for the Klamath River Sites Samples in 2004 92
Table 10-2 Combined Algae Species List for Klamath River Benthic Algae Sampling, 2004 96
Table 10-3 Combined Algae Species List for Klamath River above Trinity River (WE) 2004 97
Table 10-4 Combined Species List for Trinity River above Klamath River (TR) 2004 98
Table 10-5 Combined Species List for Klamath River above Tully Creek (TC) 2004 99
Table 10-6 Combined Species List for Klamath River at Turwar Gage (TG) 2004 100
Table 10-7 Similarity Index for All Sites and Dates* 2004 101
Table 10-8 Similarity Index for all sites during July, August and September sampling dates 2004 101
Table 10-9 Similarity Index for all sites during June, July and August sampling dates 2004 101
Table 10-10 Minimum Daily Discharge (cfs) Values for McGarvey Creek WY04 115
Table 10-11 Maximum Daily Discharge (cfs) Values for McGarvey Creek WY04 115
Table 10-12 Average Daily Discharge (cfs) Values for McGarvey Creek WY04 116
Table 10-13 McGarvey Creek Suspended Sediment Values WY04 119
Table 10-14 Minimum Daily Discharge (cfs) Values for Blue Creek WY04 120

Table 10-15 Maximum Daily Discharge (cfs) Values for Blue Creek WY04 121
Table 10-16 Average Daily Discharge (cfs) Values for Blue Creek WY04 122
Table 10-17 Blue Creek Suspended Sediment Values WY04.....125
Table 10-18 Minimum Daily Discharge (cfs) Values for Turwar Creek WY04.....126
Table 10-19 Maximum Daily Discharge (cfs) Values for Turwar Creek WY04 127
Table 10-20 Average Daily Discharge (cfs) Values for Turwar Creek WY04 128
Table 10-21 Turwar Creek Suspended Sediment Values WY04 131
Table 10-22 Macroinvertebrate Sampling WY04 131
Table 10-23 YTEP surface water monitoring in Tectah Creek watershed, March 2004.....134
Table 10-24 Laboratory analytical results for YTEP surface water monitoring, March 2004 135
Table 11-1 Metric scores for Trinity and Klamath River samples 150
Table 11-2 Top 5 most abundant algae species and their relative abundance (%) June 2004.....151
Table 11-3 Top 5 most abundant algae species and their relative abundance (%) July 2004 151
Table 11-4 Top 5 most abundant algae species and their relative abundance (%) August 2004 151
Table 11-5 Top 5 most abundant algae species and their relative abundance (%) September 2004.....151
Table 11-6 Benthic Algae SI values for four monitoring sites from June to September 2004.....152
Table 11-7 Highest and Lowest Benthic Algae SI values for four monitoring sites from June - September 2004153
Table 11-8 Stream sites ranked by metric scores (1 indicates least impairment).....169

4 Introduction

This Water Year 2004 (WY04) Report is the third in a series of annual water reports documenting water quality and hydrologic data gathered by the Yurok Tribe Environmental Program (YTEP) data collection network in the lower Klamath River watershed, specifically within and adjacent to the Yurok Indian Reservation (YIR). The long-term monitoring activities outlined in this report include water quality monitoring on the Klamath River mainstem, estuary and within the tributaries, macroinvertebrate population sampling in selected tributaries and at selected sites in the mainstem Klamath and Trinity Rivers, hydrologic monitoring performed on McGarvey, Blue, and Turwar Creeks, herbicide monitoring in selected tributaries and rainfall information from the Notchko Weather Station and other available rain gauges. The Water Year 2004 (WY04) Report is currently available for review at the Yurok Tribal Offices in Klamath, California and on the web at www.yuroktribe.org. For further information on how to obtain data and/or additional copies of the water report please contact Ken Fetcho at 707-482-1350.

5 Background

5.1 Klamath River

The health of the Klamath River and associated fisheries has been central to the life of the Yurok Tribe since time immemorial fulfilling subsistence, commercial, cultural, and ceremonial needs. Yurok oral tradition reflects this. The Yurok did not use terms for north or east, but rather spoke of direction in terms of the flow of water (Kroeber 1925). The Yurok word for salmon, *nepuy*, refers to "that which is eaten". Likewise, the local waterways and watershed divides have traditionally defined Yurok aboriginal territories. Yurok ancestral land covers about 360,000 acres and is distinguished by the Klamath and Trinity Rivers, their surrounding lands, and the Pacific Coast extending from Little River to Damnation Creek.

The fisheries resource continues to be vital to the Yurok today. The September 2002 Klamath River fish kill, where a conservative estimate of 33,000 fish died in the lower Klamath before reaching their natal streams to spawn, was a major tragedy for the Yurok people.

5.2 The Yurok Indian Reservation

The current YIR consists of a 56,000-acre corridor extending for one mile from each side of the Klamath River from the Trinity River confluence to the Pacific Ocean, including the channel (Figure 5-1). There are approximately two dozen major anadromous tributaries within that area. The mountains defining the river valley are as much as 3,000 feet high. Along most of the river, the valley is quite narrow with rugged steep slopes. The vegetation is principally redwood and douglas fir forest with little area available for agricultural development. Historically, prevalent open prairies provided complex and diverse habitat.

At this time within the reservation 3,653 acres are held in trust status, 115 acres are Tribal Housing, 4,222 acres are Tribal fee lands and 3,499 acres are allotments (Yurok Tribal Planning Department). The majority of the remaining lands in the YIR are fee lands, (mostly owned by Green Diamond Resource Company), which are managed intensively for timber products. A small portion of the YIR consists of public lands managed by Redwood National/State Parks (RNSP), the United States Forest Service (USFS) and private landholdings.

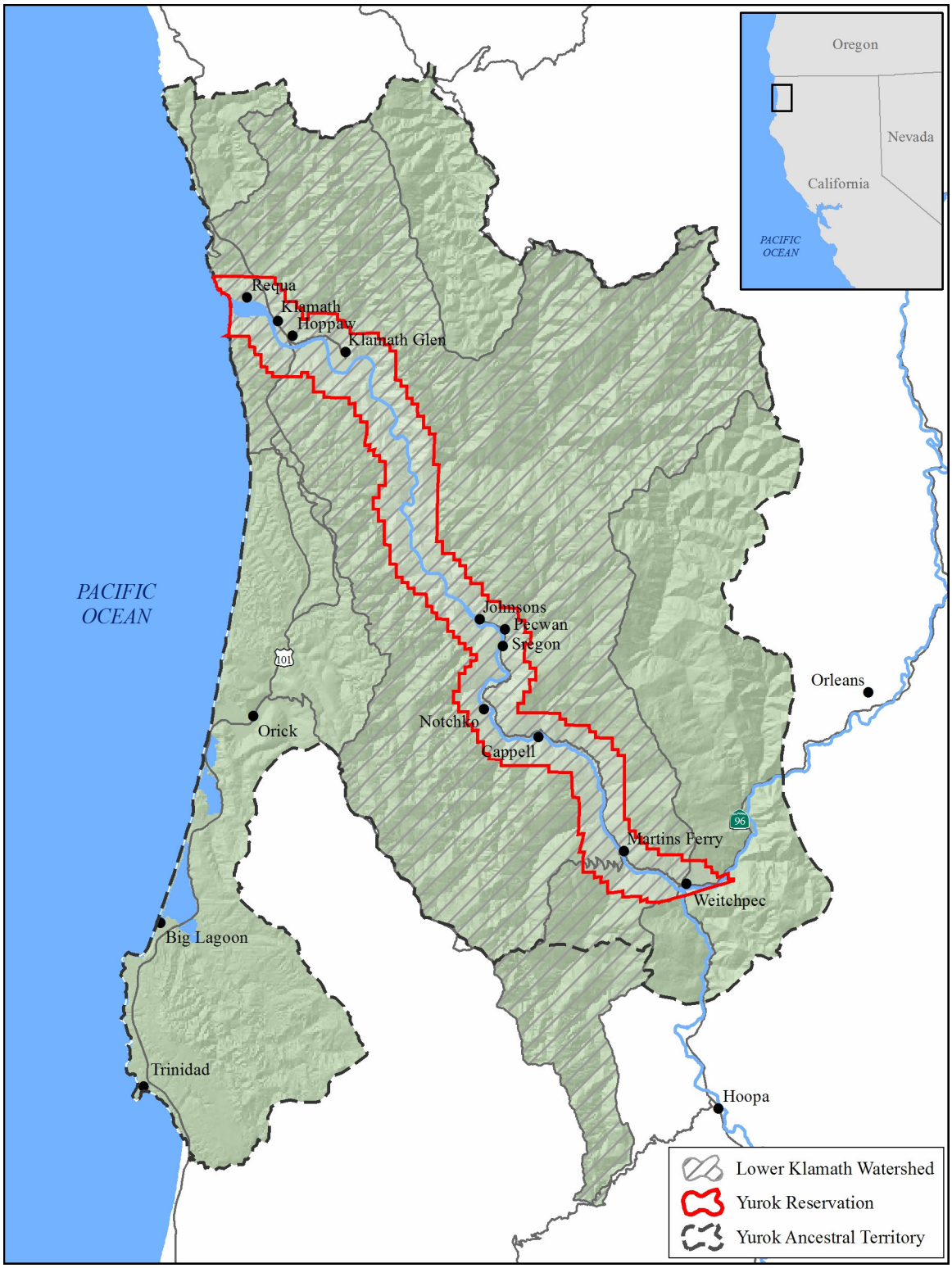

Figure 5-1 The Yurok Indian Reservation and Yurok Ancestral Territory

The YIR exists one mile on each side of the Klamath River from the village of Weitchpec, at the confluence of the Trinity and Klamath Rivers, to the mouth of the Pacific Ocean.

5.3 The Klamath River Watershed

The Klamath River system drains much of northwestern California and south-central Oregon (Figure 5-2). Thus, even activities taking place on land hundreds miles off the YIR can affect water conditions within YIR boundaries. For example, upriver hydroelectric and diversion projects have altered natural flow conditions for decades. The majority of water flowing through the YIR is derived from scheduled releases of impounded water from the Upper Klamath Basin that is often of poor quality with regards to human needs as well as the needs of fish and wildlife.

Some historically perennial streams now have ephemeral lower reaches and seasonal fish migration blockages because of inadequate dam releases from water diversion projects along the Klamath and Trinity Rivers. The releases contribute to lower mainstem levels, excessive sedimentation which in turn causes subsurface flow and aggraded deltas. Additionally, the lower slough areas of some of the lower Klamath tributaries that enter the estuary experience eutrophic conditions during periods of low flow. These can create water quality barriers to fish migration when dissolved oxygen levels are inadequate for migrating fish. The Klamath River is on California State Water Resource Control Board's (SWRCB) 1998 303(d) List as impaired for temperature, dissolved oxygen, and nutrients.

The basin's fish habitat has also been greatly diminished in area and quality during the past century by accelerated sedimentation from mining, timber harvest practices, and road construction, as stated by Congress in the Klamath River Act of 1986. Management of private lands in the basin (including fee land within Reservation boundaries) has been, and continues to be, dominated by timber harvest for the last 100 years. Associated road building and slope destabilization have contributed to aggradations from increased sediment input into many of the tributaries to the Klamath River on the YIR. The steep terrain, granular soil matrix, and high precipitation have helped to produce erosive conditions throughout the area; mass wasting is common. These conditions make road conditions difficult to stabilize and cause considerable siltation and turbidity problems in the Klamath River. The North Coast Region Water Quality Control Board (NCRWQCB) suggests in their 303(d) Update List (2001) that sediment conditions within the channel and immoderate sediment loading have impaired beneficial uses within the Klamath watershed.

Nearly all streams in the YIR having perennial flow and no physical barriers to fish migration provide spawning, incubation, and rearing habitats for anadromous fish species. Perennial tributaries also

provide important thermal refugia for fish of the Klamath River during periodic mainstem warm water episodes. Sufficient flows of clean water are essential to the long-term viability of a healthy fishery. Water quality barriers, high sediment load, and herbicide spraying within anadromous and domestic watersheds all create the need for comprehensive, continuous water quality, hydrology and herbicide monitoring.

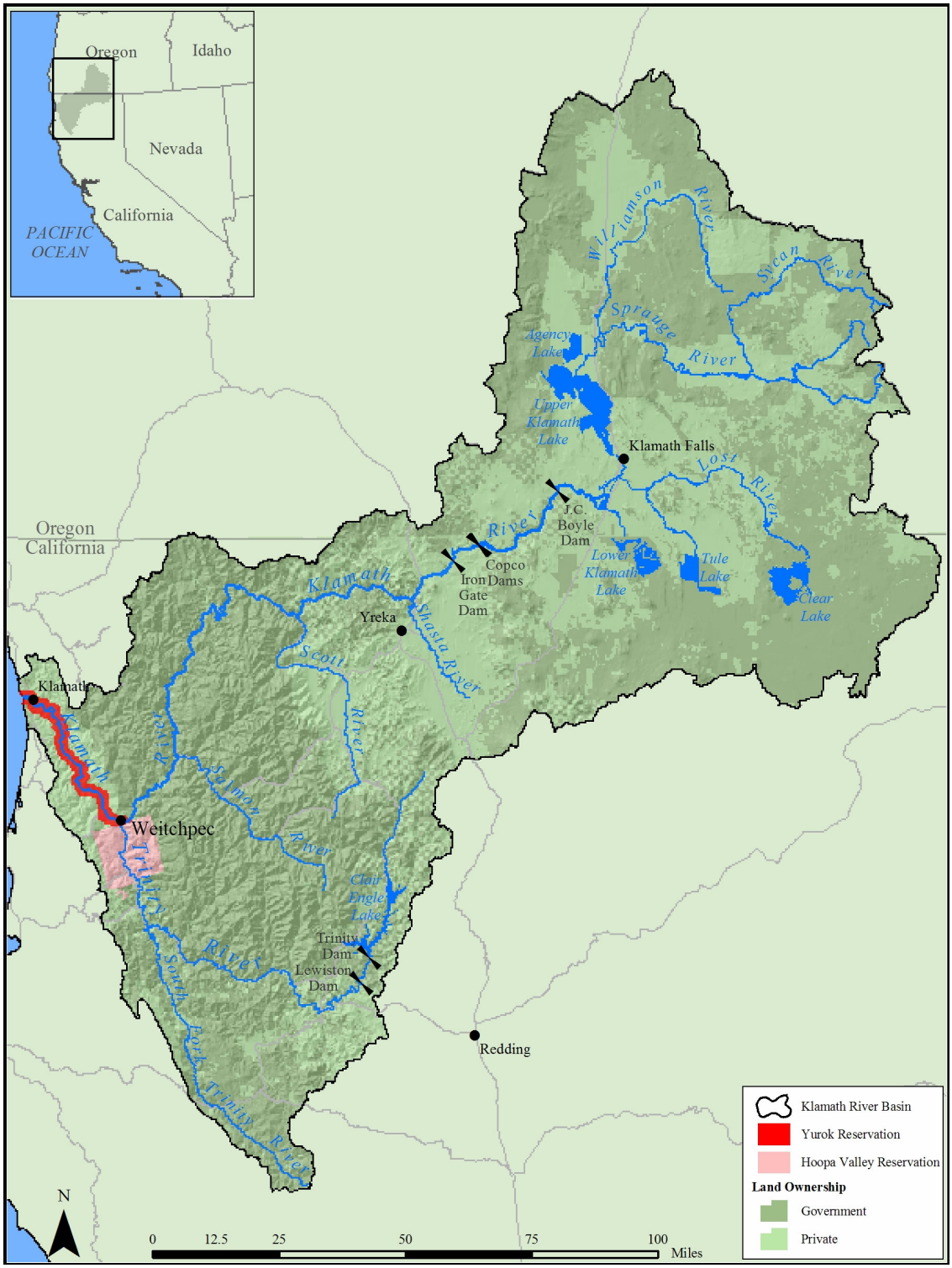

Figure 5-2 Klamath River Basin Map illustrating major tributaries and dam locations

6 Yurok Tribe Water Monitoring Division

In 1998, YTEP was created to protect and restore tribal natural resources through high quality scientific practices. YTEP is dedicated to improving and protecting the natural and cultural resources of the Yurok Tribe through collaboration and cooperation with local, private, state, tribal, and federal entities such as the Yurok Tribe Fisheries Program (YTFP), US Fish and Wildlife Service (USFWS), the United States Environmental Protection Agency (USEPA), Green Diamond Resource Company, the NCRWQCB, and the United States Geological Survey (USGS). A USEPA General Assistance Program (GAP) Grant and funding allocated under the Clean Water Act Section 106 and funding from the USFWS and YTFP primarily fund YTEP's water monitoring activities.

The purpose of this document is to present a synthesis of YTEP's hydrologic and water quality data collected in the lower Klamath watershed for WY04. This report is part of YTEP's comprehensive program of monitoring and assessment of the chemical, physical, and biological integrity of the Klamath River and its tributaries in a scientific and defensible manner.

7 Quality Assurance

YTEP staff undertook many measures to assure high quality hydrological, macroinvertebrate, herbicide, and water quality data during WY04. YTEP staff responsible for collecting this data consists of the Assistant Director Water Division, Hydrologist, Assistant Director Cross Media Division, Environmental Program Coordinators, a technician and an intern. The staff report to the Environmental Program Director, who is responsible for overseeing the USEPA-approved Quality Assurance Program Plan (QAPP) for Water Quality Assessment and Monitoring.

The QAPP details the quality assurance (QA) and quality control (QC) procedures used to ensure and document that data is accurate, precise, complete, and representative of actual field conditions. The QAPP additionally describes the planning, implementation, and assessment criteria required for projects performed by YTEP for the generation, acquisition, and use of environmental water quality data. The QAPP is also applied for water quality monitoring and sampling activities undertaken by the Yurok Tribe outside of the YIR. The QAPP further states that YTEP will follow protocols developed by another agency when collaborating on monitoring projects with other parties. Changes to the QAPP are approved by the Environmental Program Director.

In order to ensure comparability and accuracy of data, YTEP uses Standard Operating Procedures (SOPs). Where an SOP does not exist for a certain instrument or procedure, YTEP follows the manufacturer's suggested procedures. Detailed logs are kept in waterproof field notebooks and data sheets. In these logs, any malfunctions, unusual circumstances, and/or variations are noted.

A large portion of the data was collected at sites using continuous monitoring instruments such as the Hydrolab® Datasonde 4A and YSI 6600 EDS (datasonde) and H-350XL data logger. QC involves crosschecking the data from the field. For example, at the gaging stations the water level on a fixed, graduated staff plate was compared to the transducer/data collection platform reading. Equipment was also calibrated before deployment and post-calibrated after extraction. These procedures help ensure that the data is of the highest quality.

Data screening and validation are conducted on an ongoing basis. At no time is more than one month of data collected without that data being reviewed. The reviewer looks for missing data, large shifts in values, and applies common sense and her/his knowledge of the location. In addition, data validation includes checking information that has been transmitted from one form into another (e.g., field logbook

to computer file) and making sure that there have been no errors in transmission. Daily maximums and minimums were disregarded when more than five measurements were missing from a 24-hour period and when the daily maximum or minimum was expected to occur during the gap.

The quality of the data collected with datasondes was evaluated by YTEP staff using pre and post calibration information and by comparing initial deployment numbers with a secondary calibrated instrument such as a portable water quality multi-probe (Quanta). Specific conductivity and pH probes were compared to standard solutions and the dissolved oxygen (DO) probes were compared to a standard of 100% saturation using the same procedures as in the initial calibration process. The data was assigned a grade rating for each deployment period based upon comparing the datasonde's probes to a standard after extraction. Data quality ratings were adopted from the United States Geological Survey (USGS) report 00-4252. Pre and post-season testing of each instrument's temperature probes revealed the instruments to be within 0.2°C of one another and a NIST traceable thermometer (Zedonis and Cunanan 2002 and Turner and Zedonis 2003). This information suggested that there was no need to grade water temperature data from independent datasets (Pers. Comm., Randy Turner, USFWS 2003).

The grade ratings should be referenced to determine the accuracy and precision of the data when assessing the results in Section 10.1. However, care needs to be incorporated into interpreting the results along with the data set grade.

Table 7-1 Data Quality Ratings Reference Table

Quality Ratings For Raw Data					
Parameter	**A (excellent)**	**B (Good)**	**C (Fair)**	**D (Poor)**	**I (incomplete)**
Specific Conductivity	≤ ± 3%	> ± 3 to 10%	> ± 10 to 15%	> ± 15%	no post-cal info
pH	≤ ± 0.2 unit	> ± 0.2 to 0.5 unit	> ± 0.5 to 0.8 unit	> ± 0.8 unit	no post-cal info
Dissolved Oxygen (% Sat)	≤ ± 0.3 mg/L	> ± 0.3 to 0.5 mg/L	> ± 0.5 to 0.8 mg/L	> ± 0.8 mg/L	no post-cal info

Table 7-2 Raw Data Grades for Klamath River above Trinity River (WE)

Site	StartDate	End Date	SpC Grade	pH Grade	DO (mg/L) Grade
WE	6/17/2004	6/30/2004	A	A	D
WE	6/30/2004	7/14/2004	B	A	I
WE	7/14/2004	7/28/2004	A	B	C
WE	7/28/2004	7/29/2004	I	I	I
WE	8/11/2004	8/25/2004	B	A	A
WE	8/25/2004	9/9/2004	A	A	C
WE	9/9/2004	9/23/2004	B	A	A
WE	9/23/2004	10/7/2004	A	A	B
WE	10/7/2004	10/22/2004	A	A	A

Table 7-3 Raw Data Grades for Trinity River above Klamath River (TR)

Site	StartDate	End Date	SpC Grade	pH Grade	DO (mg/L) Grade
TR	6/1/2004	6/16/2004	A	A	A
TR	6/16/2004	6/30/2004	A	B	C
TR	6/30/2004	7/11/2004	A	A	D
TR	7/14/2004	7/28/2004	B	A	C
TR	7/28/2004	8/11/2004	A	A	B
TR	8/11/2004	8/25/2004	B	A	B
TR	8/25/2004	9/9/2004	A	A	C
TR	9/9/2004	9/23/2004	A	A	A
TR	9/23/2004	10/7/2004	B	A	A
TR	10/7/2004	10/22/2004	A	A	A

Table 7-4 Raw Data Grades for Klamath River above Tully Creek (TC)

Site	StartDate	End Date	SpC Grade	pH Grade	DO (mg/L) Grade
TC	6/1/2004	6/16/2004	B	A	B
TC	6/16/2004	6/30/2004	A	A	A
TC	6/30/2004	7/14/2004	A	A	B
TC	7/14/2004	7/28/2004	A	A	B
TC	7/28/2004	8/11/2004	A	A	A
TC	8/11/2004	8/25/2004	B	A	B
TC	8/25/2004	9/9/2004	B	A	A
TC	9/9/2004	9/23/2004	A	A	B
TC	9/23/2004	10/7/2004	A	A	C
TC	10/7/2004	10/22/2004	A	A	A

Table 7-5 Raw Data Grades for Klamath River above Blue Creek (BC)

Site	StartDate	End Date	SpC Grade	pH Grade	DO (mg/L) Grade
BC	5/17/2004	6/3/2004	I	A	B
BC	6/3/2004	6/14/2004	A	A	B
BC	6/14/2004	6/28/2004	A	A	B
BC	6/28/2004	7/2/2004	A	A	A
BC	7/12/2004	7/26/2004	I	I	I
BC	7/26/2004	8/9/2004	A	A	A
BC	8/10/2004	8/23/2004	B	A	D
BC	8/23/2004	9/7/2004	A	A	A
BC	9/7/2004	9/20/2004	A	A	D
BC	9/20/2004	10/4/2004	B	A	A
BC	10/4/2004	10/21/2004	A	A	A

Table 7-6 Raw Data Grades for Klamath River at Turwar Gage (TG)

Site	StartDate	End Date	SpC Grade	pH Grade	DO (mg/L) Grade
TG	5/17/2004	6/3/2004	B	A	B
TG	6/3/2004	6/14/2004	B	A	C
TG	6/14/2004	6/28/2004	A	A	C
TG	6/28/2004	7/2/2004	B	A	C
TG	7/12/2004	7/26/2004	A	B	B
TG	7/26/2004	8/9/2004	I	I	I
TG	8/9/2004	8/23/2004	B	A	B
TG	8/23/2004	9/7/2004	A	A	A
TG	9/7/2004	9/20/2004	A	A	A
TG	9/20/2004	10/4/2004	I	I	B
TG	10/4/2004	10/21/2004	B	A	A

The datasonde operation protocol followed for 2004 was designed to be able to correct the data once it had been downloaded. However, there has been considerable concern over the results because the methods used did not account for all of the biofouling on the DO probes. Therefore, YTEP decided to present the raw data in this report. YTEP will continue to work with the equipment manufacturers and USFWS personnel in order to determine the best approach to correct for DO drift during datasonde deployment.

Water chemistry data was analyzed by contract and sub-contract labs including: North Coast Labs (NCL), Sequoia Analytical Labs, Environmental Technical Services (ETS), Humboldt County Public Health Laboratory, Brelje and Race Laboratories, Incorporated. The data was reviewed and validated before it was included into this annual water report. Spike, duplicate and blank QA/QC samples were submitted to the lab by the field crew to show recovery, precision and verify that no contamination occurred during the collection of the sample water and transportation of the sample bottles. These QA/QC sample results are also reviewed to evaluate the performance of the contract and sub-contract labs.

The contract and sub-contract labs perform their own spike, duplicate and blank QA/QC samples to verify the performance of their methods and analytical equipment. These QA/QC results are reported to YTEP and are reviewed by YTEP staff to determine the quality of the data received. These QA/QC results are verified to meet the appropriate percent recovery for the particular analysis that is performed. All of the data in this document has been reviewed and verified to meet the acceptable percent recoveries suggested for each analysis.

YTEP's macroinvertebrate sampling follows the California Stream Bioassessment Protocol (CSBP) in order to ensure that the data is scientifically defensible. As part of the QA guidelines in the CSBP, 10% of the macroinvertebrate taxonomic results should be reviewed by California Department of Fish and Game's (CDFG) Aquatic Bioassessment Laboratory in Chico, CA. YTEP submitted one sample to the Chico Lab from the West Fork of Pecwan Creek sample that was collected May 6, 2004. According to Brady Richards, CDFG taxonomist, the overall taxonomy was very good and performed in accordance with the CSBP 1 standards.

YTEP's hydrological and sediment monitoring in the Klamath River tributaries follow USGS methods in order to ensure that the data is scientifically defensible.

8 Site Selection

In general, the various sampling locations were chosen in order to represent the average ambient water conditions throughout the water column. Table 8-1 shows sampling locations, their site identification code (site IDs), name of the sub-watershed, and measured parameters.

Table 8-1 Sampling sites WY04 and their respective parameters in the lower Klamath River Basin

Sub-watershed	Site Name	Site ID	Long	Lat	Stage	Temp	DO	Turb	SpCond	pH	Macro	Nutrient	Algae	SSC	Air Temp/Rel Hum
Middle Klamath	Klamath River above Trinity River	WE	123 42 11	41 11 10		C	C	D	C	C		D	D		C
Lower Trinity	Trinity River above Klamath River	TR	123 42 15	41 11 2		C	C	D	C	C	D	D	D		C
Lower Klamath	Klamath River above Tully Creek	TC	123 46 19	41 13 36		C	C	D	C	C		D	D		
Tully	Tully Creek	Ty1	123 46 31	41 13 43		D	D	D	D	D	D				
Roaches	Roaches Creek	Ro1	123 51 2	41 16 31		D	D		D	D	D				
Mettah	Mettah Creek	Me1	123 52 21	41 18 31		D	D		D	D	D				
East Fork Pecwan	East Fork Pecwan Creek	EP1	123 50 39	41 20 35		D	D		D	D	D				
West Fork Pecwan	West Fork Pecwan Creek	WP1	123 53 46	41 20 35		D	D		D	D	D				
Lower Klamath	Klamath River at Johnsons Bar 1	KJ1	123 52 35	41 21 5		D	D		D	D	D				
Lower Klamath	Klamath River at Ah Pah Riffle	AP1	123 56 04	41 24 53		D	D		D	D	D				
Lower Klamath	Klamath River above Blue Creek -7 meters	BC	123 55 41	41 25 17		C	C	D	C	C					
Lower Blue	Lower Blue 1	Lb1	123 54 4	41 26 55	C	C	C	C	C	C				D	
Lower Blue	Lower Blue 2	Lb2	123 54 30	41 26 34		D	D		D	D	D				
McGarvey	McGarvey Creek	Mc1	124 00 34	41 29 10	C	C	D	C	C	D	D			D	
Lower Klamath	Klamath River at Turwar Gage	TG	124 00 2	41 30 43		C	C	C/D	C	C		D	D		C
Turwar	Turwar Creek 2	Tu2	123 58 6	41 32 47	C	C	D	C	C	D	D			D	
Lower Klamath	Upper Estuary	UE	124 1 46	41 31 2		C	C		C	C		D			
Lower Klamath	Middle Estuary Surface and Depth	MES/MED	124 2 38	41 31 56		C	C		C	C		D			
Lower Klamath	Lower Estuary Surface and Depth	LES/LED	140 4 35	41 32 26		C	C		C	C		D			

INACTIVE SITES

Johnsons	Johnsons Creek at Johnsons Bar 1	Jo1	123 52 4	41 20 38
Tectah	Tectah Creek	Te1	123 56 27	41 18 4
NF Tectah	North Fork Tectah Creek	Te2	123 57 49	41 15 48
SF Tectah	South Fork Tectah Creek	Te3	123 57 48	41 15 47
West Fork Blue	West Fork Blue Creek	Wb1	123 53 46	41 28 4
Turwar	Turwar Creek 1	Tu1	123 58 43	41 32 6

C= Continuous Monitoring at Site; D= Discreet Monitoring at Site

DO= Dissolved oxygen; Turb=Turbidity; SpCond=Specific conductivity; Macro=Macroinvertebrate; SSC= Suspended Sediment Concentration; Air Temp/Rel Hum= Air Temperature/Relative Humidity

Table 8-2 Dates of Deployment* at Continuous Monitoring Locations WY04

Site Name	Site ID	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04
Klamath River above Trinity River	WE								17					21
Trinity River above Klamath River	TR								18					21
Klamath River above Tully Creek	TC									2				21
Klamath River above Blue Creek -25 Feet	BC								18					20
Lower Blue Creek 1	Lb1		3 26	5 7						30	17			
McGarvey Creek	Mc1		3 1	5 7	15 29	3 20								
Klamath River at Turwar Gage	TG								18					20
Turwar Creek 2	Tu2	1									25		16 30	
Upper Estuary	UE										21-24	19-22	17-31	27-30
Middle Estuary Surface and Depth	MES/MED										21-24	19-22	17-31	27-30
Lower Estuary Surface and Depth	LES/LED										21-24	19-22	17-31	27-30

Gage Height Only
Gage Height, Specific Conductivity, Turbidity, Temp
Gage Height, Turbidity, Temp
Water Quality Only

*Dates within bars indicate dates of initial deployment/ultimate retrieval

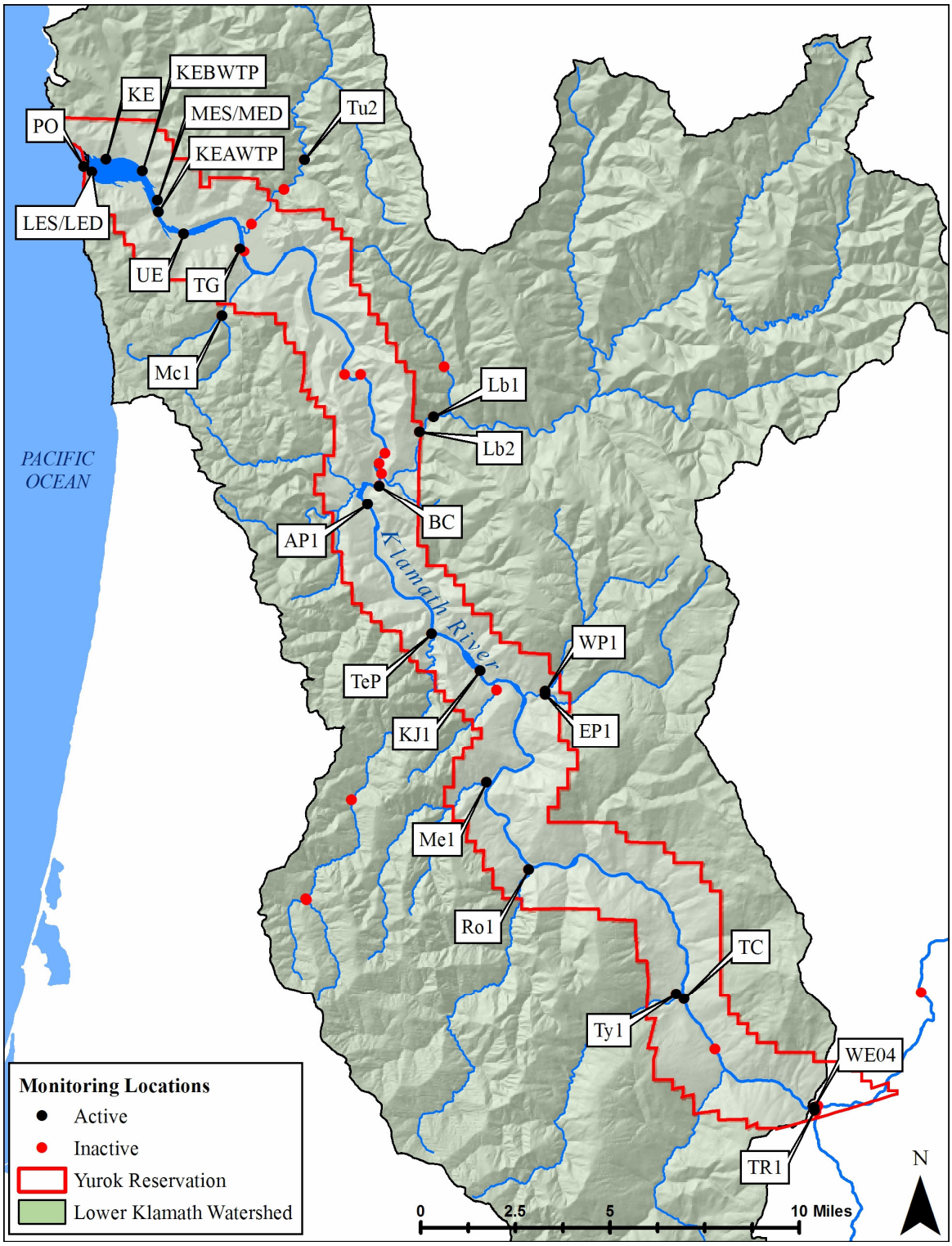

Figure 8-1 YTEP lower Klamath Basin Monitoring Locations, Active and Inactive

8.1 Water Quality

8.1.1 Mainstem

In conjunction with USFWS, NCRWQCB, and the Karuk Tribe, YTEP participated in a water quality study on the mainstem Klamath River. YTEP operated datasondes, continuous multi-probe water quality monitoring instruments, at locations detailed in this section. Latitude and longitude coordinates for these sampling sites are located in Table 8-1.

Site selection depended on the goals and objectives of the monitoring project. Accessibility and security also play a role in the decision making process. For example, sites for the water quality study on the Klamath River were chosen to develop a spatially distributed network on the river throughout the YIR. The Klamath River at Turwar Gage (TG) monitoring site (Figure 8-25) was chosen for its close proximity to the mouth of the river. The monitoring sites on the Klamath River above Tully Creek (TC) (Figure 8-4), in Weitchpec on the Klamath upstream of the Trinity River confluence (WE) and in the Trinity upstream of the Klamath (TR) (Figure 8-2) represent conditions before the two rivers merge and the conditions downstream after mixing has occurred.

In addition to operating datasondes at the above mentioned sites, YTEP also collected nutrient grab samples and benthic algae samples. These samples were collected to learn more about the nutrient conditions in the Lower Basin. Datasonde locations were chosen to collect water and algae samples so that water quality parameters could be linked to nutrient concentrations at four locations within the Lower Basin.

YTEP chose to monitor water quality on the Klamath River at approximately 500 feet upstream of Blue Creek (BC) (Figure 8-19), approximately 10 miles upstream of the TG site. This site was chosen in order to close a data gap that existed in between the TC and TG sites. This site is also important because many salmon and steelhead hold in the area near Blue Creek, resulting in the largest numbers of dead fish reported on the Klamath River during the fish kill in 2002. This site represents Klamath River conditions prior to the addition of water from Blue Creek, a major tributary. The Blue Creek site is illustrated in Figure 8-20. Water and algae samples were not collected at the Blue Creek site.

In conjunction with the NCRWQCB, YTEP participated in a water quality study in the Klamath River Estuary. The water quality monitoring surveys were conducted by YTEP staff, with financial and

technical support by the NCRWQCB. Sites were selected to represent each section of the estuary, the upper, middle and lower (Figure 8-29) in order to describe the temporal variation in water quality, and draw linkages between freshwater and tidal flows and water quality conditions. Sondes were deployed at surface and at depth at the middle and lower estuary sites and at the middle water column depth at the upper estuary site. An additional site was added in the Pacific Ocean in order for nutrient concentration to be determined outside the mouth of the estuary (near-surface grab sample only).

YTEP began monitoring for bacteria in the Klamath River Estuary in March of 2004. Three sites (Figure 8-29) were selected to characterize bacteria levels in the estuary. One site was chosen in the Lower Estuary because this is a location where YTEP staff has witnessed young people swimming in this vicinity during the summer months. Two locations were selected in the Middle Estuary in order to bracket the location where the Klamath Community Service District maintains pipelines and storage tanks that are part of the wastewater treatment facility.

8.1.2 Tributaries

The water quality monitoring sites were selected for their importance to fish habitat, potential for Tribal water sources, and current land management activities such as timber harvest and restoration projects. Water quality monitoring in the tributaries were located near the gaging stations so that water quality conditions can be linked to water levels and flow. Other factors contributing to site selection include accessibility and relative safety from vandalism.

8.2 Hydrologic Monitoring

WaterLog Pressure Transducer/Data Collection Platforms, or gaging stations, on McGarvey Creek (Figure 8-23), Blue Creek, (Figure 8-19), and Turwar Creek (Figure 8-27) monitor water levels and flow. Sediment and flow measurements are collected at Den Creek, (a tributary to McGarvey Creek); however, there is not a gaging station located on Den Creek. Flow measurements are necessary at Den Creek when a flow measurement is taken in McGarvey Creek using the crane. The bridge downstream from the confluence of McGarvey and Den Creeks is the only possible site to take a measurement using a crane. The sediment and flow measurements are subtracted from the total flow and sediment concentrations to coincide with the flow measurements and sediment samples collected upstream from the confluence at the gaging station on McGarvey Creek.

Site locations were based on the presence of fish habitat and current land management activities, such as timber harvest and restoration projects. Sites were selected low enough in the watershed to document most of the water draining from the watershed. Employee safety and the protection of equipment also required that gaging stations be in locations which do not become inundated during high flows. Site locations were chosen to represent the different geologies of lower Klamath Basin tributaries. McGarvey Creek's geology is primarily from the Fransiscan formation; the geology of Blue and Turwar Creeks is from the Fransiscan and Jurassic Galice formations. Substrate in Blue and Turwar Creeks is larger than that of McGarvey Creek; while all three creeks become turbid following rain events, Blue and Turwar Creeks become clear much more quickly than McGarvey Creek.

8.3 Macroinvertebrate Sampling

8.3.1 Mainstem

Site selection criteria for macroinvertebrate sampling in the mainstem Klamath and Trinity Rivers include collecting additional information to compliment the ongoing water quality sampling. Sites were also selected to represent spatial distribution throughout the YIR. Sampling sites were selected based on the river characteristics that would allow the sampling crew to collect samples in a riffle. Riffles were selected that were safe to wade and allowed the sampling crew to collect kick samples. The following sites met the objectives of this study: Klamath River upstream at Ah Pah riffle (Figure 8-17), Klamath River at Johnsons (Wautec) (Figure 8-14) and Trinity River above Klamath River (Figure 8-2).

8.3.2 Tributaries

Site selection criteria for macroinvertebrate sampling include spatial distribution, herbicide application activity, watershed restoration activities, proposed future development, and other concurrent water quality monitoring activities. Sites were located in the lower reaches of watersheds that characterize the water quality and watershed health condition throughout the lower Klamath (Figure 8-4, Figure 8-7, Figure 8-11, Figure 8-19, Figure 8-23, and Figure 8-27). YTEP is in the process of developing baseline conditions to document the magnitude and duration of water quality impacts. The following reasons were used as selection criteria for macroinvertebrate sampling:

1. *Spatial Distribution* - Sites located in the lower reaches of watersheds that characterize the water quality and watershed health condition throughout the lower Klamath. Areas chosen to monitor baseline and long-term trends.

2. *Activity Specific* -Sites located above and/or below herbicide applications and other activities that may potentially impact water quality.

3. *Watershed Restoration Activities*- Sites located in watersheds and sub-watersheds that have active or proposed restoration activities. Sites are selected to monitor the long-term trends by tracking the watershed's recovery.

4. *Proposed Future Development*- Sites near locations of resource and proposed resource development.

5. *Klamath Mainstem Water Quality Characterization*- Sites located in the main stem Klamath River in order to compliment the on going water quality studies and characterization.

Table 8-3 Selection criteria priority matrix for macroinvertebrate sampling

Stream	Watershed	Sub-Watershed	Site ID	Primary Criteria	Secondary Criteria	Other
Blue	Blue	Lower Blue	LB1	1	3	2
Mc Garvey	Mc Garvey	Mc Garvey	Mc1	3	1	
Turwar	Turwar	Turwar	Tu2	1	3	2
Tully	Tully	Tully	Yy1	4	1	2
Roaches	Roaches	Roaches	Ro1	1		
Mettah	Mettah	Metta	Me1	3	1	
East Fork Pecwan	Pecwan	East Fork Pecwan	EP1	1	4	
West Fork Pecwan	Pecwan	West Fork Pecwan	WP1	1	4	
Klamath River	Klamath River	Klamath River	KJ1	5	1	
Klamath River	Klamath River	Klamath River	AH1	5	1	
Trinity River	Trinity River	Lower Trinity	TR1	5	1	

8.4 Herbicide Monitoring

YTEP selects the unit(s) for surface water monitoring where herbicide migration is "most likely" to occur. Through the mapping of spray units, YTEP was able to identify units nearest creeks. Field visits to units were conducted to adequately assess slope, location to surface waters and accessibility for monitoring. Units to be sprayed with oust were not considered for monitoring because the analytical costs are too high. During this assessment, YTEP found several atrazine units that could be likely candidates for monitoring. YTEP was able to select only one site due to analytical costs. Based on the site assessment, YTEP selected timber harvest application unit SRC# 414 (unit number assigned by Green Diamond Resource Company) for monitoring.

Unit SRC# 414, 30 acres, is located in the Tectah Creek Watershed. Approximately 100 feet from the Tectah Creek mouth is a west fork tributary. The average slope for this area, according to Yurok Tribe Watershed data, is 32.25 degrees. The point at which water samples and water quality parameters were collected was approximately 200 feet from Tectah Creek up the west fork tributary (Figure 8-16).

8.5 Notchko Remote Automated Weather Station

During the initial stages of meteorological station installation several locations were assessed as to relative accessibility, vegetation cover, elevation, slope, ownership, threat of vandalism and other siting criteria as described in the Yurok Tribe Air Quality Program QAPP. The Notchko Remote Automated Weather Station (RAWS) site (Figure 8-7) was selected because of its exposure to canyon winds, placement outside of the 100 year floodplain, and its elevation above the Klamath River. Additionally, this site is owned by the Yurok Tribe, accessible year-round and not visible from the main road, thereby limiting threats of vandalism.

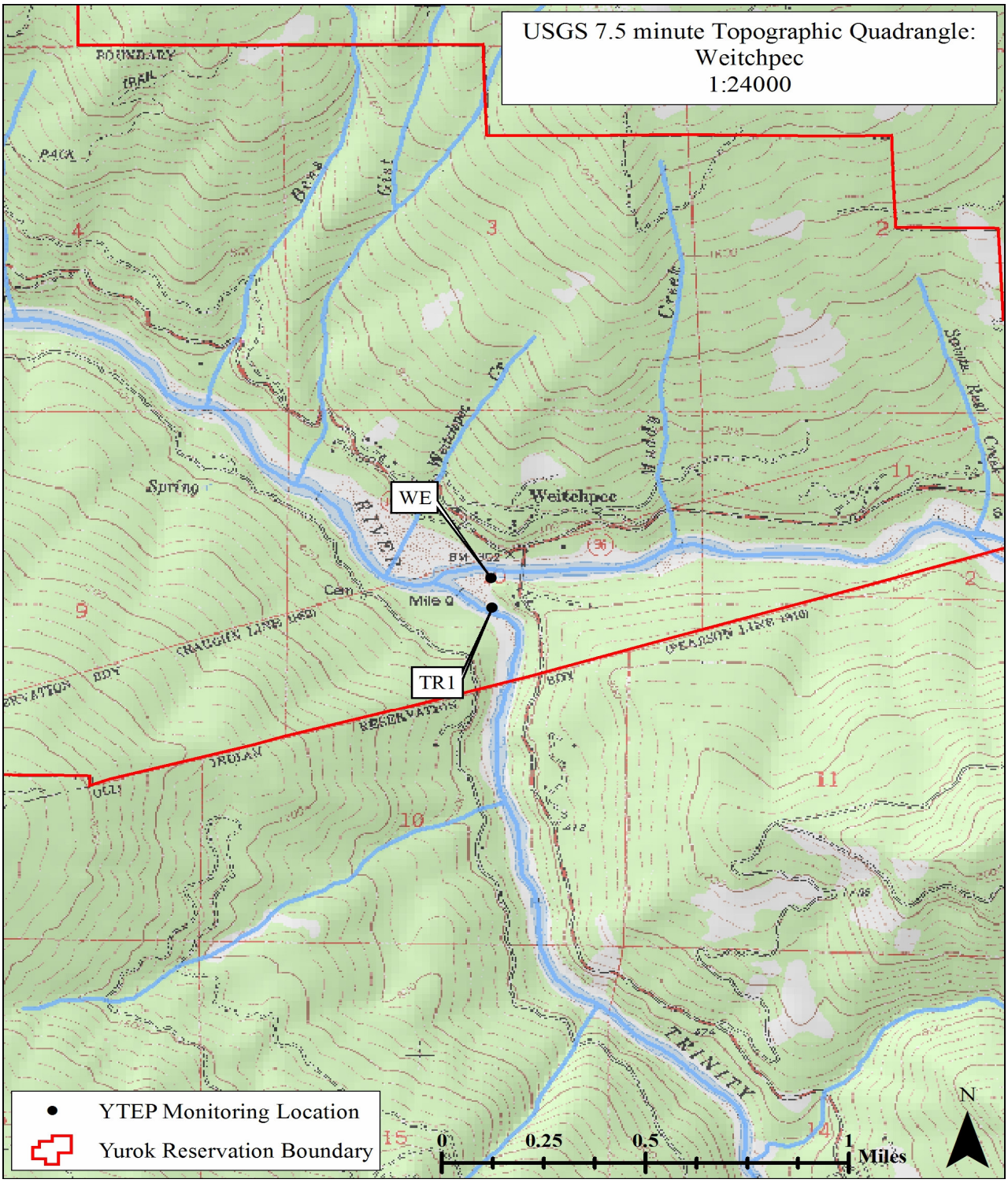

Figure 8-2 Klamath River above Trinity River (WE) and Trinity River above Klamath River (TR1) Monitoring Locations WY04

Figure 8-3 Klamath River/Trinity River Confluence 10/22/2004

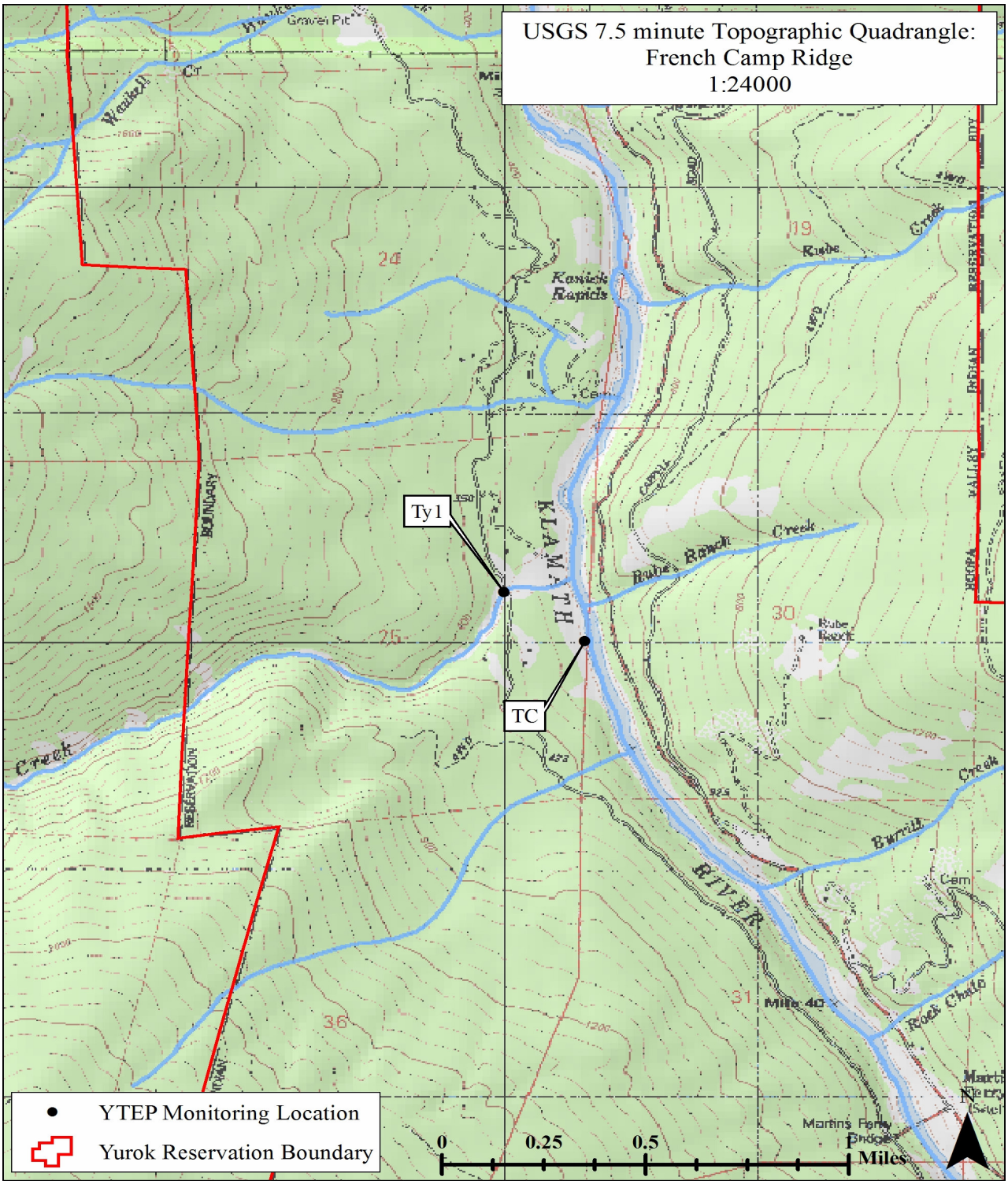

Figure 8-4 Klamath River above Tully Creek (TC), and Tully Creek (Ty1) Monitoring Locations WY04

Figure 8-5 Klamath River above Tully Creek (TC) Looking Upstream June 1, 2004

Figure 8-6 Tully Creek (TY1) Looking Downstream 4/29/2004

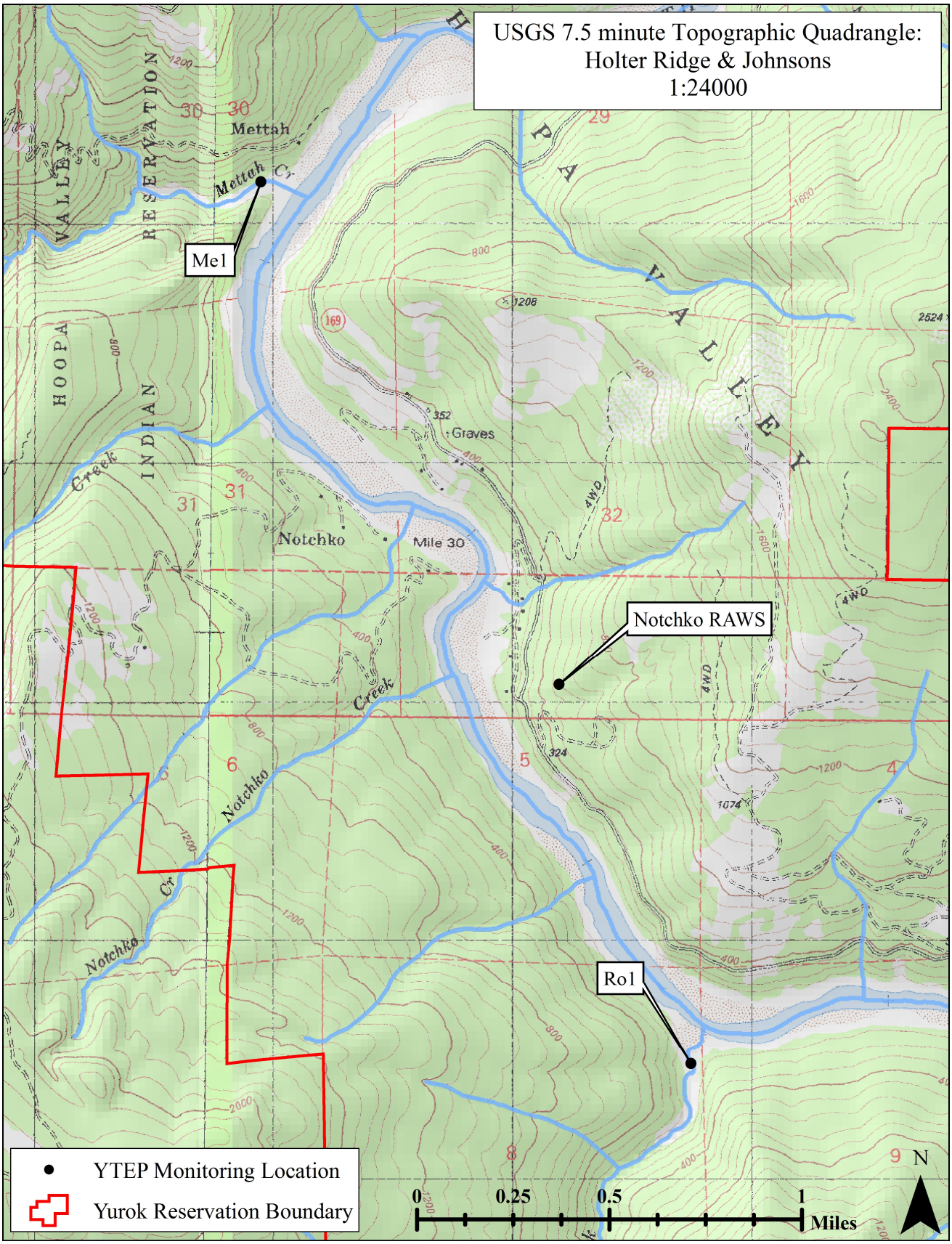

Figure 8-7 Roaches (Ro1)and Mettah (Me1) Creek Macroinvertebrate Monitoring Locations and Notchko Remote Automated Weather Station Monitoring Location WY04

Figure 8-8 Roaches Creek (Ro1) Looking Downstream April 29, 2004

Figure 8-9 Mettah Creek (Me1) Looking Downstream April 29, 2004

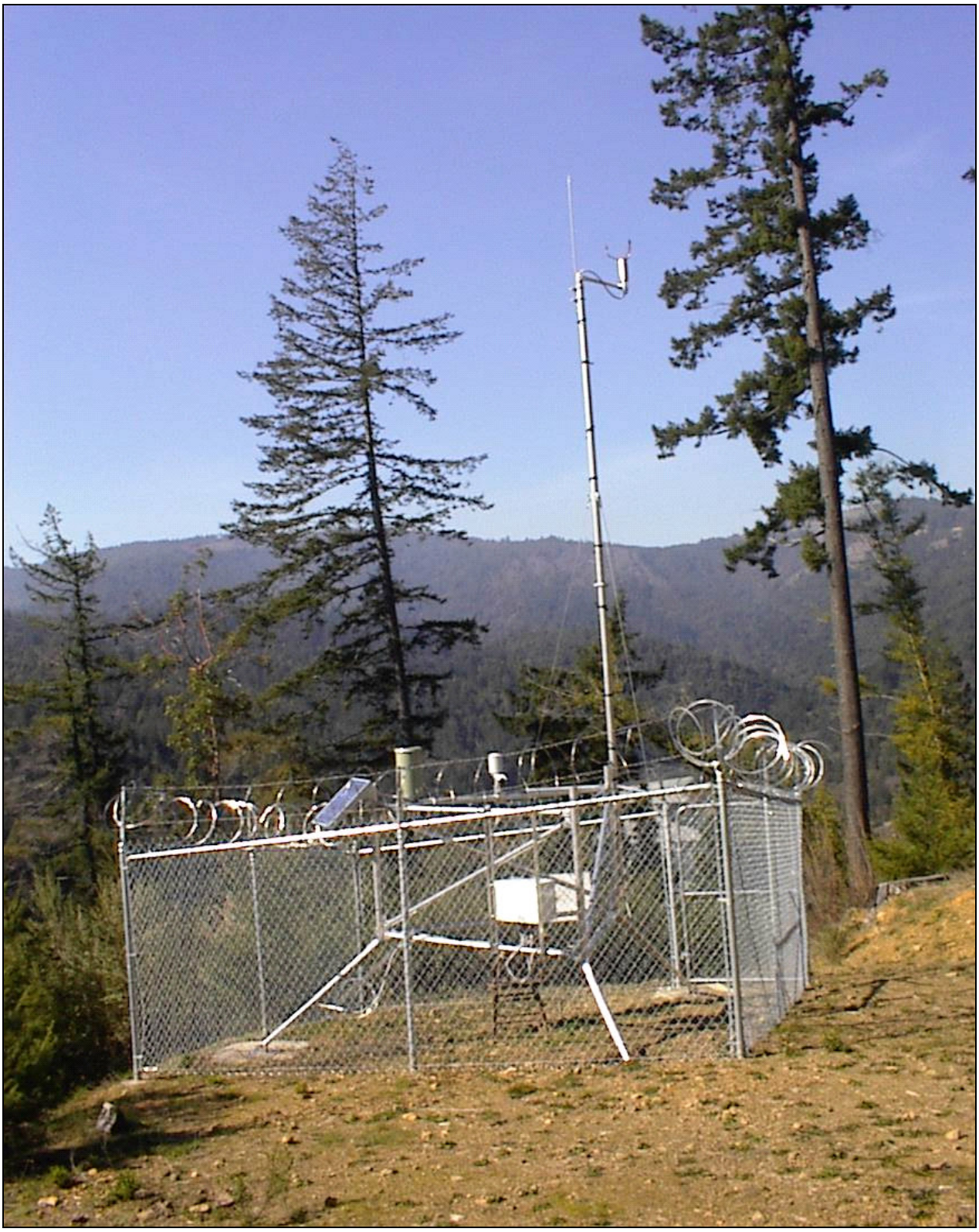

Figure 8-10 Notchko RAWS WY04

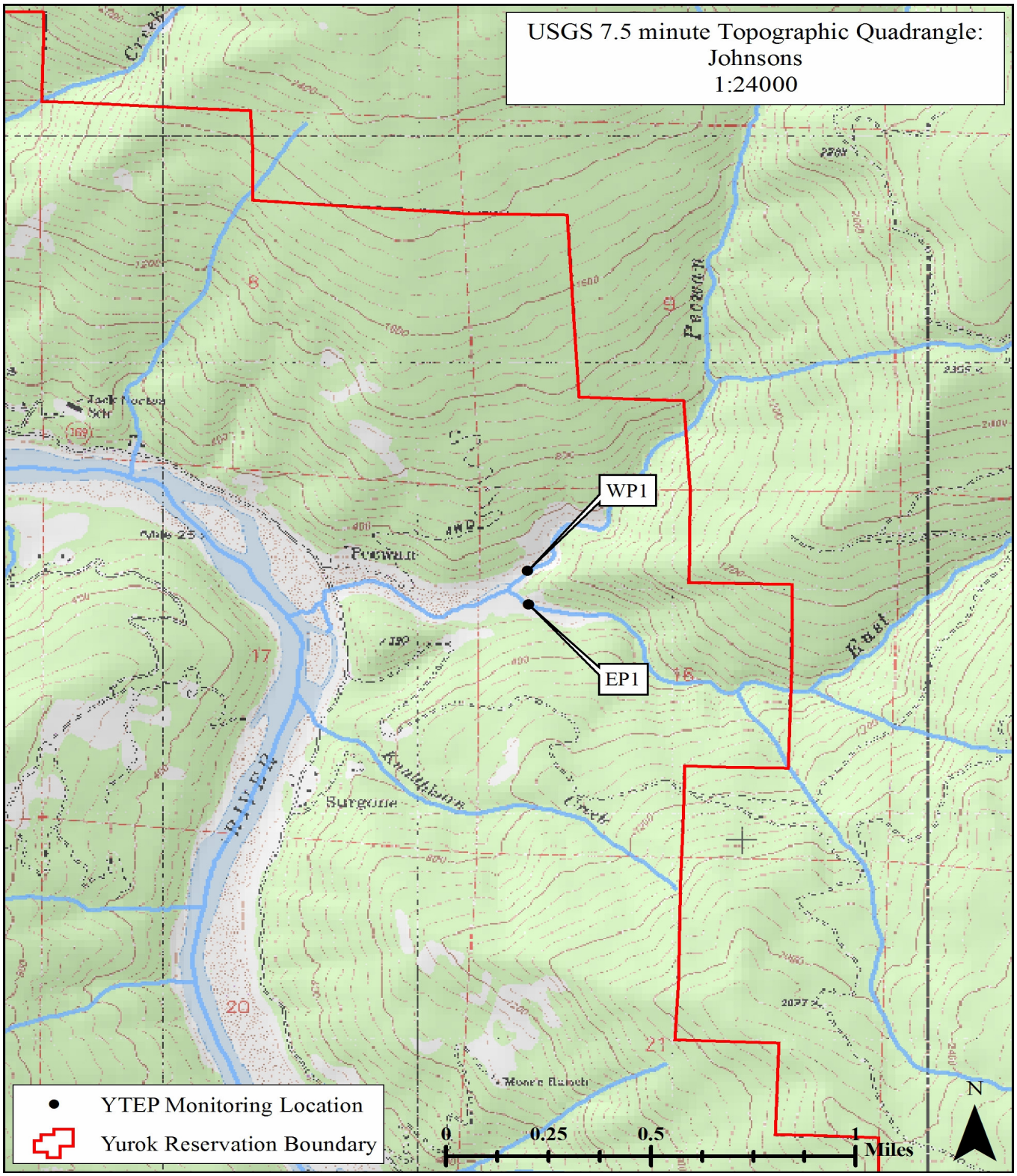

Figure 8-11 East and West Fork Pecwan Creek (EP1 and WP1) Macroinvertebrate Monitoring Locations WY04

Figure 8-12 East Fork Pecwan Creek (EP1) May 6, 2004

Figure 8-13 West Fork Pecwan Creek (WP1) May 6, 2004

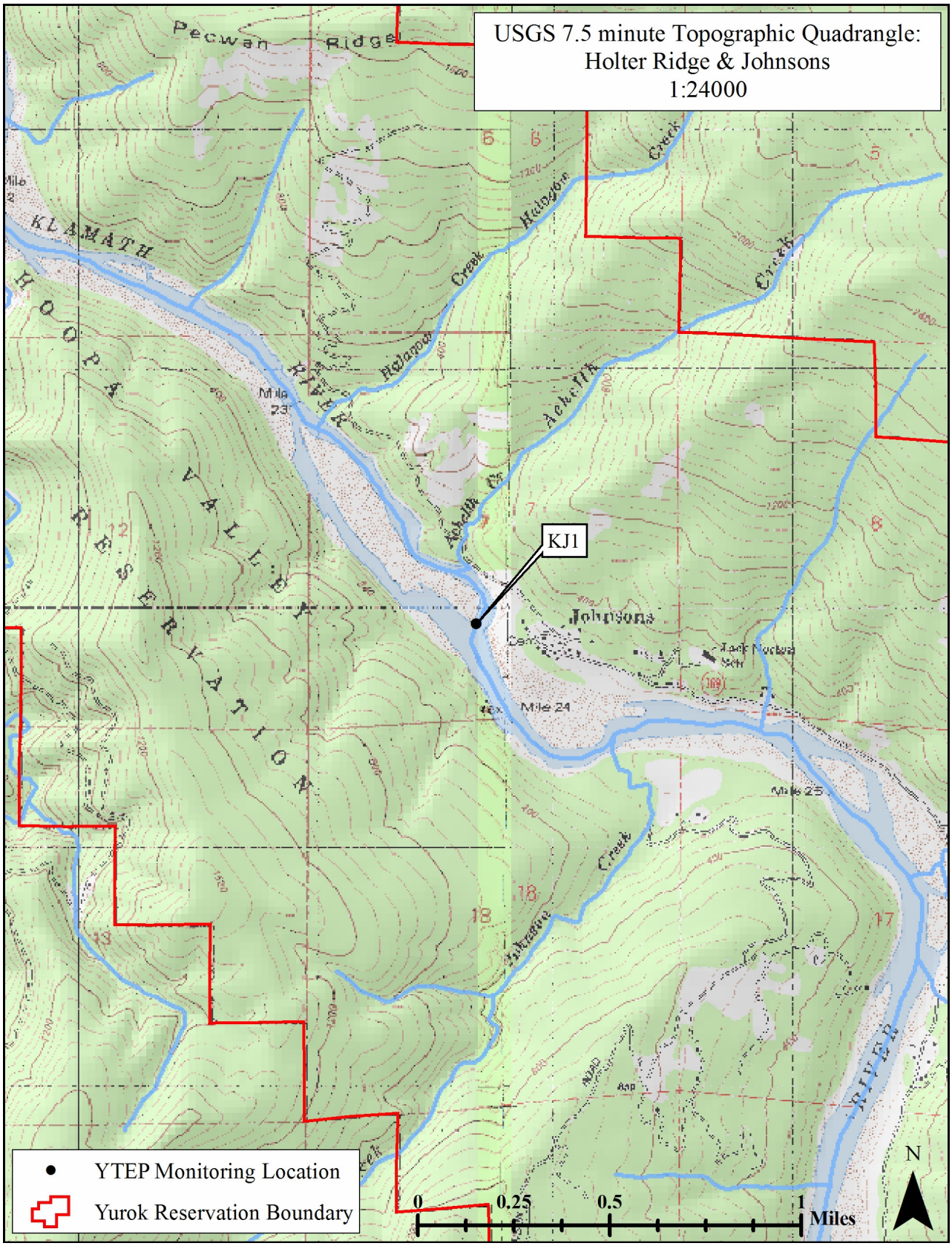

Figure 8-14 Klamath River at Johnsons (KJ1) Macroinvertebrate Monitoring Location WY04

Figure 8-15 Klamath River at Johnsons (KJ1) August 18, 2004

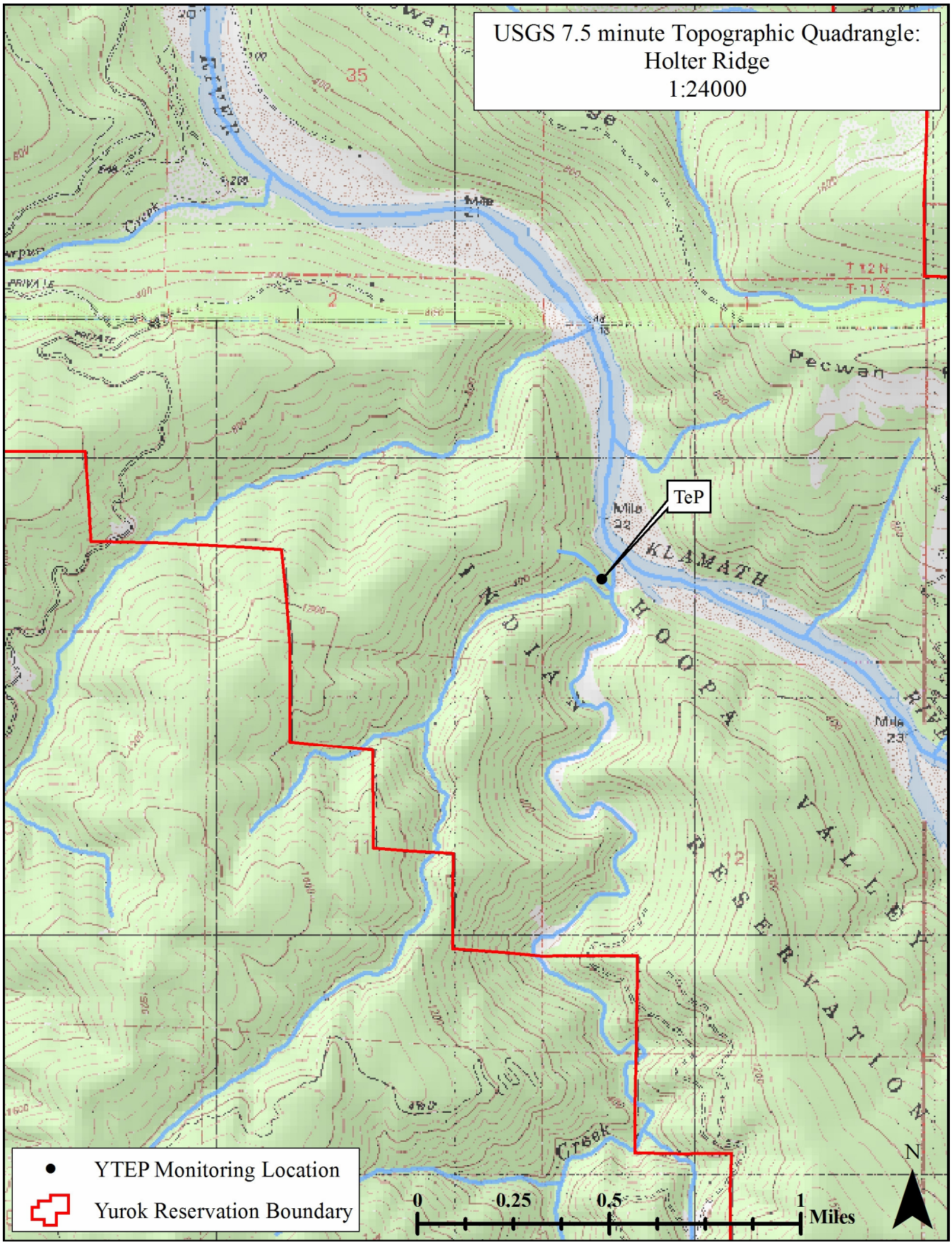

Figure 8-16 Tectah Creek (TeP) Herbicide Monitoring Location WY04

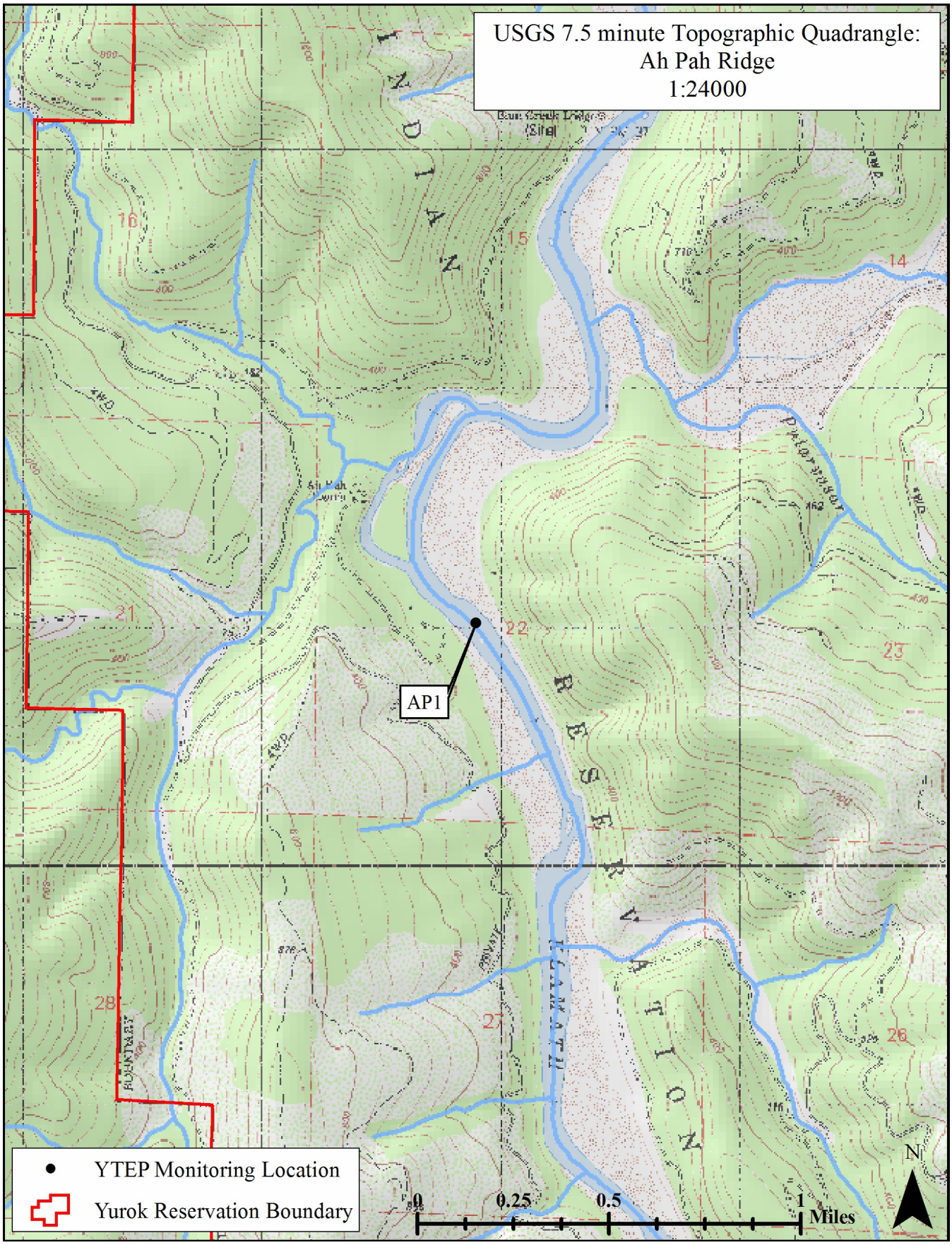

Figure 8-17 Klamath River at Ah Pah Riffle (AP1) Macroinvertebrate Monitoring Location WY04

Figure 8-18 Klamath River at Ah Pah riffle (AP1) August 18, 2004

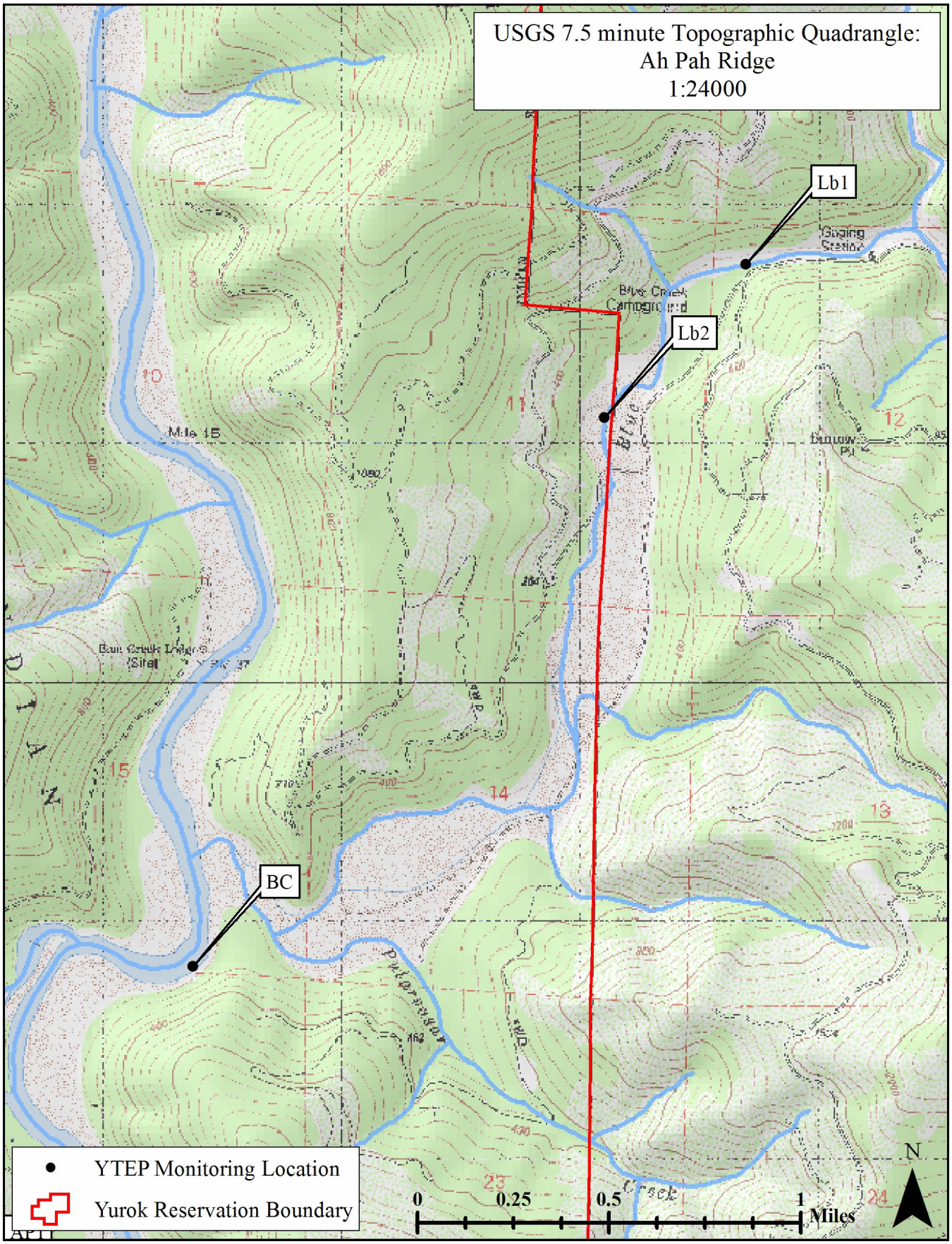

Figure 8-19 Klamath River above Blue Creek (BC) and Blue Creek Monitoring Locations (Lb1and 2) WY04

Figure 8-20 Klamath River above Blue Creek (BC) June 15, 2004

Figure 8-21 Blue Creek (Lb1) Staff Plate at Gaging Station WY04

Figure 8-22 Blue Creek (Lb2) Macroinvertebrate Sampling Riffle May 26, 2004

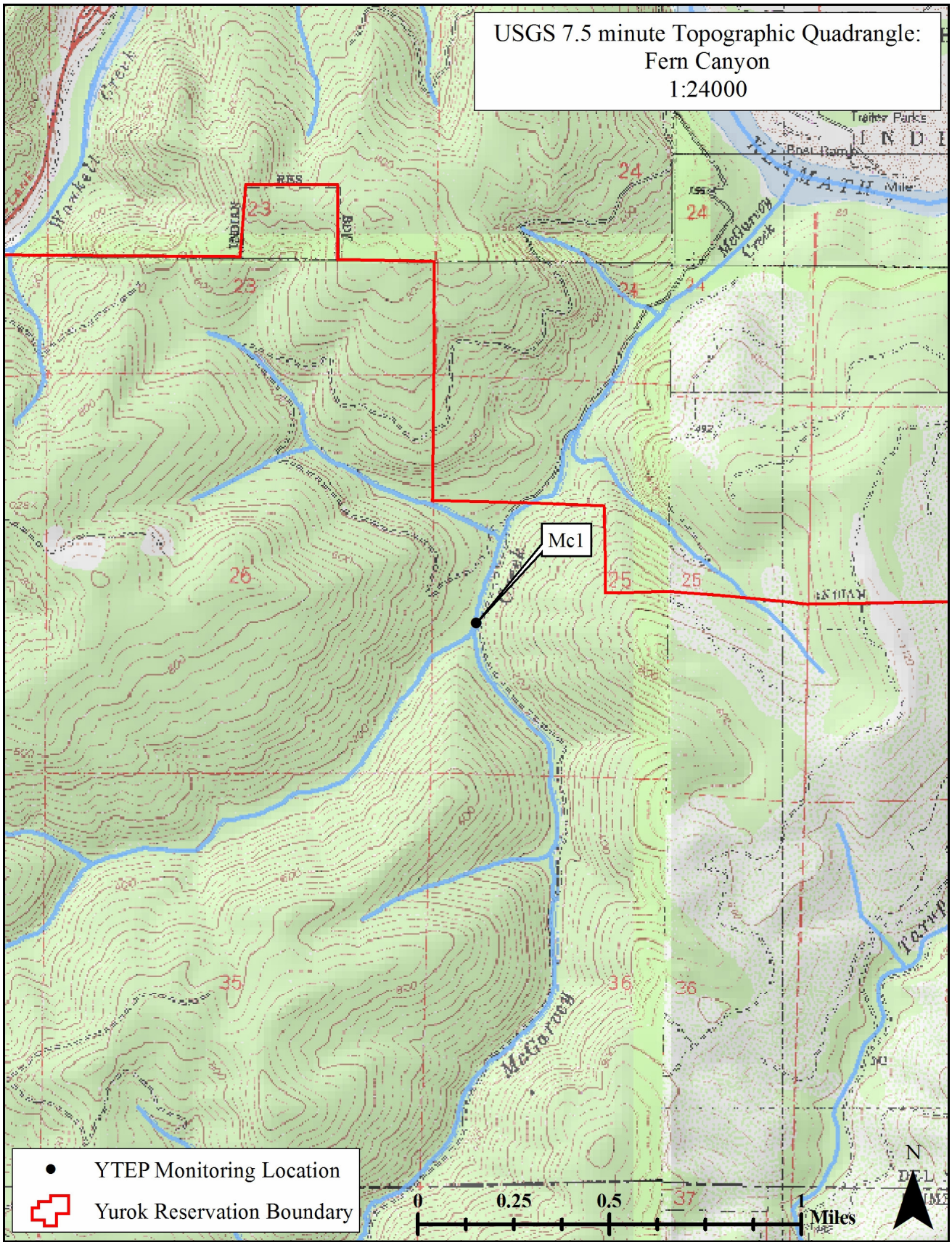

Figure 8-23 McGarvey Creek Gage Station and Macroinvertebrate Monitoring Location WY04

Figure 8-24 McGarvey Creek (Mc1) at Gaging Station WY04

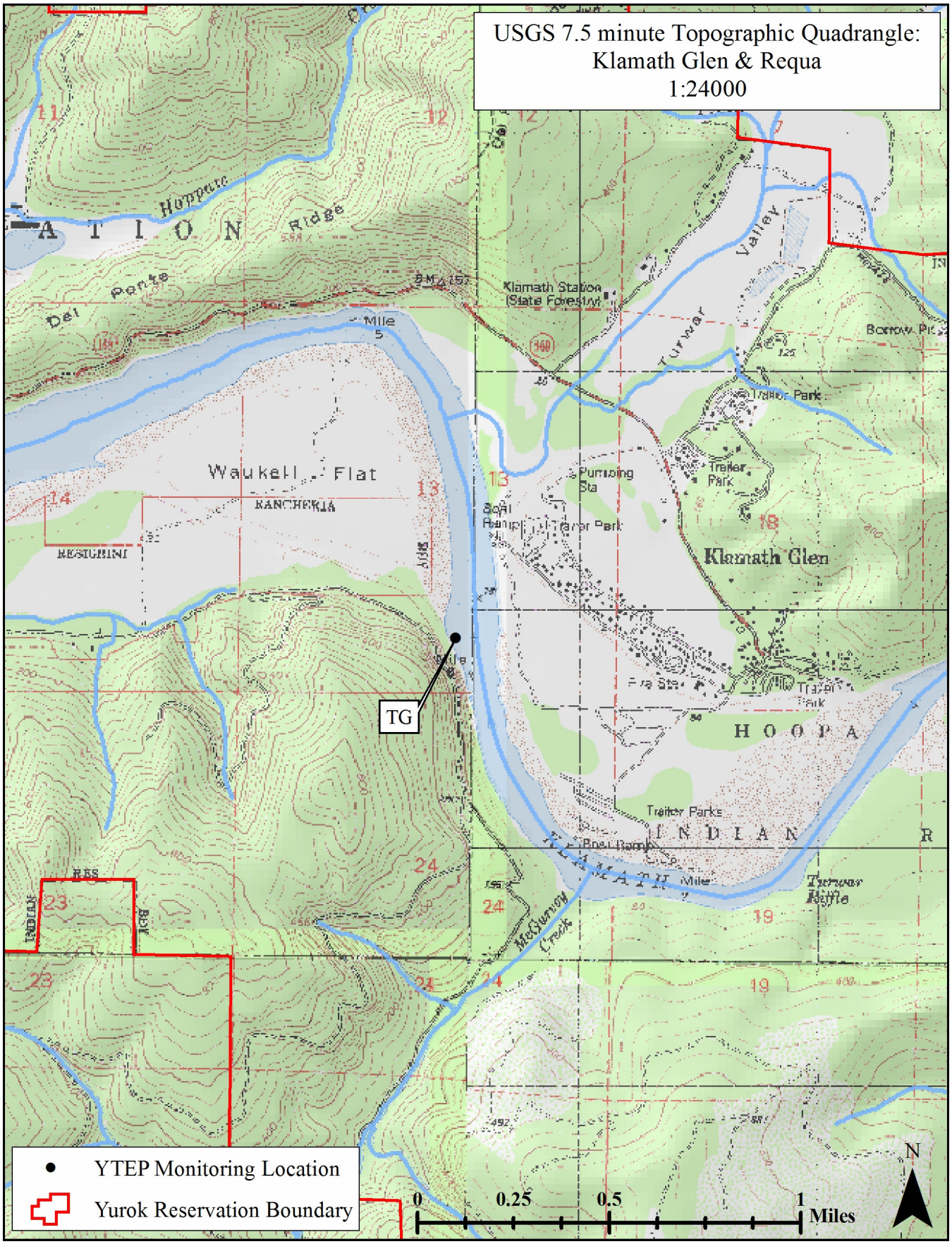

Figure 8-25 Klamath at Turwar Gage Water Quality Monitoring Location WY04

Figure 8-26 Klamath River at Turwar Gage (TG) Looking Downstream October 2004

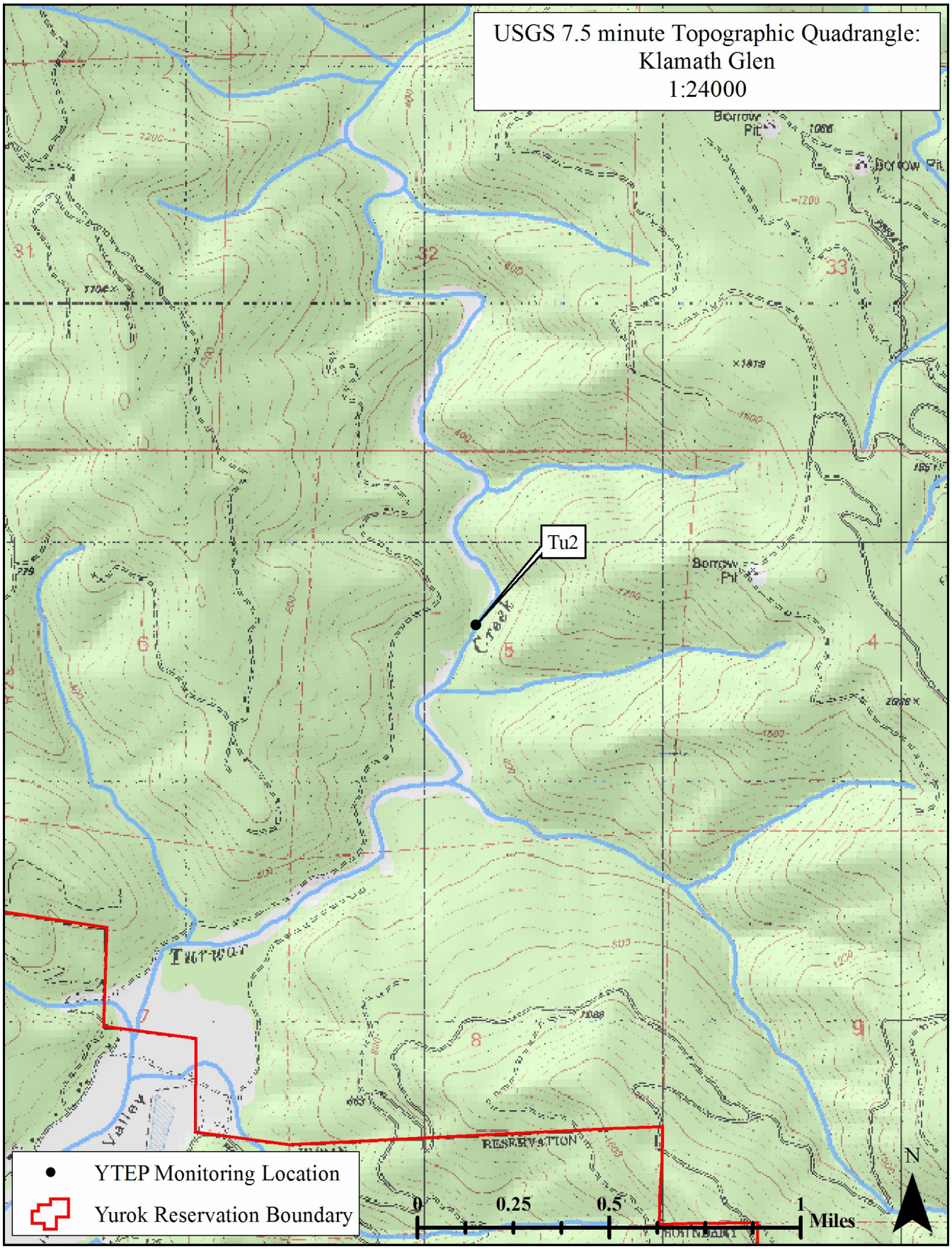

Figure 8-27 Turwar Creek Gage Station and Macroinvertebrate Monitoring Location WY04

Figure 8-28 Turwar Creek (Tu2) Looking Upstream April 27, 2004

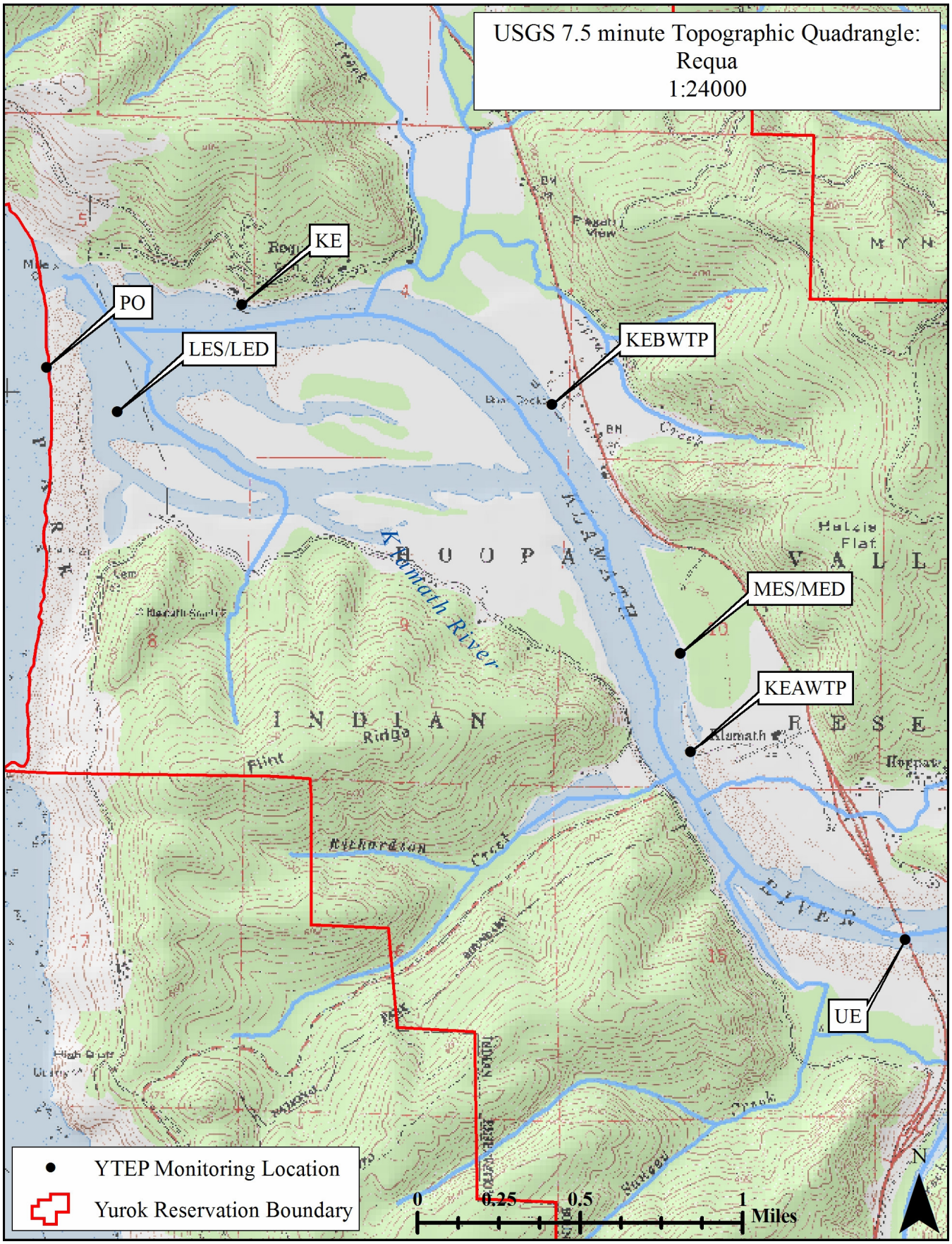

Figure 8-29 Klamath River Estuary Water Quality and Bacteria Monitoring Locations WY04

Figure 8-30 Klamath River Estuary near the mouth September 2004

9 Methods

9.1 Water Quality Monitoring

9.1.1 Mainstem

The study was initiated in the middle of May, continued throughout the summer months and terminated in October. Datasondes were programmed to record water temperature, pH, specific conductivity and DO at 30-minute intervals.

During this study, many QC measures were undertaken to ensure the data collected with the datasondes were of the highest quality. According to the 2004 datasonde operation protocol (Appendix A), datasondes were pre- and post-calibrated on site once every two weeks in order to account for electronic drift and bio-fouling. When the datasondes were deployed and extracted, an audit was performed with a freshly calibrated Hydrolab® Quanta (Quanta), a portable multi-probe instrument. Effort was made to record the Quanta measurements as close as possible to the datasonde and within five minutes of the datasonde recording a measurement.

Once the datasonde was extracted the DO membrane was either air dried or carefully dried with a Q-tip, care was taken in order to not remove any biofouling that existed on the DO membrane. The entire datasonde was then wrapped in a wet towel and DO readings were allowed to stabilize and the DO in mg/L were recorded as the initial reading. The DO probe was then calibrated for DO % saturation by entering the current site barometric pressure from the Surveyor or a handheld barometer. Field staff would then wait for the new value to stabilize and record the value in mg/L as the final reading.

Once this was done a post-calibration check and calibration of specific conductivity and pH was performed. The conductivity and pH probes were calibrated with solutions that were acclimated to the stream temperature. This entails the normal two part calibration which established the electronic drift from the initial readings of a known standard and additionally functioned as a calibration for the next deployment.

Following the calibration process, the DO membrane was replaced and other steps such as downloading the previous files, creating a new file and changing the batteries were completed. The datasonde was then redeployed to record temperature, specific conductivity and pH to maintain a continuous dataset for those parameters. The next day, YTEP staff returned to the site to calibrate dissolved oxygen percent saturation using the wet towel method as specified above. While monitoring for temperature, specific

conductivity, and pH remains consistent, on average two days of dissolved oxygen data must be disregarded during the calibration and overnight relaxation period.

Air temperature and relative humidity sensors were provided by USFWS and deployed at TG, BC, and WE sites to document meteorological conditions during the spring and summer months. YTEP deployed the sensor at the TG site on a red alder approximately 15 feet above the water's edge on the left bank looking downstream (LDS) on May 17th at 1045 hours and retrieved on October 25th at 1240 hours. YTEP deployed the air temperature/relative humidity sensor at the BC site on an Oregon ash approximately 10 feet above the water's edge on the right bank looking downstream (LDS) on May 17th at 1445 hours and retrieved on October 26th at an unknown time. USFWS staff deployed the air temperature/relative humidity sensor at the WE site on a tree behind the Yurok Tribal office approximately 50 feet above the water's edge on the right bank LDS. This sensor began logging on April 21st and the data set extends to July 6th due to battery failure.

Grab samples, discreet surface water samples, were also collected during the sampling season once a month beginning in June and ending in September. Samples were delivered to different labs during the 2004 season in an effort to find the lowest reporting limits possible. Samples were delivered to NCL in Arcata, CA and Sequoia Analytical in Petaluma, CA for analysis. NCL subcontracts chlorophyll-a and total organic carbon to Brelje and Race Laboratories, Inc., Environmental Technical Services, and Sierra Foothill Laboratory Inc., respectively. In addition, the bacteria samples collected in the Klamath River Estuary were analyzed by Humboldt County's Environmental Health laboratory. The parameters sampled are shown in Table 9-1.

During this study, many QC measures were undertaken to ensure the grab sample data that was collected was of the highest quality. Upon arrival at each site, a sampling churn was rinsed three times with deionized (DI) water. After rinsing with DI water, the churn was rinsed three times with stream water. The churn was then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allowed for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Table 9-1 Parameters measured in the Klamath River Water Quality Study

Analysis
Alkalinity
BOD / Biological Oxygen Demand
TSS / Total Suspended Solids
TDS / Total Dissolved Solids
NO2 / Nitrite
NO3 / Nitrate
NH3/ Ammonia
TKN Total Kjeldahl Nitrogen
Chlorophyll-a
Pheophytin-a
TOC / Total Organic Carbon
Total-P / Total Phosphate Phosphorus
Ortho-P / Orthophosphate Phosphorus
Ca / Calcium
Mg / Magnesium
E. Coli
Strep. Faecalis
Total Coliform

Proper use of the churn guaranteed the water was well mixed before the sample was collected. The churn was stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second. This mixing continued while the bottles were being filled. If filling had stopped for some reason, the stirring rate was resumed before the next sample was drawn from the churn.

The sample bottles and chemical preservatives used were provided by the contract lab and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn once before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples were placed in coolers on ice for transport to the contract lab for analysis.

Benthic algae sample collection methods employed were consistent with a protocol followed by other stakeholders monitoring benthic algae in the Klamath Basin in 2004. Dr. Mike Deas developed the methods based on the USGS benthic algae sampling methods for the National Water Quality Assessment Program (NAWQA) water quality sampling program. Variance from the USGS methods included selecting fewer sites than recommended (due to budget constraints) and the naming sequence.

The methods involve scraping a 1x3 inch of algae from a submerged rock and carefully pouring the scrapings into a sample jar with Lugoll's preservative. The rock was selected by the following parameters:

- Depth: 1 to 2 feet (measured with a stadia rod or current meter staff)
- Velocity: 1 to 2 feet per second (measured with a current meter)
- Exposure: clear sky (i.e., no serious topographic shading, nor riparian shading)

The sites were not random, instead the assemblage that was most prevalent was selected, i.e., not the very-near shore assemblage and not the deep water assemblage.

The water quality monitoring project in the Klamath River Estuary followed similar methods to deploying datasondes in the Klamath River. Datasondes were deployed from buoys that allowed sondes to stay in their same position as tides came in and out. The NCRWQCB provided YSI 6600 datasondes that were operated for one week in June, July and September and for two weeks in August. Datasondes were calibrated on site before deployment with support from both NCRWQCB and YTEP. When datasondes were extracted dissolved oxygen was post-calibrated on site while pH and specific conductivity was post-calibrated back in Santa Rosa at the NCRWQCB office.

Nutrient samples were collected in the estuary using a Kemmerer sampler provided by NCRWQCB. The Kemmerer was pre-rinsed before sampling occurred and rinsed again in between sites. Samples were collected at the depth and surface at the Lower Estuary and Middle Estuary locations and at the middle of the water column depth at the Upper Estuary location. The surface was defined as the top foot of the water column and the depth sample was defined as the bottom of the stream bed. Duplicate and blank samples were collected to determine if sample contamination was occurring in the field.

9.1.2 Tributaries

Water quality monitoring was periodically performed during the winter near gaging stations in Blue, McGarvey, and Turwar creeks. Most of the data collected were measurements to assist hydrologic studies in the basin. Parameters monitored varied by site and deployment date and included but were not limited to turbidity, water temperature, and specific conductivity.

Several different Hydrolab® Multi-Parameter Water Quality Datasondes were used during monitoring in Blue and McGarvey Creeks. These instruments are programmed to measure turbidity, specific conductivity, and water temperature on a fifteen-minute time step. Two of the Hydrolab® datasondes

monitor turbidity using infrared emitter and photoiode detectors (SN #37636 and #37639), one Hydrolab® uses a shuttered turbidity sensor (SN #37658), and the final Hydrolab® uses a 4-Beam turbidity probe. Table 9-2 details specific Hydrolab® use during each deployment. Between 6/30/04 – 7/14/04, a Yellow Springs Instruments® (YSI) 600QS Multi Parameter Water Quality Monitor (Serial Number (SN) #04C3936 AC) was deployed in Blue Creek. Hydrolab Datasondes® were calibrated every two weeks as prescribed in QC procedure due to bio-fouling and electronic drift during datasonde deployment and extraction. Audits were performed with a Quanta® handheld water quality meter. Measurements were recorded within five minutes of programmed datasonde measurement.

Turbidity and temperature were continuously monitored in Turwar Creek using a DTS-12 turbidity sensor (Forest Technology Systems (FTS)) programmed to record at fifteen-minute intervals. The probe is serviced and re-calibrated if necessary annually by FTS prior to redeployment.

Table 9-2 Location, deployment dates, turbidity probe type, and parameters monitored in tributaries during WY04

			Parameters					
Site	**Time Period**	**Turbidity Sensor Type**	**Turbidity (NTU)**	**Temp (C)**	**Specific Conductivity (µS/cm)**	**pH**	**DO (% Sat)**	**DO (mg/L)**
Blue	11/3/03 – 11/26/03	Hydrolab 4-Beam	X	X	X			
Blue	12/5/03 – 1/7/04	Hydrolab Infrared Emitter and Photodiode Detector	X	X	X			
Blue	6/30/04 – 7/17/04	NA		X	X	X	X	X
McGarvey	11/3/03 – 12/1/03	Hydrolab Shuttered	X	X	X			
McGarvey	12/5/03 – 1/7/04	Hydrolab Shuttered	X	X	X			
McGarvey	1/15/04 – 1/29/04	Hydrolab Shuttered	X	X	X			
McGarvey	2/13/04 – 2/20/04	Hydrolab 4-Beam	X	X	X			
McGarvey	3/3/04 – 3/19/04	Hydrolab Infrared Emitter and Photodiode Detector	X	X	X			
Turwar	10/1/03 – 6/25/04	DTS-12 Turbidity Probe	X	X	X			
Turwar	9/16/04 – 9/30/04	DTS-12 Turbidity Probe	X	X				

9.2 Hydrologic Monitoring

The NCRWQCB lists the lower Klamath River on its "impaired watch list" for excessive sediment loading, suggesting that more research is needed. YTEP hydrologic monitoring and pre-Total Maximum Daily Load (TMDL) research in selected tributaries is filling this data gap. Among other objectives, the data will be used to help develop a sediment budget for the lower Klamath River basin.

Gage height was measured at computerized gaging stations with WaterLog® Pressure Transducer/Data Collection Platforms (Models H-350 and H-350XL) at McGarvey, Blue, and Turwar Creeks. Stream levels were recorded every 15 minutes. This data was downloaded from the gaging station onto a portable laptop computer or removable data card during site visits. The stage height was compared visually to staff plate readings and was adjusted accordingly when found to be more than 0.05 feet off. Flow measurements taken at each site were used to create a rating table that was used to compute estimated discharge based on gage height. Stream discharge was measured by wading or with a bridge crane using USGS methodology (USGS 1999) (Appendix A). Discharge was measured using either a Price AA® or Pygmy® flow meter, depending on stream depth, and an AquaCalc® flow computer. Minimum, maximum, and average daily streamflow were calculated, and total monthly discharge in acre feet was calculated using the following formula:

$$\text{Acre Feet / Month} = \left\{ \frac{(x)\text{cf}}{\text{sec}} * \frac{60\,\text{sec}}{\text{min}} * \frac{60\,\text{min}}{\text{hr}} * \frac{24\text{hr}}{\text{day}} * \frac{\#\text{days}}{\text{month}} \right\} * \frac{1\text{acrefoot}}{43{,}560\,\text{cf}}$$

YTEP also periodically collected suspended sediment samples at gaging stations during WY04. Depth integrated samples were collected using either a US DH-81 wadable sediment sampler or US D-74 sampler attached to either a bank operated cableway or crane for non-wadable sampling. YTEP followed Equal Width Increment (EWI) methodology using USGS methodology (USGS 1998). Sediment samples were analyzed by Graham Mathews and Associates, Arcata, California, following all USGS protocols to determine suspended sediment concentrations (SSC).

9.3 Macroinvertebrate Sampling

Evaluating the biological community of a stream or river through assessments of macroinvertebrate provides a sensitive and cost effective means of determining stream condition. Macroinvertebrate (invertebrates large enough to be seen with the naked eye) are fairly stationary, and are responsive to human disturbances. In addition, the relative sensitivity or tolerances of many Macroinvertebrate to stream conditions is well known. Sampling of stream macroinvertebrate for biological assessments is an essential component of any comprehensive stream condition evaluation.

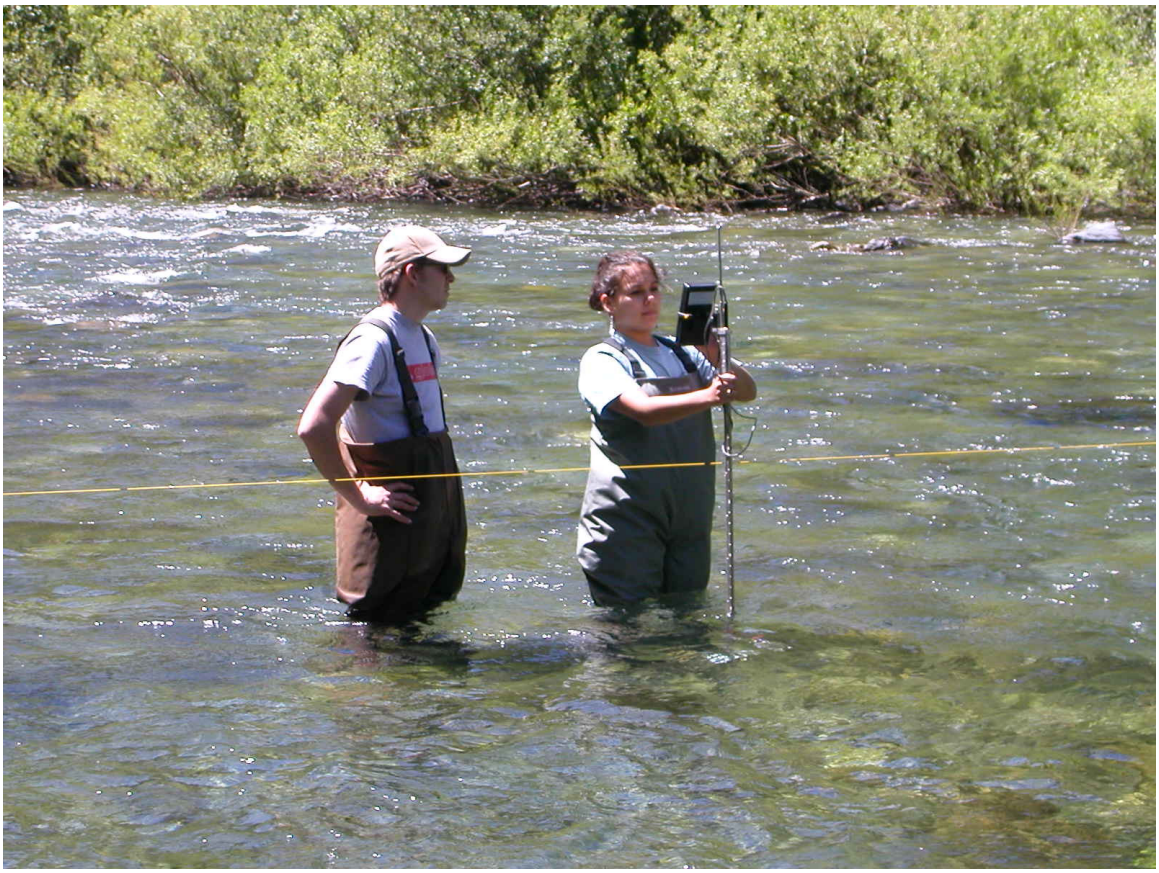

Figure 9-1 Wadable Stream Flow Measurement in Blue Creek on 5/26/2004, YTEP Assistant Director Ken Fetcho and Intern Seafha Blount

The object of studying macroinvertebrate communities is to monitor the general health and water quality of the Klamath River and its tributaries. According to the California Stream Bioassessment Procedure (CBSP) 2003 version developed by the CDFG, benthic macroinvertebrate communities indicate physical and habitat characteristics that determine the stream integrity and ecological health.

YTEP sampled benthic macroinvertebrate populations in selected tributaries of the lower Klamath River and at two locations along the Klamath River and one in the Trinity River during the spring and summer months, respectively (Table 8-1). Sampling was performed using the non-point source assessment methods located in the CSBP 2003 that the CDFG has adapted from the USEPA's *Rapid Bioassessment Protocols of use in Streams and Rivers* (EPA/841-B-99-002). This protocol is located in Appendix A. The Assistant Director, Program Coordinator, Program Technician and Program intern collected specimens which were sent to a lab where a certified taxonomist identified and calculated the number and types of species.

A variety of QC measures were undertaken in the macroinvertebrate sampling. Sample labels were properly completed, including the sample identification code, date, stream name, sampling location, and collector's name and placed into the sample container. The outside of the container was labeled with the same information. Chain-of-custody forms, when needed, included the same information as the sample container labels. After sampling had been completed at a given site, all nets, pans, etc. that had come in contact with the sample were rinsed thoroughly, examined carefully, and picked free of organisms and debris. The equipment was examined again prior to use at the next sampling site.

Data generated in the field and laboratory is reviewed prior to being released internally or to an outside agent. Laboratory processing is contracted to Jonathan Lee, a qualified local CSBP taxonomist and California Bioassessment Laboratories Network (CAMLnet) member. The CSBP has three levels of Benthic Macroinvertebrate (BMI) identification. Level 3 is the professional level equivalent and requires identification of BMIs to a standard level of taxonomy, usually the genus and/or species. If questionable macroinvertebrates are encountered, the CDFG Aquatic Bioassessment Laboratory is used as a reference to verify the specimens.

After processing the samples, the biological matrices are received from the taxonomist in an Excel spreadsheet format identifying the sample ID and the breakdown of BMI species into standard taxonomic levels.

9.4 Herbicide Monitoring

Surface water samples were collected in conformance with the *Yurok Tribe Surface Water Monitoring Sampling and Analysis Plan for Forestry Herbicides* (January, 2002). Water Samples were collected as independent discrete grab samples using a depth integrated collection method, every 30 minutes. Each sample was collected with a *Nalgene*® sampling churn and split into two one-liter amber glass bottles. All sampling equipment was triple rinsed with DI water prior to each sample collection. All water samples were transported in a cooler with blue ice. Samples were stored in the Yurok Tribe's water quality laboratory refrigerator prior to laboratory transport. An independent laboratory NCL) analyzed all surface water samples for atrazine (*EPA method 619*). In order to assure quality control for this project, a background and a field rinse blank were collected. The field rinse blank was submitted to the laboratory as a regular sample.

Water quality parameters were collected with a datasonde deployed approximately three feet below the sample point. The datasonde collected water quality parameters on a fifteen-minute continuous basis for temperature, dissolved oxygen, pH, and specific conductivity from 3/8/04 at 1410 hours to 3/25/04 at 1510 hours. Datasondes were programmed, calibrated, and installed in conformance with the *Yurok Tribe Quality Assurance Program Plan: Water Quality Assessment and Monitoring, April 2001.* A rain gauge was secured to a post in the creek; rainfall data was recorded during each site visit and sample collection.

9.5 Notchko Remote Automated Weather Station

A RAWS located across the Klamath River from Notchko Creek measures ambient weather conditions. The weather station is on loan from the Tribal Air Monitoring Support (TAMS) Center and the Institute for Tribal Environmental Professionals (ITEP). Certain procedures such as pesticide monitoring are dependant upon the amount of rainfall that has occurred. Meteorological data, specifically rainfall, provides information related to monitoring surface water for the presence of herbicides, and provides baseline information for hydrologic and water quality studies.

The Notchko RAWS began operating on October 10, 2001. The station is located at 41º 17' 23" North latitude, 123º 51' 27" West longitude, approximately 495 feet above sea level. The following parameters were measured at the site on an hourly basis throughout the year: air temperature; rainfall; average and gust wind speed/direction; barometric pressure; relative humidity; solar radiation and fuel moisture/temperature. Historic data from this site can be retrieved on the internet at http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCYUR. For the purposes of this report, only rainfall data is presented due to its relevance to the water quality and hydrology data presented.

10 Results

10.1 Water Quality (Mainstem)

10.1.1 Klamath River above Trinity River (Weitchpec)

10.1.1.1 Temperature

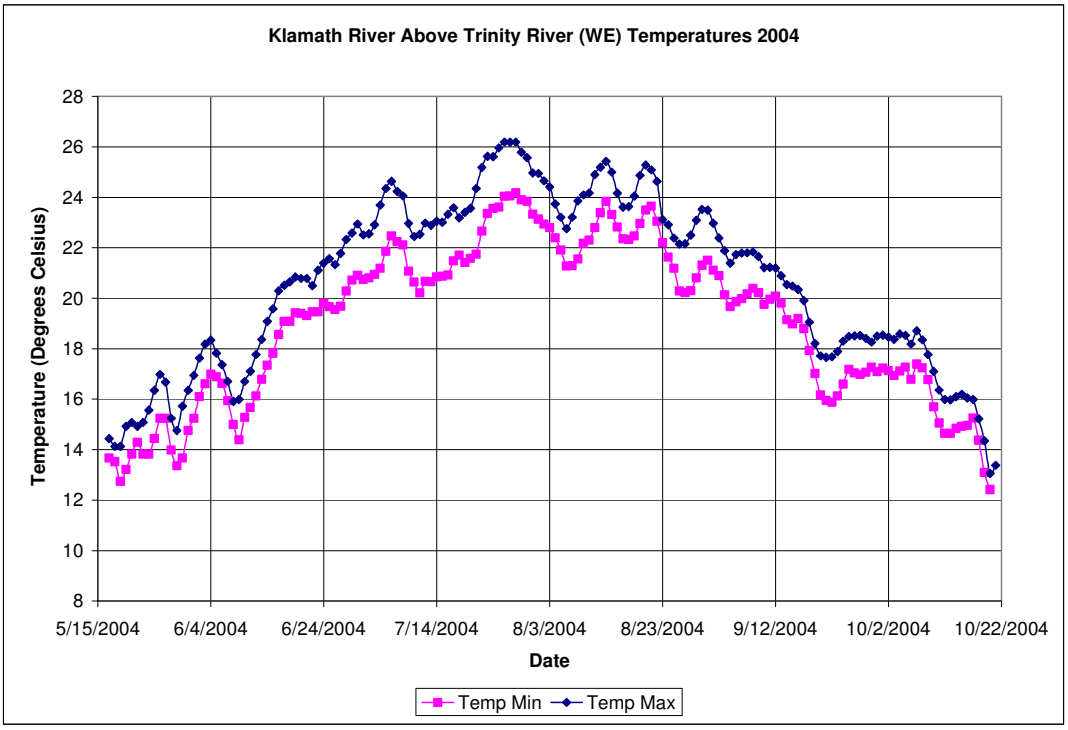

Figure 10-1 Water Temperature values for the Klamath River above Trinity River WY04

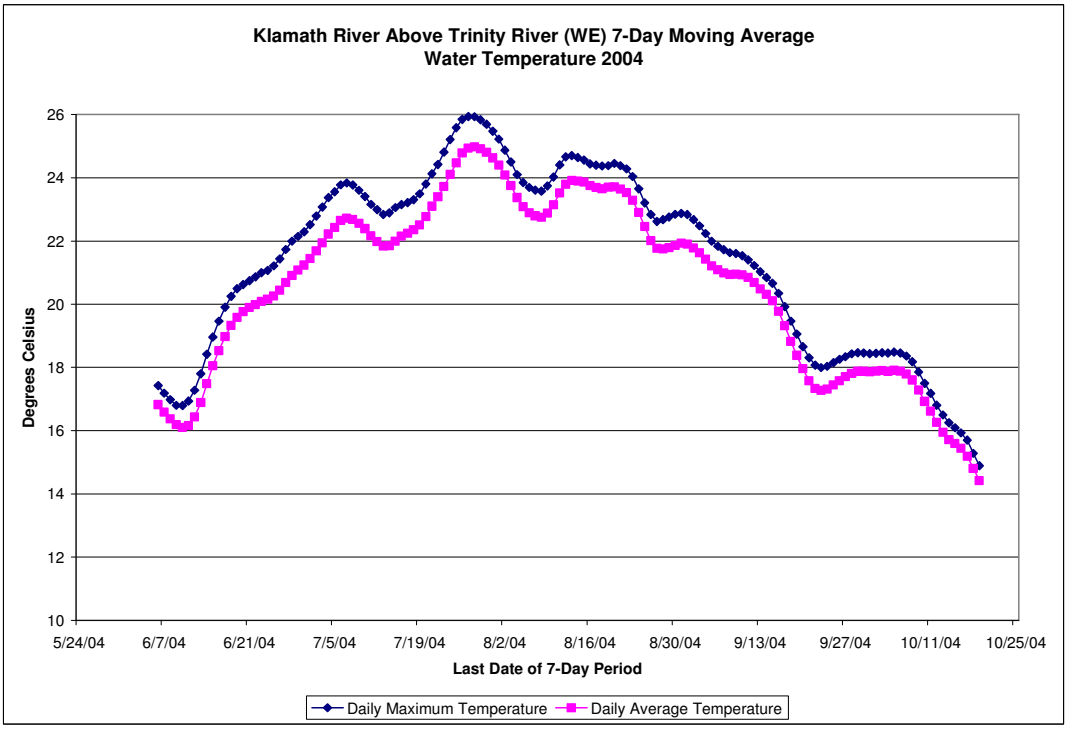

Figure 10-2 7-Day Moving Average Water Temperature for the Klamath River above Trinity River WY04

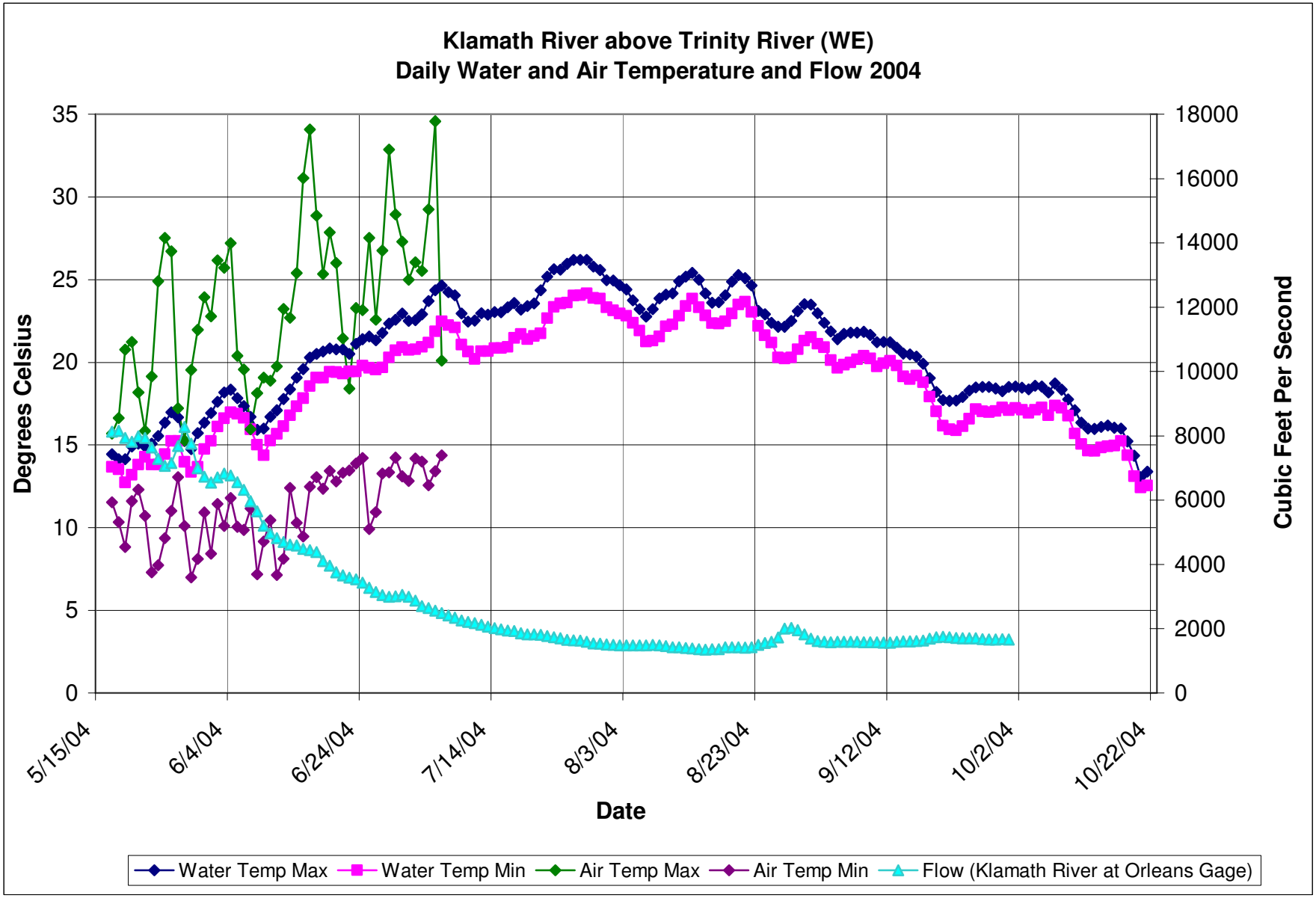

Figure 10-3 Air and Water Temperature and Flow Values for the Klamath River above Trinity River WY04

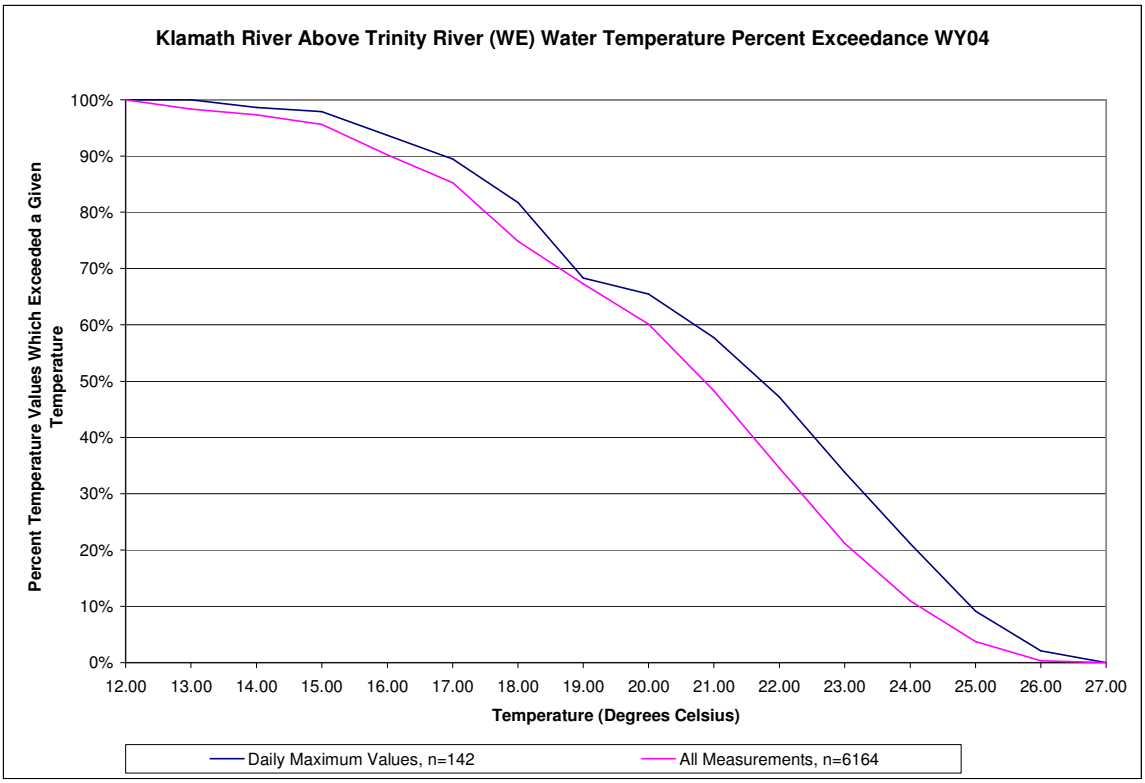

Figure 10-4 Klamath River above Trinity River Water Temperature Percent Exceedance WY04

10.1.1.2 Dissolved Oxygen

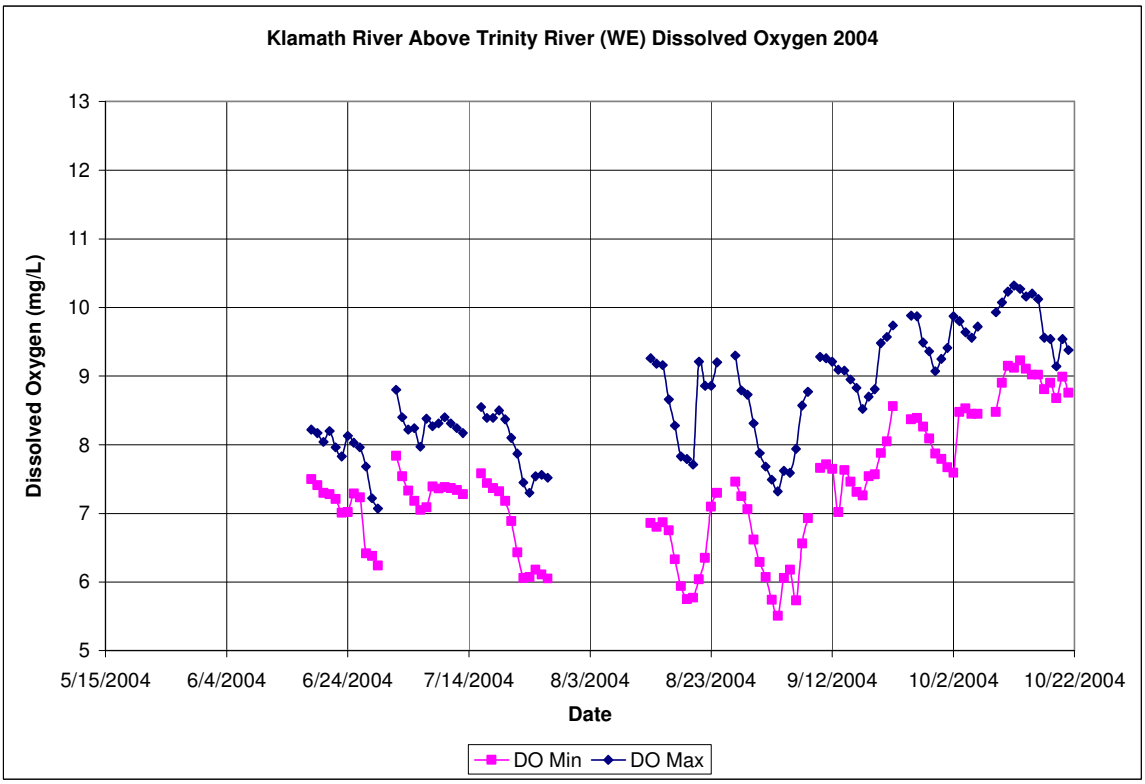

Figure 10-5 Dissolved Oxygen Values for the Klamath River above Trinity River WY04.

10.1.1.3 pH

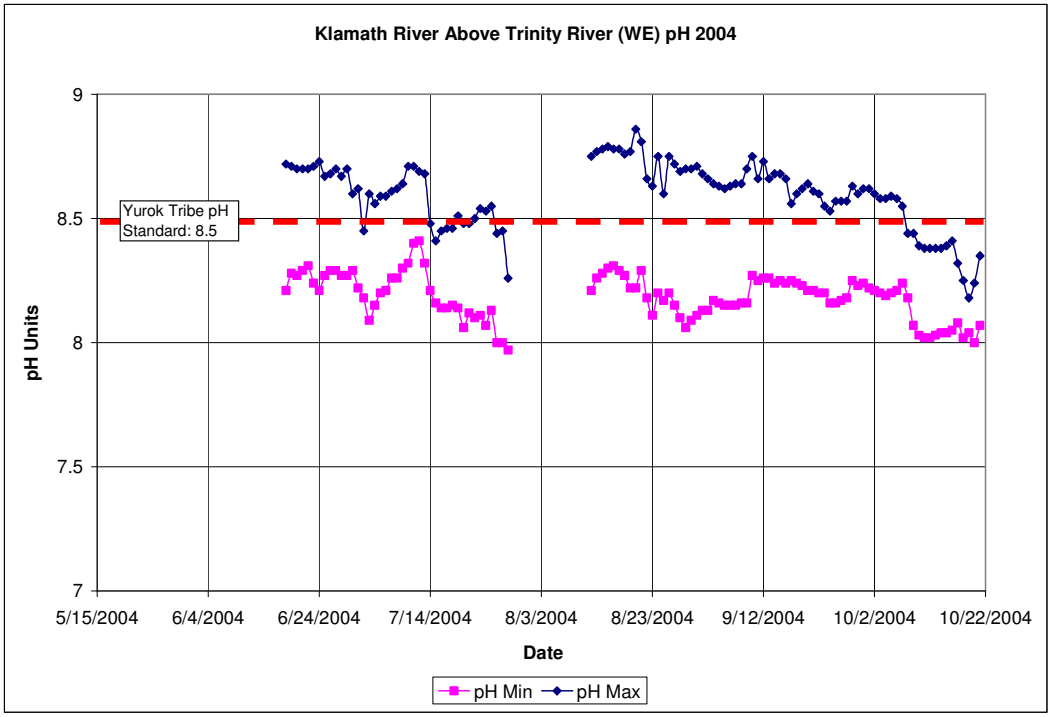

Figure 10-6 pH Values for the Klamath River above Trinity River WY04

10.1.1.4 Specific Conductivity

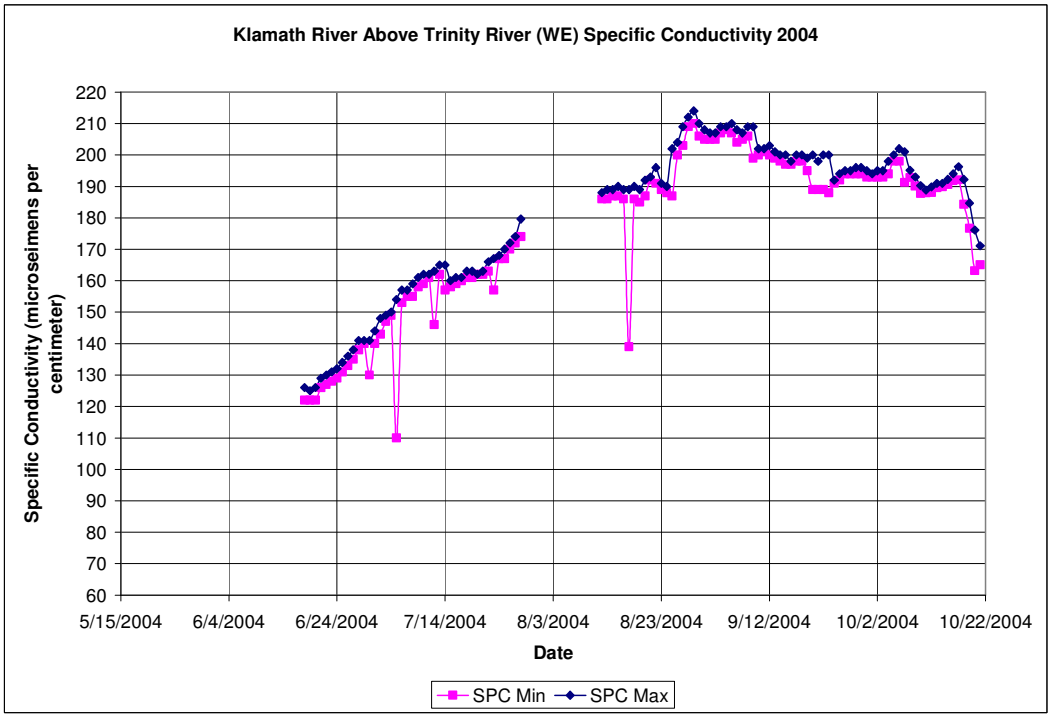

Figure 10-7 Specific Conductivity Values for the Klamath River above Trinity River WY04

10.1.2 Trinity River above Klamath River

10.1.2.1 Temperature

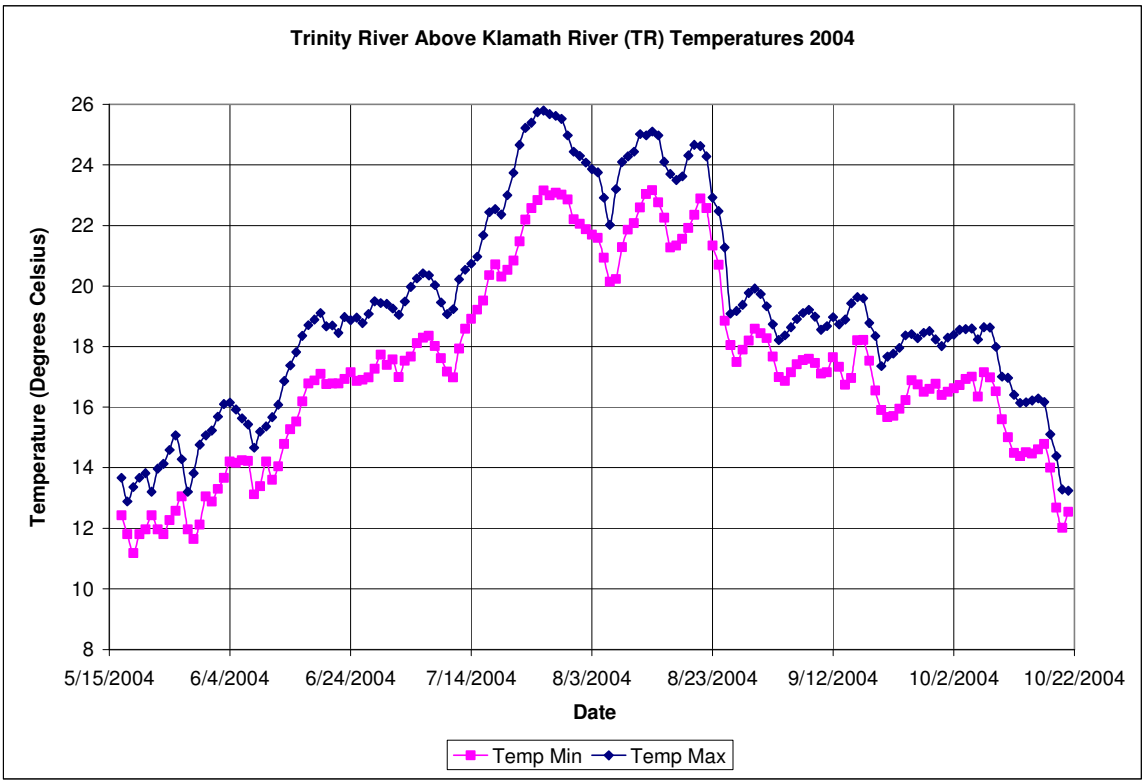

Figure 10-8 Water Temperature Values for the Trinity River above Klamath River WY04

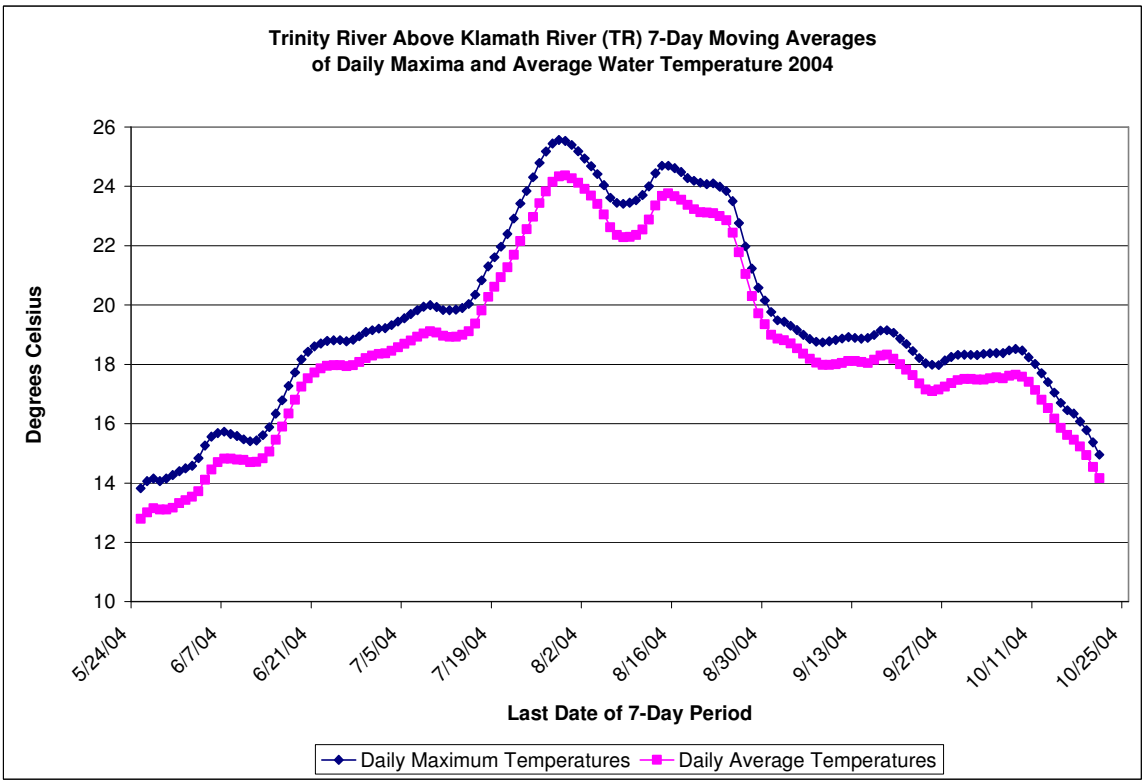

Figure 10-9 7-Day Moving Average Water Temperature for the Trinity River above Klamath River WY04

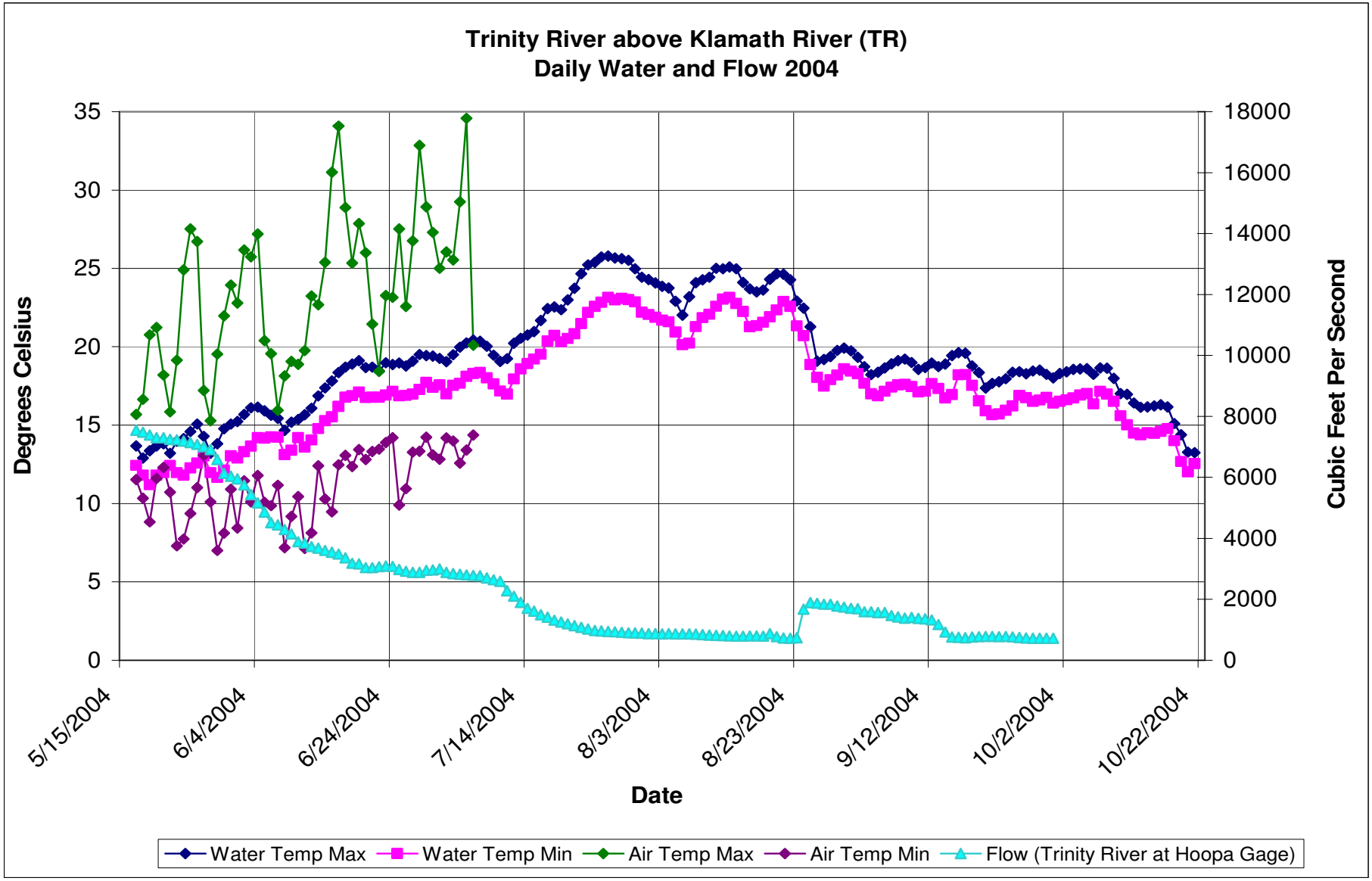

Figure 10-10 Water Temperature and Flow Values for the Trinity River above Klamath River WY04

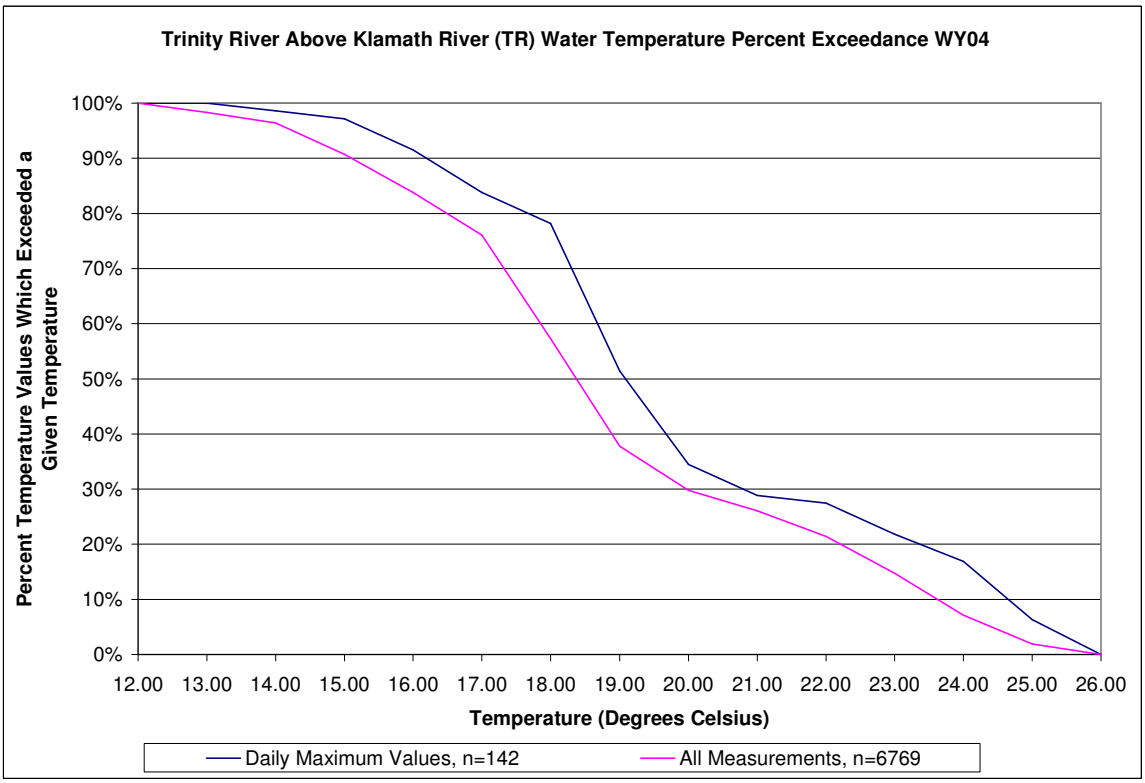

Figure 10-11 Water Temperature Percent Exceedance for Trinity River above Klamath River WY04

10.1.2.2 Dissolved Oxygen

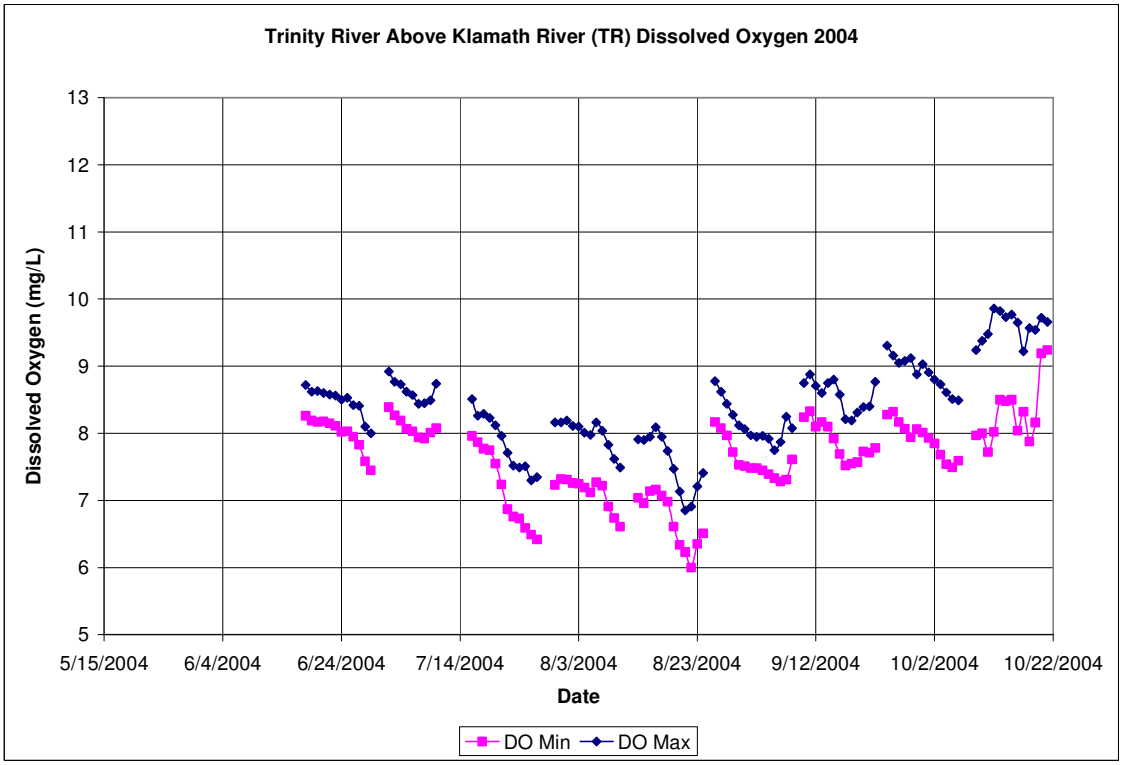

Figure 10-12 Dissolved Oxygen Values for the Trinity River above Klamath River WY04

10.1.2.3 pH

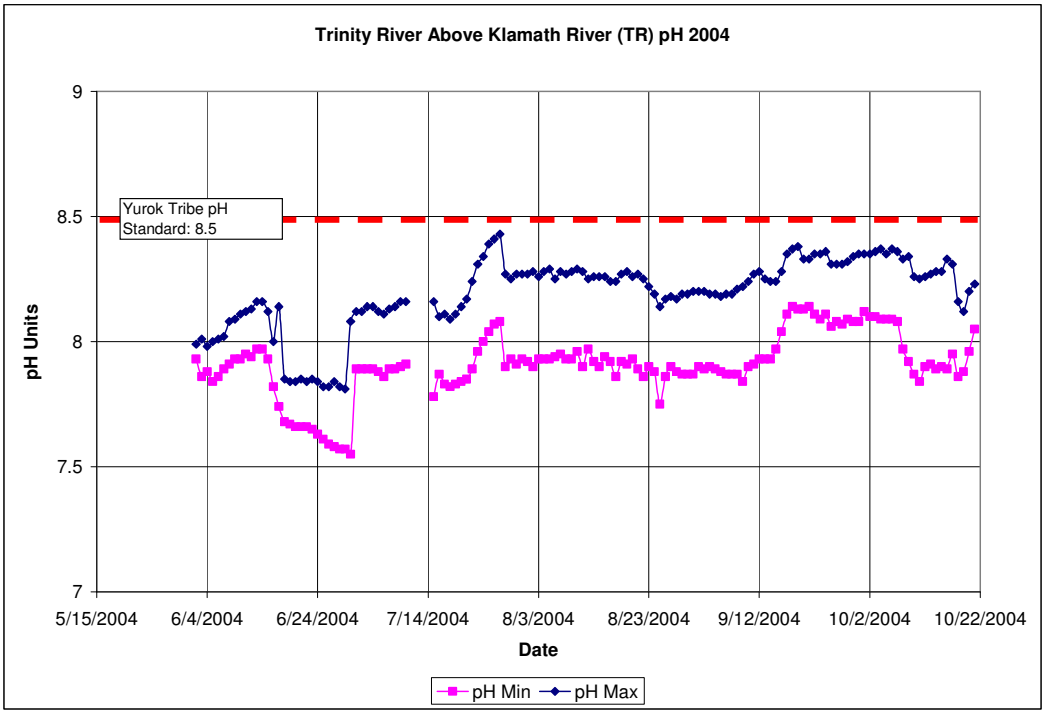

Figure 10-13 pH Values for the Trinity River above Klamath River WY04

10.1.2.4 Specific Conductivity

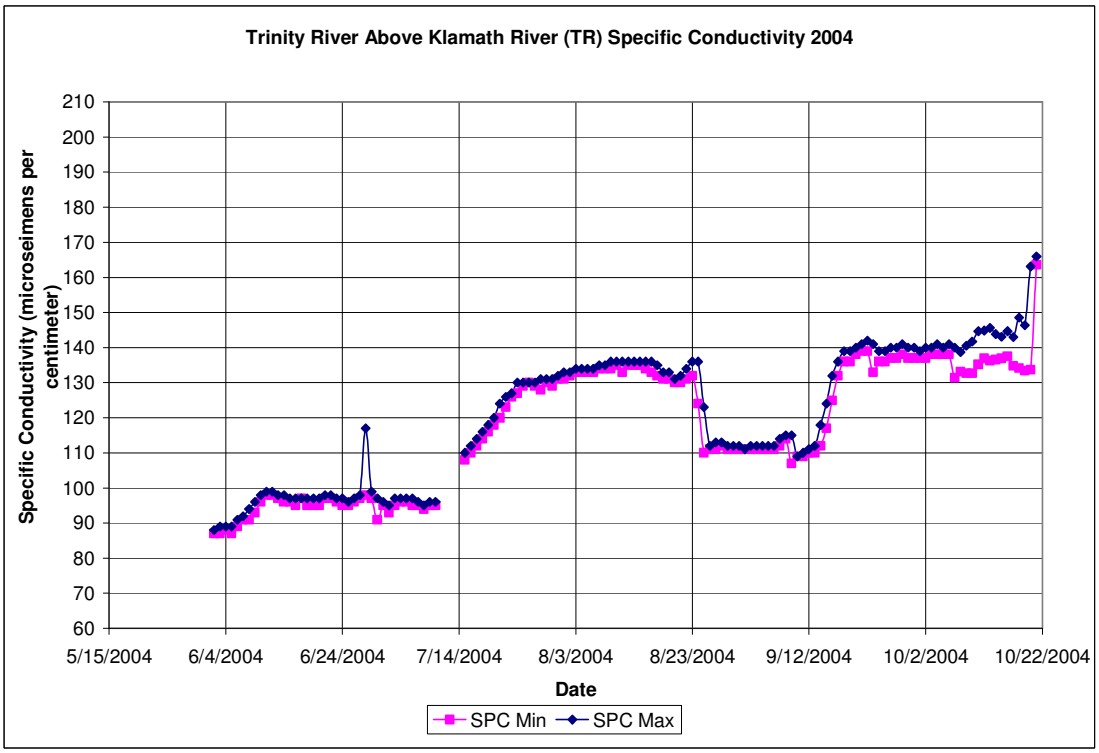

Figure 10-14 Specific Conductivity Values for the Trinity River above Klamath River WY04

10.1.3 Klamath River above Tully Creek

10.1.3.1 Temperature

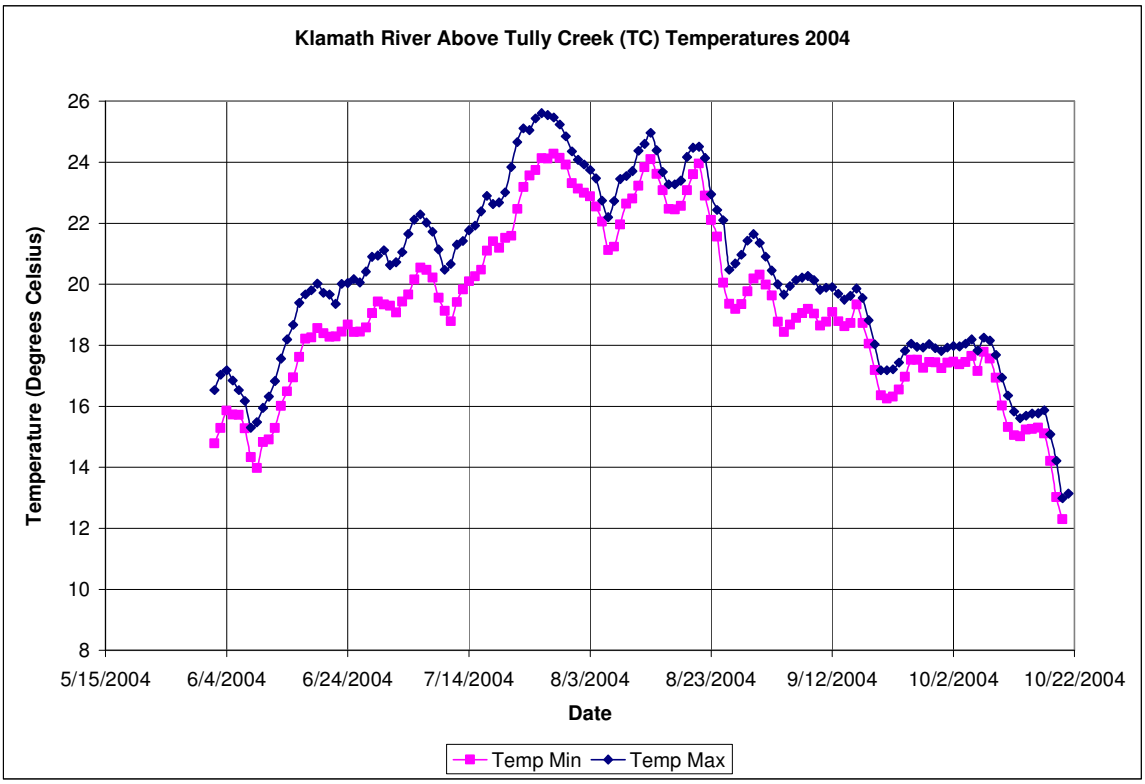

Figure 10-15 Water Temperature Values for the Klamath River above Tully Creek WY04

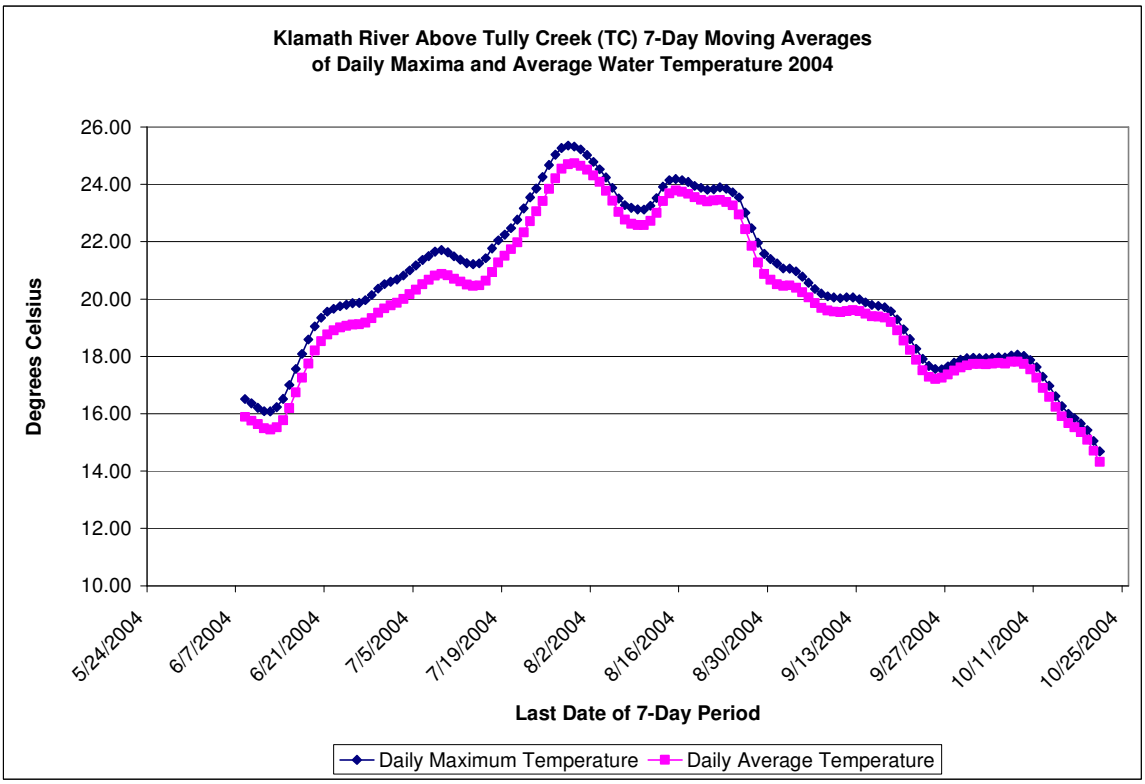

Figure 10-16 7-Day Moving Average Water Temperature for the Klamath River above Tully Creek WY04

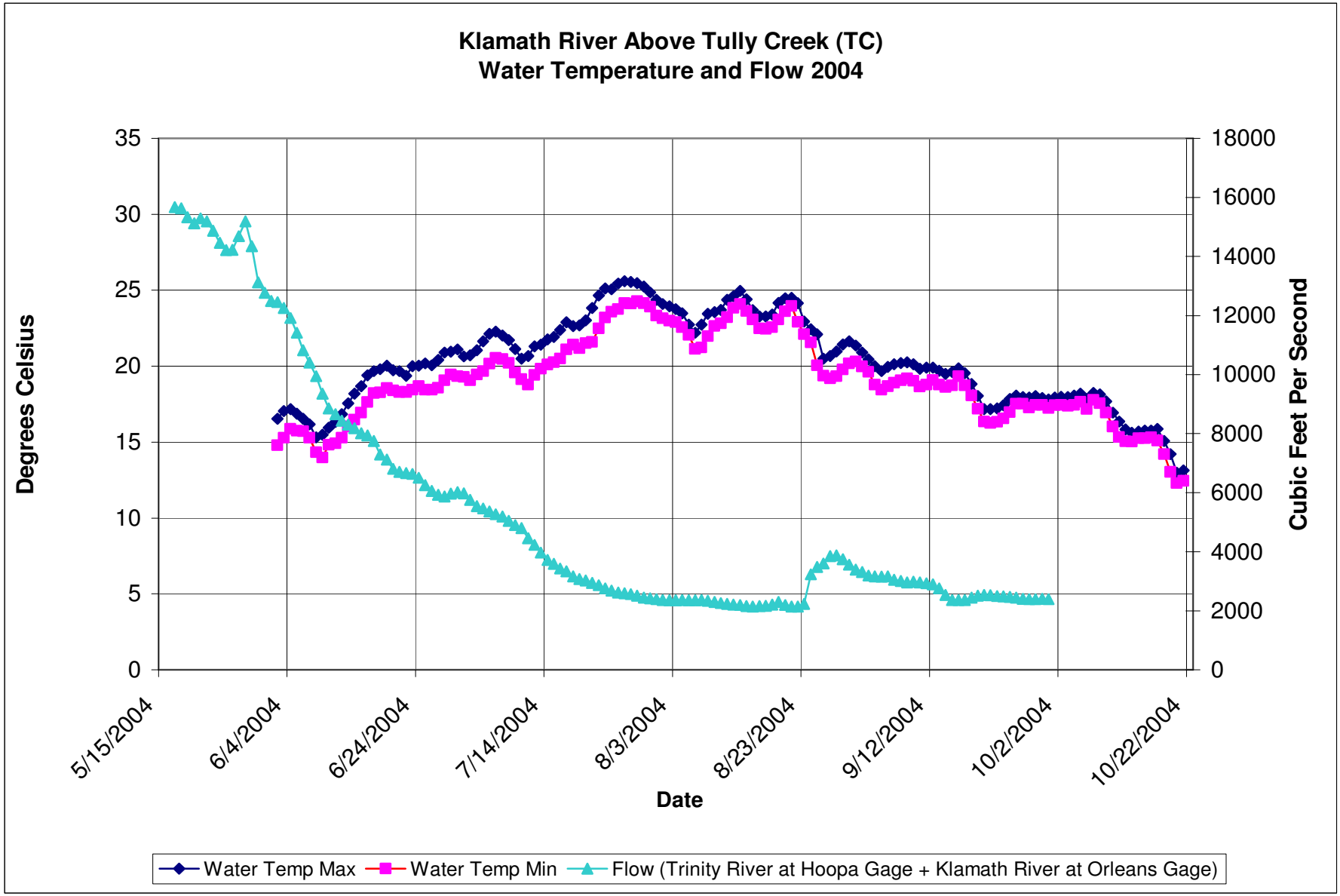

Figure 10-17 Water Temperature and Flow Values for the Klamath River above Tully Creek WY04

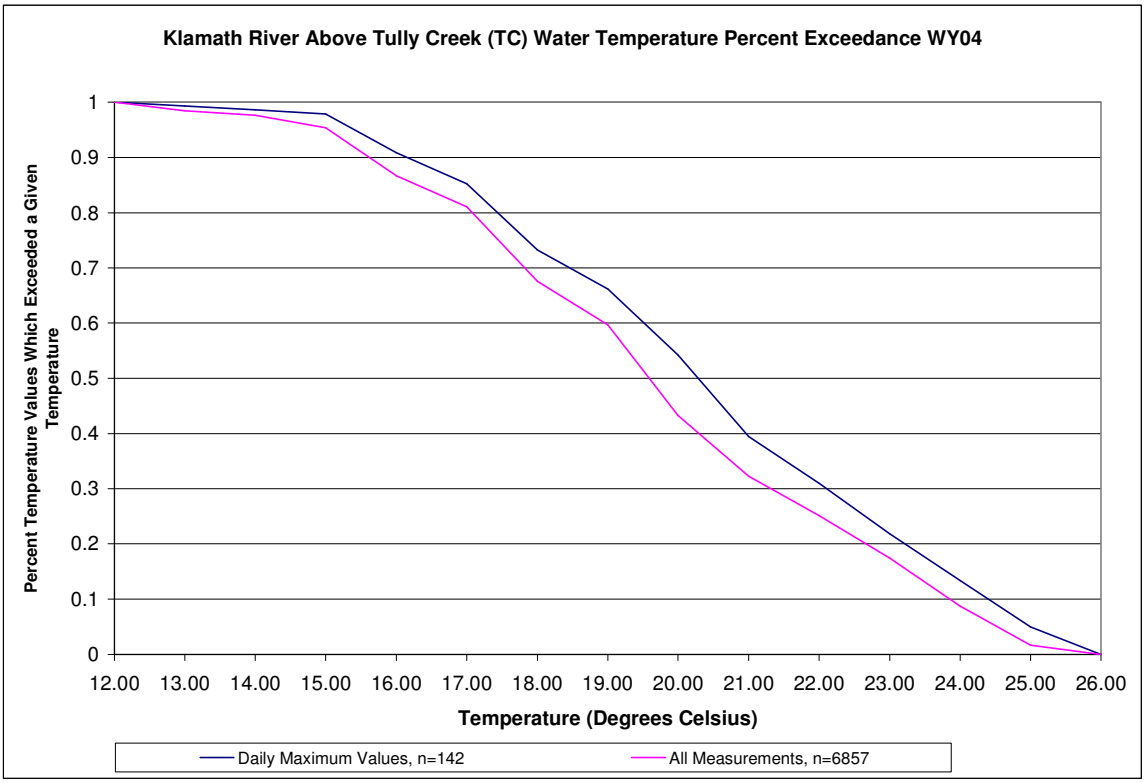

Figure 10-18 Percent Exceedance of Daily Maximum and Half-Hourly Water Temperatures for Klamath River above Tully Creek WY04

10.1.3.2 Dissolved Oxygen

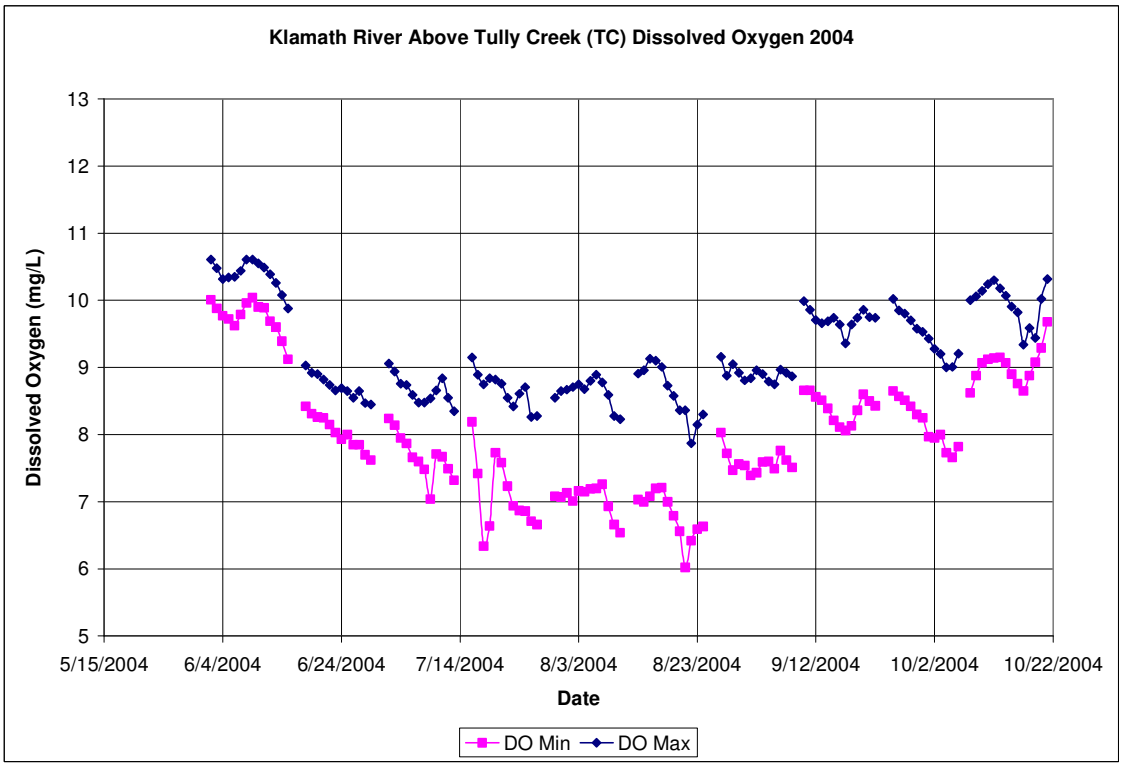

Figure 10-19 Dissolved Oxygen Values for the Klamath River above Tully Creek WY04

10.1.3.3 pH

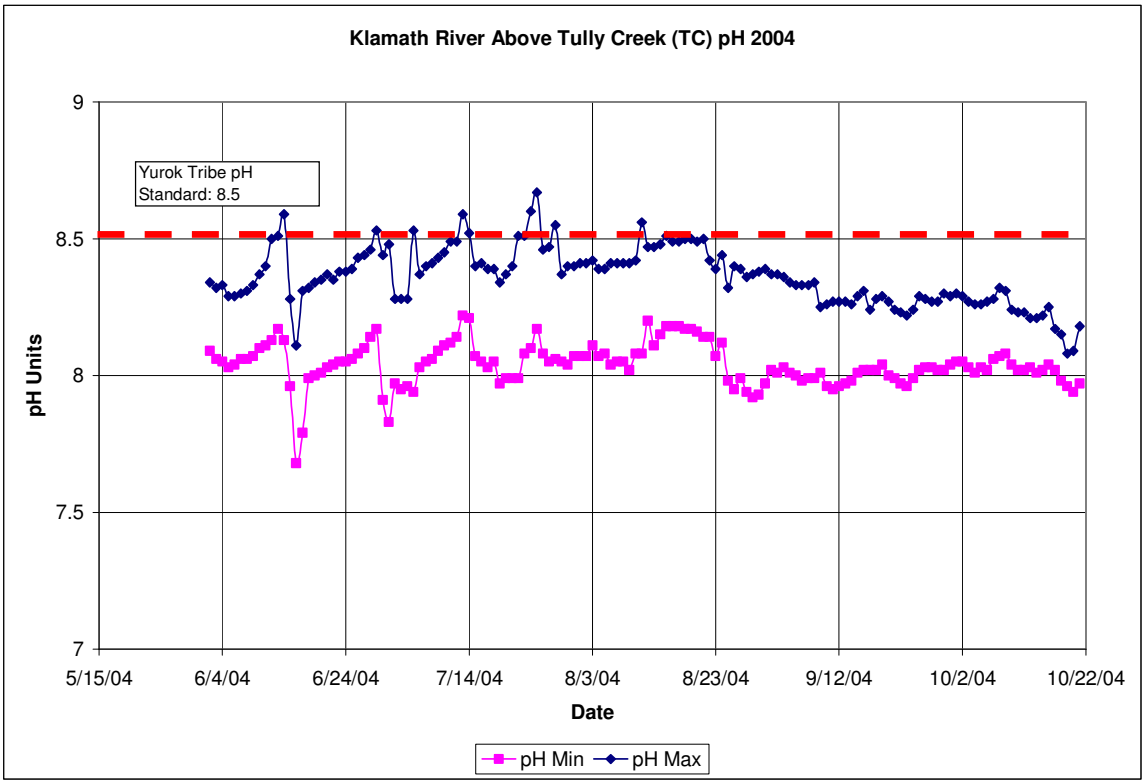

Figure 10-20 pH Values for the Klamath River above Tully Creek WY04

10.1.3.4 Specific Conductivity

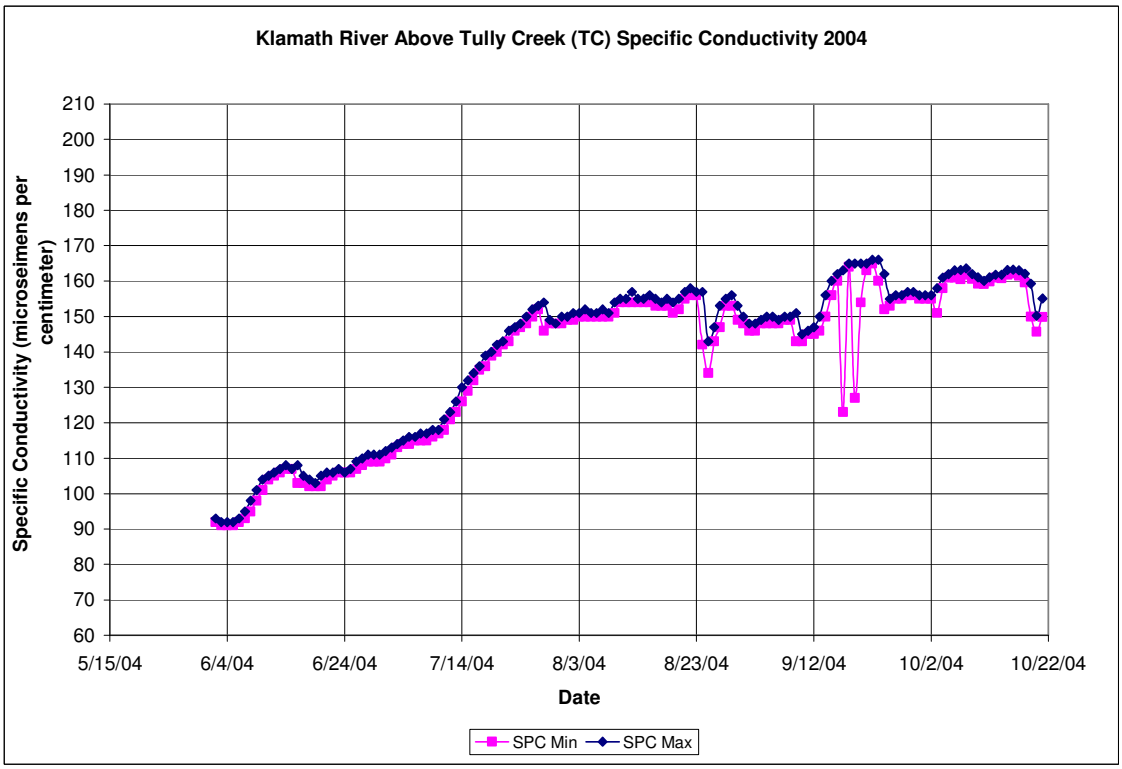

Figure 10-21 Specific Conductivity Values for the Klamath River above Tully Creek WY04

10.1.4 Klamath River above Blue Creek – 7 Meters Deep

10.1.4.1 Temperature

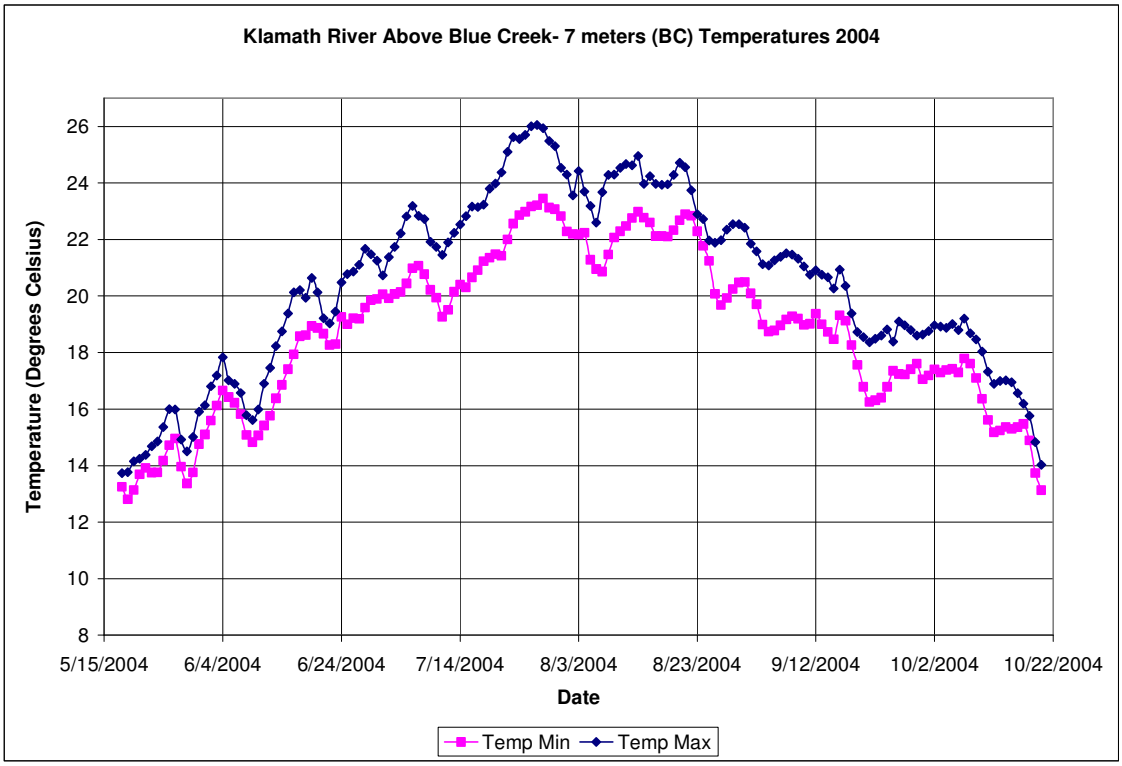

Figure 10-22 Water Temperature Values for the Klamath River above Blue Creek – 7 Meters Deep WY04

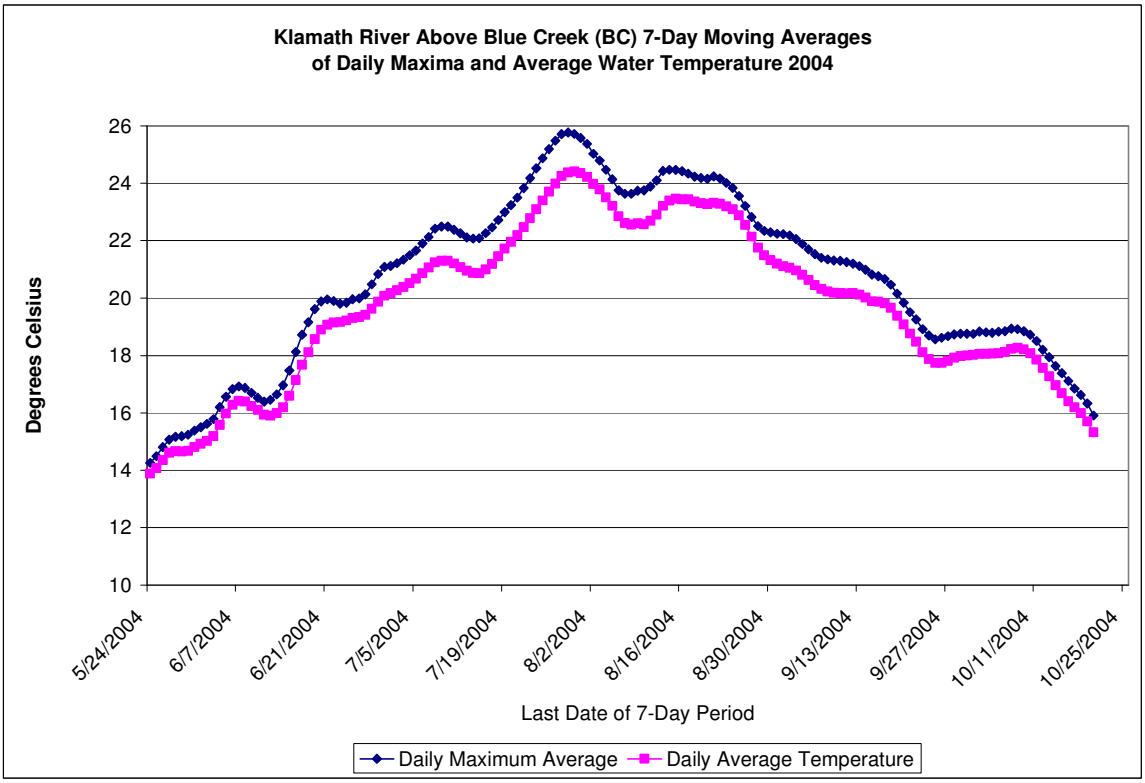

Figure 10-23 7-Day Moving Average Water Temperature for the Klamath River above Blue Creek – 7 Meters Deep WY04

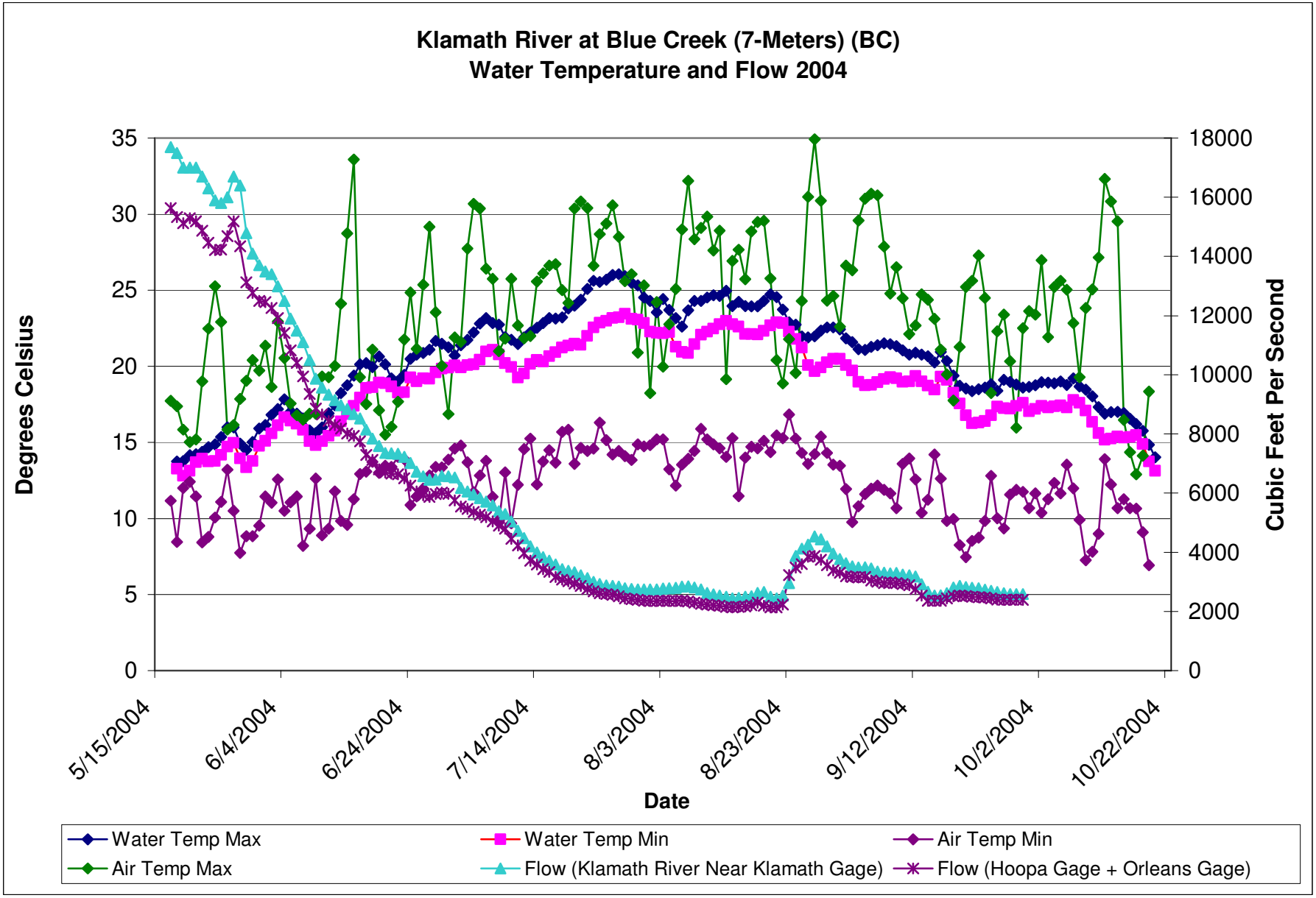

Figure 10-24 Air and Water Temperatures and Flow Values for the Klamath River above Blue Creek – 7 Meters Deep WY04

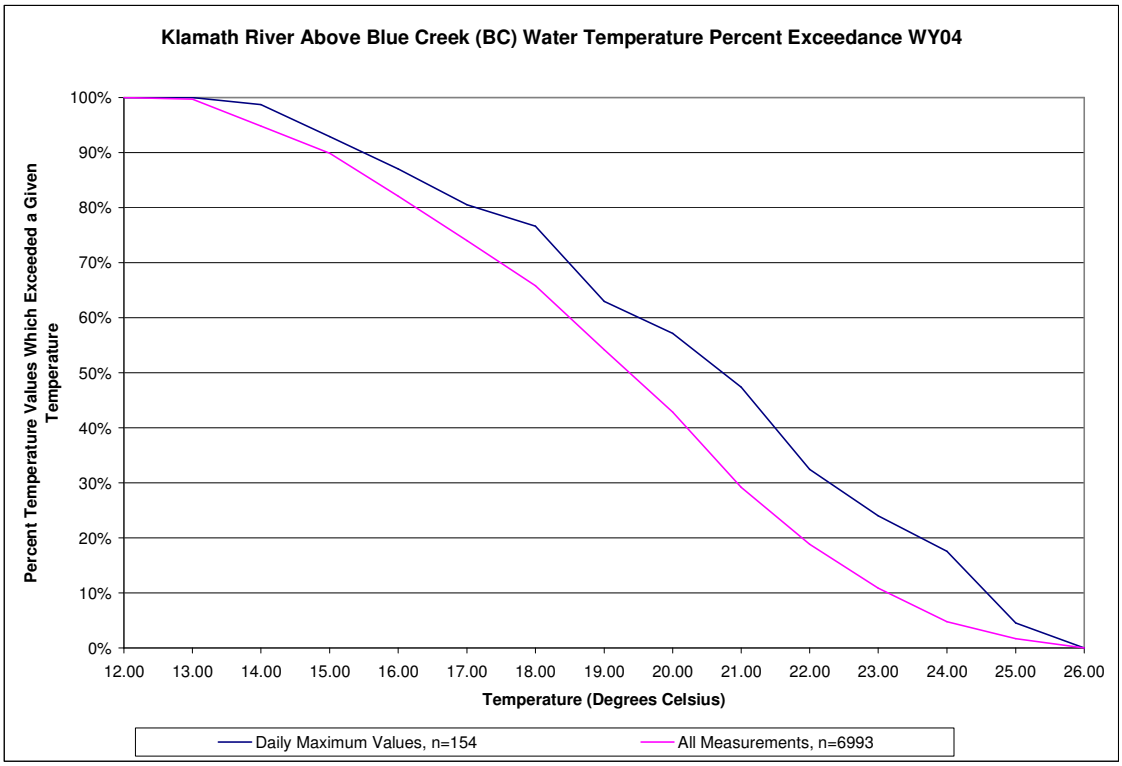

Figure 10-25 Percent Exceedance of Daily Maximum and Half-Hourly Water Temperatures for Klamath River above Blue Creek 7 Meters Deep WY04

10.1.4.2 Dissolved Oxygen

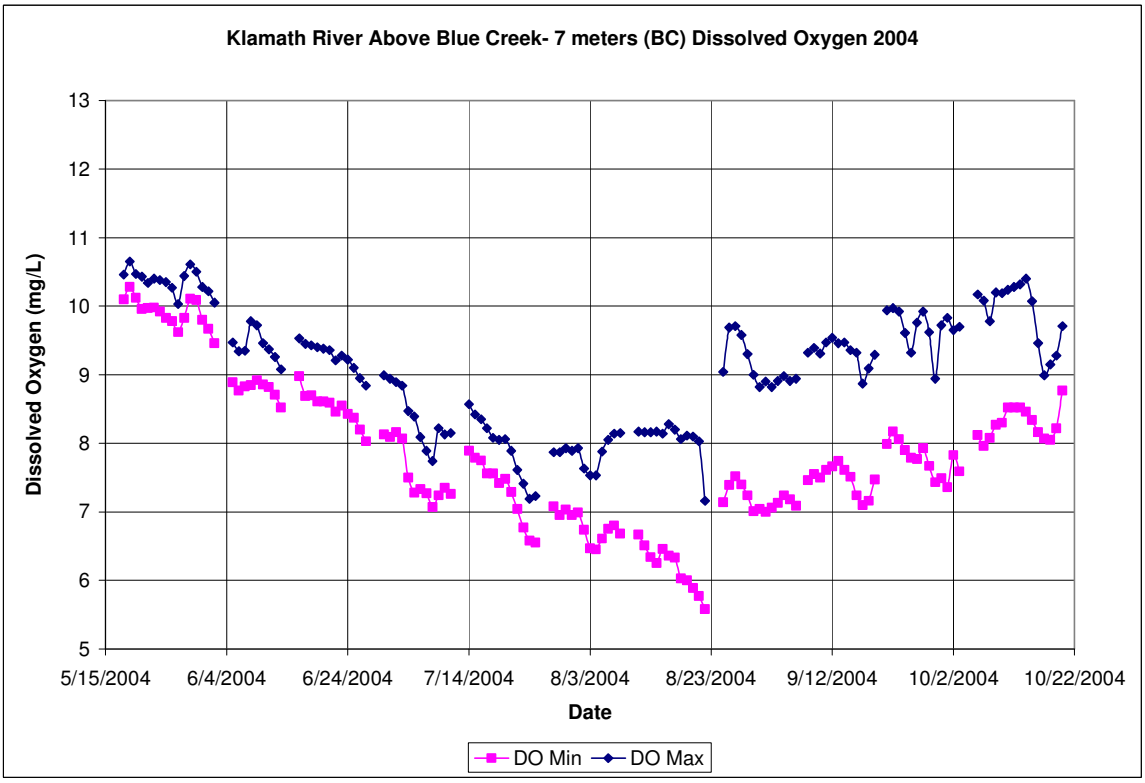

Figure 10-26 Dissolved Oxygen Values for the Klamath River above Blue Creek – 7 Meters Deep WY04

10.1.4.3 pH

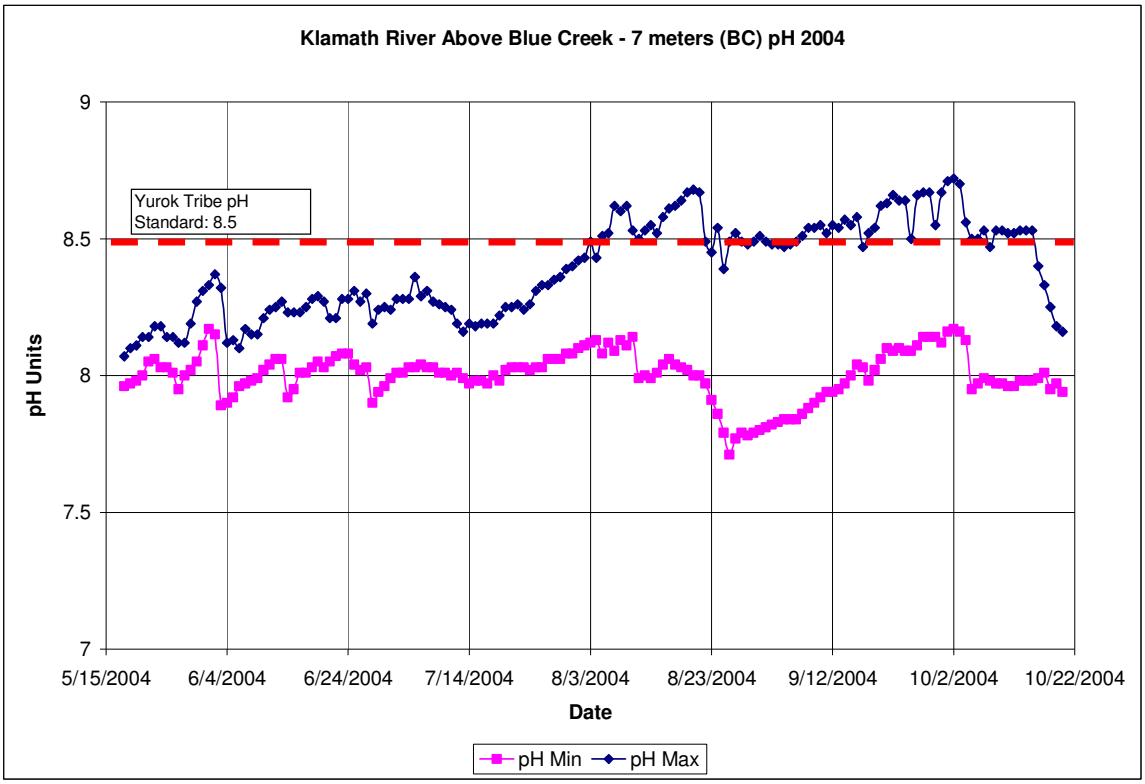

Figure 10-27 pH Values for the Klamath River above Blue Creek – 7 Meters Deep WY04

10.1.4.4 Specific Conductivity

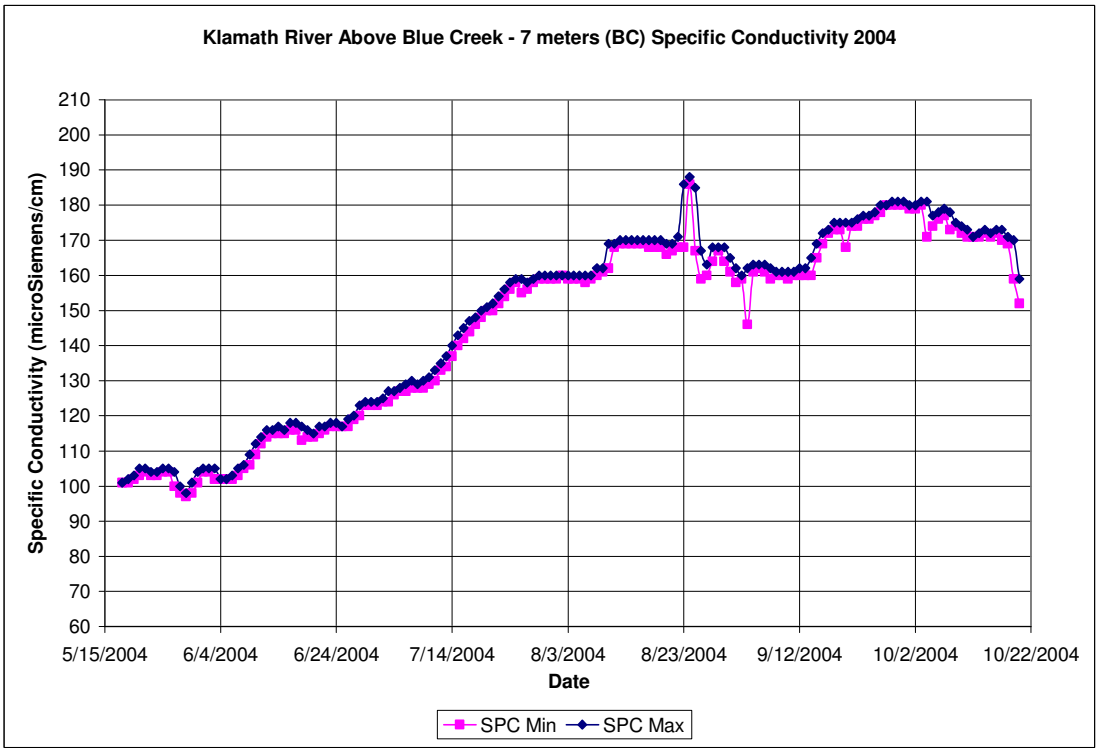

Figure 10-28 Specific Conductivity Values for the Klamath River above Blue Creek - 7 Meters Deep WY04

10.1.5 Klamath River at Turwar Gage

10.1.5.1 Temperature

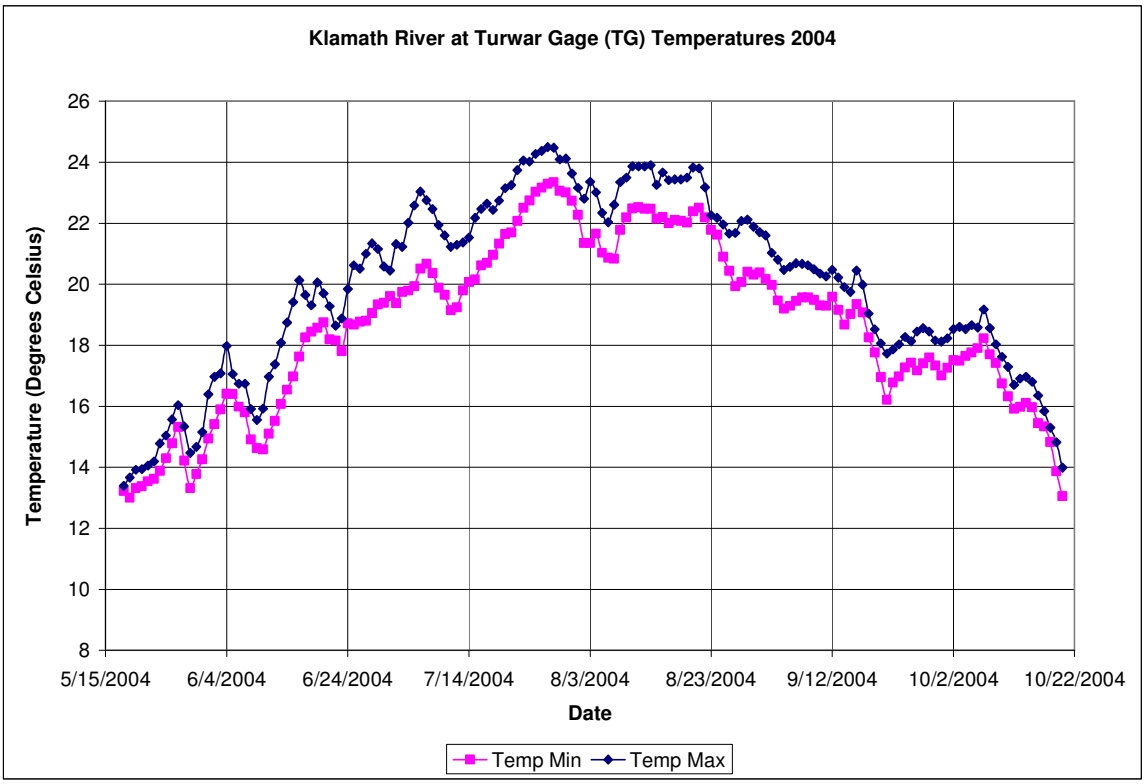

Figure 10-29 Water Temperature Values for the Klamath River at Turwar Gage WY04

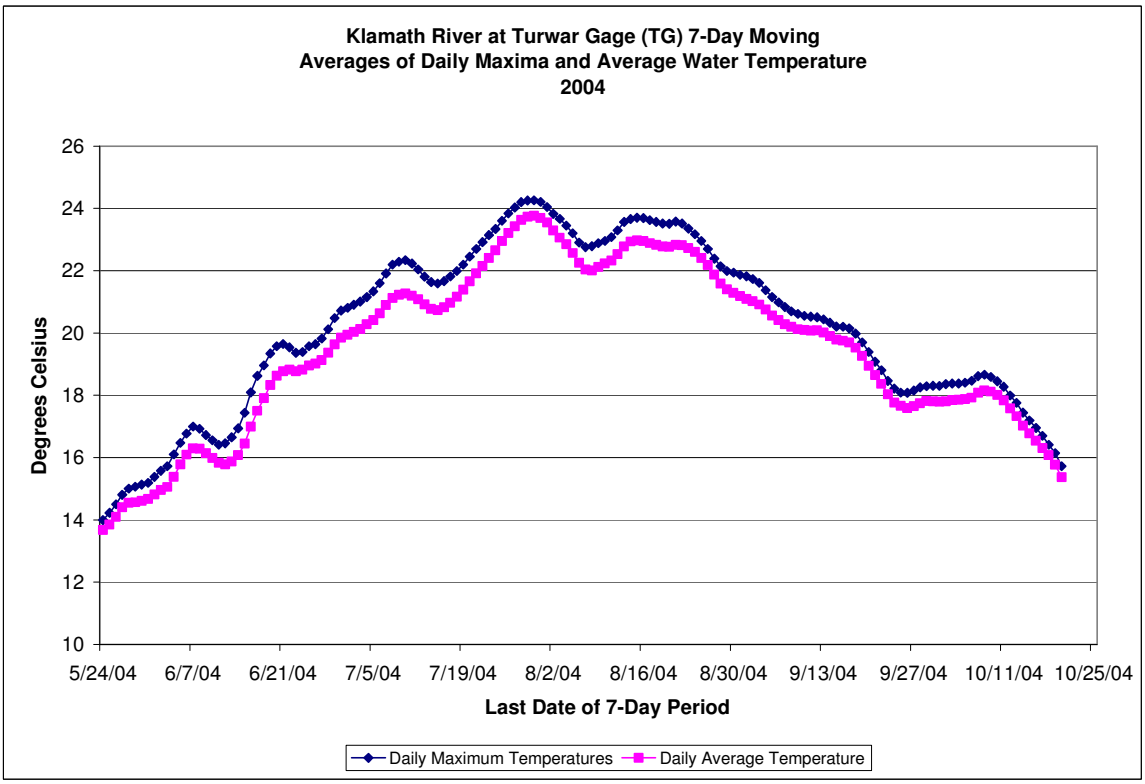

Figure 10-30 7-Day Moving Average Water Temperature the Klamath River at Turwar Gage WY04

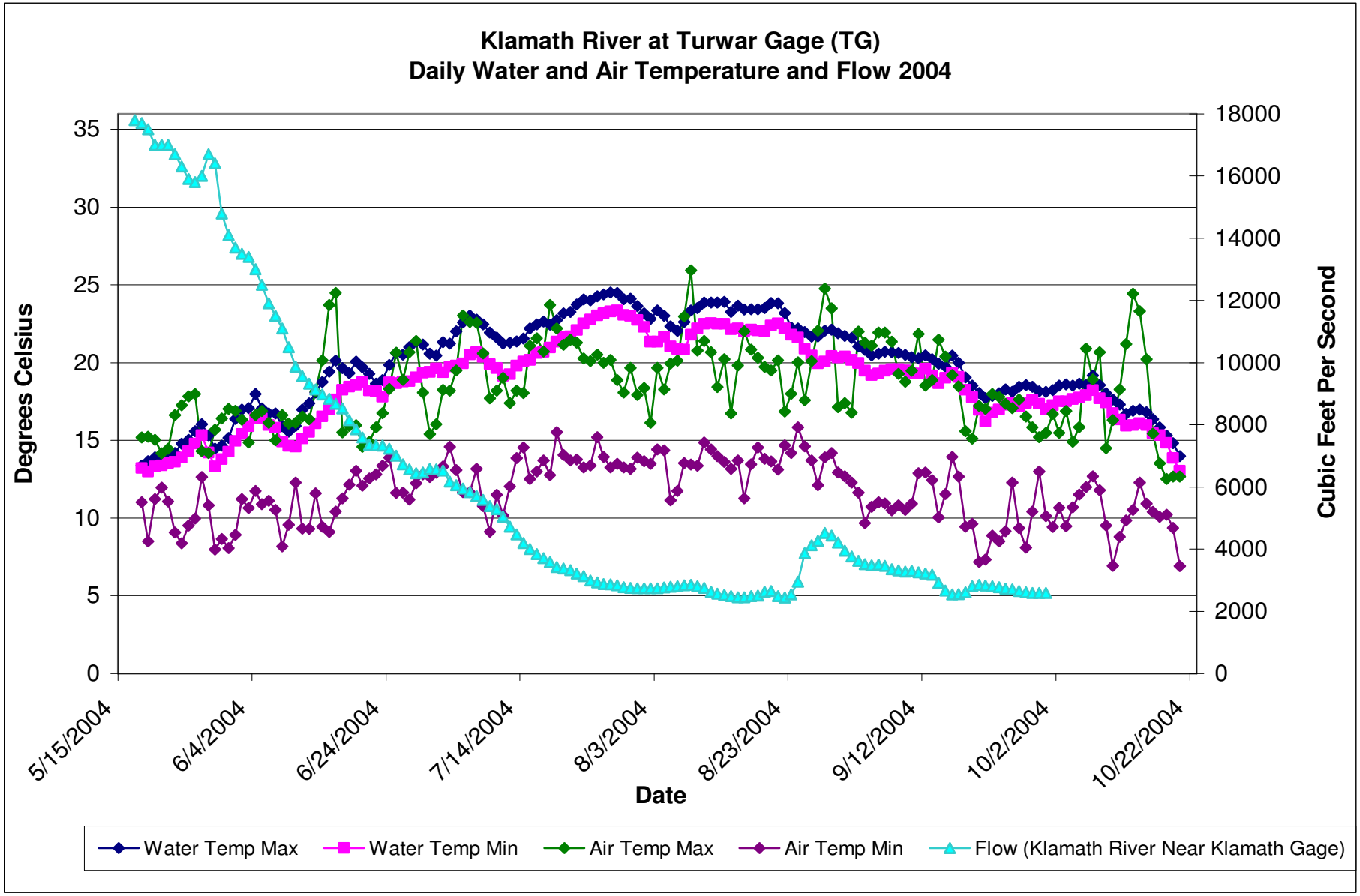

Figure 10-31 Daily Air and Water Temperature and Flow Values for the Klamath River at Turwar Gage WY04

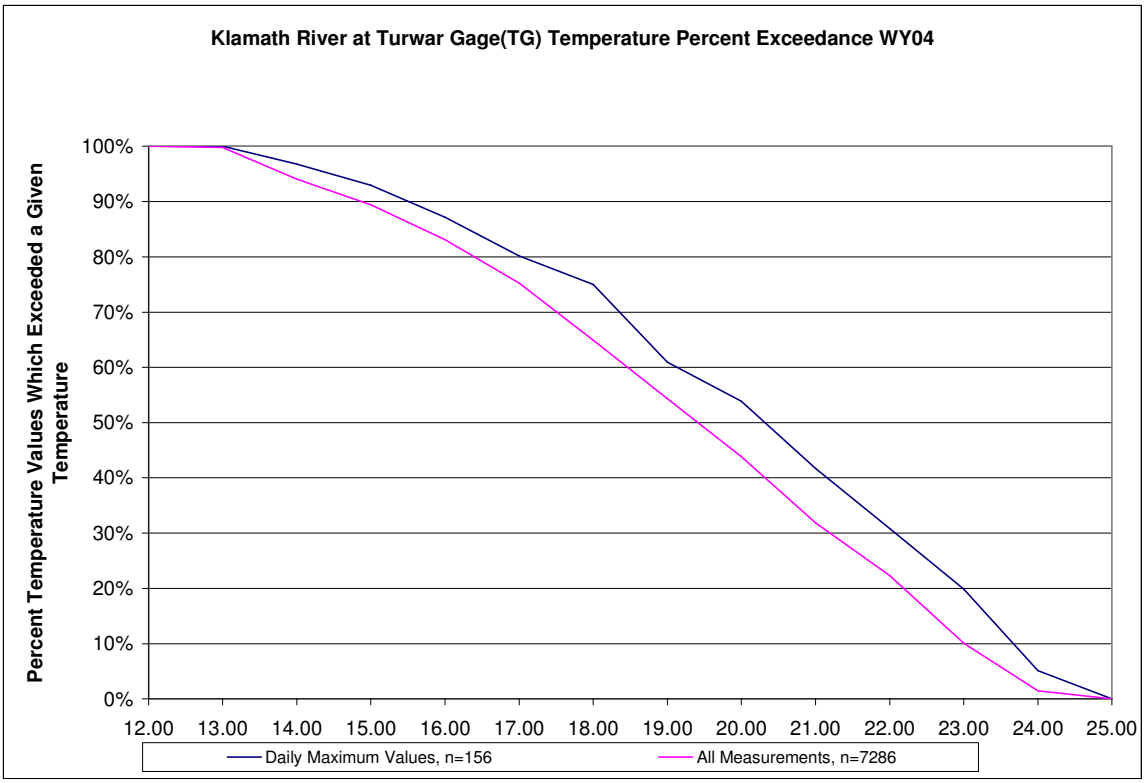

Figure 10-32 Klamath River at Turwar Gauge Water Temperature Percent Exceedance WY04

10.1.5.2 Dissolved Oxygen

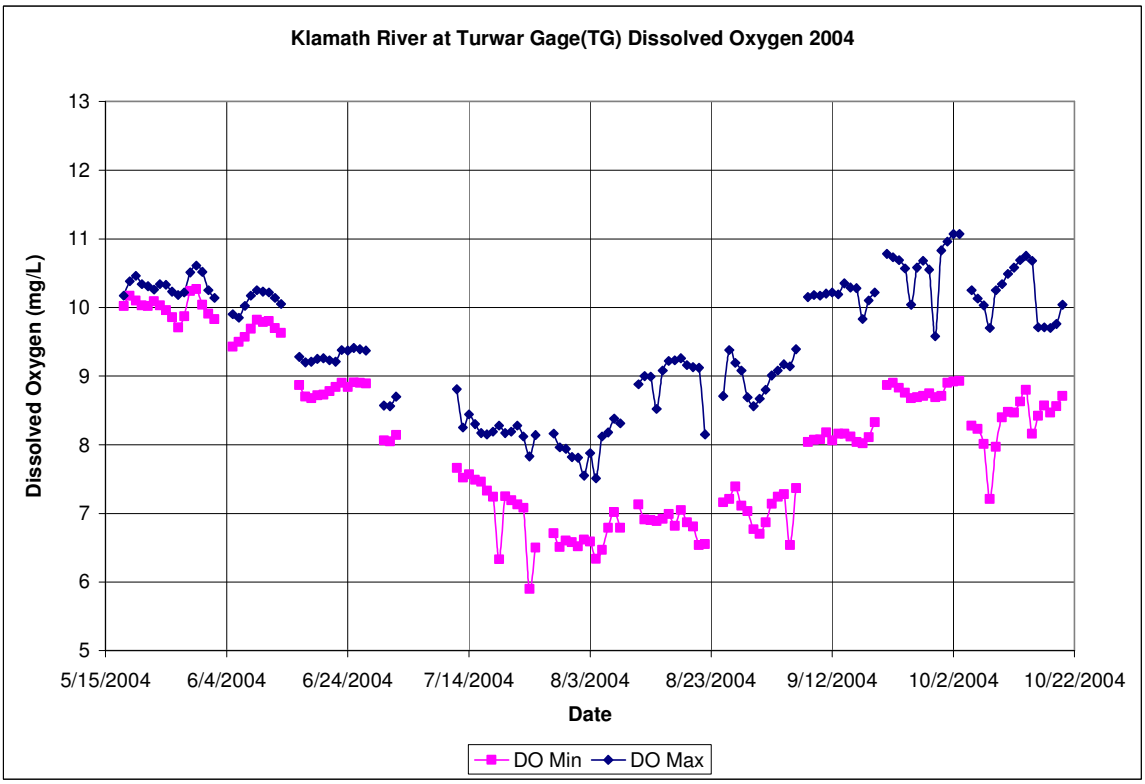

Figure 10-33 Daily DO Values for the Klamath River at Turwar Gage WY04

10.1.5.3 pH

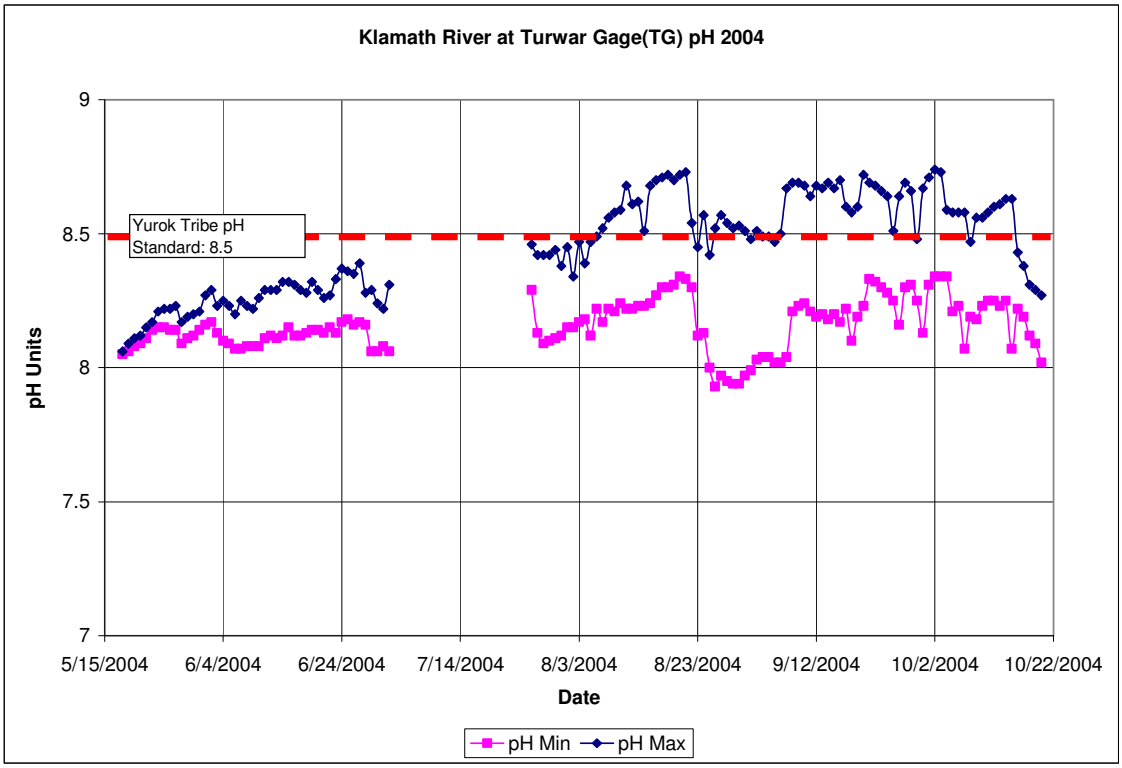

Figure 10-34 Daily pH Values for the Klamath River at Turwar Gage WY04

10.1.5.4 Specific Conductivity

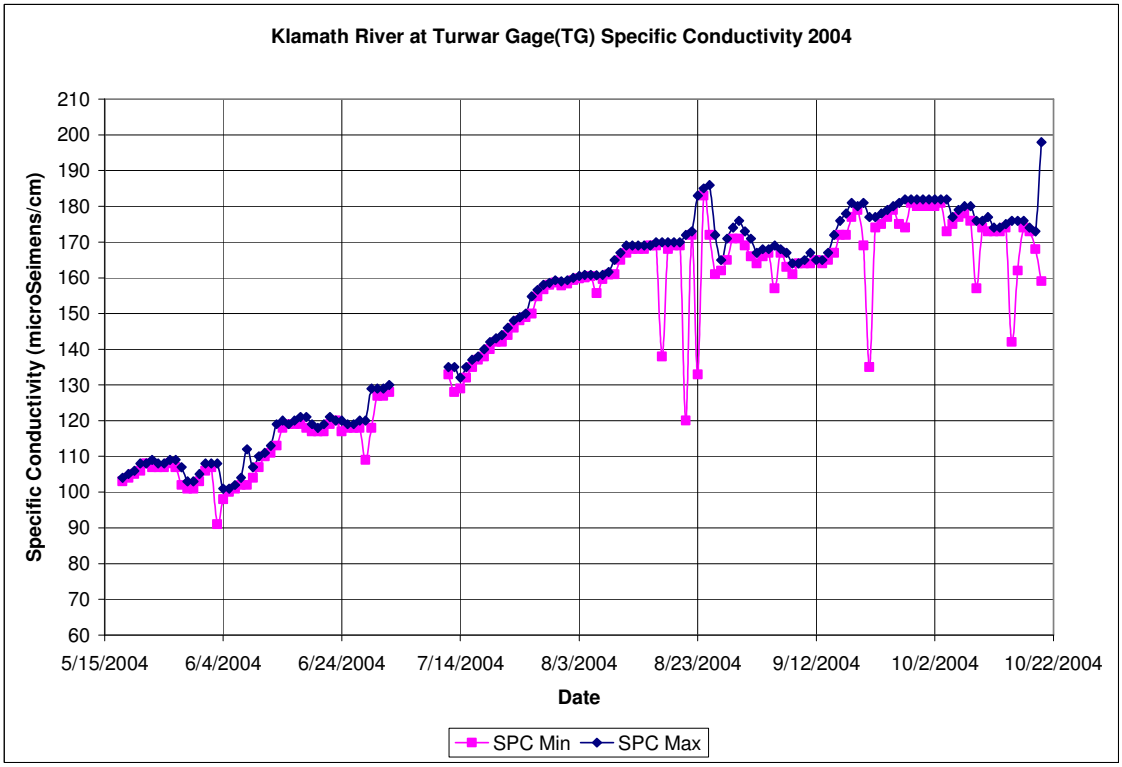

Figure 10-35 Specific Conductivity Values for the Klamath River at Turwar Gage WY04

10.1.6 Multi-Site Comparisons

10.1.6.1 Comparison: Daily Maximum Water Temperatures across All Riverine Sites Sampled for WY04

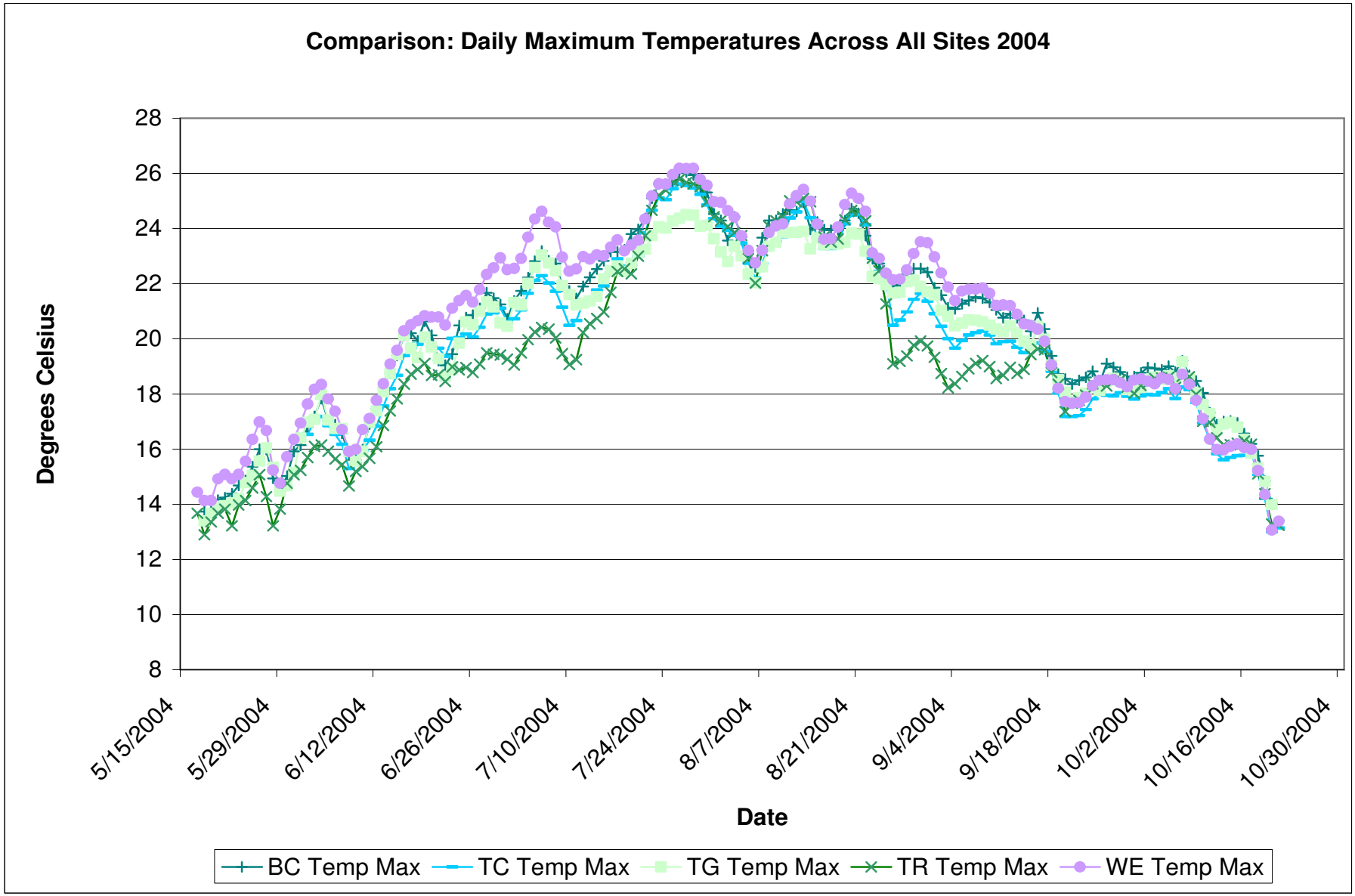

Figure 10-36 Comparison of Maximum Water Temperatures across All Sites for WY04

10.1.6.2 Comparison: Impacts of the Trinity River on Temperature in the Mainstem Klamath River: Klamath River Above the Trinity River as compared with Klamath River Above Tully Creek

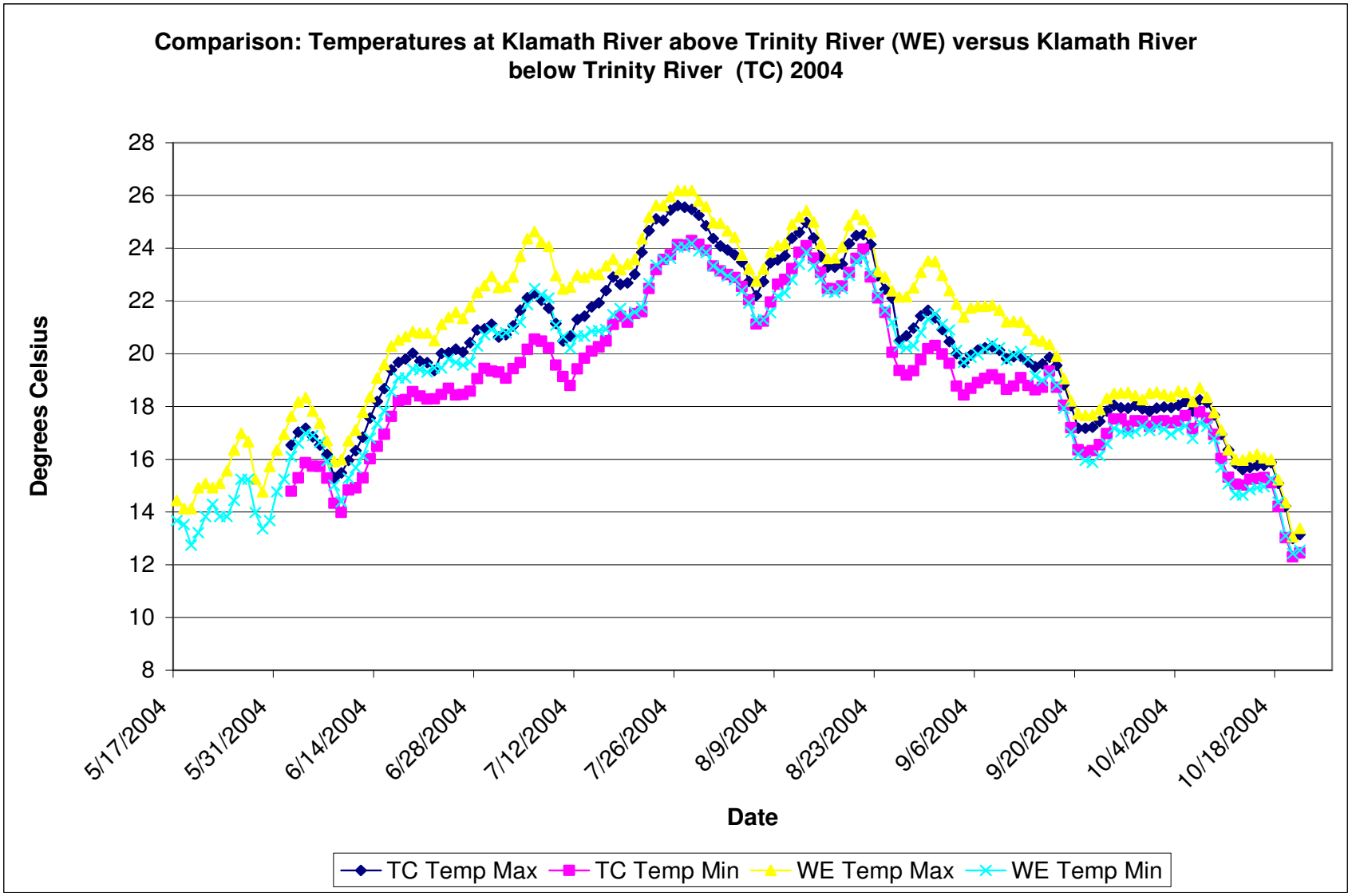

Figure 10-37 Comparison of Temperature Values in the Klamath River prior to the introduction of Trinity River Flow (Klamath River Above Trinity River) with Values Subsequent to the introduction of Trinity River Flow (Klamath River Above Tully Creek)

10.1.6.3 Comparison: Impacts of the Trinity River on Dissolved Oxygen in the Mainstem Klamath River: Klamath River Above the Trinity River as compared with Klamath River Above Tully Creek

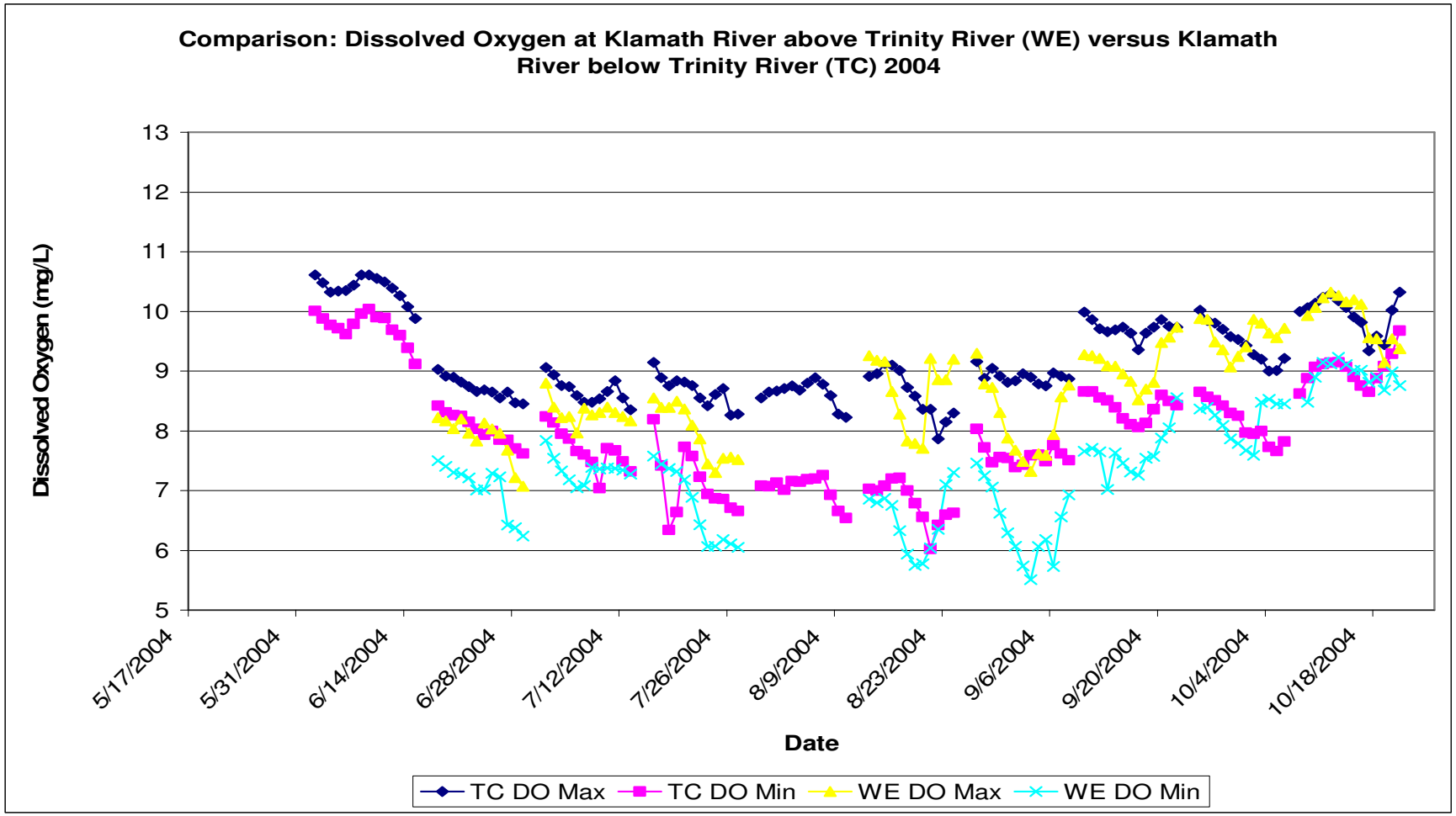

Figure 10-38 Comparison of Dissolved Oxygen Values in the Klamath River prior to the introduction of Trinity River Flow (Klamath River Above Trinity River) with Values Subsequent to the introduction of Trinity River Flow (Klamath River Above Tully Creek)

10.1.7 Special Studies –

10.1.7.1 Klamath River Macroinvertebrate Sampling August 2004

Table 10-1 Macroinvertebrate Results for the Klamath River Sites Samples in 2004

Site Name	Riffle #	Date Sampled	Total # of Specimens	Taxa Richness	EPT Taxa Richness	Sensitive EPT Index (%)	% Dominant Taxon	Tolerance Value	Shannon's Diversity Index	Estimated Relative Abundance
Klamath River at Ah Pah Riffle	1,2,3	8/18/2004	508	34	16	10.63	19.7	4.41	2.58	6126
Klamath River at Johnsons Riffle	1,2,3	8/18/2004	501	38	20	14.57	18.2	4.33	2.67	4704
Trinity River above Klamath River	1,2,3	8/20/2004	500	47	22	19.2	12.4	4.12	3.16	4048

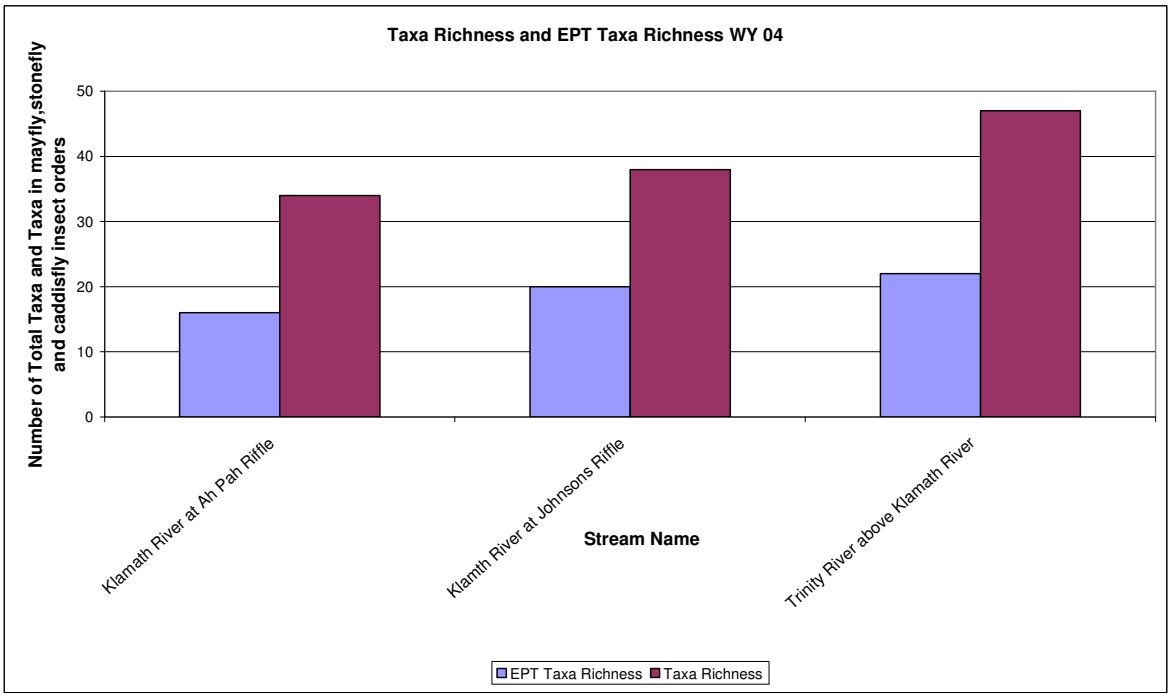

Figure 10-39 Macroinvertebrate Taxa Richness and EPT Taxa Richness

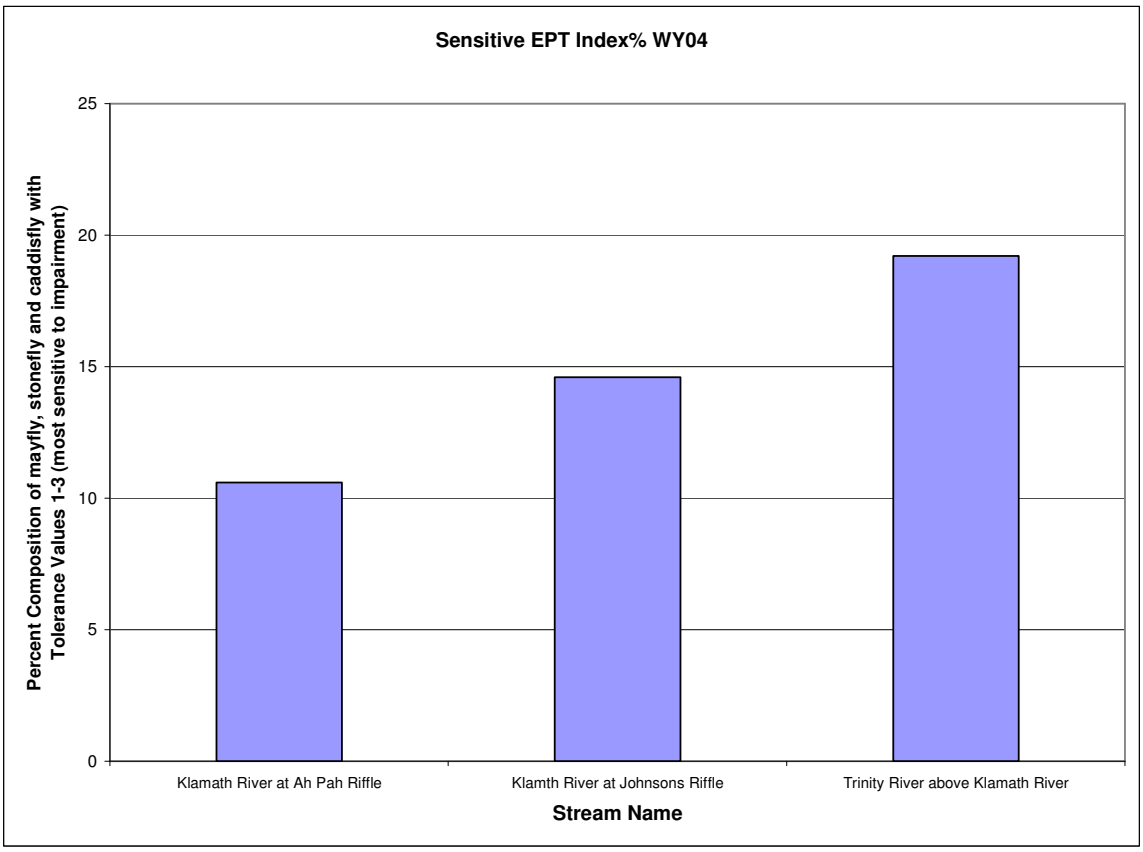

Figure 10-40 Macroinvertebrate Sensitive EPT Index

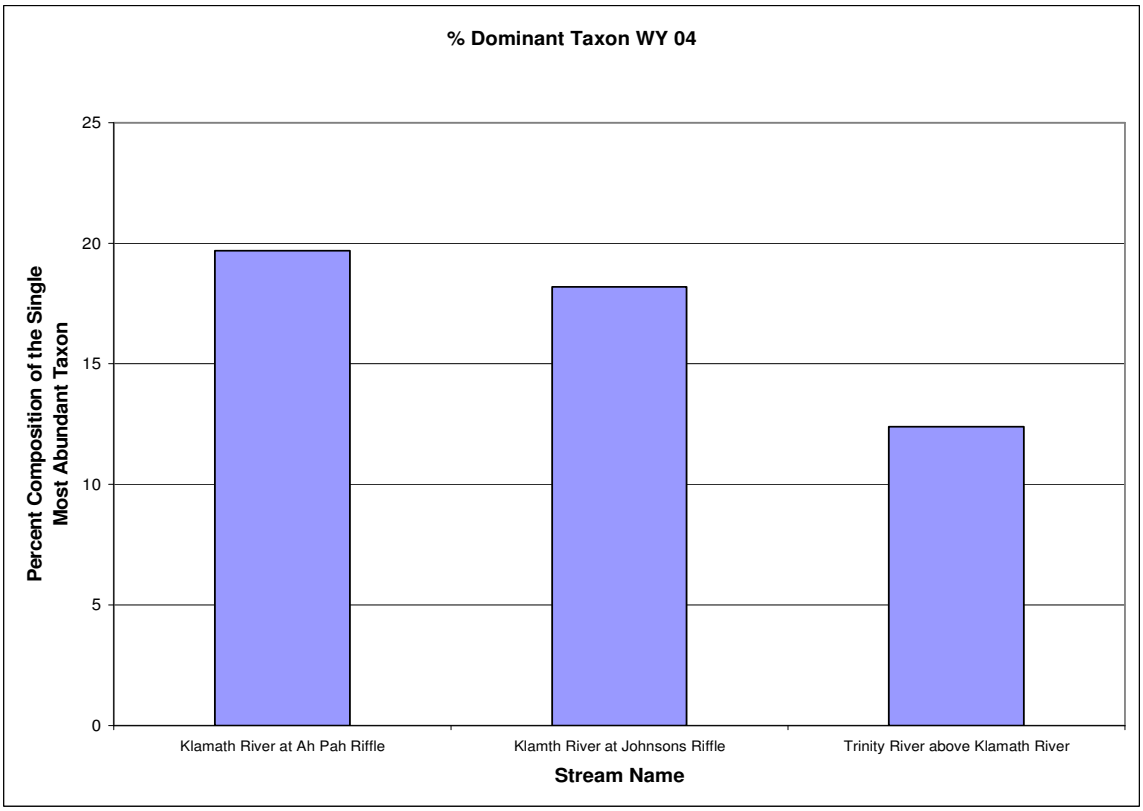

Figure 10-41 Macroinvertebrate Percent Dominant Taxon

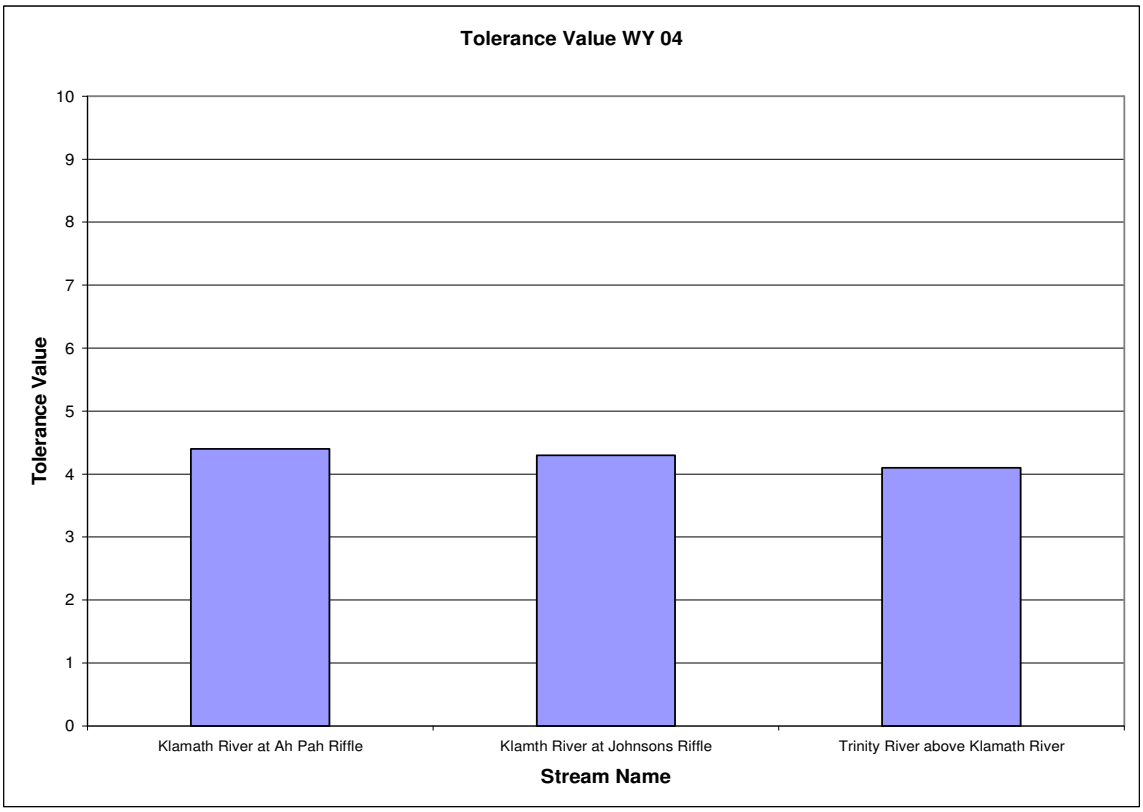

Figure 10-42 Macroinvertebrate Tolerance Value

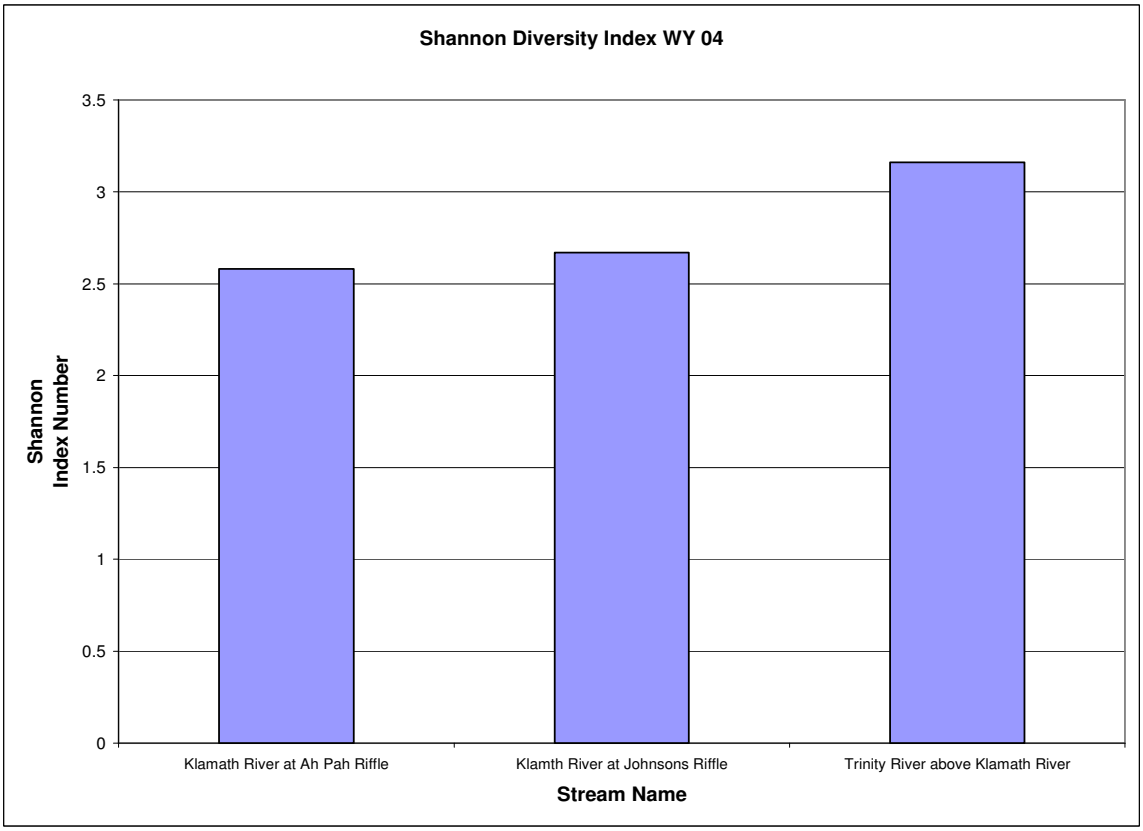

Figure 10-43 Macroinvertebrate Shannon Diversity Index

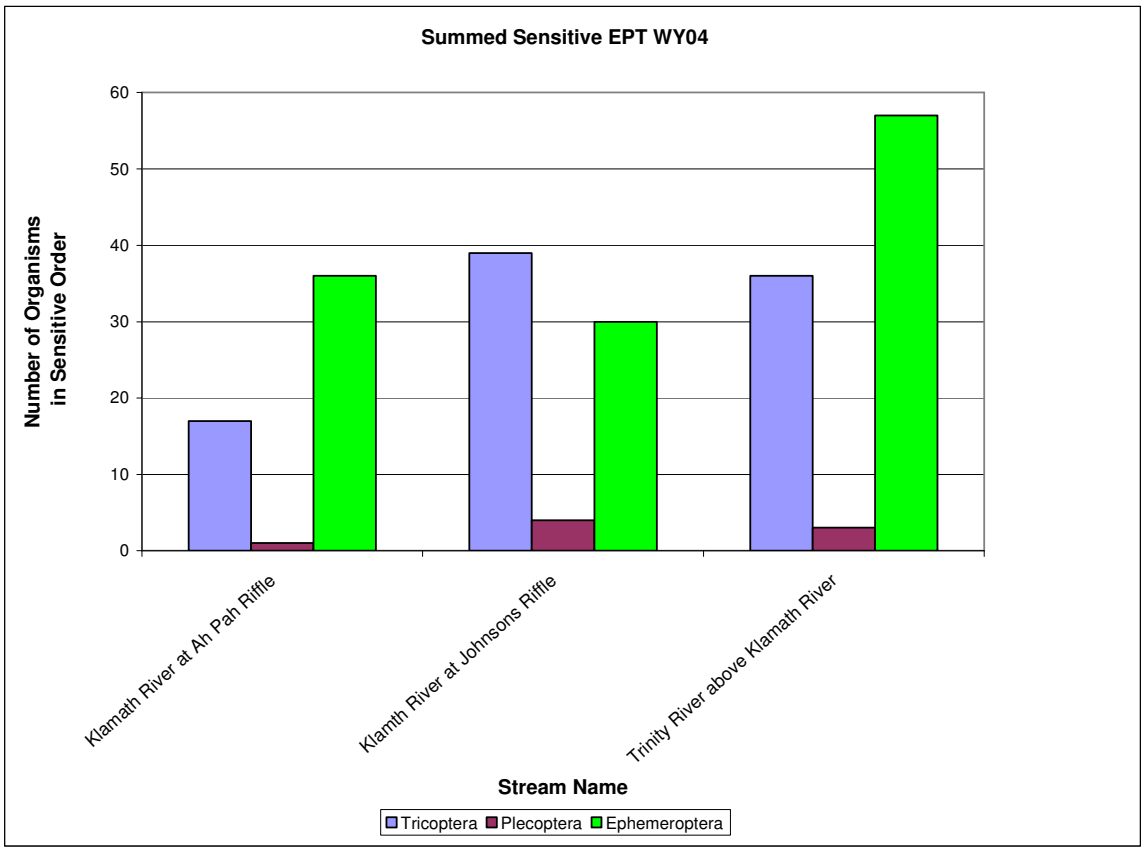

Figure 10-44 Macroinvertebrate Summed Sensitive EPT

10.1.7.2 Klamath River Benthic Algae Sampling June – September

Table 10-2 Combined Algae Species List for Klamath River Benthic Algae Sampling, 2004

	Combined Algae Species List Yurok Tribe, 2004	16	samples total	
#	Algae Species	Ave % Den	# samples	Code
1	Epithemia sorex	30.11	14	EPSX
2	Cymbella affinis	17.90	16	CMAF
3	Diatoma vulgare	10.89	14	DTVL
4	Achnanthes minutissima	9.32	13	ACMN
5	Nitzschia frustulum	4.97	14	NZFR
6	Cocconeis placentula	3.91	10	COPC
7	Rhoicosphenia curvata	3.09	9	RHCU
8	Oscillatoria sp.	2.45	8	OSXX
9	Nitzschia paleacea	2.13	10	NZPC
10	Synedra mazamaensis	2.03	8	SNMZ
11	Nitzschia communis	1.12	8	NZCM
12	Ulothrix sp.	1.07	2	ULXX
13	Synedra ulna	0.98	8	SNUL
14	Navicula cryptocephala	0.93	4	NVCR
15	Gomphonema ventricosum	0.87	8	GFVT
16	Calothrix sp.	0.81	2	KXXX
17	Nitzschia innominata	0.78	5	NZIN
18	Gomphonema angustatum	0.59	6	GFAN
19	Achnanthes linearis	0.49	4	ACLN
20	Gomphoneis herculeana	0.48	7	GSHR
21	Cymbella sinuata	0.47	6	CMSN
22	Navicula cryptocephala veneta	0.45	6	NVCV
23	Nitzschia dissipata	0.44	2	NZDS
24	Gomphonema subclavatum	0.41	4	GFSB
25	Scenedesmus quadricauda	0.32	4	SCQD
26	Nitzschia sp.	0.27	4	NZXX
27	Rhopalodia gibba	0.24	4	RPGB
28	Cymbella minuta	0.23	3	CMMN
29	Amphora perpusilla	0.22	3	AFPR
30	Cocconeis pediculus	0.20	3	COPD
31	Fragilaria construens	0.17	2	FRCN
32	Nitzschia palea	0.17	2	NZPL
33	Navicula tripunctata	0.17	2	NVTP
34	Achnanthes lanceolata	0.17	2	ACLC
35	Fragilaria vaucheria	0.12	2	FRVA
36	Amphora ovalis	0.11	2	AFOV
37	Cyclotella meneghiniana	0.11	2	CCMG
38	Nitzschia volcanica	0.11	2	NZVL
39	Selenastrum minutum	0.07	1	SLMN
40	Ankistrodesmus falcatus	0.07	1	AKFL
41	Gomphonema olivaceum	0.06	1	GFOM
42	Nitzschia fonticola	0.06	1	NZFT
43	Pinnularia sp.	0.06	1	PLXX
44	Amphipleura pellucida	0.06	1	AMPL
45	Caloneis ventricosa minuta	0.06	1	CAVM
46	Fragilaria construens venter	0.06	1	FRCV
47	Fragilaria crotonensis	0.06	1	FRCR
48	Melosira varians	0.06	1	MLVR
49	Navicula cascadensis	0.05	1	NVCS
50	Nitzschia capitellata	0.04	1	NZCP

Table 10-3 Combined Algae Species List for Klamath River above Trinity River (WE) 2004

	Combined Algae Species List			
	Yurok Tribe, 2004, WE	4	samples total	
#	Algae Species	Ave % Den	# samples	Code
1	Epithemia sorex	38.8	3	EPSX
2	Cymbella affinis	10.8	4	CMAF
3	Achnanthes minutissima	9.7	2	ACMN
4	Oscillatoria sp.	6.1	3	OSXX
5	Rhoicosphenia curvata	4.7	3	RHCU
6	Nitzschia frustulum	4.3	4	NZFR
7	Calothrix sp.	3.3	2	KXXX
8	Nitzschia communis	3.1	3	NZCM
9	Nitzschia paleacea	2.5	2	NZPC
10	Synedra ulna	2.2	3	SNUL
11	Diatoma vulgare	1.9	2	DTVL
12	Cocconeis placentula	1.8	2	COPC
13	Achnanthes linearis	1.5	2	ACLN
14	Navicula cryptocephala	1.3	2	NVCR
15	Nitzschia innominata	1.1	2	NZIN
16	Gomphoneis herculeana	0.9	2	GSHR
17	Scenedesmus quadricauda	0.7	2	SCQD
18	Synedra mazamaensis	0.7	2	SNMZ
19	Gomphonema subclavatum	0.6	2	GFSB
20	Nitzschia palea	0.5	1	NZPL
21	Cymbella minuta	0.5	1	CMMN
22	Navicula cryptocephala veneta	0.4	2	NVCV
23	Cymbella sinuata	0.4	2	CMSN
24	Gomphonema ventricosum	0.4	2	GFVT
25	Cyclotella meneghiniana	0.2	1	CCMG
26	Caloneis ventricosa minuta	0.2	1	CAVM
27	Fragilaria construens venter	0.2	1	FRCV
28	Fragilaria crotonensis	0.2	1	FRCR
29	Melosira varians	0.2	1	MLVR
30	Amphora ovalis	0.2	1	AFOV
31	Navicula cascadensis	0.2	1	NVCS
32	Ulothrix sp.	0.2	1	ULXX
33	Nitzschia volcanica	0.2	1	NZVL

Table 10-4 Combined Species List for Trinity River above Klamath River (TR) 2004

	Combined Algae Species List			
	Yurok Tribe, Klamath Basin, TR, 2004	4	samples total	
#	Algae Species	Ave % Den	# samples	Code
1	Cymbella affinis	38.2	4	CMAF
2	Epithemia sorex	15.6	4	EPSX
3	Achnanthes minutissima	11.9	4	ACMN
4	Diatoma vulgare	10.7	4	DTVL
5	Ulothrix sp.	4.1	1	ULXX
6	Cocconeis placentula	3.5	4	COPC
7	Oscillatoria sp.	2.6	3	OSXX
8	Nitzschia frustulum	2.4	3	NZFR
9	Nitzschia paleacea	1.1	3	NZPC
10	Gomphonema angustatum	0.9	2	GFAN
11	Nitzschia communis	0.9	3	NZCM
12	Gomphonema ventricosum	0.9	2	GFVT
13	Gomphonema subclavatum	0.7	1	GFSB
14	Cymbella sinuata	0.7	1	CMSN
15	Nitzschia innominata	0.5	1	NZIN
16	Synedra mazamaensis	0.5	2	SNMZ
17	Navicula cryptocephala veneta	0.5	2	NVCV
18	Nitzschia sp.	0.5	1	NZXX
19	Achnanthes linearis	0.5	2	ACLN
20	Amphora perpusilla	0.4	2	AFPR
21	Synedra ulna	0.4	2	SNUL
22	Rhoicosphenia curvata	0.2	1	RHCU
23	Rhopalodia gibba	0.2	1	RPGB
24	Gomphoneis herculeana	0.2	1	GSHR
25	Fragilaria construens	0.2	1	FRCN
26	Fragilaria vaucheria	0.2	1	FRVA
27	Gomphonema olivaceum	0.2	1	GFOM
28	Cymbella minuta	0.2	1	CMMN
29	Nitzschia fonticola	0.2	1	NZFT
30	Pinnularia sp.	0.2	1	PLXX
31	Amphipleura pellucida	0.2	1	AMPL

Table 10-5 Combined Species List for Klamath River above Tully Creek (TC) 2004

	Combined Algae Species List			
	Yurok Tribe, Klamath Basin, Site TC, 2004	4	samples total	
#	Algae Species	Ave % Den	# samples	Code
1	Epithemia sorex	33.9	3	EPSX
2	Diatoma vulgare	18.7	4	DTVL
3	Nitzschia frustulum	8.6	4	NZFR
4	Achnanthes minutissima	8.2	3	ACMN
5	Synedra mazamaensis	6.0	2	SNMZ
6	Cocconeis placentula	5.6	2	COPC
7	Rhoicosphenia curvata	4.6	2	RHCU
8	Cymbella affinis	4.4	4	CMAF
9	Nitzschia paleacea	2.8	2	NZPC
10	Gomphonema ventricosum	1.3	3	GFVT
11	Nitzschia innominata	0.9	1	NZIN
12	Gomphonema angustatum	0.6	2	GFAN
13	Rhopalodia gibba	0.5	2	RPGB
14	Achnanthes lanceolata	0.4	1	ACLC
15	Navicula tripunctata	0.4	1	NVTP
16	Nitzschia sp.	0.4	2	NZXX
17	Synedra ulna	0.3	2	SNUL
18	Gomphoneis herculeana	0.3	2	GSHR
19	Cocconeis pediculus	0.3	1	COPD
20	Scenedesmus quadricauda	0.3	1	SCQD
21	Nitzschia dissipata	0.2	1	NZDS
22	Navicula cryptocephala veneta	0.2	1	NVCV
23	Cymbella minuta	0.2	1	CMMN
24	Nitzschia communis	0.2	1	NZCM
25	Oscillatoria sp.	0.2	1	OSXX
26	Nitzschia capitellata	0.2	1	NZCP

Table 10-6 Combined Species List for Klamath River at Turwar Gage (TG) 2004

	Combined Algae Species List			
	Yurok Tribe, Klamath Basin, Site TG, 2004	4	samples total	
#	Algae Species	Ave % Den	# samples	Code
1	Epithemia sorex	32.2	4	EPSX
2	Cymbella affinis	18.2	4	CMAF
3	Diatoma vulgare	12.2	4	DTVL
4	Achnanthes minutissima	7.4	4	ACMN
5	Cocconeis placentula	4.8	2	COPC
6	Nitzschia frustulum	4.7	3	NZFR
7	Rhoicosphenia curvata	2.8	3	RHCU
8	Navicula cryptocephala	2.4	2	NVCR
9	Nitzschia paleacea	2.1	3	NZPC
10	Nitzschia dissipata	1.5	1	NZDS
11	Synedra ulna	1.0	1	SNUL
12	Synedra mazamaensis	0.9	2	SNMZ
13	Oscillatoria sp.	0.9	1	OSXX
14	Gomphonema ventricosum	0.8	1	GFVT
15	Gomphonema angustatum	0.8	2	GFAN
16	Cymbella sinuata	0.7	3	CMSN
17	Navicula cryptocephala veneta	0.7	1	NVCV
18	Nitzschia innominata	0.7	1	NZIN
19	Cocconeis pediculus	0.5	2	COPD
20	Fragilaria construens	0.5	1	FRCN
21	Amphora perpusilla	0.4	1	AFPR
22	Gomphoneis herculeana	0.4	2	GSHR
23	Scenedesmus quadricauda	0.3	1	SCQD
24	Gomphonema subclavatum	0.3	1	GFSB
25	Selenastrum minutum	0.3	1	SLMN
26	Ankistrodesmus falcatus	0.3	1	AKFL
27	Navicula tripunctata	0.2	1	NVTP
28	Amphora ovalis	0.2	1	AFOV
29	Nitzschia palea	0.2	1	NZPL
30	Nitzschia sp.	0.2	1	NZXX
31	Fragilaria vaucheria	0.2	1	FRVA
32	Achnanthes lanceolata	0.2	1	ACLC
33	Nitzschia communis	0.2	1	NZCM
34	Nitzschia volcanica	0.2	1	NZVL
35	Cyclotella meneghiniana	0.2	1	CCMG
36	Rhopalodia gibba	0.2	1	RPGB

Table 10-7 Similarity Index for All Sites and Dates* 2004

	TG6/11	TC6/11	WE6/11	TR6/11	TG7/21	TC7/21	WE7/21	TR7/21	TG8/11	TC8/11	TR8-11	TG9-15	TC9-15	TR9-15	WE9-15
TG6/11	-----	12	9	14	7	6	10	7	8	8	7	6	7	10	8
TC6/11	54	-----	8	11	5	5	9	5	6	5	5	6	5	8	7
WE6/11	42	57	-----	11	5	4	8	6	6	5	4	6	4	8	6
TR6/11	59	50	41	-----	11	9	16	11	10	11	7	10	9	10	11
TG7/21	45	31	24	56	-----	8	10	7	6	6	5	7	8	6	7
TC7/21	32	36	33	44	56	-----	7	7	5	6	4	7	6	6	7
WE7/21	50	20	20	43	55	24	-----	8	9	9	7	8	9	9	10
TR7/21	52	19	26	44	46	20	54	-----	6	9	6	8	7	7	7
TG8/11	50	33	26	49	60	33	68	44	-----	9	6	8	8	6	10
TC8/11	31	24	20	42	43	30	53	31	69	-----	6	7	9	7	7
TR8-11	50	19	20	27	28	12	39	71	28	12	-----	6	6	8	6
TG9-15	18	15	18	31	39	22	44	31	56	72	10	-----	7	7	10
TC9-15	23	20	14	33	39	23	40	24	58	78	7	77	-----	8	8
TR9-15	42	32	26	50	60	40	52	37	61	54	21	48	50	-----	8
WE9-15	15	11	10	29	34	16	42	24	52	68	8	84	76	43	-----

*This similarity Index does not include the WE8/11 sample because the maximum number of samples that can fit into this format is 15.

Table 10-8 Similarity Index for all sites during July, August and September sampling dates 2004

	TG7/21	TC7/21	WE7/21	TR7/21	TG8/11	TC8/11	TR8/11	WE8/11	TG9/15	TC9/15	TR9/15	WE9/15
TG7/21	-----	8	10	7	6	6	5	4	7	8	6	7
TC7/21	56	-----	7	7	5	6	4	4	7	6	6	7
WE7/21	55	24	-----	8	9	9	7	8	8	9	9	10
TR7/21	46	20	54	-----	6	9	6	5	8	7	7	7
TG8/11	60	33	68	44	-----	9	6	5	8	8	6	10
TC8/11	43	30	53	31	69	-----	6	6	7	9	7	7
TR8/11	28	12	39	71	28	12	-----	4	6	6	8	6
WE8/11	29	11	40	30	46	67	9	-----	5	5	6	6
TG9/15	39	22	44	31	56	72	10	69	-----	7	7	10
TC9/15	39	23	40	24	58	78	7	63	77	-----	8	8
TR9/15	60	40	52	37	61	54	21	39	48	50	-----	8
WE9/15	34	16	42	24	52	68	8	67	84	76	43	-----

Table 10-9 Similarity Index for all sites during June, July and August sampling dates 2004

	TG6/11	TC6/11	WE6/11	TR6/11	TG7/21	TC7/21	WE7/21	TR7/21	TG8/11	TC8/11	TR8/11	WE8/11
TG6/11	-----	12	9	14	7	6	10	7	8	8	7	4
TC6/11	54	-----	8	11	5	5	9	5	6	5	5	3
WE6/11	42	57	-----	11	5	4	8	6	6	5	4	4
TR6/11	59	50	41	-----	11	9	16	11	10	11	7	7
TG7/21	45	31	24	56	-----	8	10	7	6	6	5	4
TC7/21	32	36	33	44	56	-----	7	7	5	6	4	4
WE7/21	50	20	20	43	55	24	-----	8	9	9	7	8
TR7/21	52	19	26	44	46	20	54	-----	6	9	6	5
TG8/11	50	33	26	49	60	33	68	44	-----	9	6	5
TC8/11	31	24	20	42	43	30	53	31	69	-----	6	6
TR8/11	50	19	20	27	28	12	39	71	28	12	-----	4
WE8/11	11	5	12	25	29	11	40	30	46	67	9	-----

Similarity Indices are given in the lower left half of the table. Number of species common to both samples are given in the upper right half of the table. The SI ranges from 0 for totally dissimilar samples, to 100 for identical samples.

10.1.7.3 Klamath River Estuary Water Quality Monitoring June - September

10.1.7.3.1 Klamath River Upper Estuary

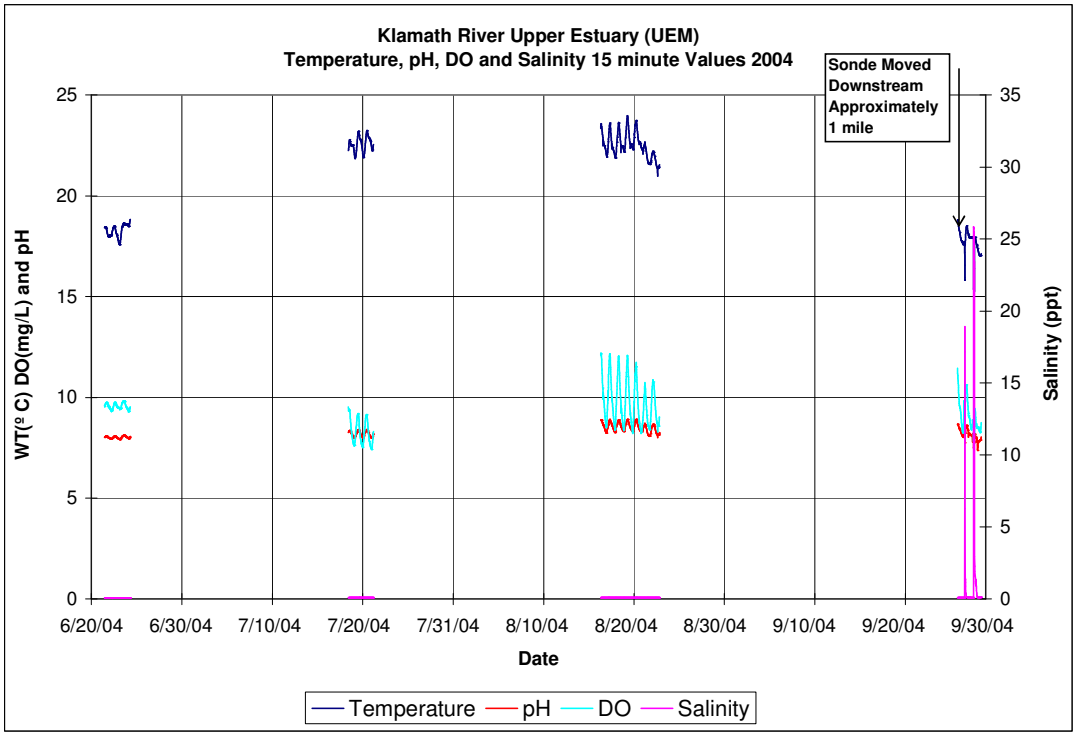

Figure 10-45 Water Temperature, pH, DO and Salinity Values for the Klamath River Upper Estuary WY04

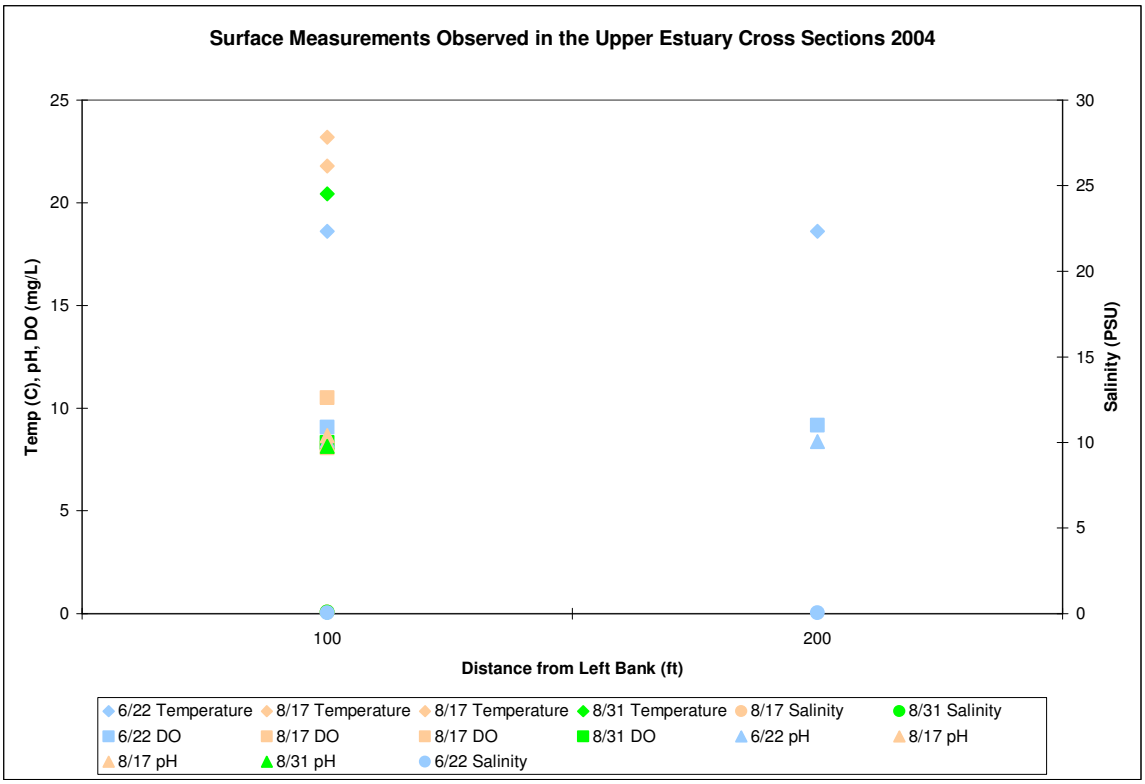

Figure 10-46 Cross Section Surface Measurements in the Klamath River Upper Estuary WY04

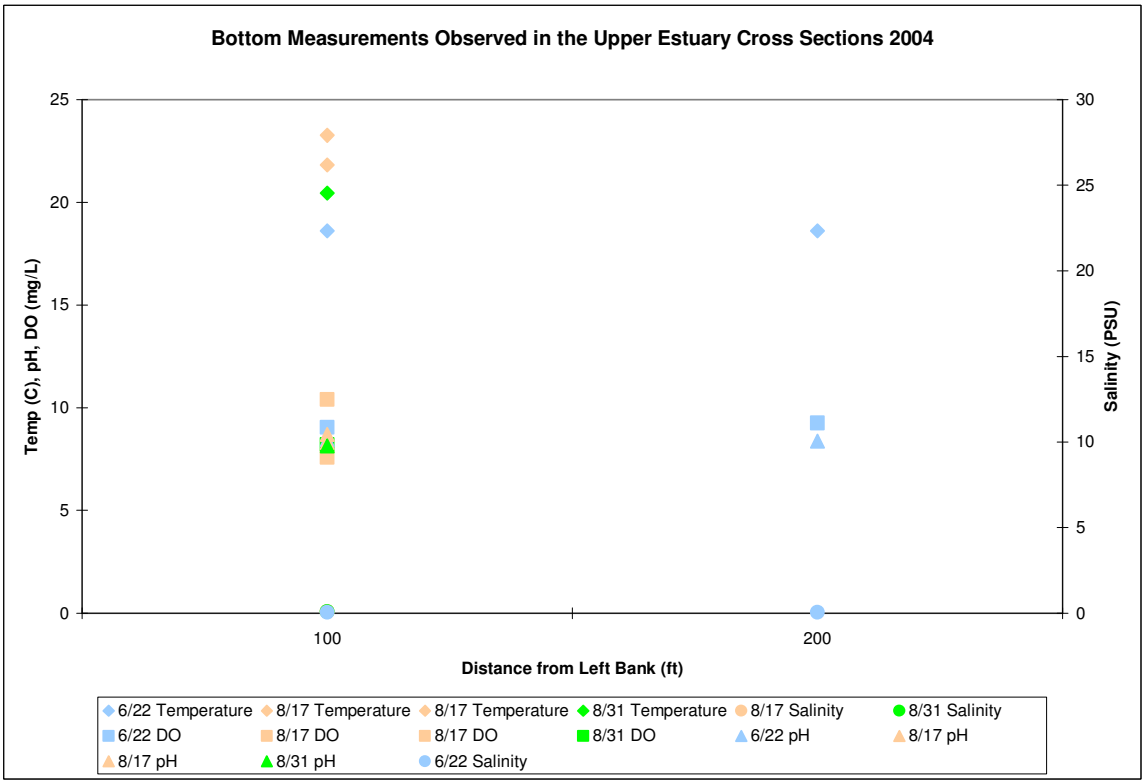

Figure 10-47 Cross Section Bottom Measurements in the Klamath River Upper Estuary WY04

10.1.7.3.2 Klamath River Middle Estuary

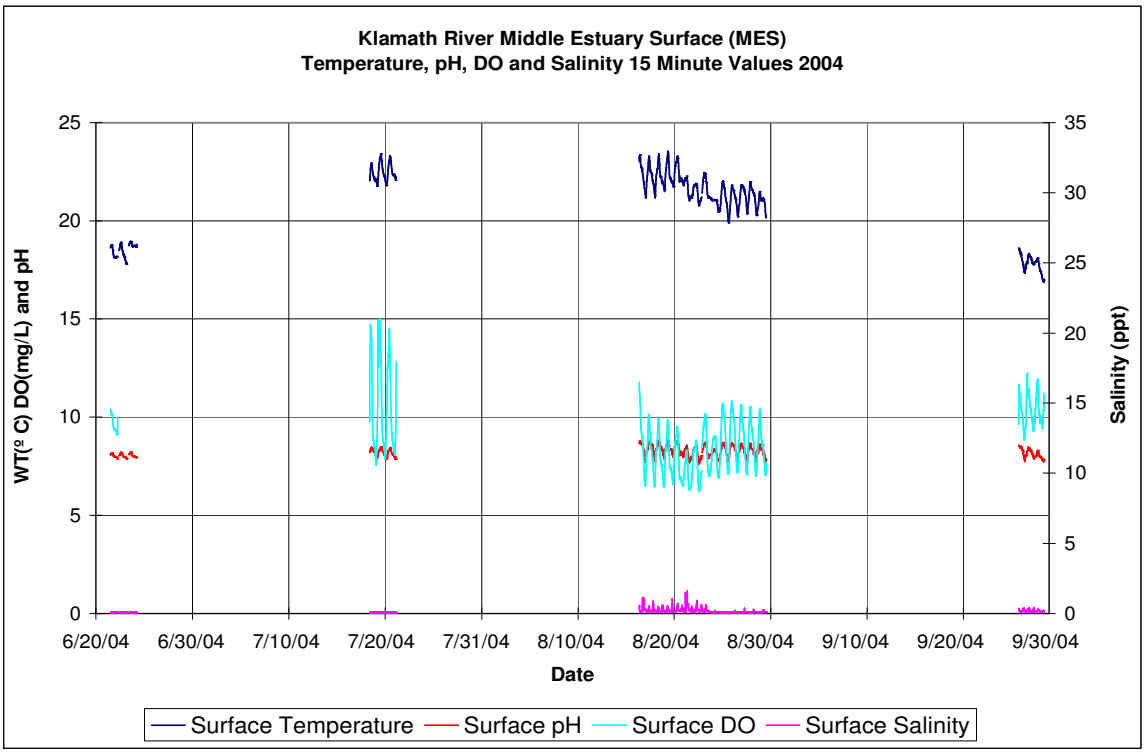

Figure 10-48 Water Temperature, pH, DO and Salinity Values for the Klamath River Middle Estuary Surface WY04

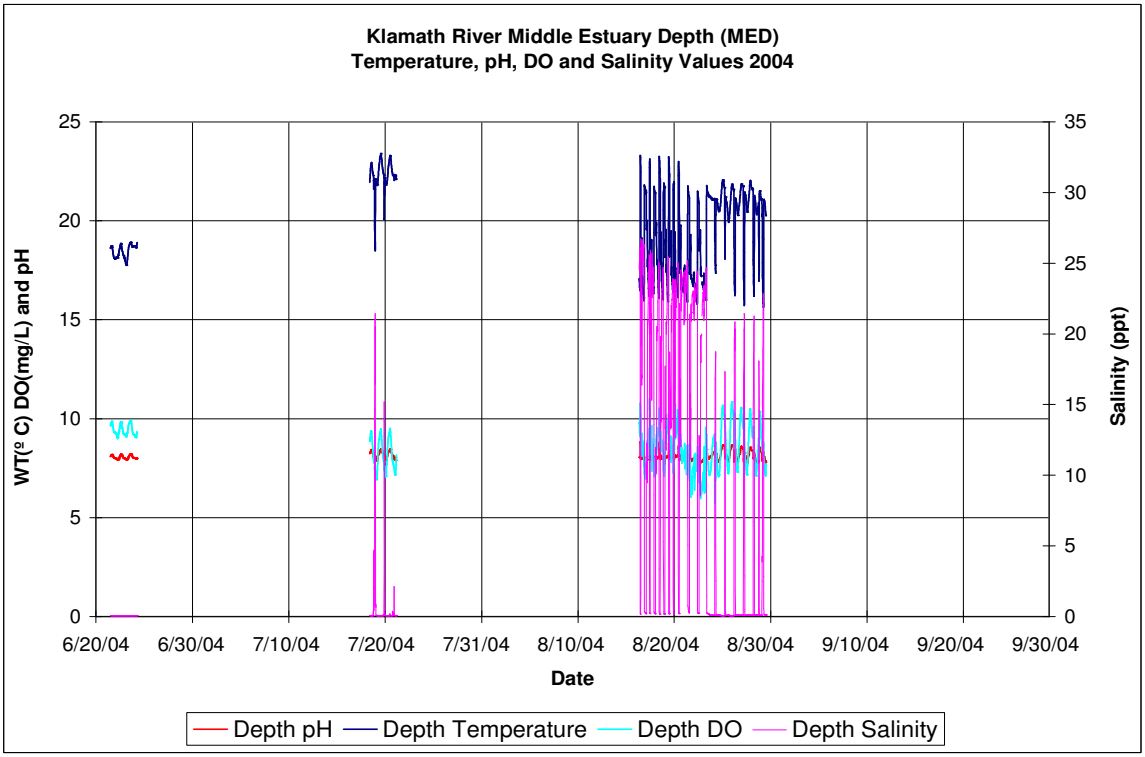

Figure 10-49 Water Temperature, pH, DO and Salinity Values for the Klamath River Middle Estuary Depth WY04

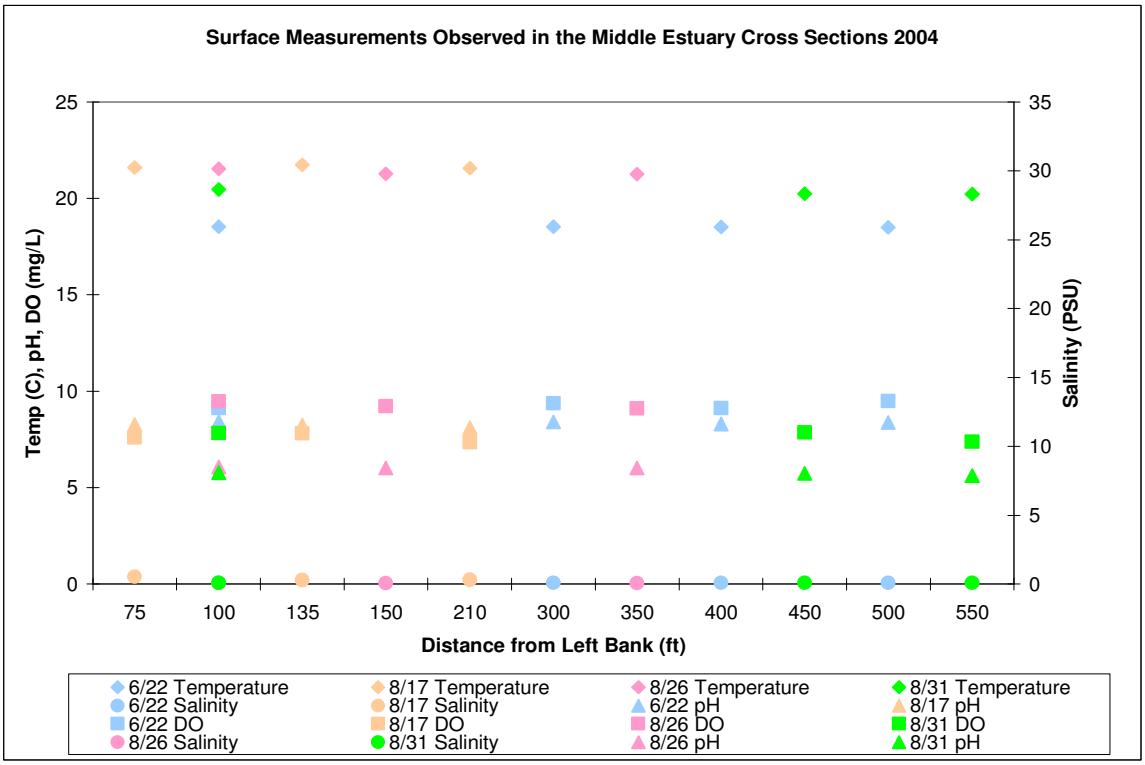

Figure 10-50 Cross Section Surface Measurements in the Klamath River Middle Estuary WY04

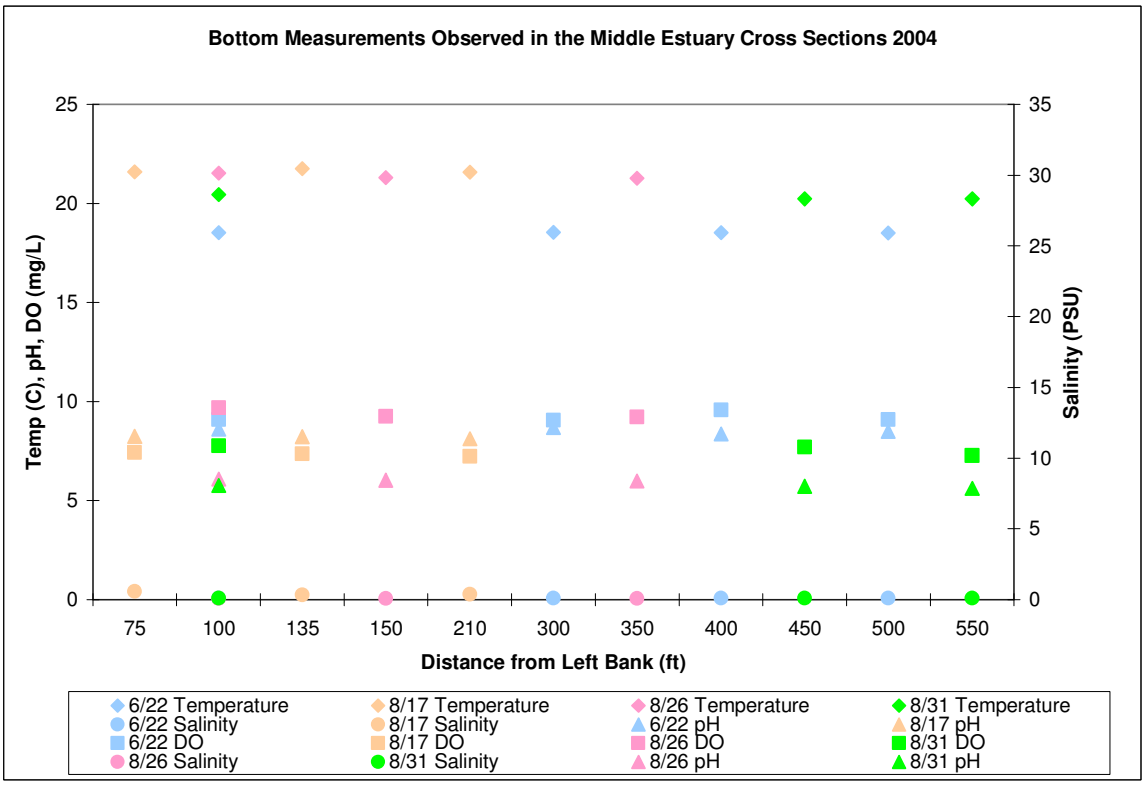

Figure 10-51 Cross Section Bottom Measurements in the Klamath River Middle Estuary WY04

10.1.7.3.3 Klamath River Lower Estuary

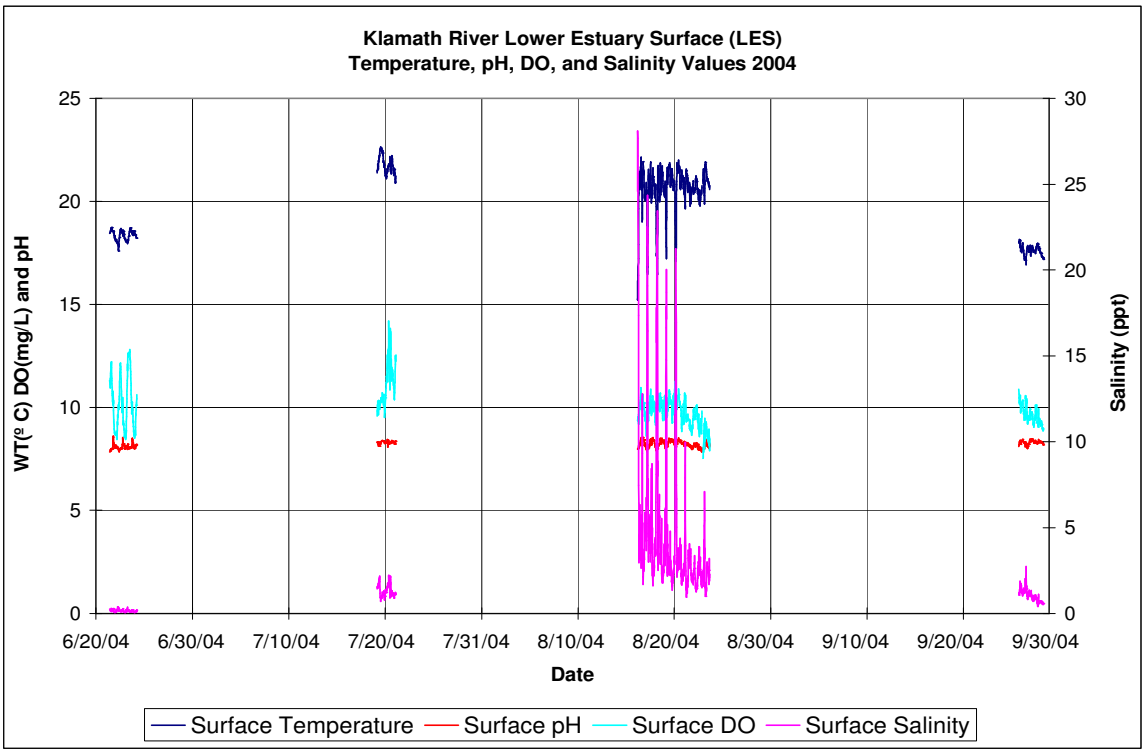

Figure 10-52 Water Temperature, pH, DO and Salinity Values for the Klamath River Lower Estuary Surface WY04

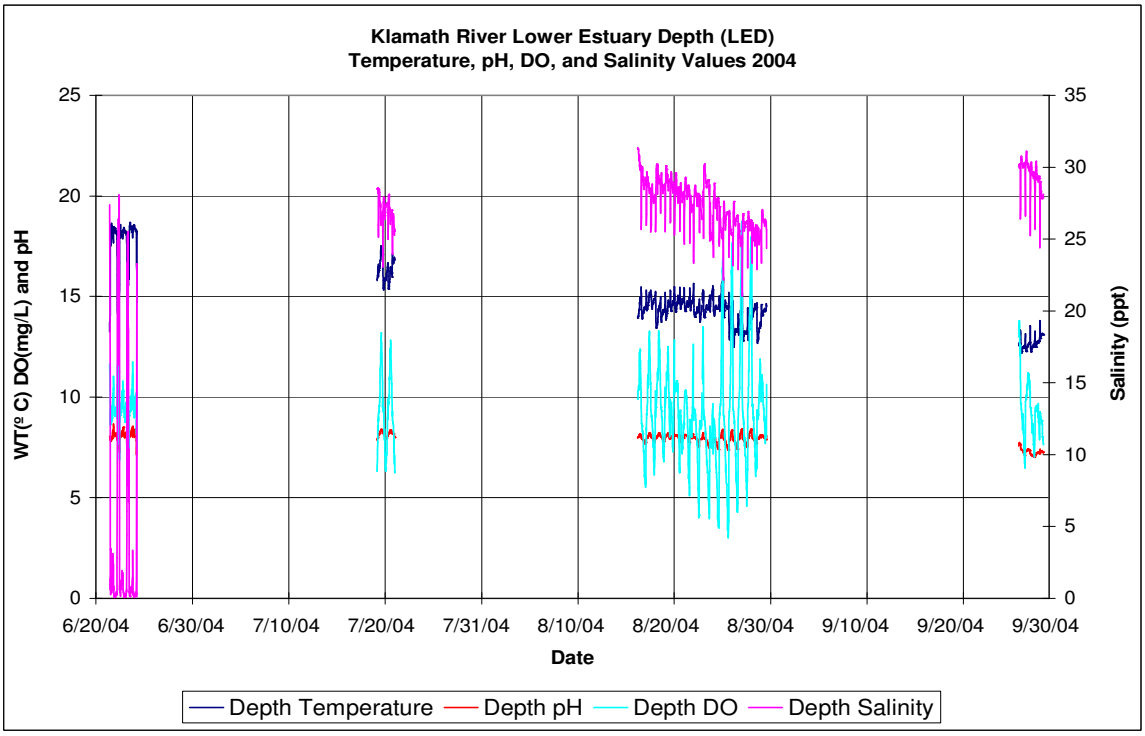

Figure 10-53 Water Temperature, pH, DO and Salinity Values for the Klamath River Lower Estuary Depth WY04

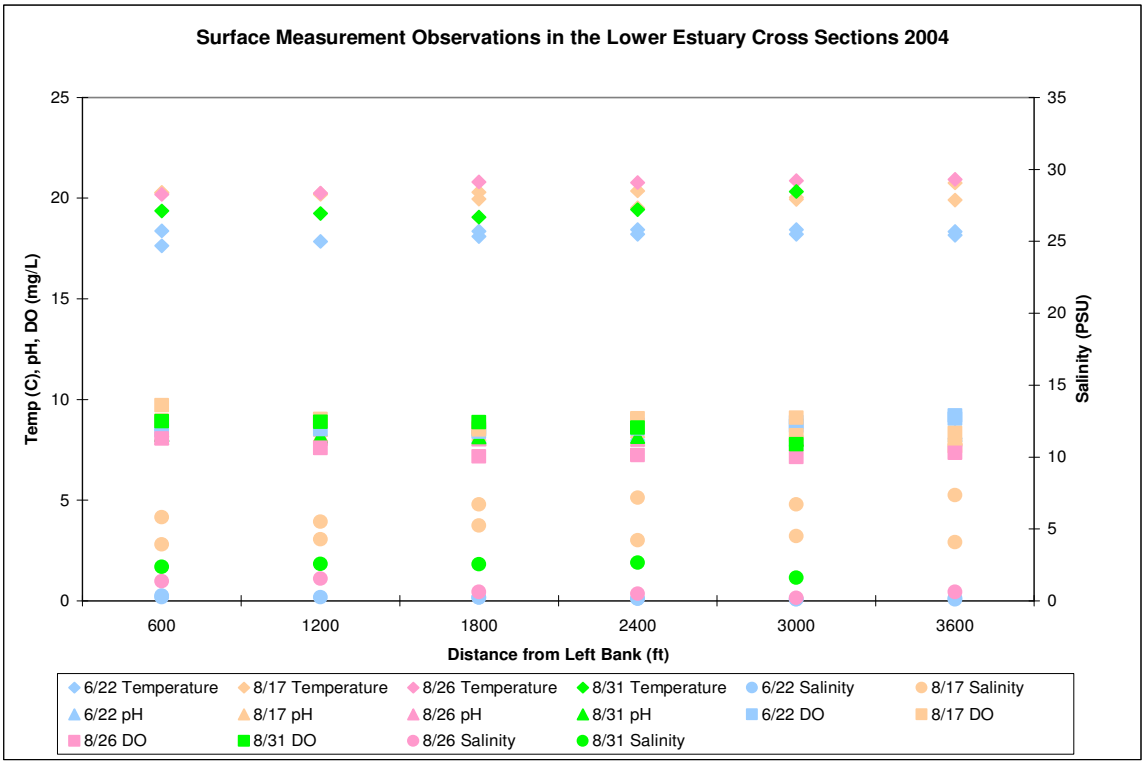

Figure 10-54 Cross Section Surface Measurements in the Klamath River Lower Estuary WY04

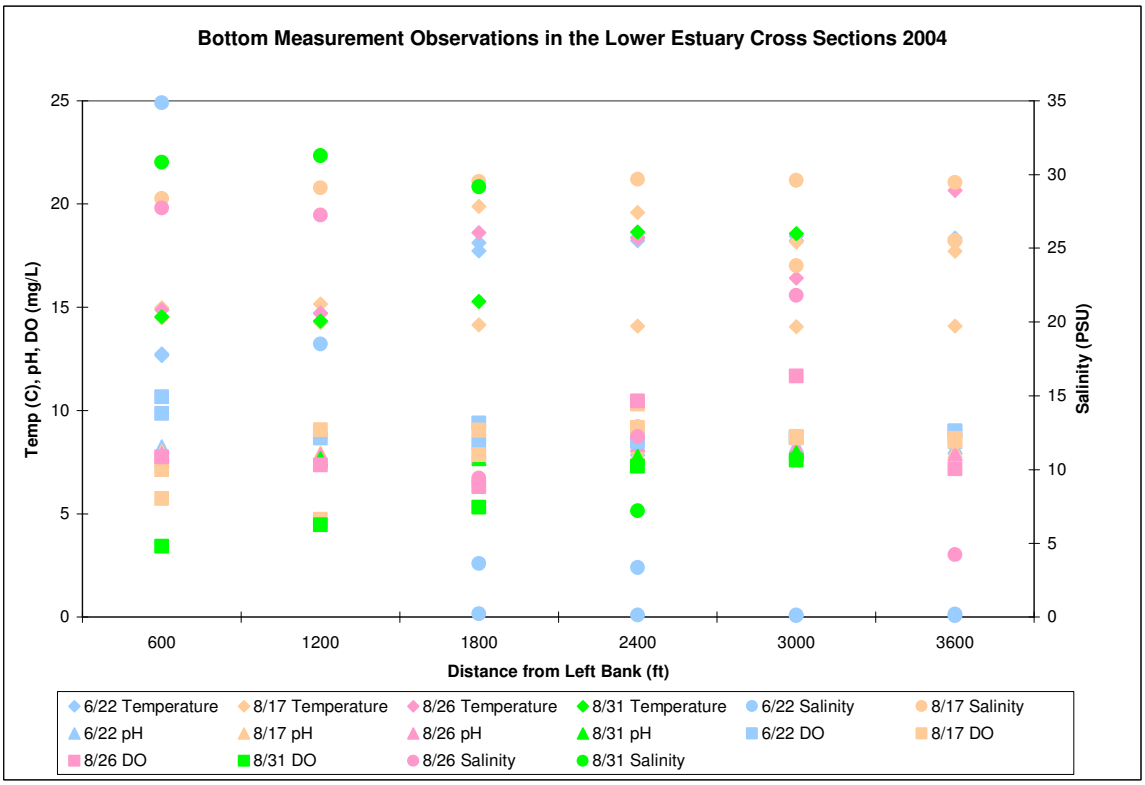

Figure 10-55 Cross Section Bottom Measurements in the Klamath River Lower Estuary WY04

10.1.8 Mainstem Grab Samples

10.1.8.1 Nutrients

Nutrients

Nitrate (as Nitrogen)
mg/L; Report Limit: 0.050
12/17/03 and 1/22/04 =0.10
7/22/04 LED and PO samples
8/24/04 LES, LED and MED
8/31/04 LES,LED and PO
were diluted and reporting limits
raised due to matrix interference
7/22/04 LED and PO = 1.0
8/24/04 MED and LED=0.50 LES=0.25
8/31/04 LED, PO and LES=1.0 LEM=2.5

Site	Date 12/17/03	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	0.11		<0.050			<0.050		<0.050			<0.050	
TG	0.12	0.12	<0.050			<0.050		<0.050			<0.050	
TR	<0.10	<0.10	<0.050			<0.050		<0.050			<0.050	
WE	0.14	<0.10	<0.050			<0.050		<0.050			<0.050	
LES				<0.10	<0.10		<0.050		<0.25	<1.0		<0.050
LED				<0.10	<0.10		<1.0		<0.50	<1.0		<0.050
MES				<0.10	<0.10		<0.050		<0.050	<0.050		<0.050
MED				<0.10	<0.10		<0.050		<0.50	<0.050		<0.050
UEM				<0.10	<0.10		<0.050		<0.050			<0.050
PO					<0.10		<1.0			<1.0		

Nitrite (as Nitrogen)
mg/L; Report Limit: 0.050
12/17/03 and 1/22/04 = 0.10
7/22/04 LED and PO samples
8/24/04 LES,LED, and MED
8/31/04 LES, LED and LEM
were diluted and reporting limits
raised due to matrix interference
7/22/04 LES = 1.0 LED = 2.5 PO = 5.0
8/24/04 MED=5.0 LES =0.50 LED=2.5
8/31/04 LED and LES=2.5 PO=5.0 LEM=5.0

Site	12/17/03	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	<0.10		<0.050									
TG	<0.10	<0.10	<0.050									
TR	<0.10	<0.10	<0.050									
WE	<0.10	<0.10	<0.050									
LES				<0.10	<0.10		<1.0		<0.50	<2.5		<0.050
LED				<0.10	<0.10		<2.5		<2.5	<2.5		<0.050
MES				<0.10	<0.10		<0.050		<0.050	<0.050		<0.050
MED				<0.10	<0.10		<0.050		<5.0	<0.050		<0.050
UEM				<0.10	<0.10		<0.050		<0.050			<0.050
PO					<0.10		<5.0			<5.0		

Total Nitrogen
mg/L; Report Limit 0.55

Site	12/17/03	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC												
TG												
TR												
WE												
LES												<0.55
LED												<0.55
MES												<0.55
MED												0.60
UEM												<0.55
PO												

Nitrogen - Total Kjeldahl
mg/L; Report Limit: 1.0
6/10/04, 7/22/04, 8/17/04, 8/24/04, = 0.50
8/31/04 and 9/14/04, 9/27/04= 0.50
7/22/04 PO = 1.5

Site	12/17/03	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	<1.0		<0.50			<0.50		<0.50			<0.50	
TG	<1.0	<1.0	<0.50			<0.50		<0.50			0.59	
TR	<1.0	<1.0	<0.50			<0.50		<0.50			<0.50	
WE	<1.0	<1.0	<0.50			<0.50		<0.50			<0.50	
LES				<1.0	<1.0		<0.50		<0.50	<0.50		0.53
LED				<1.0	<1.0		<0.50		<0.50	0.89		<0.50
MES				<1.0	<1.0		<0.50		<0.50	<0.50		<0.50
MED				<1.0	<1.0		<0.50		<0.50	<0.50		0.60
UEM				<1.0	<1.0		<0.50		<0.50			<0.50
PO					<1.0		<1.5			1.60		

Ammonia Nitrogen
mg/L; Report Limit: 0.20
6/10/04, 7/20/04, 7/22/04, 8/24/04, 8/31/04,
and 9/14/04 = 0.10
8/17/04 and 9/27/04 = 0.050

Site	12/17/03	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	<0.20		<0.10			<0.10		<0.050			<0.10	
TG	<0.20	<0.20	<0.10			<0.10		<0.050			<0.10	
TR	<0.20	<0.20	<0.10			<0.10		<0.050			<0.10	
WE	<0.20	<0.20	<0.10			<0.10		0.062			<0.10	
LES				<0.20	<0.20		<0.10		<0.10	<0.10		0.065
LED				<0.20	<0.20		<0.10		<0.10	<0.10		<0.050
MES				<0.20	<0.20		<0.10		<0.10	<0.10		<0.050
MED				<0.20	<0.20		<0.10		<0.10	<0.10		0.072
UEM				<0.20	<0.20		<0.10		<0.10			<0.050
PO					<0.20		<0.10			<0.10		

Total Phosphate Phosphorous
mg/L; Report Limit: 0.020

Site	12/17/03	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	0.048		0.028			0.069		0.054			0.160	
TG	0.059	<0.020	0.027			0.026		0.047			0.160	
TR	0.060	<0.020	<0.020			<0.020		0.023			0.100	
WE	0.055	<0.020	0.035			0.042		0.081			0.220	
LES				0.120	0.021		0.062		0.053	0.200		<0.050
LED				0.120	<0.020		0.042		0.031	0.082		<0.050
MES				0.150	<0.020		0.100		0.047	0.2000		<0.050
MED				0.190	<0.020		0.075		0.048	0.220		<0.050
UEM				0.150	<0.020		0.082		0.054			<0.050
PO					0.039		0.086			0.550		

Orthophosphate Phosphorous
mg/L; Report Limit: 0.010
9/27/04 = 0.050

Site	12/17/03	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	0.032		<0.010			0.013		0.015			0.040	
TG	0.038	0.025	<0.010			0.013		<0.010			0.032	
TR	0.047	0.025	<0.010			<0.010		<0.010			<0.010	
WE	0.024	0.018	<0.010			0.026		0.026			0.071	
LES				<0.010	<0.010		<0.010		<0.010	0.020		<0.050
LED				0.019	<0.010		<0.010		<0.010	<0.010		<0.050
MES				<0.010	<0.010		<0.010		<0.010	0.025		<0.050
MED				<0.010	<0.010		<0.010		0.011	0.027		<0.050
UEM				<0.010	<0.010		0.011		<0.010			<0.050
PO					<0.010		0.035			0.043		

10.1.8.2 Other Analytes

Other Analytes

Alkalinity
EPA: CCC is 20,000.
mg/L CaCO3; Report Limit: 1.0

Site	Date 12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	62.0		56.0			72		79				
TG	57.0	64.0	57.0			73		78				
TR	63.0	72.0	53.0			64		67				
WE	58.0	62.0	58.0			78		67				
LES												
LED												
MES												
MED												
UEM												
PO												

Biochemical Oxygen Demand
mg/L; Report Limit: 2.0
9/27/04 = 1.0

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	<2.0											
TG	<2.0	<2.0										
TR	<2.0	<2.0										
WE	<2.0	<2.0										
LES							<2.0		<2.0	<2.0		<1.0
LED							<2.0		<2.0	<2.0		<1.0
MES							<2.0		<2.0	<2.0		<1.0
MED							<2.0		<2.0	<2.0		<1.0
UEM							<2.0		<2.0			<1.0
PO							<2.0			2.3		

Calcium
µg/L; Report Limit: 1,000
8/17/04 = 100

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	14000		12000					17000				
TG	13000	15000	12000					18000				
TR	17000	19000	11000					16000				
WE	11000	13000	13000					17000				
LES												
LED												
MES												
MED												
UEM												
PO												

Chlorophyll a
mg/m^3; Report Limit: 0.1
6/10/04, 6/21/04,6/23/04 =10 mg/m^3
9/27/04 = 0.5mg/m^3

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	<0.1		<10			<0.1		0.3			0.3	
TG	<0.1	0.1	<10			<0.1		0.1			1.1	
TR	<0.1	0.1	<10			0.3		0.5			0.8	
WE	<0.1	0.2	<10			<0.1		0.1			0.8	
LES				<10	<10		<0.1		0.3	1.9		1.6
LED				<10	<10		<0.1		1.9	2.9		6.9
MES				<10	<10		<0.1		1.3	2.4		1.6
MED				<10	<10		0.3		<0.1	1.9		2.0
UEM				<10	<10		1.9		0.8			19.0
PO					<10		1.3			5.3		

Pheophytin
mg/m^3; Report Limit: 0.1
6/10/04 =10 mg/m^3

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	1.3		<10			1.5		1.6			2.2	
TG	0.9	0.4	<10			1.3		1.5			1.5	
TR	1.6	0.9	<10			<0.1		0.1			<0.1	
WE	0.9	0.5	<10			1.1		1.9			2.2	
LES							1.4		0.9	<0.1		
LED							1.3		0.7	2.5		
MES							1.9		0.7	<0.1		
MED							1.4		3.3	1.3		
UEM							<0.1		2.2			
PO							3.5			2.7		

Magnesium
µg/L; Report Limit: 250
8/17/04 = 100

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	7100		6700					8400				
TG	7100	7400	6700					8500				
TR	7400	7700	7000					7300				
WE	6900	7300	6500					9000				
LES												
LED												
MES												
MED												
UEM												
PO												

Non-Filterable Residue (TSS)
mg/L; Report Limit: 1.0

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	14.0		4.8			1.3		1.2			1.6	
TG	14.0	11.0	4.0			<1.0		1.0			2.8	
TR	8.4	14.0	4.4			<1.0		<1.0			<1.0	
WE	2.4	2.0	3.2			<1.0		<1.0			2.6	
LES				2.0	1.4		1.0		<1.0	3.2		<10
LED				10.0	1.8		10.0		7.8	6.8		<10
MES				2.6	1.0		1.4		2.2	4.8		<10
MED				2.0	1.2		1.2		13.0	3.8		15.0
UEM				2.4	2.6		1.0		1.6			<10
PO					25.0		35.0			64.0		

Total Dissolved Solids (TDS)
mg/L; Report Limit: 10
9/27/04 = 25

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	110		83			100		110			100	
TG	110	84	82			100		100			100	
TR	120	94	76			78		90			70	
WE	120	87	88			120		130			120	
LES												1000
LED												2400
MES												150
MED												21000
UEM												120
PO												

Total Organic Carbon
mg/L; Report Limit: 0.20 - 0.50
9/27/04=0.80

Site	12/17/2003	1/22/04	6/10/04	6/21/04	6/23/04	7/20/04	7/22/04	8/17/04	8/24/04	8/31/04	9/14/04	9/27/04
TC	1.90		1.10			1.30		1.80			1.80	
TG	1.80	1.20	0.98			1.20		1.50			1.60	
TR	2.40	1.10	0.83			0.69		0.72			0.74	
WE	2.30	1.40	1.50			1.80		2.40			2.60	
LES				1.20	1.40		1.20		1.50	1.30		1.70
LED				0.78	1.20		1.20		0.49	<0.30		1.80
MES				1.10	1.30		1.10		1.70	1.90		1.90
MED				1.10	1.10		1.20		0.51	1.80		0.83
UEM				1.10	1.10		1.10		1.70			1.70
PO					<0.30		<0.30			<0.30		

10.1.8.3 Bacteria Analytes

Bacteria

E. coli
CFU; Report Limit: 1.0
YTWQCP: *E. coli* single sample maximum 235 CFU/100ml

Site	Date 12/17/03	1/22/2004	3/12/04	4/23/04	5/18/04	6/10/04	7/20/04	8/17/04	9/14/04	10/27/04
TC	8.5					4			23	
TG	15.8	3.1				1.1			2	
TR	10.9	1.0				4			2	
WE	14.4	3.0				<2			13	
Klamath Estuary			10	20	20	<10	<10	<10	10	52
K.R. >WTP			<10	30	10	<10	10	<10	10	52
K.R. < WTP			<10	<10	30	<10	20	<10	10	20

Strep. faecalis
CFU; Report Limit: 1.0
YTWQCP: *Strep. faecalis* single sample maximum 61 CFU/100

Site	Date 12/17/03	1/22/04	3/12/04	4/23/04	5/18/04	6/10/04	7/20/04	8/17/2004	9/14/04	10/27/04
TC	<1									
TG	8.6	<1								
TR	3.1	1.0								
WE	6.3	<1								
Klamath Estuary			<10	<10	10	<10	<10	10	10	10
K.R. >WTP			20	<10	<10	<10	10	<10	10	31
K.R. < WTP			<10	<10	<10	10	<10	10	<10	30

Total Coliform
CFU; Report Limit: 1.0

Site	Date 12/17/03	1/22/04	3/12/04	4/23/04	5/18/04	6/10/04	7/20/04	8/17/04	9/14/04	10/27/04
TC	816.4					130			500	
TG	920.8	275.5				>230			110	
TR	579.4	290.9				30			130	
WE	866.4	214.3				80			500	
Klamath Estuary			281	341	473	368	1,374	3,076	3433	991
K.R. >WTP			216	301	295	408	987	1,450	2140	1296
K.R. < WTP			295	226	546	161	1,374	2,613	2933	2863

10.2 Water Quality and Hydrology (Tributaries)

10.2.1 McGarvey Creek

The McGarvey gaging station has been in operation since December 1, 2001. The station is located at 41° 29' 11.29" North latitude, 124° 00' 34.46" West longitude. Geographically, it is located just downstream of the West Fork and Mainstem confluence and upstream McGarvey Creek's confluence with Den Creek. The total drainage area of the watershed is 8.9 square miles. The following parameters are measured at the site on a fifteen-minute time interval throughout the year: date, time, stage, air temperature (inside the gaging box), and battery voltage. Flow measurements are collected at the gaging station periodically and a rating curve has been established in order to convert continuous stage records to discharge values. Turbidity, water temperature, and specific conductivity were periodically monitored during the winter using a datasonde programmed to record every fifteen-minutes.

YTFP monitored water temperature at various locations throughout the McGarvey Creek drainage and at the gaging station site. YTFP also monitored rainfall events in McGarvey Creek located near the north end of the Simpson M920 road, south of the junction near the M900 road entrance. Rainfall was measured using tipping bucket rain gages that records rainfall events equivalent to 1/100 of an inch of rainfall. Data collected by YTFP is not presented in this report (Contact Dan Gale at 707-482-2841 for more information).

10.2.1.1 Discharge

Table 10-10 Minimum Daily Discharge (cfs) Values for McGarvey Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	Aug	Sept
1	1.17	0.82	14.06	113.24	32.10	59.45	10.28	8.32	2.81	1.86	1.23	1.01
2	1.17	0.82	13.31	129.60	30.66	49.55	9.40	7.81	2.70	1.78	1.23	1.01
3	1.17	2.02	13.31	123.26	29.96	25.40	8.58	7.33	2.70	1.78	1.23	1.01
4	1.23	2.02	14.45	125.35	25.40	21.93	8.32	7.10	2.70	1.70	1.23	0.91
5	1.29	2.30	39.23	60.64	21.93	20.34	7.57	6.66	2.60	1.63	1.17	0.91
6	1.35	2.49	38.39	48.53	21.39	17.43	7.33	6.23	2.60	1.55	1.17	0.87
7	1.35	3.41	40.10	40.10	44.63	15.68	6.88	6.23	2.60	1.48	1.17	0.82
8	1.35	6.44	34.36	37.55	36.73	13.68	6.66	5.83	2.60	1.48	1.12	0.82
9	1.55	8.32	29.28	34.36	29.96	12.94	6.23	5.45	2.49	1.42	1.06	0.78
10	1.55	4.74	24.20	34.36	23.62	11.89	5.83	5.27	2.39	1.42	1.01	0.70
11	1.48	3.29	29.28	29.96	20.86	10.90	5.64	5.27	2.30	1.42	1.01	0.67
12	1.70	2.81	32.10	23.62	17.89	10.28	5.45	4.91	2.30	1.42	1.01	0.63
13	1.70	2.60	349.53	20.34	16.98	9.69	5.45	4.74	2.20	1.48	1.01	0.60
14	1.55	2.49	127.46	19.83	15.26	9.12	6.23	4.58	2.20	1.48	1.06	0.42
15	1.48	5.09	77.81	29.96	14.06	8.58	13.68	4.42	2.11	1.35	1.12	0.29
16	1.55	9.69	59.45	25.40	16.98	8.06	10.90	4.26	2.02	1.35	1.01	0.12
17	1.55	9.12	44.63	22.48	66.85	7.81	9.40	4.26	2.11	1.35	0.96	0.11
18	1.55	6.44	35.93	20.86	88.50	7.57	9.40	4.11	2.11	1.35	0.96	0.50
19	1.55	5.83	32.10	19.83	109.41	7.10	9.40	3.96	2.20	1.29	0.96	0.78
20	1.55	10.90	31.38	17.89	70.81	6.66	18.36	3.96	2.20	1.29	0.91	1.23
21	1.48	10.90	27.94	16.10	54.88	6.44	61.84	3.29	2.20	1.29	0.91	1.01
22	1.48	9.69	21.39	14.85	47.53	6.44	47.53	3.29	2.20	1.23	0.91	0.91
23	1.63	8.84	20.86	14.45	39.23	6.23	39.23	3.16	2.20	1.23	1.48	0.87
24	1.86	8.32	23.05	29.28	38.39	6.03	31.38	3.04	2.02	1.23	1.23	0.82
25	1.70	8.32	23.62	28.60	36.73	6.23	25.40	2.93	1.86	1.23	1.23	0.82
26	1.48	11.55	27.94	26.02	57.13	12.58	15.26	2.81	1.86	1.23	1.42	0.74
27	1.35	10.28	26.02	27.94	103.86	12.94	13.31	2.93	1.78	1.17	1.23	0.70
28	1.23	9.40	24.80	53.78	79.27	11.22	11.55	3.82	1.78	1.17	1.12	0.70
29	1.01	9.40	57.13	40.97	72.17	9.98	9.98	3.29	1.78	1.17	1.06	0.70
30	0.96	14.06	127.46	40.10		9.98	9.12	3.04	1.78	1.23	1.01	0.74
31	0.96		111.31	37.55		10.90		2.93		1.23	1.01	
Monthly Statistics												
Total	44.06	192.41	1571.86	1306.83	1263.22	433.04	435.59	145.25	67.41	43.32	34.30	22.24
Mean	1.42	6.41	50.71	42.16	43.56	13.97	14.52	4.69	2.25	1.40	1.11	0.74
Max	1.86	14.06	349.53	129.60	109.41	59.45	61.84	8.32	2.81	1.86	1.48	1.23
Min	0.96	0.82	13.31	14.45	14.06	6.03	5.45	2.81	1.78	1.17	0.91	0.11

Table 10-11 Maximum Daily Discharge (cfs) Values for McGarvey Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	1.35	0.96	20.34	184.10	37.55	79.27	11.22	9.12	2.93	1.94	1.29	1.23
2	1.29	3.41	17.43	167.75	47.53	60.64	10.28	8.32	2.93	1.94	1.29	1.06
3	1.35	3.41	17.89	140.71	35.93	50.58	9.69	9.69	2.81	1.86	1.35	1.06
4	1.42	2.30	52.70	150.12	31.38	25.40	9.12	7.57	2.81	2.02	1.23	1.01
5	1.48	2.93	52.70	125.35	25.40	21.93	8.32	7.10	2.70	1.78	1.29	0.96
6	1.48	4.58	160.01	61.84	54.88	20.34	8.06	6.66	2.70	1.70	1.23	0.91
7	1.48	8.06	80.76	50.58	54.88	17.43	7.57	7.81	2.81	1.70	1.29	0.87
8	1.55	22.48	47.53	42.77	44.63	15.68	7.33	6.23	2.60	1.63	1.17	0.87
9	1.78	13.31	34.36	37.55	36.73	14.06	6.88	5.83	2.60	1.55	1.12	0.82
10	1.70	11.55	29.96	43.69	30.66	12.94	6.66	5.64	2.60	1.55	1.06	0.78
11	1.70	4.74	43.69	34.36	24.20	12.23	6.23	5.64	2.49	1.55	1.06	0.74
12	1.94	3.29	710.02	35.93	36.73	11.22	6.03	5.27	2.39	1.55	1.06	0.70
13	1.94	2.81	1372.53	23.62	18.36	10.59	6.44	5.09	2.39	1.63	1.06	0.67
14	1.78	4.74	776.40	32.84	17.43	9.69	19.83	4.91	2.49	1.63	1.12	0.60
15	1.63	32.84	140.71	35.93	16.54	9.12	18.36	4.74	2.30	1.55	1.17	0.44
16	1.70	23.05	77.81	29.96	83.79	8.84	14.45	4.58	2.20	1.48	1.12	0.35
17	1.70	23.05	58.28	26.02	117.17	8.32	10.90	4.42	2.20	1.55	1.01	0.47
18	1.70	9.12	44.63	23.05	195.66	8.06	9.98	4.42	2.20	1.48	1.01	0.82
19	1.70	16.98	43.69	21.93	162.56	7.57	27.94	4.26	2.30	1.48	0.96	1.42
20	1.78	16.54	40.97	20.34	109.41	7.33	76.37	4.11	2.20	1.42	0.96	1.35
21	1.70	12.23	31.38	17.89	70.81	7.10	150.12	3.96	2.30	1.42	0.96	1.06
22	1.70	11.22	27.94	16.10	55.99	6.88	65.57	3.41	2.30	1.42	4.42	1.01
23	2.30	9.69	22.48	33.59	49.55	6.88	53.78	3.29	2.30	1.35	2.49	0.96
24	2.02	9.12	28.60	40.10	42.77	8.06	40.10	3.16	2.20	1.35	1.55	0.87
25	1.94	11.55	40.10	33.59	61.84	19.33	31.38	3.16	2.02	1.35	2.81	0.82
26	1.78	14.06	32.84	28.60	103.86	18.36	26.02	3.04	1.94	1.35	2.11	0.82
27	1.55	12.23	28.60	100.28	175.78	16.98	15.68	3.68	1.94	1.29	1.42	0.74
28	1.42	10.28	49.55	70.81	145.36	12.94	13.31	7.57	1.94	1.23	1.23	0.74
29	1.29	16.10	354.18	54.88	86.90	11.22	11.89	4.11	1.86	1.29	1.17	0.74
30	1.06	15.68	217.24	54.88		19.83	10.28	3.29	1.86	1.29	1.06	0.78
31	1.12		129.60	44.63		12.58		3.04		1.29	1.01	
Monthly Statistics												
Total	50.33	332.31	4784.93	1783.81	1974.31	551.43	699.78	163.14	71.30	47.65	43.13	25.72
Mean	1.62	11.08	154.35	57.54	68.08	17.79	23.33	5.26	2.38	1.54	1.39	0.86
Max	2.30	32.84	1372.53	184.10	195.66	79.27	150.12	9.69	2.93	2.02	4.42	1.42
Min	1.06	0.96	17.43	16.10	16.54	6.88	6.03	3.04	1.86	1.23	0.96	0.35

Table 10-12 Average Daily Discharge (cfs) Values for McGarvey Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	1.23	0.90	16.42	155.06	34.92	68.30	10.70	8.85	2.88	1.90	1.27	1.04
2	1.21	1.12	14.98	150.67	37.77	55.25	9.95	8.12	2.80	1.87	1.27	1.06
3	1.25	2.38	15.22	132.52	32.73	37.55	9.19	7.74	2.80	1.82	1.30	1.04
4	1.29	2.11	18.76	138.60	28.28	23.85	8.59	7.32	2.77	1.79	1.23	0.96
5	1.36	2.60	44.47	96.45	23.99	21.18	8.05	6.91	2.68	1.70	1.24	0.93
6	1.36	3.14	75.02	55.25	32.23	18.80	7.58	6.51	2.69	1.62	1.21	0.90
7	1.39	4.73	51.44	44.72	49.56	16.53	7.19	6.67	2.74	1.58	1.24	0.86
8	1.43	10.42	40.42	40.20	40.47	15.00	6.84	6.08	2.60	1.55	1.15	0.85
9	1.64	10.37	31.21	36.22	33.24	13.56	6.54	5.74	2.56	1.52	1.08	0.81
10	1.61	6.96	26.53	37.73	27.18	12.47	6.16	5.52	2.48	1.51	1.04	0.76
11	1.58	3.83	36.69	32.49	22.64	11.60	5.84	5.38	2.38	1.49	1.01	0.71
12	1.82	3.05	88.51	28.55	19.83	10.75	5.64	5.11	2.33	1.50	1.02	0.68
13	1.79	2.67	668.74	21.82	17.70	10.07	5.63	4.89	2.29	1.54	1.05	0.64
14	1.68	2.72	289.61	22.99	16.16	9.39	10.91	4.74	2.26	1.55	1.09	0.56
15	1.54	15.43	98.94	32.36	15.19	8.83	15.22	4.56	2.18	1.48	1.14	0.40
16	1.57	11.87	68.24	27.75	36.04	8.37	12.41	4.44	2.14	1.42	1.05	0.25
17	1.56	13.91	51.16	24.42	99.09	8.05	10.21	4.42	2.12	1.42	1.00	0.21
18	1.56	7.39	40.07	22.14	142.87	7.75	9.53	4.32	2.20	1.41	0.97	0.74
19	1.60	7.58	36.75	20.68	129.78	7.34	11.17	4.07	2.21	1.41	0.96	1.26
20	1.62	12.48	34.87	18.91	83.21	6.98	33.14	4.03	2.20	1.36	0.95	1.28
21	1.54	11.49	29.94	16.93	62.76	6.69	84.59	3.72	2.26	1.34	0.92	1.03
22	1.53	10.34	25.21	15.44	51.51	6.53	55.34	3.37	2.29	1.30	1.71	0.98
23	1.93	9.28	21.37	18.46	43.25	6.39	45.39	3.24	2.25	1.28	1.75	0.91
24	1.89	8.74	24.96	36.37	40.33	6.78	35.53	3.12	2.13	1.27	1.42	0.86
25	1.79	9.18	32.83	31.05	46.11	9.23	28.51	3.04	1.99	1.29	1.82	0.82
26	1.63	12.74	30.07	27.25	81.12	15.16	19.62	2.95	1.91	1.28	1.72	0.80
27	1.44	11.11	27.50	60.75	126.40	14.88	14.37	3.14	1.88	1.24	1.34	0.74
28	1.33	9.91	27.56	60.71	114.89	12.05	12.57	5.50	1.84	1.20	1.20	0.73
29	1.16	11.68	181.18	46.75	77.44	10.55	11.05	3.58	1.81	1.22	1.11	0.74
30	0.98	14.58	155.67	47.16		14.38	9.74	3.17	1.85	1.25	1.05	0.76
31	1.01		119.05	40.55		11.90		3.00		1.25	1.01	
Monthly Statistics												
Total	46.34	234.71	2423.39	1540.96	1566.69	486.16	517.18	153.24	69.51	45.36	37.29	24.33
Mean	1.49	7.82	78.17	49.71	54.02	15.68	17.24	4.94	2.32	1.46	1.20	0.81
Max	1.93	15.43	668.74	155.06	142.87	68.30	84.59	8.85	2.88	1.90	1.82	1.28
Min	0.98	0.90	14.98	15.44	15.19	6.39	5.63	2.95	1.81	1.20	0.92	0.21
Acre Feet	91.91	465.54	4806.73	3056.45	3107.48	964.29	1025.81	303.96	137.87	89.96	73.95	48.26
Total Acre Feet for WY04			14172.20									

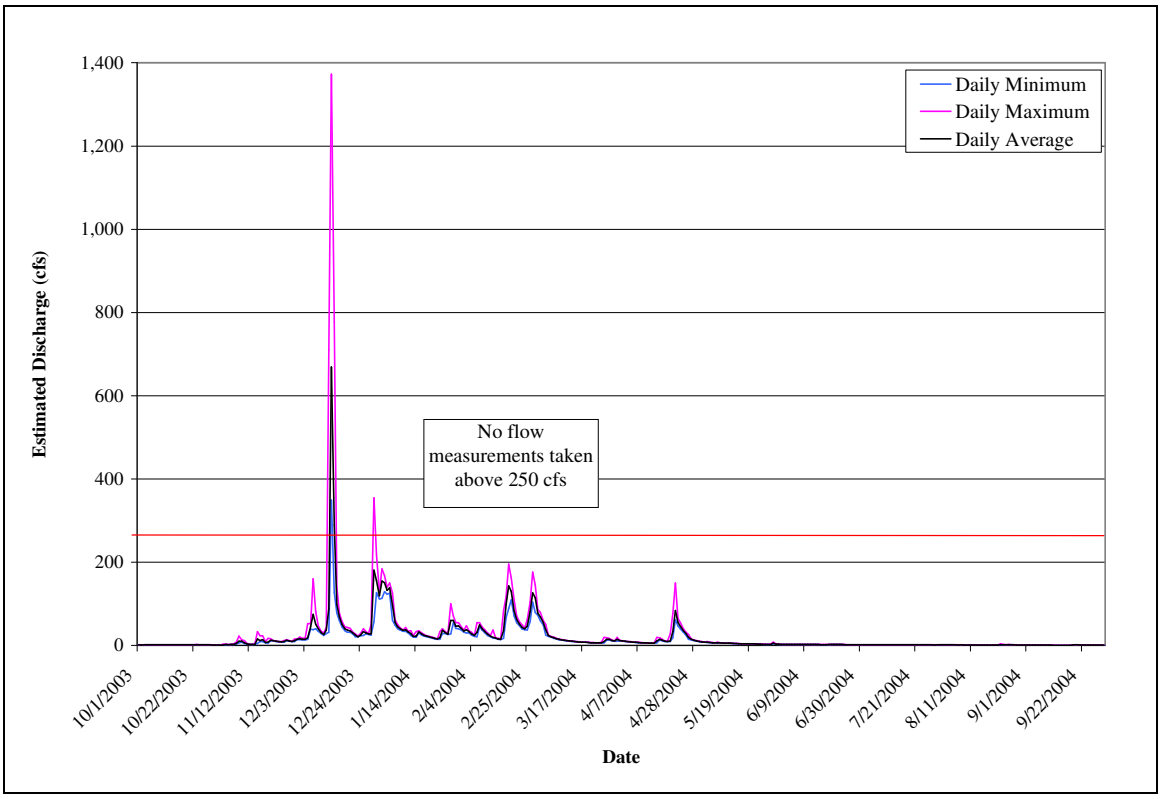

Figure 10-56 Mean, Minimum, and Maximum Daily Discharge Estimates for McGarvey Creek WY04

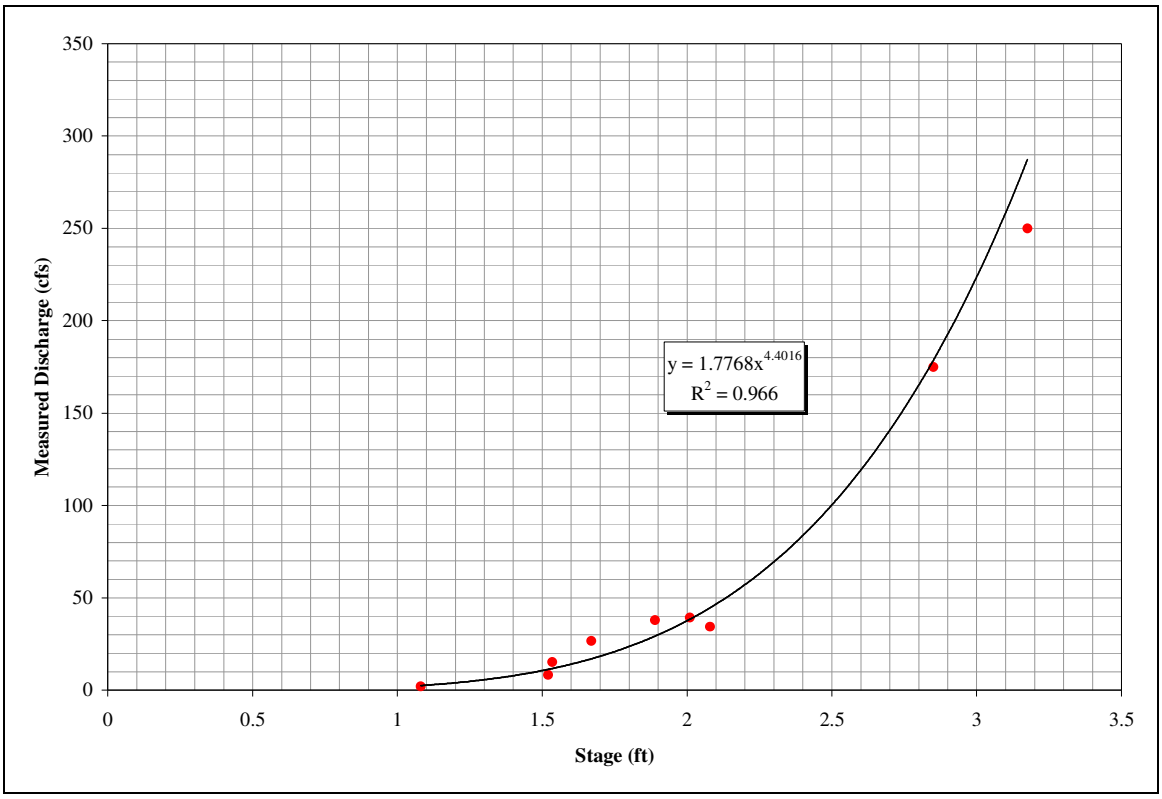

Figure 10-57 Discharge Rating Curve Values for McGarvey Creek Gaging Station WY04

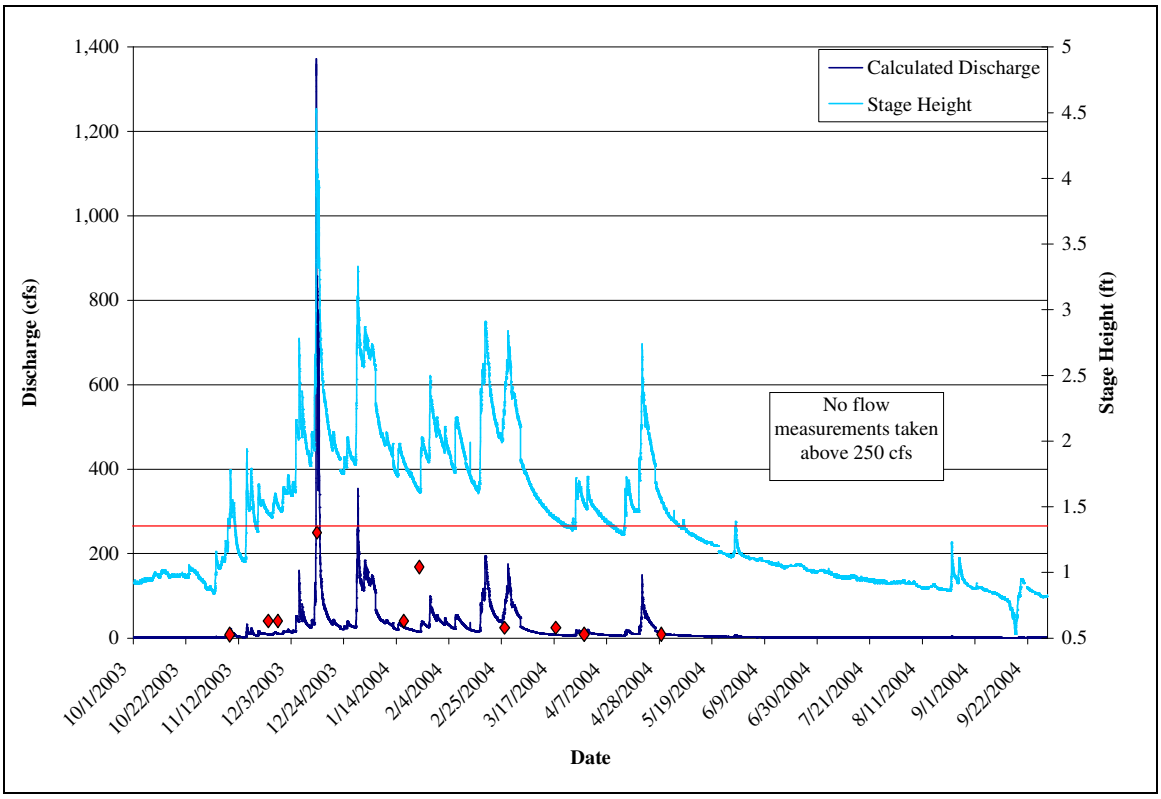

Figure 10-58 McGarvey Creek Stage Height, Hydrograph, and Flow Measurements for WY04

10.2.1.2 Turbidity and Specific Conductivity

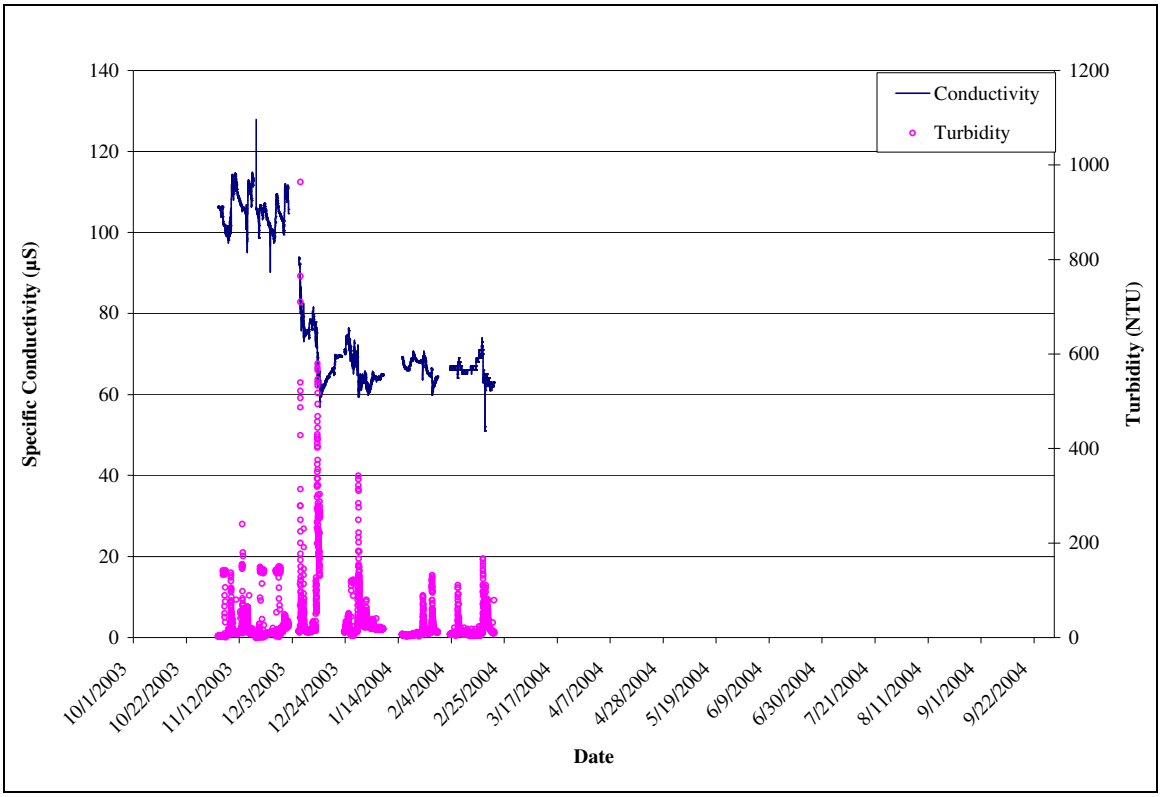

Figure 10-59 Fifteen Minute Turbidity and Specific Conductivity Data for McGarvey Creek WY04

10.2.1.3 Water Temperature

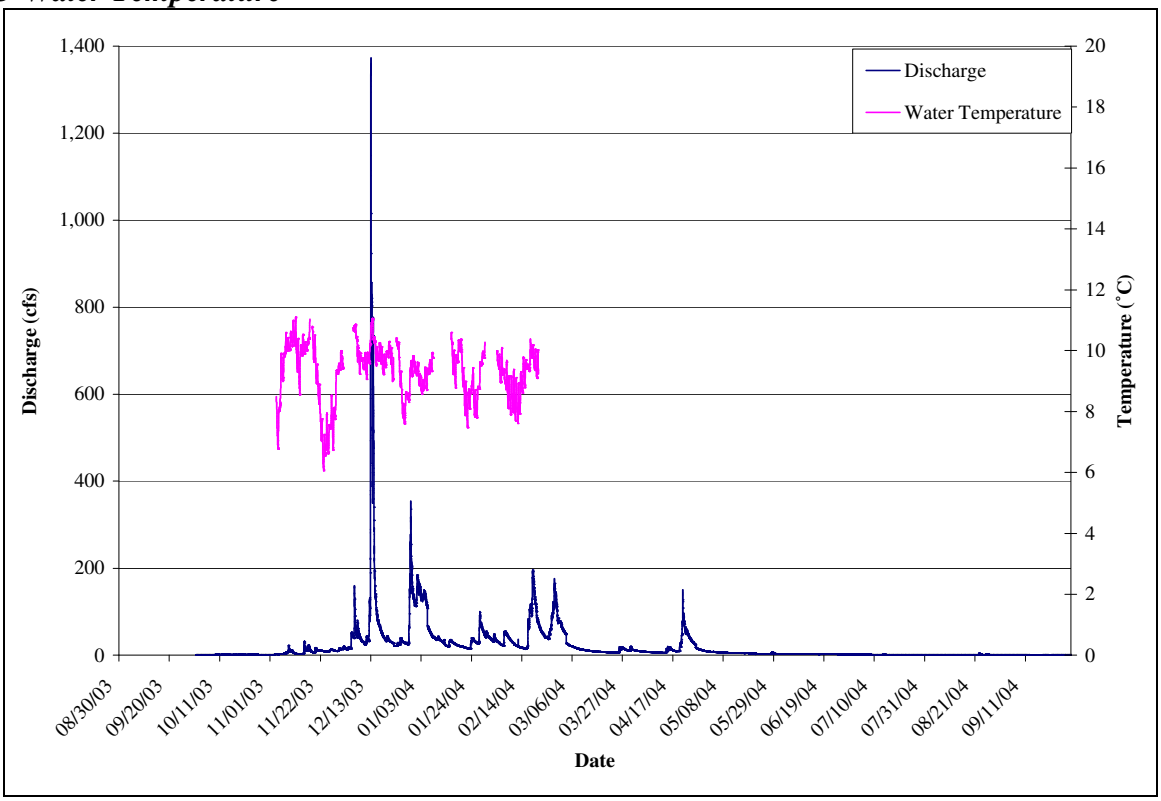

Figure 10-60 Fifteen Minute Water Temperature Data for McGarvey Creek WY04

10.2.1.4 Suspended Sediment

Table 10-13 McGarvey Creek Suspended Sediment Values WY04

Sample ID	Bottle Number	Date Collected	Time Collected	SSC (mg/L)	Turbidity (NTU)	Gage Height (ft)	Flow Est (cfs)
McGar		12/11/2003	14:30	6.9	5.46	2	39.3**
McGar		12/11/2003	14:35	15.7	4.86	2	39.3**
McGar	5	1/29/2004	13:52	8.1	5.5	2.08	40.91
McGar	8	2/18/2004	11:15	89.1	30.9	2.85	175**
McGar	9	2/18/2004	11:20	70	31.4	2.85	175**

**Actual flow measerement taken

10.2.2 Den Creek

10.2.2.1 Discharge

Den Creek is a tributary to McGarvey Creek that enters the flow regime of McGarvey Creek approximately one-half a mile downstream from the gaging station. Den Creek is a small tributary to McGarvey Creek, but it does experience measurable flows large enough to influence flow measurements taken at a bridge downstream from the gaging station. The majority of flow measurements taken in McGarvey Creek are at the gaging station using a wading rod and flow meter. However, during large storm events, McGarvey Creek flows are high enough that wadable flow measurements cannot be performed. In order to measure high flows, YTEP staff uses a crane and B-reel to lower a sounding weight and flow meter from the bridge downstream of the gaging station. The bridge is located just below the confluence of McGarvey and Den Creek, making it necessary to collect flow measurements in Den Creek so that the measurements may be subtracted from the flow measurements collected from the bridge. This is also true for suspended sediment samples that may be collected from the bridge.

10.2.3 Blue Creek

The Blue Creek gaging station has been in operation since April 2003 and is located at 41° 27’ 00” north latitude, 123° 53’ 40” west longitude. The total drainage area of the watershed is 125 square miles, with approximately 24 square miles owned by Green Diamond Resource Company and the remaining land owned and managed by USFS. The following parameters are measured at the site on a fifteen-minute time interval throughout the year: date, time, stage, air temperature (inside the gaging box), and battery voltage. Turbidity, water temperature, and specific conductivity were periodically monitored during the winter using a datasonde programmed to record every fifteen-minutes. YTFD monitors water temperature at various locations throughout Blue Creek, including a site near the gaging station. YTFP also operates a rain gage in Blue Creek, which is located on a flood terrace adjacent to lower Blue Creek, just upstream of Green Diamond Resource Company’s PC10 road washout (0.75 miles south of

Blue Creek Bridge and the junction of the PC10 and B10 roads). Data collected by YTFD are not presented in this report.

10.2.3.1 Discharge

Table 10-14 Minimum Daily Discharge (cfs) Values for Blue Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	55.98	49.61	287.26	1655.66	1655.66	1687.91	744.78	664.77	233.47	120.23	66.34	51.16
2	55.98	49.61	229.86	2138.73	1613.20	1469.35	690.88	632.91	226.29	115.27	66.34	49.61
3	55.98	64.54	226.29	1709.61	1499.55	1304.59	658.33	595.81	222.74	115.27	64.54	48.08
4	55.98	59.32	303.76	1419.76	1295.24	1176.99	632.91	571.77	212.29	112.83	66.34	48.08
5	55.98	68.16	548.27	1212.71	1168.16	1107.32	614.20	525.32	208.87	108.04	66.34	46.58
6	54.35	66.34	1230.79	1141.87	1115.90	1023.53	565.84	497.38	208.87	103.36	66.34	45.11
7	54.35	71.88	1150.59	1168.16	1249.02	991.03	542.48	508.45	208.87	103.36	68.16	45.11
8	54.35	77.68	786.67	1371.12	1141.87	1023.53	542.48	481.03	205.47	101.06	62.78	43.66
9	59.32	138.52	632.91	1923.34	1023.53	1124.52	531.00	444.04	198.78	98.80	61.04	43.66
10	57.64	103.36	519.66	1764.50	935.54	1090.27	514.04	433.77	195.48	98.80	57.64	43.66
11	55.98	79.66	651.92	1530.09	881.81	1023.53	508.45	418.61	185.77	96.56	57.64	43.66
12	66.34	68.16	645.55	1449.40	829.84	974.99	481.03	394.01	179.44	94.35	55.98	43.66
13	59.32	62.78	8304.32	1519.87	808.10	927.76	475.64	384.40	176.32	92.17	54.35	43.66
14	55.98	61.04	3786.26	1509.69	786.67	881.81	542.48	365.57	170.18	92.17	54.35	45.11
15	55.98	68.16	2114.17	1923.34	758.60	851.90	737.92	360.95	164.16	90.01	54.35	43.66
16	59.32	208.87	1479.38	1581.75	851.90	829.84	684.30	347.27	158.25	90.01	52.74	43.66
17	59.32	237.11	1133.18	1342.39	3685.68	800.92	614.20	342.77	155.34	87.89	52.74	43.66
18	57.64	144.01	943.36	1304.59	3803.16	772.57	589.75	347.27	155.34	87.89	52.74	51.16
19	55.98	120.23	889.38	1249.02	2775.55	710.83	639.21	325.11	149.62	85.79	51.16	66.34
20	62.78	164.16	982.99	1141.87	2077.63	658.33	844.51	316.48	149.62	83.72	49.61	57.64
21	59.32	146.80	822.56	1015.35	1677.13	658.33	3068.14	307.97	146.80	81.68	48.08	51.16
22	57.64	120.23	737.92	920.01	1509.69	651.92	1981.90	299.59	146.80	79.66	48.08	48.08
23	57.64	105.68	710.83	881.81	1285.92	620.40	1519.87	283.21	144.01	77.68	73.79	45.11
24	54.35	101.06	744.78	1419.76	1285.92	614.20	1276.64	271.26	141.25	75.72	68.16	43.66
25	52.74	96.56	1276.64	1185.87	1285.92	626.64	1159.36	263.45	133.15	73.79	66.34	43.66
26	51.16	144.01	1031.74	1107.32	2017.51	765.57	1056.61	255.77	133.15	71.88	75.72	43.66
27	49.61	144.01	904.63	1361.51	2327.92	1168.16	967.03	259.59	130.51	70.01	62.78	42.24
28	49.61	125.31	822.56	2406.08	1888.67	1007.20	844.51	283.21	125.31	68.16	57.64	42.24
29	48.08	122.76	1239.89	2089.77	1655.66	967.03	765.57	271.26	122.76	68.16	54.35	42.24
30	48.08	356.36	1958.36	2089.77		959.10	704.14	255.77	120.23	66.34	52.74	42.24
31	49.61		1602.67	1888.67		822.56		244.48		66.34	51.16	
Monthly Statistics												
Total	1726.35	3425.96	38699.13	46423.38	44890.93	29292.63	25498.21	11953.23	5109.12	2776.97	1840.31	1391.18
Mean	55.89	114.20	1236.55	1484.49	1547.96	949.00	849.94	390.29	170.30	90.35	59.64	46.37
Max	66.34	356.36	8304.32	2406.08	3803.16	1687.91	3068.14	664.77	233.47	120.23	75.72	66.34
Min	48.08	49.61	226.29	881.81	758.60	614.20	475.64	244.48	120.23	66.34	48.08	42.24

Table 10-15 Maximum Daily Discharge (cfs) Values for Blue Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	59.32	51.16	360.95	3652.48	1934.98	1831.65	851.90	744.78	251.97	125.31	70.01	54.35
2	59.32	70.01	291.34	3128.61	1934.98	1731.45	758.60	697.49	240.78	125.31	70.01	52.74
3	57.64	73.79	370.23	2213.34	1764.50	1499.55	710.83	677.75	233.47	120.23	70.01	51.16
4	57.64	70.01	519.66	1709.61	1509.69	1323.41	684.30	632.91	226.29	120.23	68.16	51.16
5	57.64	75.72	1304.59	1439.48	1323.41	1194.78	664.77	589.75	229.86	115.27	70.01	49.61
6	55.98	71.88	3685.68	1239.89	1489.44	1124.52	626.64	548.27	215.74	110.42	71.88	48.08
7	55.98	79.66	1323.41	1419.76	1459.35	1064.97	601.91	577.73	229.86	108.04	73.79	48.08
8	61.04	141.25	1267.39	2005.60	1285.92	1133.18	577.73	571.77	226.29	105.68	70.01	46.58
9	62.78	173.24	779.60	2089.77	1159.36	1185.87	571.77	491.90	208.87	103.36	64.54	46.58
10	59.32	146.80	651.92	2101.95	1048.28	1194.78	559.95	464.97	202.11	103.36	62.78	46.58
11	64.54	103.36	751.67	1797.90	959.10	1115.90	559.95	449.22	198.78	103.36	61.04	45.11
12	70.01	79.66	8122.99	1602.67	904.63	1064.97	542.48	433.77	188.98	101.06	59.32	46.58
13	66.34	68.16	12272.86	1634.35	874.28	1023.53	536.72	413.62	185.77	98.80	59.32	49.61
14	59.32	68.16	11139.01	2539.52	859.33	974.99	866.79	403.75	179.44	96.56	57.64	48.08
15	59.32	295.45	3922.69	2553.09	844.51	935.54	866.79	389.19	173.24	96.56	57.64	45.11
16	62.78	475.64	2163.44	1958.36	4275.50	904.63	859.33	379.65	170.18	92.17	57.64	46.58
17	62.78	525.32	1469.35	1592.19	5856.77	874.28	697.49	360.95	164.16	92.17	55.98	52.74
18	59.32	240.78	1150.59	1380.78	5518.49	851.90	664.77	370.23	164.16	90.01	55.98	68.16
19	62.78	161.19	1185.87	1351.93	4026.77	800.92	800.92	356.36	158.25	92.17	54.35	85.79
20	68.16	251.97	1194.78	1304.59	2789.80	724.30	3282.63	333.88	155.34	90.01	52.74	73.79
21	64.54	188.98	999.10	1159.36	2163.44	690.88	4992.40	325.11	152.46	87.89	52.74	57.64
22	59.32	146.80	844.51	1040.00	1764.50	697.49	3128.61	320.78	152.46	85.79	79.66	51.16
23	61.04	120.23	751.67	1439.48	1509.69	697.49	1993.73	303.76	152.46	83.72	77.68	48.08
24	59.32	105.68	1634.35	1655.66	1479.38	704.14	1560.97	295.45	149.62	79.66	75.72	46.58
25	55.98	144.01	1489.44	1429.61	1993.73	904.63	1313.98	283.21	144.01	77.68	96.56	46.58
26	52.74	182.59	1267.39	1361.51	3251.50	1159.36	1212.71	279.20	138.52	77.68	98.80	45.11
27	51.16	176.32	1048.28	4203.59	3128.61	1698.74	1115.90	279.20	141.25	75.72	75.72	45.11
28	51.16	144.01	1185.87	3472.88	2353.81	1267.39	1007.20	360.95	135.82	73.79	62.78	43.66
29	51.16	651.92	3905.49	2458.98	1923.34	1064.97	866.79	329.48	130.51	71.88	59.32	43.66
30	51.16	632.91	3189.73	2704.93		1098.78	800.92	279.20	127.89	71.88	55.98	45.11
31	51.16		1981.90	2340.84		974.99		259.59		70.01	54.35	
Monthly Statistics												
Total	1830.75	5716.65	72225.77	61982.72	61387.10	33514.00	34279.48	13203.85	5428.53	2945.77	2052.13	1529.14
Mean	59.32	190.55	2341.46	1988.06	2116.80	1084.63	1142.65	431.48	180.95	95.86	66.59	50.97
Max	70.01	651.92	12272.86	4203.59	5856.77	1831.65	4992.40	744.78	251.97	125.31	98.80	85.79
Min	51.16	51.16	291.34	1040.00	844.51	690.88	536.72	259.59	127.89	70.01	52.74	43.66

Table 10-16 Average Daily Discharge (cfs) Values for Blue Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	57.60	49.96	311.06	2721.90	1773.05	1760.81	795.93	704.70	243.01	122.10	69.00	52.10
2	57.29	53.87	262.32	2574.93	1753.10	1596.66	725.08	666.72	235.55	120.47	68.24	51.52
3	57.15	69.91	282.88	1915.48	1604.43	1401.62	681.91	638.75	228.67	118.02	67.95	49.90
4	56.93	63.14	336.87	1569.07	1401.52	1246.26	662.01	599.55	220.62	116.14	67.38	48.95
5	56.53	72.46	1110.54	1311.24	1240.27	1145.86	639.93	563.57	213.83	112.78	68.54	47.97
6	55.57	68.85	2053.21	1195.71	1258.00	1073.02	603.50	526.91	212.25	108.58	68.91	47.22
7	55.35	75.19	1229.94	1324.10	1331.50	1019.35	575.61	537.32	218.39	105.78	72.26	46.27
8	56.94	99.67	995.56	1738.54	1205.78	1081.27	560.93	521.66	214.44	104.08	67.72	45.41
9	60.28	157.00	678.16	2007.46	1090.10	1158.99	551.42	473.85	204.77	102.07	63.31	44.96
10	58.55	123.66	572.76	1930.73	993.97	1148.59	541.88	449.44	198.37	101.11	60.89	44.58
11	59.04	88.92	695.35	1634.24	922.35	1073.81	534.75	438.94	191.71	100.12	59.52	44.20
12	67.97	73.03	1961.17	1507.68	869.91	1025.58	516.79	415.96	185.87	98.00	58.06	44.76
13	62.74	65.25	10534.91	1580.01	836.93	977.49	499.56	399.37	180.82	95.91	56.82	45.60
14	58.34	62.92	6179.42	1794.18	814.86	934.48	613.50	386.19	176.39	94.97	55.67	46.13
15	57.36	193.71	2839.37	2226.18	782.69	896.67	794.22	374.29	170.82	92.80	56.10	44.74
16	61.51	271.26	1764.04	1759.09	1946.28	866.01	762.08	363.26	165.34	90.97	55.70	44.60
17	60.43	381.77	1284.85	1465.28	4984.82	836.01	652.65	352.03	160.97	90.39	54.30	46.16
18	58.25	179.47	1043.70	1337.33	4834.75	808.85	615.17	359.17	158.68	88.81	53.74	61.20
19	59.78	132.15	961.41	1291.74	3294.02	760.41	674.16	340.63	155.28	88.95	52.82	76.65
20	66.22	215.78	1085.15	1223.43	2437.69	689.57	1433.51	326.66	151.84	87.14	51.50	65.13
21	62.10	165.93	907.02	1090.01	1927.34	674.16	3973.46	317.24	150.56	85.40	50.45	54.26
22	58.83	131.82	787.26	975.41	1611.22	674.83	2421.58	309.78	150.24	83.04	62.90	49.64
23	59.25	112.90	733.01	996.07	1394.62	660.00	1710.51	295.40	148.70	80.21	75.74	47.40
24	56.98	103.82	1342.39	1534.68	1380.27	658.59	1400.60	284.22	144.36	77.66	73.63	45.90
25	53.96	108.01	1389.25	1296.89	1544.63	718.74	1228.24	275.09	139.48	76.25	77.76	44.99
26	52.08	170.59	1150.59	1157.80	2721.61	856.46	1128.39	267.75	135.46	74.81	87.69	44.58
27	50.96	160.24	971.92	2860.42	2647.42	1446.92	1032.86	269.12	134.37	73.01	69.02	43.81
28	50.17	132.18	887.25	2787.42	2089.90	1107.59	923.23	332.09	131.05	70.92	60.96	43.21
29	49.67	293.13	3166.25	2221.46	1759.32	1019.77	816.89	297.64	127.17	69.99	56.93	42.68
30	49.75	464.03	2446.80	2449.29		1026.86	751.31	266.89	124.74	69.37	54.70	43.33
31	50.32		1744.84	2105.51		898.10		253.31		68.89	53.07	
Monthly Statistics												
Total	1777.89	4340.65	51709.29	53583.26	52452.31	31243.33	28821.68	12607.49	5273.75	2868.71	1951.27	1457.85
Mean	57.35	144.69	1668.04	1728.49	1808.70	1007.85	960.72	406.69	175.79	92.54	62.94	48.59
Max	67.97	464.03	10534.91	2860.42	4984.82	1760.81	3973.46	704.70	243.01	122.10	87.69	76.65
Min	49.67	49.96	262.32	975.41	782.69	658.59	499.56	253.31	124.74	68.89	50.45	42.68
Acre Feet	3526.40	8609.56	102563.87	106280.84	104037.64	61970.25	57166.97	25006.60	10460.32	5689.99	3870.30	2891.60
Total Acre Feet for WY04			492074.35									

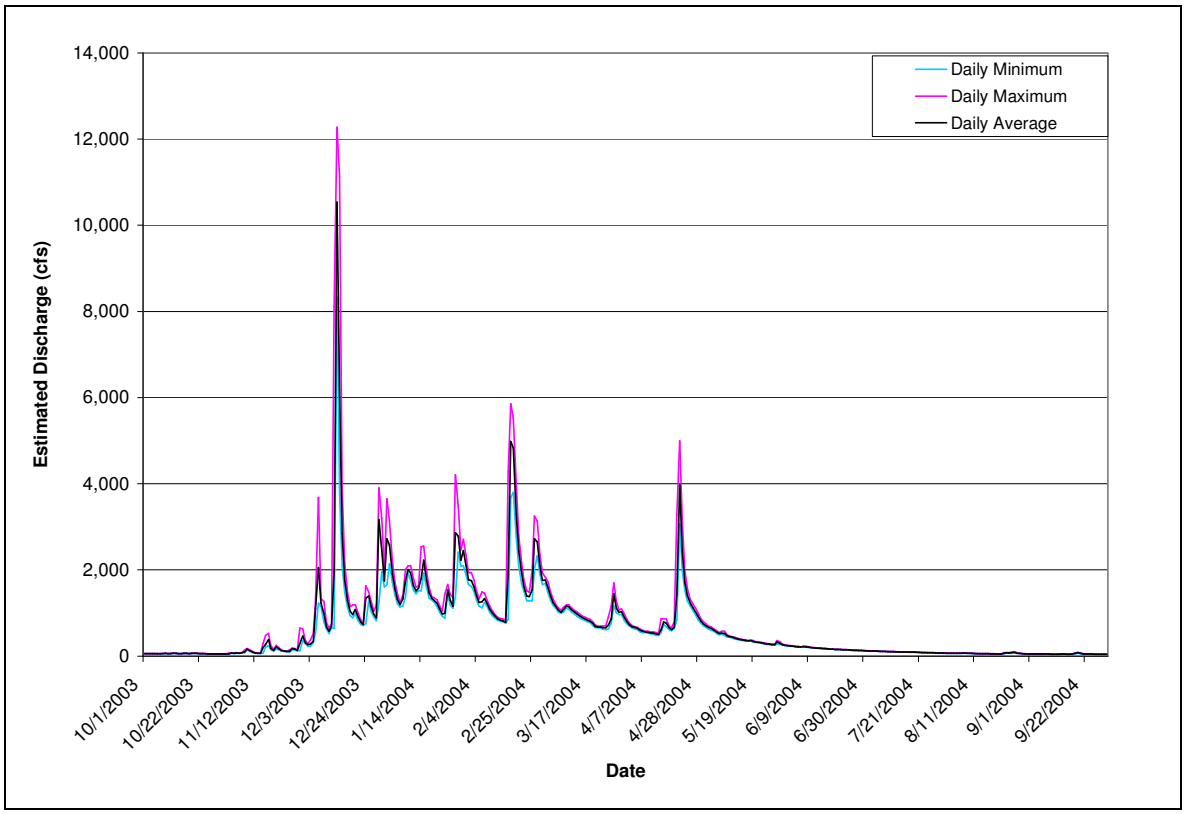

Figure 10-61 Mean, minimum, and maximum discharges recorded at Blue Creek gaging site from October 1, 2003 through September 30, 2004

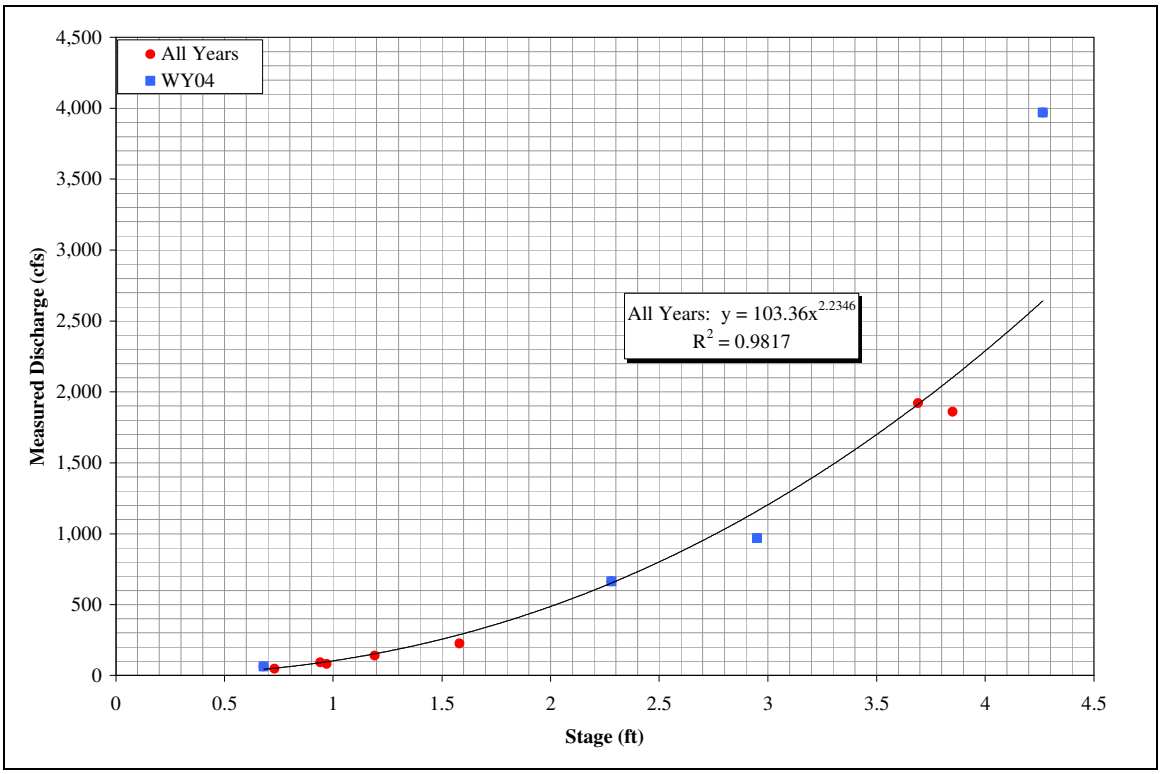

Figure 10-62 Discharge Rating Curve Values for Blue Creek Gaging Station for All Years (WY02 - WY04) and WY04

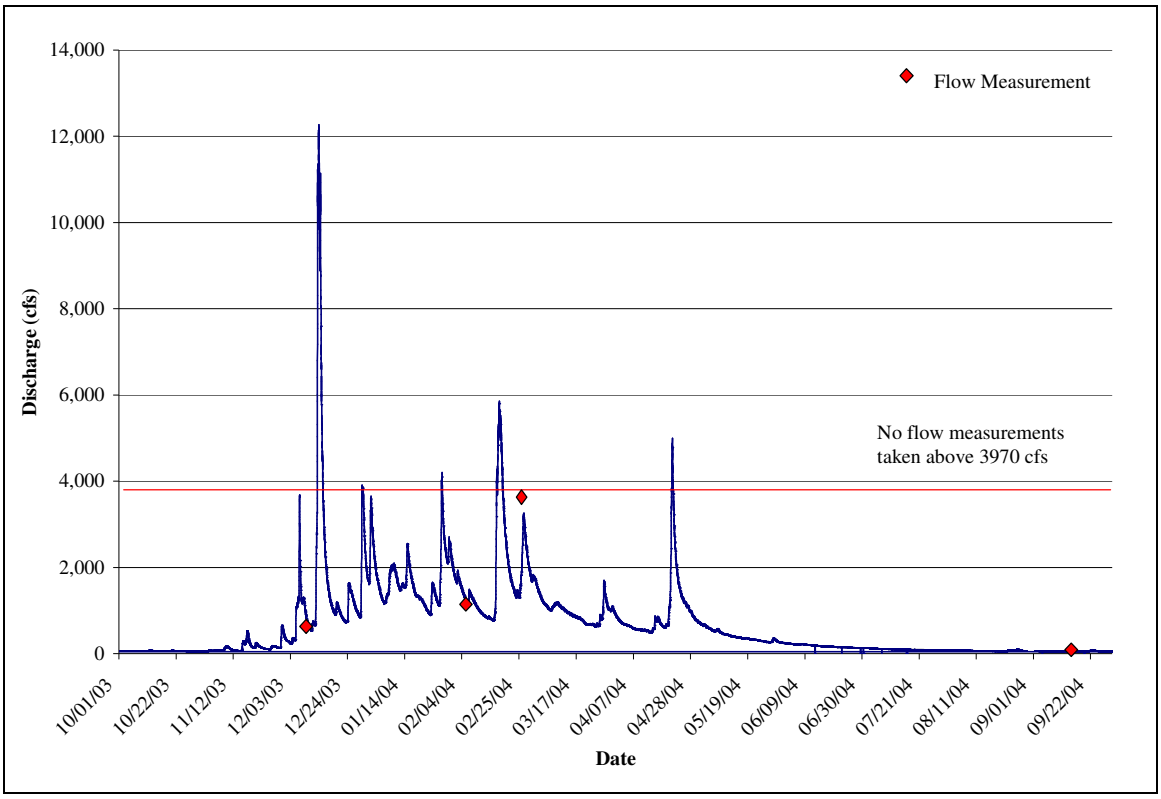

Figure 10-63 Blue Creek Hydrograph and Flow Measurements for WY04

10.2.3.2 Turbidity and Specific Conductivity

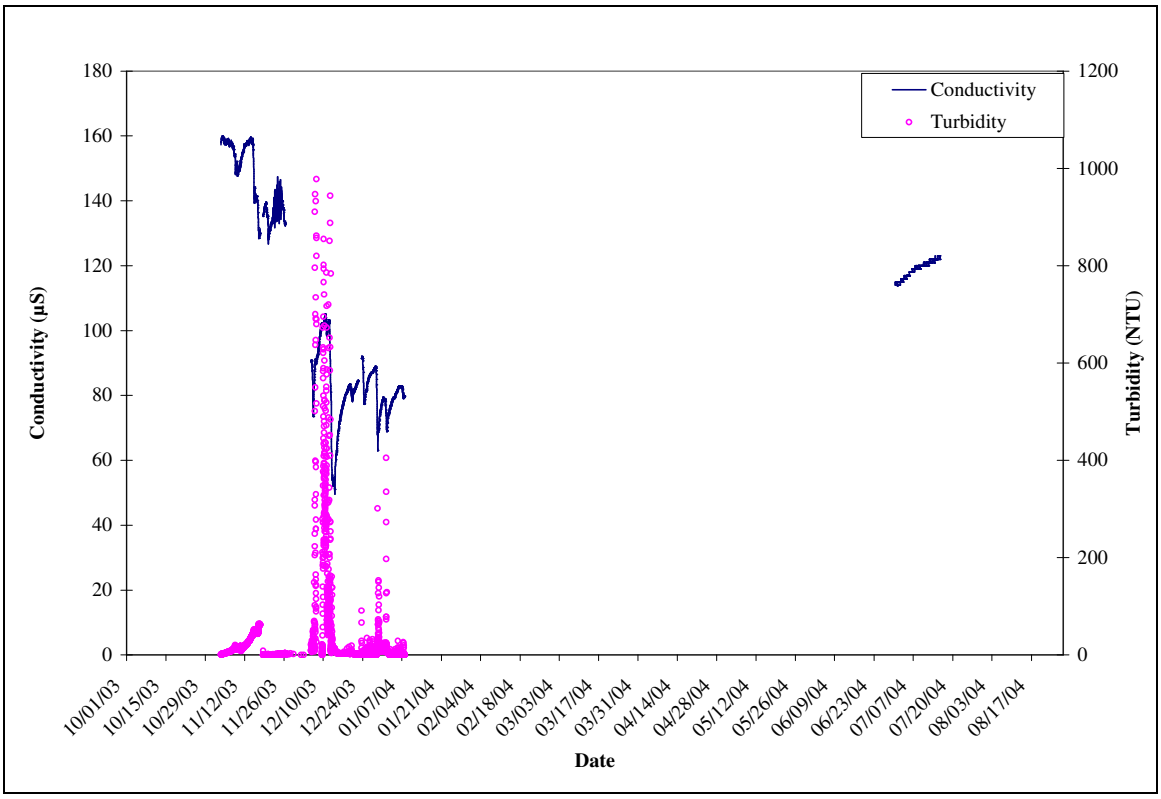

Figure 10-64 Fifteen Minute Turbidity and Specific Conductivity Data for Blue Creek WY04

10.2.3.3 Water Temperature

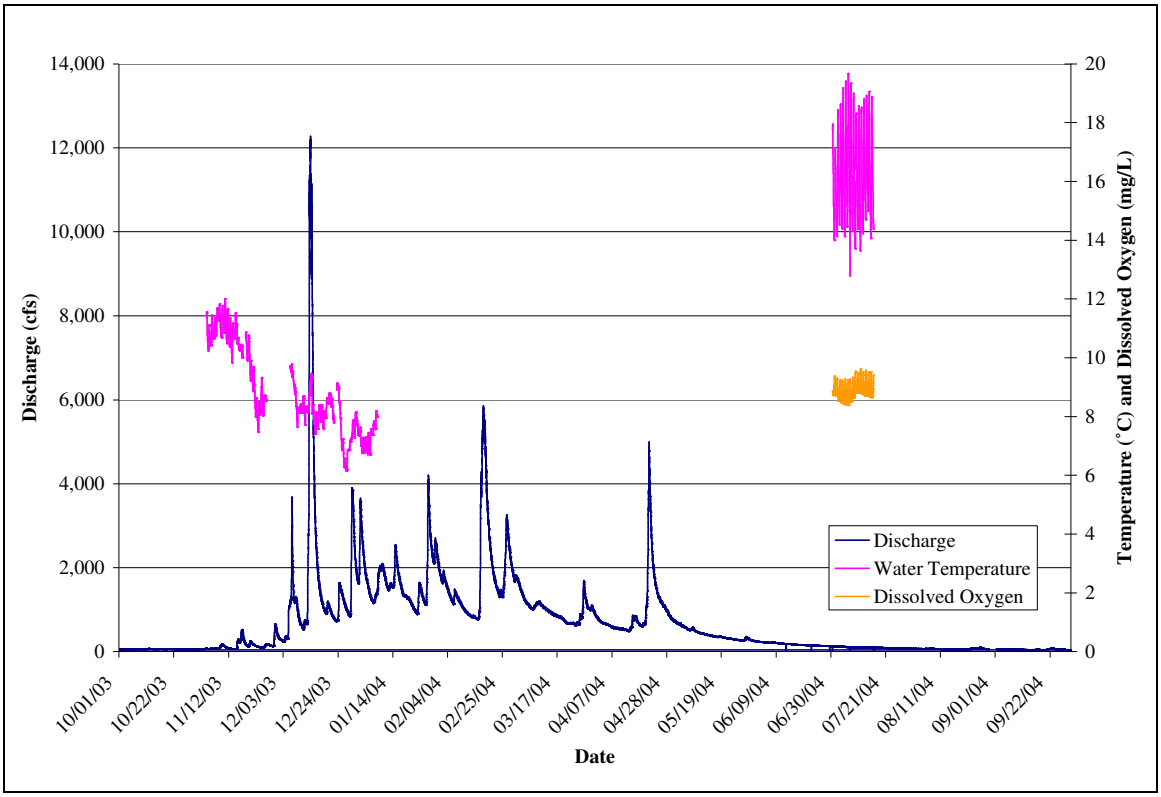

Figure 10-65 Fifteen Minute Water Temperature and Dissolved Oxygen Data for Blue Creek WY04

10.2.3.4 Suspended Sediment

Table 10-17 Blue Creek Suspended Sediment Values WY04

Sample ID	Bottle Number	Date Collected	Time Collected	SSC (mg/L)	Turbidity (NTU)	Gage Height (ft)	Flow Est (cfs)
Blue	1000	12/9/2003	14:50	14.3	2.55	2.28	664**
Blue	1001	12/9/2003	14:55	5.1	1.02	2.28	664**
Blue	1002	12/9/2003	14:59	16.7	2.48	2.28	664**
Blue	1003	12/9/2003	15:10	16.7	1.43	2.28	664**
Blue	1004	12/9/2003	15:15	4.8	1.65	2.28	664**
Blue	1005	12/9/2003	15:20	6.6	2.04	2.28	664**
Blue	1006	12/9/2003	15:05	5.6	1.62	2.28	664**
Blue	6 (1-A)	1/29/2004	11:16	7.6	2.5	3.9	2163.44
Blue	7 (1-A)	2/27/2004	12:50	5.51	3.67	4.28	3970**

**Actual flow measerement taken

10.2.4 Turwar Creek

The Turwar gaging station has been in operation since October 9th, 2003. The station is located at 41° 32' 6" north latitude, 123° 58' 43" west longitude. The total drainage area of the watershed is 31.8 square miles. The following parameters are measured at the site on a fifteen-minute time interval throughout the year: date, time, stage, air temperature (inside the gaging box), water temperature,

turbidity, and battery voltage. Turbidity and temperature are measured using a DTS-12 turbidity probe (FTS), which measures turbidity and water temperature on a fifteen minute time interval.

YTFP also monitors water temperature at various locations throughout Turwar Creek; those data are not presented in this report. USGS operates a rain gage in the Klamath River near the mouth of Turwar Creek. We are including data from the rain gage as a reference for precipitation and hydrologic activity.

10.2.4.1 Discharge

Table 10-18 Minimum Daily Discharge (cfs) Values for Turwar Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	47.42	48.70	154.22	849.11	271.01	305.10	78.91	71.51	24.18	14.28	14.28	12.12
2	47.42	48.70	161.09	1286.14	255.19	255.19	71.51	66.35	23.48	14.28	14.28	11.34
3	47.42	54.08	161.09	892.09	221.27	203.64	64.70	61.50	22.78	14.28	14.28	11.73
4	48.70	54.08	221.27	755.50	179.40	164.63	59.95	58.44	22.11	14.28	14.28	11.73
5	48.70	58.44	362.91	317.23	150.88	147.60	55.50	54.08	22.11	14.28	13.83	11.73
6	48.70	58.44	682.28	282.00	141.21	126.25	51.33	50.00	22.11	14.28	13.83	11.34
7	48.70	64.70	807.87	293.36	265.65	110.06	48.70	50.00	23.48	14.28	14.28	11.34
8	48.70	77.00	593.96	329.76	203.64	97.93	46.18	46.18	22.11	14.28	13.39	10.97
9	50.00	107.54	479.51	329.76	168.22	89.06	42.60	43.77	21.45	14.28	12.53	10.97
10	48.70	84.87	398.79	299.18	141.21	80.86	40.35	42.60	20.81	14.28	12.53	10.97
11	48.70	68.03	488.28	230.55	120.64	75.14	39.26	41.46	20.19	14.28	12.53	10.97
12	52.69	61.50	573.44	203.64	105.07	68.03	38.20	38.20	19.58	14.28	12.12	11.34
13	51.33	58.44	not reported	175.61	95.65	63.08	37.16	37.16	18.98	14.28	12.12	11.34
14	48.70	56.95	1763.81	168.22	89.06	58.44	48.70	35.15	18.41	14.28	11.73	11.34
15	48.70	64.70	742.86	225.87	91.21	55.50	129.13	34.18	17.84	14.28	12.12	11.34
16	51.33	144.37	437.60	183.27	102.64	51.33	117.92	33.24	17.29	14.28	12.12	11.73
17	51.33	168.22	276.46	154.22	670.68	48.70	95.65	33.24	17.29	14.28	11.73	11.34
18	50.00	117.92	207.93	141.21	999.50	46.18	89.06	32.31	17.29	14.28	11.73	12.53
19	50.00	105.07	187.20	135.06	515.41	43.77	97.93	30.53	16.76	14.28	11.73	13.39
20	52.69	154.22	175.61	126.25	323.44	42.60	225.87	29.66	16.76	14.28	11.34	13.83
21	52.69	126.25	150.88	112.63	235.32	40.35	1453.40	29.66	17.29	14.28	11.34	12.53
22	51.33	110.06	129.13	100.27	187.20	38.20	604.45	28.82	17.29	14.28	11.34	12.12
23	52.69	100.27	117.92	95.65	150.88	37.16	349.33	27.20	17.29	14.28	16.24	11.73
24	51.33	95.65	129.13	171.88	150.88	37.16	235.32	26.42	16.76	14.28	15.23	11.34
25	50.00	93.41	230.55	168.22	157.63	37.16	179.40	24.91	15.73	14.28	14.75	11.34
26	48.70	129.13	225.87	150.88	230.55	77.00	141.21	24.18	15.23	14.28	17.29	11.34
27	48.70	138.10	187.20	175.61	682.28	187.20	117.92	24.18	15.23	14.28	14.28	11.34
28	47.42	120.64	164.63	453.98	421.71	123.42	102.64	31.41	14.28	14.28	13.39	11.34
29	46.18	120.64	271.01	336.18	317.23	97.93	89.06	28.82	14.28	14.28	12.53	10.97
30	47.42	154.22	967.77	336.18		97.93	78.91	27.20	14.28	14.28	12.12	11.34
31	48.70		682.28	376.92		86.94		25.66		14.28	12.12	
Monthly Statistics												
Total	1535.01	2844.33	12132.57	9856.42	7644.66	2993.53	4830.24	1188.01	562.71	442.83	407.47	348.77
Mean	49.54	94.81	394.84	315.98	263.61	96.89	161.01	38.75	18.76	14.28	13.18	11.63
Max	52.69	168.22	1763.81	1286.14	999.50	305.10	1453.40	71.51	24.18	14.28	17.29	13.83
Min	46.18	48.70	117.92	95.65	89.06	37.16	37.16	24.18	14.28	14.28	11.34	10.97

Table 10-19 Maximum Daily Discharge (cfs) Values for Turwar Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	50.00	51.33	187.20	2733.64	384.10	362.91	91.21	78.91	26.42	15.73	14.75	12.53
2	51.33	58.44	179.40	2009.66	323.44	329.76	78.91	71.51	24.91	15.73	14.75	12.53
3	50.00	61.50	245.09	1431.55	276.46	255.19	71.51	66.35	24.18	14.75	14.75	12.53
4	51.33	59.95	349.33	1065.59	221.27	203.64	64.70	61.50	23.48	14.75	14.75	12.12
5	51.33	63.08	821.43	921.75	179.40	168.22	59.95	58.44	22.78	14.75	14.28	12.12
6	51.33	68.03	2517.47	317.23	265.65	144.37	56.95	54.08	23.48	14.75	14.75	11.73
7	51.33	77.00	1082.67	329.76	293.36	123.42	52.69	55.50	26.42	14.75	15.23	11.73
8	52.69	132.06	921.75	421.71	265.65	110.06	48.70	51.33	24.18	14.75	14.28	11.34
9	52.69	129.13	604.45	406.31	203.64	100.27	46.18	46.18	22.11	14.75	13.39	11.34
10	51.33	110.06	488.28	369.86	168.22	89.06	42.60	44.96	22.11	14.75	12.95	11.73
11	55.50	84.87	636.84	299.18	141.21	82.85	41.46	43.77	21.45	14.75	12.95	11.34
12	56.95	68.03	not reported	235.32	120.64	75.14	39.26	41.46	20.81	14.75	12.95	11.73
13	54.08	63.08	not reported	207.93	105.07	68.03	48.70	39.26	20.19	14.75	12.53	12.12
14	51.33	63.08	not reported	240.16	120.64	63.08	150.88	37.16	19.58	14.75	12.53	11.73
15	52.69	260.38	1738.12	245.09	120.64	58.44	171.88	36.14	18.98	14.75	12.95	11.73
16	54.08	356.06	742.86	230.55	730.40	55.50	171.88	34.18	18.41	14.75	12.53	11.73
17	54.08	384.10	437.60	187.20	1497.94	51.33	117.92	33.24	17.84	14.75	12.53	12.53
18	52.69	168.22	276.46	161.09	1367.63	48.70	102.64	33.24	17.84	14.75	12.12	13.83
19	54.08	191.20	225.87	141.21	967.77	46.18	221.27	32.31	17.84	14.75	12.12	17.84
20	55.50	207.93	216.75	138.10	515.41	43.77	2552.47	31.41	17.29	14.75	11.73	16.24
21	55.50	157.63	179.40	126.25	329.76	42.60	5281.17	30.53	17.29	14.75	11.73	13.83
22	54.08	129.13	150.88	112.63	235.32	40.35	1409.97	29.66	17.84	14.75	18.41	12.53
23	55.50	112.63	132.06	179.40	187.20	39.26	593.96	28.82	17.84	14.75	16.76	12.12
24	54.08	102.64	235.32	212.30	187.20	43.77	342.70	28.00	17.84	14.75	16.76	11.73
25	52.69	132.06	329.76	203.64	230.55	82.85	240.16	26.42	16.76	14.75	22.11	11.34
26	51.33	161.09	299.18	175.61	1048.73	199.42	179.40	25.66	16.24	14.75	22.11	11.73
27	50.00	161.09	230.55	1286.14	1015.69	276.46	141.21	31.41	16.24	14.75	17.29	11.73
28	50.00	138.10	255.19	835.17	682.28	187.20	117.92	43.77	16.24	14.75	14.28	11.34
29	48.70	157.63	4494.89	453.98	421.71	123.42	102.64	35.15	15.73	14.75	13.39	11.34
30	50.00	161.09	3128.32	647.96		115.25	89.06	28.82	15.73	14.75	12.53	11.73
31	51.33		1326.37	573.44		100.27		27.20		14.75	12.53	
Monthly Statistics												
Total	1627.50	4070.66	22433.49	16899.42	12607.00	3730.73	12729.97	1286.35	598.06	459.30	446.78	369.95
Mean	52.54	135.69	781.75	544.20	434.72	121.02	424.33	41.97	19.94	14.82	14.47	12.33
Max	56.95	384.10	4494.89	2733.64	1497.94	362.91	5281.17	78.91	26.42	15.73	22.11	17.84
Min	48.70	51.33	132.06	112.63	105.07	39.26	39.26	25.66	15.73	14.75	11.73	11.34

Table 10-20 Average Daily Discharge (cfs) Values for Turwar Creek WY04

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	49.09	49.19	164.22	1718.00	319.16	335.44	83.48	76.10	25.33	14.81	14.40	12.40
2	49.11	51.33	171.42	1635.67	286.98	289.83	74.90	69.28	24.32	14.78	14.31	12.34
3	49.14	57.20	199.86	1116.22	247.53	225.58	67.66	64.16	23.59	14.45	14.44	12.19
4	49.66	56.28	239.55	887.84	198.20	182.45	61.78	60.48	23.03	14.49	14.39	11.93
5	49.78	60.26	665.18	559.96	164.44	155.95	57.47	56.54	22.48	14.52	14.18	11.81
6	49.59	62.17	1413.32	292.40	182.34	134.58	53.85	52.77	22.38	14.51	14.30	11.59
7	49.63	68.26	935.45	311.87	282.06	117.19	50.29	52.63	24.57	14.54	14.78	11.46
8	49.83	93.94	738.04	388.41	233.17	104.79	47.61	49.17	23.25	14.46	13.89	11.31
9	51.19	114.95	521.41	364.99	185.14	94.20	44.71	45.67	22.08	14.37	13.14	11.21
10	49.98	96.26	441.65	334.36	153.66	85.41	41.97	43.52	21.74	14.46	12.80	11.25
11	50.37	74.44	590.93	262.51	129.61	77.99	40.01	42.71	20.77	14.45	12.72	11.24
12	54.34	65.14	not reported	219.00	111.58	71.44	38.56	40.21	20.07	14.38	12.45	11.59
13	52.63	60.14	not reported	190.40	100.39	66.04	38.87	38.07	19.62	14.45	12.26	11.66
14	50.34	58.39	not reported	185.96	93.80	61.08	69.23	36.63	19.17	14.36	12.21	11.69
15	50.13	149.78	1113.84	238.18	98.37	56.94	148.21	35.11	18.45	14.52	12.43	11.55
16	52.40	182.09	585.34	205.82	254.34	53.51	143.58	33.95	17.88	14.50	12.32	11.73
17	52.03	252.74	337.53	171.34	1107.25	50.60	105.48	33.24	17.43	14.45	12.02	11.91
18	51.23	137.78	235.87	151.40	1222.36	47.98	93.78	33.03	17.60	14.51	11.93	13.06
19	52.05	120.27	203.69	137.15	698.89	45.47	108.38	31.81	17.65	14.59	11.85	16.28
20	53.85	177.62	195.88	131.08	410.84	43.36	528.94	30.49	17.25	14.57	11.61	14.97
21	53.21	141.27	164.40	118.88	278.01	41.19	2749.99	29.83	17.29	14.55	11.54	13.04
22	51.93	118.99	139.97	105.73	208.75	39.68	877.87	29.53	17.77	14.55	14.35	12.21
23	53.64	106.04	125.86	113.55	166.49	38.72	443.68	28.42	17.69	14.51	16.58	11.83
24	52.70	98.95	187.53	198.07	167.39	39.67	282.00	27.15	17.18	14.47	16.08	11.58
25	51.05	102.24	291.86	185.18	178.61	49.90	204.44	26.15	16.54	14.59	17.43	11.34
26	49.63	150.64	264.65	160.33	577.88	111.85	158.70	25.22	15.78	14.51	20.00	11.45
27	48.98	148.14	207.62	555.26	855.56	233.87	130.13	26.70	15.57	14.52	15.69	11.42
28	48.04	128.61	182.66	576.29	540.96	149.61	110.62	39.18	15.33	14.48	13.90	11.34
29	47.43	134.40	2120.54	378.63	357.76	109.64	96.40	31.95	14.83	14.42	12.93	11.34
30	48.35	156.66	1698.34	557.73		106.07	84.98	28.33	14.63	14.43	12.52	11.35
31	49.78		955.76	461.48		93.96		26.71		14.35	12.39	
Monthly Statistics												
Total	1571.11	3274.19	15092.35	12913.72	9811.52	3313.97	7037.55	1244.76	581.27	449.54	425.85	360.08
Mean	50.68	109.14	539.01	416.57	338.33	106.90	234.58	40.15	19.38	14.50	13.74	12.00
Max	54.34	252.74	2120.54	1718.00	1222.36	335.44	2749.99	76.10	25.33	14.81	20.00	16.28
Min	47.43	49.19	125.86	105.73	93.80	38.72	38.56	25.22	14.63	14.35	11.54	11.21
Acre Feet	3116.25	6494.26	29935.24	25613.98	19460.87	6573.17	13958.77	2468.94	1152.94	891.65	844.67	714.21
Total Acre Feet for WY04			111224.95									

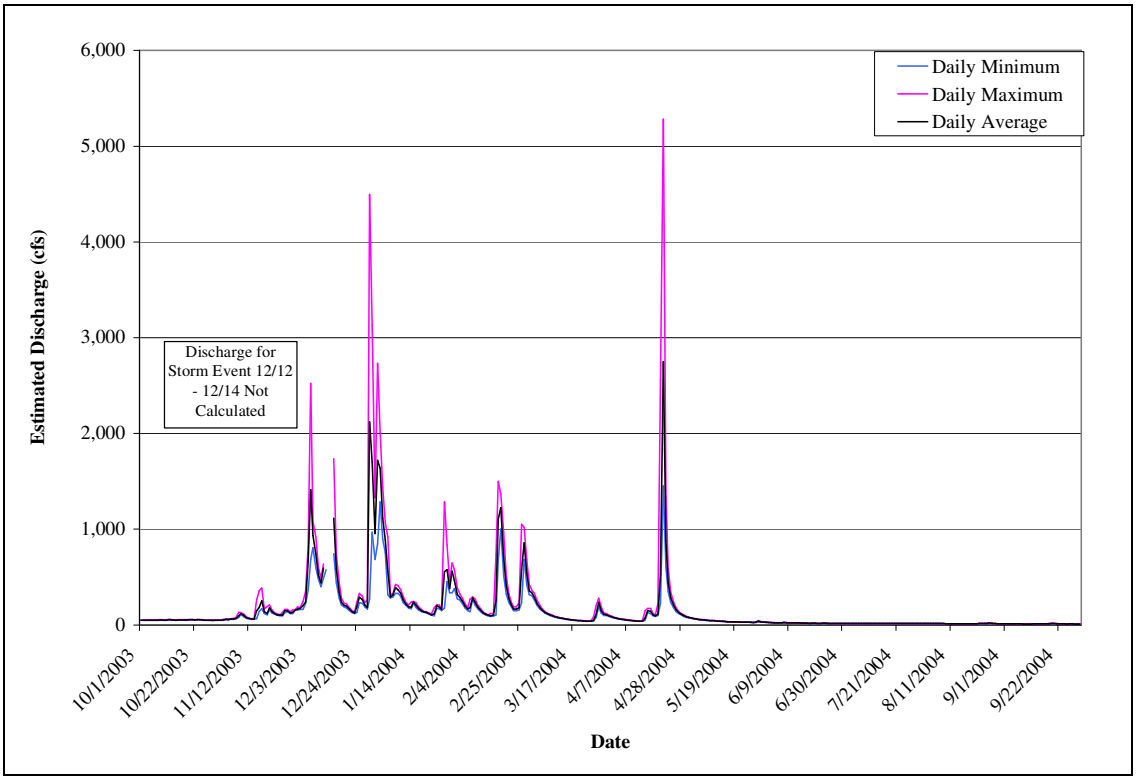

Figure 10-66 Mean, Minimum, and Maximum Daily Discharge Estimates for Turwar Creek WY04

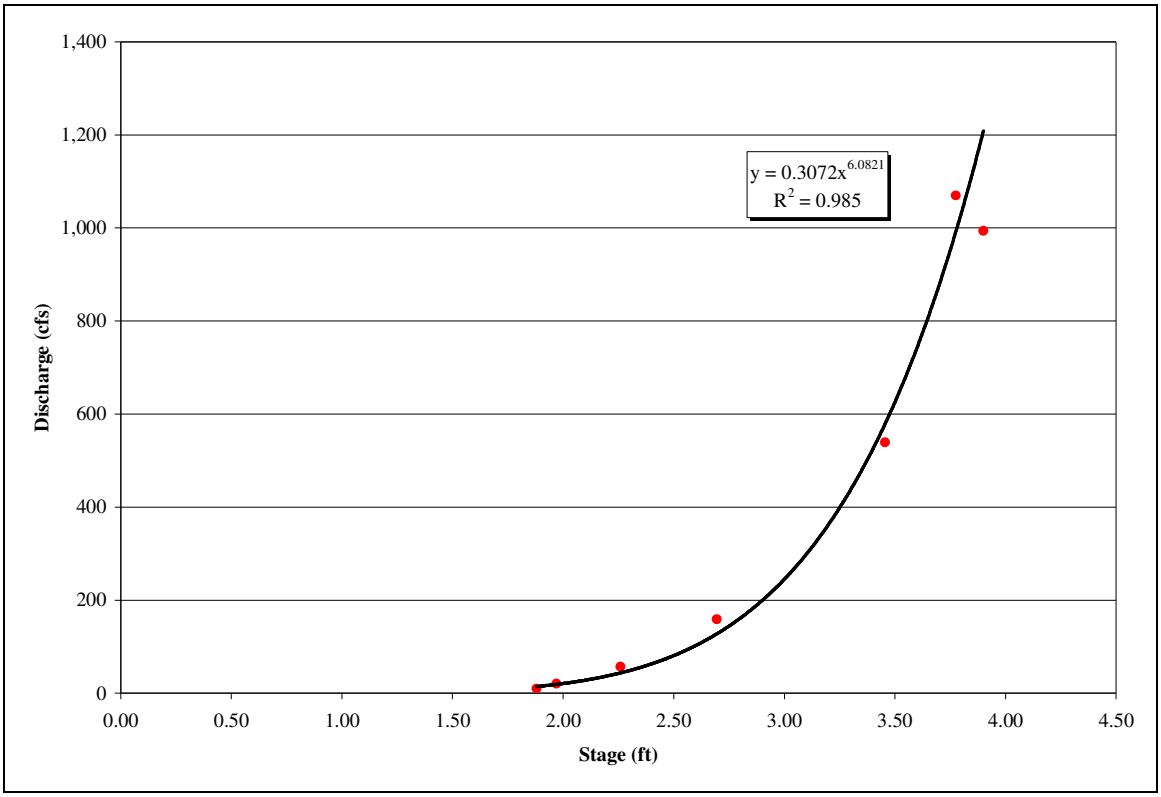

Figure 10-67 Turwar Creek Rating Curve WY04

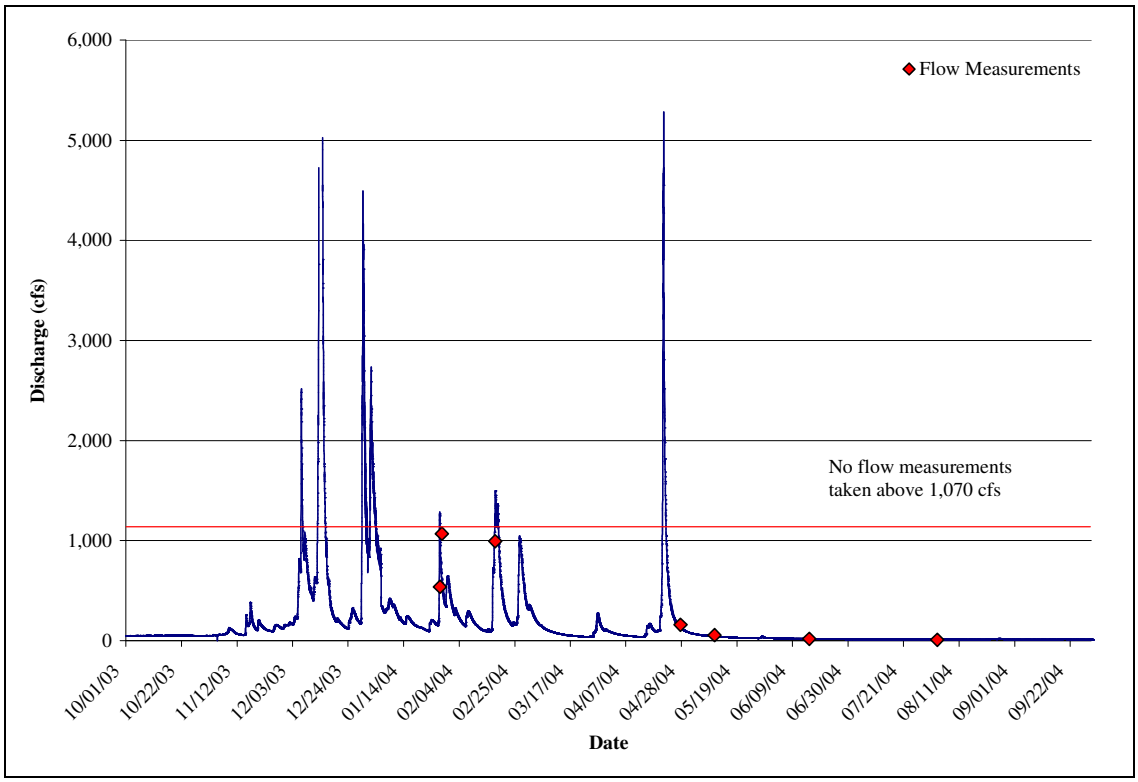

Figure 10-68 Turwar Creek Hydrograph and Flow Measurements for WY04

10.2.4.2 Turbidity

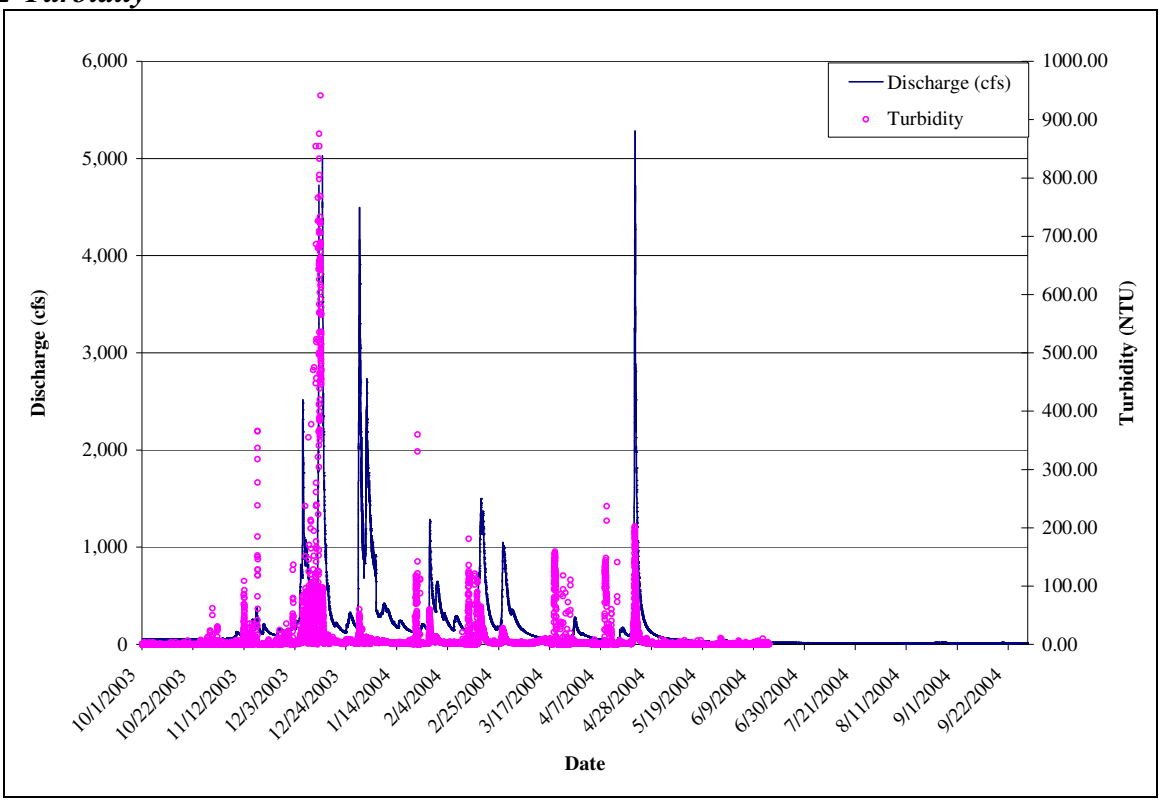

Figure 10-69 Fifteen Minute Turbidity Data for Turwar Creek WY04

10.2.4.3 Water Temperature

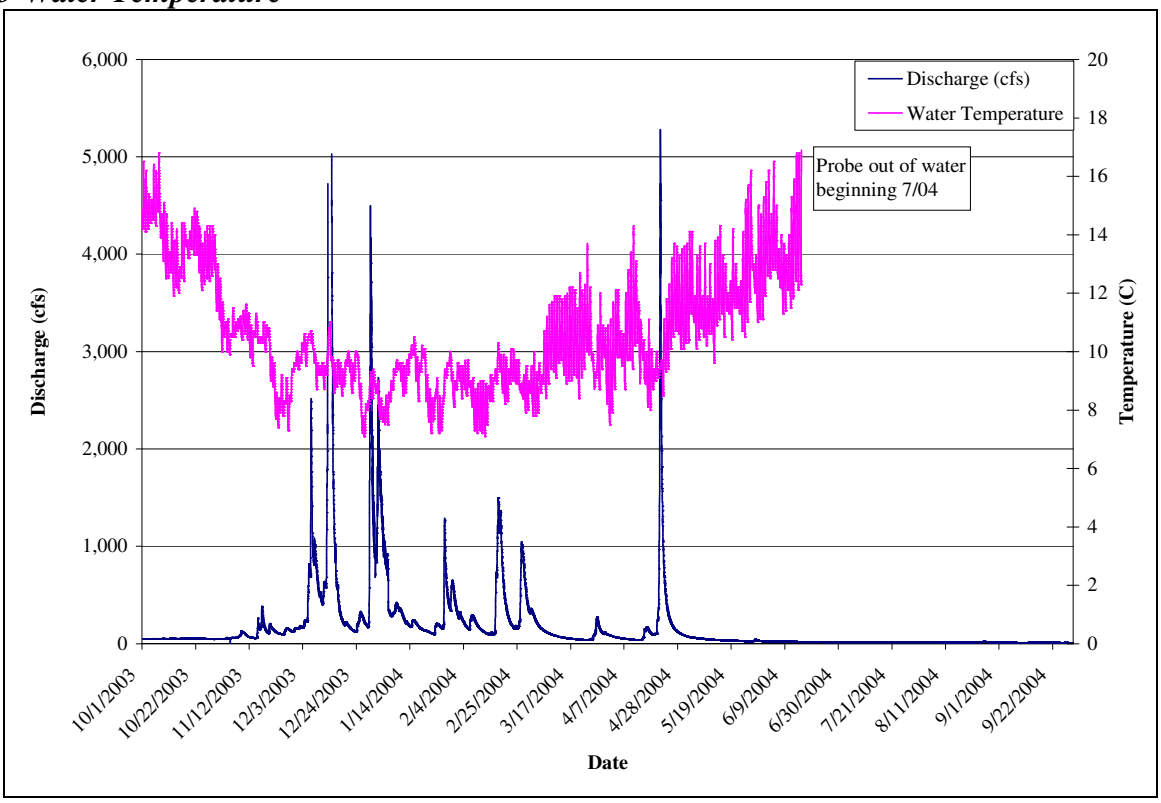

Figure 10-70 Fifteen Minute Water Temperature Data for Turwar Creek WY04

10.2.4.4 Suspended Sediment

Table 10-21 Turwar Creek Suspended Sediment Values WY04

Sample ID	Date Collected	Time Collected	SSC (mg/L)	Turbidity (NTU)	Gage Height (ft)	Flow Est (cfs)
Turwar	1/27/2004	12:16	176	38.6	3.93	1070**
Turwar	1/27/2004	13:00	161	38.8	3.9	1070**
Turwar	1/28/2004	11:35	33.3	8.7	3.48	604.45
Turwar	1/28/2004	11:45	13.3	8.8	3.48	604.45
Turwar	2/17/2004	13:31	125	26	3.88	996**

**Actual flow measerement taken

10.3 Macroinvertebrate Sampling

Table 10-22 Macroinvertebrate Sampling WY04

Stream Name	Riffle #	Date Sampled	Total # of Specimens	Taxa Richness	EPT Taxa Richness	Sensitive EPT Index (%)	% Dominant Taxon	Tolerance Value	Shannon's Diversity Index	Estimated Relative Abundance
McGarvey	1,2,3	4/26/2004	500	37	21	45.8	25.8	2.69	2.56	1862
Tully	1,2,3	4/28/2004	505	44	20	30.89	28.9	3.34	2.8	1006
Turwar	1,2,3	4/27/2004	501	36	22	36.93	35.1	2.98	2.58	796
W. Fork Pecwan	1,2,3	5/6/2004	500	47	26	55.4	19.2	2.52	3.01	1509
E. Fork Pecwan	1,2,3,	5/6/2004	509	45	26	43.03	13.6	2.98	3.01	1509
Metah	1,2,3	4/29/2004	500	42	23	43.6	15.6	3.18	3.06	2472
Roaches	1,2,3	4/29/2004	500	46	28	40.8	12.6	3.21	3.16	1425
Blue	1,2,3	5/26/2004	502	40	21	20.32	29.9	4.2	2.64	4304

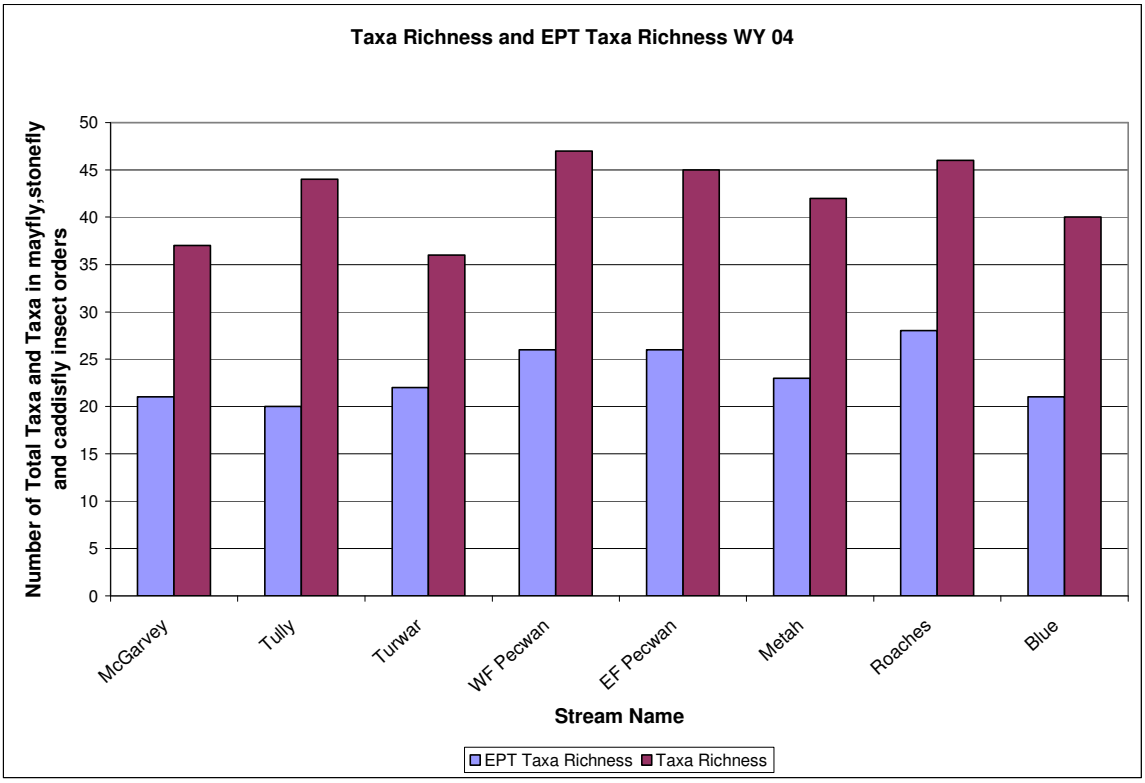

Figure 10-71 Macroinvertebrate Taxa Richness and EPT Taxa Richness WY04

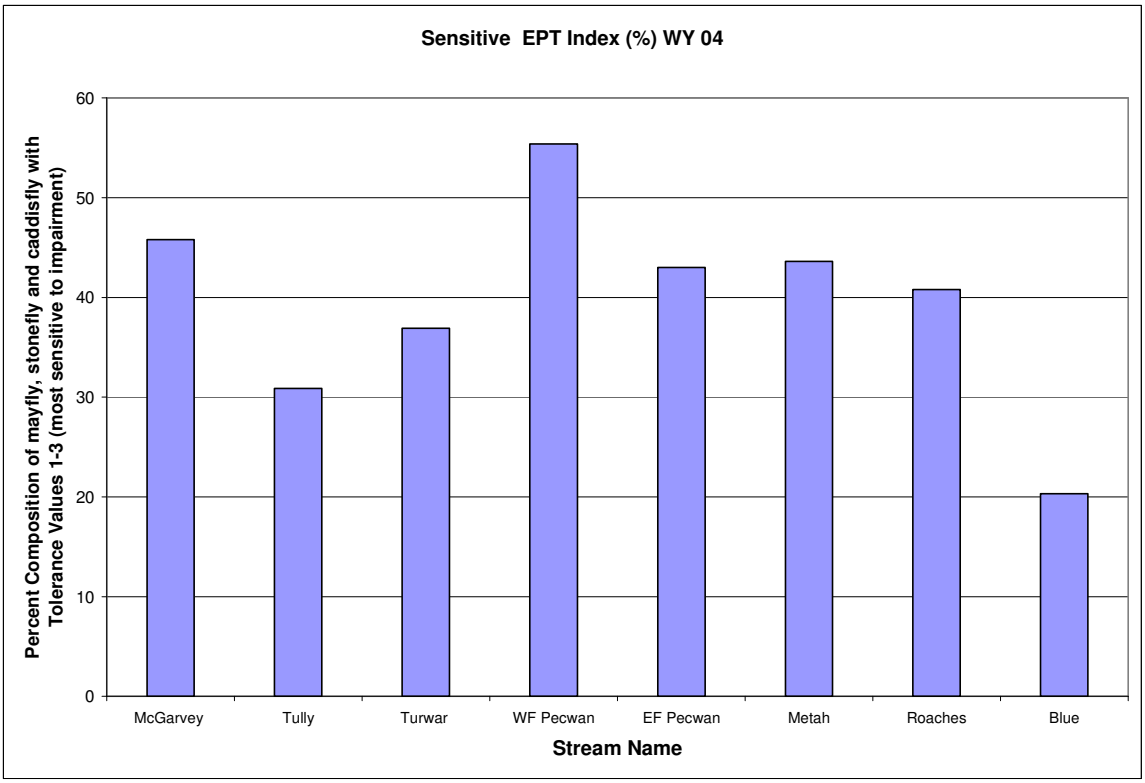

Figure 10-72 Macroinvertebrate Sensitive EPT Index

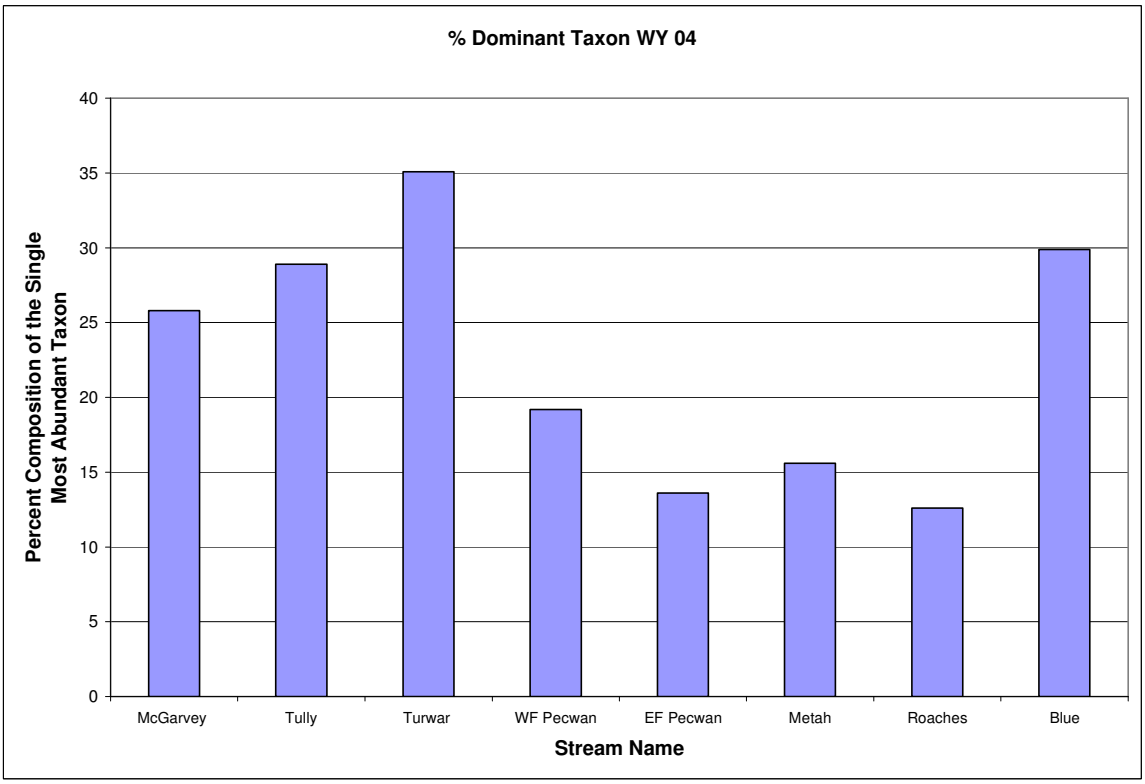

Figure 10-73 Macroinvertebrate Percent Dominant Taxon

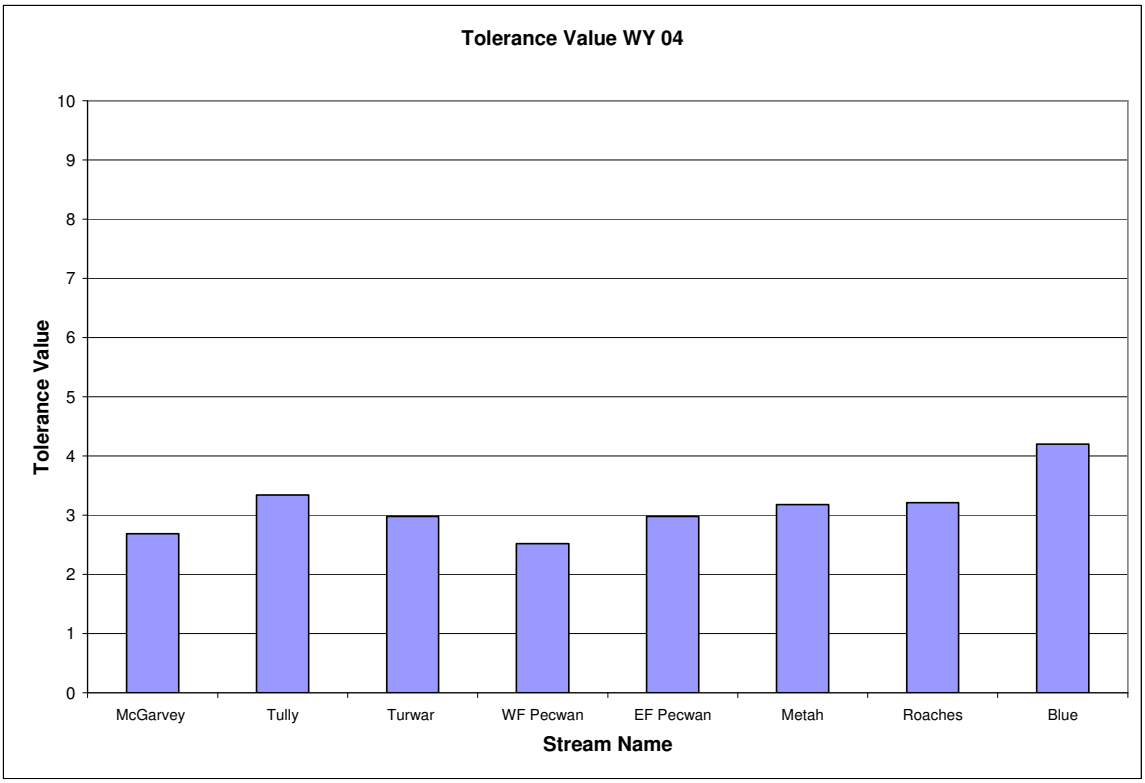

Figure 10-74 Macroinvertebrate Tolerance Value

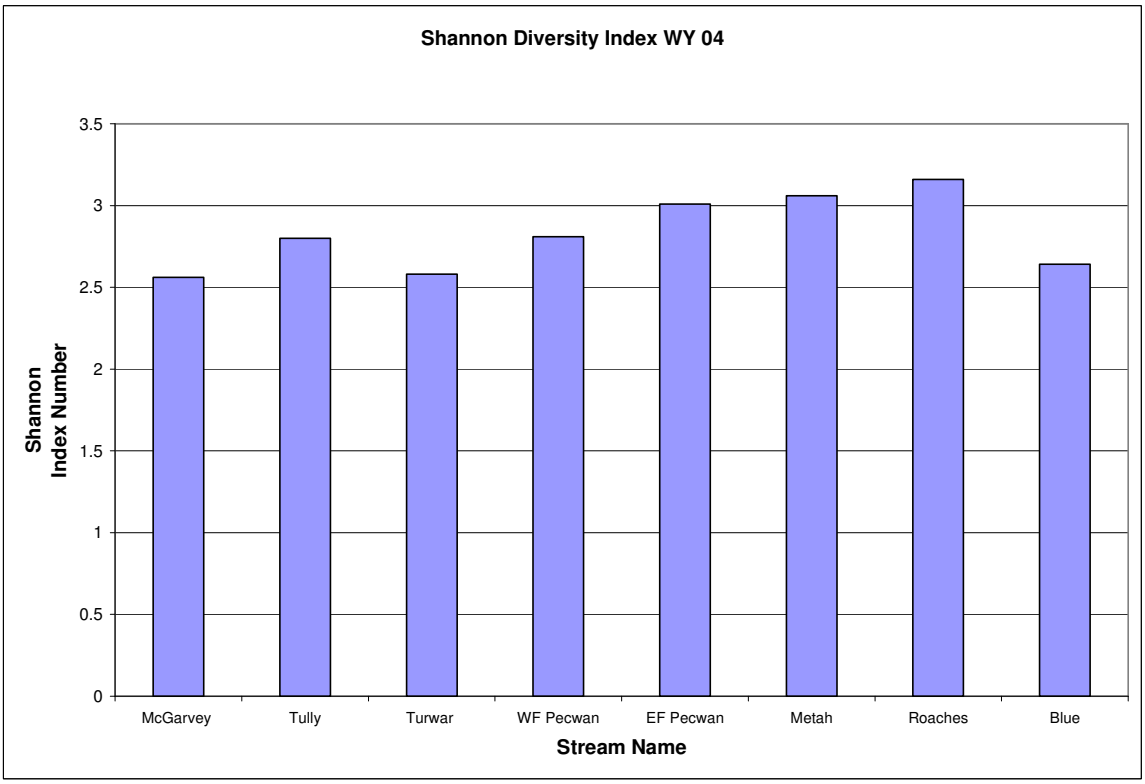

Figure 10-75 Macroinvertebrate Shannon Diversity Index

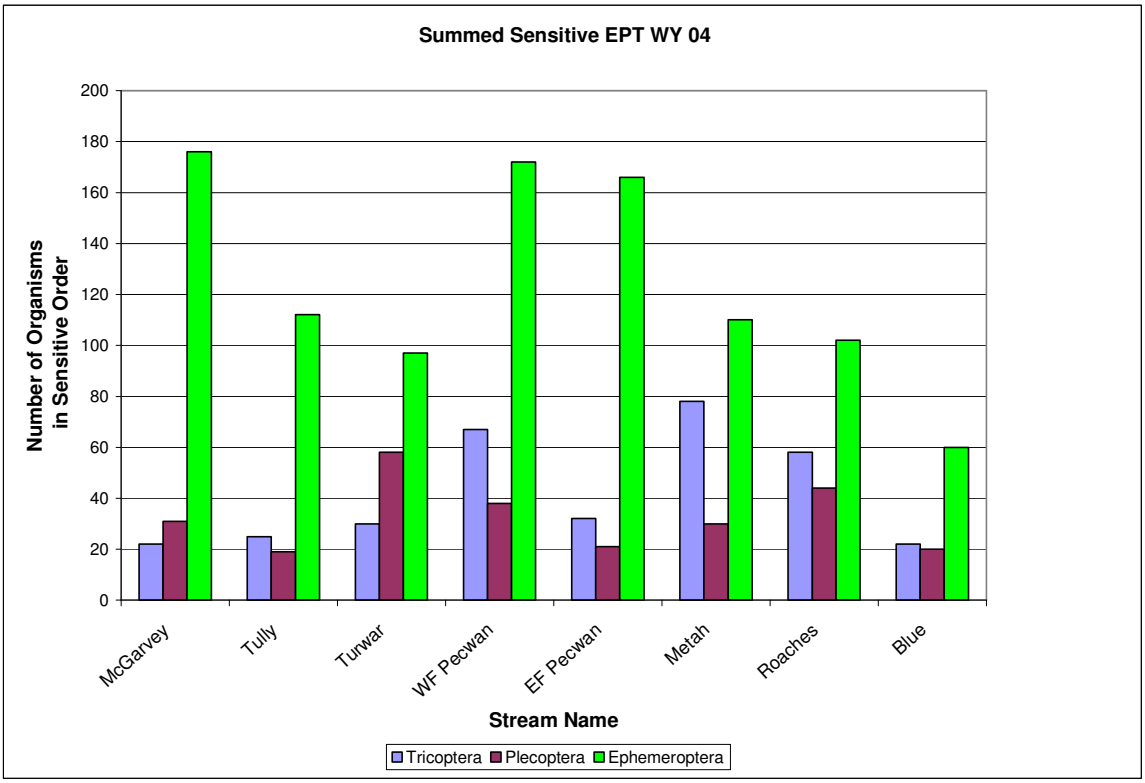

Figure 10-76 Summed Sensitive EPT

10.4 Herbicide Monitoring

Table 10-23 YTEP surface water monitoring in Tectah Creek watershed, March 2004

Sample ID	Matrix*	Sample Type	Collection Date	Collection Time	Rain Gauge (inches)*
3804-1	SW	Background	3/8/2004	1420	0
32504-4	SW	Primary	3/25/2004	1120	0.25
32504-6	SW	Primary	3/25/2004	1200	0.25
32504-8	SW	Primary	3/25/2004	1230	0.4
32504-10	SW	Primary	3/25/2004	1300	0.55
32504-12	SW	Primary	3/25/2004	1330	0.66
32504-14	SW	Primary	3/25/2004	1400	0.72
32504-16	SW	Primary	3/25/2004	1430	0.86
32504-18	SW	Primary	3/25/2004	1500	0.9
32504-20	SW	Field Blank	3/25/2004	1405	0.72
*SW=Surface Water, inches=cumulative inches in rain gauge					

Table 10-24 Laboratory analytical results for YTEP surface water monitoring, March 2004

Sample ID	Received Date	Parameter	Extraction Date	Analysis Date	Result (ug/L)	Limit (ug/L)
3804-1/BS	3/15/2004	Atrazine	3/15/2004	3/26/2004	ND	0.5
32504-4	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-6	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-8	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-10	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-12	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-14	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-16	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-18	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
32504-20/ FB	3/30/2004	Atrazine	4/1/2004	4/6/2004	ND	0.5
BS=Background Sample, FB=Field Blank, ND=Not Detected at the Reporting Limit, Limit=Reporting Limit						

10.5 Notchko RAWS Rainfall Data

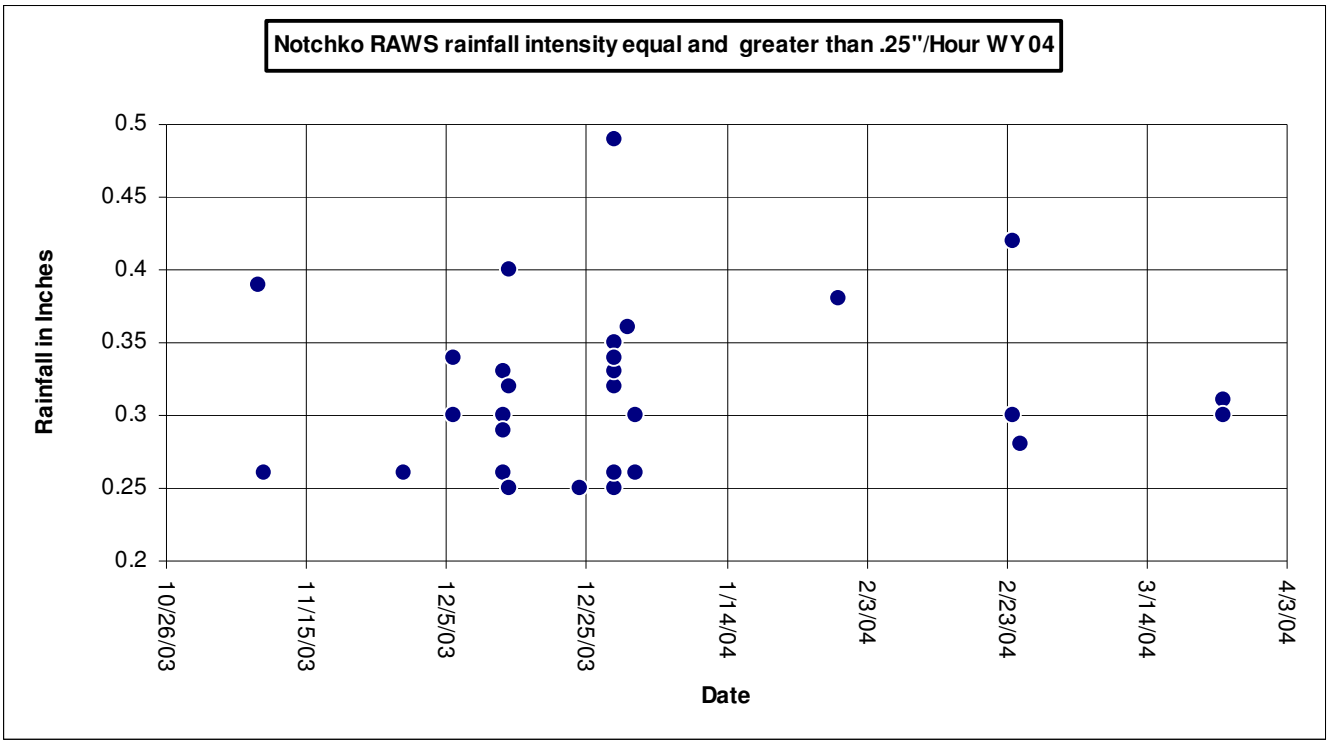

Figure 10-77 Notchko RAWS One-Hour Rainfall Intensity Greater than 0.25 inches/hour WY04

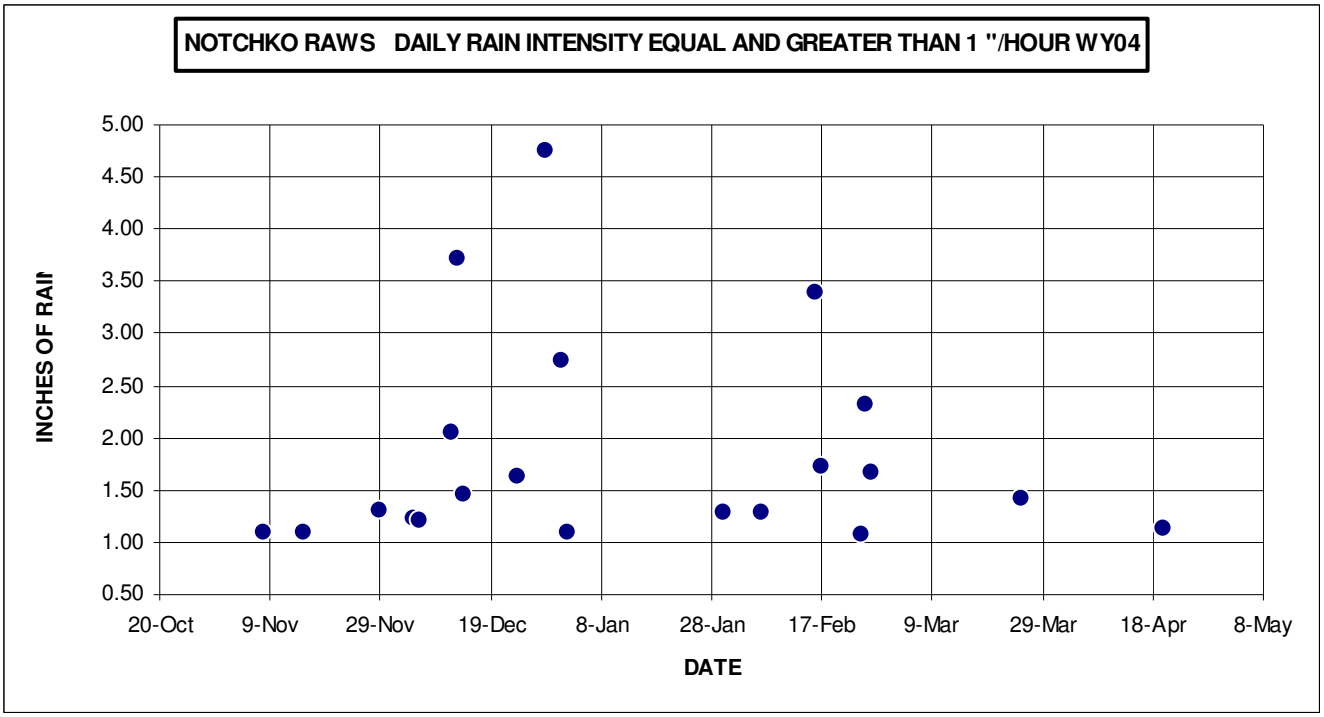

Figure 10-78 Notchko RAWS Daily Rainfall Intensity Equal and Greater than 1 inch/hour WY04

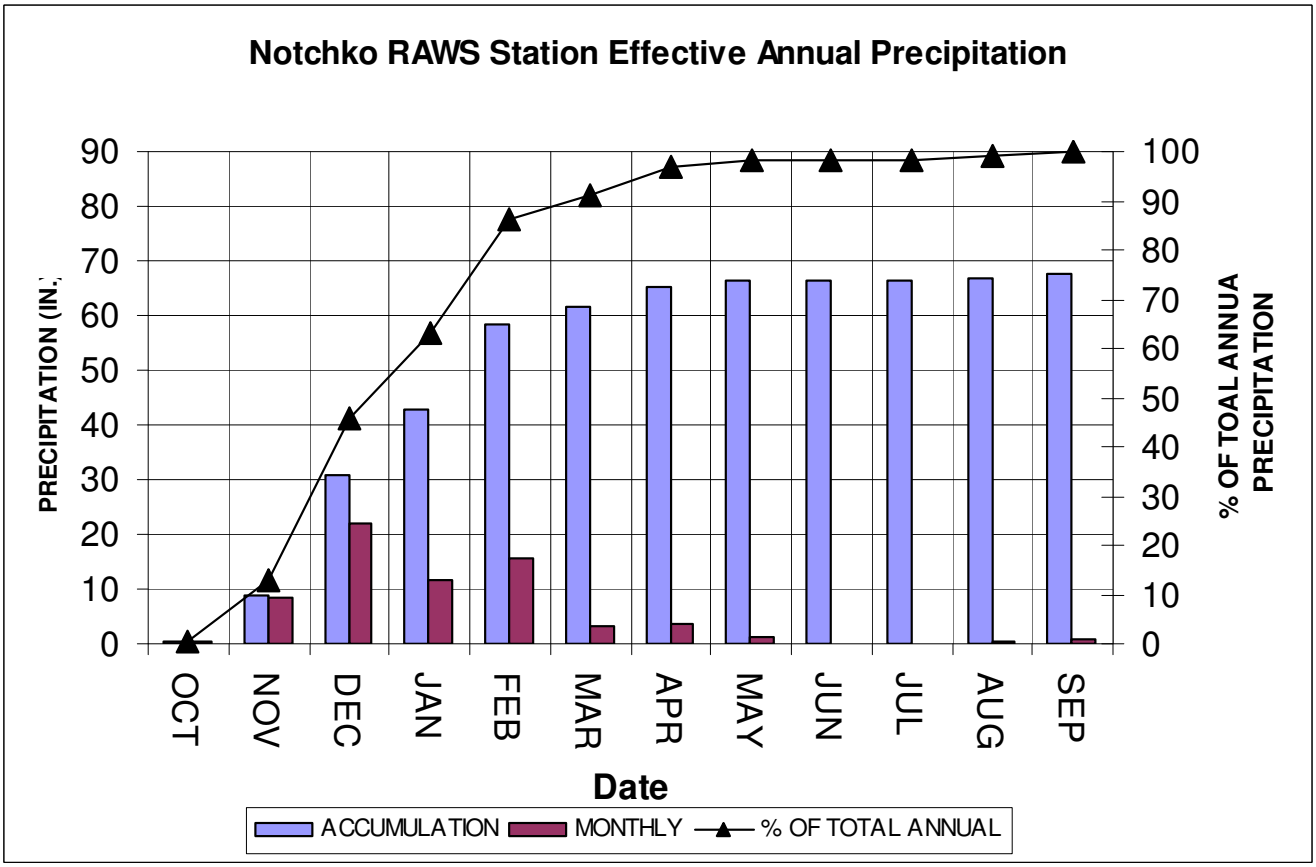

Figure 10-79 Notchko RAWS Effective Rainfall (represents 100% annual precipitation) WY04

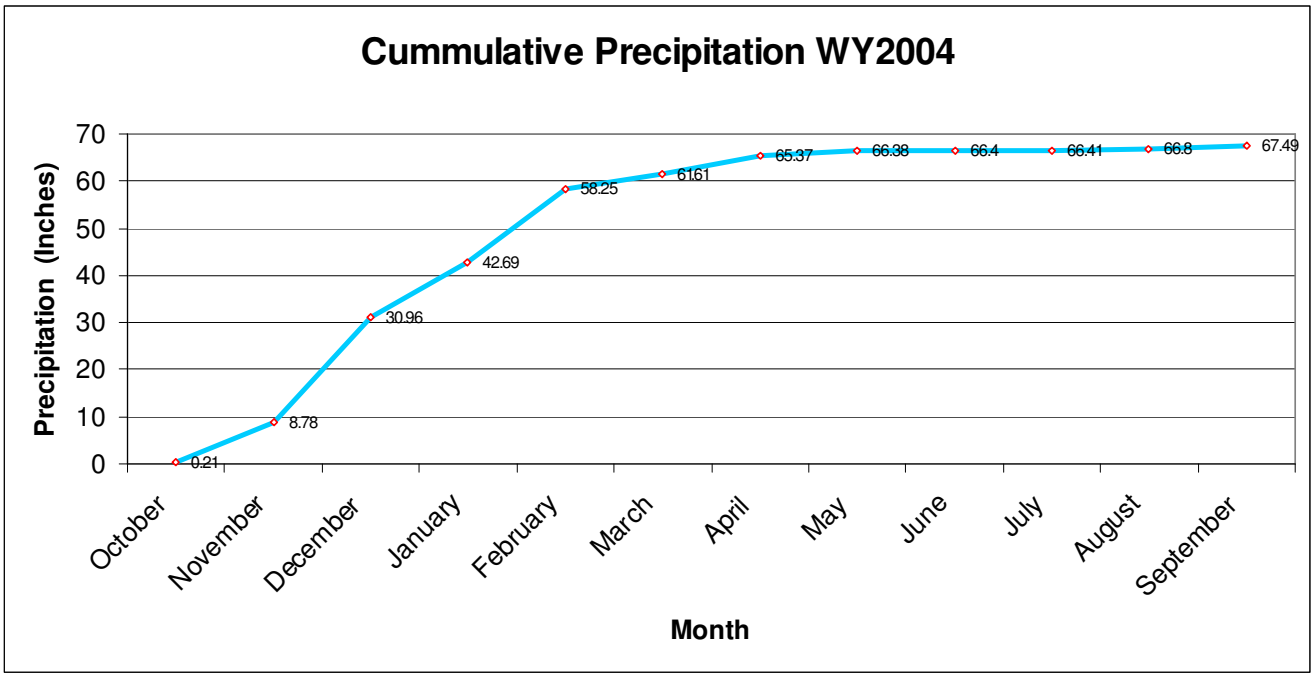

Figure 10-80 Notchko RAWS Cumulative Annual Precipitation WY04

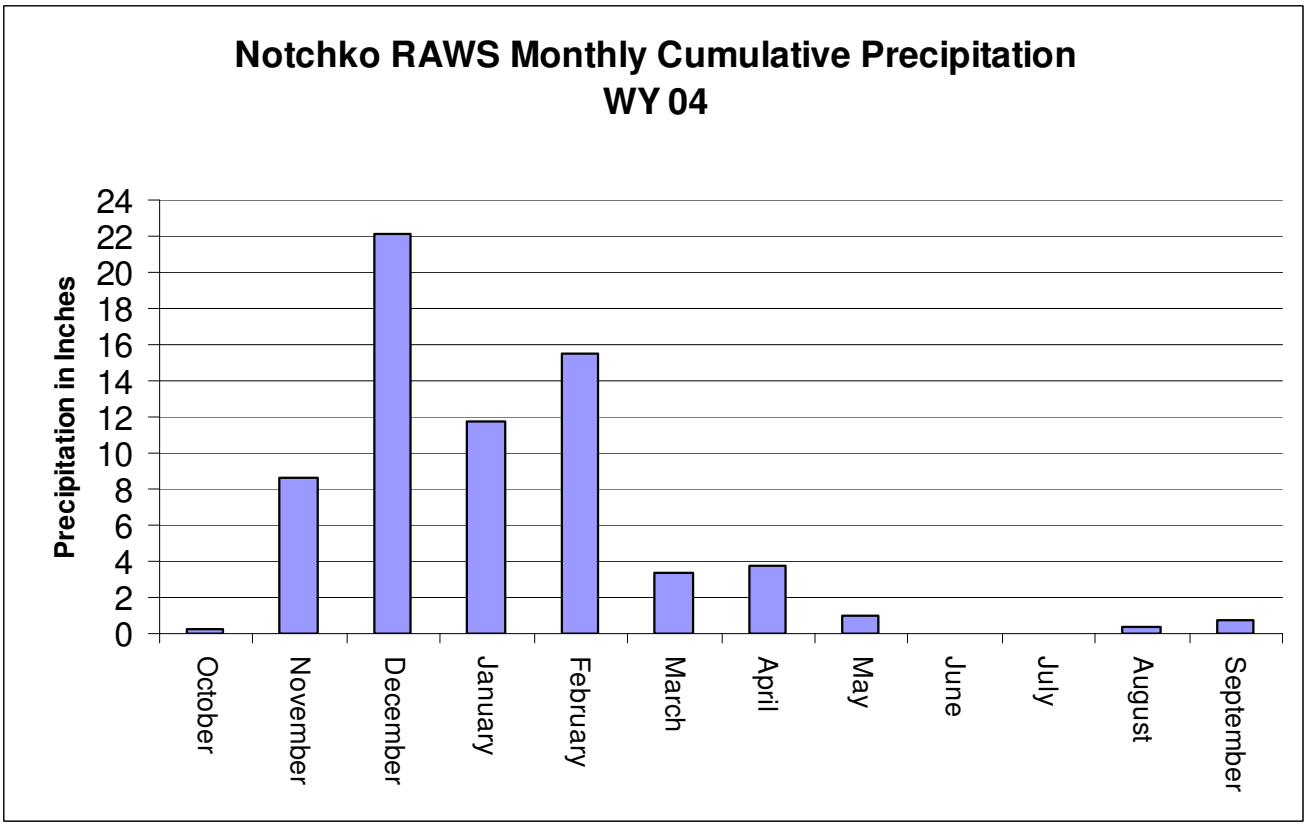

Figure 10-81 Notchko RAWS Monthly Cumulative Precipitation WY04

11 Discussion

11.1 Water Quality (Mainstem)

11.1.1 Temperature

11.1.1.1 Water Temperature – All Riverine Sites

Daily maximums and minimums were disregarded when more than five measurements were missing from a 24-hour period and when the daily maximum or minimum was expected to occur during the gap. Gaps in data may occur during service or due to instrument malfunction or vandalism.

Water temperatures of the lower Klamath and Trinity River varied greatly over the spring and summer of 2004 (Figure 10-1, Figure 10-8, Figure 10-15, Figure 10-22, Figure 10-29). The coolest daily water temperature was 11.19° Celsius on May 19th at the TR site. Water temperatures steadily increased until the end of July. The warmest daily water temperature was 26.19° Celsius on July 26th and 28th at the WE site. After August 20th water temperatures steadily dropped until the end of the monitoring season in October with the exception of water temperatures at the WE site which rose for six days at the end of August.

In this discussion the daily minimum and maximum water temperatures were compared to the Yurok Tribe's water temperature standards in order to assess the water temperatures of the Klamath and Trinity Rivers. The discussion reflects water temperature standards as of November 1, 2005. Temperature standards are currently under review and will be updated for all salmonid life stages. Percent exceedance graphs are only provided for sites that had an entire season of water temperature data.

At some sites additional graphs have been generated to illustrate how the water temperatures may have been affected by the ambient air temperature and volume of water present in the river at that time. Air temperature data used to generate these graphs are from air temperature/relative humidity sensors that were mounted at the TG, BC and WE sites. Flow discharge data used to generate these graphs was downloaded from the USGS website. These graphs provide additional information when trying to determine the impact air temperature or flow had on the water temperature.

11.1.1.2 Klamath River above Trinity River (WE)

Water temperatures varied greatly over the sampling period, the lowest daily water temperature was 12.74° Celsius on May 19th and the highest daily water temperature was 26.19°C on July 26th and 28th. The daily maximum water temperature of the Klamath River at the WE site exceeded 21° Celsius

beginning on June 23rd. Maximum water temperatures remained above 21° Celsius until September 13th.

Daily maximum water temperatures of the Klamath River at the WE site exceeded 21° Celsius 58% of the time or 82 of 142 days during the monitoring season. This metric was created for days with at least 43 measurements per day. Water temperatures exceeded 21° Celsius 48% of the time for all half-hourly measurements (6,164) during the monitoring season.

The seven-day moving average of the daily maxima exceeded 15.5° Celsius from the beginning of the monitoring season (June 2nd) and continued to exceed this standard until October 17th

11.1.1.3 Trinity River above Klamath River (TR)

Water temperatures varied greatly over the sampling period, the lowest daily water temperature was 11.19° Celsius on May 19th and the highest water temperature recorded was 25.79°C on July 26th. The daily maximum water temperature at the TR site exceeded 21° Celsius on July 16th and continued to exceed 21° Celsius until August 25th. Daily maximum water temperatures at TR exceeded 21° Celsius 29% of the time during the monitoring season or 42 or 142 days during the monitoring season. This metric was created for days with at least 43 measurements per day. Water temperatures exceeded 21° Celsius 26% of the time for all half-hourly measurements (6,769) during the monitoring season.

The seven-day moving average of the daily maxima began to exceed 15.5° Celsius on June 5th and continued to exceed 15.5° Celsius until October 19th with the exception of June 10-June 12 when the seven-day moving average of the daily maxima dipped slightly below 15.5° Celsius.

The pulse flow from the Lewiston Dam that began on August 24th and ended September 14th appears to have reduced the maximum water temperatures of the Trinity River by approximately 3.4° Celsius from August 24th to August 26th. After the pulse flow reached the monitoring site on the Trinity River maximum water temperatures dropped below 20° Celsius within two days and remained below 20° Celsius for the remainder of the monitoring season (through October 21st). The water temperatures of the Trinity River were also influenced from slightly cooler ambient air temperatures that occurred prior to the pulse flow arriving at the TR site location.

11.1.1.4 Klamath River above Tully Creek

Water temperatures varied greatly over the sampling period, the lowest daily water temperature was 13.98° Celsius on June 9th and the highest daily water temperature was 25.61° Celsius on July 26th. The daily maximum water temperature of the Klamath River at the TC site exceeded 21° Celsius beginning on June 30th and continued to exceed this standard until September 1st (with the exception of the following dates: July 1,2,10,11 and August 26-28th) when the water temperature dipped slightly below 21° Celsius and stayed below 21° Celsius for the remainder of the monitoring season (October 21st). Daily maximum water temperatures at the TC site exceeded 21° Celsius 40% of the time during the monitoring season or 56 days of 142 days during the monitoring season. This metric was created for days with at least 43 measurements per day. Water temperatures at the TC site exceeded 21° Celsius 32% of the time for all half-hourly measurements (6,857) during the monitoring season.

The seven-day moving average of the daily maxima exceeded 15.5° Celsius from the beginning of the monitoring season on June 8th and continued to exceed this standard until October 19th.

The pulse flow from the Lewiston Dam that began on August 24th and ended September 15th appears to have reduced the daily maximum water temperatures of the Klamath River at the TC site by 1.96° Celsius from August 24th to August 26th. The water temperatures of the Klamath River were also influenced from slightly cooler ambient air temperatures that occurred prior to the pulse flow arriving at the TR site location.

11.1.1.5 Klamath River above Blue Creek – 7 meters deep

Water temperatures varied greatly over the sampling period, the lowest daily water temperature was 12.81° Celsius on May 19th and the highest daily water temperature was 26.05° Celsius on July 27th. The daily maximum water temperature at BC exceeded 21° Celsius beginning on June 27th and continued to exceed 21° Celsius until September 10th, except on July 1 when the daily maximum water temperature dipped slightly below 21° Celsius. Daily maximum water temperatures at BC exceeded 21° Celsius 48% of the time during the monitoring season or 76 of 154 days during the monitoring season. This metric was created for days with at least 43 measurements per day. Water temperatures at BC exceeded 21° Celsius 29% of the time for all half-hourly measurements (6,993) during the monitoring season.

The seven-day moving average of the daily maxima exceeded 15.5° Celsius beginning on June 1 and continued until October 20th.

11.1.1.6 Klamath River at Turwar Gage

Water temperatures varied greatly over the sampling period, the lowest water temperature recorded was 13.00° Celsius on May 19th and the highest water temperature recorded was 24.50° Celsius on July 27th. The daily maximum water temperature of the Klamath River at TG exceeded 21° Celsius on June 27th and continued to exceed 21° Celsius until September 3rd, with the exception of June 30th and July 1st when maximum daily water temperatures dipped slightly below 21° Celsius. Daily maximum water temperatures of the Klamath River at TG exceeded 21° Celsius 42% of the time during the monitoring season or for 66 of 156 days during the monitoring season. This metric was created for days with at least 43 measurements per day. Water temperatures at TG exceeded 21° Celsius 32% of the time for all half-hourly measurements (7,286) during the monitoring season.

The seven-day moving average of the daily maxima began to exceed 15.5° Celsius on June 2nd and continued until October 19th.

11.1.2 Dissolved Oxygen

11.1.2.1 Dissolved Oxygen – All Riverine Sites

DO results are reported in milligrams per liter (mg/L). The datasonde also recorded DO in percent saturation and this information is available to those that request it from YTEP. It is important to note that DO is the most difficult parameter to monitor continuously. Electronic drift and biofouling contribute to lower DO readings. Therefore, the low DO levels that are reflected in the DO graphs may not be accurate. DO levels significantly rise when the DO membrane on the datasonde's DO probe was changed and the probe was then calibrated. This trend can be observed throughout the entire data set and is problematic when analyzing the data. This information needs to be kept in mind when determining if the DO levels were as low as recorded. The grade ratings summarized in section 4 may be of assistance when determining the level of confidence in the data.

In general the DO levels of the lower Klamath and Trinity Rivers followed an inverse relationship compared to water temperature. At the TG and BC sites DO levels decreased from the beginning of May to the end of July. At the TG and BC sites DO levels generally began to increase near the beginning of August and continued to do so until the end of the monitoring season (October 20th-21st). At the TC and

TR sites DO levels decreased from the beginning of May to the end of August, while the DO levels at the WE site decreased until the first week of September. At the TC and TR sites DO levels generally began to increase near the end of August and continued to do so until the end of the monitoring season (October 20th-21st). DO levels at the WE site began to increase after the first week of September and continued to do so until the end of the monitoring season.

Minimum DO values occurred late at night and/or early in the morning. This trend is related to the period of time when aquatic vegetation is respiring and photosynthesis is not occurring. Daily minimum and maximum DO values have not been reported if there were less than 48 measurements per day. Gaps in the data may also result due to equipment malfunction or other problems associated with DO membrane integrity.

11.1.2.2 Klamath River above Trinity River

DO levels varied over the sampling period, the lowest DO level recorded was 5.51 mg/L on September 3rd and the highest DO level recorded was 10.32 mg/L on October 12th. The minimum DO level fell below 7 mg/L for thirty days. There were two periods of time when the daily minimum DO values were below 7 mg/L for an extended period of time (8/13-8/22 and 8/30-9/8). It is likely that the low DO concentrations recorded were accurate because the DO numbers recorded were not a constant decline but rather exhibited a more dynamic state which is more likely to represent environmental conditions. It is possible that biofouling and electronic drift contributed to the low DO levels recorded on some of these days. Low DO levels on June 27th to June 29th and July 22nd through July 27th occurred at the end of the datasonde deployment period, which may have occurred due to excessive biofouling on the membranes. However, low DO levels on August 13th-22nd and August 30th – September 8th occurred at or near the beginning of the deployment period and showed increases as well as decreases that indicate that a steady decline was not attributable to biofouling.

11.1.2.3 Trinity River above Klamath River

DO levels varied over the sampling period, the lowest DO level recorded was 6.00 mg/L on September 22nd and the highest DO level recorded was 9.86 mg/L on October 12th. The daily minimum DO levels fell below 7 mg/L for 15 days. It is possible that biofouling and electronic drift contributed to the low DO levels recorded on these days. Low DO levels were recorded at the end of the datasonde deployment period. Low DO levels that occurred from August 19th to August 24th were near the end of the

deployment period and showed increases after decreases occurred; therefore, indicating that a steady decline did not occur due to biofouling.

11.1.2.4 Klamath River above Tully Creek

DO levels varied over the sampling period, the lowest DO level recorded was 6.02 mg/L on October 21st and the highest DO level recorded was 10.61 mg/L on June 2nd, 8th and 9th. The daily minimum DO levels fell below 7 mg/L for 16 days. The minimum daily values began to drop below 7.0 mg/L on July 18th and by August 24th minimum DO levels remained above 7.0 mg/L for the remainder of the sampling period. There were two periods of time when the daily minimum DO values were below 7 mg/L for an extended period of time (7/18-7/27 and 8/19-8/24). It is likely that the low DO concentrations recorded were accurate because the DO numbers recorded were not a constant decline but rather exhibited a more dynamic state which is more likely to represent environmental conditions. Low DO levels on August 8th – August 10th occurred at the end of the datasonde deployment period and exhibited a steady decline, which may have occurred due to excessive biofouling on the membranes.

11.1.2.5 Klamath River above Blue Creek- 7 meters Deep

DO levels varied over the sampling period, the lowest DO level recorded was 5.58 mg/L on August 22nd and the highest DO level recorded was 10.65 mg/L on May 19th. The minimum DO level fell below 7 mg/L for 25 days. The minimum daily values dropped below 7.0 mg/L beginning on July 23rd and by August 22nd DO levels remained above 7.0 mg/L for the remainder of the sampling period. There were two periods of time when the daily minimum DO values were below 7 mg/L for an extended period of time (8/2-8/8 and 8/11-8/22). It is likely that the low DO concentrations recorded were accurate from 8/2 -8/8 because the DO numbers recorded were not a constant decline but rather exhibited a more dynamic state which is more likely to represent environmental conditions. However, the period of time from August 11th to August 22nd was a steady decline from the beginning of the deployment period. It is possible that biofouling and electronic drift contributed to the low DO levels recorded on these days. Low DO levels on July 23rd – 25th occurred at the end of the datasonde deployment period and exhibited a steady decline, which may have occurred to excessive biofouling on the membranes.

11.1.2.6 Klamath River at Turwar Gage

DO levels varied over the sampling period, the lowest DO level recorded was 5.90 mg/L on July 24th and the highest DO level recorded was 10.07 mg/L on October 2nd and 3rd. The minimum DO level fell below 7 mg/L for 28 days. The minimum daily values dropped below 7.0 mg/L beginning on July 19th

and by September 6th DO levels remained above 7.0 mg/L. There were two periods of time when the daily minimum DO values were below 7 mg/L for an extended period of time (7/28-8/8 and 8/11-8/22). It is likely that the low DO concentrations recorded were accurate during these deployment periods because the DO numbers recorded were not a constant decline but rather exhibited a more dynamic state which is more likely to represent environmental conditions.

11.1.3 pH

11.1.3.1 Klamath River above Trinity River

The pH values recorded at WE were variable during the monitoring season. In general, the pH values gradually increased until the end of August. pH diurnal fluctuation began to decrease at the beginning of September. Maximum daily pH values remained above the Yurok Tribe's pH standard of 8.5 for the majority of the monitoring season (85 out of 110 days). The lowest pH value recorded at WE was 7.97 on July 28th and the highest pH value recorded was 8.86 on August 20th.

11.1.3.2 Trinity River above Klamath River

The pH values recorded at TR were less variable than the other Klamath River monitoring sites. The diurnal variation was not as great when compared to the other Klamath River monitoring sites. The maximum daily pH values did not exceed the Yurok Tribe's pH standard of 8.5 during the entire monitoring season. The lowest pH value recorded was 7.55 on June 30th and the highest pH value recorded was 8.43 on July 27th.

11.1.3.3 Klamath River above Tully Creek

The pH values recorded at TC were variable during the monitoring season. In general, pH values gradually increased until the end of August then decreased until the end of the monitoring season. pH diurnal fluctuation also increased until the end of August and began to decrease at the beginning of September and continued to decrease until the end of the monitoring season. Maximum daily pH values exceeded the Yurok Tribe's pH standard of 8.5 for 13 days. The lowest pH value recorded was 7.68 on June 16th and the highest pH value recorded was 8.67 on July 25th.

11.1.3.4 Klamath River above Blue Creek – 7 meters Deep

The pH values recorded at BC were variable during the monitoring season. In general, pH values remained relatively stable from Mid May until the end of July. At the end of July pH levels began to increase until the beginning of October. Diurnal fluctuation was also the greatest from the end of July

until the beginning of October. Maximum daily pH values exceeded the Yurok Tribe's pH standard of 8.5 for 53 days. The lowest pH value recorded was 7.71 on August 26th and the highest pH value recorded was 8.72 on October 2nd.

11.1.3.5 Klamath River at Turwar Gage

The pH values recorded at BC were variable during the monitoring season. In general, pH values remained relatively stable from Mid-May until the end of July. pH levels gradually increased from the end of July to mid October, then decreased until the end of the monitoring season. pH diurnal fluctuation was greatest from the beginning of August to mid October. The lowest pH level recorded was 7.93 on August 26th and the highest pH level recorded was 8.74 on October 2nd. Daily maximum pH values exceeded the Yurok Tribe's pH standard of 8.5 for 61 days.

11.1.4 Specific Conductivity

11.1.4.1 Specific Conductivity – All Sites

Gaps in data occurred due to equipment malfunction. Minimum and maximum values were not generated on days with only partial data (less than 43 measurements taken at ½ hour intervals).

Specific conductivity measures how well an aqueous solution can pass an electric current, which increases with the amount of dissolved ionic substances, thus another method to determine the level of dissolved substances present in the water column. Specific conductivity levels at the five water quality monitoring sites varied over the sampling period. In general, specific conductivity levels increased throughout the monitoring season at all of the five sites. The four sites on the Klamath River all exhibited a similar trend where specific conductivity levels gradually increased until the beginning of October when levels slowly began to decrease until the end of the monitoring season on October 20th and 21st. The Klamath River at Weitchpec site recorded the highest daily maximum specific conductivity value of 214 micro siemens per centimeter.

The specific conductivity levels recorded at the Trinity River site exhibited a different trend compared to the Klamath River sites. The Trinity River site recorded the lowest daily minimum specific conductivity value 87 microsiemens per centimeter. Specific conductivity levels gradually increased throughout the monitoring season. Specific conductivity levels decreased during the Trinity River pulse flow event and continued to increase after the flows subsided. Specific conductivity levels recorded at the Trinity River site did not decrease at the end of the monitoring season as was seen at the Klamath River sites.

11.1.4.2 Klamath River above Trinity River

The specific conductivity levels recorded at the WE site were variable during the monitoring season. In general, the specific conductivity levels gradually increased until the end of August and then began a gradual decline until the end of the monitoring season (October 21st). It appears that specific conductivity levels rose slightly in response to the Klamath River pulse flow event that occurred at the end of August. The lowest specific conductivity level recorded at the WE site was 110 micro siemens on July 5th and the highest specific conductivity level recorded was 214 micro siemens on August 29th.

The specific conductivity levels did not exceed the Yurok Tribe's specific conductivity standard which sates that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius. Percent upper limits means that 90% (or 50%) or more of the values must be less than or equal to an upper limit.

11.1.4.3 Trinity River above Klamath River

The specific conductivity levels recorded at the TR site were variable during the monitoring season. In general, the specific conductivity levels gradually increased until the end of the monitoring season (October 21st). Specific Conductivity levels did decrease during the beginning of the Trinity River pulse flow and leveled off until the Trinity River pulse flow began to subside on September 14th at which time specific conductivity levels returned to pre-pulse flow levels. The lowest specific conductivity level recorded at the TR site was 87 micro siemens on June 2nd-4th and the highest specific conductivity level recorded was 166 micro siemens on October 21st.

The specific conductivity levels did not exceed the Yurok Tribe's specific conductivity standard which sates that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius.

11.1.4.4 Klamath River above Tully Creek

The specific conductivity levels recorded at the TC site were variable during the monitoring season. In general, the specific conductivity levels gradually increased until the end of the monitoring season (October 21st). Specific Conductivity levels did decrease during the beginning of the Trinity River pulse flow and leveled off until the Trinity River pulse flow began to subside on September 14th at which time specific conductivity levels continued to increase. The lowest specific conductivity level recorded at the

TC site was 91 micro siemens on June 3rd-5th and the highest specific conductivity level recorded was 166 micro siemens on September 22nd and 23rd.

The specific conductivity levels did not exceed the Yurok Tribe's specific conductivity standard which sates that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius. Percent upper limits means that 90% (or 50%) or more of the values must be less than or equal to an upper limit.

11.1.4.5 Klamath River above Blue Creek

The specific conductivity levels recorded at the BC site were variable during the monitoring season. In general, the specific conductivity levels gradually increased until the beginning of October and then began to decline until the end of the monitoring season (October 20th). Specific Conductivity levels did increase sharply for a couple of days during the beginning of the Klamath and Trinity River pulse flow events near the end of August. Specific conductivity levels then dropped and leveled off until the Klamath and Trinity River pulse flow events began to subside on September 14th at which time specific conductivity levels continued to increase until the beginning of October. The lowest specific conductivity level recorded at the BC site was 97 micro siemens on May 29th and the highest specific conductivity level recorded was 188 micro siemens on August 24th.

The specific conductivity levels did not exceed the Yurok Tribe's specific conductivity standard which sates that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius.

11.1.4.6 Klamath River at Turwar Gage

The specific conductivity levels recorded at the TG site were variable during the monitoring season and exhibited a similar trend that was observed at the BC site. In general, the specific conductivity levels gradually increased until the beginning of October and then began to decline until the end of the monitoring season (October 20th). Specific conductivity levels did increase sharply for a couple of days during the beginning of the Klamath and Trinity River pulse flow events near the end of August. Specific conductivity levels then dropped and leveled off until the Klamath and Trinity River pulse flow events began to subside on September 14th at which time specific conductivity levels continued to increase until the beginning of October.

The lowest specific conductivity level recorded at the TG site was 91 micro siemens on June 3rd and the highest specific conductivity level recorded was 188 micro siemens on August 24th. The sharp declines in specific conductivity that were recorded throughout August, September and October are believed to be caused by the boat traffic that is most common in the lower Klamath River. These sharp declines were not recorded at the other Klamath River monitoring sites.

The specific conductivity levels did not exceed the Yurok Tribe's specific conductivity standard which sates that levels shall have a 90% upper limit of 300 µmhos/cm @ 25° Celsius and a 50% upper limit of 200 µmhos/cm @ 25° Celsius.

11.1.5 Multi-Site Comparisons

11.1.5.1 Maximum Water Temperatures – All Riverine Sites

In general the warmest water temperatures were recorded at the WE site until September 13th. After September 13th the BC site recorded the warmest water temperatures within the Yurok Reservation. In general, the TR site recorded the coolest water temperatures resulting in cooler water temperatures at the TC site compared to the WE site. As the water continued to travel downstream warm air temperatures caused the water to heat up resulting in warmer water temperatures being recorded at the BC site compared to the TC site. As the water continued to get closer to the Pacific coast cooler air temperatures caused the water to cool down resulting in cooler water temperatures being recorded at the TG site compared to the BC site.

Shortly after flows from the Lewiston Dam were increased in August all Klamath River monitoring sites below the Trinity River confluence recorded cooler water temperatures than were recorded above the confluence. During the time of the pulse flow the Trinity River had the greatest cooling effect on the Klamath River.

11.1.5.2 Impacts of the Trinity River on Temperature in the Mainstem Klamath River

Water temperatures of the Klamath River below the Trinity River confluence change over time. From June 2nd to June 16th maximum water temperatures recorded above and below the confluence are within 0.5º Celsius. Maximum water temperatures are noticeably cooler below the Trinity River confluence when compared to water temperatures recorded above the confluence after June 16th. This general trend can be observed until July 21st when maximum water temperatures above and below the Trinity River confluence are within 0.5º Celsius. This trend continued until August 26th when the Trinity River Pulse Flow arrived and cooled the Klamath River below the confluence by approximately 1.6º Celsius when

comparing the daily maximum water temperatures on August 25 and 26th. The Trinity River had its greatest cooling effect on the Klamath River during the pulse flow from Lewiston Dam during August 26-September 16th. After September 16th the maximum water temperatures recorded above and below the confluence are within 0.5º Celsius.

11.1.5.3 Impacts of the Trinity River on Dissolved Oxygen in the Mainstem Klamath River

DO levels of the Klamath River above and below the confluence with the Trinity River change over time. In general the maximum DO concentrations were greater below the confluence with the Trinity River when compared to DO concentrations above the confluence with the Trinity River. There were 17 days between August 13th and October 17th that maximum DO concentrations were greater above the confluence with the Trinity River when compared to DO concentrations below the confluence with the Trinity River.

In general, the minimum DO concentrations were lower above the confluence with the Trinity River when compared to DO concentrations below the confluence with the Trinity River. There were 10 days between July 9th and October 17th when minimum DO concentrations were lower below the confluence with the Trinity River when compared to DO concentrations above the confluence with the Trinity River.

11.1.6 Special Studies

11.1.6.1 Mainstem Macroinvertebrate Sampling – August

Benthic macroinvertebrate samples were collected at shallow riffles in the Klamath River above the mouth of Ah Pah Creek and below the mouth of Johnsons Creek. One sample was collected in the Trinity River above the confluence with the Klamath River at Weitchpec.

The two Klamath River samples, in contrast to the Klamath River tributary samples, have a large number of tolerant taxa (both had 8 taxa that were considered to be tolerant) and only one taxon considered intolerant (*Blepharicera*). The high number of tolerant taxa is not unexpected as many organisms listed as tolerant are considered tolerant of warm water, fine sediment, and filamentous algae growth (Wisseman 1996). Ross (1956), discussing the evolution of caddisflies, indicates a shift from cold water primitive taxa to warm water adaptive taxa at about 65 - 68° F. He notes that this is also the high end of the optimal range for cool-adapted species of trout. It is presumed that other groups of aquatic organisms may respond in kind. This shift is apparently evident in the Klamath River samples.

The stable sand community discussed by Lenat et al. (1981) most likely made up a portion of the Klamath River samples as suggested by the high number of oligochaetes in the samples. These segmented aquatic worms occur in fine sediment.

A large number of tolerant taxa (10) were also evident in the Trinity River sample. As with the Klamath River samples these may be related to a larger, summer warm river. All of the metric scores suggest a less impaired habitat or better water quality in the Trinity River sites compared to the Klamath River sites as is evident in Table 11-1 below.

Table 11-1 Metric scores for Trinity and Klamath River samples

	Klamath River at Ah Pah	Klamath River at Johnsons	Trinity River at Weitchpec
Taxa Richness	34	38	47
EPT Taxa Richness	16	20	22
% Sensitive EPT	10.6	14.6	19.2
% Dominant taxon	19.7	18.2	12.4
Tolerance Value	4.41	4.33	4.12
Shannons D.I.	2.58	2.67	3.16

Also of note in the Trinity River samples were some mayfly taxa not often found in samples from smaller, coastal streams. The common (and ubiquitous) *Baetis* species in northern California is *B. tricaudatus*. In the Trinity River sample were several nymphs which keyed to *Baetis notos*. Other interesting taxa in the family Baetidae in the Trinity River samples were *Camelobaetidius* and *Procloeon*. A mayfly not formally listed to occur in California but common in larger streams near the Sierra Nevada mountain range is *Homoleptohyphes dimorphus* (Leptohyphidae). One male specimen of this species was found in the Trinity River sample which suggests a broad distribution of this species in northern California.

11.1.6.2 Klamath River Benthic Algae Sampling June – September

Benthic algae samples were collected at four locations at monthly intervals. Samples were collected near datasonde deployment locations at TG, TC, TR and WE the day after nutrient grab samples were collected. Watercourse Engineering Inc. field crew collected the August sample at Weitchpec and graciously shared the data with us and is included in the combined species table but was not included in table 7-7 because the maximum number of sites for the table format was 15. However, it has been included in tables 7-8 and 7-9 in order to examine the relationships between sites and dates. The

combined species lists that are presented in Section 7.1.7.2 list all of the algae species found and its relative abundance (in percent) at all of the four sampling sites and at each site.

Table 11-2 Top 5 most abundant algae species and their relative abundance (%) June 2004

Achnanthes minutissima	26.3
Diatoma vulgare	15.3
Cymbella affinis	12.4
Nitzschia frustulum	6.6
Synedra mazamaensis	6.5

Table 11-3 Top 5 most abundant algae species and their relative abundance (%) July 2004

Cymbella affinis	28
Epithemia sorex	17.1
Diatoma vulgare	15
Cocconeis placentula	10.2
Rhoicosphenia curvata	5.9

Table 11-4 Top 5 most abundant algae species and their relative abundance (%) August 2004

Epithemia sorex	39.7
Cymbella affinis	27.7
Diatoma vulgare	5.6
Nitzschia frustulum	4.6
Oscillatoria sp.	4.6

Table 11-5 Top 5 most abundant algae species and their relative abundance (%) September 2004

Epithemia sorex	58.6
Diatoma vulgare	7.6
Cocconeis placentula	4.8
Nitzschia frustulum	4.7
Ulothrix sp.	4.1

From the shortened combined species list tables provided above it is evident that species shifted from *Achnanthes minutissima* dominating samples in June followed by *Cymbella affinis* dominating samples in July and *Epithemia sorex* dominating samples in August and September. Sites TG, TC, and WE were dominated by *Epithemia sorex* and site TR was dominated by *Cymbella affinis*. *Achnanthes minutissima* was considered by Cholnoky (1968) as "oxygen-loving" because they were found in turbulent, well-oxygenated water. *Cymbella affinis* is described by Patrick and Reimer (1975) as alkaliphilic with wide distribution in lakes and streams and the USGS classifies it as a species that is associated with waters that are eutrophic and alkaliphilic. However, Biggs and Hickey (1994) and Biggs (1995) found that in less enriched streams, stalked and tube-dwelling diatoms such as *Cymbella affinis* can dominate the

substrate. *Epithemia sorex* is described by Patrick and Reimer (1966) to be found often in waters of high nutrient content and prefers cool, flowing waters. Borchardt (1996) found *Epithemia sorex* in nitrogen limited waters and the USGS classifies this algae species as a nitrogen fixer found in eutrophic and alkaliphilic waters.

The similarity indices (SI's) listed in Section 10.1.7.2 and below in Table 11-6 provide comparisons between each sample with the others. The SI uses the relative abundance of each species in each sample, and the SI ranges from 0 for totally dissimilar samples, to 100 for identical samples.

Table 11-6 Benthic Algae SI values for four monitoring sites from June to September 2004

	Jun-Jul	Jul-Aug	Aug-Sep
TG	45	60	56
TC	36	30	78
TR	44	71	21
WE	20	40	67

*The SI ranges from 0 for totally dissimilar samples, to 100 for identical samples

The table above indicates that the SI between June and July at the TG site was 45, between July and August it was 60 and between August and September it was 56. This means that the two months that contained the most similar algae species was July and August and the two months that contained algae species that were not alike was June and July. This means that algae species composition did not change as much between July and August as they did between June and July. It is interesting to note that TG changed moderately from month to month and that TC changed from June to July to August but was quite similar from August to September. The algae community at site TR did not change as much between July and August (SI=71) but did from August to September. The Trinity River pulse flow event may have had an influence on the algae communities in the Trinity River just upstream of the Klamath River confluence. Algae communities changed most drastically from June to July at the WE site, moderately from July to August and were relatively stable from August to September.

Information can be gained to understand relationships between sites by looking at the SI's, as well. June SI's ranged from 41 to 59, July from 20 to 56, August from 9 to 69 and September ranged from 43 to 84. The highest and lowest SI's between sites each month are given in Table 11-7, below.

Table 11-7 Highest and Lowest Benthic Algae SI values for four monitoring sites from June to September 2004

	Highest	Lowest
June	59 (TC-TR)	41 (WE-TR)
July	56 (TG-TC)	24 (TC-TR)
August	69 (TG-TC)	9 (TR-WE)
September	84 (TG-WE)	43 (TR-WE)

There appears to be not strong pattern. The TR site's algae community is the least similar with the other sites, except for the month of June when site TG and TR were the most similar. While the TG site's algae community was always most similar to some other site in each month but was variable over time. Sites TG and WE algae communities were most similar during the month of September.

11.1.6.3 Klamath River Estuary Water Quality Monitoring June – September, 2004

11.1.6.3.1 Water Temperature - Klamath River Upper Estuary

A complete record of water temperatures in the Upper Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Water temperatures varied greatly over the sampling period, the lowest water temperature recorded was 14.98° Celsius on September 29th and the highest water temperature recorded was 23.96° Celsius on August 20th. The water temperatures in the Upper Estuary are comparable to the water temperatures recorded at the TG site located approximately two miles upstream. The water temperatures recorded in the Upper Estuary at the Highway 101 Bridge were not influenced by salt water intrusion.

However, salt water intrusion did influence water temperatures after the datasonde was moved downstream approximately 1 mile during the September deployment period. The datasonde was deployed on the bottom of the stream bed.

11.1.6.3.2 Dissolved Oxygen - Klamath River Upper Estuary

A complete record of dissolved oxygen concentrations in the Upper Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. DO levels varied greatly over the sampling period, the lowest DO concentration recorded was 7.42 mg/L on July 22nd and the highest DO concentration recorded was 12.19 mg/L on August 17th. Due to the short duration of the deployment periods it is not believed that biofouling or electronic drift affected the DO probe's accuracy and precision. The DO concentrations recorded in the Upper Estuary at the Highway 101 Bridge were not influenced by salt water intrusion. However, salt water intrusion did influence DO concentrations

after the datasonde was moved downstream approximately 1 mile during the September deployment period. The datasonde was deployed on the bottom of the stream bed in September.

11.1.6.3.3 pH - Klamath River Upper Estuary

A complete record of pH levels in the Upper Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. pH levels varied greatly over the sampling period, the lowest pH level recorded was 7.38 on September 30th and the highest pH level recorded was 8.92 on August 21st. The diurnal fluctuation was greatest during the August deployment period. The pH levels recorded in the Upper Estuary at the Highway 101 Bridge were not influenced by salt water intrusion. However, salt water intrusion did influence pH levels after the datasonde was moved downstream approximately 1 mile during the September deployment period. The datasonde was deployed on the bottom of the stream bed in September. As the salinity of the water increased pH levels decreased.

11.1.6.3.4 Salinity - Klamath River Upper Estuary

A complete record of salinity levels in the Upper Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. The datasonde in the Upper Estuary at the Highway 101 Bridge did not record salinity levels above 0.09 parts per thousand (ppt) during the June July and August deployment periods. Water with salinity levels of 0.5 ppt are considered to be freshwater and full strength salt water has a salinity of 35 ppt. However, salinity levels did increase after the datasonde was moved downstream approximately 1 mile during the September deployment period. The datasonde was deployed on the bottom of the stream bed in September. Salinity levels during the September deployment period varied greatly over the sampling period, the lowest salinity level recorded was 0.09 ppt on September 27th - 30th and the highest salinity level recorded was 25.86 ppt on September 29th. A salt wedge appeared to be present at this site for a duration of four hours during high tide on September 28th and 29th.

11.1.6.3.5 Water Temperature - Klamath River Middle Estuary Surface and Depth

A complete record of water temperatures in the Middle Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and operator error.

Water temperatures in the Middle Estuary at the surface varied greatly over the sampling period, the lowest water temperature recorded was 16.87° Celsius on September 30th and the highest water temperature recorded was 23.54° Celsius on August 20th. The water temperatures in the Middle Estuary

at the surface are comparable to the water temperatures recorded at the Upper Estuary in the middle of the water column. The water temperatures in the Middle Estuary at the surface were not influenced by salt water intrusion.

Water temperatures in the Middle Estuary at depth varied greatly over the sampling period, the lowest water temperature recorded was 13.60° Celsius on September 29th and the highest water temperature recorded was 23.40° Celsius on July 20th. The water temperatures in the Middle Estuary at depth were influenced by salt water intrusion intermittently.

11.1.6.3.6 Dissolved Oxygen - Klamath River Middle Estuary Surface and Depth

A complete record of DO concentrations in the Middle Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and operator error.

DO concentrations in the Middle Estuary at the surface varied greatly over the sampling period, the lowest DO concentration recorded was 6.24 mg/L on August 24th and the highest DO concentration recorded was 15.01 mg/L on July 20th. The DO concentrations in the Middle Estuary at the surface were not influenced by salt water intrusion.

DO concentrations in the Middle Estuary at depth varied greatly over the sampling period, the lowest DO concentration recorded was 6.03 mg/L on August 23rd and the highest DO concentration recorded was 10.86 mg/L on August 27th. The DO concentrations in the Middle Estuary at depth were influenced by salt water intrusion intermittently.

Due to the short duration of the deployment periods in June, July and September it is not believed that biofouling or electronic drift affected the DO probe's accuracy and precision. The DO probes were replaced half way through the two week deployment period in August to ensure that biofouling and electronic drift was not affecting the DO readings.

11.1.6.3.7 pH - Klamath River Middle Estuary Surface and Depth

A complete record of pH levels in the Middle Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and operator error.

The pH levels in the Middle Estuary at the surface varied greatly over the sampling period, the lowest pH level recorded was 7.63 on August 24th and the highest pH level recorded was 8.82 on August 18th. The diurnal fluctuation was greatest during the August deployment period. The pH levels in the Middle Estuary at the surface were not influenced by salt water intrusion.

The pH levels in the Middle Estuary at depth varied greatly over the sampling period, the lowest pH level recorded was 7.63 on August 25th and the highest pH level recorded was 8.82 on August 17th. The diurnal fluctuation was greatest during the August deployment period. The pH levels in the Middle Estuary at depth were influenced by salt water intrusion intermittently. As the salinity of the water increased pH levels decreased.

11.1.6.3.8 Salinity - Klamath River Middle Estuary Surface and Depth

A complete record of salinity levels in the Middle Estuary at the surface and depth was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and operator error.

The datasonde in the Middle Estuary at the surface did not record salinity levels above 1.61 ppt during the monitoring season.

The datasonde in the Middle Estuary at depth did record higher salinity levels than were recorded at the surface. Salinity levels were variable throughout the monitoring season. In June salinity levels stayed constant at 0.06 ppt. In July higher salinity levels were recorded intermittently at depth as the salt water intrusion extended up to the Middle Estuary. In August the salinity levels were higher than in July and occurred more often as the salt water intrusion extended into the Middle Estuary at depth. The Klamath and Trinity River pulse flow events caused salinity levels in the Middle Estuary at depth to be lower and to occur for a shorter amount of time. An error in programming the datasonde in the Middle Estuary at depth prevented YTEP from understanding what the salinity levels were during the September deployment period. All four measurements that were taken at 15 hour intervals detected salinity levels above 27.4 ppt. The lowest salinity level recorded was 0.06 ppt during the June deployment period and the highest salinity level recorded was 27.84 ppt on September 28th.

11.1.6.3.9 Water Temperature - Klamath River Lower Estuary Surface and Depth

A complete record of water temperatures in the Lower Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and equipment malfunction.

Water temperatures in the Lower Estuary at the surface varied greatly over the sampling period, the lowest water temperature recorded was 15.22° Celsius on August 17th and the highest water temperature recorded was 22.63° Celsius on July 20th. The water temperatures in the Lower Estuary at the surface were influenced by salt water intrusion intermittently.

Water Temperatures in the Lower Estuary at depth varied greatly over the sampling period, the lowest water temperature recorded was 12.20° Celsius on September 28th and the highest water temperature recorded was 18.67° Celsius on June 23rd. Water temperatures were influenced by salt water intrusion intermittently in the month of June and constantly during the months of July, August and September.

11.1.6.3.10 Dissolved Oxygen - Klamath River Lower Estuary Surface and Depth

A complete record of DO concentrations in the Lower Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and equipment malfunction.

DO concentrations in the Lower Estuary at the surface varied greatly over the sampling period, the lowest DO concentration recorded was 7.54 mg/L on August 24th and the highest DO concentration recorded was 14.18 mg/L on July 21st. The DO concentrations in the Lower Estuary at the surface were influenced by salt water intrusion intermittently. The salt water intrusion was greatest during the August deployment period.

DO concentrations in the Lower Estuary at depth varied greatly over the sampling period, the lowest DO concentration recorded was 4.56 mg/L on August 29th and the highest DO concentration recorded was 18.72 mg/L on August 29th. The DO concentrations were influenced by salt water intrusion intermittently in the month of June and constantly during the months of July, August and September.

Due to the short duration of the deployment periods in June, July and September it is not believed that biofouling or electronic drift affected the DO probe's accuracy and precision. The DO probes were

replaced half way through the two week deployment period in August to ensure that biofouling and electronic drift was not affecting the DO readings.

11.1.6.3.11 pH - Klamath River Lower Estuary Surface and depth

A complete record of pH levels in the Lower Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and equipment malfunction.

The pH levels in the Lower Estuary at the surface varied greatly over the sampling period, the lowest pH level recorded was 7.85 on June 21st, 22nd and August 24th and the highest pH level recorded was 8.60 on June 21st. The diurnal fluctuation was greatest during the June deployment period. The pH levels in the Lower Estuary at the surface were influenced by salt water intrusion intermittently in August. As the salinity of the water increased pH levels decreased.

The pH levels in the Lower Estuary at depth varied greatly over the sampling period, the lowest pH level recorded was 7.01 on September 29th and the highest pH level recorded was 8.67 on June 21st. The diurnal fluctuation was greatest during the June deployment period. The pH levels in the Lower Estuary at depth were influenced by salt water intrusion throughout the June – September deployment periods. The influence of high salinity levels on pH levels in the Lower Estuary at depth was not as clear as the other Klamath River Estuary monitoring sites.

11.1.6.3.12 Salinity - Klamath River Lower Estuary Surface and Depth

A complete record of salinity levels in the Lower Estuary was not collected. The following discussion will include information for the periods stated in Table 8-2. Gaps in the data during the deployment periods occurred due to equipment being stranded at low tides and equipment malfunction.

Salinity levels in the Lower Estuary at the surface were variable throughout the monitoring season. In June salinity levels were relatively constant and did not exceed 0.39 ppt. In July slightly higher salinity levels were recorded and did not exceed 2.22 ppt. In August the salinity levels were significantly higher than in July as the salt water intrusion intermittently reached the surface in the Lower Estuary. YTEP was unable to determine the effect that the Klamath and Trinity River pulse flow events had on salinity levels in the Lower Estuary at the surface because the datasonde's batteries failed. In September salinity levels were lower than in August and did not exceed 2.74 ppt. The lowest salinity level recorded was

0.07 ppt during the June deployment period and the highest salinity level recorded was 28.09 ppt on August 17th.

The datasonde in the Lower Estuary at depth did record higher salinity levels than were recorded at the surface. Salinity levels were variable throughout the monitoring season. In June salinity levels were the most variable with salinity levels ranging from 0.07 ppt to 28.09 ppt. In July higher salinity levels were recorded than in June and were relatively constant, ranging from 23.08 ppt to 28.57 ppt. In August the salinity levels were more variable than in July and ranged from 22.15 ppt to 31.29 ppt. The Klamath and Trinity River pulse flow events caused salinity levels in the Lower Estuary at depth to be lower and more variable. In September salinity levels were generally higher than in August and were less variable, ranging from 26.42 ppt to 31.08. The lowest salinity level recorded was 0.07 ppt on June 22nd and the highest salinity level recorded was 31.29 ppt on August 17th.

11.1.7 Grab Samples

11.1.7.1 Mainstem Grab Samples

Nutrient grab samples were performed within the YIR at monthly intervals in the Klamath River from June to September in coordination with the Karuk Tribe and USFWS. Nutrient samples were also collected in December and January in order to assess nutrient levels during winter months. YTEP also assisted the NCRWQCB in collecting nutrient grab samples in the Klamath Estuary and the Pacific Ocean from June to September. The samples were collected as part of the model calibration procedures for the TMDL process for the Klamath River.

11.1.7.1.1 Nutrient Grab Samples-All Sites

Nutrient levels in the lower Klamath and Trinity Rivers were at low levels or at levels that are below the lab reporting limits (see tables in Section 10.1.8). Nitrate was only detected in the Klamath River during winter months and was not detected above reporting limits in the Klamath Estuary during the entire monitoring season. Nitrite was not detected above reporting limits in every sampling event in the Klamath and Trinity Rivers and the Klamath Estuary.

Total Kjeldahl nitrogen (TKN) levels were not detected in the Klamath or Trinity Rivers in the winter or summer months with the exception of it being detected at the TG site on September 14 at 0.59 mg/L. TKN levels in the Klamath Estuary and Pacific Ocean were not detected with the exception of it being detected at levels slightly above reporting limits on August 31st and September 27th.

Ammonia nitrogen levels were not detected in the Klamath or Trinity Rivers in the winter or summer months with the exception of it being detected at the WE site on August 17th at 0.062 mg/L.

Ammonia nitrogen levels in the Klamath Estuary and Pacific Ocean were not detected with the exception of the September 27th sample event when it was detected at 0.065 and 0.072 mg/L at the LES and the MED sites, respectively. Reporting limit levels varied greatly for Nitrogen analytes throughout the monitoring season, inconsistent reporting limits hinder the ability to know if nitrogen exists at low levels in the lower Klamath River system.

Total phosphate phosphorus levels in the Klamath and Trinity Rivers were variable throughout the winter and summer months. Total phosphate phosphorus levels ranged from less than 0.020 mg/L to 0.22 mg/L. Total phosphate phosphorus levels increased over the monitoring season with the September levels being on average three times higher than the August levels.

Total phosphate phosphorus levels in the Klamath Estuary and the Pacific Ocean were variable throughout the monitoring season. Total phosphate phosphorus levels ranged from less than 0.020 mg/L to 0.55 mg/L which was detected in the Pacific Ocean on August 31. Total phosphate phosphorus levels increased over the monitoring season with the August 31st levels being on average four times higher than the August 24th levels.

Orthophosphate phosphorus levels in the Klamath and Trinity Rivers were variable throughout the winter and summer months. Orthophosphate phosphorus levels ranged from less than 0.010 mg/L to 0.071 mg/L which was detected at the WE site on September 14th. Orthophosphate phosphorus levels in the Trinity River were highest during the winter months. Orthophosphate phosphorus levels in the Klamath River increased over the monitoring season with the September levels being on average three times higher than the August levels.

Orthophosphate phosphorus levels in the Klamath Estuary and the Pacific Ocean were variable throughout the monitoring season. Orthophosphate phosphorus levels ranged from less than 0.010 mg/L to 0.043 mg/L which was detected in the Pacific Ocean on August 31. Orthophosphate phosphorus levels increased over the monitoring season with the August 31st levels being on average two times higher than the August 24th levels.

11.1.7.1.2 Minerals-All Sites

Calcium and magnesium levels in the Klamath and Trinity Rivers remained relatively constant over the winter and summer months. Magnesium levels ranged from 6,500 µg/L recorded at the WE site on June 10th to 9,000 µg/L recorded at the WE site on August 17th. Minimum calcium levels were 11,000 µg/L at the WE and TR site on December 17th and June 10th, respectively. The maximum calcium level recorded was 19,000 µg/L recorded at the TR site on January 22nd.

11.1.7.1.3 Bacteria-All sites

Bacteria levels in the Klamath and Trinity Rivers were variable throughout the winter and summer months. *E. coli* levels in the Klamath and Trinity Rivers ranged from 1.0 coliform forming units (CFU) which was recorded at the TR site on January 22nd to 23 CFU, which was recorded at the TC site on September 14th. *E. coli* levels in the Klamath Estuary ranged from less than 10 CFU which was recorded at multiple sites and dates to 52 CFU, which was recorded at the Klamath Estuary and KR > WTP sites on October 27th, 2004.

Strep. faecalis levels in the Klamath and Trinity Rivers during the winter months ranged from less than 1.0 CFU to 8.6 CFU which was recorded at the TG site on December 17th. *Strep. faecalis* levels in the Klamath Estuary ranged from less than 10 CFU which was recorded at multiple sites and dates to 31 CFU, which was recorded at the KR > WTP site on October 27th, 2004. All bacteria levels detected were below the Yurok Tribe's bacteria standards.

11.1.7.1.4 Other Analytes-All Sites

Alkalinity (measured as CaCO3 mg/L) levels during the winter and summer months in the Klamath and Trinity Rivers ranged from 53.0 recorded at the TR site on June 10th to 79 at the TC site on August 17th. Alkalinity levels were not measured in the Klamath Estuary.

BOD levels in the Klamath, Trinity Rivers and the Klamath Estuary and the Pacific Ocean were not detected above reporting limits with the exception of the Pacific Ocean site on August 31st which detected a BOD level of 2.3 mg/L.

Chlorophyll-a levels were variable during the winter and summer months in the Klamath and Trinity Rivers. Chlorophyll-a levels ranged from less than 0.1 mg/m³ recorded at multiple sites and dates to 1.1 mg/m³ recorded at the TG site on September 14th. Chlorophyll-a levels were variable in the Klamath

Estuary and the Pacific Ocean. Chlorophyll-a levels ranged from less than 0.1 mg/m³ recorded at multiple sites and dates to 19 mg/m³ recorded at the UEM site on September 27th.

Pheophytin levels were variable during the winter and summer months in the Klamath and Trinity Rivers. Pheophytin levels ranged from less than 0.1 mg/m³ recorded at multiple sites and dates to 2.2 mg/m³ recorded at the TC and WE sites on September 14th. Pheophytin levels were variable in the Klamath Estuary and the Pacific Ocean. Pheophytin levels ranged from less than 0.1 mg/m³ recorded at multiple sites and dates to 3.5 mg/m³ recorded at the PO site on July 22nd.

Non-filterable Residue or TSS levels were variable during the winter and summer months in the Klamath and Trinity Rivers. TSS levels ranged from less than 1.0 mg/L recorded at multiple sites and dates to 14.0 mg/L recorded at the TC and TG sites on December 17th and the TR site on January 22nd. TSS levels were variable in the Klamath Estuary and the Pacific Ocean. TSS levels ranged from 1.0 mg/L recorded at the LES site on August 24th to 64 mg/L recorded in the Pacific Ocean on August 31st.

TDS levels were variable during the winter and summer months in the Klamath and Trinity Rivers. TDS levels ranged from 70 mg/L recorded at the TR site on September 14th to 130 mg/L recorded at the WE site on August 17th. TDS was sampled for in the Klamath Estuary on September 27th, only. TDS levels ranged from 120 mg/L recorded at the UEM site to 21,000 mg/L recorded at the MED site.

TOC levels were variable during the winter and summer months in the Klamath and Trinity Rivers. TOC levels ranged from 0.69 mg/L recorded at the TR site on July 20th to 2.60 mg/L recorded at the WE site on September 14th. TOC levels were variable in the Klamath Estuary and the Pacific Ocean. TOC levels ranged from less than 0.30 mg/L recorded at multiple sites and dates to 1.9 mg/L recorded at the MES site on August 31st and September 27th.

11.2 Water Quality and Hydrology (Tributaries)

11.2.1 McGarvey Creek

11.2.1.1 Discharge

Discharge values were calculated using the rating curve produced by relating flow measurements taken in the field with gage height. Minimum, maximum, and average daily gage height measurements were used to compile statistical data for minimum, maximum, and average daily discharge, which are presented in Table 10-10, Table 10-11, and Table 10-12 (respectively). A new rating curve is compiled

annually for McGarvey Creek due to changing channel morphology at the gaging station. The rating curve for WY04 produced the following formula (
Figure 10-57):

$y = 1.7768x^{4.4016}$, where y = discharge in cfs and x = gage height

McGarvey Creek frequently experiences subsurface flows during the late summer downstream of the gaging station. Flows were subsurface at the beginning of WY04 until rainfall on 11/02/03 restored continuous flow (Figure 10-58). The highest flow measurement taken at McGarvey Creek during the water year was 250 cfs (Figure 10-58); therefore, the flows calculated above the maximum flow were extrapolated from the rating curve. Two storm events exceeded measured flows, and the estimates of these discharges should be considered with caution because they are only as robust as the rating curve is. In general, estimated flows exceeding 100% of measured flows are not to be considered accurate. The maximum estimated flow at McGarvey was 1372 cfs on 12/13/03.

11.2.1.2 Turbidity

Turbidity data was recorded intermittently in McGarvey Creek between November and January. Typically, turbidity is apparent during the winter months when storm events cause increased flows, turbulence, and mobilize small particles in the water column. The highest turbidity observation was 964 NTUs on 12/6/03 during the first significant storm event, which peaked at 160 cfs and served as the first flushing event of the season (Figure 10-59). The next storm event was the largest, peaking at 1372 cfs, but turbidity was only observed to reach 579 NTUs. During each successive storm event, peak turbidity observations were lower than the previous storm. During monitoring of rain events between 1/16/04 – 2/20/04, turbidity peaks were lower than previous storm events and never exceeded 166 NTUs (Figure 10-59).

11.2.1.3 Water Temperature

Water temperature data was recorded periodically between November and January at McGarvey Creek as part of turbidity and specific conductivity monitoring. Water temperature is not necessarily a parameter of concern in the winter, however the data can show the improvements in the watershed or lack there of over time when the data is paired with other parameters such as turbidity or sediment data. The lowest water temperature recorded was 6.06°C on at 0945 hours on 11/23/03. The highest water temperature recorded during monitoring was 11.11°C on 11/11/03 at 1700 hours (Figure 10-60).

11.2.1.4 Specific Conductivity

Specific conductivity was monitored intermittently in McGarvey Creek between November and January with temperature and turbidity. Conductivity is defined as the ability for a water body to conduct an electric current, and is directly related to temperature and the concentration of dissolved solids present in the water. Water in streams that is quickly transferred from rainfall to runoff tends to have a lower concentration of dissolved ions, resulting in a lower conductivity. Therefore, there is an inverse relationship between specific conductivity and the parameters of flow, precipitation, and turbidity. As winter storms occur, rainfall is quickly transferred into the streams, increasing discharge and turbidity and resulting in a decrease in specific conductivity.

Conductivity in McGarvey Creek was highest during November before water levels increased due to storm events. Drops in specific conductivity were observed during storm events on 12/04/03 and 12/07/03 and were inversely related to both discharge and turbidity (Figure 10-59).

11.2.1.5 Suspended Sediment

The suspended sediment samples collected represent only an instantaneous rate of sediment transport within the system. Samples at McGarvey Creek were collected using a DH-81 wadable sediment sampler. The highest SSC samples were collected on 2/18/04 near the peak of a storm event. The estimated flow measurement was 175 cfs and suspended sediment concentrations were 89.1 and 70 mg/L (Table 10-13). Samples taken on 12/11/03 and 1/29/04 ranged between 6.9 – 15.7 mg/L and were taken when flows were approximately 40 cfs (Table 10-13).

11.2.2 Blue Creek

11.2.2.1 Discharge

Blue Creek flows continuously throughout the year at the gaging station site. The estimated minimum daily flow was approximately 42.24 cfs between 9/26/04 and 9/30/04 (Table 10-14). The highest estimated flow for WY04 was 12,273 cfs on 12/13/03 (

Table 10-15). A typical water-year for Blue Creek may produce instantaneous flows near or over 11,000 cfs in the winter (USGS, 2004). The highest discharge measured at Blue Creek was approximately 3,970 cfs on 2/27/04. All discharge values above this are extrapolated from the rating curve and rating curve equation which was created using flow measurements during WY02 – WY04 and produced an R^2 value of 0.9817, indicating a strong relationship between flow measurements and gage height. The rating curve for all years (WY02 – WY04) was based on the following formula (
Figure **10-62**):

$y = 103.36x^{2.2346}$, where y = discharge in cfs and x = gage height

11.2.2.2 Turbidity

Turbidity data was recorded periodically during WY04 between November and early January to monitor winter storm events. Turbidity during base flows was below 10 NTUs, but increased during storm events. The highest peaks in turbidity occurred during storm events between 12/07/03 – 12/13/03 (978 NTUs) and 12/31/03 – 1/01/04 (405 NTUs)(Figure 10-64).

11.2.2.3 Water Temperature

Blue Creek water temperature was measured periodically through the winter with turbidity and specific conductivity and during the summer between 7/02/04 – 7/16/04. Temperatures between November and early January ranged between 6.28 – 12.01°C. July temperatures ranged between 13.64 – 19.67°C (Figure 10-65).

11.2.2.4 Specific Conductivity

Specific conductivity was measured periodically through the winter with turbidity and water temperature and during the summer between 7/02/04 – 7/16/04. The values ranged from 49.5 µS/cm to 160 µS/cm during winter monitoring and 114 µS/cm to 123 µS/cm between 7/02/04 – 7/16/04. Conductivity varied little during summer months since flows are consistent and the watershed receives little rain during this time; however, conductivity dropped significantly between November and December monitoring events due to rainfall. Rainfall decreases the concentration of ions in the water, therefore reducing conductivity (Figure 10-64).

11.2.2.5 Suspended Sediment

Samples at Blue Creek were collected using a D-74 sediment sampler suspended from a bridge using a crane on 12/9/03, 1/29/04, and 2/27/04. The bridge is approximately a half-mile downstream from the

gaging station and datasonde deployment site. All samples were taken on a descending limb of the hydrograph during a storm event. On 12/9/03 during a flow of 664 cfs, six EWI (equal width increment) samples were taken and ranged between 4.8 – 16.7 mg/L with a mean value of 7.91 mg/L. One duplicate sample was taken with a SSC of 5.6 mg/L (Table 10-17). On 1/29/04 a single grab sample was taken and SSC was analyzed at 7.6 mg/L. No flow was taken on 1/29/04, but estimated flow using our rating table curve was 2163 cfs. An EWI composite sample was collected on 2/27/04 after a flow measurement of 3970 cfs was taken and SSC was 5.51 mg/L (Table 10-17).

11.2.3 Turwar Creek

11.2.3.1 Discharge

Discharge was calculated using a rating curve produced by relating flow measurements to observed gage height. Minimum, maximum, and average daily gage height measurements were used to compile statistical data which are presented in Table 10-18, Table 10-19, and Table 10-20. A new rating curve was compiled for Turwar Creek during WY04 because the staff plate was moved to a new location. Seven flow measurements were taken during the year, ranging between 9.76 – 1070 cfs. Those flow measurements and corresponding gage height measurements produced the following rating curve for WY04: $y = 1.7768x^{4.4016}$, where y = discharge in cfs and x = gage height

Turwar Creek experiences subsurface flow approximately ¼ mile downstream from the gaging station and very low flows at the gaging station during the summer and fall months (Figure 10-66). The minimum estimated discharge recorded at the gaging station was 10.97 cfs between 9/8/04 – 9/11/04 (Table 10-18).

The highest flow measurement taken was 1070 cfs (Figure 10-67), therefore flows calculated above the maximum flow were extrapolated from the rating curve. Five storm events exceeded measured flows, and the estimates of these discharges should be considered with caution because they are only as robust as the rating curve is. Discharge estimates for 12/12/03 – 12/14/03 are not reported because stage height exceeded 5 feet, producing an estimated discharge exceeding 10,000 cfs. We believe this to be erroneously high and are working to be able to estimate highest peak flow at each gaging station to prevent data reporting errors.

11.2.3.2 Turbidity

Turbidity measurements were recorded using a DTS-12 turbidity probe deployed at the gaging station. Data was compiled between 10/1/03 – 6/25/04 until the probe was unable to be submerged underwater

due to low flows. Turbidity during late summer and early fall base flows remained below 1 NTU. The highest peak in turbidity occurred during a storm event on 12/13/03 (942 NTUs). Other storm events caused spikes in turbidity, but none exceeded 400 NTUs (Figure 10-69).

11.2.3.3 Water Temperature

Water temperature at Turwar Creek was recorded simultaneously with turbidity using a DTS-12 turbidity probe between 10/1/03 – 6/25/04. Temperatures during this time ranged between 7.10 – 18.40°C (Figure 10-70).

11.2.3.4 Suspended Sediment

Samples at Turwar Creek were collected using a D-74 sediment sampler suspended from a bank operated cableway at the gaging station site. All samples were EWI composites with the number of verticals samples varying between three and five. Two samples were collected on 1/27/04 during a storm event very close to the peak flow on the ascending limb of the hydrograph. Measured flow before collection of sediment samples was 1070 cfs, and SSC in the samples was 161 and 176 mg/L. Two SSC samples taken during the descending limb of the hydrograph of the same storm event on 1/28/04 were 13.3 and 33.3 mg/L. Suspended sediment samples were also collected on 2/17/04 near the peak of a storm event. Flow was measured at 996 cfs and SSC from the sample was 125 mg/L (Table 10-21).

11.3 Macroinvertebrate Sampling

Metric scores calculated using the California Stream Bioassessment Procedure can be used to describe macroinvertebrate community structure and determine disturbance status of a stream habitat. Two primary means of interpreting metric scores are to compare them to a reference site or to an Index of Biotic Integrity (IBI). A reference site should exhibit the least disturbed condition for similar size streams within the watershed. The test sites are then compared to the reference site and the degree of variation form the reference site can be used to interpret the degree of impairment. An IBI qualifies the metric score in terms of deviation form an unimpaired condition. For example, Fore et al. (1996), gave the following scores for Taxa Richness in second to fourth order Oregon streams: $< 40 = 1$ (strong deviation from expectation); 40-54 = 3 (moderate deviation from expectation); $> 54 = 5$(deviates little from expected condition).

A reference site or IBI are not currently available for the study area in question. A simple ranking system will be used to compare stream sample sites. Each stream site was ranked from least (1) to most

(8) disturbed based on the predicted response of the macroinvertebrate community as described by the metric.

Following is a brief description of metrics calculated for the YTEP samples which have proven to be useful in the Pacific Northwest (Fore et al. 1996; Karr and Chu 1999) and northern California (Harrington et al. 1999).

- *Taxa Richness:* A richness measure. The total number of distinct taxa in a sample. Reflects health of the community through measurement of the variety of taxa present. Generally increases with increasing water quality, habitat diversity, and/or habitat suitability (Plafkin et al. 1989).
- *EPT Taxa Richness:* A richness measure. The total number of Ephemeroptera (Mayfly), Plecoptera (Stonefly), and Trichoptera (Caddisfly) taxa present. These orders are considered generally sensitive to disturbance. Expected to decrease with human induced disturbance.
- *Percent Sensitive EPT Index:* A composition measure. Proportion of sample composed of Ephemeroptera, Plecoptera and Trichoptera taxa which have been assigned a tolerance value of 0 to 3. Expected to decrease with degraded habitat.
- *Percent Dominant Taxon:* A Tolerance/Intolerance measure. Percent contribution of the most numerous taxon present in a sample. A community dominated by relatively few taxa would indicate environmental stress (Plafkin et al. 1989). Expected to increase with stress.
- *Tolerance Value:* A tolerance/intolerance measure. A biotic index which evaluates tolerance of benthic macroinvertebrate to organic enrichment. Taxa tolerant of organic enrichment are also generally tolerant of warm water, fine sediment, and heavy filamentous algal growth (Wisseman 1996). Scale is 0 through 10, 0 being highly intolerant and 10 being highly tolerant of organic enrichment. The tolerance value is calculated as: TV=_(n_i t_i)/N, where n_i is the number of individuals in a taxon, t_i is the tolerance value for that taxon, and N is the total number of individuals in the sample. Value expected to increase with stressed environment. Tolerance values are from California Department of Fish and Game (2003) listed values, however are subject to modification as more data is gathered.
- *Shannons Diversity Index (H):* A diversity index is a mathematical measure of taxa diversity in a community. Shannons index accounts for both abundance and evenness of the taxa present. The proportion of taxa *i* relative to the total number of taxa (p_i) is calculated, and then multiplied by the natural log of this proportion (lnp*i*). The resulting product is summed across taxa, and multiplied by -1: ***H***=-_$p_i$lnp_i ; Diversity is expected to decrease with disturbance.

Karr and Chu (1999) consider relative abundance to be a poor candidate for use in stream monitoring because of the great natural variation that can occur. Low relative abundance during rapid flow may, in fact, be related to sediment input. The primary disturbance within the study streams is expected to be an increase in fine sediment. Fine sediment reduces the area of substrate available for colonization by macroinvertebrates. Areas of fine sediment in running water are unstable and do not allow a foothold for macroinvertebrates. Fine sediment also fills in areas around cobble substrates reducing usable habitat. Lenat et al. (1981), in North Carolina streams, found that during high flows the addition of sediment simply reduced the available habitat and therefore invertebrate density. Exposed cobble/rubble substrates act as refugia but the number of exposed surfaces is reduced by sediment input. Reduced species richness were an artifact of reduced sample size.

Lenat et al. (1981) also noted a stable sand community which developed during low flow conditions. This consisted of tolerant small grazers capable of rapid colonization and reproduction which utilized increased periphyton growing on the stable sand. Relative abundance and tolerance values would increase in stable sand.

11.3.1 ***Metric rankings***

The metric rankings are based on the metrics calculated from the benthic samples. Stream size, stream habitat conditions, and physical/chemical data were not available for consideration. When comparing stream sites, stream size is an important consideration. Streams of similar size (stream order) should be compared to evaluate disturbance conditions within those watersheds. A dissimilar invertebrate community would be expected from a fifth order, low gradient, open canopy stream compared to a second order, high gradient, closed canopy stream. Based on macroinvertebrate data, Blue Creek appears to be a larger, open canopy stream and the most dissimilar of the streams sampled. With that caveat, ranked metrics for samples from each stream site are given in Table 11-8.

Table 11-8 Stream sites ranked by metric scores (1 indicates least impairment)

	McGarvey	Tully	Turwar	W.F. Pecwan	E.F. Pecwan	Mettah	Roaches	Blue
Taxa Richness	7	4	8	1	3	5	2	6
EPT Richness	6	8	5	2	2	4	1	6
Sensitive EPT	2	7	6	1	4	3	5	8
% Dominant	5	6	8	4	2	3	1	7
Tolerance Value	1	7	3	2	3	5	6	8
Diversity Index	8	5	7	4	3	2	1	6
Mean Rank	5	6	6	1	3	4	2	8

The metric data indicate the WP1 samples contained benthic macroinvertebrates from habitat suggesting the least impairment. Mean stream site metric rankings following WP1 in descending order from least to most disturbed are: Roaches Creek, EP1, Mettah Creek, McGarvey Creek, Tully and Turwar Creeks, and Blue Creek.

Each site contained from 2 to 4 tolerant taxa (Wisseman 1996) while the EP1 samples had the highest number of intolerant taxa (6), followed by WP1 (4). and Roaches (3). Intolerant taxa can be considered indicator organisms; there presence or absence suggesting a least impaired to impaired site, respectively.

11.3.1.1 West Fork Pecwan Creek

WP1 had the highest taxa richness and % sensitive EPT taxa scores, and the second highest EPT taxa richness score. Highly intolerant taxa (Wisseman 1996) in the samples included the net-winged midge *Blepharicera* (Blephariceridae), the stoneflies *Paraperla* (Chloroperlidae) and *Doroneuria baumanni* (Perlidae), the caddisfly *Dolophilodes* (Philopotamidae), and 2 species of the mayfly *Drunella* (Ephemerellidae) *D. doddsi* and *D. pelosa* (these are not included in the taxa list since it goes beyond CSBP taxonomic level 1). Highly Tolerant taxa (Wisseman 1996) occurring in the samples include the riffle beetles *Optioservus* and *Zaitzevia* (Elmidae), the scud *Gammarus* (Gammaridae), and the snail *Juga* (Pleuroceridae).

11.3.1.2 Roaches Creek

Roaches Creek had the second highest taxa richness score and the highest ranking scores for EPT richness, % dominant taxon, and Shannon's diversity index. Intolerant taxa found in the Roaches Creek samples include the mayfly *Caudatella* (Ephemerellidae) and the stoneflies *Paraperla* and *Soliperla* (Peltoperlidae). Tolerant taxa in the Roaches samples include the beetles *Optioservus, Zaitzevia* and *Eubrianax edwardsi* (Psephenidae).

11.3.1.3 East Fork Pecwan Creek

The EP1 metric scores ranked either second or third except for the sensitive EPT index (4th). Intolerant taxa in the EP1 samples include the elmid beetle *Rhizelmis nigra* (Wisseman 1996 lists as Class 0 - generally intolerant taxa not commonly associated with mid-order streams), the mayflies *Caudatella* and *Cinygma* (Heptageniidae), the stoneflies *Yoraperla* (Peltoperlidae) and *Doroneuria baumanni*, and the caddisfly *Dolophilodes*. Tolerant taxa found in the EP1 samples include *Optioservus* and *Juga*.

11.3.1.4 Mettah Creek

The Mettah Creek sample metric scores generally ranked third to fifth, however the diversity index score was second highest among sample sites. Intolerant taxa found in the samples include *Caudatella* and *Dolophilodes*. Tolerant taxa include the beetles *Oreodytes* (Dytiscidae), *Optioservus* and *Zaitzevia.*

11.3.1.5 McGarvey Creek

The McGarvey Creek sample metric scores showed the highest ranking tolerance value but the lowest ranked diversity index and second lowest ranked taxa richness. The large number (129) of the heptageniid mayfly *Epeorus* (tolerance value = 0) contributed to the low tolerance value. This large number of *Epirus* and relatively low taxa richness contribute to the low diversity index score, also. Though *Epirus* is generally considered a positive sign a large number of a particular taxon may indicate an unbalanced habitat. Intolerant taxa in the McGarvey Creek samples include *Peripheral* and *Yoraperla*. Tolerant taxa in the McGarvey Creek samples include *Optioservus, Zaitzevia, Gammarus,* and *Juga*.

11.3.1.6 Tully Creek

The Tully Creek metric scores showed the lowest ranking EPT taxa richness, and second lowest ranked sensitive EPT index and tolerance value. No intolerant taxa were found in the Tully Creek samples however the midge *Boreoheptagyia* (Diamesinae: Chironomidae) might fit into this category (found in cool, clear mountain or glacier-fed streams (Oliver 1983)). Tolerant taxa found in the samples include *Optioservus, Zaitzevia*, and *E. edwardsi*.

11.3.1.7 Turwar Creek

Turwar Creek had the lowest ranking metric scores for taxa richness and % dominant taxon. One intolerant taxon occurred in the samples - *Caudatella*. Tolerant taxa include *Optioservus, Zaitzevia*, and *E. edwardsi*. The Turwar Creek samples also exhibited the lowest estimated relative abundance of any of the sample sites (796 individuals/9 ft.^{2}). Though the sampling technique is semi-quantitative general estimates of abundance can be made. The low estimated relative abundance may be associated with high sediment input (Lenat et al. 1981).

11.3.1.8 Blue Creek

Blue Creek metric scores ranked sixth to eighth for each of the primary metrics. Blue Creek showed the lowest sensitive EPT index and tolerance value of the sample sites. *Blepharicera* was the only intolerant taxon found in the samples. Tolerant taxa include *Optioservus, Zaitzevia*, the aquatic moth *Petrophila* (Pyralidae), and the net-spinning caddis *Cheumatopsyche* (Hydropsychidae). This is the only site where the latter two taxa, as well as the baetid mayfly *Acentrella* and the caddis *Brachycentrus* (Brachycentridae) were found. The occurrence of these taxa and the highest estimated relative abundance of the sample sites (4304 individuals/9 ft. ^{2}) suggest a larger, warmer, open canopy stream which may be an outlier among the sample sites.

11.4 Herbicide Monitoring

An independent laboratory, NCL, analyzed all surface water samples for atrazine (*EPA method 619*). In order to assure quality control for this project, a background sample and an equipment rinse blank were collected. NCL's reporting limit for atrazine, Method number 619, is 0.5 parts per billion (ppb). NCL reports any amount above 0.5ppb as a detection and any amount below as a non-detection. Results from NCL can be found in Table 10-24. Both the background sample and the equipment rinse blank showed no detections for presence of atrazine.

YTEP staff did not inspect atrazine applications in the Tectah Creek watershed. YTEP did not verify through tank sampling or pesticide use reporting that atrazine was actually used in the Tectah Creek watershed. Based on the information and results contained in this report, YTEP determines that during monitoring of the small unnamed tributary to Tectah Creek there was no presence of atrazine above 0.5ppb. Presence of atrazine in surface water below 0.5ppb is unconfirmed. The maximum contaminant level (MCL) for atrazine in California drinking water is set at 3ppb.

11.5 Notchko Weather Station

The Notchko RAWS was operational from October 1, 2004 to September 30, 2005. Notchko Weather data has been validated and reviewed according to the Yurok Tribe Air Program QAPP (January 2004).

In WY04, a total of 67.49 inches of rainfall were recorded at the Notchko RAWS. The highest monthly total and daily intensity both occurred in December 2004. A total of 22.18 inches of rainfall were recorded in December, making up approximately 32% of the total annual rainfall. On December 29th 4.76 inches of rain was recorded at the Notchko RAWS.

12 Cooperation with Outside Agencies

The Yurok Tribe regularly coordinates its water quality monitoring activities with outside agencies. YTEP specifically coordinates with agencies conducting water quality and hydrologic monitoring on the YIR and lower Klamath tributaries. Every effort is made to coordinate various sampling protocols, site location, data distribution and staffing. Those interested in data collected by partner agencies should contact the cooperating agencies listed below:

Karuk Tribe
Yurok Tribe Fisheries Program
North Coast Regional Water Quality Control Board
U.S. Geological Survey
California Department of Fish and Game
Humboldt State University, Professor Bob Gearhardt
U.S. Fish and Wildlife Service
Watercourse Engineering, Incorporated – collecting data for PacifiCorp

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Appendix A – Protocols, Methods, and Processes Utilized by YTEP during WY04

Included herein:

1. Protocol for the operation of the datasonde – Arcata Fish and Wildlife's Multi-Probe Maintenance and Deployment Protocol
2. Protocol for the collection of grab samples
3. Protocol for Macroinvertebrate Sampling – Rapid Bioassessment Protocol
4. Protocol for Flow Measurement
5. Protocol for Sediment Sampling
6. Protocol for Benthic Algae Sampling

Arcata Fish and Wildlife Service's 2004 Multiprobe Maintenance and Deployment Protocol

By

R. Turner and P. Zedonis

ARCATA FISH AND WILDLIFE OFFICE
U.S. Fish and Wildlife Service
1655 Heindon Rd
Arcata, California, 95521

May, 2004

The use of firm, trade, and brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Fish and Wildlife Service.

PURPOSE STATEMENT

The challenge associated with water quality monitoring is to collect data that consistently represents the environmental conditions (Ministry 1999). To be able to best represent these conditions, it is important to develop a thorough protocol to obtain comparable data. To ensure the collection of good data, a quality assurance/quality control (QA/QC) program must be incorporated into the plans.

This document is part of a continuing effort for the Arcata Fish and Wildlife Office (AFWO). Based on information learned from the literature, during trainings and in the field, our project has made efforts to continually improve our protocol based on the latest industry trends and most applicable field techniques. Our database development has driven our QA/QC practices and has yielded important information regarding the effectiveness of field techniques. This document was largely put together to assure that the different persons involved with the Water Quality Monitoring Project are consistent in the protocols that they use in the field. Specifically, this document covers protocols for the calibration and collection of continuous and spot data with multimeter probes (e.g. Hydrolab DataSondes and Quantas).

QUALITY ASSURANCE/QUALITY CONTROL

Two major components of QA/QC are accuracy and precision. Accuracy is how close the results are to a true or expected value. Instrument calibration is the necessary first step to assure accurate performance in the field. Precision, on the other hand, is the amount of agreement (or random error) among repeated independent measurements of the same parameter. Comparisons between instruments, whether in the field or laboratory, allow for an understanding of instrument precision. The protocol identified herein, describes techniques used to obtain accurate and precise data.

If you have not operated these instruments before, it is necessary that you spend some time reading the users guide, past reports, and practicing the calibration of the instrumentation. Demonstration of the instrumentation by veteran users is valuable and should be sought where available. As with any equipment, the knowledge you attain with the instrumentation will translate to collecting better quality data. Attention to detail with the calibration procedures is required in order to obtain good data quality and defensible results.

DATASONDE AND QUANTA UTILIZATION

Step 1: Is Your DataSonde Ready To Be Used?

Many things are necessary to consider before the start of the field season, upon receiving a DataSonde from the manufacturer, or pulling one out of storage. For example, how long since the pH reference solution was changed? If there is a low ionic strength reference probe, how old is it and should it be replaced? Is the gold cathode or the silver anode of the DO sensor discolored? These are but a few questions you must ask yourself before using the instrumentation. A thorough examination of the manufacturers recommended maintenance schedule will generally supply you with a list of things to consider. In some cases, previously collected data may provide some evidence as to where probes are starting to fail, allowing one to obtain a replacement probe early in the season. Making sure the instruments have met the maintenance schedules and are running correctly before the season starts serves as a first line of defense to help assure that data collection efforts are successful. AFWO regularly conducts a preseason comparison study that allows us to compare instrumentation together under the same conditions, prioritize probes needing replacement and promote general sonde

maintenance. The preseason instrument check further limits instrumentation failures in the field and prevent excessive bias from being introduced into the data.

Step 2: Preparation of the Instrument for Deployment

Study Sites, Housing and Security

The monetary value of the instruments and the importance of the data collected require that water quality instruments be secure when in the field. Study locations are chosen at the discretion of the researchers and must meet the study's objectives. In many cases, instrument placement includes considerations of vandalism, ecological effects, access, etc. An ideal site is one that is representative of the section of water being measured and has some object such as riparian trees, large boulders, bridge abutments or pilings that can provide a secure point of attachment for the equipment. Place the DataSonde in a 4"- 6" diameter perforated aluminum housing. Attach the housing to the object that is being used as a permanent anchor with a section of chain. Use locks, to ensure it is not removed from the tree or boulder, and so the sonde is not removed from the housing. Avoid sites that have frequent visitors and try to conceal the unit so it doesn't attract unnecessary attention. Care should be taken to avoid placement of the probe-end of the DataSonde in areas with silt or algae. Housings that include "legs" to maintain the sensor end above the substrate are useful in these situations. Additionally, wading upstream of a deployed DataSonde disturbs sediments or algae and should be avoided to prevent erroneous readings

Sampling Intervals

Based on protocol developed by the USGS, our water quality instrument deployment interval will be extended from one week intervals to two weeks in 2004. Based on the ability to correct for biological fouling and electronic drift, USGS showed that a two week interval was appropriate for sonde deployment in the Klamath River (Friebel, *Pers. Comm*, 2004). During the 2003 field season, protocol involved measurements at the end of the deployment that attempted to estimate the effects of biofouling. Through this process, biofouling was not shown to cause consistent error to any of the probes, regardless of the site or season sampled. Because of the longer deployment time planned for 2004, it is important to be able to service the sonde on the two week schedule and not allow for longer deployments.

Parameter Set-up

The Surveyor® data logger and display, used in conjunction with the DataSonde multiprobe, allows the user to set the DataSonde to record the desired parameters, calibrate the instrument, and download the sonde files. For specific methods on using the Surveyor, refer to the Surveyor 4 Water Quality Data Display User's Manual (Hydrolab, 1999).

When first hooking up the DataSonde to the Surveyor, set the date and time on the DataSonde. This step is crucial to maintaining consistent data throughout the season. Calibrate the DataSonde clock every field visit to maintain accuracy of the sonde.

All parameters and units to be measured should be set through the Surveyor to record in the following sequence. Enter each of these parameters separately and in the order they are to be displayed on the screen (from left to right). Parameters include: Date, Time, Temp (^{o}C), Specific Conductivity (µS/cm), pH, Dissolved Oxygen (mg/L), Dissolved Oxygen (% Saturation), and I Batt (internal battery level). This sequence provides all the data necessary for the database in the easily importable format.

File Creation

The creation of a file describes where an instrument will be placed, the time frame in which it will be deployed and extracted, and its recording interval. Define the file name by using the site abbreviation followed by the underscore symbol then the deployment date. For example, TR_070302 is a file that was deployed in the Trinity River on July 3rd, 2002. This pattern is important for accurate tracking and management of files. When setting the start time, make sure it is set on the half hour and there is enough time to get the unit in the water before the recording starts. The stop date should be set for at least a week past the date you expect to extract the unit. This gives the user time to reschedule an extraction in case of unforeseen circumstances. Stop time should be set for sometime after dark so that an extraction audit is not missed in the middle of the last day of the file. Set the instrument to record every 30 minutes; on the Surveyor this is an interval time of 003000. Set sensor and circulator warm up for 000200 to give the instruments two minutes to warm up before taking the recording. At this point, the file setup is complete.

Step 3: DataSonde Field Timeline

Upon arrival at each monitoring site, numerous tasks must be performed to successfully meet the QA/QC protocol and service the DataSonde. Properly filling out the calibration sheet is critical to collecting all the data that is needed for the evaluation of the sonde file. Here is an overview of a typical field tour consisting of extracting the sonde, performing scheduled maintenance, redeploying and returning the next day to calibrate for dissolved oxygen.

1. Arrive on site and acclimate pH and conductivity standards to ambient stream temperature in order to accurately post calibrate/calibrate the DataSonde. There are two possible methods to do this.
   - Method One: Collect water from the stream that is representative of the ambient stream temperature. Place the stream water, pH and conductivity buffers, as well as jugs of deionized water in a cooler to equalize the standards to ambient stream conditions. This acclimation procedure can take 15-30 minutes. Be very careful to have all lids properly capped so that buffers are not contaminated by stream water.
   - Method Two: place the standards and deionized water in a durable mesh laundry bag and secure it in the stream. This will allow for a more rapid heat transfer and more precise acclimation to stream temperature.
2. Record current barometric pressure at the site along with other environmental conditions, such as, weather, changing water levels, etc. Calibrate the Quanta if it has not been calibrated already. If it has been calibrated recently, adjust the dissolved oxygen (percent saturation) for current site barometric pressure and deploy next to the sonde at least five minutes before the half hour.
3. As close to the half hour as possible, record the Quanta information. Once the sonde has recorded on the half hour, carefully remove the sonde from the housing trying not to disturb any fouling on the probes.
4. Remove any water from the membrane and perform the post calibration of the DO probe. See the post calibration section for a detailed description of techniques.
5. Clean the rest of the probes and sensor area with alcohol and Kim wipes. Perform post calibration on the specific conductivity and pH probes using stream acclimated standards.
6. Perform file maintenance; download old file, back it up on a floppy disc and create a new file.
7. Change batteries before every deployment. Previously batteries were changed around every three weeks and missing data because of battery failure is not worth the risk of replacing once a month. Check clock and recalibrate if off by more than 10 seconds.
8. Replace the dissolve oxygen membrane. The DO membrane o-ring should be replaced once a month also.

9. Redeploy the DataSonde and obtain Quanta information at the time of the first half hour recording of the sonde.
10. The next day, return and calibrate for dissolved oxygen using the same technique as during the post calibration. Be sure to extract the DataSonde shortly after it records on the half hour. This will give you enough time to calibrate and return it to the water before the next reading on the half hour, allowing for a continuous data set for the other parameters. Redeploy the DataSonde and record Quanta information to obtain real-time information for all the parameters. The reading should be taken on the half hour and recorded into the audit section of the datasheet.

Step 5: Post Calibration/ Calibration

Calibration of the instrumentation in the field to a standard of known value is critical for accurate and precise measurements of the multiprobes. Post calibration of the instruments is similarly necessary to understand how the instrument is performing at the end of the deployment period. The post-calibration check is vital to the QA/QC process and provides a necessary evaluation of the instrumentation for the previous deployment. This check is required to estimate the electronic drift and for dissolved oxygen only, the effects of biofouling, of a dataset after instrument extraction. In the case of pH and specific conductivity, because the instrument has already been cleaned, the post-calibration also calibrates the instrument for the next deployment. The DO probe requires a separate calibration the following day. Because of the need for the overnight relaxation period after replacing the DO membrane, calibration occurs on the following day. Temperature probes do not undergo a weekly post-calibration process.

Consistently following the post calibration/calibration procedures outlined below will help ensure the data is of good quality. In addition, inconsistent application of a rigid protocol weakens the confidence of the data that in turn may inhibit the ability to draw any conclusions from the study. In general, when waiting for a parameter to stabilize, write down on the side or make a mental note of what the value is and when you check periodically, see whether it is still drifting one way or another. When the parameter stops drifting in one direction, it is a good sign that it is beginning to stabilize. This method works for any parameter you are calibrating for.

Dissolved Oxygen
Dissolved oxygen sensors are sophisticated electronic instruments that require frequent maintenance and delicate handling. Care should be taken so as to prevent the membrane from drying out, as well as protecting the instruments from sudden impacts, drastic temperature changes, and extremes of heat and cold.

Maintenance issues of the dissolved oxygen probe generally are associated with the membrane. The thin Teflon membrane is affected by biological fouling changing the permeability rate of the electrolyte solution through the membrane. Replacing the membrane and electrolyte solution every deployment should eliminate or limit any bias due to a change in electrolyte concentration. Accuracy and precision of dissolved oxygen data is not only dependent on the frequency of sampling and environmental conditions where the samples are being taken (e.g. eutrophic water), but also on the extended use of the instrument. It is necessary to regularly calibrate the DataSonde for dissolved oxygen. Calibrate for dissolved oxygen in mg/L based on DO % saturation at 100%. The US Fish and Wildlife Service uses a modified wet towel method, a water saturated air method, to calibrate the DataSonde for dissolved oxygen. The method is described below:

> *Modified Wet Towel Method:* Remove the field cup of the DataSonde or Quanta. Use the corner of a non-abrasive tissue such as Kim-wipe to absorb any water on the surface of the membrane.

Be careful not to remove any fouling material from the membrane at this time. Alternatively, allow the membrane to air dry if hot and dry conditions are present. Air drying may only take a few minutes and improves the accuracy of the biofouling estimate.
Place a small wet sponge in the bottom of the sensor area, wedging it between the probes while avoiding direct contact with both the DO membrane and the temperature probe. Replace the field cup and wrap the sonde in a white towel that has been soaked in water and gently wrung out so it is not dripping wet. The towel should cover the entire sonde and go around the sensor area at least twice. Make sure the field cup is completely covered with the towel to make sure the probe is in a 100 percent saturated environment. Allow the dissolved oxygen mg/L readings on the Surveyor to stabilize (about 10-15 minutes) and record the mg/L value as the initial reading. After you record the initial reading calibrate for Dissolved Oxygen % saturation by entering the current site barometric pressure from the Surveyor or a handheld barometer. Wait for the new value to stabilize then record the value in mg/L as the final reading. The difference between the initial and final reading will incorporate the effects of bio-fouling and electronic drift over the course of the deployment.

Calibration the following day is essentially the same as the post-calibration. Follow the same procedure and understand the initial and final values are really of no importance for all practical purposes, only that you wait until they are stable to achieve a proper calibration.

Specific Conductance
Calibration should occur with a standard that brackets the range of conditions expected in the field. A two-point calibration of zero to 447µS/cm is appropriate for most northern California freshwater systems. In the Klamath River this range of standards is appropriate for most sites except the highly conductive Shasta River where a 718 µS/cm standard should be used.

With the conductivity and pH solutions acclimated to the stream temperature, calibration can commence. Rinse the probes three times with DI water. Drain the calibration cup and dry the probe thoroughly. Calibrate the zero point for specific conductivity by doing the following in air. Record the initial reading for the air calibration then calibrate the DataSonde for specific conductivity in air by entering in the Surveyor 0.0 µS/cm. It is necessary to perform the air calibration on the instrument even when the instrument may initially read 0.0 µS/cm because this creates the start point for the slope equation to determine conductivity.

Follow this by rinsing sparingly three times with the standard solution. When rinsing, be sure to swirl the solution adequately to remove or continually dilute any residual DI water remaining in the calibration cup. Discard standards after each use. Fill the calibration cup with enough standard to cover the probe and allow a few minutes for readings to stabilize. After stabilization, record the value as the initial reading. Calibrate the DataSonde for specific conductivity by entering the standard solution value. Record the final value once the reading stabilizes again. Rinse the probes three times with DI water.
Used solutions from conductivity and pH calibrations should not be disposed of in the field but should be retained and disposed of appropriately.

pH

Calibration for pH is also performed in the field with buffers that have been allowed to reach ambient stream temperature. Use standards that bracket expected environmental conditions. For the Klamath River, pH standards of 7.0 and 10.0 are appropriate.

Rinse the calibration cup and associated probes three times with DI water. Rinse sparingly three times with pH 7.0 buffer that has been equilibrated to ambient stream temperature. Again, be sure to swirl the solution adequately to remove or continually dilute any residual DI water in the calibration cup. Fill with pH 7.0 buffer and allow the meter readings to stabilize. Record this as the initial value, which also is the post-calibration check, and then enter the buffer value of 7.0_ (varies based on temperature of the standard) into the laptop. Enter this as the final calibration value once it stabilizes. Now pH 10.0 must be calibrated. Repeat the same process this time switching to pH 10.0 buffer. Be sure to rinse with DI water and buffer three times before calibrating.

Water Temperature

Before and after the field season, it is pertinent to verify that the thermisters of each instrument meet the manufacturer's specifications. . Verification builds the researchers confidence that the data that has been or will be collected is of good quality; this may be especially true as the instruments age. The verification process takes place in a water bath and should span a temperature range that is representative of the field setting. This should be done both at the beginning and end of the field season; in multiyear studies this can be accomplished with one experiment. Verification studies conducted by the AFWO following the 2001 through 2003 field seasons found that all multiprobes were within $\pm$ 0.2°C when compared to a NIST thermometer. It is not possible to calibrate for temperature on a weekly basis although it is necessary to verify that the instruments are performing as specified. A check between the DataSonde and auditing Quanta will reveal differences that need further attention. In order to ensure a continuous record of water temperature throughout the season additional calibrated temperature probes (e.g. Optic Stowaways) should be placed at the study sites. These will also act to independently verify the sonde temperature's accuracy.

DATABASE DEVELOPMENT AND USE

Quality assurance and quality control extends from the time of data collection, all the way through the processing and reporting of the recorded data. To process the large amount of data that is generated from water quality monitoring, a Microsoft Access® database was created by the AFWO to summarize, manage, and critique information collected throughout the year. As part of this process, the database offers the capability to correct data and automatically provide graphics on water quality trends.

Data processing begins with receiving DataSonde data files and calibration records for each DataSonde deployment from cooperators and Service staff who participate in the monitoring program. Sonde files are converted into Excel®, then formatted and imported into Access. Calibration and audit records are entered and then double-checked to limit any data entry errors.

The post-calibration information for each file is required to correct bias of data (biological fouling and electronic drift). By entering this into the database, each file is automatically adjusted to correct for the effects of these variables.

Because of the vast size of the database, searching for values out of the expected range is best done through examination of graphics. Here points and trends can be found that do not fit into the realm of the expected or possible, identifying times for instance that an instrument may have been out of the water or malfunctioning.

DATA CORRECTION AND REPORTING

It is recommended that continuous water quality records be characterized by the accuracy of the data collected. AFWO uses multiple steps to evaluate the quality of the data sets and correct for any errors the probe may be encountering at the end of a deployment. In previous years, before we developed the ability to correct data automatically, grades were applied to each data set based on the post calibration comparison to standards (See Table 2). These grades (A, B, C or D) are based on previously determined expectations and determine the quality of each raw data set. By using these qualifiers, data sets that grade D are determined to not meet our standards and hint at improper calibration or post-calibration procedures of a malfunctioning instrument. The D datasets are not used for reporting purposes while all other files move forward towards the correction process. By finding the amount of biofouling and/or electronic drift at the end of the deployment, these values were then being applied to the data collected to correct for the drift as it occurred. Assuming that both of these types of drift increased in a linear fashion, the opposite of that drift is then applied back to each data point in the data set.

Table 2. Rating continuous records (adopted from USGS 2000)

Measured Physical Property	**QUALITY RATING**			
	A (Excellent)	**B (Good)**	**C (Fair)**	**D (Poor or No QA/QC)**
Water Temperature	≤ ± 0.2°C	> ± 0.2 to 0.5°C	> ± 0.5 to 0.8°C	> ± 0.8°C
Specific Conductance	≤ ± 3%	> ± 3 to 10 %	> ± 10 to 15%	> ± 15%
Dissolved Oxygen	≤ ± 0.3 mg/L	> ± 0.3 to 0.5 mg/L	> ± 0.5 to 0.8 mg/L	> ± 0.8 mg/L
pH	≤ ± 0.2 unit	> ± 0.2 to 0.5 unit	> ± 0.5 to 0.8 unit	> ± 0.8 unit
Percent Saturation [a]	≤ ± 3%	> ± 3% to 5%	> ± 5% to 8%	> ± 8%
Air Temperature [a]	≤ ± 0.2°C	> ± 0.2 to 0.5°C	> ± 0.5 to 0.8°C	> ± 0.8°C
Relative Humidity [a]	≤ ± 3%	> ± 3% to 5%	> ± 5% to 8%	> ± 8%

a – rating established by AFWO

Consider a situation where DO has no biofouling error but post calibrates at 98% of saturation. At the end of the file the last recording would be reading 2% lower than expected due to a combination of electronic drift and biofouling. The file which had 300 data points would have no correction for the first data point, each subsequent point in the data set getting a slightly increasing amount of correction, finishing with the full 2% correction to the last point.

For example: 2% / 300 recordings= 0.00667% cumulative error per recording interval.
We take the error per recording (0.00667%), and apply this correction to the second point, twice that value to the third point, three times that value to the next point, etc. This would lead to the full 2% correction by the final point of the file. This way the effects of both biofouling and electronic drift are increased slowly over the deployment period and corrected for appropriately.

Other facets of the QA process include collection of audit information with independent instrumentation that assists in determination of the accuracy of the datasets. These readings show real time water quality data and can be used to verify malfunctioning probes.

The volume of data collected along with the significant amount of QA/QC that is applied makes any program time consuming to produce quality data with defensible results. The evolution of the program over the years has incorporated the goal of increasing the quality of the data, providing for continual improvements in field techniques, analysis and reporting of data. At the same time, advances in database design have automated many of the processing and graphic design stages, allowing for quicker evaluation of data sets. This is an ongoing effort and thus becomes a dynamic process and document, changing as the industry standards change. Sharing this protocol with others in the field will provide insight and feedback that will hopefully produce valuable additional changes to ours and other programs that will better characterize the conditions that are present.

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2004 Grab Sample Protocol

Grab Samples

'Grab sampling' refers to water samples obtained by dipping a collection container into the upper layer of a body of water and collecting a water sample (USGS File Report -00213). Monthly grab samples are to be taken from June to October 2004 at select monitoring sites. For quality assurance/ quality control (QA/QC) purposes duplicate, blank, and spiked bottle sets were prepared and collected for one site each sampling period. These additional bottle sets were handled, prepared and filled following the same protocol used for regular bottle sets and samples. General water quality parameters were also measured with a Hydrolab Quanta during grab samples and recorded onto data sheets.

Upon arrival at each site, the sampling churn was rinsed three times with deionized (D.I.) water. The goal of rinsing is 'equipment decontamination – the removal from equipment, residues from construction and machining and the removal of substances adhering to equipment from previous exposure to environmental and other media' (USGS Open File Report 00213). After rinsing with D.I. water, the churn was rinsed three times with stream water. The churn is then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allowed for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guarantees the water is well mixed before the sample is collected. The churn should be stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second (Bel-Art Products, 1993). This mixing must continue while the bottles are being filled. If filling is stopped for some reason, the stirring rate must be resumed before the next sample is drawn from the churn. As the volume of water in the churn decreases, the round trip frequency increases as the velocity of the churn splitter remains the same. Care must be taken to avoid breaking the surface of the water as the splitter rises toward the top of the water in the churn.

Sample bottles and chemical preservatives used were provided by associated laboratories and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn 2-3 times before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples were placed in coolers on ice or dry ice for transport to contracted laboratories for analysis.

QA/QC – Duplicate, Spike and Blank bottle sets

To ensure laboratory and sampling accuracy, one site every sampling period was randomly selected to receive three additional QA/QC bottle sets. These bottle sets contain duplicate, spike, and blank water samples. Duplicate samples are obtained using the same process as regular samples. These are used to assure the laboratory maintains precision within results.

A limited bottle set containing 'spiked' samples is also collected. Known concentrations of the appropriate analyte are added directly to the bottle instead of sample water to provide a sample with known levels of the specified analyte. Data forms containing the known spike concentrations are kept to verify that the lab is attaining accurate results. Spike concentrations are determined based on past findings for each analyte. The spikes should be between 5 and 50 times the minimum detection limit or between 1 and 10 times the ambient level, whichever is greater (Eaton *et. al.*, 1995).

Blank sample bottles are utilized to assess accuracy of the analysis and verify that the sampling method or equipment does not influence the results. After collection of all other samples at the QA/QC site, the churn is rinsed three times with D.I. water before being filled with D.I. water. The blank bottle

sets are collected in the same way as other samples, except using D.I. water in place of stream water. Blank samples are collected after all stream water samples are taken and act as a final rinse to decontaminate the churn.

All bottle sets are then placed on ice and are transported to the associated laboratories. When necessary, dry ice was used for preserving samples. All grab samples were processed within 24 hours or within known laboratory holding periods.

Turbidity Samples

Turbidity samples are drawn directly from the flowing stream. The turbidity bottle should be rinsed with stream water three times before taking sample. Once the bottle has been rinsed, it is submerged and allowed to fill to the top, excluding air bubbles. Care should be taken to avoid the collection of surface water in the bottle. Once the bottle is filled, it is capped and placed into a cooler with ice and the other water samples.

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CALIFORNIA DEPARTMENT OF FISH AND GAME WATER POLLUTION CONTROL LABORATORY
AQUATIC BIOASSESSMENT LABORATORY REVISION DATE - DECEMBER, 2003
CALIFORNIA STREAM BIOASSESSMENT PROCEDURE

(Protocol Brief for Biological and Physical/Habitat Assessment in Wadeable Streams)
The California Stream Bioassessment Procedure (CSBP) is a standardized protocol for assessing biological and physical/habitat conditions of wadeable streams in California. The CSBP is a regional adaptation of the national Rapid Bioassessment Protocols outlined by the U.S. Environmental Protection Agency in "Rapid Bioassessment Protocols for use in Streams and Rivers" (EPA/841-B-99-002). The CSBP is a cost-effective tool that utilizes measures of the stream's benthic macroinvertebrate (BMI) community and its physical/habitat characteristics to determine the stream's biological and physical integrity. The purpose of this Protocol Brief is to introduce the techniques of bioassessment to aquatic resource professionals and help standardize data for statewide bioassessment efforts. The Protocol Brief is only a summary and does not contain all the necessary information that may be required to understand the concepts of bioassessment and to implement a successful monitoring program. Additional information and updates on bioassessment can be obtained by visiting the DFG Aquatic Bioassessment Laboratory website at www.dfg.ca.gov/cabw/cabwhome.html.

History of the CSBP
The CSBP was originally developed in 1993 to measure biological response from point-source discharges of chemical contaminants, inorganic sediment and elements of organic enrichment. The method was based on sampling the single richest habitat in a stream reach; this was the most common technique at the time (Rosenberg and Resh 1993, Loeb and Spacie 1994, Lenat and Barbour 1994) and consistent with the U.S. EPA's Rapid Bioassessment Protocols (RBP) (Plafkin et al. 1989). In 1995, the CSBP was adapted for use in ambient and non-point source pollution monitoring programs and this version was reviewed by a Technical Advisory Committee assembled by DFG and the U.S. EPA. The 1996 edition of the CSBP was widely distributed in California and accepted as the state's standardized RBP protocol (Davis et al. 1996 U.S. EPA 2002). A 1999 revision added quality assurance and control (QA/QC) techniques to ensure high quality field collections, laboratory analysis and taxonomic consistency.

As of 2003, the CSBP is the most often used RBP protocol in California (Barbour and Hill, 2003). This unique protocol allows the user to produce biological and physical/habitat data that can be used to measure differences between sites, compare to a regional Index of Biological Integrity (IBI) (Ode et al. 2003) and help diagnose response to individual stressors. In addition to the high gradient riffle based procedure, the 2003 edition of the CSBP describes techniques for use in unique channels and a technique for low gradient channels that blends elements of the CSBP with those of a multi-habitat technique recommended by the U.S. EPA (Barbour et al. 1999).

The CSBP 2003 has four notable changes to the existing protocol; 1) the stream reach for the assessment is no longer defined by a set of five pool-riffle sequences, but rather by a discreet length of 100 m (300 ft); 2) the area of benthos sampled has been reduced from 1.6 m2 (18 ft2) to 0.8 m2 (9 ft2); 3) although 3 independent samples will be collected at each reach, there is now an option to composite the 3 samples in the laboratory and reduce the total number of BMIs identified at each reach from 900 to 500; and 4) there is a new QA/QC procedure to collect a set of duplicate samples at 10% of the reaches for projects with more than 20 sites. These changes were based on experiences gained from several years of field testing, changes in the national RBP (Barbour et al.

1999), recommendations from Barbour and Hill (2003) and methods comparison studies conducted by DFG. Data collected with these modifications can easily be made compatible with previous CSBP data and these changes make the CSBP more consistent with other BMI protocols used in the western US.

OVERVIEW OF THE CSBP

The CSBP can be used to measure biological and physical/habitat condition in all freshwater lotic environments (streams and rivers) shallow enough to allow safe wading (¡Â1.5 m). The CSBP samples benthic macroinvertebrates with a 0.5mm mesh net from the richest habitat along 3 randomly selected transects within a 100 m (300 ft) reach of stream or river. The 3 transects are placed within shallow-fast water habitat (usually riffle) for high gradient channels and throughout the entire reach for low gradient channels. At each transect, three 0.09 m2 (1 ft2) areas of stream benthos are sampled and composited into a single sample. In low gradient channels, the 3 collections along the transect are selected to represent the relative proportions of the different richest habitat categories present (submerged vegetation, hard substrate of natural rock or concrete, soft substrate of sand or mud, stream bank vegetation and woody debris). Physical/habitat is measured using a qualitative U.S. EPA procedure throughout the entire reach and additional quantitative measures within the vicinity of the BMI samples. Taxonomic identification of the BMI samples is performed on a fixed count of 300 organisms from the 3 samples (total of 900 for the entire reach) or 500 from the composite of the 3 samples. There are two standard levels of taxonomic identification: one standardized for the state by the California Bioassessment Laboratory Network (CAMLnet; www.dfg.ca.gov/cabw/camlnetste.pdf) and a more precise level based on the U.S. EPA's Environmental Monitoring and Assessment Program (EMAP).

CALIFORNIA DEPARTMENT OF FISH AND GAME SCIENTIFIC COLLECTING PERMIT

Anyone who collects fish, amphibians, or invertebrates from the waters of the state must have a DFG Scientific Collecting Permit in their possession. The permit can be obtained from the DFG License and Revenue Branch in Sacramento (916-227-2225). Those conducting bioassessment in California should specify on the permit application that they will take freshwater invertebrates (authorization 5), incidental fish (authorization 6) and amphibians (authorization 8). It is also advisable to contact the local Game Warden and District Fisheries Biologist at the closest Regional Office prior to collecting.

FIELD PROCEDURES FOR COLLECTING BMI SAMPLES

The CSBP can be used to sample BMIs from all streams and rivers where the access and depth (¡Â1.5 m) do not require the use of a boat. The step-by-step procedures described in this document have been divided into three sections: high gradient channels, low gradient channels and considerations for unusual channel conditions. Contact DFG or visit the DFG Aquatic Bioassessment Laboratory website for more information on Rapid Bioassessment procedures for boatable streams and rivers and lentic or still water environments.

CSBP for High Gradient Channels

High gradient channels usually have greater than a 1% slope and will always contain pool-riffle sequences with a ratio high enough to contain at least 3 riffles per 100 m (300 ft) reach. Riffle substrate could be rock, sand or mud, but must be at least 1 m (3 ft) wide with flow velocities greater than 0.3 m/sec (1 ft/sec).

Step 1. Measure a 100 m (300 ft) reach of channel and count the number of riffles greater than 1 m (3 ft) wide and 1 m (3 ft) long. Randomly choose 3 of the riffles within the stream reach.

Step 2. Starting with the downstream riffle, place the measuring tape along the bank of the entire riffle while being careful not to walk in the stream. Select one transect from all possible 1/3 m (1 ft) marks using a random number table. For riffles longer than 10 m (30 ft), randomly place the transect within the top third of the riffle.

Step 3. Inspect the transect before collecting BMIs by imagining a line going from one bank to the other, perpendicular to the flow. Choose 3 locations along that line where you will place your net to collect BMIs. If the substrate is fairly similar and there is no structure along the transect, the 3 locations will be on the side margins and the center of the stream. If the substrate is structurally complex along the transect, then place the 3 collections to reflect it.

Step 4. Collect BMIs at the 3 locations along the transect by placing the D-shaped net on the substrate and disturbing an area as wide as the net and 1 ft upstream. Excavate the 0.09 m2 (1ft2) area to an approximate depth of 10-15 cm (4-6 in) by kicking or by using a tool to loosen the substrate. Pick-up and scrub large rocks by hand under water in front of the net. If the substrate is sand or mud, a hand rake can be used to prevent substrate from filling the net. Maintain a consistent sampling effort (approximately 1-3 minutes) at each area. Combine the 3 collections within the net to make one composite sample.

Step 5. Place the contents of the net in a standard size 35 sieve (0.5 mm mesh) or white enameled tray. Remove the larger twigs, leaves and rocks by hand after carefully inspecting for clinging organisms. If the pan is used, place the material through the sieve to remove excess water before placing the material in the jar. Place the sampled material in a jar and completely fill with 95% ethanol. Never fill a jar more than 2/3 full with course sampled material or 1/2 full with sand or mud. Gently agitate jars that contain primarily mud or sand to help mix the alcohol, taking care to not damage any organisms present.

Step 6. Place a label containing descriptive information about the sites (see box) in each jar. An additional label can be taped to the outside of the jar to help with the sample log-in process at the laboratory. A Chain of Custody (COC) should accompany the samples during transportation to the laboratory.

Step 7. Proceeding upstream, Repeat Steps 2 through 5 for the next two riffles within the stream reach.

Step 8. QA/QC Repeat Sampling Procedure. For projects with 20 or more sites, duplicate samples must be collected at 10% of the reaches. For reaches containing more than six riffles, randomly choose 3 riffles for the primary set of samples and randomly choose 3 more riffles for the duplicate set of samples. For reaches that contain 6 or less riffles, measure the entire length of all riffle habitat and randomly select 3 transects from the total length for the primary samples and randomly select 3 for the duplicate samples. For both methods, start at the downstream riffle or transect, proceeding upstream collecting the 6 samples designating them as primary or duplicate.

Bioassessment Sample Label
Project Name:
Site Name/Code:
County:
Riffle/Reach Number:
Transect Number:
Date/Time:
Sampled by:

Biological and Physical/Habitat Equipment List
Measuring tape (300 ft or 100 m)
D-shaped kick net (0.5 mm mesh)
Standard size 35 sieve (0.5 mm)
Wide-mouth 500 ml plastic jars
White enameled pan and forceps
95% ethanol
California Bioassessment Worksheet (CBW)
Physical/Habitat Quality Form
Chain of Custody Form (COC)
Random Number Table
pH, temp, DO and conductivity meter
Stadia rod and hand level or clinometer
Densiometer

CSBP for Low Gradient Channels
Low gradient channels usually have less than a 1% grade and will never have more than two riffles. These channels can be as deep as 1.5 m, but with low enough water velocity to allow safe wading. Channels greater than 1.5 m deep, with swift water velocities and/or which can not be accessed on at least one bank will require a boat.

Step 1. Measure a 100 m (300 ft) section of channel trying to avoid large human-made structures such as bridges or dams. The stream reach can be less than 100 m (300 ft) if access or obstacles are a problem, especially if the channel is morphologically homogeneous.

Step 2. Without entering the water, survey the entire reach for approximate percentages of 5 generalized habitat categories: a. submerged vegetation, b. hard substrate of natural rock or concrete, c. soft substrate of sand or mud, d. stream bank vegetation and e. woody debris. Record the proportions and make note if it was difficult to determine depth and habitat type (e.g. water was highly turbid).

Step 3. Determine how many 2 m (6 ft) intervals can be established along the entire length of the reach. Randomly select 3 of the intervals and using a range finder or measuring tape, locate the three points on the bank of the reach.

Step 4. Starting with the downstream point, establish a transect across the channel perpendicular to the flow. Sample BMIs at 3 locations along that transect, choosing areas representing the generalized habitats identified in Step 2. Collect BMIs by placing the D-shaped kick-net on the substrate or vegetation and disturb a 0.09 m2 (1 ft2) portion of habitat upstream of the kick-net.

Maintain a consistent sampling effort (approximately 1-3 minutes) at each site. Combine the 3 collections within the kick-net to make one composite sample. Note the 3 generalized habitats that were sampled along the transect on the field form.

Step 5. Place the contents of the kick-net in a standard size 35 sieve (0.5 mm mesh) or white enameled tray. Remove the larger twigs, leaves and rocks by hand after carefully inspecting for clinging organisms. If the pan is used, place the material through the sieve to remove excess water before placing the material in the jar. Place the sampled material and label (see box) in a jar and completely fill with 95% ethanol. Never fill a jar more than 2/3 full with course sampled material or 1/2 full with sand or mud. Gently agitate jars that contain primarily mud or sand to help mix the alcohol, taking care to not damage any organisms present.

Step 6. Place a label containing descriptive information about the sites (see page 4 box) in each jar. An additional label can be taped to the outside of the jar to help with the sample log-in process at the laboratory. A Chain of Custody (COC) should accompany the samples during transportation to the laboratory.

Step 7. Proceeding upstream, Repeat Steps 4 and 5 for the next two transects within the reach. Try to choose generalized habitats for the 9 collections (3 areas along 3 transects) in proportion to what was determined in Step 2.

Step 8. QA/QC Repeat Sampling Procedure. For projects with 20 or more sites, duplicate samples must be collected at 10% of the reaches. After determining how many 2 m (6 ft) intervals can be established along the entire length of the reach, randomly select 3 of the intervals for collecting the primary samples and randomly select 3 more intervals for the duplicate samples. Starting with the downstream transect, proceed upstream collecting the 6 samples and designating them as primary or duplicate.

PROTOCOL CONSIDERATIONS FOR UNUSUAL CHANNEL CONDITIONS
CSBP

For Intermittent or Ephemeral Channels: Intermittent or ephemeral channels will have flowing water during the rainy season and be dry during mid to late summer. These channels can be sampled using the CSBP for high or low gradient streams, but must be sampled in a spring (March through May) index period or at the end of the wet period.

CSBP for No Flow Conditions in High and Low Gradient Channels: Although this is very problematic for sampling BMIs, sometimes sampling areas in high gradient streams have pocket water with little or no flow. In this case, put the net at the downstream portion of the sampling area, disturb the substrate and push the water into the net with vigorous hand motions. Strained water from the surface of a nearby pool with a bucket can be used to move organisms into the net by pouring the water into the pocket area in front of the net. In low gradient channels, low flow or no flow conditions can be quite common. In this case, put the net downstream of the sampling area, get in front of the net and agitate the substrate with a twisting foot motion for 30 seconds. At 5-10 second intervals throughout the agitation, step aside and swiftly move the net in a ¡°figure eight¡± motion through the cloud of suspended substrate.

CSBP for Bifurcated or Braided Channels: Low gradient channels can have two or more channels flowing through a typically wide riparian corridor. There is no need to extend the transect through islands or sand bars separating these bifurcated or braided high gradient channels. Use the

standard procedure for sampling the dominant channel or randomly selected one channel if there are more than 2 similar channels >1 m (>3 ft) wide.

CSBP for Channels <1 M (3 ft) Wide: (the Spot-Sampling¡± modification): High gradient channels <1 m (<3 ft) wide can not be sampled using the 1/3 m (1 ft) wide D-frame net at three places along the transect. In this case, divide the channel into an upper, middle and lower section, relative to the flow. Each section should be approximately 30 m long, but could be divided by natural breaks in the morphology of the channel. Survey each section, without stepping into the channel for all 0.09 m2 (1 ft2) areas where the substrate and flow resemble a riffle. Randomly select 3 of these sampleable areas in the lower section and composite them into one sample. Proceed upstream and repeat for each section.

CSBP for Large Boulder Channels: High gradient channels that are dominated by boulder substrates too large to move, but with enough gravel substrate in patches between the boulder can be sampled similarly to the previous modification. After dividing the channel into three sections, count the patches of substrate small enough to sample and randomly select three patches. Composite the three samples and proceed upstream to sample the next two sections.

CSBP for Channels Immediately Below Water Impoundments: High gradient channels immediately below a water impoundment structure that prevents gravels and fines from moving downstream will often not contain shallow-fast water habitats with gravel or cobble substrates. These channels can be sampled either using the modification for large boulder channels or by using the low gradient procedure where 3 transects are chosen randomly from the entire reach.

CSBP for Cement Channels: Cement channels in urban areas will typically have uniform shape and depth with no natural habitat. These channels should be sampled using the low gradient protocol of 3 randomly selected transects along 100 m (300 ft) of channel. The 3 collections can be simply taken from the left margin, center and right margin of the channel. Try to avoid human made habitats such as shopping carts and other transient debris.

CSBP for Channels with Gradient Controls: Some low gradient urban streams will have low level dams to control the gradient. The channel will be transformed into small impoundments separated by extremely high gradient sections of large boulders to dissipate the energy. Do not sample the high gradient sections. Sample the impounded areas using the low gradient protocol or if the impoundments are too deep to wade, sample along the littoral zone of one bank. Divide the bank into upper, middle and lower sections, randomly pick three points at 1 m (3 ft) intervals and at each point, take a 0.09 m2 (1ft2) sweep through the vegetation trying to disturb the sediment if present. Composite the 3 collections and repeat for each section.

CSBP for Channels with Three or Fewer Riffles: High gradient channels that are wider than 1 m (3 ft), but have 3 or fewer riffles within the 100 m (300 ft) reach will not allow for an independent sample from several riffles. In these cases, measure the entire length of all riffle habitat and select the 3 transects randomly from the total length.

CSBP for Channels with Continuous Riffle Habitat: Stream reaches (usually very high gradient) that have continuous riffle habitat should be sampled using the low gradient procedure where 3 transects are chosen randomly from the entire reach.

CSBP for Channels with Transitional Gradient: Large watersheds can have wide channels where the gradient transitions from high to low. Riffle pool sequences can be present, but further apart than in higher gradient channels. In these cases, expand the reach length to 40 times the average width to allow for an adequate number of riffles to sample. If riffle habitat is limited to one or two riffles in a greater than 100 m (300 ft) transitional gradient reach, then consider the riffle to be hard substrate and use the low gradient procedures.

FIELD PROCEDURES FOR MEASURING CHEMICAL AND PHYSICAL/HABITAT QUALITY

The EPAs physical/habitat scoring criteria is a nationally standardized method (Barbour et al. 1999). It is used to measure the physical integrity of a stream and can provide a stand alone evaluation or used in conjunction with a bioassessment sampling event. DFG recommends that this procedure be conducted on every 100 m (300 ft) reach as part of a bioassessment program. A detailed description of the scoring criteria is available through the DFG Aquatic Bioassessment Laboratory website. This procedure is an effective measure of a stream¡¯s physical/habitat quality, but can produce inconsistent measures if QA/QC measures are not regularly implemented. This procedure requires field training prior to its use and field audits throughout the program.

The following list of quantitative measures of chemical and physical/habitat characteristics are considered minimal and should be measured when rapid bioassessments are not part of an existing chemical or fisheries habitat program where a more extensive list of parameters are measured. The information produced from measuring chemical and physical/habitat characteristics can be used to classify stream reaches and to help explain data anomalies.

Reach-Wide Parameters:

- GPS coordinates at the top and bottom of the reach
- Water temperature, specific conductance, pH, alkalinity and dissolved oxygen at the center of the reach using approved standardized procedures and instruments
- Reach length, average width and gradient
- Visually estimated substrate composition using the following categories: fines (<0.25 cm) (<0.1in.), gravel (0.25-0.8 cm) (0.1-2 in.), cobble (0.8-25 cm) (2-10 in.), boulder (>25 cm) (>10 in.) and bedrock (solid)

Sample Site Specific Parameters:

- Average length, width and depth for each of the 3 randomly chosen riffles (for unmodified high gradient protocol only)
- Water velocity immediately upstream of the three composite samples along each of the 3 transects
- Percent cover upstream of the three composite samples along each of the 3 transects. Measure this parameter using a densiometer 1/3 m (1 ft) above the water surface and averaged for each transect
- Substrate consolidation at the three sample excavations along the 3 transects. Estimates are obtained while collecting the BMI sample by noting whether the substrate is loosely, moderately or tightly cemented
- Pebble count and percent embeddedness immediately upstream of the 3 transects where BMI samples were collected. Measure this parameter by establishing a transect approximately 1/3 m (1 ft) upstream of the sample transect, randomly choosing 10 points along the transect, reaching down to the point at the end of a wooden dowel or tip of the boot and measure the

width of the particle. For every third particle (3 on each transect), estimate percent embeddedness by noting how much of the particle was surrounded by fine substrate.

LABORATORY PROCEDURES FOR ANALYZING BMI SAMPLES

DFG recommends that taxonomic identification of BMI samples collected using the CSBP is performed by a professional or permanent university laboratory with extensive experience with California taxa. These bioassessment laboratories should participate in the California Bioassessment Laboratories Network (CAMLnet) to ensure that they are aware of the standardized level of taxonomy and QA/QC procedures recommended for bioassessments conducted in California.

To ensure a high quality product, all contracts to a bioassessment laboratory should require:
1. A Laboratory Standard Operation Procedure (SOP) document and Quality Assurance Protection Plan (QAPP)
2. A list of all taxonomists that will work on the samples including their education, years of experience and any specialized training they have received.
3. Internal QA/QC documentation for sub-sampling and taxonomic validation (can be specified to provide this information upon request);
4. Be able and willing to perform taxonomy consistent with the CAMLnet Taxonomic Effort Standards (www.dfg.ca.gov/cabw/camlnetste.pdf).

Project managers are encouraged to subject all laboratory data to an external review by an independent laboratory at the rate of 10% to 20% (depending on experience and nature of the project) of the project samples. The DFG Aquatic Bioassessment Laboratory performs this QC procedure and can be contacted about information on the procedure requirements and costs.

Taxonomic Level of BMI Identification

There are two levels of taxonomic identification for samples collected using the CSBP. It is the ultimate responsibly of the contractor or project manager to guarantee that the level of taxonomy reported is consistent with the CSBP standards.

CSBP Level 1 is used for most state-wide rapid bioassessment projects and it is imperative when comparing data to the Southern California IBI. In general, Level 1 taxonomic effort is to genera where possible for most taxonomic groups, order for oligochaetes and family for chironomids.

CSBP Level 2 is based on the taxonomic effort levels established by the U.S. EPA for the Western Pilot EMAP. In general, Level 2 taxonomic effort identifies insects to species level where possible and the Dipteran Family: Chironomidae to genus.

Compositing Samples or Data

There will always be 3 samples collected at each sampling reach when using the CSBP. Depending on the objectives of the project, the samples can be processed as individual samples and subsampled for 300 organisms/sample (900 organisms total per site) or composited at the laboratory and subsampled for 500 organisms.

Subsampling

The CSBP requires fixed count subsampling with a +/- 10% accuracy. The total count of BMIs must come from at least 3 randomly selected grids within a subsampling tray. The last grid must be fully

counted to get an estimate of relative abundance. The debris from processed grids should be put in a clean remnant jar and the remaining contents of the tray should be placed back into the original sample jar. If a large and rare survey is preformed on the sample, it should be conducted after the subsampling procedure and counted separately.

Data Production, Storage and Analysis

DFG has developed a Microsoft Access database based loosely on the U.S. EPA's Environmental Data Analysis System (EDAS). The structure of the CalEDAS database is available through the DFG Aquatic Bioassessment Laboratory website, but it does not currently come with end-user support. Whether using the DFG database or other software, the laboratory analysis should produce a BMI taxa list that is consistent with CAMLnet (see above) for all samples and a list of common or project specific biological metrics. Many common biological metrics are listed in the U.S. EPA's RBP document (Barbour et al 1999) and several other sources of bioassessment literature. When BMI samples are processed independently, there are two options for calculating metrics depending on the needs of the project:

1. Calculate metrics for all three samples independently and calculate metric averages at each site
2. The three samples can be composited in the analysis stage, and a 500 count subsample of the 900 organisms can be used to generate one set of cumulative metrics for each site.

QA/QC CONSIDERATIONS FOR USING THE CSBP

All private and public entities conducting bioassessment using the CSBP should have a Standard Operating Procedures document (SOP) and a Quality Assurance Protection Plan (QAPP). Large programs and laboratories can have a quality assurance officer and some smaller operations may only have a field or laboratory supervisor. In either case, those individuals responsible for assuring the quality of samples collected in the field and processed in the laboratory should be trained on all aspects of the CSBP. Two 3-day courses on bioassessment concepts and the use of the CSBP are available through the American Fisheries Society (CalNeva AFS) and the Society of Environmental Toxicology and Chemistry (NorCal and SoCal SETAC). Information on these courses can be found at www.slsii.org

The details of a QAPP should be tailored for particular bioassessment operations. Depending on the nature of the project, appropriate boiler plate for QAPPs may be available through Regional Water Quality Control Boards or the State Water Resources Control Board. These agencies should be contacted before developing a QAPP and initiating a bioassessment program.

REFERENCES USED IN THIS DOCUMENT

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Measuring Stream Discharge with the AquaCalc and the Price AA or Pygmy Meter

Field SOP
10/16/02

Attaching the Flow Meter to the Wading Rod

1. Remove the flow meter from its storage case
2. Attach the flow meter to the wading rod by slipping the flow meter attachment end over the wading rod nub and tightening the screw on the flow meter with a straight slot screwdriver. **(Making sure the flow meter is perpendicular with the flow meter)**
3. Attach the electrical wire that is connected to the wading rod to the flow meter and tighten the nut gently with a pair of pliers

Attaching the AquaCalc to the Wading Rod

1. Remove the AquaCalc from its storage case
2. Attach the AquaCalc to the top of the wading rod with the Velcro
3. Attach the AquaCalc's 8 pin connector "pig tail" to the cable that is mounted on top of the wading rod

Field Testing the Instrumentation

1. Turn on the AquaCalc and hit **Enter** when the Date and Time is displayed
2. Press the **go to Transect #** and enter an unused and available transect number
3. Hit the **Next Observe** key to select any observation but #1
4. Spin the cups on the current meter and press the **Measure** key
5. The timer will immediately start and then restart after the first revolution of the cups. After the first revolution, the counter will show revolutions.
6. Visually count the revolutions
7. Compare this to the amount counted by the AquaCalc
8. If the AquaCalc does not match you visual count refer to the *Troubleshooting* chapter in the owner's manual

<u>Spin Testing the Flow Meter</u>

1. Give the current meter a rapid spin in still air and record the time until the cups stop spinning.

USGS spin tests for Price Type AA and Pygmy meters are shown in the following table:

Meter	Normal Spin	Minimum Spin
Price "AA"	4 min	1.5 min
Pygmy	1.5 min	0.5 min

Measuring stream discharge across a transect

(This SOP will be set up to perform a simple 6 tenths wading measurement, good for stream depths below 2.5 feet. For streams with a depth greater than 2.5 feet consult the Owner's Manual for changing the AquaCalc setting to calculate the 2 tenths and 8 tenths measurements.)

1. Secure the tape measurer or Kevlar tag line to one side of the stream bed (trees work good or use a metal stake)
2. Carefully walk across the stream and secure the tape or tag line on the other side of the stream bed so that the transect is perpendicular to the stream.
3. Determine what the stream width is and divide by 25
4. This will determine what your sampling interval will be
5. Turn on the AquaCalc
6. Press the **Go To Transect #** key and select the Transect # that has been assigned to the stream you are measuring at (see cheat sheet on back of AquaCalc)
7. If there are existing measurements in the rest of the transect's stations, you can erase them by pressing and holding the **Erase** key for three seconds while in Observation #1.
8. Repeatedly press the **Previous Observe** key to go to Observation #1 in the AquaCalc
9. Enter the Gage Height and the Staff Height into the AquaCalc. (For these purposes the stage height displayed on the data logger at the gaging station will be used for the gage height and the water level at the graduated Staff plate will be the staff height.)
10. Press the **Menu** key
11. Press the **Enter** key to scroll to Set Gage HT.
12. Press the **+/-** key and enter the height displayed on the data logger.
13. Press the **Enter** key
14. Press the **+/-** key and enter the water height on the graduated Staff plate
15. Press the **Enter** key
16. Select Meter Type (Pygmy ST2 for depths <1.5ft, Price AA 1:1 ST2 for depths >1.5 ft)
17. Establish the Edge-of-Water (EOW) in the AquaCalc. No measurements can be made at Station #1. Just press the **Set Distance** key and enter the number that is on the measuring tape or tag line that coincides with the EOW
18. If you are at a wall or a vertical bedrock edge, enter the depth at the wall by pressing the **Set Depth** key and entering the stream depth from the top of the water to the bottom of the wall and then press the **Enter** key **(do not press the Measure key at this observation point)**
19. Press the **Next Observe** key to move to Station #2.
20. Move to your first measurement location in the stream.
21. Press the **Set Distance** key. Enter the distance from the measuring tape or tag line.
22. Press the **Set Depth** key (by pressing the Set Depth instead of Enter the AquaCalc will automatically enter the distance and ready the AquaCalc to accept the Depth) Enter the depth of the stream at your location
23. Push the rubber button on the wading rod handle that will allow you to adjust the flow meter to its correct height. Slide the rod up or down to match the rod height inscribed on the wading rod handle with the correct stream depth.
24. Press the **Measure** key. The AquaCalc will immediately start counting revolutions after the first revolution and display the running mean velocity.
25. When the AquaCalc has satisfactorily completed its measurement the **Measurement Complete** screen will appear, showing counts, elapsed time and velocity for the measurement.
26. Press the **Enter** key to continue
27. Press the **Next Station** key to move to the next station
28. Move to your next measurement location and repeat the previous steps for each station in the transect

29. After completing the measurement at the last station, press **Next Station** key and enter the ending EOW location as read on the tape or tag line and input a depth of zero.
30. In the case of ending the transect at a vertical wall or bedrock, enter the ending distance at the wall and the depth at the wall as usual, but ***add a station following the wall with a depth of zero.*** The distance you enter in this next station is not critical, so long as it is greater than zero. It is helpful to use a distance beyond the closing wall location.
31. Press the **Calculate Discharge** key and record this number in the logbook in the gaging station box
32. Enter the ending Gage Height and the Staff Height into the AquaCalc. (For these purposes the stage height displayed on the data logger at the gaging station will be used for the gage height and the water level at the graduated Staff plate will be the staff height.)
33. Press the **Menu** key
34. Press the **Enter** key to scroll to Set Gage HT.
35. Press the **+/-** key and enter the height displayed on the data logger.
36. Press the **Enter** key
37. Press the **+/-** key and enter the water height on the graduated Staff plate
38. Press the **Enter** key
39. Turn off the AquaCalc by holding down the **OFF** key for a couple of seconds
40. Detach the AquaCalc and current meter from the wading rod and put them in their protective cases
41. Do not close the lid on the current meter so it can air dry, when you return to the office rinse with tap water and dry off with the supplied yellow cloth

SUSPENDED SEDIMENT DATA COLLECTION PROTOCOL
NON-WADABLE SAMPLE USING A US-D-74 SAMPLER AND B-REEL

1. Sites should be established prior to planned storm sampling, with site selection considerations based on access, local hydraulics, and high-flow sampling access. If possible, have a fiberglass tape left at sampling section so that same stations are used each time.

2. Upon arriving at site, record gage height and time (24hr clock).

3. Determine if it is safe to collect depth-integrated sample (DIS) or only a grab sample.

4. Fit quart bottle into sampler and make sure it is properly seated. Attach ¼" nozzle to sampler and make sure it is not clogged.

5. Calculate maximum transit rate for ¼" nozzle and quart bottle using the following formula:
   Maximum Velocity in Transect (ft/sec) x 0.4 = Maximum Transit Rate
   For example: If the swiftest part of your transect is 7ft/sec (as determined by taking a flow or estimation), your maximum transit rate (the fastest rate at which you would lower/raise the US-D-74 through the water column) would be 7 x 0.4 = 2.8ft/second.

6. Divide stream into 8-20 verticals for Equal Width Increment (EWI) method. Collect samples at mid-point of verticals in each width increment.
   For example: If your cross section is 80 ft wide and you are taking 10 verticals, your sampling increment will be 8 ft. Therefore, take samples at 4 ft, 12 ft, 20 ft, etc.

7. Attach D-74 to B-Reel (either operated from cableway or crane). Lower sampler vertically into flow at a uniform rate, not to exceed maximum transit rate, reversing immediately upon touching bottom. Raise sampler at same rate as lowering.

8. Check fullness of sample bottle regularly during high flow events, as it fills up quickly. If the sample bottle is more than 90% full after a single vertical, discard sample, rinse bottle, and collect a new sample at a slightly faster rate. If the sample bottle is less than 60% full, repeat the sample collection at the next vertical. If the sample bottle is between 60 – 90% full, remove and replace with new bottle. Multiple bottles can be used to collect a single cross channel sample. Sample bottles will be composited in the lab.

9. Every 10 samples, a second pass at the same site should be made (10% of the samples with have a replicate) using identical stations or procedures. The purpose of the replicate is for Quality Control documentation.

10. Remove and label (Sample ID and Vertical Location along Transect) each sample bottle. Tightly cap sample bottle. Store in ice chest or refrigerator until transferred to lab for processing.

11. Record the following information for each sample in your field notebook and on the datasheet: Site, Date, Time, Gage Height, Sampler used (DH-48), sample type (EWI or grab), # of verticals sampled, stations sampled if tape is available, Assigned Bottle Name or Number (usually GageName_Date), # of bottles (if multiple bottles are used), Discharge Measurement (if made), Location on hydrograph (rising, falling, peak event), and any general notes as to weather, unusual site conditions, etc.

Benthic Algae Sample Collection Methods

In order for samples to be collected in a consistent manner the below methods were employed when collecting benthic algae samples.

a) A fixed area sample (a 1x3" microscope) slide area of substrate was sampled.
b) Two samples per location were collected for (a) ash free dry weight (b) species identification and enumeration
c) To identify sites that had consistent characteristics the following criteria was used:
    a. Depth: 1 to 3 feet (used current meter staff)
    b. Velocity: 1 to 2 feet per second (current meter)
    c. Exposure: clear sky (i.e., no serious topographic shading, no riparian shading)
d) Thus the sites were not "random" – instead the most prevalant community in the river was selected (i.e., not the very-near shore assemblage, not the deep water assemblage).

When a sampling location was reached, a representative area was identified and then cobbles were selected to sample. The sample was collected by selecting a relatively flat rock, firmly hold the microscope slide to rock (pinning down the algae), then with a brush clean off that face of the rock. The remaining 1x3 sample was then brushed into a small plastic tray. The contents of the tray were then carefully poured into the sample bottle containing Lugol's iodine solution.

A grid (1x1" mesh) was also laid on the river bed to determine approximate percentage of cover.

Sample bottles were labeled by site and date and stored in a dark, cool and dry location. Water quality parameters were collected and recorded onto datasheets along with other pertinent information. Samples were delivered overnight to Jim Sweet at Aquatic Analysts in white Salmon, WA for speciation and enumeration.

Appendix B – Flow Schedules

Included herein:

1. Trinity River Spring 2004 Pulse Flow Schedule
2. Trinity River Fall 2004 Pulse Flow Schedule

Trinity River Spring 2004 Release Schedule

From Date	To Date	Flow (cfs)
01-Oct-03	15-Oct-03	450
16-Oct-03	04-May-04	300
05-May-04	05-May-04	2,000
06-May-04	11-May-04	2,500
12-May-04	13-May-04	3,000
14-May-04	15-May-04	4,500
16-May-04	25-May-04	6,000
26-May-04	26-May-04	5,700
27-May-04	27-May-04	5,400
28-May-04	28-May-04	5,100
29-May-04	29-May-04	4,800
30-May-04	31-May-04	4,500
01-Jun-04	01-Jun-04	4,200
02-Jun-04	02-Jun-04	3,900
03-Jun-04	03-Jun-04	3,600
04-Jun-04	04-Jun-04	3,300
05-Jun-04	08-Jun-04	3,000
09-Jun-04	10-Jun-04	2,800
11-Jun-04	12-Jun-04	2,600
13-Jun-04	14-Jun-04	2,400
15-Jun-04	15-Jun-04	2,300
16-Jun-04	16-Jun-04	2,200
17-Jun-04	17-Jun-04	2,100
18-Jun-04	09-Jul-04	2,000
10-Jul-04	10-Jul-04	1,700
11-Jul-04	11-Jul-04	1,500
12-Jul-04	12-Jul-04	1,350
13-Jul-04	13-Jul-04	1,200
14-Jul-04	14-Jul-04	1,050
15-Jul-04	15-Jul-04	950
16-Jul-04	16-Jul-04	850
17-Jul-04	17-Jul-04	750
18-Jul-04	18-Jul-04	675
19-Jul-04	19-Jul-04	600
20-Jul-04	20-Jul-04	550
21-Jul-04	21-Jul-04	500
22-Jul-04	22-Aug-04	450

RECLAMATION RELEASES NEW TRINITY RIVER FLOW SCHEDULE

A Ninth Circuit Court ruling on April 23 significantly increased the volume available to the Trinity River. The Court's ruling came as a result of a request from the Hoopa Valley Tribe. In December 2002, U.S. District Court Judge Oliver Wanger limited the available volume of water to 453,000 acre-feet pending completion of a final Supplemental Environmental Impact Statement/Report. The Ninth

Circuit Court's ruling, in response to the emergency motion, increased that volume to 647,000 acre-feet for this year.

The newly revised 2004 flow schedule will be finalized by the Department of the Interior, based on a recommendation made by the Trinity Management Council to achieve a wide variety of physical and biological objectives. This schedule will not only benefit smolt (juvenile salmon and steelhead) growth and survival in late spring and early summer, but will also achieve substantial geomorphic benefits by flushing large accumulations of fine sediment that have been deposited over the past two years, move and redeposit gravel, and scour 1-2 year old riparian vegetation that has re-encroached along the channel's edge, all of which will improve habitat conditions throughout the system.

Under the newly approved flow schedule, current releases from Lewiston Dam to the Trinity River will continue at 300 cubic feet per second
(cfs) through Tuesday, May 4, ramp up to 2,500 cfs by Thursday, May 6, and then continue up to 6,000 cfs by Sunday, May 16. The schedule calls for these releases to continue at 6,000 cfs from May 16 through Tuesday, May 25, gradually ramping down to 2,000 cfs by June 18, and finally reaching the summer base level of 450 cfs by July 22.

The new flow release schedule is available online at Reclamation's Central Valley Operations (CVO) web site at www.usbr.gov/mp/cvo

For additional information, please call Jeffrey McCracken in Reclamation's Public Affairs Office at 916-978-5100 (TDD 916-978-5608). You may also contact Doug Schleusner at the Trinity River Restoration Program at 530-623-1800 or Tom Morstein-Marx at CVO at 916-979-2196, (TDD 916-979-2183).

2004 Trinity River Fall Pulse Release schedule

Project: Lewiston Dam

Please make the following changes to the Trinity River

Date	Time	From (CFS)	To (CFS)
8/22/2004	1800	450	550
8/22/2004	2000	550	800
8/22/2004	2200	800	1050
8/23/2004	0000	1050	1300
8/23/2004	0200	1300	1550
8/23/2004	0400	1550	1650
8/24/2004	0000	1650	1590
8/26/2004	0000	1590	1530
8/28/2004	0000	1530	1470
8/30/2004	0000	1470	1410
9/1/2004	0000	1410	1350
9/3/2004	0000	1350	1290
9/5/2004	0000	1290	1230
9/7/2004	0000	1230	1170
9/9/2004	0000	1170	1110
9/11/2004	0000	1110	1050
9/12/2004	0000	1050	950
9/12/2004	0400	950	850
9/12/2004	0800	850	750
9/13/2004	0000	750	650
9/13/2004	0400	650	550
9/13/2004	0800	550	500
9/13/2004	1200	500	450