Salmon Recovery Index Watershed Monitoring Program

Water Quality Index Report, October 2000 – September 2001

December 2001

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Salmon Recovery Index Watershed Monitoring Program

Water Quality Index Report, October 2000 – September 2001

by
John H. Summers VII

Environmental Assessment Program
Olympia, Washington 98504-7710

December 2001

Waterbody Numbers: (see Abstract)

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Abstract

In October 2000, The Washington State Department of Ecology began a monitoring program to evaluate long-term trends in water quality, temperature, flow, and benthic macroinvertebrate assemblages in five index watersheds that were also being monitored for salmon production by the Washington Department of Fish and Wildlife (WDFW). The goal of this program was to develop a long-term environmental indicator that could be used to relate water quality factors with salmon production.

The five watersheds currently being monitored are Big Beef Creek, Bingham Creek, Cedar Creek, Chiwawa River, and Deschutes River. Water quality parameters being monitored include dissolved oxygen, turbidity, total suspended solids, fecal coliform bacteria, ammonia-N, nitrate+nitrite-N, total nitrogen, total phosphorus, soluble reactive phosphorus (orthophosphate), hardness, dissolved metals (copper and zinc), pH, conductivity, continuous temperature, and flow.

This report presents the data collected during the first year of monitoring, October 2000 to September 2001, by Ecology. Smolt production data are reported by the WDFW.

Results indicated that even though there were a few digressions from optimum biological conditions, all five watersheds in the program are healthy except for Cedar Creek. Cedar Creek, which had numerous water quality and temperature exceedences and a low benthic index score, was the most impaired watershed in the program.

Waterbody Numbers:

1.	Big Beef Creek	1227820476521	(WA-15-7000)
2.	Bingham Creek	1234007471431	(WA-22-4090)
3.	Cedar Creek	1226174459365	(WA-27-2045)
4.	Chiwawa River	1226459477877	(WA-45-2000)
5.	Deschutes River	1229018470117	(WA-13-1010)

Issaquah Creek	1220590475589	(WA-08-1110)
Mannser Creek	1219187482652	(WA-03-1020)

Acknowledgments

This project was made possible through the efforts of many individuals. The author wishes to acknowledge all who have played a role in the monitoring project and the larger effort to promote Salmon recovery. Particular appreciation is extended to:

- Ecology staff who provided guidance and support: Dale Norton, Dave Serdar, Will Kendra, Dave Hallock, Robert Plotnikoff, Chad Wiseman, and Bernard Strong.

- Ecology's Stream Hydrology Unit: Brad Hopkins and Casey Clishe.

- Staff at the Ecology-EPA Manchester Laboratory who processed and analyzed water quality samples: Will White, Pam Covey, Sally Cull, James Ross, and Stuart Magoon.

- The dedicated and hard working staff at Washington Department of Fish and Wildlife (WDFW) whose dedication to Salmon recovery is beyond reproach: Greg Volkhardt, Dave Seiler, Steve Neuhauser, Kris Peterson, and Dan Rawding,

- Ecology and WDFW staff who assisted with field sampling activities.

- Wease Bollman at Rhithron Biological Associates who analyzed the macroinvertebrate samples and calculated biological metrics for various indices.

- Those who have supported the Salmon Recovery Index Monitoring Program: Cindy Raekes of the US Forest Service; Judith De La Vergne of the US Fish and Wildlife Service; and Karen Schmitt Ph.D. and Gordy George of the University of Washington.

Introduction

Background

Wild salmon, steelhead, and trout[1] populations in Washington State are being significantly depleted, and many stocks are being pushed to extinction. Since the early 1800s human activities and decisions have resulted in the depletion of many wild stocks. As of 1999, 15 salmon species have been listed under the Endangered Species Act (ESA) as threatened or endangered. The listings cover 75% of the state, and more are anticipated in the future.

The need to reverse the declining trend in salmon stocks has been acknowledged by the Governor and recently culminated in *Extinction is Not an Option: A Statewide Strategy to Recover Salmon* released by the Joint Natural Resources Cabinet (JNRC) in September 1999 (JNRC, 1999). The Salmon Strategy addresses the four major factors affecting salmon – habitat, hatcheries, harvest, and hydropower – as well as science-based approaches to assess the effectiveness and validity of the Strategy elements. One such approach is a statewide system of index watersheds to monitor long-term watershed responses to the Strategy.

Efforts to recover salmon through habitat protection and restoration are predicated on the tenet that degradation of their physical habitat and the loss of cool, clean waters on which salmon rely are key elements in their decline. The index watershed monitoring program seeks to determine both the validity of these assumptions and to assess the Salmon Strategy's effectiveness in improving these components of the salmon recovery puzzle. This is being evaluated by monitoring stream temperature, water quality and quantity, benthic macroinvertebrate communities, and smolt production in five index watersheds. As conceived, the index monitoring program will be a long-term coordinated effort between the Washington State Departments of Ecology (Ecology) and Fish & Wildlife (WDFW).

Ecology has the lead in the water quality/quantity, temperature, and macroinvertebrate monitoring tasks; WDFW has the lead for the smolt monitoring task. The project plan for smolt monitoring has been prepared separately by WDFW and is not discussed here.

Monitoring data will be reported to JNRC on a yearly basis as Salmon Strategy performance indicators. Models for these indicators are currently being developed by separate work groups. Conceptually, the water quality indicator will be a composite of variables scored relative to favorable/unfavorable conditions for salmon. Possible approaches to deriving water quantity scores include comparing index watershed flow data to critical high/low flows or to natural flow regimes. WDFW will develop the performance indicator for smolt production.

[1] Hereafter salmon, steelhead, and trout are collectively referred to as “salmon.”

Study Objectives

The objectives for Ecology's component of the monitoring program are to:

- Assess long-term trends in stream temperature, water quality, benthic macroinvertebrate assemblages, and flows in index watersheds.
- Provide data to calculate salmon recovery indices of water quality/quantity and biotic integrity.
- Determine if water quality/quantity and benthic macroinvertebrate variables correlate over time with smolt production in index watersheds.
- Identify index watersheds needing improvements in water quality/quantity to meet the requirements of salmon throughout their freshwater life stages. This is a secondary objective since the initial monitoring effort is limited to a pilot scale (five watersheds). Identifying areas needing improvement will become a more prominent goal as the system of index watersheds expands over time.

Study Areas

The initial five watersheds selected for index monitoring were:

- Big Beef Creek in the Hood Canal drainage
- Bingham Creek in the Satsop/Chehalis basin
- Cedar Creek in the Lewis/Lower Columbia basin
- Issaquah Creek in the Lake Washington basin
- Mannser Creek in the Skagit River basin

After six months of monitoring, Issaquah and Mannser creeks were dropped due to logistical issues between the smolt monitoring and water quality programs. These two were replaced with the following watersheds:

- Chiwawa River in the Wenatchee basin
- Deschutes River which drains into South Puget Sound

The locations of all watersheds are shown in Figure 1. Watershed site information is described in Appendix A.

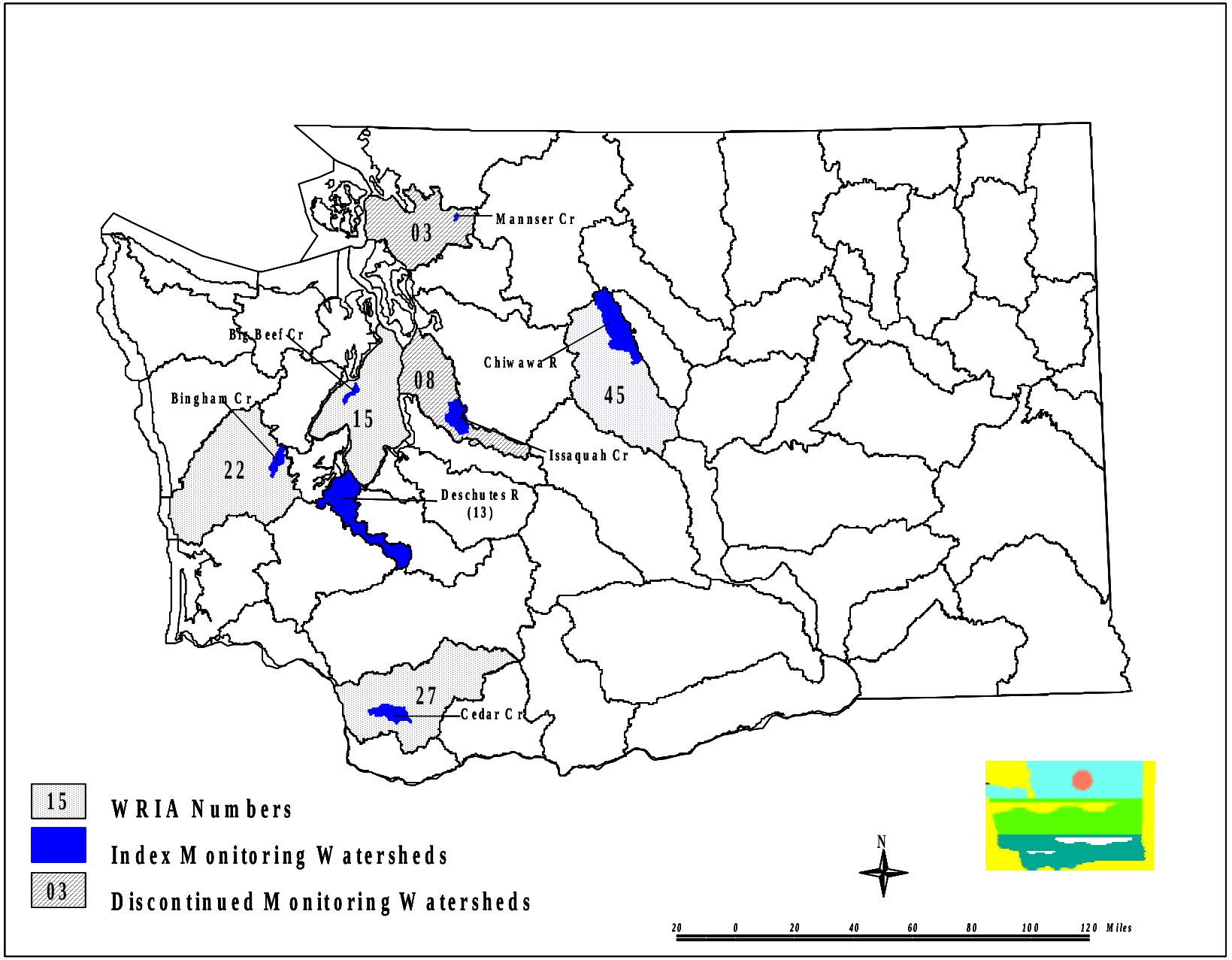

Figure 1: Location of Index Monitoring Watersheds

Methods

The methods used in this program are described in the Quality Assurance Program Plan (Summers and Serdar, 2001). The monitoring components are shown in Table 1 and are described below:

Table 1. Summary of Monitoring Components

Ecology	Frequency	Number of stations per watershed
Water Quality	Monthly	1
Temperature	Continuous	2-4
Flow	Continuous	1
Benthic Macroinvertebrates	Annual Collection	1
WDFW		
Smolt Production	Annual Collection	1

Ecology

Water Quality

Thirteen monthly water quality surveys were conducted between October 2000 and September 2001. All samples were collected near the mouth of each stream, except for the Deschutes River where the samples are taken at river mile 21.61. Exact locations of all stations are given in Appendix A. Water quality parameters determined at the Ecology-EPA Manchester Environmental Laboratory (MEL) included turbidity, total suspended solids, fecal coliform bacteria, ammonia-N, nitrate+nitrite-N, total nitrogen, total phosphorus, soluble reactive phosphorus (orthophosphate), hardness, and dissolved metals (copper and zinc) (MEL, 2000). Field measurements included dissolved oxygen, temperature, pH, and conductivity. Field sampling and measurement protocols followed those in the Watershed Assessment Section protocols manual (Ecology, 1992). Laboratory analyses, analytical methods, and the detection of precision limits for field measurements are listed in Appendix B.

Continuous Instream Temperature Monitoring

Remote Tidbit temperature data loggers were used to record continuous (hourly), year-round stream temperature at two to four sites per watershed. The loggers were set in one and one-half inch galvanized pipe. The pipes were mounted so they were located in shaded pools at approximately one-quarter to one-half of pool depth, in flowing water. Pre-installation calibrations were performed on all loggers using an ice bath and a calibrated thermometer. With the exception of one logger at Bingham Creek and one at Mannser Creek, which were lost, all other loggers were functioning as intended.

Benthic Macroinvertebrate

Annual sampling of benthic macroinvertebrates and habitat surveys were conducted each fall. Four composite riffle samples were collected at one site per watershed. Benthic community data from each site were summarized for metrics and indices at the contract laboratory. These data are included in Appendix E. Habitat surveys included substrate, canopy cover, and gradient. Additional water quality sampling was conducted concurrently to help interpret results of the macroinvertebrate sampling.

The Benthic Index of Biological Integrity (B-IBI) for the Puget Sound Lowland rivers and streams was chosen to evaluate each sample due to proximity to the Puget Lowlands Ecoregion (Fore et al., 2001). The B-IBI is a composite of ten metrics that measure different aspects of stream biology, including taxonomic richness and composition, tolerance and intolerance, habitat, reproductive strategy, feeding ecology, and population structure. Metrics are given a scoring range value of 1, 3, or 5. These ten scores are summed to produce the overall B-IBI score which ranges from 10 to 50.

A summary of the B-IBI scoring system is shown below in Table 2.

Table 2: Summary of B-IBI Scoring System

Rating	Score	Description
Excellent	45-50	Natural stream conditions
Good	37-<45	Minimum impairment of stream conditions
Fair	27-<37	Moderate impairment of stream conditions
Poor	17-<27	Obvious impairment of stream conditions
Very Poor	10-<17	Degraded stream conditions

Continuous Instream Flow Monitoring

Flow data are collected from permanently installed gaging stations at Big Beef, Bingham, and Cedar creeks following Ecology's Stream Hydrology Unit procedures and protocols described in Hopkins, (1999). For more information about Ecology's Stream Hydrology Unit, visit their web site at http://www.ecy.wa.gov/programs/eap/flow/shu_main.html

The United States Geological Survey (USGS) also collects flow data for this program at the following sites: Deschutes River at Rainier station (ID# 12079000), Deschutes River at E Street Bridge station (ID# 12080010), Big Beef Creek near Seabeck station (ID# 12069550), and Chiwawa River near Plain station (ID# 12456500). For complete data and methods information, visit the USGS web site at http://wa.water.usgs.gov/realtime/current.html

WDFW

Smolt Monitoring

Data collection methods for Salmonid smolt production using smolt traps are available from WDFW at their web site, www.wa.gov/wdfw/recovery

Data Quality

Data Quality Objectives (DQOs) for the monitoring program are described in the Salmon Recovery Index Quality Assurance Program Plan (Summers and Serdar, 2001). Following is a general review of all project data.

Laboratory Data

Laboratory data quality was acceptable, with a few exceptions. Laboratory analysis followed data quality objectives and quality control procedures stated in the Manchester Environmental Laboratory User's Manual (MEL, 2000). All metals and conventional chemistry samples met holding time requirements. Microbiology samples were analyzed within 30 hours, which is standard procedure for MEL. Because of the logistical challenges in collecting and transporting microbiology samples within the given timeframe, samples were not analyzed within the six-hour period described in Standard Methods (APHA, 1998).

Lab data quality was evaluated through the use of duplicate sampling. Duplicates were taken each month at one of the five sampling sties. Duplicates are two samples collected 15-20 minutes apart at the same station. Duplicate samples were used to estimate sampling precision, presented in two ways, as the Relative Percent Difference (RPD) and Coefficient of Variation (%CV). At levels close to the method detection limit, small differences in duplicate results can generate higher RPD and %CV numbers. Consequently, it is acceptable for the RPD and %CV numbers to be greater when results are close to the method detection limit.

Precision for fecal coliform bacteria field duplicate results should not exceed 50% CV. Of the 12 duplicate fecal coliform samples only two were above the 50% CV. Considering the variability in bacteria parameters, precision for fecal coliform was very good.

For all other parameters, precision for field duplicate measurements should not exceed 20% CV for results above the reporting limit. All duplicates samples met the 20% CV requirement. Data quality for all laboratory data is considered acceptable for use, subject to the qualifications provided. Complete quality assurance data summaries are shown in Appendix B.

Field Data

Field data quality was excellent, with few exceptions. Field instruments were used to measure temperature, conductivity, and pH. Instruments were calibrated to manufacturers' instructions before each sampling event. Meters measuring pH were calibrated against known standards and always met manufacturers' specifications. Precision of replicate observations was excellent with field duplication results never exceeding 6% CV. Conductivity meters were calibrated using standard solutions, and the precision for conductivity duplicates was excellent with %CV never exceeding 6. Although the %CV is well below the acceptable limit, on October 10, 2000 all conductivity measurements were much lower than expected. Consequently all conductivity data from this date are qualified as estimates. Duplicate samples for dissolved oxygen were measured using the Winkler titration method, and precision was excellent.

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Results

Results of the monitoring conducted in each watershed are presented below. Each parameter is discussed in the following order: water quality, temperature, flow, and macroinvertebrates. Station identification names are shown along with the parameters for ease of use when determining station locations and the number of sites monitored. (SRIW = Salmon Recovery in Index Watersheds)

1. Big Beef Creek

Water Quality - SRIW 1501

Summarized in Table 3 are water quality results for Big Beef Creek collected between October 2000 and September 2001. For the 12 months that water quality was monitored on the creek, all parameters were within the normal range expected, with the exception of pH. pH in February 2001 was below the class AA standard of 6.5. Dissolved copper and zinc concentrations were also low and well within the standard.

Temperature - SRIW 1503, 1504, 1505

Daily maximum stream temperatures at each monitoring site are shown in Figure 2. Stream temperatures during the monitoring period at all three sites, SRIW 1503, 1504, and 1505, exceeded the water quality standard of 16^0C 1.4%, 44.7%, and 1.6% of the time, respectively. Complete temperature profiles used to construct the daily maximums for each station are in Appendix C.

Flow - SRIW 1506

Ecology monitors discharge on Big Beef Creek. Hydrograph and daily discharge averages for October 2000 through September 2001 are in Appendix D. In general, discharge was typical of low-flow, drought conditions. Average daily discharge ranged from less than 2cfs to almost 42cfs. An equipment malfunction from June 24 through July 2 resulted in a temporary data loss for the station; otherwise the discharge record was complete.

Benthic Macroinvertebrates - SRIW 1502

Benthic macroinvertebrate sampling of Big Beef Creek was conducted in September 2000. Information collected for each survey consisted of stream gradient, flow, water quality, substrate, and canopy cover. These data are summarized in Table 4. The macroinvertebrate results are presented in Table 4 as a B-IBI score. Karr (1998) and Fore (1999) point out B-IBI scores are calculated to measure the condition or overall watershed health. The score for Big Beef Creek was 28, and is rated “fair” with only moderate impairment of stream conditions. A detailed taxonomic report for Big Beef Creek is included in Appendix E.

Table 3. Water Quality Results for Big Beef Creek, October 2000 to September 2001

SRIW 1501 WQ													Class: AA	Latitude: 47.6483		
													River mile: 0.25	Longitude: 122.7810		
														WRIA: 15 Hood Canal		
Date/Time		Temp °C	Conductivity umhos/cm	Dissolved Oxygen mg/L	pH std units	Suspended Solids mg/L	Total Persulfate Nitrogen mg/L	Ammonia Nitrogen mg/L	Nitrate+ Nitrite mg/L	Total Phosphorus mg/L	Soluble Reactive P mg/L	Turbidity NTU	Fecal Coliforms #/100/mL	Hardness mg/L	Dissolved Copper mg/L	Dissolved Zinc mg/L
10/18/00	17:15	11.5	13J	9.6	7.48	2	0.083	0.01 U	0.087	0.022	0.01	1.4	10	37.2	0.36	2.2
11/14/00	16:20	6.1	55	11.7	7.33	1 U	0.104	0.01 U	0.074	0.026	0.008	0.5 U	1 U	40.8	0.32	0.4U
12/12/00	15:00	3.2	40	12.8	7	1 U	0.354	0.01 U	0.291	0.021	0.008	0.6	2	28.6	0.42	1.7
01/10/01	8:35	5.8	32.7	11.9	6.28	1	0.352	0.01 U	0.304	0.013	0.006	1.3	12 J	21.5	0.38	1.1
02/14/01	8:10	3.1	35.1	13.1	6.47	1	0.341	0.01 U	0.287	0.023	0.007	0.6	38 J	25	0.31	0.33
03/13/01	15:20	9.3	44.8	11.1	7.66	1	0.272	0.01 U	0.205	0.021	0.007	0.9	1 U	25.2	0.32	0.47
04/11/01	11:30	7.6	60	11.6	6.56	1 U	0.225	0.01 U	0.151	0.016	0.008	0.6	1	28.7	0.31	0.2
05/15/01	15:20	12.8	56.8	10.1	6.76	2	0.168	0.01 U	0.086	0.018	0.008	1.4	3	32	0.33	0.19
06/12/01	14:45	12.9	62.3	10.3	7.31	2	0.219	0.01 U	0.094	0.028	0.01	1.5	38	35.3	0.35	0.25
07/17/01	14:50	13.4	76.4	10.25	6.68	1	0.216	0.01 U	0.152	0.023	0.016	0.9	53	no data	no data	no data
08/14/01	14:30	15.9	85.8	9.69	7.15	1	0.211	0.01 U	0.156	0.029	0.017	0.7	5	45.5	0.26	1.1
09/11/01	14:30	13.4	79.7	10.6	7.03	1 U	0.196	0.01 U	0.145	0.022	0.015	1	4	44.4	0.27	2.2
Minimum		3.1	13*	9.6	6.28	1	0.083	U	0.074	0.013	0.006	0.5**	1	21.5	0.26	0.19
Maximum		15.9	85.8	13.1	7.66	2	0.354	U	0.304	0.029	0.017	1.5	53	45.5	0.42	2.2
Mean		9.6	53.5*	11.1	7.0	1.3**	0.228	U	0.169	0.022	0.010	1.0**		33.1	0.33	0.92**
Geometric Mean													6*(**)			
WQ Standard		16.0		9.5	6.5-8.5								50/100ml***			

* = Estimated results ("J") used to calculate Minimum, Maximum and Mean values
** = Detection limit ("U") results used to calculate Minimum, Maximum or Mean values.
***= WAC 173-201A-030 fecal coliform levels shall not exceed a geometric mean value of 50 colonies/100ml and not have more than 10% of all sample obtained for calculating the geometric mean value exceeding 100 colonies/100ml.
J = Numerical result is an estimate.
U = Analyte not detected at or above the detection limit shown.
= Value did not meet water quality standard.
Latitude/Longitude - Decimal Degrees Datum - NAD27

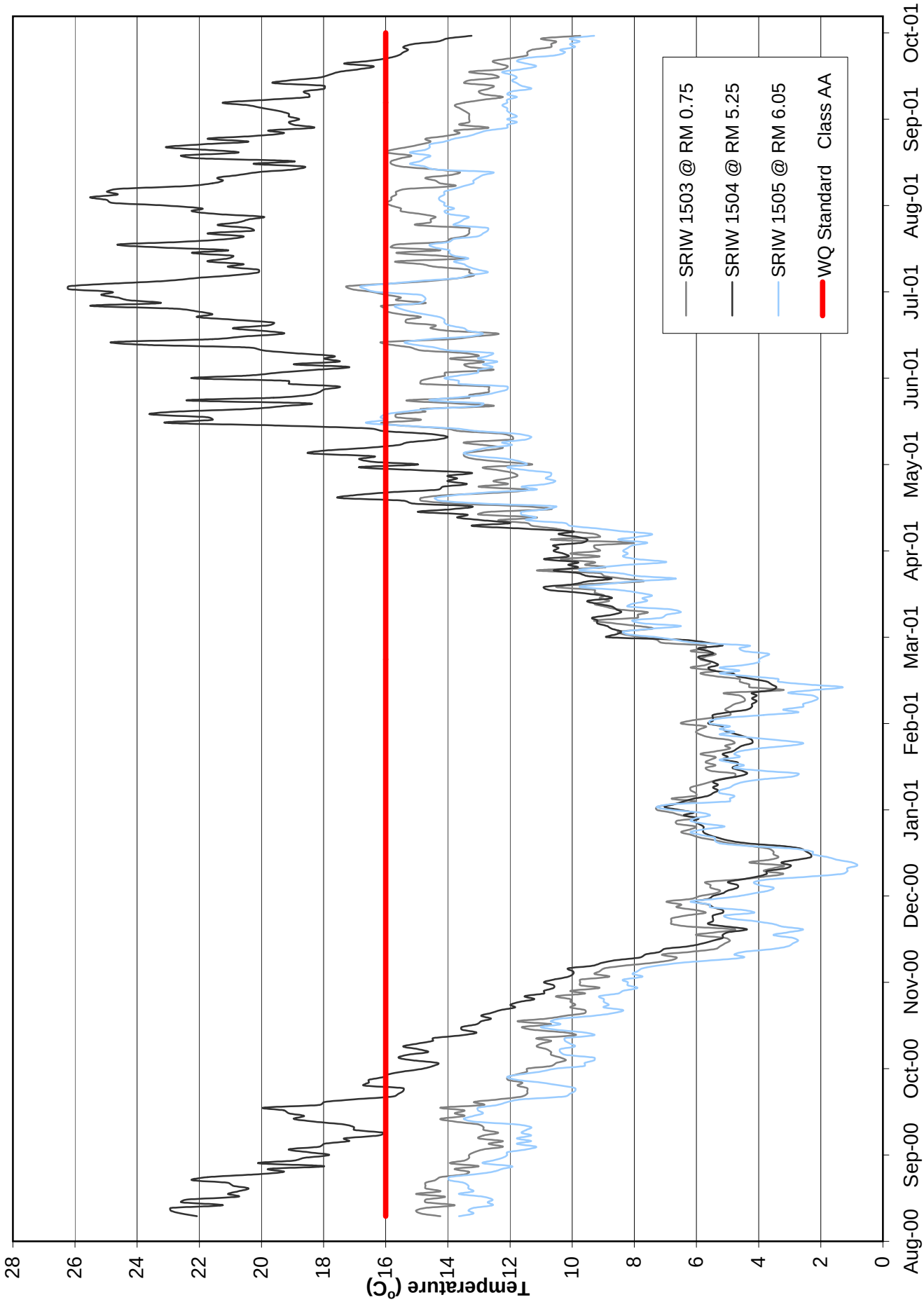

Figure 2. Big Beef Creek: Comparison of Daily Maximum Temperatures to WQ Standard, August 2000 to October 2001

Table 4. Stream Bioassessment Summary for Big Beef Creek

SRIW 1502
Macroinvertebrate and Habitat Survey
9/18/00

Station Location/Information	
WRIA	15, Hood Canal
Class	AA
Latitude	47.6471
Longitude	122.7813
Elevation (ft)	70
River Mile	0.31
Macroinvertebrate	
B-IBI Score	28
Flow	
stream flow (cubic ft./sec.)	2.7
Water Quality Measurements	
water temperature (^{0}C)	13.8
conductivity (µmhos/cm)	101.2
dissolved oxygen (mg/liter)	10.48
acidity (pH)	7.91
Stream Gradient	
stream gradient	1.40%
Stream Velocity (ft/sec)	
six tenths depth stream velocity	1.11
full depth stream velocity	1.00
Substrate	
bedrock (smooth)	0%
bedrock (rough)	0%
boulder (250 to 4000 mm)	0%
cobble (64 to 250 mm)	9%
coarse gravel (16 to 64 mm)	64%
fine gravel (2 to 16 mm)	23%
sand (0.06 to 2 mm)	3%
silt clay (not gritty)	0%
wood (any size)	1%
other	0%
Canopy Cover (% shade)	
canopy cover	95%

2. Bingham Creek

Water Quality - SRIW 2203

Summarized in Table 5 are water quality results for Bingham Creek collected between October 2000 and September 2001. For the 12 months that water quality was monitored on the creek all parameters were within the normal range expected, with two exceptions. pH in January and July 2001 were below the class AA standard of 6.5. Dissolved copper and zinc concentrations were also low and well within the standard.

Temperature - SRIW 2202, 2205, 2206

Daily maximum stream temperatures at each monitoring site are shown in Figure 3. During the monitoring period, none of the monitoring sites exceeded the class AA standard of 16^0C. At station SRIW 2206 the data logger was lost and no data were recorded. The logger was not replaced due to poor access and potential site disturbance. Complete temperature profiles used to construct the daily maximums for each station are in Appendix C.

Flow - SRIW 2201

Ecology monitors discharge on Bingham Creek. Hydrograph and daily discharge averages for October 2000 through September 2001 are in Appendix D. In general, discharge was typical of low-flow, drought conditions. Average daily discharge ranged from 21.9cfs to just over 135cfs. Continuous discharge was recorded for the entire water year except for a period between June 20 and July 12 when the data were lost due to an equipment malfunction.

Benthic Macroinvertebrates - SRIW 2204

Benthic macroinvertebrate sampling of Bingham Creek was conducted in September 2000. Information collected for each survey consisted of stream gradient, flow, water quality, substrate, and canopy cover. These data are summarized in Table 6. The macroinvertebrate results are presented in Table 6 as a B-IBI score. Karr (1998) and Fore (1999) point out B-IBI scores are calculated to measure the condition or overall watershed health. The score for Bingham Creek was 38, and is rated “good” with only minimum impairment of stream conditions. A detailed taxonomic report for Bingham Creek is included in Appendix E.

Table 5. Water Quality Results for Bingham Creek, October 2000 to September 2001

SRIW 2203 WQ												Class: AA		Latitude: 47.1450		
												River mile: 0.16		Longitude: 123.4004		
														WRIA: 22 Chehalis		
Date/Time		Temp °C	Conductivity umhos/cm	Dissolved Oxygen mg/L	pH std units	Suspended Solids mg/L	Total Persulfate Nitrogen mg/L	Ammonia Nitrogen mg/L	Nitrate+ Nitrite mg/L	Total Phosphorus mg/L	Soluble Reactive P mg/L	Turbidity NTU	Fecal Coliforms #/100/mL	Hardness mg/L	Dissolved Copper mg/L	Dissolved Zinc mg/L
10/18/00	14:50	10.5	9J	11.2	7.39	2	0.05 J	0.01 U	0.083	0.019	0.01	0.5	9	23.3	0.21	2.2
11/14/00	13:40	7.0	39	11.6	7.14	1 U	0.106	0.01 U	0.063	0.03	0.01	0.5 U	3	25.2	0.14	0.4U
12/12/00	12:15	5.1	35	12.9	7.24	1 U	0.11	0.01 U	0.127	0.024	0.009	0.5	1 U	20.6	0.16	0.69
01/09/01	15:15	7.1	32.4	11.4	6.2	3	0.147 J	0.01 U	0.137	0.016	0.008	0.9	1	18.9	0.18	12.3
02/13/01	15:40	6.7	34.6	12.4	6.74	1 U	0.147	0.01 U	0.102	0.028	0.009	0.4	1 U	20.6	0.13	0.2
03/13/01	13:00	8.6	38.8	11.8	6.99	1 U	0.133	0.01 U	0.083	0.026	0.008	0.5 U	1	20.8	0.13	0.36
04/10/01	13:40	8.4	58	11.5	7.24	1 U	0.147	0.01 U	0.071	0.02	0.009	0.5 U	6	20.8	0.12	0.01U
05/15/01	11:35	9.4	38.7	11.2	7.07	1	0.129	0.01 U	0.091	0.017	0.009	0.7	19	20.9	0.21	0.32
06/12/01	12:00	9.8	43.7	11.5	7.14	2	0.114	0.01 U	0.048	0.029	0.008	0.5 U	11	23.8	0.15	0.54
07/17/01	9:45	10.8	46.7	11.05	5.91	1 U	0.073	0.01 U	0.043	0.014	0.009	0.5	16	no data	no data	no data
08/14/01	10:15	12.4	47.8	10.5	6.77	1 U	0.069	0.01 U	0.069	0.018	0.01	0.5 U	29 J	25.6	0.14	1.3
09/11/01	10:00	10.4	47.1	10.9	6.78	1 U	0.101	0.01 U	0.084	0.016	0.0086	0.5 U	8 J	25.4	0.13	1.1
Minimum		5.1	9*	10.5	5.91	1	0.05*	U	0.043	0.014	0.008	0.4	1	18.9	0.12	0.01**
Maximum		12.4	58	12.9	7.39	3	0.147	U	0.137	0.03	0.01	0.9	29*	25.6	0.21	12.3
Mean		8.9	39.2*	11.5	6.88	1.3**	0.111*	U	0.083	0.021	0.009	0.5**		22.4	0.15	1.77**
Geometric Mean													5*(**)			
WQ Standard		16.0		9.5	6.5-8.5								50/100ml***			

* = Estimated results ("J") used to calculate Minimum, Maximum and Mean values
** = Detection limit ("U") results used to calculate Minimum, Maximum or Mean values.
***= WAC 173-201A-030 fecal coliform levels shall not exceed a geometric mean value of 50 colonies/100ml and not have more than 10% of all sample obtained for calculating the geometric mean value exceeding 100 colonies/100ml.
J = Numerical result is an estimate.
U = Analyte not detected at or above the detection limit shown.
= Value did not meet water quality standard.
Latitude/Longitude - Decimal Degrees Datum - NAD27

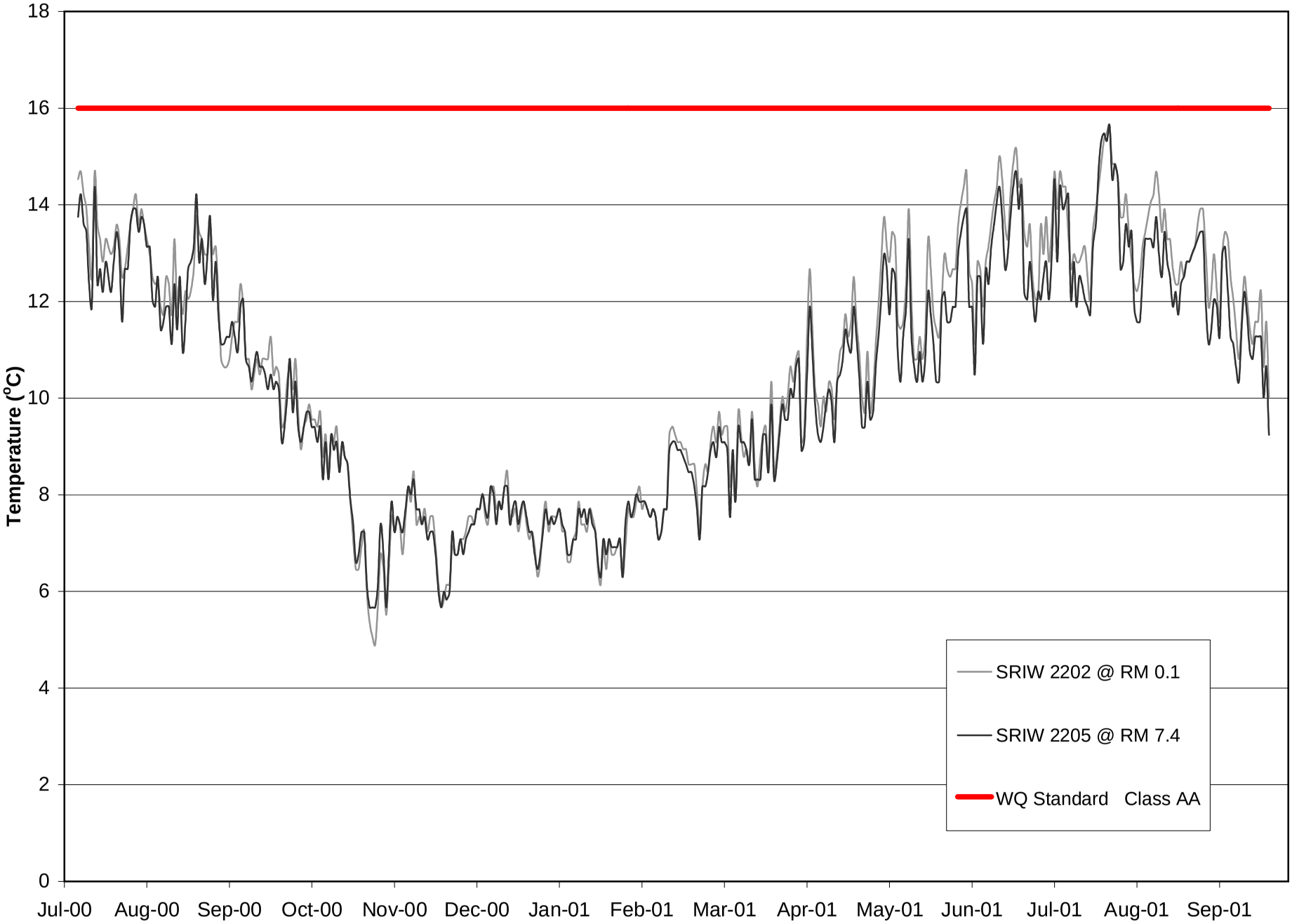

Figure 3. Bingham Creek: Comparison of Daily Maximum Temperatures to WQ Standard, July 2000 to October 2001

Table 6. Stream Bioassessment Summary for Bingham Creek

SRIW 2204
Macroinvertebrate and Habitat Survey
9/18/00

Station Location/Information	
WRIA	22, Chehalis
Class	AA
Latitude	47.1452
Longitude	123.4001
Elevation (ft)	245
River Mile	0.25
Macroinvertebrate	
B-IBI Score	38
Flow	
stream flow (cubic ft./sec.)	17.58
Water Quality Measurements	
water temperature (^{0}C)	12.5
conductivity (µmhos/cm)	61.9
dissolved oxygen (mg/liter)	10.55
acidity (pH)	7.53
Stream Gradient	
stream gradient	1.40%
Stream Velocity (ft/sec)	
six tenths depth stream velocity	1.08
full depth stream velocity	0.44
Substrate	
bedrock (smooth)	0%
bedrock (rough)	0%
boulder (250 to 4000 mm)	13%
cobble (64 to 250 mm)	37%
coarse gravel (16 to 64 mm)	34%
fine gravel (2 to 16 mm)	14%
sand (0.06 to 2 mm)	2%
silt clay (not gritty)	0%
wood (any size)	0%
other	0%
Canopy Cover (% shade)	
canopy cover	52%

3. Cedar Creek

Water Quality - SRIW 2703

Summarized in Table 7 are water quality results for Cedar Creek collected between October 2000 and September 2001. Water quality conditions at Cedar Creek are impaired at various times of the year. For the 12 months that water quality was monitored on Cedar Creek pH was below the class A standard of 6.5 in March, May, and July 2001. Fecal Coliform was above the class A standard of 200 colonies/100ml in May and June 2001. Temperature exceeded the class A standard of 18.0^{0}C in August 2001. Dissolved copper and zinc concentrations were low and well within the standard.

Temperature - SRIW 2702, 2705, 2706

Daily maximum stream temperatures at each monitoring site are shown in Figure 4. During the monitoring period, stream temperature all three sites, SRIW 2702, 2705, and 2706, exceeded the class A standard of 18^{0}C 12.8%, 1%, and 2.7% of the time, respectively. Complete temperature profiles used to construct the daily maximums for each station are in Appendix C.

Flow - SRIW 2701

Ecology monitors discharge on Bingham Creek. Hydrograph and daily discharge averages for October 2000 through September 2001 are in Appendix D. In general, discharge was typical of low-flow, drought conditions. Discharge ranged from less than 15cfs to just over 225cfs. The station provided a continuous discharge record, except for June 20 through July 15 when data were lost due to equipment malfunction

Benthic Macroinvertebrates - SRIW 2704

Benthic macroinvertebrate sampling of Cedar Creek was conducted in October 2000. Information collected for each survey consisted of stream gradient, flow, water quality, substrate, and canopy cover. These data are summarized in Table 8. Cedar Creek SRIW 2704 is located on the border of the Puget Lowland and Willamette Ecoregions. This site will be scored using the Puget Lowlands Ecoregion criteria for comparability. The macroinvertebrate results are presented in Table 8 as a B-IBI score. Karr (1998) and Fore (1999) point out B-IBI scores are calculated to measure the condition or overall watershed health. The score for Cedar Creek was 26, and is rated “poor” with obvious impairment of stream conditions. A detailed taxonomic report for Cedar Creek is included in Appendix E.

Table 7. Water Quality Results for Cedar Creek, October 2000 to September 2001

SRIW 2703 WQ													Class: A	Latitude: 45.9383			
													River mile: 2.43	Longitude: 122.5818			
														WRIA: 27 Lewis			
Date/Time		Temp °C	Conductivity umhos/cm	Dissolved Oxygen mg/L	pH std units	Suspended Solids mg/L	Total Persulfate Nitrogen mg/L	Ammonia Nitrogen mg/L	Nitrate+ Nitrite mg/L	Total Phosphorus mg/L	Soluble Reactive P mg/L	Turbidity NTU	Fecal Coliforms #/100/mL	Hardness mg/L	Dissolved Copper mg/L	Dissolved Zinc mg/L	
10/18/00	11:20	11.8	13J	10.6	7.64	2	0.434	0.01 U	0.311	0.024	0.009	0.8	16	25.6	0.34	1.7	
11/14/00	10:10	3.7	36	13	7.03	1 U	0.547	0.01 U	0.509	0.028	0.006	0.6	18	22.3	0.24	0.5	
12/12/00	9:05	3	33	13.3	7.58	1 U	0.789	0.01 U	0.619	0.026	0.006	0.8	13 J	17.9	0.24	1.1	
01/09/01	10:15	5.6	31.9	12.1	6.85	2	0.788	0.01 U	0.773	0.019	0.008	1.3	29	17	0.26	7.01	
02/13/01	11:35	4	28.1	13.1	6.64	2	0.902	0.01 U	0.831	0.031	0.007	1.3	13	15.3	0.19	0.3	
03/13/01	9:15	7.5	35.9	12.2	6.21	2	0.776	0.01 U	0.706	0.027	0.007	1.3	5	16.8	0.23	0.24	
04/10/01	10:00	7.4	47	11.7	7.46	4	0.857	0.01 U	0.764	0.023	0.008	2.4	17	14.1	0.19	0.23	
05/14/01	15:15	11.2	55.4	10.7	6.46	13	0.64	0.011	0.521	0.032	0.01	6.8	800 J	16.9	0.29	0.33	
06/11/01	11:55	12.4	44.3	10.55	6.84	9	0.565	0.01 U	0.426	0.041	0.008	5.5	730 J	19.4	0.3	0.82	
07/16/01	14:15	14.4	57.6	10.25	6.31	2	0.452	0.01 U	0.35	0.023	0.01	1.7	160 J	no data	no data	no data	
08/13/01	13:50	20.1	74.5	9.1	6.5	3	0.399	0.01 U	0.296	0.03	0.011	1.7	56	26.9	0.35	0.37	
09/10/01	15:05	15.2	74.4	10	6.97	4	0.358	0.01 U	0.297	0.026	0.01	1.5	36	30.7	0.28	1.3	
Minimum		3	13*	9.1	6.21	1**	0.358	0.01**	0.296	0.019	0.006	0.6	5	14.1	0.19	0.23	
Maximum		20.1	74.5	13.3	7.64	13	0.902	0.011	0.831	0.041	0.011	6.8	800*	30.7	0.35	7.01	
Mean		9.7	44.3*	11.4	6.87	3.8**	0.626	0.01**	0.534	0.028	0.008	2.1		20.3	0.26	1.26	
Geometric Mean													41*				
90th%tile													324*				
WQ Standard		18.0		8.0	6.5-8.5								100/100ml***				

* = Estimated results ("J") used to calculate Minimum, Maximum and Mean values
** = Detection limit ("U") results used to calculate Minimum, Maximum or Mean values.
***= WAC 173-201A-030 fecal coliform levels shall not exceed a geometric mean value of 100 colonies/100ml and not have more than 10% of all sample obtained for calculating the geometric mean value exceeding 200 colonies/100ml.
J = Numerical result is an estimate.
U = Analyte not detected at or above the detection limit shown.
= Value did not meet water quality standard.
Latitude/Longitude - Decimal Degrees Datum - NAD27

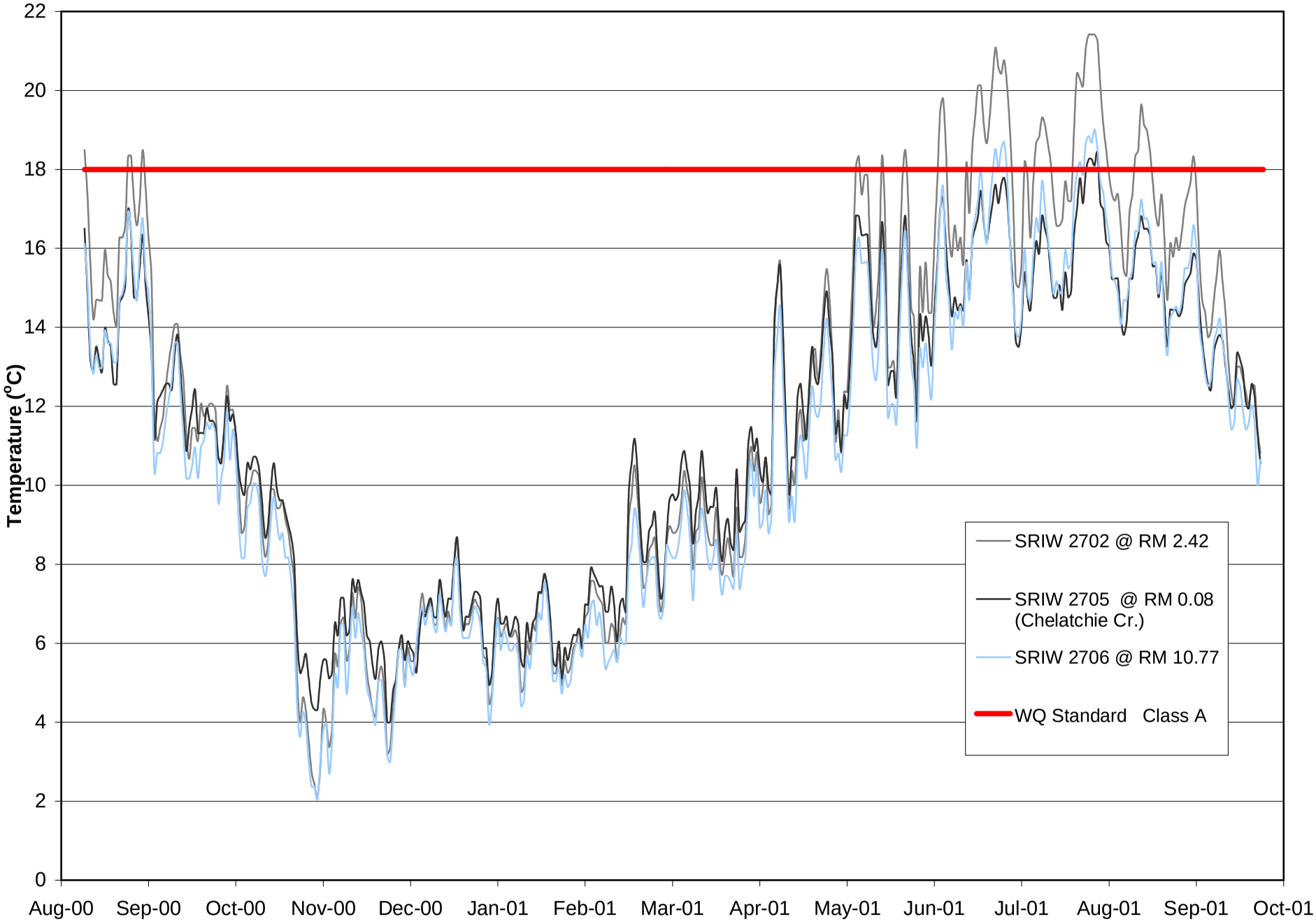

Figure 4. Cedar Creek: Comparison of Daily Maximum Temperatures to WQ Standard, August 2000 to October 2001

Table 8. Stream Bioassessment Summary for Cedar Creek

SRIW 2704

Macroinvertebrate and Habitat Survey

10/16/00

Station Location/Information	
WRIA	27, Lewis
Class	A
Latitude	45.9381
Longitude	122.5815
Elevation (ft)	175
River Mile	2.48
Macroinvertebrate	
B-IBI Score	26
Flow	
stream flow (cubic ft./sec.)	16.57
Water Quality Measurements	
water temperature (^{0}C)	9.7
conductivity (µmhos/cm)	81.9
dissolved oxygen (mg/liter)	11.52
acidity (pH)	7.62
Stream Gradient	
stream gradient	1.40%
Stream Velocity (ft/sec)	
six tenths depth stream velocity	1.68
full depth stream velocity	0.97
Substrate	
bedrock (smooth)	8%
bedrock (rough)	0%
boulder (250 to 4000 mm)	23%
cobble (64 to 250 mm)	30%
coarse gravel (16 to 64 mm)	19%
fine gravel (2 to 16 mm)	17%
sand (0.06 to 2 mm)	3%
silt clay (not gritty)	0%
wood (any size)	0%
other	0%
Canopy Cover (% shade)	
canopy cover	75%

4. Chiwawa River

Water Quality - SRIW 4502

Summarized in Table 9 are water quality results for Chiwawa River collected between May and September 2001. For the five months that water quality was monitored on the creek, all parameters were within the normal range expected, with three exceptions. Temperature exceeded the class AA standard of 16.0^{0}C once in August 2001. Dissolved oxygen was below the class AA standard of 9.5 in August 2001. pH was below the class AA standard of 6.5 in May 2001. Dissolved copper and zinc concentrations were low and well within the standard.

Temperature - SRIW 4501, 4504, 4505, 4506

Daily maximum stream temperatures at each monitoring site are shown in Figure 5. During the monitoring period, only one station, SRIW 4504, exceeded the class AA standard of 16^{0}C 5% of the time. Station SRIW 4501 is maintained by WDFW, and data from that station are not included in this report. Complete temperature profiles used to construct the daily maximums for each station are in Appendix C.

Flow - SRIW 4503

USGS monitors discharge at one site on the Chiwawa River, station 12456500 Chiwawa River near Plain. USGS station information, discharge, and daily mean flow statistics can be viewed at the USGS web site
http://water.usgs.gov/wa/nwis/dv/?site_no=12456500&PARAmeter_cd=00060,00065

Benthic Macroinvertebrates - SRIW 4507

In 2001 the Chiwawa River was added to the monitoring program. 2001 samples have not been analyzed and will not be included in this report.

Table 9. Water Quality Results for Chiwawa River, May 2000 to September 2001

SRIW 4502 WQ																
												Class: AA		Latitude: 47.7971		
												River mile: 2.1		Longitude: 120.6376		
														WRIA: 45 Wenatchee		
Date/Time		Temp ºC	Conductivity umhos/cm	Dissolved Oxygen mg/L	pH std units	Suspended Solids mg/L	Total Persulfate Nitrogen mg/L	Ammonia Nitrogen mg/L	Nitrate+ Nitrite mg/L	Total Phosphorus mg/L	Soluble Reactive P mg/L	Turbidity NTU	Fecal Coliforms #/100/mL	Hardness mg/L	Dissolved Copper mg/L	Dissolved Zinc mg/L
05/16/01	12:35	6.8	26.3	11.5	6.26	10	0.134	0.01U	0.103	0.02	0.005U	3.3	1U	16.1	0.29	0.93
06/13/01	9:45	7.4	27.8	11.3	7.26	3	0.063	0.01U	0.038	0.017	0.005U	1	1U	14.8	0.2	0.32
07/18/01	12:10	12.9	36.8	10.2	6.66	2	0.022	0.01U	0.01U	0.01U	0.005U	0.7	1	no data	no data	no data
08/15/01	13:10	17.4	43.4	9.2	6.61	3	0.033	0.01U	0.01U	0.01U	0.005U	1	3	21.7	0.23	0.88
09/12/01	12:55	13.7	47.9	9.9	6.89	1U	0.03	0.01U	0.01U	0.01U	0.003U	0.6	1	no data	no data	no data
Minimum		6.8	26.3	9.2	6.26	1**	0.022	U	0.01**	0.01**	U	0.6	1	14.8	0.2	0.32
Maximum		17.4	47.9	11.5	7.26	10	0.134	U	0.103	0.02	U	3.3	3	21.7	0.29	0.93
Mean		11.6	36.4	10.4	6.74	3.8**	0.056	U	0.034**	0.013**	U	1.3		17.5	0.24	0.71
Geometric Mean													1**			
WQ Standard		16.0		9.5	6.5-8.5								50/100ml***			

** = Detection limit ("U") results used to calculate Minimum or Mean results.
***= WAC 173-201A-030 fecal coliform levels shall not exceed a geometric mean value of 50 colonies/100ml and not have more than 10% of all sample obtained for calculating the geometric mean value exceeding 100 colonies/100ml.
U = Analyte not detected at or above the detection limit shown.
= Value did not meet water quality standard.
Latitude/Longitude - Decimal Degrees Datum - NAD27

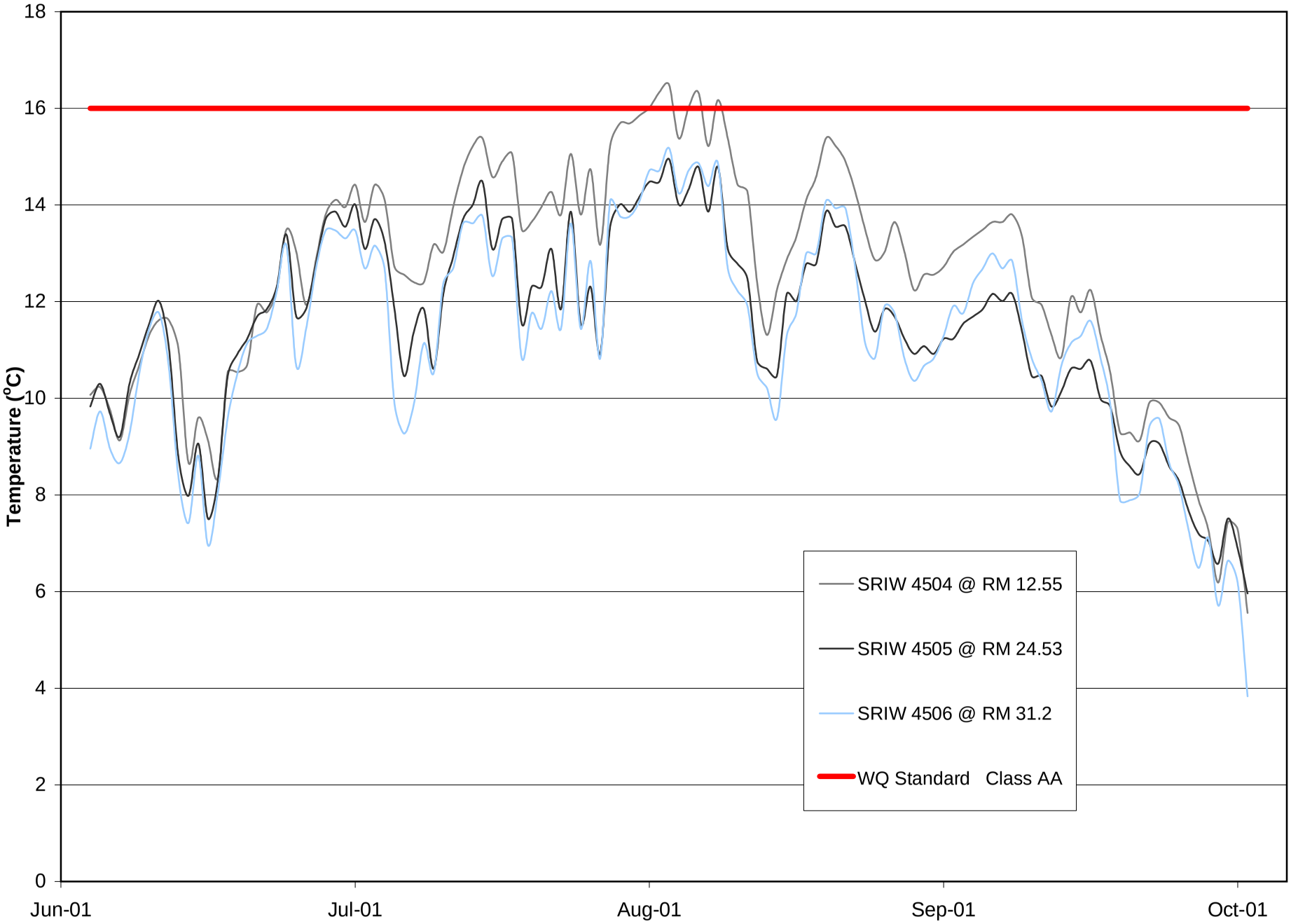

Figure 5. Chiwawa River: Comparison of Daily Maximum Temperatures to WQ Standard, June to October 2001

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5. Deschutes River

Water Quality - SRIW 1305

Summarized in Table 10 are water quality results for Deschutes River collected between May and September 2001. For the five months that water quality was monitored on the creek all parameters were within the normal range expected, with one exception. pH was below the class A standard of 6.5 in August 2001. Dissolved copper and zinc concentrations were also low and well within the standard.

Temperature - SRIW 1302, 1304, 1307

Daily maximum stream temperatures at each monitoring site are shown in Figure 6. During the monitoring period, two stations, SRIW 1302 and 1304, exceeded the class AA standard of 16^0C 22.7% and 29.4% of the time, respectively. Complete temperature profiles used to construct the daily maximums for each station are in Appendix C.

Flow - SRIW 1303, 1306

USGS monitors discharge at two sites on the Deschutes River, station 12080010 Deschutes River at E Street Bridge and station 12079000 Deschutes River near Rainier. Station information, discharge, and daily mean flow statistics can be viewed at the USGS web site http://water.usgs.gov/wa/nwis/dv/?site_no=12079000&PARAmeter_cd=00060,00065

Benthic Macroinvertebrates - SRIW 1308

In 2001 the Deschutes River was added to the monitoring program. 2001 samples have not been analyzed and will not be included in this report.

Table 10. Water Quality Results for Deschutes River, May to September 2001

SRIW 1305 WQ																
												Class: A		Latitude: 46.8731		
												River mile: 21.61		Longitude: 122.7291		
														WRIA: 13 Deschutes		
Date/Time		Temp °C	Conductivity umhos/cm	Dissolved Oxygen mg/L	pH std units	Suspended Solids mg/L	Total Persulfate Nitrogen mg/L	Ammonia Nitrogen mg/L	Nitrate+ Nitrite mg/L	Total Phosphorus mg/L	Soluble Reactive P mg/L	Turbidity NTU	Fecal Coliforms #/100/mL	Hardness mg/L	Dissolved Copper mg/L	Dissolved Zinc mg/L
05/14/01	11:20	12.1	77.4	10.3	6.87	2	0.445	0.013	0.295	0.032	0.015	1.7	28	36.6	0.42	0.28
06/11/01	14:30	13.4	84	10.55	6.95	2	0.336	0.01U	0.235	0.043	0.013	2.2	150	39.9	0.44	0.17
07/16/01	10:55	14.1	104.6	10.2	6.41	2	0.397	0.011	0.288	0.026	0.014	1.1	58	no data	no data	no data
08/13/01	11:00	17.8	130.1	9.5	6.39	2	0.508	0.02	0.383	0.038	0.016	1.1	41	52.6	0.42	0.4U
09/10/01	11:45	14.2	116.6	10.6	7.19	1	0.437	0.01U	0.357	0.027	0.013	1.4	21	no data	no data	no data
Minimum		12.1	77.4	9.5	6.39	1	0.336	0.01**	0.235	0.026	0.013	1.1	21	36.6	0.42	0.17
Maximum		17.8	130.1	10.6	7.19	2	0.508	0.02	0.383	0.043	0.016	2.2	150	52.6	0.44	0.4
Mean		14.3	102.5	10.2	6.8	1.8	0.425	0.013**	0.312	0.033	0.014	1.5		43.0	0.43	0.28
Geometric Mean													46			
WQ Standard		18.0		8.0	6.5-8.5								100/100ml***			

** = Detection limit ("U") results used to calculate Minimum, Maximum or Mean values.
***= WAC 173-201A-030 fecal coliform levels shall not exceed a geometric mean value of 100 colonies/100ml and not have more than 10% of all sample obtained for calculating the geometric mean value exceeding 200 colonies/100ml.
U = Analyte not detected at or above the detection limit shown.
= Value did not meet water quality standard.
Latitude/Longitude - Decimal Degrees Datum - NAD27

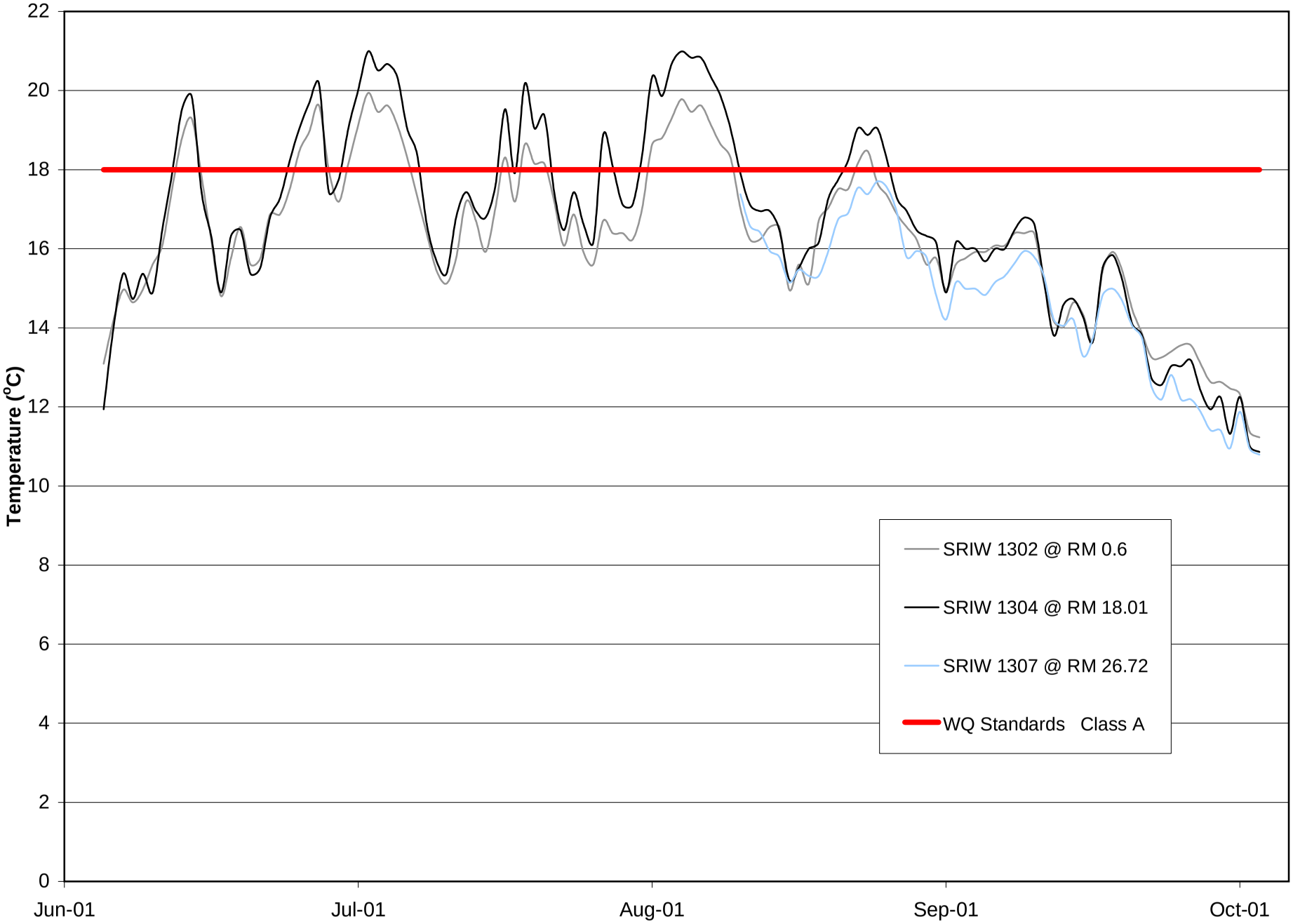

Figure 6. Deschutes River: Comparison of Daily Maximum Temperatures to WQ Standard, June to October 2001

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Issaquah Creek

Water Quality - SRIW 0801

Summarized in Table 11 are water quality results for Issaquah Creek collected between October 2000 and March 2001. For the six months that water quality was monitored on the creek, all parameters were within the normal range expected. Dissolved copper and zinc concentrations were also low and well within the standard.

Temperature - SRIW 0802, 0805, 0806, 0807

Daily maximum stream temperatures at each monitoring site are shown in Figure 7. During the monitoring period, stream temperatures at all monitoring sites never exceeded the class A standard of 18^0C. Complete temperature profiles used to construct the daily maximums for each station are in Appendix C.

Flow -SRIW 0803

USGS monitors discharge at two sites on Issaquah Creek, station 12120600 Issaquah Creek near Hobart and station 12121600 near the mouth of Issaquah Creek. Station information, discharge, and daily mean flow statistics can be viewed at the USGS web site http://water.usgs.gov/wa/nwis/dv/?site_no=12120600&PARAmeter_cd=00060,00065 and http://water.usgs.gov/wa/nwis/dv/?site_no=12121600&PARAmeter_cd=00060,00065

Benthic Macroinvertebrates -SRIW 0804

Benthic macroinvertebrate sampling of Issaquah Creek was conducted in October 2000. Information collected for each survey consisted of stream gradient, flow, water quality, substrate, and canopy cover. These data are summarized in Table 12. The macroinvertebrate results are presented in Table 12 as a B-IBI score. Karr (1998) and Fore (1999) point out B-IBI scores are calculated to measure the condition or overall watershed health. The score for Issaquah Creek was 30, and is rated “fair” with only moderate impairment of stream conditions. A detailed taxonomic report for Issaquah Creek is included in Appendix E.

Table 11. Water Quality Results for Issaquah Creek, October 2000 to March 2001

SRIW 0801 WQ																
												Class: A		Latitude: 47.5280		
												River mile: 3.7		Longitude: 122.0373		
														WRIA: 08 Lake Washington		
Date/Time		Temp °C	Conductivity umhos/cm	Dissolved Oxygen mg/L	pH std units	Suspended Solids mg/L	Total Persulfate Nitrogen mg/L	Ammonia Nitrogen mg/L	Nitrate+ Nitrite mg/L	Total Phosphorus mg/L	Soluble Reactive P mg/L	Turbidity NTU	Fecal Coliforms #/100/mL	Hardness mg/L	Dissolved Copper mg/L	Dissolved Zinc mg/L
10/19/00	14:35	10.4	20J	10.7	7.31	5	0.922	0.01U	0.902	0.037	0.016	2.6	35	51.8	0.46	0.95
11/15/00	15:15	5	83	12.3	7.33	3	1.06	0.021	0.992	0.051	0.02	2	59	60.9	0.37	0.41
12/13/00	15:30	4	80	12.5	7.22	3	1.12	0.016	1.06	0.034	0.016	1.7	15	53.1	0.4	11
01/10/01	16:50	7	70.4	11.6	6.68	4	1.6	0.01U	1.48	0.024	0.013	2.4	36	41.9	0.44	5.5
02/14/01	15:10	4.8	70	12.6	6.72	4	1.38	0.01U	1.32	0.037	0.012	2.2	3	45.6	0.38	0.44
03/14/01	15:00	8.6	90	11.9	7.28	2	1.02	0.01U	0.96	0.038	0.011	1.6	4	50.5	0.37	0.37
Minimum		4	20*	10.7	6.68	2	0.922	0.01**	0.902	0.024	0.011	1.6	3	41.9	0.37	0.37
Maximum		10.4	90	12.6	7.33	5	1.600	0.021	1.480	0.051	0.020	2.6	59	60.9	0.46	11
Mean		6.6	68.9*	11.9	7.09	3.5	1.184	0.013**	1.119	0.037	0.015	2.1		50.6	0.40	3.11
Geometric Mean													15			
WQ Standard		18.0		8.0	6.5-8.5								100/100ml***			

* = Estimated results ("J") used to calculate Minimum, Maximum and Mean values
** = Detection limit ("U") results used to calculate Minimum, Maximum or Mean values.
***= WAC 173-201A-030 fecal coliform levels shall not exceed a geometric mean value of 100 colonies/100ml and not have more than 10% of all sample obtained for calculating the geometric mean value exceeding 200 colonies/100ml.
J = Numerical result is an estimate.
U = Analyte not detected at or above the detection limit shown.
Latitude/Longitude - Decimal Degrees Datum - NAD27

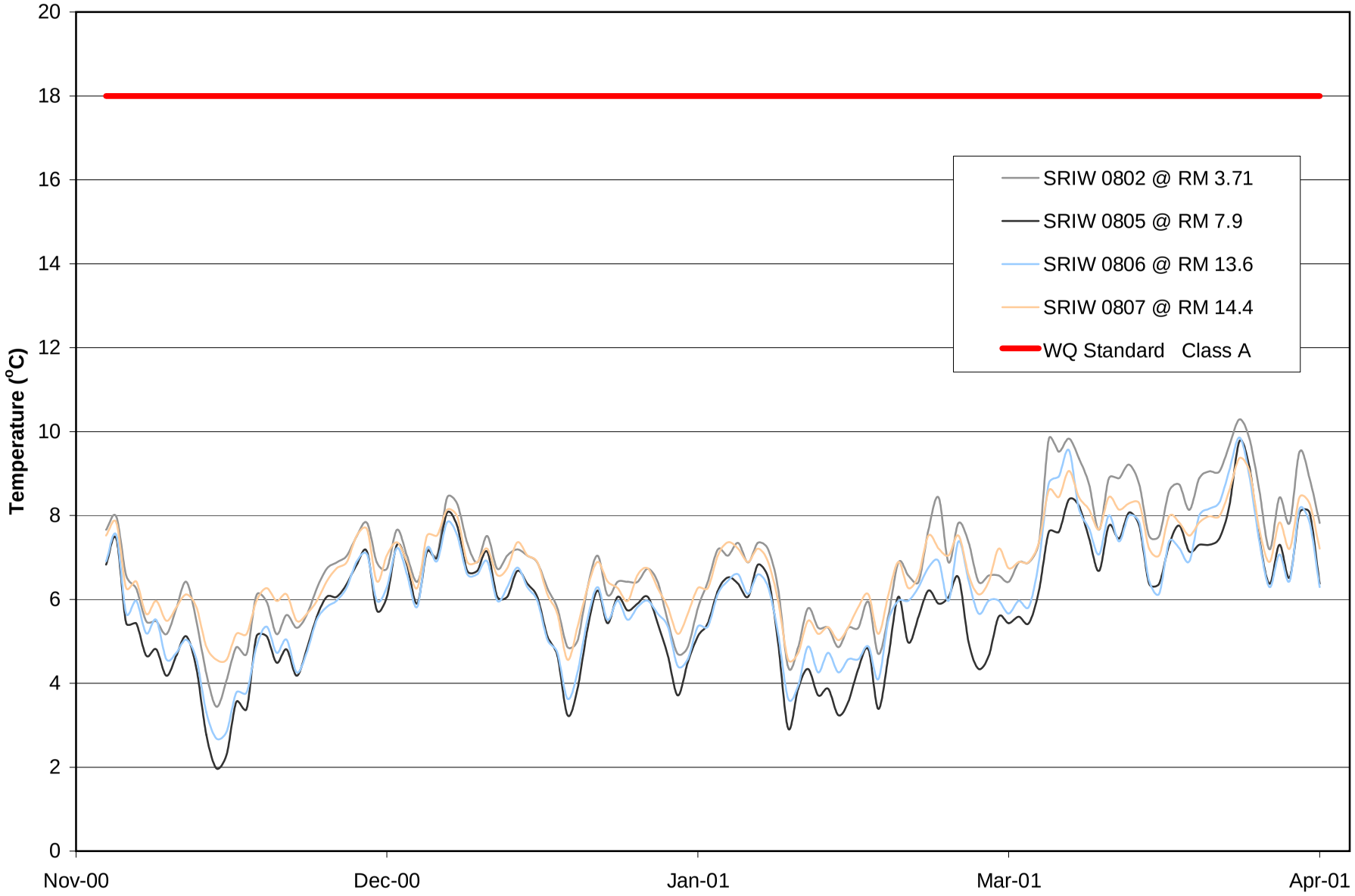

Figure 7. Issaquah Creek: Comparison of Daily Maximum Temperatures to WQ Standard, November 2000 to April 2001

Table 12. Stream Bioassessment Summary for Issaquah Creek

SRIW 0804
Macroinvertebrate and Habitat Survey
10/16/00

Station Location/Information	
WRIA	08, Lake Washington
Class	AA
Latitude	47.5006
Longitude	122.0235
Elevation (ft)	170
River Mile	6.18
Macroinvertebrate	
B-IBI Score	30
Flow	
stream flow (cubic ft./sec.)	25.58
Water Quality Measurements	
water temperature (^{0}C)	10.6
conductivity (µmhos/cm)	127.2
dissolved oxygen (mg/liter)	9.38
acidity (pH)	7.51
Stream Gradient	
stream gradient	0.50%
Stream Velocity (ft/sec)	
six tenths depth stream velocity	1.22
full depth stream velocity	0.84
Substrate	
bedrock (smooth)	0%
bedrock (rough)	0%
boulder (250 to 4000 mm)	0%
cobble (64 to 250 mm)	23%
coarse gravel (16 to 64 mm)	39%
fine gravel (2 to 16 mm)	31%
sand (0.06 to 2 mm)	6%
silt clay (not gritty)	0%
wood (any size)	1%
other	0%
Canopy Cover (% shade)	
canopy cover	62%

Mannser Creek

Water Quality - SRIW 0302

Summarized in Table 13 are water quality results for Mannser Creek collected between October 2001 and March 2000. For the six months that water quality was monitored on the creek, all parameters were within the normal range expected for western Washington rivers, with the exception of dissolved oxygen and pH. Dissolved oxygen levels were below the class AA standard of 9.5 in five of six months. pH had a single exceedence below the class AA standard of 6.5 in May 2001. Dissolved copper and zinc concentrations were low and well within the standard.

Temperature - SRIW 0301, 0303

Daily maximum stream temperatures at each monitoring site are shown in Figure 8. None of the monitoring sites exceeded the class AA standard of 16^0C during the monitoring period. At station SRIW 0301 the data logger was lost and only four months of data were recorded. The logger was not replaced due to poor access and potential site disturbance. Complete temperature profiles used to construct the daily maximums for each station are in Appendix C.

Flow - SRIW 0304

Appendix D shows the Hydrograph for January through April 2001. Discharge ranged from just over 1.5cfs to just over 3.5cfs. Due to insufficient flow data, it is assumed that discharge was typical of low-flow, drought conditions.

Benthic Macroinvertebrates - SRIW 0305

Benthic macroinvertebrate sampling of Mannser Creek was conducted in October 2000. Information collected for each survey consisted of stream gradient, flow, water quality, substrate, and canopy cover. These data are summarized in Table 14. The macroinvertebrate results are presented in Table 14 as a B-IBI score. Karr (1998) and Fore (1999) point out B-IBI scores are calculated to measure the condition or overall watershed health. The score for Bingham Creek was 40, and is rated “good” with only minimum impairment of stream conditions. A detailed taxonomic report for Mannser Creek is included in Appendix E.

Table 13. Water Quality Results for Mannser Creek, October 2000 to March 2001

SRIW 0302 WQ																
												Class: AA		Latitude: 48.5274		
												River mile: 0.52		Longitude: 122.0413		
														WRIA: 03 Skagit		
Date/Time		Temp °C	Conductivity umhos/cm	Dissolved Oxygen mg/L	pH std units	Suspended Solids mg/L	Total Persulfate Nitrogen mg/L	Ammonia Nitrogen mg/L	Nitrate+ Nitrite mg/L	Total Phosphorus mg/L	Soluble Reactive P mg/L	Turbidity NTU	Fecal Coliforms #/100/mL	Hardness mg/L	Dissolved Copper mg/L	Dissolved Zinc mg/L
10/19/00	11:30	9.5	18J	6.5	7.56	3	0.325	0.01 U	0.285	0.026	0.007	1.6	23	51.5	0.44	0.77
11/15/00	12:25	3.9	77	9.4	7.10	1U	0.543	0.01 U	0.463	0.028	0.007	0.8	2J	61.1	0.22	0.4U
12/13/00	12:00	2.5	77	9.9	7.07	2	0.607	0.01 U	0.549	0.019	0.006	1	1	56.5	0.24	9.51
01/10/01	12:25	6.8	76.5	7.3	6.68	1	0.704	0.01 U	0.497	0.018	0.008	0.9	9	52.6	0.31	5.19
02/14/01	11:45	3.7	69.1	9.4	6.49	1	0.716	0.011	0.616	0.028	0.007	0.7	3	53.6	0.22	0.42
03/14/01	11:55	7.1	82.8	9.1	6.74	3	0.682	0.01U	0.564	0.03	0.007	1.3	2	51.9	0.24	0.28
Minimum		2.5	18*	6.5	6.49	1	0.325	0.01**	0.285	0.018	0.006	0.7	1	51.5	0.22	0.28
Maximum		9.5	82.8	9.9	7.56	3	0.716	0.011	0.616	0.03	0.008	1.6	23	61.1	0.44	9.51
Mean		5.6	66.7*	8.6	6.94	1.8**	0.596	0.01**	0.496	0.025	0.007	1.1		54.5	0.28	2.76**
Geometric Mean													4*			
WQ Standard		16.0		9.5	6.5-8.5								50/100ml***			

* = Estimated results ("J") used to calculate Minimum, Maximum and Mean values
** = Detection limit ("U") results used to calculate Minimum, Maximum or Mean values.
***= WAC 173-201A-030 fecal coliform levels shall not exceed a geometric mean value of 50 colonies/100ml and not have more than 10% of all sample obtained for calculating the geometric mean value exceeding 100 colonies/100ml.
J = Numerical result is an estimate.
U = Analyte not detected at or above the detection limit shown.
= Value did not meet water quality standard.
Latitude/Longitude - Decimal Degrees Datum - NAD27

Figure 8. Mannser Creek: Comparison of Daily Maximum Temperatures to WQ Standard, August 2000 to May 2001

Table 14. Stream Bioassessment Summary for Mannser Creek

SRIW 0305

Macroinvertebrate and Habitat Survey

10/31/00

Station Location/Information	
WRIA	03, Skagit
Class	AA
Latitude	48.5395
Longitude	122.0299
Elevation (ft)	150
River Mile	2.01
Macroinvertebrate	
B-IBI Score	40
Flow	
stream flow (cubic ft./sec.)	1.5
Water Quality Measurements	
water temperature (^{0}C)	8.3
conductivity (µmhos/cm)	186
dissolved oxygen (mg/liter)	11.4
acidity (pH)	7.86
Stream Gradient	
stream gradient	2.40%
Stream Velocity (ft/sec)	
six tenths depth stream velocity	1.22
full depth stream velocity	0.84
Substrate	
bedrock (smooth)	0%
bedrock (rough)	0%
boulder (250 to 4000 mm)	0%
cobble (64 to 250 mm)	29%
coarse gravel (16 to 64 mm)	18%
fine gravel (2 to 16 mm)	33%
sand (0.06 to 2 mm)	20%
silt clay (not gritty)	0%
wood (any size)	0%
other	0%
Canopy Cover (% shade)	
canopy cover	89%

Discussion

Water Quality Index (WQI)

Many water quality indices have been introduced and used nationwide to describe the overall water quality condition in streams and rivers. Ecology's River and Stream Monitoring Unit recently modified an index originally pioneered by the U.S. Environmental Protection Agency (EPA) Region 10, and started reporting a WQI for Washington (Hallock, 2001 in prep).

This index was developed to summarize water quality data through an easily understood format using a unitless number, ranging from 10 to 100. The higher the number, the better the water quality relative to expectations. Washington's WQI indicates how well water quality at a station meets expectations, not how good the absolute water quality is.

Although the current WQI has been refined, it is only a tool to measure the overall water quality found in natural systems. It is not intended to produce critical analyses of water quality data measures. A minimum of 12 months of data is needed to calculate a WQI score for each watershed. Scores less than 40 indicate water quality did not meet expectations; these are areas of highest concern. Scores of 40 to 79 are indicative of moderate concern. Scores equal to or greater than 80 indicate water quality met or exceeded expectations; these are areas of lowest concern.

Watersheds with the required 12 months of data are Big Beef, Bingham, and Cedar creeks. Annual WQI scores and individual scores by parameter are shown in Table 15. Monthly WQI scores are shown in Appendix F.

Table 15 shows Big Beef Creek (SRIW 1501) and Bingham Creek (SRIW 2203) both scoring 88 overall, meeting all water quality expectations with regard to their class AA standard, except for pH at Bingham Creek (SRIW 2203). The WQI scores indicate that Big Beef and Bingham creeks are meeting all expectations.

Cedar Creek (SRIW 2703) with its class A standard had an overall score of 58, with individual scores below water quality expectations for fecal coliform, total persulfate nitrogen, and total phosphorus and scores close to exceeding water quality standards for pH, TSS, temperature and turbidity. The WQI score for Cedar Creek indicates that some expectations are not being met and degradations in portions of this watershed have occurred.

In Figure 9 comparisons of frequency distribution for the three SRIW WQI scores to Ecology's River and Stream Monitoring Unit scores show the range and variability of Washington rivers and streams.

- 10% of Washington rivers and streams were below 40 and are of "high" concern
- 42% are between 40-79 and are of "moderate" concern
- 48% are above or equal to 80 and are of "low" concern

Big Beef Creek and Bingham Creek fall into the upper 79% of all stations. Cedar Creek is down, at 24% of all stations.

For more information and detailed methodology of Washington's WQI, visit Ecology's River and Stream Water Quality Monitoring web page at
http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html

Table 15. Water Quality Index Summary for Big Beef, Bingham, and Cedar Creeks.

Water Quality Index

Overall water quality index scores and annual index scores by parameter.

Data collected between 10/01/00 and 10/01/01.

Station	Overall WQI Score	Class	Ecoregion	Fecal Coliform Bacteria	Dissolved Oxygen	pH	Total Suspended Solids	Temperature ^{0}C	Total Persulfate Nitrogen	Total Phosphorus	Turbidity
Big Beef Creek											
SRIW 1501	88	AA	2	85.1772	86.1095	82.7715	97.4370	85.4986	91.8023	81.7410	97.8679
Bingham Creek											
SRIW 2203	88	AA	2	88.3882	93.4407	79.2508	97.4370	93.2415	99.1855	88.2692	100
Cedar Creek											
SRIW 2703	58	A	3	56.3600	97.1512	81.8746	82.0350	82.9545	55.1115	78.0603	82.4060

Index Scores:
<40 - water quality does not meet expectations (highest concern)
40-79 - some water quality standard exceedences (moderate concern)
≥80 - water quality met expectations (lowest concern)

WQI Source: Hallock, 2001

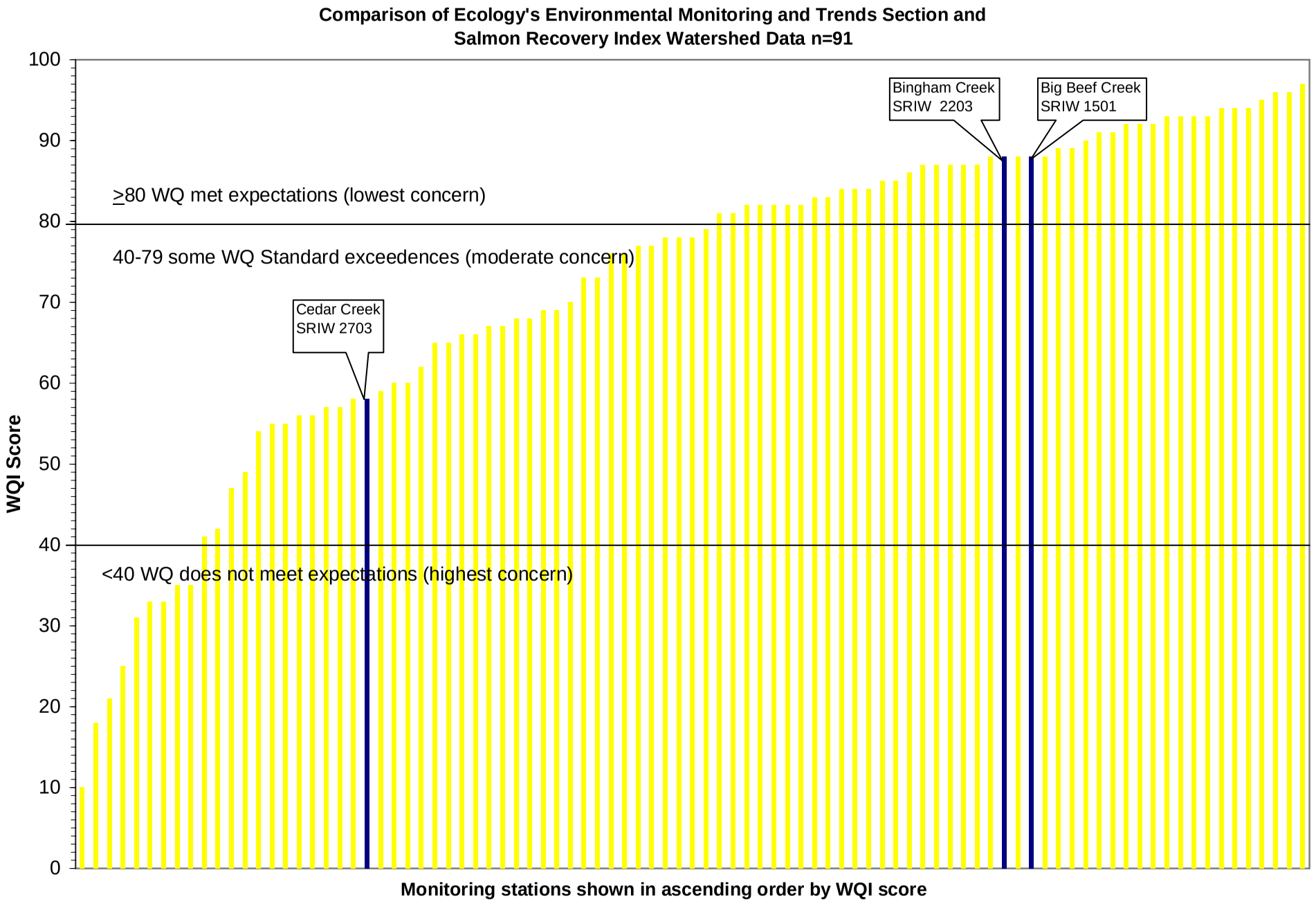

Figure 9. Frequency Distribution for all WQI Watersheds Monitored (Water Year 2000)

WQ Index Source: Hallock, 2001

Comparison of Continuous Temperature Data to Water Quality Standard

Continuous temperature records were collected at a number of sites within each watershed. Table 16 shows the watershed, station, monitoring period, and percentage of days exceeding the applicable water quality temperature standard.

- The highest percentage of days exceeding the water quality standard was measured at river mile 5.25 of Big Beef Creek, station SRIW 1504. This is attributed to high surface water temperatures at Lake William Symington and the placement of the temperature logger below the Lake William Symington dam.

- The Deschutes River had two stations with a relatively high percentage of days exceeding the standard, SRIW 1302 at river mile 0.6 (22.7%) and SRIW 1304 at river mile 18.01 (29.4%).

- Cedar Creek had one site, station SRIW 2702 at river mile 2.42, that exceeded the standard 12.8% of the days monitored.

Lack of adequate shade, agricultural and silviculture practices, urbanization, and inadequate flow may be contributing factors to the high temperatures.

Comparison of Benthic Macroinvertebrate Index Scores

Benthic macroinvertebrate samples were collected at one station within each watershed. Comparisons of B-IBI scores for year 2000 samples are shown in Figure 10.

Big Beef Creek, Bingham Creek, Issaquah Creek, and Mannser Creek are shown to be in relatively healthy condition.

- Bingham Creek and Mannser Creek were rated “good” with scores of 38 and 40 respectively.
- Big Beef Creek and Issaquah Creek were rated “fair” with scores of 28 and 30 respectively.

Cedar Creek, with the lowest score of 26, was rated “poor” and is the most impacted stream in the program. This may be due to urbanization, and agricultural and silviculture practices.

Table 16. Percentage of Days in Exceedance of Water Quality Temperature Standard

Watershed	Station	Monitoring Period	% of Days Exceeded in Monitoring Period
1. Big Beef Creek [1]			
WQ Standard	SRIW 1503 at RM 0.75	Aug 00 - Oct 01	1.4%
Class AA 16^{0}C	SRIW 1504 at RM 5.25	Aug 00 - Oct 01	44.7%
	SRIW 1505 at RM 6.05	Aug 00 - Oct 01	1.6%
2. Bingham Creek [1]			
WQ Standard	SRIW 2202 at RM 0.1	July 00 - Oct 01	0.0%
Class AA 16^{0}C	SRIW 2205 at RM 7.4	July 00 - Oct 01	0.0%
	SRIW 2206 at RM 12.8	Probe Lost	No Data
3. Cedar Creek [1]			
WQ Standard	SRIW 2702 at RM 2.42	Aug 00 - Oct 01	12.8%
Class A 18^{0}C	SRIW 2705 at RM 10.77	Aug 00 - Oct 01	1.0%
	SRIW 2706 at RM 0.08 (Chelatchie Creek)	Aug 00 - Oct 01	2.7%
4. Chiwawa River [2]			
WQ Standard	SRIW 4501 at RM 0.9	June 01 - Oct 01	No Data
Class AA 16^{0}C	SRIW 4504 at RM 12.55	June 01 - Oct 01	5.0%
	SRIW 4505 at RM 24.53	June 01 - Oct 01	0.0%
	SRIW 4506 at RM 31.2	June 01 - Oct 01	0.0%
5. Deschutes River [2]			
WQ Standard	SRIW 1302 at RM 0.6	June 01 - Oct 01	22.7%
Class A 18^{0}C	SRIW 1304 at RM 18.01	June 01 - Oct 01	29.4%
	SRIW 1307 at RM 26.72	Aug 01 - Oct 01	0.0%
Issaquah Creek [2]			
WQ Standard	SRIW 0802 at RM 3.71	Nov 00 - April 01	0.0%
Class A 18^{0}C	SRIW 0805 at RM 7.9 (Fifteen Mile Creek)	Nov 00 - April 01	0.0%
	SRIW 0806 at RM 13.6 (Holder Creek)	Nov 00 - April 01	0.0%
	SRIW 0807 at RM 14.4 (Carey Creek)	Nov 00 - April 01	0.0%
Mannser Creek [2]			
WQ Standard	SRIW 0301 at RM 0.43	Aug 00 - Dec 01	0.0%
Class AA 16^{0}C	SRIW 0303 at RM 1.5	Aug 00 - April 01	0.0%

[1] Monitoring period greater than 1 year
[2] Monitoring period less than 1 year

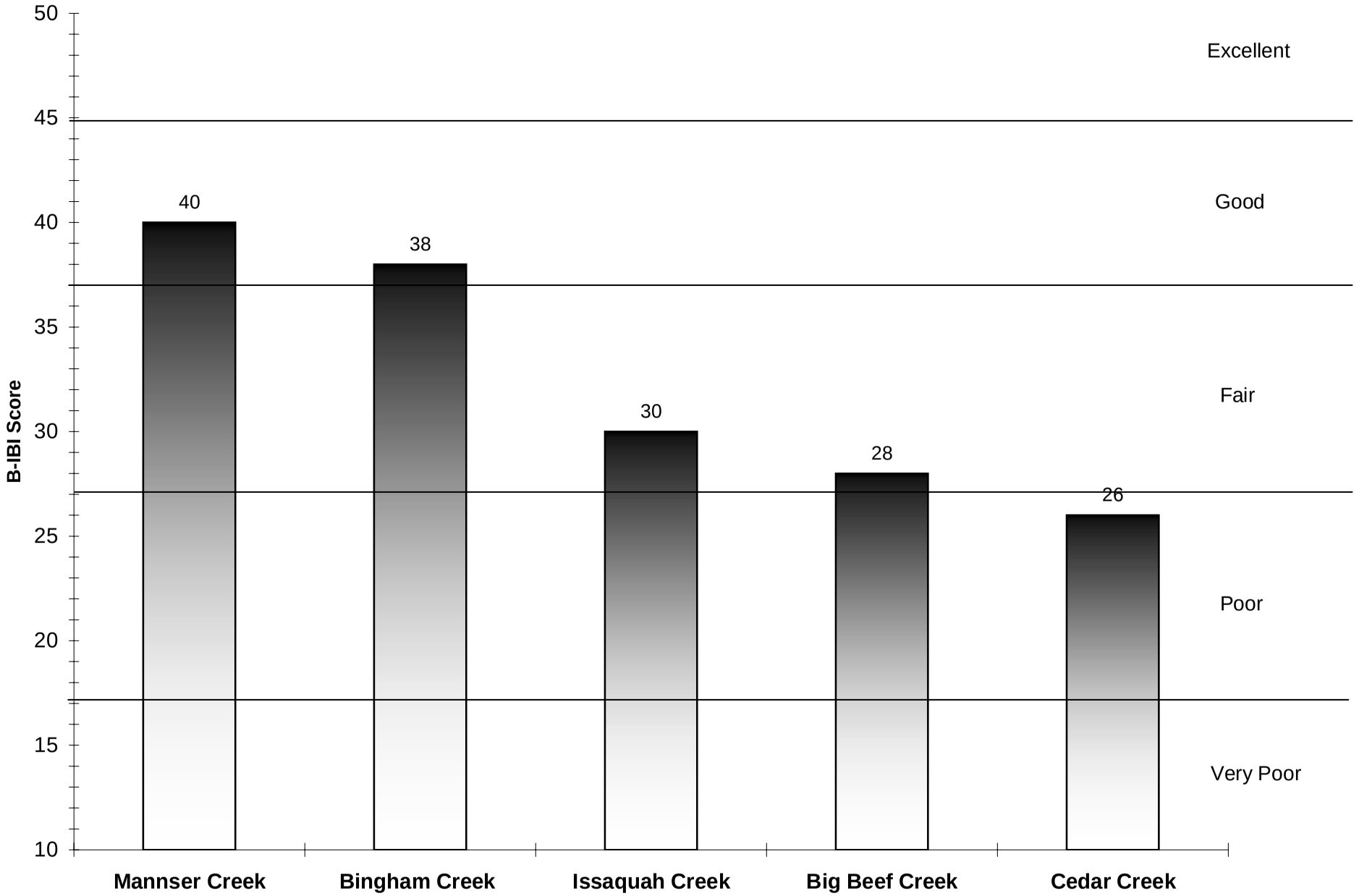

Figure 10. Benthic Index of Biological Indicators (B-IBI) for Year 2000 Watersheds, Using Puget Lowland Ecoregion Scoring Criteria

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Conclusions

Water quality, temperature, flow, and benthic macroinvertebrate samples and measurements were collected, and the data were analyzed. Results indicate that, even though there were a few digressions from optimum biological conditions and several temperature exceedances, all watersheds in the program are relatively healthy except for Cedar Creek. With numerous water quality and temperature exceedences and a low B-IBI score, Cedar Creek was the most impaired watershed in the program.

Significant findings from this first year of monitoring are summarized below.

- At the five watersheds currently being monitored – Big Beef Creek, Bingham Creek, Cedar Creek, Chiwawa River, and Deschutes River – there were no chronic water quality exceedences, and each watershed (except for Cedar Creek) is meeting water quality goals.

- Issaquah Creek and Mannser Creek were monitored for only the first six months of the program. At Mannser Creek one parameter, dissolved oxygen, was below the water quality standard five of six months.

- Temperatures at Big Beef Creek, Cedar Creek, Chiwawa River, and Deschutes River exceeded the applicable water quality standard. Big Beef Creek had the greatest percentage of days exceeding the temperature standard, followed by the Cedar Creek, Deschutes River, and Chiwawa River. There were no temperature exceedences at Bingham Creek, Issaquah Creek, or Mannser Creek.

- State officials declared water year 2001 a drought year in Washington State. The low-flow, drought-like conditions were observed and recorded in each watershed.

- Benthic macroinvertebrates were collected and B-IBI scores calculated for Big Beef Creek, Bingham Creek, Cedar Creek, Issaquah Creek, and Mannser Creek.
  - The scores for Bingham Creek and Mannser Creek were 38 and 40, indicating good overall stream health.
  - The scores for Big Beef and Issaquah Creeks were 28 and 30, indicating stream impairment.
  - The score for Cedar Creek was the lowest at 26, indicating obvious impairment of stream conditions.

- A water quality index (WQI) was calculated for the three watersheds that had adequate monitoring data. Big Beef Creek and Bingham Creek had scores of 88, indicating good overall stream reach health. Cedar Creek scored 58, indicating a source of habitat/chemical degradation is present.

Recommendations

1. Discontinue metals monitoring for copper and zinc, due to the high cost and the low concentrations measured.

2. Long-term water quality monitoring records (> one year) are needed to calculate the water quality index.

3. Evaluation of smolt production in each watershed by WDFW is needed to determine any correlation with water quality and benthic macroinvertebrate data being collected.

4. Increase the number of monitoring sites in each watershed to better characterize both spatial and temporal changes in water quality, temperature, flow, and macroinvertebrates assemblages.

5. Additional monitoring of habitat conditions is needed for more complete understanding of watershed health.

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Appendix A

Watershed Site Information

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Appendix A. Watershed Site Information

FIVE CONTINUING WATERSHEDS

1. Big Beef Creek on Hood Canal - WRIA 15

Monitoring Initiated - October 2000

The study area focuses on Big Beef Creek. Big Beef Creek is located in central Puget Sound on the north west side of the Kitsap Peninsula in Kitsap County. It lies approximately 12 miles northwest of the town of Bremerton and three miles east of Seabeck. From its headwaters at approximately 500 feet elevation, the stream flows northward for five miles where it enters Lake Symington, a 79 acre artificial lake constructed in 1965 with a storage capacity of approximately 987,000 cubic meters. It then flows another six miles to the marine waters of Hood Canal. The approximate drainage area for Big Beef Creek and its tributaries is 14 square miles.

Historically Big Beef Creek has provided exceptional spawning and rearing habitat for coho and chum salmon, steelhead, and cutthroat trout, with the majority of Big Beef Creek being used by coho and chum. Since the early 1900s and continuing today, the impact of human development has dramatically changed the watershed. Logging, road construction, residential and commercial development, channelization of the creek to reduce flooding, construction of weirs and fish-rearing ponds, and the damming of Lake Symington have all had impacts on salmon habitat. The University of Washington and National Marine Fisheries Service maintain a Fisheries Research Institute near the mouth of the creek.

2. Bingham Creek, a tributary of the Satsop River - WRIA 22

Monitoring Initiated - October 2000

The study area focuses on Bingham Creek, a tributary of the East Fork Satsop River. The confluence of the East Fork Satsop River and Bingham Creek is located in southwest Mason County at river mile 17.5. Draining approximately 35 square miles of commercial forest lands and rural housing developments, Bingham Creek flows southward from the forested slopes of the southernmost peaks of the Olympic Mountains to the East Fork of the Satsop River, which drains into Chehalis River near the town of Satsop.

Coho salmon and steelhead spawn and rear in Bingham Creek. The Washington Department of Fish and Wildlife spawn, rear, and release both coho and steelhead from their hatchery facility located at the confluence of Bingham Creek and the East Fork Satsop River.

3. Cedar Creek, a tributary of the Lewis River - WRIA 27

Monitoring Initiated - October 2000

The study area focuses on Cedar Creek, a tributary to the Lewis River. Located in north central Clark County, Cedar Creek drains approximately 56 square miles of forest and agricultural lands. From its headwaters at 1850 feet, Cedar Creek flows approximately 23 miles west to the confluence of the Lewis River at river mile 15.5, elevation 30 feet.

Coho, steelhead, and possibly chinook salmon spawn and rear in Cedar Creek.

4. Chiwawa River, a tributary of the Wenatchee River - WRIA 45

Monitoring Initiated – May 2001

The study area focuses on the Chiwawa River, a tributary to the Wenatchee River. Located in central Chelan County north of the town of Plain, the Chiwawa River drains approximately 175 square miles of national forest and rural land. From its headwaters at 5870 feet, the Chiwawa River flows south for approximately 40 miles to the Wenatchee River, elevation 1840 feet.

Chinook, steelhead, and Bull trout spawn and rear in the Chiwawa River.

5. Deschutes River on Budd Inlet/South Puget Sound - WRIA 13

Monitoring Initiated - May 2001

The study area focuses on the Deschutes River at the most southern part of Puget Sound. From the commercial forestlands of its headwaters, to the rural, agricultural area of the mid-basin, to the suburban and urban area of Olympia, the Deschutes River is a multiple land use basin. The headwaters of the Deschutes River emanate from the Bald Hills in southeastern Thurston County near the north central edge of Lewis County and flow for 57 miles running in a northwesterly direction where it empties into Capital Lake and Budd Inlet.

Coho, chinook, steelhead, and cutthroat trout spawn and rear in the Deschutes. The Washington Department of Fish and Wildlife spawn, rear, and release coho, chinook, and steelhead from their hatchery facility located near the mouth of the Deschutes River.

TWO WATERSHEDS DISCONTINUED APRIL 2001

1. Issaquah Creek, a tributary of Lake Washington - WRIA 08

Monitoring Initiated - October 2000

The study area focuses on Issaquah Creek, a tributary to Lake Washington. Issaquah Creek is located in King County south of the town of Issaquah. Its forested headwaters emanate from Tiger Mountain at an elevation of 2580 feet and flow 20 miles to Lake Washington, elevation 35 ft. Issaquah Creek basin, including Tibbitts Creek, is 61 square miles.

The Washington Department of Fish and Wildlife spawn, rear, and release coho, chinook, and steelhead from their hatchery facility located at river mile 3.6.

2. Mannser Creek, a tributary of the Skagit River - WRIA 03

Monitoring Initiated - October 2000

The study area focuses on Mannser Creek, a tributary of the Skagit River. The Skagit River from its headwaters in British Columbia (BC) to its termination in Puget Sound has a drainage area of approximately 3,100 square miles. It is 120 miles long with 25 miles lying in BC Canada. In Washington State the Skagit is the largest watershed in the Puget Sound basin, second in size only to the Columbia River. The confluence of the Skagit River and Mannser Creek is located in the northwestern part of the state between the cities of Lyman and Hamilton. From its headwaters at an elevation of 700 feet, Mannser Creek flows southwesterly to where it enters the Skagit River at river mile 35.2, elevation 60 feet. The Mannser Creek basin is approximately three and one-half miles long and drains an area roughly 1.76 square miles. Land use is predominately forest and rural residential noncommercial hobby farms.

Coho spawn and rear in Mannser Creek.

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Table A1. Station Location Information

I. Big Beef Creek (station ongoing)

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at UW Field Station SRIW 1501	AA	47.648300	122.781000	65	0.25

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Macroinvertebrate at UW Field Station SRIW 1502	AA	47.647100	122.781300	70	0.31

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at UW Field Station SRIW 1503	AA	47.640700	122.784100	80	0.75

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature below Lake Symington Spillway SRIW 1504	AA	47.598800	122.823800	350	5.25

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature above Lake Symington (Holly Rd.) SRIW 1505	AA	47.593200	122.835800	390	6.05

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Flow above Lake Symington (Holly Rd.) SRIW 1506	AA	47.593300	122.835900	390	6.05

2. Bingham Creek (station ongoing)

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Flow at WDFW Hatchery SRIW 2201	AA	47.144600	123.400900	240	0.1

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at WDFW Hatchery SRIW 2202	AA	47.144700	123.400800	240	0.1

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at WDFW Hatchery SRIW 2203	AA	47.145000	123.400400	240	0.16

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Macroinvertebrate at WDFW Hatchery SRIW 2204	AA	47.145200	123.400100	245	0.25

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Shelton-Matlock Rd SRIW 2205	AA	47.236800	123.379800	345	7.4

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Simpson Timber Rd SRIW 2206	AA	47.292900	123.332600	550	12.8

Latitude/Longitude - Decimal Degrees Datum - NAD27

Table A1. Station Location Information

3. Cedar Creek (station ongoing)

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Flow at Grist Mill SRIW 2701	A	45.938700	122.582100	150	2.35

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Grist Mill (trap) SRIW 2702	A	45.938300	122.581800	160	2.42

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at Grist Mill SRIW 2703	A	45.938300	122.581700	165	2.43

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Macroinvertebrate at Grist Mill SRIW 2704	A	45.938100	122.581500	175	2.48

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Chelatchie Cr. SRIW 2705	A	45.911300	122.445400	390	0.08

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Amboy SRIW 2706	A	45.910300	122.446000	390	10.77

4. Chiwawa River (new station 5/15/01)

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at WDFW Hatchery SRIW 4501	AA	47.787700	120.645900	1865	0.9

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at Chiwawa Loop Bridge SRIW 4502	AA	47.797100	120.637600	1940	2.1

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
USGS Flow across from Goose Creek CG SRIW 4503	AA	47.837700	120.658500	2100	6.2

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Huckleberry Ford CG SRIW 4504	AA	47.897200	120.716000	2365	12.55

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Atkinson Flat CG SRIW 4505	AA	47.999400	120.816400	2490	24.53

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Phelps Creek CG SRIW 4506	AA	48.068700	120.846600	2550	31.2

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Macroinvertebrate near Atkinson Flat CG SRIW 4507	AA	47.990600	120.810200	2530	23.83

Latitude/Longitude - Decimal Degrees Datum - NAD27

Table A1. Station Location Information

5. Deschutes River (new station 5/15/01)

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at "E" St Bridge SRIW 1301	A	47.011700	122.901800	93	0.6

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at "E" St Bridge SRIW 1302	A	47.011700	122.901900	93	0.6

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
USGS Flow at "E" St Bridge SRIW 1303	A	47.011700	122.902000	93	0.6

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Waldrick Rd SRIW 1304	A	46.920400	122.808600	270	18.01

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at Hwy 507 Bridge SRIW 1305	A	46.873100	122.729100	370	21.61

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
USGS Flow at Vail loop bridge SRIW 1306	A	46.852200	122.667800	380	25.91

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Woodbrook Ln SRIW 1307	A	46.849500	122.653300	388	26.72

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Macroinvertebrate at Pioneer Park SRIW 1308	A	46.993400	122.885700	105	2.42

Latitude/Longitude - Decimal Degrees Datum - NAD27

Table A1. Station Location Information

Issaquah Creek (discontinued 4/30/01)

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at Newport Way Rd SRIW 0801	A	47.528000	122.037300	90	3.7

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Newport Way Rd SRIW 0802	A	47.528100	122.037400	90	3.71

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Flow near Sycamore St SRIW 0803	A	47.515300	122.024900	120	4.95

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Macroinvertebrate at 113th St SRIW 0804	A	47.500600	122.023500	170	6.18

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Fifteen Mile Creek SRIW 0805	A	47.480400	122.027600	350	7.9

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Holder Creek SRIW 0806	A	47.437200	121.976500	490	13.6

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Carey Creek SRIW 0807	A	47.427200	121.971900	480	14.4

Mannser Creek (discontinued 4/30/01)

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature @ Foot Bridge SRIW 0301	AA	48.526000	122.042900	65	0.43

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Water Quality at Lyman-Hamilton Rd and R R SRIW 0302	AA	48.527400	122.041300	70	0.52

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Temperature at Lyman-Cemetery Rd SRIW 0303	AA	48.534200	122.031500	90	1.45

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Flow SRIW 0304	AA	48.539200	122.031800	135	1.84

Station	Class	Latitude	Longitude	Elevation (ft)	River Mile
Macroinvertebrate SRIW 0305	AA	48.539500	122.029900	150	2.01

Latitude/Longitude - Decimal Degrees Datum - NAD27

Appendix B

Quality Assurance Data

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Appendix B-1

The laboratory's data quality objectives and quality control procedures are documented in the Manchester Environmental Laboratory's Lab Users Manual (MEL, 1994).

Table 1 Summary of laboratory methods, and lower reporting limits.

Parameters	Methods[a]	Lower reporting limit
Fecal coliform	SM18 Membrane Filter 9222D	1 cfu/100 ml
Dissolved copper (low level)	EPA 200.8	0.03 µg/l
Dissolved zinc (low level)	EPA 200.8	0.4 µg/l
Turbidity	EPA 180.1	0.1 NTU
Total N	SM 4500 NO_3-F	10 µg/L
Ammonia-N	EPA 350.1	10 µg/L
Nitrite+nitrate-N	EPA 353.2	10 µg/L
Orthophosphate	EPA 365.1	10 µg/L
Total phosphorus	EPA 365.1	10 µg/L
Total suspended solids	EPA 160.2	1 mg/L

[a] Sources: EPA, 1993 and APHA, 1998 (SM)

Table 2 Container type, water volume required, method of preservation, and maximum permissible holding times for water samples.

Variable	Container Type	Sample Volume (ml)	Preservation	Holding Time
Turbidity	poly	100	cool to <4 C	48 hrs
Total suspended solids	poly	1000	cool to <4 C	7 days
Total phosphorus	poly	125	adjust pH<2 w/ H_2SO_4 and cool to <4 C	28 days
Orthophosphate	brown poly	125	filter in field and cool to <4 C	48 hrs
Nitrate+Nitrite-N	poly	125	adjust pH<2 w/ H_2SO_4 and cool to <4 C	28 days
Ammonia-N	poly	125	adjust pH<2 w/ H_2SO_4 and cool to 4 C	28 days
Total N	poly	125	adjust pH<2 w/ H_2SO_4 and cool to <4 C	28 days
Fecal coliform	Autoclaved glass/ploy	250	cool < 4 C	30 hrs
Copper	Teflon	1000	filter in field, adjust pH<2 w/ HNO_3 and cool to <4 C	6 months
Zinc	Teflon	1000	filter in field, adjust pH<2 w/ HNO_3 and cool to <4 C	6 months
Hardness	poly	125	adjust pH<2 w/ HNO_3 and cool to <4 C	6 months

Table 3 Summary of field measurements, methods, and accuracy.

Variable	Method	Accuracy
Velocity	Current meter	± 0.1 f/s
Specific Conductivity	Field meter	± 5%
pH	Field meter	± 0.2 standard units
Temperature	Red liquid thermometer	± 0.2ºC
Dissolved Oxygen	Winkler Modified Azide (EPA360.20 Field Meter)	± 0.1 mg/L ± 0.2 mg/L
Stage Height	Data logger and probe	± 0.03 feet
Continuous Temperature	Underwater data logger	± 0.2ºC @ 21ºC

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Appendix B-2. Quality Assurance Summary Statistics for Duplicate WQ Samples

Station	*Mannser Creek SRIW 0302*						*Issaquah Creek SRIW 0801*						*Deschutes River SRIW 1305*					
Date	01/10/01						02/14/01						06/11/01					
	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)
Field																		
Conductivity umhos/cm	76.5	77.6	1	0.78	77.05	1	70	70	0	0	70	0	84	83.8	0	0.14	83.9	0
Oxygen mg/L	7.3	7.3	0	0	7.3	0	12.6	12.6	0	0	12.6	0	10.55	10.65	1	0.071	10.6	1
pH std units	6.68	6.79	2	0.08	6.74	1	6.72	6.7	0	0.014	6.71	0	6.95	7.09	2	0.099	7.02	1
Conventionals																		
Total Suspended Solids mg/L	1	1U	0	0	0.50	0	4	3	29	0.71	3.5	20	2	3	40	0.71	2.5	**28**
Total Persulfate Nitrogen mg/L	0.704	0.484	37	0.16	0.59	**26**	1.38	1.38	0	0	1.38	0	0.336	0.33	2	0.0042	0.333	1
Ammonia Nitrogen mg/L	0.01 U	0.01U	0	0	0	0	0.01U	0.01U	0	0	0	0	0.01U	0.01U	0	0	0	0
Nitrate+ Nitrite mg/L	0.497	0.497	0	0	0.497	0	1.32	1.32	0	0	1.32	0	0.235	0.234	0	0.0007	0.2345	0
Total Phosphorus mg/L	0.018	0.018	0	0	0.018	0	0.037	0.039	5	0.0014	0.038	4	0.043	0.042	2	0.0007	0.0425	2
Soluble Reactive P mg/L	0.008	0.008	0	0	0.008	0	0.012	0.012	0	0	0.012	0	0.013	0.013	0	0	0.013	0
Turbidity NTU	0.9	0.8	12	0.07	0.85	8	2.2	1.9	15	0.212	2.05	10	2.2	2.2	0	0	2.2	0
Fecal Coliforms #/100/mL	9	4	77	3.54	6.5	**54**	3	2	40	0.707	2.5	**28**	150	230	42	56.6	190	**30**
Metals																		
Hardness mg/L	52.6	53.1	1	0.35	52.9	1	45.6	46	1	0.283	45.8	1	39.9	39.2	2	0.49	39.55	1
Dissolved Copper mg/L	0.31	0.33	6	0.01	0.32	4	0.38	0.37	3	0.007	0.375	2	0.44	0.44	0	0	0.44	0
Dissolved Zinc mg/L	5.19	0.7	152	3.17	2.95	**108**	0.44	0.55	22	0.078	0.495	16	0.17	0.26	42	0.06	0.215	**30**

Station	*Big Beef Creek SRIW 1501*						*Big Beef Creek SRIW 1501*						*Big Beef Creek SRIW 1501*					
Date	12/12/00						05/15/01						08/14/01					
	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)
Field																		
Conductivity umhos/cm	40	40	0	0	40	0	56.8	57	0	0.14	56.9	0	85.8	85.9	0	0.07	85.85	0
Oxygen mg/L	12.8	12.8	0	0	12.8	0	10.1	9.9	2	0.14	10	1	9.7	9.7	0	0	9.7	0
pH std units	7	7.08	1	0.057	7.04	1	6.76	6.83	1	0.049	6.80	1	7.15	7.18	0	0.02	7.165	0
Conventionals																		
Total Suspended Solids mg/L	1	2	67	0.707	1.5	**47**	2	2	0	0	2	0	1	1	0	0	1	0
Total Persulfate Nitrogen mg/L	0.7071	0.416	52	0.206	0.562	**37**	0.168	0.181	7	0.009	0.175	5	0.211	0.201	5	0.0071	0.206	3
Ammonia Nitrogen mg/L	0.01 U	0.01U	0	0	0	0	0.01 U	0.01U	0	0	0	0	0.01 U	0.01U	0	0	0	0
Nitrate+ Nitrite mg/L	0.291	0.293	1	0.0014	0.292	0	0.086	0.085	1	0.0007	0.0855	1	0.156	0.155	1	0.0007	0.1555	0
Total Phosphorus mg/L	0.021	0.022	5	0.0007	0.0215	3	0.018	0.019	5	0.0007	0.0185	4	0.029	0.027	7	0.0014	0.028	5
Soluble Reactive P mg/L	0.008	0.008	0	0	0.008	0	0.008	0.009	12	0.0007	0.0085	8	0.017	0.017	0	0.0	0.017	0
Turbidity NTU	0.6	0.6	0	0	0.6	0	1.4	1.1	24	0.21	1.25	17	0.7	0.7	0	0.0	0.7	0
Fecal Coliforms #/100/mL	2	3	40	0.707	2.5	**28**	3	6	67	2.12	4.5	**47**	5	9	57	2.83	7	**40**
Metals																		
Hardness mg/L	28.6	28.5	0	0.071	28.55	0	32	32	0	0	32	0	45.5	45.8	1	0.21	45.65	0
Dissolved Copper mg/L	0.42	0.43	2	0.007	0.425	2	0.33	0.34	3	0.007	0.335	2	0.26	0.26	0	0	0.26	0
Dissolved Zinc mg/L	1.7	1.6	6	0.071	1.65	4	0.19	0.22	15	0.021	0.205	10	1.1	0.86	24	0.17	0.98	17

J = Numerical result is an estimate.

U = Analyte not detected at or above the detection limit shown.

RPD = Relative percent difference (range as percent of duplicate mean).

Bold values are above the DQO.

Appendix B-2 (pg 2). Quality Assurance Summary Statistics for Duplicate WQ Samples

Station	*Bingham Creek SRIW 2203*						*Bingham Creek SRIW 2203*						*Bingham Creek SRIW 2203*					
Date	11/14/00						04/10/01						07/17/01					
	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)
Field																		
Conductivity umhos/cm	39	39	0	0	39	0	58	58	0	0	58	0	46.7	46.3	1	0.283	46.5	1
Oxygen mg/L	11.6	11.6	0	0	11.6	0	11.5	11.5	0	0	11.5	0	11.05	11	0	0.035	11.025	0
pH std units	7.14	7.47	5	0.23	7.305	3	7.24	7.2	1	0.0283	7.22	0	5.91	6.27	6	0.255	6.09	4
Conventionals																		
Total Suspended Solids mg/L	1 U	1U	0	0	0	0	1 U	1U	0	0	0	0	1 U	1U	0	0	0	0
Total Persulfate Nitrogen mg/L	0.106	0.071	40	0.0247	0.089	**28**	0.147	0.118	22	0.0205	0.133	15	0.073	0.074	1	0.0007	0.0735	1
Ammonia Nitrogen mg/L	0.01 U	0.01U	0	0	0	0	0.01 U	0.01U	0	0	0	0	0.01 U	0.01U	0	0	0	0
Nitrate+ Nitrite mg/L	0.063	0.065	3	0.0014	0.064	2	0.071	0.073	3	0.0014	0.072	2	0.043	0.044	2	0.0007	0.0435	2
Total Phosphorus mg/L	0.03	0.028	7	0.0014	0.029	5	0.02	0.018	11	0.0014	0.019	7	0.014	0.014	0	0	0.014	0
Soluble Reactive P mg/L	0.01	0.01	0	0	0.01	0	0.009	0.009	0	0	0.009	0	0.009	0.009	0	0	0.009	0
Turbidity NTU	0.5 U	0.5U	0	0	0	0	0.5 U	.5U	0	0	0	0	0.5	.5U	0	0	0.25	0
Fecal Coliforms #/100/mL	3	3	0	0	3	0	6	11	59	3.54	8.5	**42**	16	17	6	0.707	16.5	4
Metals																		
Hardness mg/L	25.2	24.5	3	0.4950	24.85	2	20.8	21	1	0.14	20.9	1	na	na	na	na	na	na
Dissolved Copper mg/L	0.14	0.16	13	0.0141	0.15	9	0.12	0.12	0	0	0.12	0	na	na	na	na	na	na
Dissolved Zinc mg/L	0.4U	0.4U	0	0	0	0	0.01U	0.01U	0	0	0	0	na	na	na	na	na	na

Station	*Cedar Creek SRIW 2703*						*Cedar Creek SRIW 2703*						*Chiwawa River SRIW 4502*					
Date	10/18/00						03/13/01						09/12/01					
	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)	Dup #1	Dup #2	RPD (%)	STDEV	MEAN	CV (%)
Field																		
Conductivity umhos/cm	13J	12J	8	0.707	12.5	6	35.9	35.8	0	0.071	35.85	0	47.9	47.7	0	0.14	47.8	0
Oxygen mg/L	10.6	10.8	2	0.14	10.7	1	12.2	12.1	1	0.071	12.15	1	9.9	9.9	0	0	9.9	0
pH std units	7.64	7.59	1	0.035	7.615	0	6.21	6.77	9	0.396	6.49	6	6.89	7.13	3	0.17	7.01	2
Conventionals																		
Total Suspended Solids mg/L	2	6	100	2.83	4	**71**	2	2	0	0	2	0	1U	1	0	0	0.5	0
Total Persulfate Nitrogen mg/L	0.434	0.33	27	0.074	0.382	19	0.776	0.764	2	0.0085	0.77	1	0.03	0.036	18	0.004	0.033	13
Ammonia Nitrogen mg/L	0.01 U	0.01U	0	0	0	0	0.01 U	0.01U	0	0	0	0	0.01U	0.01U	0	0	0	0
Nitrate+ Nitrite mg/L	0.311	0.31	0	0.0007	0.3105	0	0.706	0.705	0	0.0007	0.7055	0	0.01U	0.01U	0	0	0	0
Total Phosphorus mg/L	0.024	0.025	4	0.0007	0.0245	3	0.027	0.028	4	0.0007	0.0275	3	0.01U	0.01U	0	0	0	0
Soluble Reactive P mg/L	0.009	0.009	0	0.0000	0.009	0	0.007	0.007	0	0	0.007	0	0.003U	0.003U	0	0	0	0
Turbidity NTU	0.8	1.5	61	0.495	1.15	**43**	1.3	1.4	7	0.071	1.35	5	0.6	0.5	18	0.071	0.55	13
Fecal Coliforms #/100/mL	16	17	6	0.707	16.5	4	5	1	133	2.83	3	**94**	1	1	0	0	1	0
Metals																		
Hardness mg/L	25.6	26	2	0.28	25.8	1	16.8	16.3	3	0.354	16.55	2	na	na	na	na	na	na
Dissolved Copper mg/L	0.34	0.3	13	0.028	0.32	9	0.23	0.22	4	0.0071	0.225	3	na	na	na	na	na	na
Dissolved Zinc mg/L	1.7	1.6	6.1	0.071	1.65	4	0.24	0.24	0	0	0.24	0	na	na	na	na	na	na

J = Numerical result is an estimate.

U = Analyte not detected at or above the detection limit shown.

RPD = Relative percent difference (range as percent of duplicate mean).

na = not analyzed

Bold values are above the DQO.

Appendix C

Continuous Temperature Profiles

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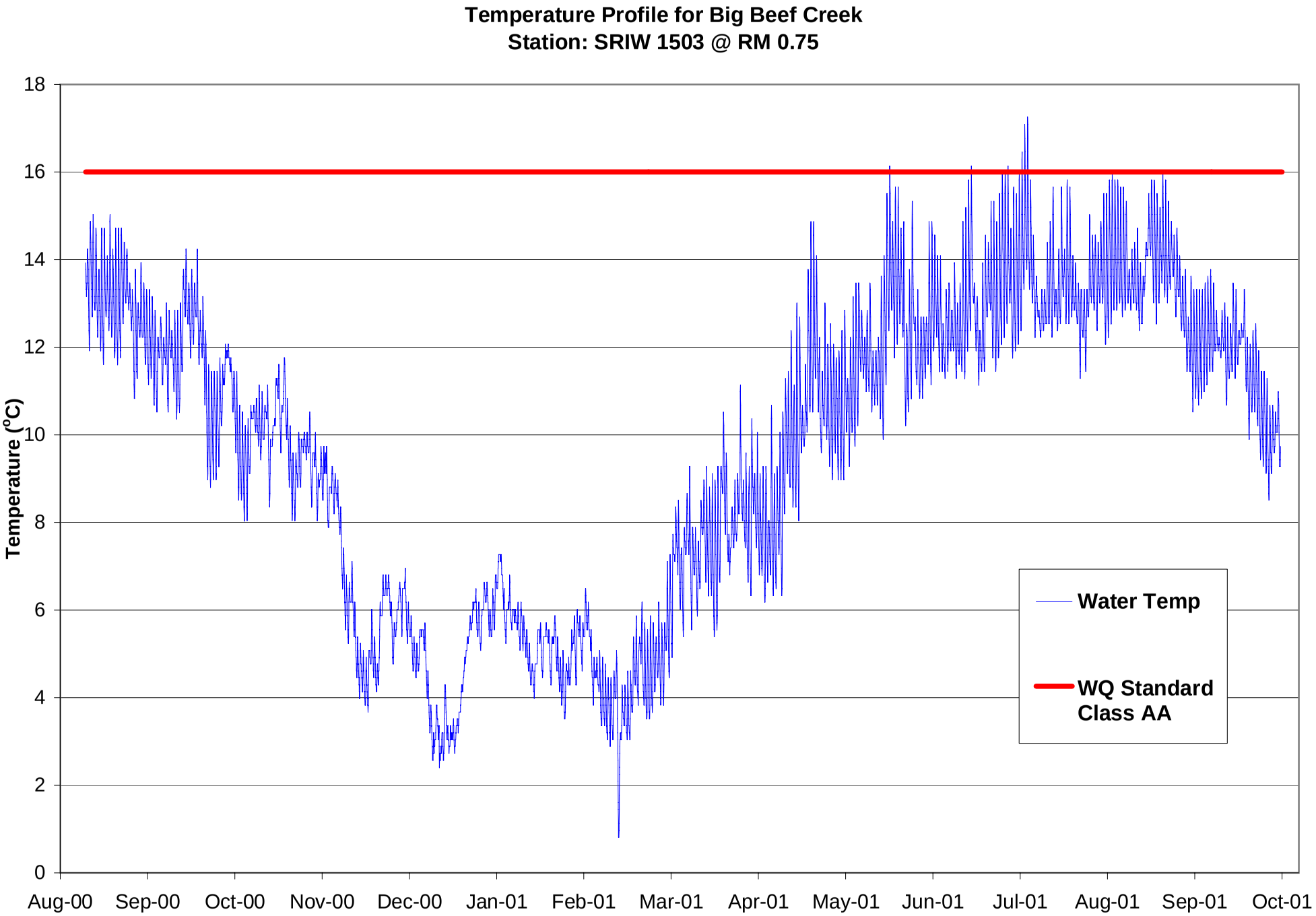
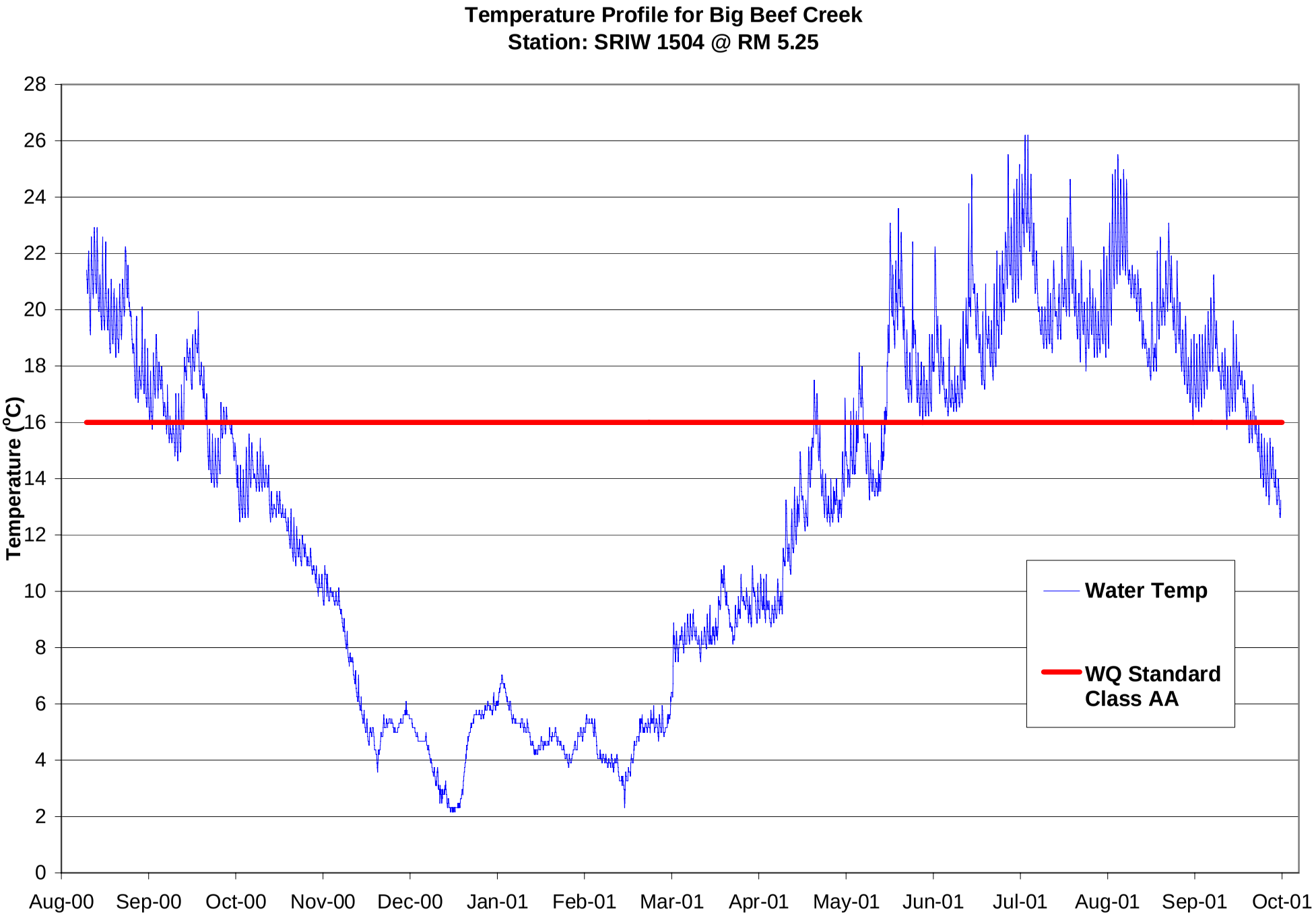
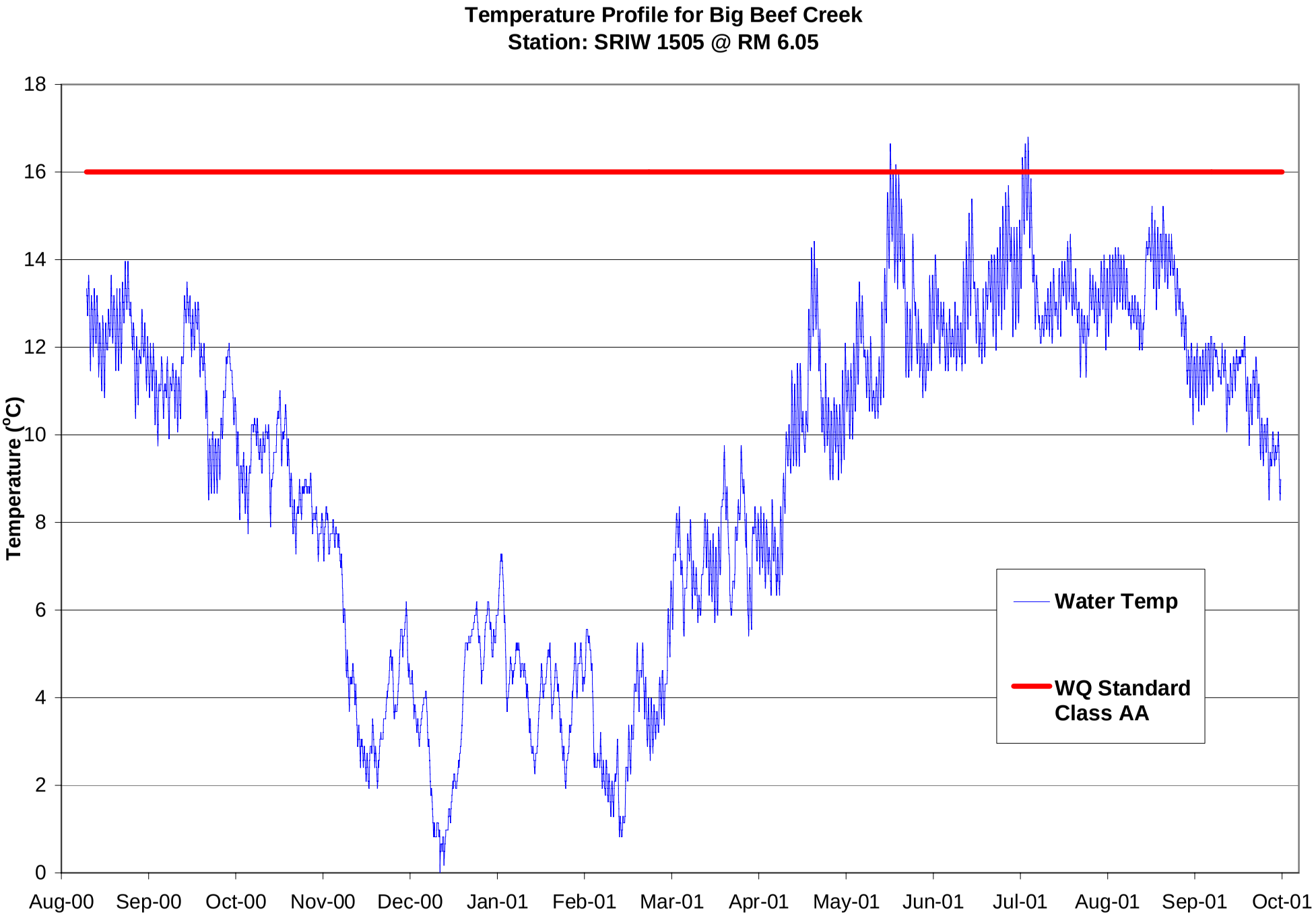
Appendix C1 Average Hourly Temperature Profile



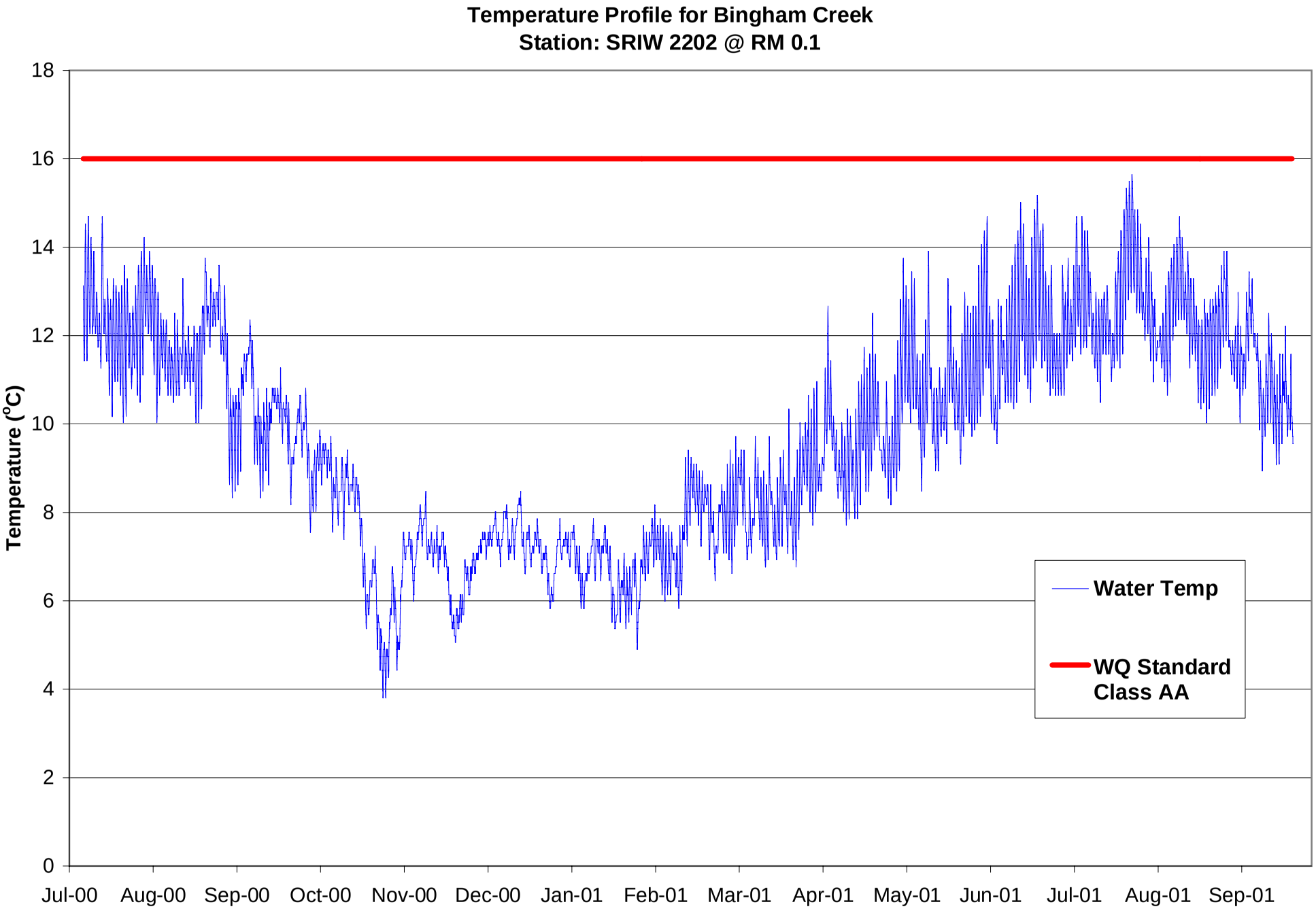
Appendix C2 Average Hourly Temperature Profile



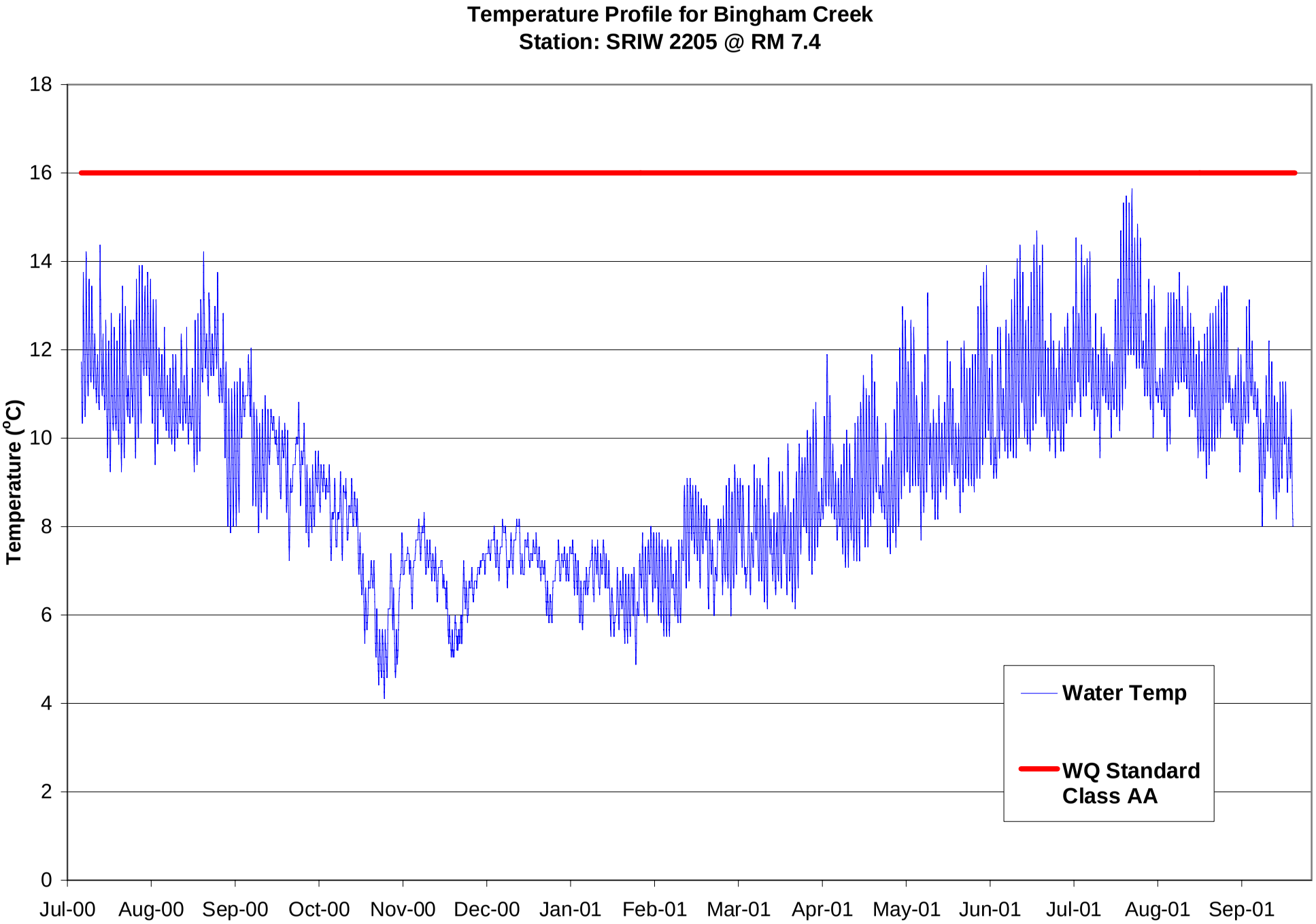
Appendix C3 Average Hourly Temperature Profile



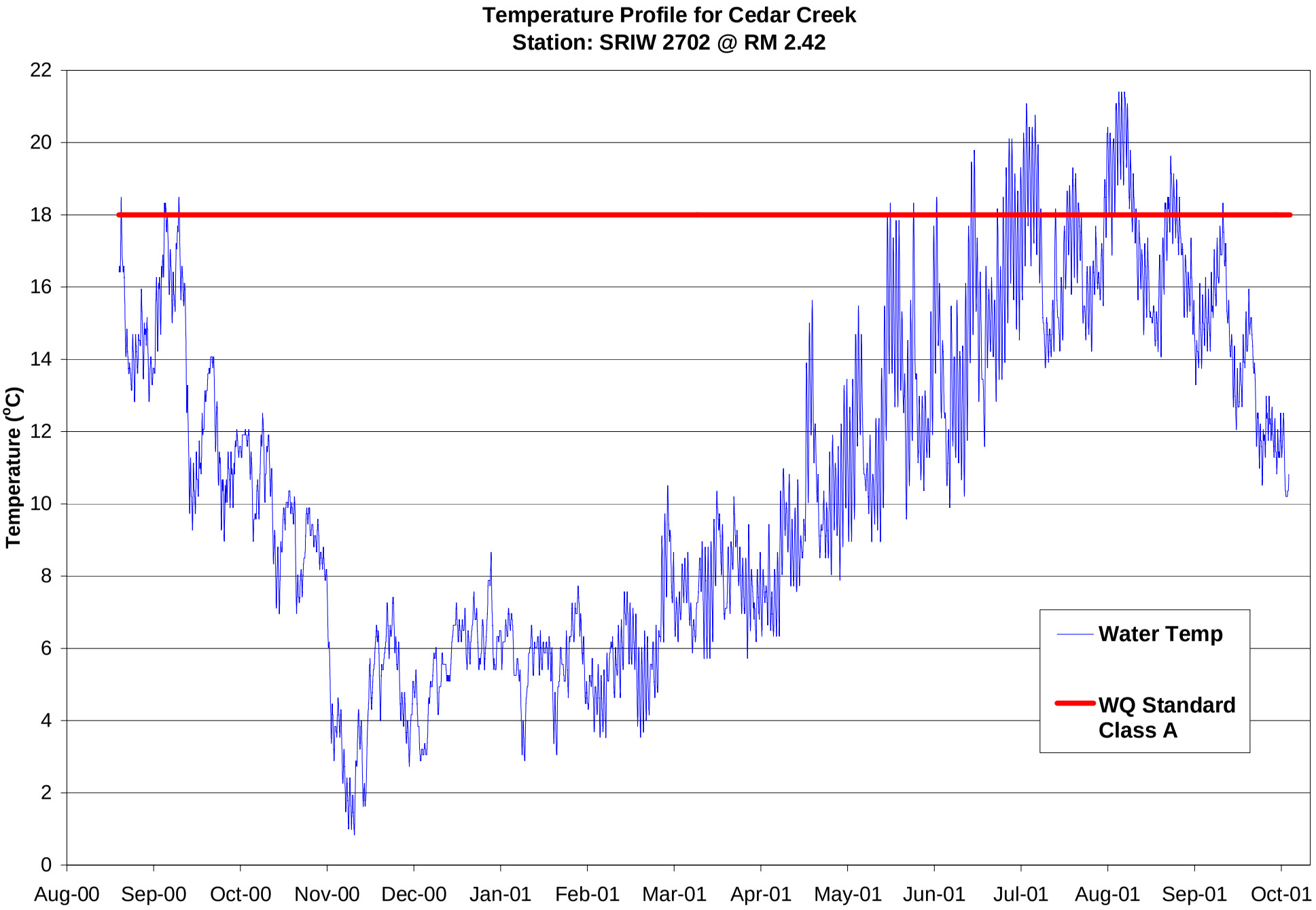
Appendix C4 Average Hourly Temperature Profile



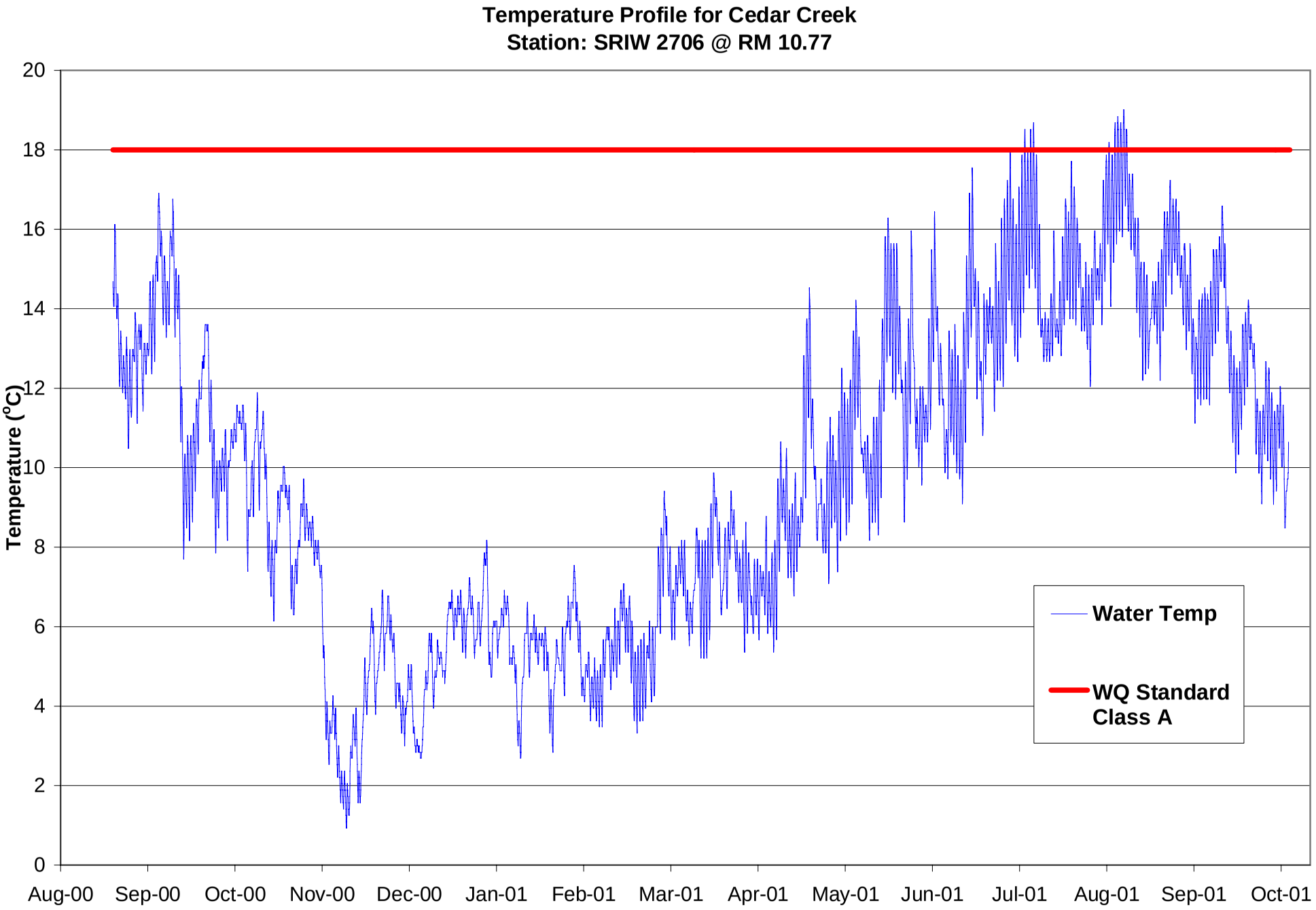
Appendix C5 Average Hourly Temperature Profile



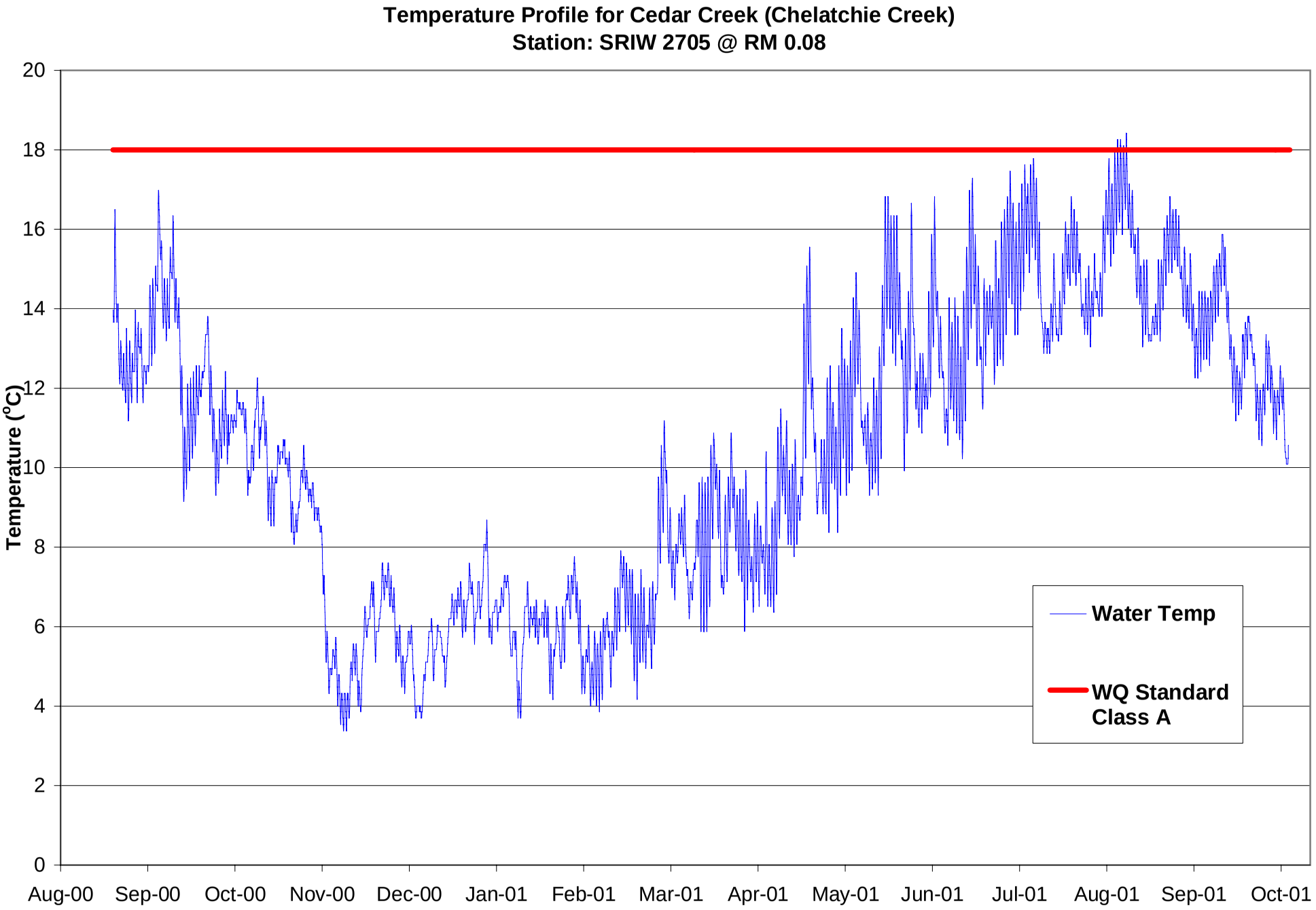
Appendix C6 Average Hourly Temperature Profile



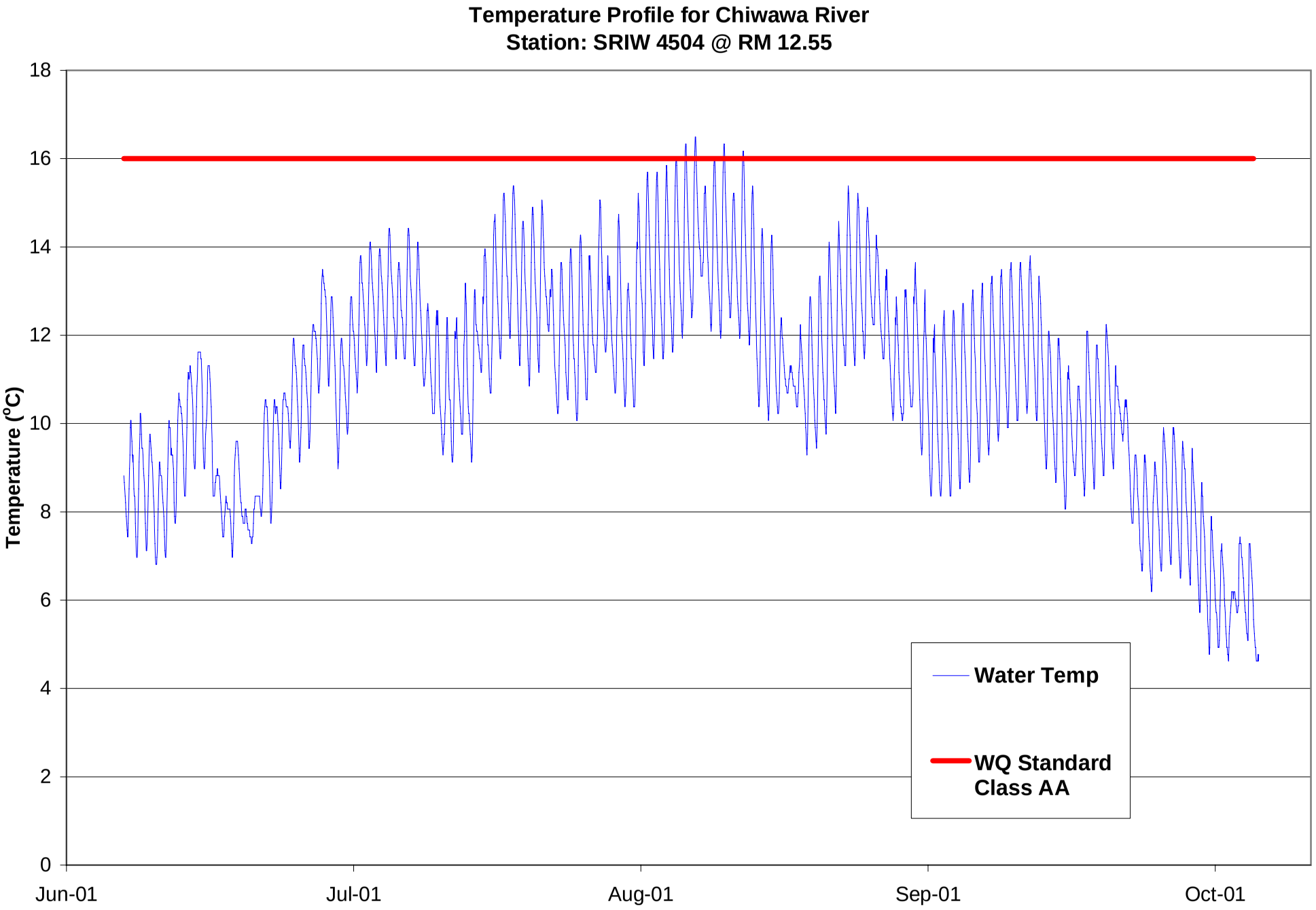
Appendix C7 Average Hourly Temperature Profile



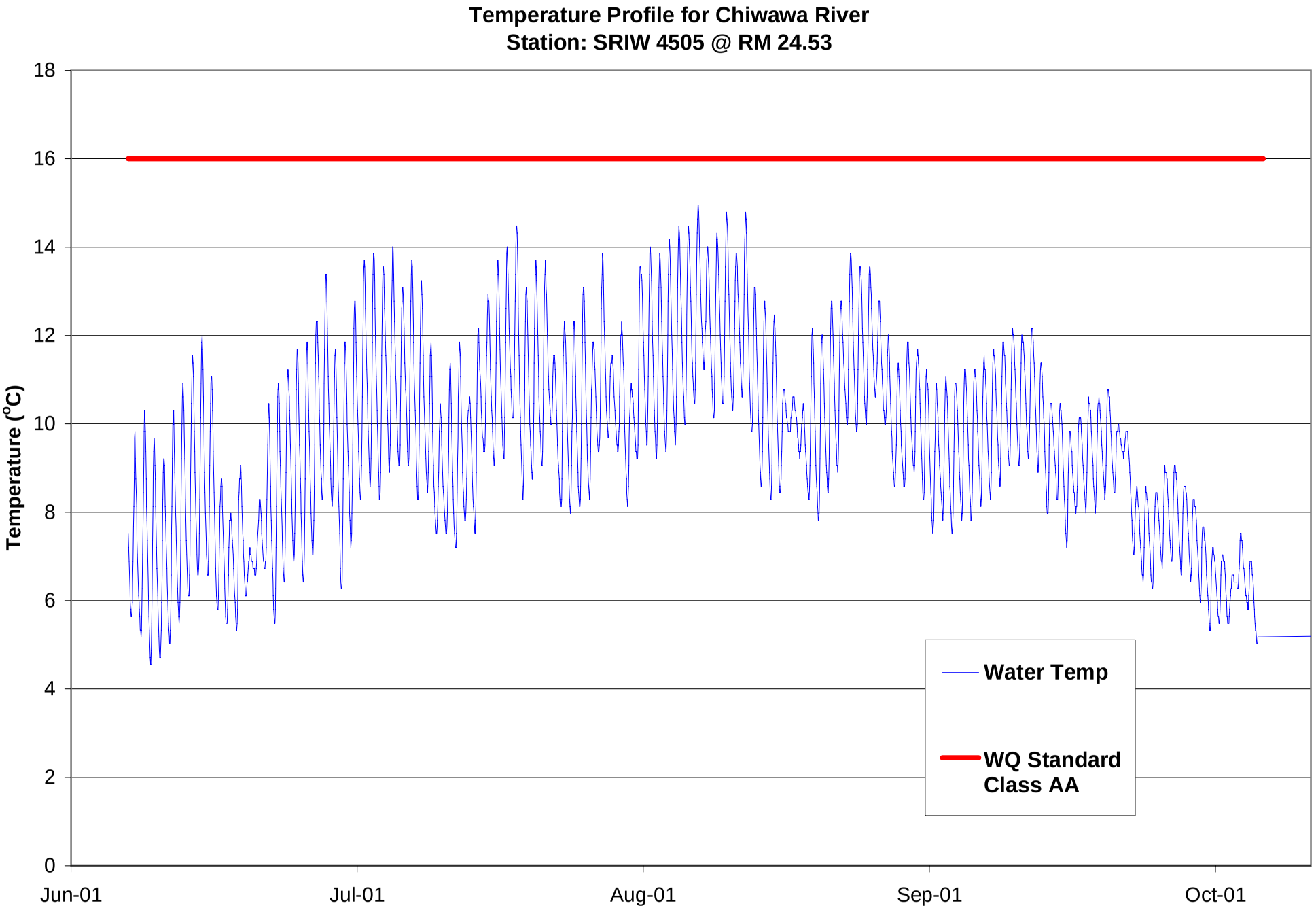
Appendix C8 Average Hourly Temperature Profile



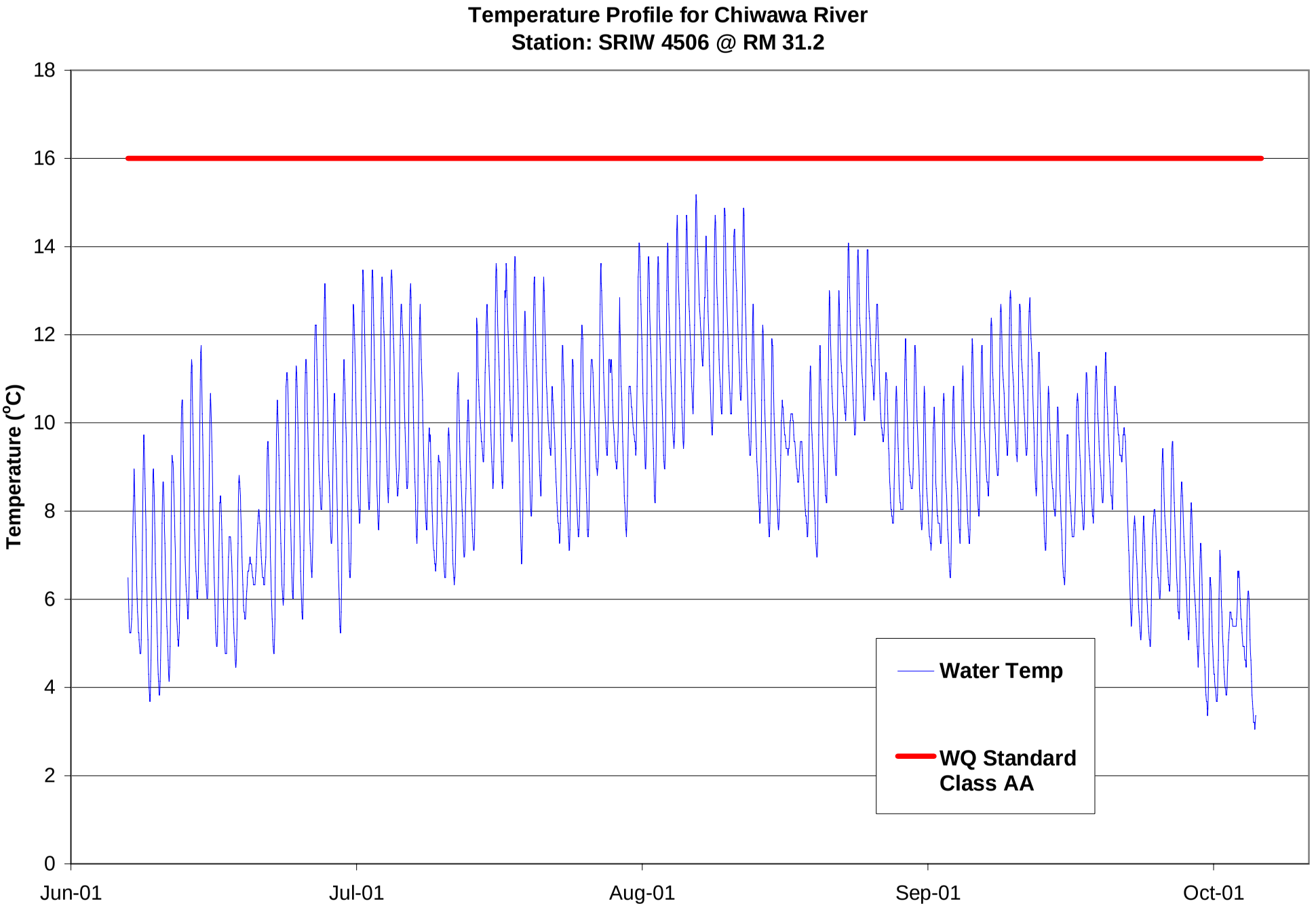
Appendix C9 Average Hourly Temperature Profile



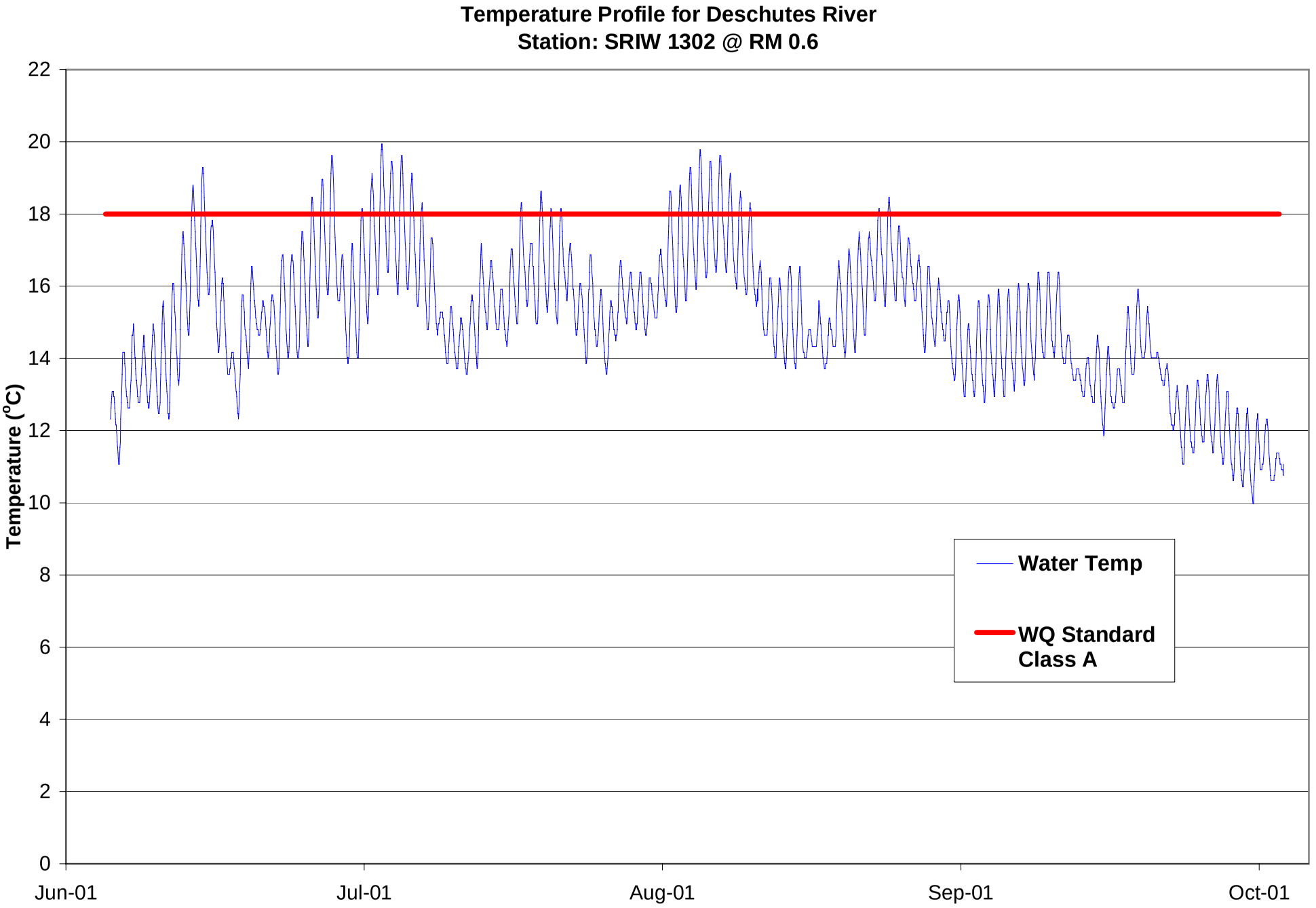
Appendix C10 Average Hourly Temperature Profile



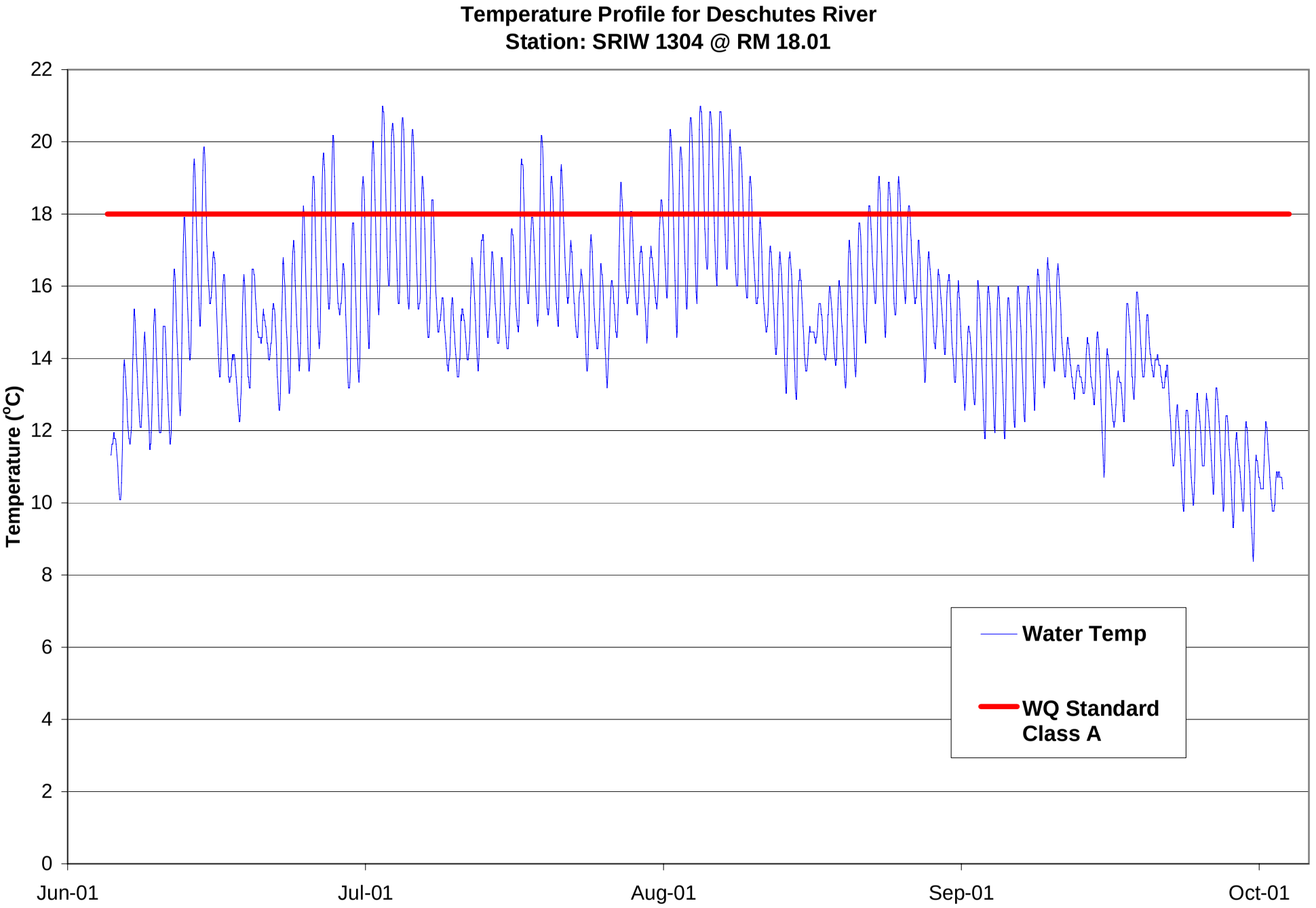
Appendix C11 Average Hourly Temperature Profile



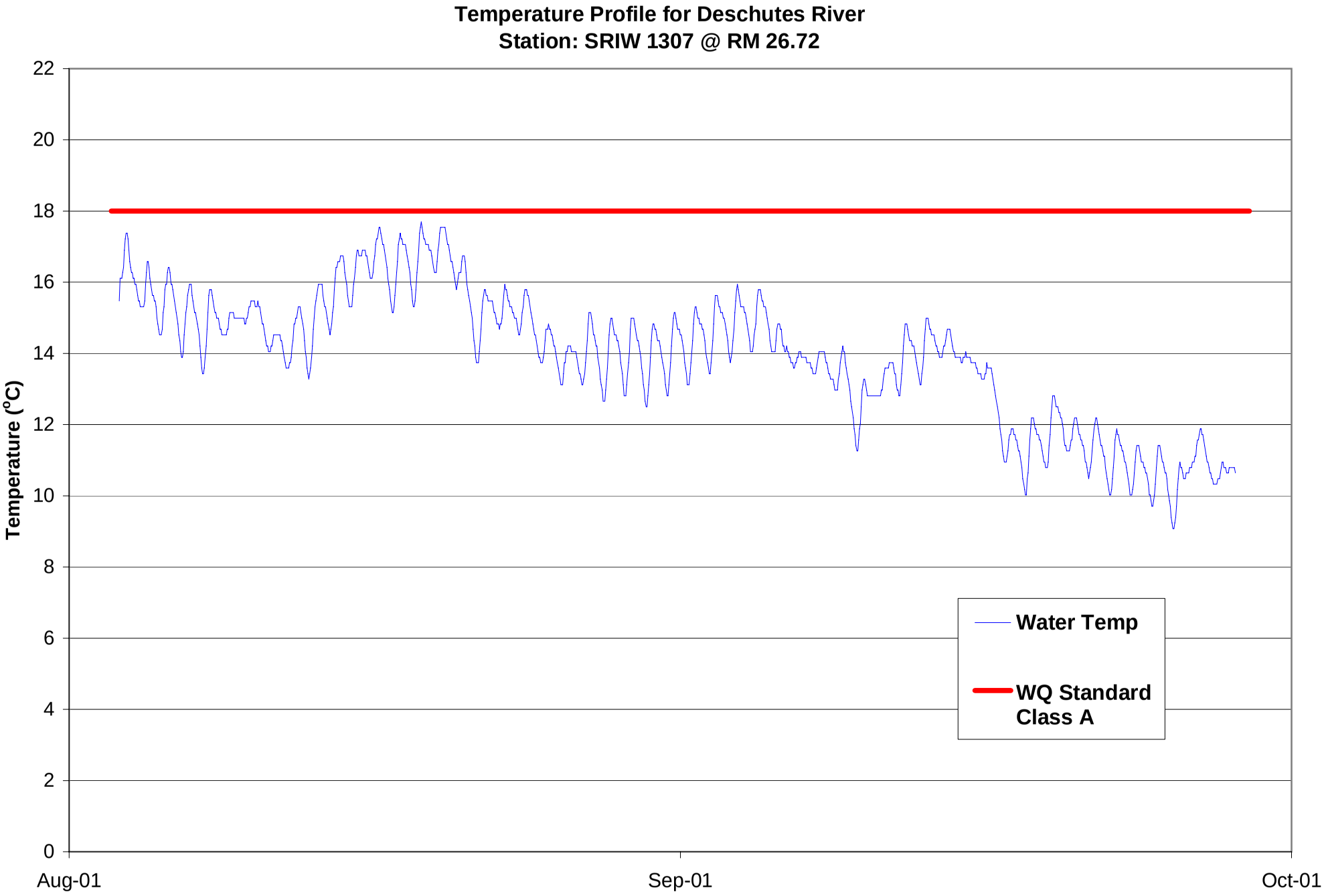
Appendix C12 Average Hourly Temperature Profile

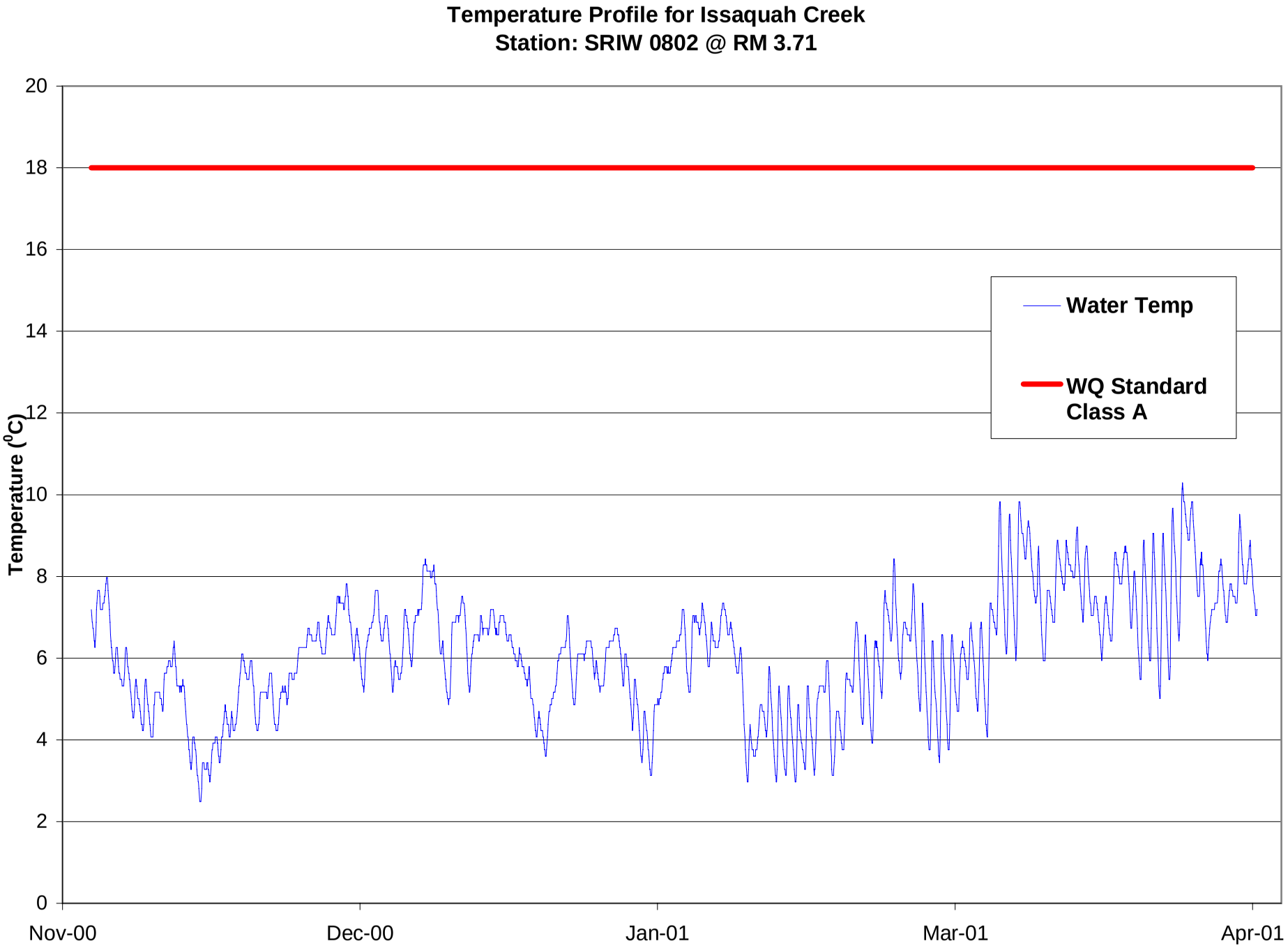


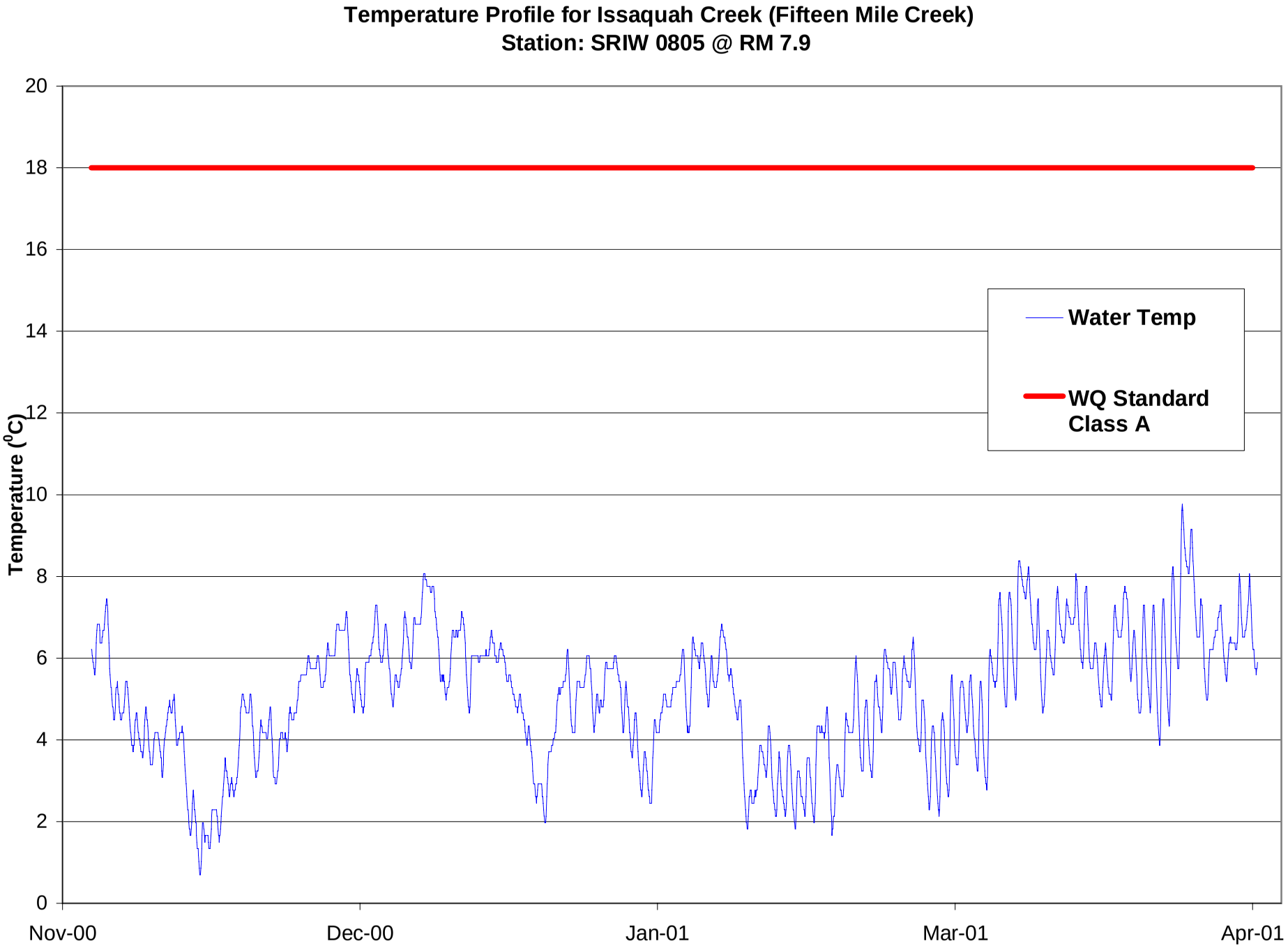
Appendix C13 Average Hourly Temperature Profile

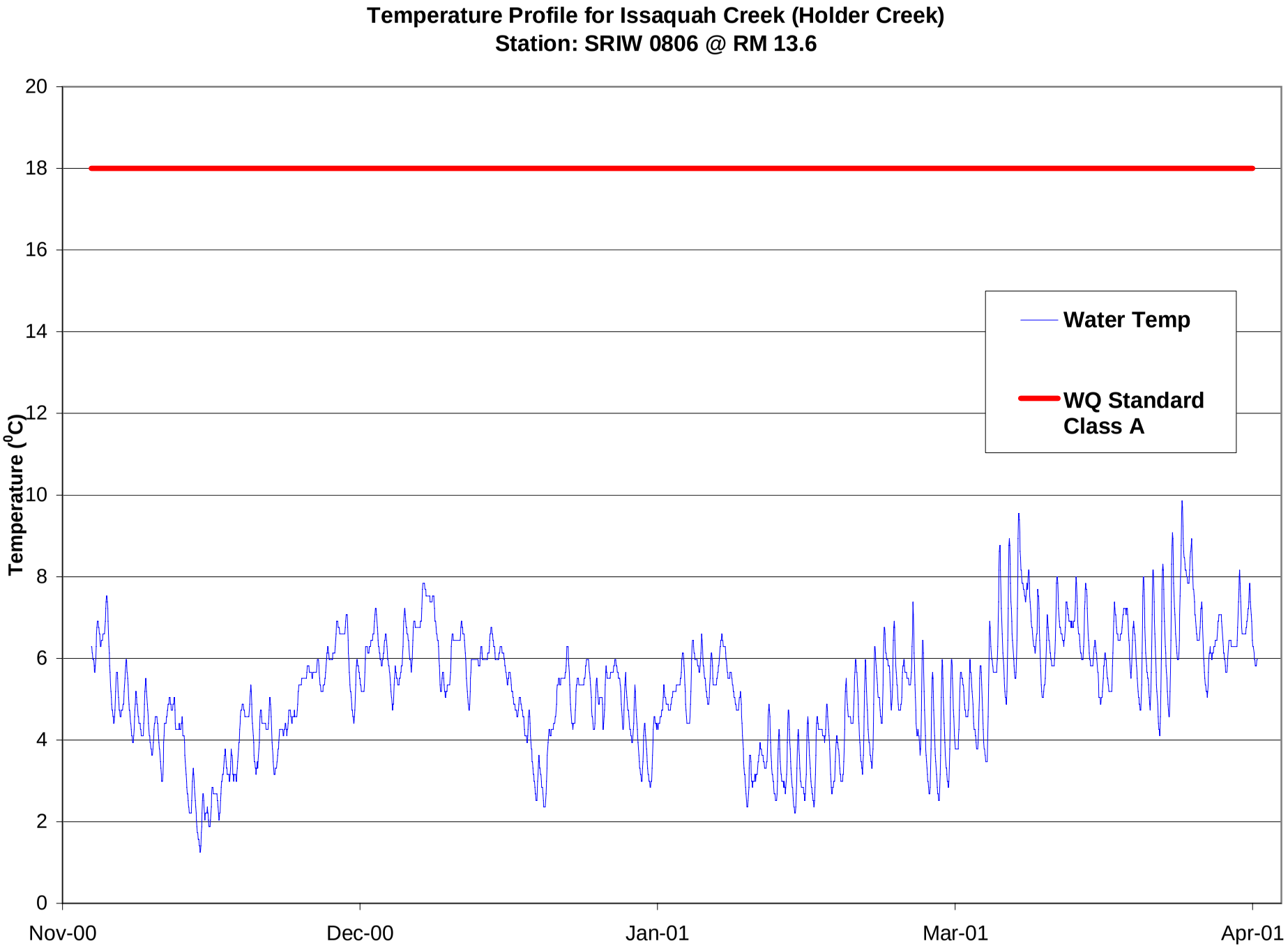


Appendix C14 Average Hourly Temperature Profile

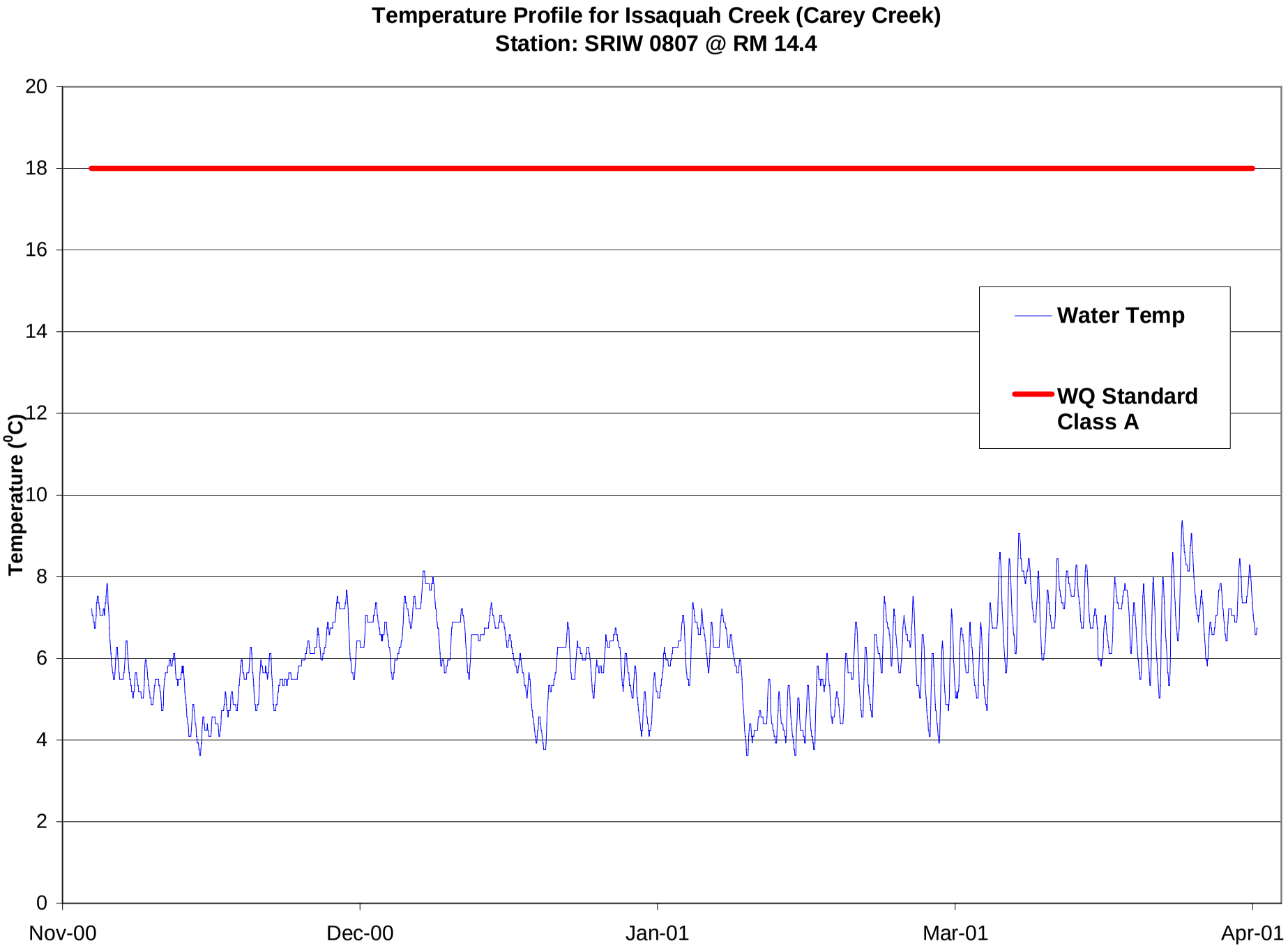


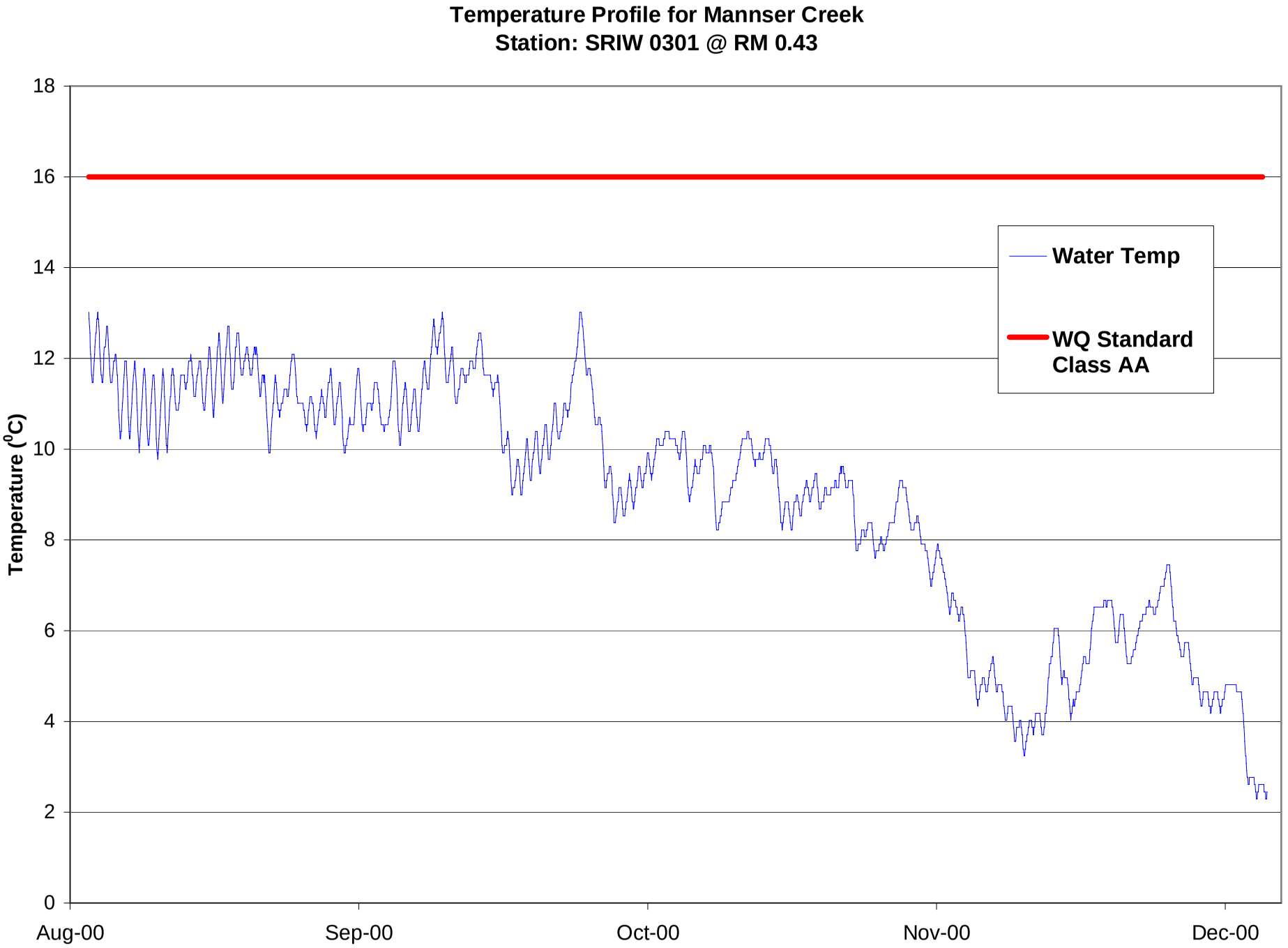

Temperature Profile for Issaquah Creek
Station: SRIW 0802 @ RM 3.71
Temperature (°C)
20
18
16
14
12
10
8
6
4
2
0
Nov-00
Dec-00
Jan-01
Mar-01
Apr-01
Water Temp
WQ Standard Class A

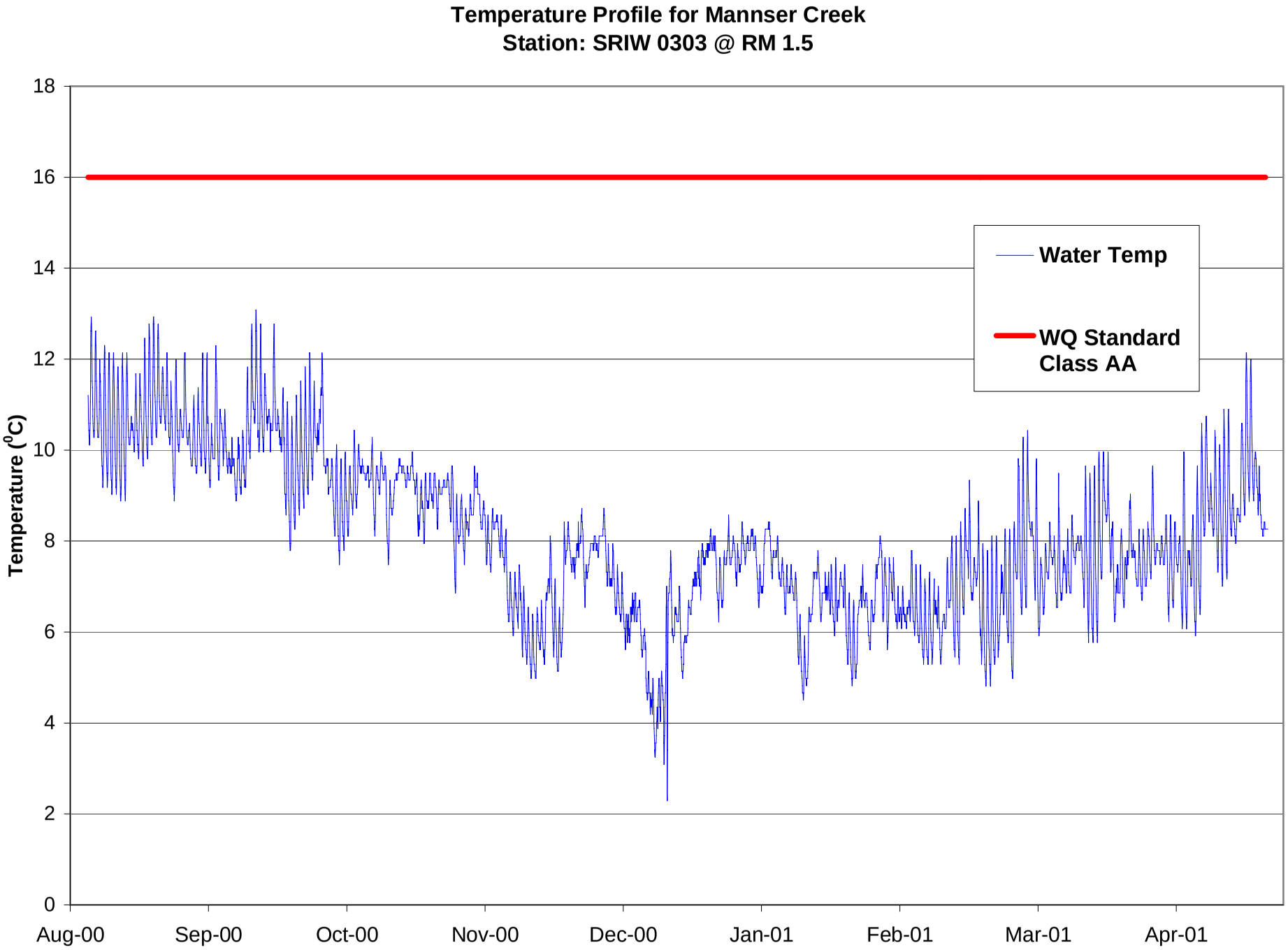

Temperature Profile for Issaquah Creek (Fifteen Mile Creek)
Station: SRIW 0805 @ RM 7.9
Temperature (°C)
20
18
16
14
12
10
8
6
4
2
0
Nov-00
Dec-00
Jan-01
Mar-01
Apr-01
Water Temp
WQ Standard Class A


Temperature Profile for Issaquah Creek (Holder Creek)
Station: SRIW 0806 @ RM 13.6
Temperature (°C)
20
18
16
14
12
10
8
6
4
2
0
Nov-00
Dec-00
Jan-01
Mar-01
Apr-01
Water Temp
WQ Standard Class A

Appendix C18 Average Hourly Temperature Profile




Temperature Profile for Mannser Creek
Station: SRIW 0301 @ RM 0.43
Temperature (°C)
18
16
14
12
10
8
6
4
2
0
Aug-00
Sep-00
Oct-00
Nov-00
Dec-00
Water Temp
WQ Standard Class AA


Temperature Profile for Mannser Creek
Station: SRIW 0303 @ RM 1.5
Temperature (°C)
18
16
14
12
10
8
6
4
2
0
Aug-00
Sep-00
Oct-00
Nov-00
Dec-00
Jan-01
Feb-01
Mar-01
Apr-01
Water Temp
WQ Standard Class AA

Laboratory data sheets are not available electronically.

To read the sheets, request a printed copy of this report (see back of front cover for ordering details)

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Appendix D

Stream Flow Hydrographs

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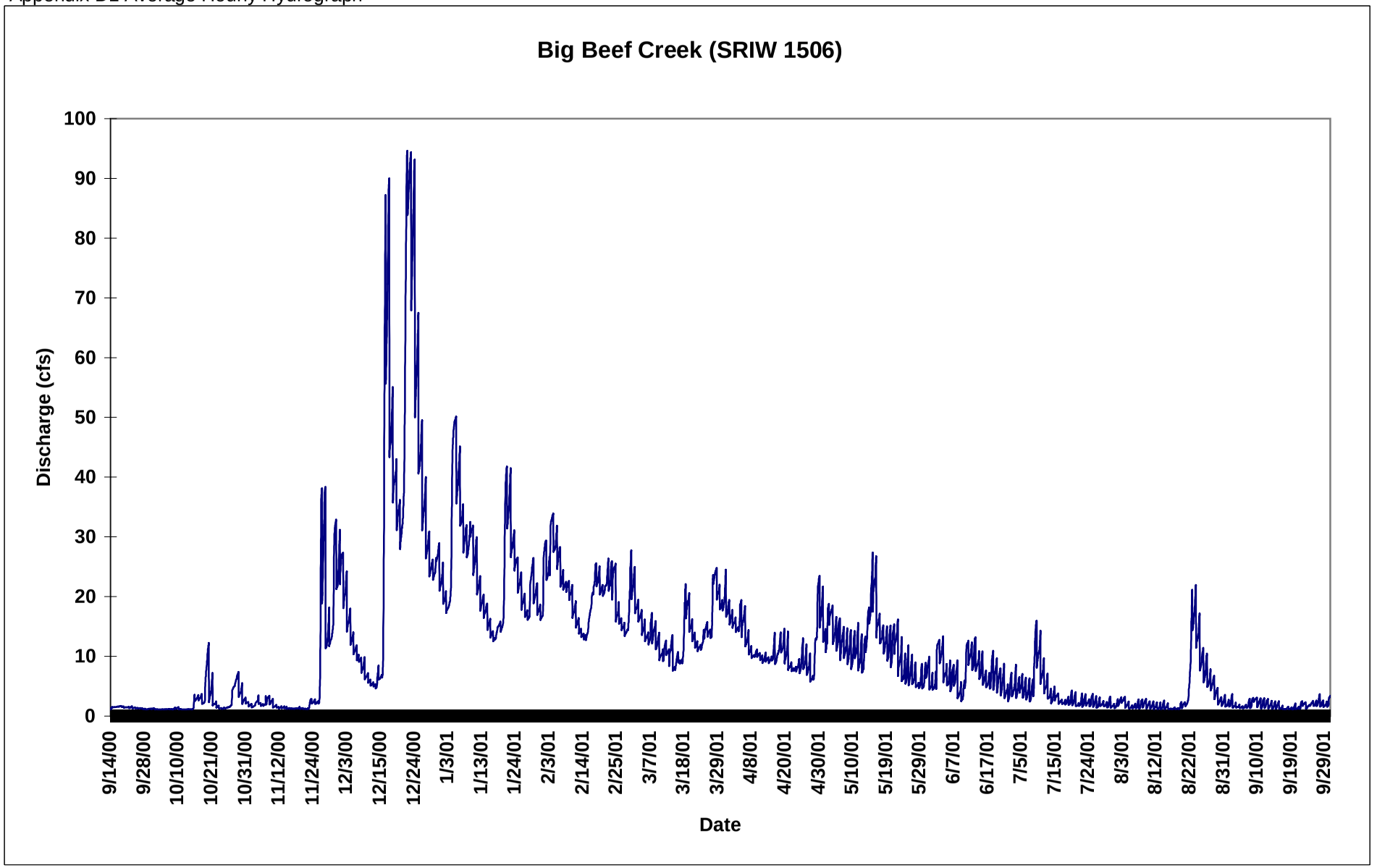
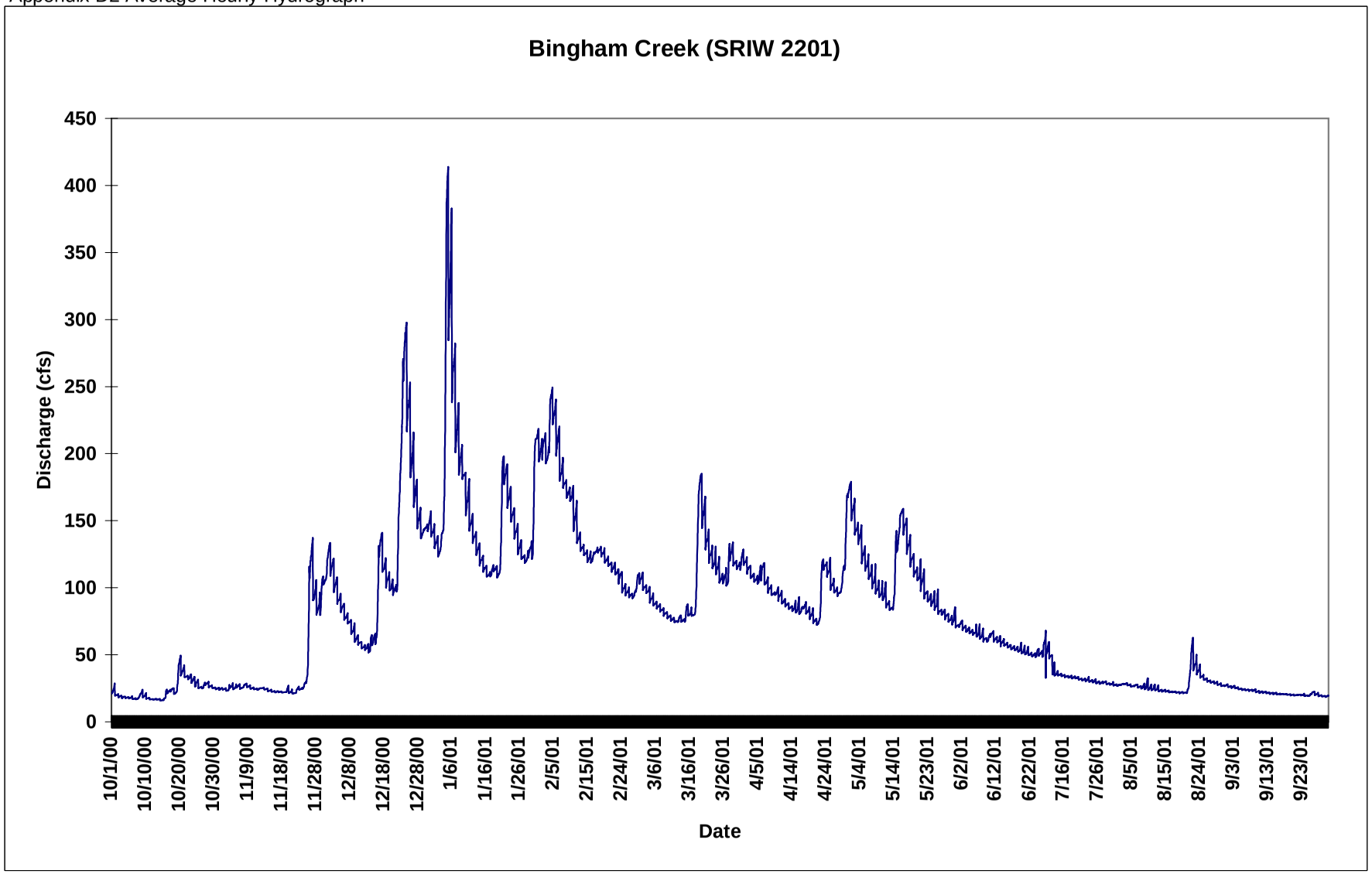
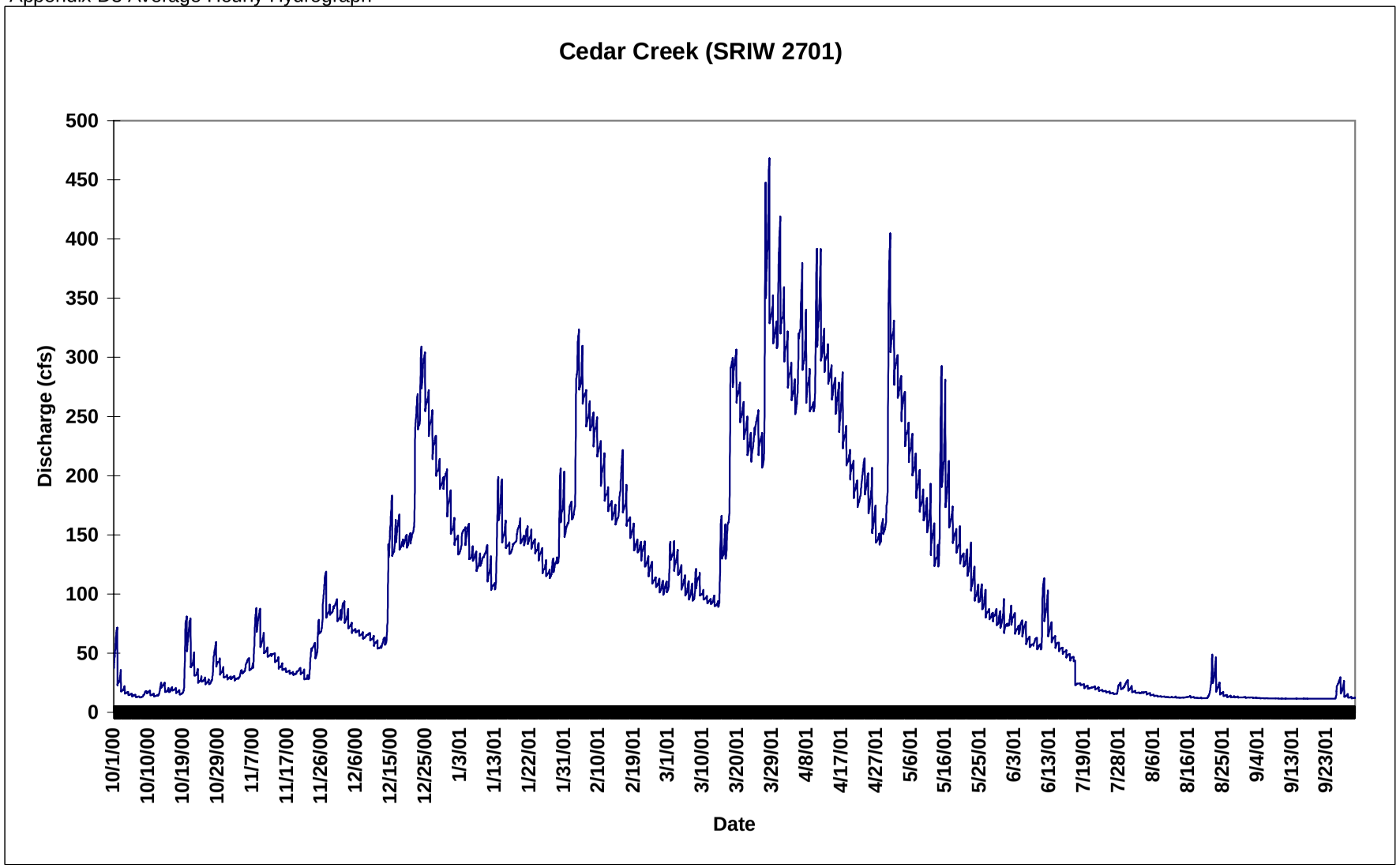
Appendix D1 Average Hourly Hydrograph



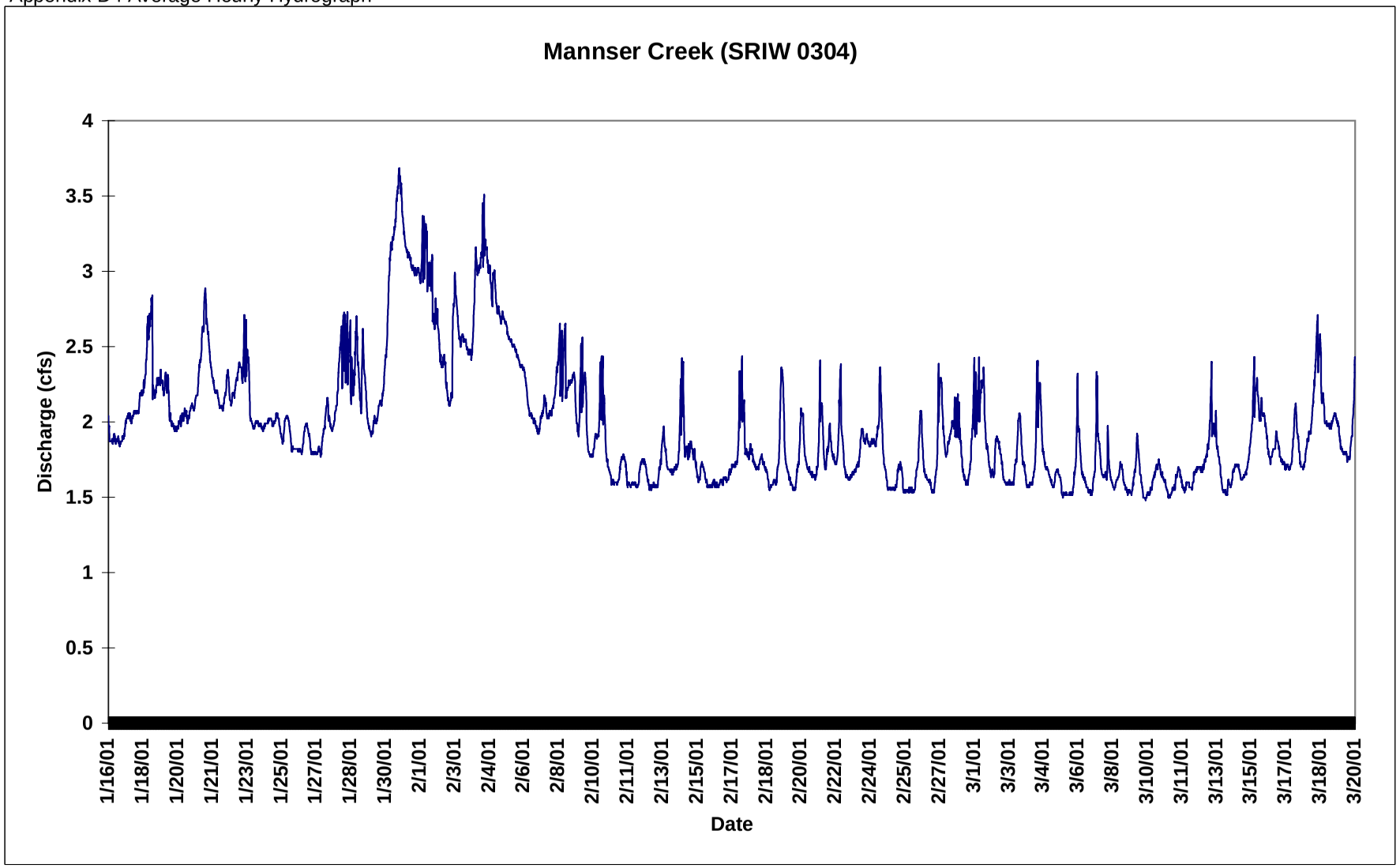
Appendix D2 Average Hourly Hydrograph



Appendix D3 Average Hourly Hydrograph



Appendix D4 Average Hourly Hydrograph



Appendix E

Biological Monitoring Results and B-IBI Scoring Criteria

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Appendix E Biological Monitoring Results

Washington DOE: 2000

Taxon				Big Beef Creek 9/18/00 Count	Unique?	Bingham Creek 9/18/00 Count	Unique?	Issaquah Creek 10/16/00 Count	Unique?	Cedar Creek 10/16/00 Count	Unique?	Mannser 10/31/00 Count	Unique?
Turbellaria			*Polycelis coronata*									28	
			Dugesia							1			
Nematoda			Nematoda	1		1							
Oligochaeta			Oligochaeta	3		1		4		3		196	
Gastropoda	Ancylidae		*Ferrissia*							4			
		Hydrobiidae	*Fluminicola*			1				1			
		Pleuroceridae	*Juga*			1							
Hydracarina			Acari	3		9		8		10			
Ephemeroptera	Baetidae		*Acentrella insignificans*	3		18							
			Baetis tricaudatus	236		69		25		71		14	
			Diphetor hageni	3		1							
		Ephemerellidae	Ephemerellidae - early instar			1		24		5		37	
			Attenella - early instar					4					
			Drunella doddsi			5						10	
		Heptageniidae	*Cinygmula*	11								72	
			Epeorus -early instar					2		9		9	
			Ironodes	3		1						3	
			Rhithrogena robusta	100		87		185		92		2	
		Leptophlebiidae	*Paraleptophlebia- early instar or damaged*	12				1		2			
			Paraleptophlebia temporalis									1	
		Ameletidae	*Ameletus*									2	
		Tricorythidae	*Tricorythodes minutus*							1			
Plecoptera	Capniidae		*Capnia*							4			
			Paraperla									2	
			Sweltsa	35		105		6		3		2	
		Leuctridae	Leuctridae-early instar			1							
		Nemouridae	*Zapada cinctipes*	17		65		3		10			
			Zapada Oregonensis Gr.									1	
		Perlidae	Perlidae - early instar									4	no
			Calineuria californica	2		13		2		1			
			Doroneuria									3	
			Hesperoperla pacifica	3									
		Perlodidae	Perlodidae - early instar							5		6	
			Cultus					3					
			Isoperla	11		1		4					
			Skwala	2		1		2		1			
		Peltoperlidae	*Yoraperla*									27	
Trichoptera	"Arctopsychinae"		*Parapsyche elsis*									8	
		Brachycentridae	*Brachycentrus* -early instar			1	no	22	no				
			Brachycentrus americanus	1		58		2					
			Micrasema			4						3	
		Glossosomatidae	*Glossosoma*	9		57		79		16		41	
		Hydropsychidae	*Hydropsyche*	25		26		15		101			
		Lepidostomatidae	*Lepidostoma* -sand case larvae			1						6	
			Lepidostoma -turret case larvae									1	
		Limnephilidae	Limnephilidae - pupae	2		3							
			Ecclisomyia									1	
		Apataniidae	*Pedomoecus sierra*									2	
		Philopotamidae	*Wormaldia*									2	
		Rhyacophilidae	*Rhyacophila* - early instar							2		1	
			Rhyacophila Betteni Gr.			1						1	
			Rhyacophila Brunnea Gr.	1		7		5		2		5	
			Rhyacophila narvae			3		1				1	
			Rhyacophila valuma									2	
Coleoptera		Elmidae	Elmidae - early instar	4	no	7	no	31	no	6	no		
			Heterlimnius	4		13		14		1			
			Narpus					1					
			Optioservus			1		1		22			
			Zaitzevia	3		1		3		4			
Diptera	Ceratopogonidae		Ceratopogoninae									6	
		Empididae	*Chelifera*	1				1					
			Clinocera					1		3			
		Pelecorhynchidae	*Glutops*			3							
		Psychodidae	*Pericoma*									4	
		Simuliidae	*Simulium*	5						1		2	
		Tipulidae	*Antocha*			1		1		2		39	
			Dicranota	1								5	
			Hexatoma									1	
			Limnophila									1	
		Chironomidae	*Brillia*			3		1				3	
			Eukiefferiella Gracei Gr.			3						13	
			Eukiefferiella Pseudomontana Gr.	10		10							
			Micropsectra	41		40		2		1			
			Orthocladius (Orthocladius)	3		2							
			Pagastia	1		3							
			Parametriocnemus	2								3	
			Polypedilum	11									
			Rheotanytarsus	1		1							
			Stempellinella									3	
			Synorthocladius									2	
			Thienemanniella	1									
			Total identified	571		630		453		384		575	
			Percent of sample used	33		23		27		100		100	
			Estimated total abundance	1730		2739		1678		384		575	
			B-IBI SCORE	28		38		30		26		40	

	Other Selected Metrics					
Richness Measures						
	Taxa Richness	34	39	28	28	42
	EPT Richness	18	22	17	16	28
	E Taxa	7	7	6	6	9
	P Taxa	6	6	6	6	6
	T Taxa	5	9	5	4	13
	Odonata Taxa	0	0	0	0	0
	Coleoptera Taxa	2	3	4	3	0
	Chironomidae Taxa	8	7	2	1	5
	Ephemerellidae Taxa	0	2	2	1	2
	Heptageniidae Taxa	3	2	2	2	4
	Rhyacophilidae Richness	1	3	2	2	5
	Total Individuals	1730	2739	1678	384	575
Composition Measures						
	Percent EPT	83.36	83.97	84.99	84.64	46.78
	Percent Ephemeroptera	64.45	28.89	53.20	46.88	26.09
	Percent Chironomidae	12.26	9.84	0.66	0.26	4.17
	Percent Odonata	0.00	0.00	0.00	0.00	0.00
	Percent Plecoptera	12.26	29.52	4.42	6.25	7.83
	Percent Megaloptera	0.00	0.00	0.00	0.00	0.00
	Percent Coleoptera	1.93	3.49	11.04	8.59	0.00
	Percent Diptera (not incl. Chironomidae)	1.23	0.63	0.66	1.56	10.09
	Percent Contribution of dominant taxon	41.33	16.67	40.84	26.30	34.09
	Percent Contribution of 5 dominant taxa	76.53	60.95	75.94	78.65	66.96
	Percent Multivoltine	55.34	25.40	7.95	21.61	11.48
	Percent Univoltine	41.68	59.37	75.28	69.27	85.57
	Percent Semivoltine	2.98	15.24	16.78	9.11	2.96
	Ratio EPT/Chironomidae	6.80	8.53	128.33	325.00	11.21
Tolerance Measures						
	Number Intolerant Taxa	0.00	3.00	1.00	0.00	7.00
	Percent Tolerant Organisms	43.61	13.17	6.40	26.82	2.61
	HBI	4.15	2.52	1.53	3.08	4.40
	Hydropsychidae/Total Trichoptera	0.66	0.16	0.12	0.83	0.00
	Baetidae/Total Ephemeroptera	0.66	0.48	0.10	0.39	0.09
Trophic/Habit Measures						
	Number Clinger Taxa	13	16	16	14	21.5
	Percent Clingers	31.52	45.56	82.12	69.53	42.26
	Number Filterer Taxa	3	2	1	2	2
	Percent Filterers	5.43	4.29	3.31	26.56	0.70
	Number Scraper Taxa	4	6	4	6	6
	Percent Scrapers	21.54	23.49	58.94	37.50	22.43
	Number Predator Taxa	8	8	9	7	13
	Percent Predators	9.81	21.27	5.52	4.43	8.17
	Number Collector-Gatherer Taxa	12	12	10	10	11
	Percent Collector-Gatherer Taxa	55.34	25.71	24.28	25.26	58.43
	Number Shredder Taxa	1	4	2	2	5
	Percent Shredder Taxa	2.98	11.11	0.88	3.65	6.61
	Scraper/(Scraper+Filterer)	0.80	0.85	0.95	0.59	0.97
	Scrapers/Filterers	3.97	5.48	17.80	1.41	32.25
	B-IBI METRICS					
	Taxa richness	34	39	28	28	42
	E richness	7	7	6	6	9
	P richness	6	6	6	6	6
	T richness	5	9	5	4	13
	INTOLERANT taxa richness	0	3	1	0	7
	Clinger richness	13	16	16	14	21.5
	LL richness	5	7	6	5	3
	% tolerant	43.61	13.17	6.40	26.82	2.61
	% predator	9.81	21.27	5.52	4.43	8.17
	% dominance (3)	66.02	41.43	65.12	68.75	53.74
	METRIC SCORES					
	Taxa richness	3	3	3	3	5
	E richness	3	3	3	3	5
	P richness	3	3	3	3	3
	T richness	3	3	3	1	5
	INTOLERANT taxa richness	1	3	1	1	5
	Clinger richness	3	3	3	3	5
	LL richness	5	5	5	5	3
	% tolerant	3	5	5	3	5
	% predator	1	5	1	1	1
	% dominance (3)	3	5	3	3	3

Appendix E2. B-IBI Scoring Criteria

Biological metrics for stream invertebrates, response to human disturbance, and scoring criteria used to integrate into the benthic index of biological integrity, B-IBI. Criteria are for species level identification of most insects, rhyacophilids to subgroup, and chironomids to genus. Square braces indicate the value next to the brace is included in the range; rounded parentheses indicate the value is *not* included.

		Scoring criteria		
Metric	**Response**	**1**	**3**	**5**
Taxa richness and composition				
Total number of taxa	Decrease	[0, 20)	[20, 40]	> 40
Number of Ephemeroptera taxa	Decrease	[0, 4]	(4, 8]	> 8
Number of Plecoptera taxa	Decrease	[0, 3]	(3, 7]	> 7
Number of Trichoptera taxa	Decrease	[0, 5)	[5, 10)	10
Number of long-lived taxa	Decrease	[0, 2]	(2, 4]	> 4
Tolerance				
Number of intolerant taxa	Decrease	[0, 2]	(2, 3]	> 3
% of individuals in tolerant taxa	Increase	50	(19, 50)	[0, 19]
Feeding ecology				
% of predator individuals	Decrease	[0, 10)	[10, 20)	20
Number of clinger taxa	Decrease	[0, 10]	(10, 20]	> 20
Population attributes				
% dominance (3 taxa)	Increase	75	[50, 75)	[0, 50)

Sources:

Fore, L.S. (1999) Measuring the effects of urbanization on Bellevue streams. Final report to City of Bellevue Utilities Department, Bellevue, Washington.

Fore, L.S., K. Paulsen, & K. O'Laughlin. (In press) Assessing the performance of volunteers in monitoring streams. Freshwater Biology.

Karr, J. R. (1998) Rivers as sentinels: using the biology of rivers to guide landscape management. River Ecology and Management: Lessons from the Pacific Coastal Ecosystem (eds. R.J. Naiman and R.E. Bilby), pp. 502-528. Springer, NY.

Karr, J. R. (1999) Defining and measuring river health. Freshwater Biology, 41, 221-234.

Adjustments to scoring criteria for family-level identification of chironomids

Some metric values will change when chironomids are identified to the level of family rather than genus; other metrics will not be affected. Total taxa richness and number of clinger taxa are lower for samples without genus-level identification for chironomids and the scoring criteria are adjusted below (Table A-1). A few chironomids are predators and the values for this metric decline slightly; but differences are too small to change scoring criteria. Percent dominance increases because the family group of chironomids will be larger. Chironomids could be excluded from this metric, but are included because chironomids often dominate at disturbed sites. Taxa richness of Ephemeroptera, Plecoptera, and Trichoptera do not change. There are no long-lived chironomids. Chironomids are not included in the percent tolerant or intolerant taxa richness metrics because I am not confident that their assignments are correct; I have seen many "intolerant" chironomids at extremely degraded sites. Thus these metrics do not change when chironomids are identified to the level of family.

Table E-2. Biological metrics for which scoring criteria change when chironomids are identified at the family rather than genus level. Name of the metrics, response to human disturbance, and scoring criteria are listed. Criteria require species level identification for most insects. Square braces indicate the value next to the brace is included in the range; rounded parentheses indicate the value is *not* included.

		Scoring criteria		
Metric	**Response**	**1**	**3**	**5**
Total number of taxa	Decrease	[0, 15)	[15, 28]	> 28
Number of clinger taxa	Decrease	[0, 8]	(8, 18]	> 18
% dominance (3 taxa)	Increase	80	[60, 80)	[0, 60)

Appendix F

Water Quality Index

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Appendix F: Monthly Water Quality Index Scores

Monthly water quality index scores sorted by parameter.
Data collected between 10/01/00 and 10/01/01.

Date	Station	Monthly WQI Score	Class	Ecoregion	Fecal Coliform Bacteria	Dissolved Oxygen	pH	Total Suspended Solids	Temperature ^{0}C	Total Persulfate Nitrogen	Total Phosphorus	Turbidity
Big Beef Creek												
Oct-00	SRIW1501	92	AA	2	92.72	82.77	100	92.31	92.70	99.33	86.23	95.31
Nov-00	SRIW1501	99	AA	2	100	99.03	99.00	100	100	100	88.25	100
Dec-00	SRIW1501	98	AA	2	100	100	93.60	100	100	93.01	91.75	100
Jan-01	SRIW1501	88	AA	2	91.43	100	74.31	100	100	93.11	98.39	99.98
Feb-01	SRIW1501	92	AA	2	81.18	100	80.40	100	100	93.63	90.30	100
Mar-01	SRIW1501	98	AA	2	100	95.49	98.98	100	96.87	96.58	91.75	100
Apr-01	SRIW1501	96	AA	2	100	98.50	83.04	100	99.19	98.27	95.73	100
May-01	SRIW1501	94	AA	2	98.97	87.62	88.32	100	89.62	99.98	94.07	99.62
Jun-01	SRIW1501	90	AA	2	81.18	89.39	98.74	92.31	89.36	91.57	80.45	93.99
Jul-01	SRIW1501	84	AA	2	77.55	88.96	86.30	100	88.04	91.76	85.20	100
Aug-01	SRIW1501	90	AA	2	96.80	83.69	96.33	100	80.42	92.08	79.57	100
Sep-01	SRIW1501	94	AA	2	97.83	91.86	94.18	100	88.04	93.02	86.23	100
Bingham Creek												
Oct-00	SRIW2203	96	AA	2	93.42	96.14	99.75	92.31	94.76	100	89.49	100
Nov-00	SRIW2203	98	AA	2	98.97	98.50	96.16	100	99.82	100	85.71	100
Dec-00	SRIW2203	99	AA	2	100	100	97.74	100	100	100	89.60	100
Jan-01	SRIW2203	88	AA	2	100	97.37	71.53	98.66	99.73	100	95.73	100
Feb-01	SRIW2203	97	AA	2	100	100	87.82	100	100	100	86.96	100
Mar-01	SRIW2203	97	AA	2	100	99.53	93.40	100	97.92	100	88.25	100
Apr-01	SRIW2203	98	AA	2	95.85	97.94	97.74	100	98.20	100	92.51	100
May-01	SRIW2203	95	AA	2	87.77	96.14	94.93	100	96.71	100	94.89	100
Jun-01	SRIW2203	94	AA	2	92.05	97.94	96.16	92.31	96.03	97.73	79.57	100
Jul-01	SRIW2203	77	AA	2	89.21	95.15	60.39	100	94.17	99.82	95.68	100
Aug-01	SRIW2203	92	AA	2	83.91	91.06	88.56	100	90.61	100	90.64	100
Sep-01	SRIW2203	95	AA	2	94.17	94.11	88.80	100	94.95	98.42	93.07	100
Cedar Creek												
Oct-00	SRIW2703	91	A	3	92.56	100	99.26	92.31	97.74	75.28	84.20	100
Nov-00	SRIW2703	95	A	3	91.80	100	94.18	100	100	81.53	86.96	100
Dec-00	SRIW2703	88	A	3	93.81	100	100	100	100	60.99	88.25	100
Jan-01	SRIW2703	87	A	3	88.35	100	90.43	100	100	61.09	93.28	99.98
Feb-01	SRIW2703	79	A	3	93.81	100	85.24	100	100	49.07	85.11	99.98
Mar-01	SRIW2703	78	A	3	98.17	100	71.89	100	100	62.27	87.60	99.98
Apr-01	SRIW2703	84	A	3	92.17	100	100	96.54	100	54.00	90.30	96.39
May-01	SRIW2703	61	A	3	48.19	100	80.10	85.17	99.06	74.44	84.52	87.17
Jun-01	SRIW2703	43	A	3	49.68	100	90.20	68.62	96.33	62.95	70.27	68.47
Jul-01	SRIW2703	70	A	3	71.21	99.57	75.32	92.31	90.91	73.70	85.20	91.58
Aug-01	SRIW2703	71	A	3	82.63	93.40	81.30	86.31	69.52	78.27	78.71	91.58
Sep-01	SRIW2703	89	A	3	86.59	98.48	93.00	81.88	88.44	81.60	82.28	93.99

<40 WQ does not meet expectations (highest concern) 40-79 some WQ Standard exceedences (moderate concern) ≥80 WQ met expectations (lowest concern)