WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

# River and Stream Ambient Monitoring Report for Water Year 1998

September 2000

Publication No. 00-03-035
*Printed on Recycled Paper*

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ECOLOGY

# River and Stream Ambient Monitoring Report for Water Year 1998

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# Acknowledgments

Many people contributed time, effort, and expertise to the Water Year 1998 program:

- ◊ Special thanks to Rob Plotnikoff and Dale Clark who helped collect samples. Thanks for the long hours behind the wheel and a dedication to get the job done.

- ◊ Thanks to Ken Dzinbal and Art Johnson, who reviewed the manuscript, and Michelle Ideker, who prepared the final document.

At Manchester Environmental Laboratory:

- ◊ Pam Covey, Karin Feddersen, Stuart Magoon, and Debi Case did the sample tracking.
- ◊ Kitty Bickle, Becky Bogaczyk, Debbie LaCroix, Casey Maggart, and Aileen Richmond performed general chemistry analyses.
- ◊ Nancy Jensen was responsible for the microbiology.
- ◊ Sally Cull, Susan Davis, Randy Knox, Myrna McIntosh, and Jim Ross worked on low level metals.
- ◊ Will White was the sample courier.

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# Abstract

The Washington State Department of Ecology collected monthly water quality information at 84 river and stream monitoring stations during Water Year (WY) 1998 (October 1, 1997 through September 30, 1998). The principal goals of this ongoing monitoring program are to characterize the rivers and streams of Washington State and to track changes in water quality.

Overall, water quality for WY 1998 was similar to that measured in previous years, based on the total number of results exceeding water quality criteria. Fewer results exceeded the fecal coliform bacteria criteria in western Washington, but more results exceeded the temperature and pH criteria in eastern Washington than in the past few years. The fecal coliform bacteria geometric mean was still the most frequently exceeded criterion based on individual samples. The geometric mean criterion was exceeded 113 times and 57 samples exceeded the “10 percent not to exceed” criterion, out of about 1000 samples collected. Forty-five of 84 stations had at least one sample that exceeded the geometric mean criterion. Twenty-five stations were west of the Cascade Mountains, and 14 were stations on streams that drain to Puget Sound.

Temperature and pH standards criteria were exceeded 88 and 59 times, respectively, at 50 and 24 stations, mostly in eastern Washington. The dissolved oxygen criterion was exceeded 39 times at 25 stations, also most often in eastern Washington. A description of this long-term monitoring program and access to historical data can be found on Ecology's internet web site at http://www.ecy.wa.gov/ under “Conditions and Trends” and “Watersheds”.

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# Introduction

The Washington State Department of Ecology (Ecology) and its predecessor agency has operated a long-term Ambient Water Quality Monitoring Program since 1959. The current program consists of monthly water quality monitoring for conventional parameters at about 80 stations on rivers and streams within Washington State. The principal goals of this program are to characterize stream water quality and to evaluate spatial and temporal changes in water quality (trends). Within Ecology, the data generated by the River and Stream Ambient Monitoring Program are used to determine if designated uses are supported (e.g., Ecology, 1996), to support wasteload allocation models, to develop water quality based permits, to prepare 305(b) and other management reports, and to provide water quality information necessary to prioritize grant awards.

The purpose of this report is to:

◊ Describe the Water Year (WY) 1998 monitoring program.
◊ Discuss data quality.
◊ Present results.

More detailed analyses and interpretations of ambient monitoring data are reported elsewhere. The Environmental Monitoring and Trends (EMT) section analyzes results at specific stations in response to requests by clients, especially in association with the data analysis phase of the “basin approach” (e.g., Hallock, 1996). The basin approach consists of a five-year cycle of scoping, data collection, data analysis, planning, and implementation of plans in 22 hydrologic Water Quality Management Areas (WQMA) or "basins" statewide (Wrye, 1993). In any given year, each of the above activities will be underway in four groups of basins, one in each Ecology region. Other programs conduct some analyses of their own; for example, Ecology’s Water Quality Program applies its own data reduction procedures prior to updating Washington’s 305(b) report.

EMT section data were analyzed from the following basins during the scoping phase of the cycle: Spokane (Ehinger et. al, 1997), Lower Yakima (Joy, et al., 1996), Cedar/Green (Erickson, et. al, 1997), and Eastern Olympics (Norton, et. al, 1997). Additional data collection was focused in these basins in WY 1998.

# Methods

## Sampling Network

The ambient monitoring network in WY 1998 consisted of monthly water collection at two types of stations:  (1) long-term and (2) regional or basin stations (Ehinger, 1995).  Long-term stations are monitored every year to track water quality changes over time (trends) and to assess inter-annual variability, as well as to collect current water quality information.  These stations are generally located near the mouths of major rivers, below major population centers, upstream from most anthropogenic sources of water quality problems, or where major streams enter the state.  Basin stations are generally monitored for one year only (although they may be re-visited every five years) to collect current water quality information.  These stations are selected to support Ecology's basin approach to water quality management, the waste discharge permitting process, and to allow expanded coverage over a long-term network.  Some basin stations are selected to target known problems and may not necessarily reflect ambient conditions.

The locations of ambient stations monitored during WY 1998 are presented in Figure 1 and Table 1.  Four WQMAs were scheduled for more intensive monitoring in WY 1998: Mid-Columbia, Upper Yakima, Kitsap, and Lower Columbia.  Most, but not all, "basin stations" were located in these WQMAs.  Appendix A lists current and historical monitoring locations and the years they were monitored by Ecology and its predecessor agencies.  Historical data for these stations are available from Ecology's EMT section on request.  Also, a description of our long-term monitoring program and access to historical data can be found on the Ecology internet web site at http://www.ecy.wa.gov/ under "Conditions and Trends" and "Watersheds".

## Sample Collection and Analysis

The majority of water samples were collected as single surface grab samples from highway bridges.  Twelve water quality constituents were monitored at all stations monthly in WY 1998 (Table 2) and metals plus total hardness were monitored bimonthly at selected stations (Table 3).  Recording thermisters were placed in several streams in July and August.  Data are included here for Crab Creek above Moses Lake and Sand Hollow Creek.  Also, a continuous recording device was placed in the Spokane River for one week during each of those months.  Sample collection and analytical methods are described in detail in earlier annual reports (e.g., Hallock, et al., 1998) in the EMT section's quality assurance documents (i.e., Hopkins, 1996 and Ehinger, 1995) and in Manchester Environmental Laboratory's (MEL) Laboratory User's Manual (Ecology, 1994).

Any long-term monitoring program will experience changes in sampling or analytical procedures that can potentially affect results.  Normally, changes will result in improved precision or reduced bias.  Most changes will have only a minor affect on a synoptic analysis of the data but even improvements in procedures can mislead the unwary analyst of long-term trends.  We made no changes to collection or analytical procedures in WY 1998.  All earlier known and suspected changes to methods and procedures during the history of the River and Stream Ambient Monitoring Program, as well as large-scale environmental changes that may affect trends are documented in Appendix B.

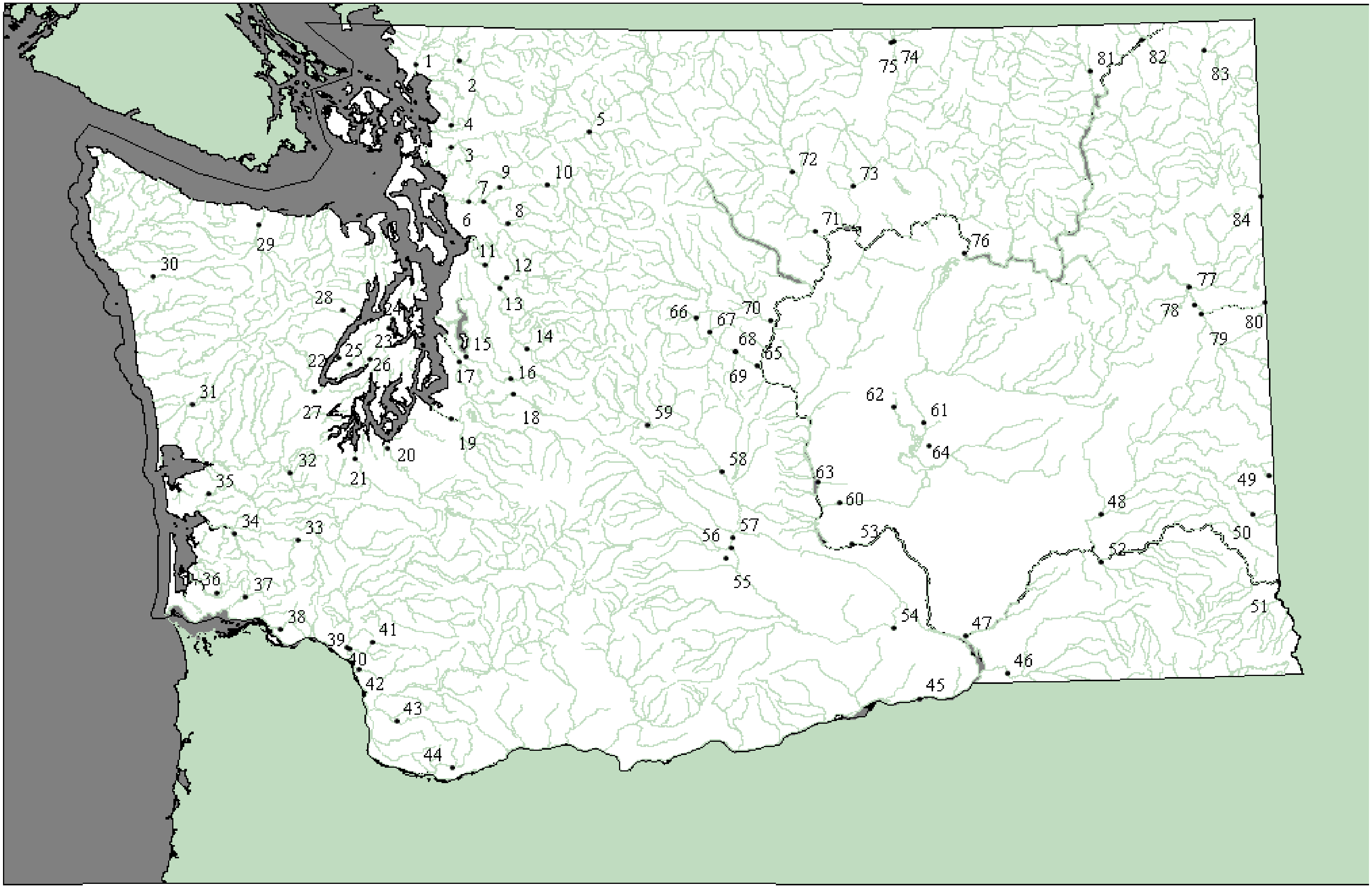


Figure 1. Ecology's river and stream monitoring stations for water year 1998. Table 1 is the map key.

Table 1. Ecology river and stream ambient monitoring stations for Water Year 1998. Stations in WQMAs scheduled for data collection are shown in bold type.

| Map | Station | Station Name | Map | Station | Station Name |
|---|---|---|---|---|---|
| 1 | 01A050 | Nooksack R @ Brennan | 43 | 27D090 | EF Lewis R nr Dollar Corner |
| 2 | 01A120 | Nooksack R @ No Cedarville | 44 | 28B110 | Washougal R blw Canyon Ck |
| 3 | 03A060 | Skagit R nr Mount Vernon | 45 | 31A070 | Columbia R @ Umatilla |
| 4 | 03B050 | Samish R nr Burlington | 46 | 32A070 | Walla Walla R nr Touchet |
| 5 | 04A100 | Skagit R @ Marblemount | 47 | 33A050 | Snake R nr Pasco |
| 6 | 05A070 | Stillaguamish R nr Silvana | 48 | 34A070 | Palouse R @ Hooper |
| 7 | 05A090 | SF Stillaguamish @ Arlington | 49 | 34A170 | Palouse R @ Palouse |
| 8 | 05A110 | SF Stilly nr Granite Falls | 50 | 34B110 | SF Palouse R @ Pullman |
| 9 | 05B070 | NF Stillaguamish @ Cicero | 51 | 35A150 | Snake R @ Interstate Br |
| 10 | 05B110 | NF Stilly nr Darrington | 52 | 35B060 | Tucannon R @ Powers |
| 11 | 07A090 | Snohomish R @ Snohomish | 53 | 36A070 | Columbia R nr Vernita |
| 12 | 07C070 | Skykomish R @ Monroe | 54 | 37A090 | Yakima R @ Kiona |
| 13 | 07D050 | Snoqualmie R nr Monroe | 55 | 37A205 | Yakima R @ Knob Hill |
| 14 | 07D130 | Snoqualmie R @ Snoqualmie | **56** | **38A050** | **Naches R @ Yakima on US HWY 97** |
| 15 | 08C070 | Cedar R @ Logan St/Renton | **57** | **39A050** | **Yakima R @ Harrison Bridge** |
| 16 | 08C110 | Cedar R nr Landsburg | **58** | **39A060** | **Yakima R @ Ellensburg** |
| 17 | 09A080 | Green R @ Tukwila | **59** | **39A090** | **Yakima R nr Cle Elum** |
| 18 | 09A190 | Green R @ Kanaskat | **60** | **41A070** | **Crab Cr nr Beverly** |
| 19 | 10A070 | Puyallup R @ Meridian St | **61** | **41A110** | **Crab Cr nr Moses Lake** |
| 20 | 11A070 | Nisqually R @ Nisqually | **62** | **41D070** | **Rocky Ford Creek @ Hwy 17** |
| 21 | 13A060 | Deschutes R @ E St Bridge | **63** | **41E070** | **Sand Hollow Creek on Hwy 26** |
| **22** | **15A070** | **Dewatto R nr Dewatto** | **64** | **41F100** | **Rocky Ford Coulee Drain** |
| **23** | **15B050** | **Chico Cr nr Chico** | 65 | 45A070 | Wenatchee R @ Wenatchee |
| **24** | **15C070** | **Clear Cr @ Silverdale** | 66 | 45A110 | Wenatchee R nr Leavenworth |
| **25** | **15D090** | **Tahuya R nr Belfair** | 67 | 45C070 | Chumstick Cr nr Leavenworth |
| **26** | **15E070** | **Union R nr Belfair** | 68 | 45D070 | Brender Cr nr Cashmere |
| 27 | 16A070 | Skokomish R nr Potlatch | 69 | 45E070 | Mission Cr nr Cashmere |
| 28 | 16C090 | Duckabush R nr Brinnon | 70 | 46A070 | Entiat R nr Entiat |
| 29 | 18B070 | Elwha R nr Port Angeles | 71 | 48A070 | Methow R nr Pateros |
| 30 | 20B070 | Hoh R @ DNR Campground | 72 | 48A140 | Methow R @ Twisp |
| 31 | 22A070 | Humptulips R nr Humptulips | 73 | 49A070 | Okanogan R @ Malott |
| 32 | 23A070 | Chehalis R @ Porter | 74 | 49A190 | Okanogan R @ Oroville |
| 33 | 23A160 | Chehalis R @ Dryad | 75 | 49B070 | Similkameen R @ Oroville |
| **34** | **24B090** | **Willapa R nr Willapa** | 76 | 53A070 | Columbia R @ Grand Coulee |
| **35** | **24D070** | **North R nr Raymond** | 77 | 54A120 | Spokane R @ Riverside State Pk |
| **36** | **24F070** | **Naselle R nr Naselle** | 78 | 55B070 | Little Spokane R nr Mouth |
| **37** | **25B070** | **Grays R nr Grays River** | 79 | 56A070 | Hangman Cr @ Mouth |
| **38** | **25C070** | **Elochoman R nr Cathlamet** | 80 | 57A150 | Spokane R @ Stateline Br |
| **39** | **26B070** | **Cowlitz R @ Kelso** | 81 | 60A070 | Kettle R nr Barstow |
| **40** | **26C070** | **Coweeman R @ Kelso** | 82 | 61A070 | Columbia R @ Northport (USGS) |
| **41** | **26C080** | **Coweeman R av Goble Cr** | 83 | 62A090 | Pend Oreille @ Metaline Falls |
| 42 | 27B070 | Kalama R nr Kalama | 84 | 62A150 | Pend Oreille R @ Newport |

Table 2. Water quality constituents monitored monthly in Water Year 1998 as part of Ecology's river and stream ambient monitoring program.

| Standard constituents monitored at all stations: | | |
|---|---|---|
| conductivity | total suspended solids | total phosphorus |
| dissolved oxygen | turbidity | ammonia |
| ph | fecal coliform bacteria | nitrate + nitrite |
| temperature | soluble reactive phosphorus | total nitrogen |

Table 3. Metals were sampled approximately bi-monthly at the listed stations. (Total hardness was also sampled at all metals stations.)

| STATION Number | Name | Dissolved metals and total mercury [a] | Total recoverable metals [b] |
|---|---|---|---|
| 08C070 | Cedar R nr Logan St/Renton | X | X |
| 11A070 | Nisqually R @ Nisqually | X | X |
| 45A070 | Wenatchee R @ Wenatchee | X | |
| 57A150 | Spokane R @ Stateline Br | X | X |
| 61A070 | Columbia R @ Northport | X | |

[a]Dissolved metals: cadmium, copper, lead, and nickel, zinc
[b]Total recoverable metals: arsenic, cadmium, chromium, copper, and lead, zinc

## Quality Assurance

MEL's Quality Assurance (QA) Program includes the use of quality control charts, check standards, in-house matrix spikes and laboratory blanks, along with quarterly performance evaluation samples. For a more complete discussion of laboratory quality assurance, see MEL's Quality Assurance Manual (Ecology, 1988) and Laboratory User's Manual (Ecology, 1994).

The QA program for field sampling consisted of three parts: (1) adherence to a procedures manual for sample/data collection and periodic evaluation of sampling personnel, (2) instrument calibration methods and schedules, and (3) the collection of a field quality control (QC) sample twice during each sampling run. Our QA program is described in detail in Ehinger (1995).

Three types of field QC samples were collected:

◊ Duplicate (Sequential) Field Samples - These consisted of an additional sample collection made approximately 15-20 minutes after the initial collection at a station. These samples represent the variability due to short-term in-stream processes, sample collection and processing, and laboratory analysis.

◊ Field Blank - These consisted of the submission and analysis of deionized water. The expected value for all analyses is the reporting limit for that analysis. Significantly higher results would indicate that sample contamination had occurred during field processing or during laboratory analysis.

◊ Duplicate (Split) Field Samples - These consisted of one sample split into two containers which are processed as individual samples. This eliminates the in-stream variability and isolates the variability to that due to field processing and laboratory analysis.

Because of problems with incorrectly identified sequential and split samples, these results were pooled. QC samples were submitted semi-blind to the laboratory (they were identified as QC samples, but sample type (duplicate, blank, or split) and station were not identified).

Approximately 80 field QC samples were processed: five field blanks and 75 field splits and sequential samples. In addition, the laboratory analyzed some field QC samples in duplicate (*i.e.*, lab split samples). The central tendency of the variance of pairs of split field samples was summarized by calculating the square root of the mean of the sample-pair variances (root-mean-square - RMS). These figures provide an unbiased (and higher) estimate than other commonly used statistics (mean or median of the standard deviations).

A two-tiered system was used to evaluate data quality. The first tier consisted of five automated checks, including holding time, variability in field duplicates, and reasonableness of the result. Results exceeding pre-set limits were flagged. The second tier QC evaluation was a manual review of the data flagged in the first tier. Data were then coded from one through nine (one = data meets all QA requirements, nine = data are unusable). Data with quality codes greater than four are generally not distributed outside the agency.

# Results and Discussion

The primary purpose of this report is to present the results of Ecology's river and stream monitoring in WY 1998. Appendix C is a list, by Ecology region, of station and number of results exceeding various criteria. Appendix D contains results for each station monitored in WY 1998. Appendix E is a quarterly summary of data collected during the past six years for each long-term station. Raw data are available in computer formats on request and the most recent published WY's data are posted on Ecology's World Wide Web pages (http://www.ecy.wa.gov/). Appendix F is a series of graphics showing results of continuous monitoring (mostly of temperature).

While a station-by-station data analysis is not within the scope of this report, some general observations are appropriate. This section summarizes general water quality with respect to Washington's water quality standards (Washington Administrative Code, Chapter 173-201A). Basin stations were included in the following analyses, although they are tabulated separately in Appendix C. These stations, however, are sometimes selected because of a known water quality problem and results may not necessarily be representative of general water quality conditions in the state. Therefore, the summaries in this report may be slightly biased toward worse water quality than a true statewide average.

The discussion, below, focuses on excursions beyond criteria presented in the water quality standards (Table 4), that is, results outside an acceptable range. An excursion beyond a criterion does not necessarily indicate a water quality standards violation. To be considered a violation, a temperature result, for example, must exceed the criterion *due to human activities*. The fecal coliform standards imply data should be collected within a 30-day period, although the standards do not specify the number of samples required. (In our opinion, if greater than 10 percent of monthly samples exceed the "10 percent" criterion, there is a very high probability that several samples collected within 30 days would also exceed the criterion.) Ultimately, Ecology's Water Quality Program has the responsibility and authority for designating water segments as being in violation of state water quality standards. Segments in violation of standards are reported to the EPA every two years in Ecology's "303(d)" list (e.g., Ecology, 1996).

Water quality for WY 1998 was similar to that measured in previous years based on the total number of results exceeding water quality criteria. Fewer results exceeded the fecal coliform bacteria criteria in western Washington, but more results exceeded the temperature and pH criteria in eastern Washington than in the past few years, probably due to a warmer and drier summer than usual (Henderson, 1998 and Lilly, 1999). The fecal coliform bacteria geometric mean was still the most frequently exceeded criterion *based on individual samples*. The geometric mean criterion was exceeded by 113 samples and 57 samples exceeded the "10 percent not to exceed" criterion, out of about 1000 samples collected. Forty-five of 84 stations had at least one sample that exceeded the geometric mean criterion. Twenty-five stations were west of the Cascades and 14 were stations on streams that drain to Puget Sound. Temperature and pH standards criteria were exceeded 88 and 59 times, respectively, at 50 and 24 stations, mostly in eastern Washington. The dissolved oxygen criterion was exceeded 39 times at 25 stations, also most often in eastern Washington. (Table 5).

Table 4. Water quality criteria used to evaluate monitoring results. (Results outside the ranges indicated are considered to exceed the criterion.) WAC 173-201A-130 identifies exceptions to the standard criteria for some stream segments. These exceptions are indicated in footnotes to Appendix C.

| | | | | Fecal Coliform | |
|---|---|---|---|---|---|
| Class | Temperature | Oxygen | pH | 10 Percent | Geometric mean |
| AA | <=16°C | >9.5 mg/L | 6.5<=pH<=8.5 | <=100 | <=50 |
| A | <=18°C | >8.0 mg/L | 6.5<=pH<=8.5 | <=200 | <=100 |
| B | <=21°C | >6.5 mg/L | 6.5<=pH<=8.5 | <=400 | <=200 |

Table 5. Spatial distribution of results exceeding water quality criteria for temperature, dissolved oxygen, pH, and fecal coliform bacteria (FC) in WY 1998 (counts include basin stations).

| Region | No. of Stations Parameter or Samples[a] | Temp | Oxygen | pH | FC[b] | FC[c] |
|---|---|---|---|---|---|---|
| **BY STATION** | | | | | | |
| Ecology Region | | | | | | |
| Central | 20 | 16 | 7 | 11 | 3 | 7 |
| Eastern | 20 | 17 | 12 | 11 | 9 | 13 |
| Northwest | 23 | 5 | 1 | 2 | 8 | 13 |
| Southwest | 21 | 12 | 5 | 0 | 9 | 12 |
| East of Cascades | 40 | 33 | 19 | 22 | 12 | 20 |
| West of Cascades | 44 | 17 | 6 | 2 | 17 | 25 |
| Puget Sound Basin | 29 | 6 | 3 | 2 | 9 | 14 |
| All stations | 84 | 50 | 25 | 24 | 29 | 45 |
| **BY SAMPLE** | | | | | | |
| Ecology Region | | | | | | |
| Central | 240 | 28 | 12 | 25 | 11 | 15 |
| Eastern | 240 | 41 | 21 | 31 | 17 | 42 |
| Northwest | 276 | 5 | 1 | 3 | 15 | 33 |
| Southwest | 252 | 14 | 5 | 0 | 14 | 23 |
| East of Cascades | 480 | 69 | 33 | 56 | 28 | 57 |
| West of Cascades | 528 | 19 | 6 | 3 | 29 | 56 |
| Puget Sound Basin | 456 | 6 | 3 | 3 | 19 | 37 |
| All stations | 1008 | 88 | 39 | 59 | 57 | 113 |

[a] Number of samples assumes 12 samples per station. Actual number may be less due to equipment malfunction, loss of sample, lack of access, etc.
[b] Based on individual results greater than the "10 percent not to exceed" criteria. See text.
c Based on individual results greater than the "geometric mean" criteria.

## Quality Assurance

Because the variability of many parameters increases with increasing mean concentration, the RMS values of some variables are presented according to concentration ranges (of the mean of the sample pair) (Table 6). The true value of lab variability should be equal to or less than that of the field samples. In practice, the estimates of the variability are strongly influenced by extreme values (which are related to mean value of the sample pair), especially when sample size is small. The analysis is further complicated because all concentration data are truncated at the reporting limit, effectively producing a variance of zero between any two samples that are below this limit. This skews the variability estimate downward for the lowest concentration ranges.

The expected results of the analyses of the blank samples were 'below reporting limits' for all concentrations and turbidity, and less than three µS (micro Siemans) for specific conductivity. Temperature, dissolved oxygen, pH, and fecal coliform were not measured on blanks. All soluble reactive phosphorus, nitrate+nitrite, ammonia, turbidity, and suspended solids concentration results were reported as 'less than the reporting limits' (Table 7). Total persulfate nitrogen was detected in two samples and total phosphorus in four of the five blanks submitted for each analysis. Mean conductivity of blank samples was 7.4 µS (standard error=10.1 µS), but this was largely due to one blank value of 25 µS.

The remaining elements of the laboratory QA program were assessed by laboratory staff through a manual review of laboratory quality control charts, check standards, in-house matrix spikes, and laboratory blanks. The results were within acceptable ranges as defined by MEL's Quality Assurance Manual (Ecology, 1988).

Table 6. Root mean square of the standard deviation of sequential samples, field splits, and laboratory splits. Field QC results were calculated from Water Year 1998 QA data. Lab splits results were calculated using all Water Year 1998 and Water Year l999 data. *n* = number of sample pairs.

| | | Field QA | | Lab Splits | |
|---|---|---|---|---|---|
| Variable | Range | RMS | sample size, *n* | RMS | sample size, *n* |
| Temperature (C) | all | 0.2 | *71* | NA | - |
| PH | all | 0.1 | *77* | NA | - |
| Dissolved oxygen | all | 0.1 | *74* | NA | - |
| Specific conductivity (mS) | all | 3.3 | *75* | NA | - |
| Turbidity (NTU) | ≤10<br>>10 | 0.8<br>26.8 | *36*<br>*7* | 0.2<br>1.8 | *284*<br>*75* |
| Suspended solids (mg $L^{-1}$) | ≤10<br>>10 | 0.4<br>0.9 | *65*<br>*11* | 0.5<br>5.3 | *140*<br>*141* |
| Total phosphorus (µg $L^{-1}$) | ≤50<br>>50 | 7.6<br>19.6 | *53*<br>*24* | 2.3<br>14.9 | *193*<br>*85* |
| Soluble reactive P (µg $L^{-1}$) | ≤50<br>>50 | 1.3<br>15.9 | *65*<br>*12* | 2.7<br>37.9 | *343*<br>*37* |
| Total Nitrogen (µg $L^{-1}$) | ≤500<br>>500 | 15.5<br>23.3 | *46*<br>*31* | 20.9<br>38.9 | *194*<br>*89* |
| $NO_3$/$NO_2$-N (µg $L^{-1}$) | ≤500<br>>500 | 18.7<br>21.5 | *48*<br>*29* | 4.9<br>33.9 | *211*<br>*73* |
| $NH_3$-N (µg $L^{-1}$) | ≤20<br>>20 | 1.5<br>7.2 | *70*<br>*7* | 1.6<br>3.2 | *196*<br>*72* |
| Fecal coliform (# 100 $mL^{-1}$) | ≤50<br>>50 | 3.0<br>41.5 | *32*<br>*8* | 2.4<br>55.0 | *259*<br>*36* |

Table 7. Results of blind blank (deionized water) sample submission.

| Variable | reporting limit | # above reporting limit (conc) | sample size, *n* |
|---|---|---|---|
| Specific conductivity (µS) | NA | mean= 7.4<br>sd= 10.1 | 5 |
| Turbidity (NTU) | 0.5 | 0 | 5 |
| Suspended solids (mg $L^{-1}$) | 1.0 | 0 | 5 |
| Total phosphorus (µg $L^{-1}$) | 10 | 4 (15, 17, 18, 21) | 5 |
| Soluble reactive P (µg $L^{-1}$) | 5 | 0 | 5 |
| Total Nitrogen (µg $L^{-1}$) | 10 | 2 (13, 15) | 5 |
| $NO_3$/$NO_2$-N (µg $L^{-1}$) | 10 | 0 | 5 |
| $NH_3$-N (µg $L^{-1}$) | 10 | 0 | 5 |

# Conclusions

Overall, a typical number of water quality standards criteria were exceeded in WY 1998. Fewer than normal fecal coliform bacteria results exceeded standards criteria in western Washington, but this was balanced by more than the usual number of results exceeding temperature and pH criteria in eastern Washington. In both cases, warmer and drier weather than usual may be the cause.

Individual stations worthy of note and not discussed in earlier reports include the following:

◊ Kettle River (60A070) - Temperature and oxygen both exceeded the river's class "AA" criteria. One fecal coliform bacteria result exceeded the "10 percent" criterion (97/10/07; 110 colonies/100 mL). More intensive sampling could show whether the river is degraded in the U.S. or Canada or whether high temperatures are natural and the class "AA" designation for temperature is too stringent.

◊ Hangman Creek (56A070) - Temperature, pH, and fecal coliform bacteria can all be high in this stream. The Spokane County Conservation District is currently monitoring more intensively.

◊ Clear Creek (15C070) - Four samples exceeded the fecal coliform "10 percent" criterion, and five the geometric mean criterion. The highest count was 1500J colonies/100mL collected on 98/06/24.

◊ Puyallup River (10A070) - Four samples exceeded the fecal coliform "10 percent" criterion. The highest count was an unusually high 1200J colonies/100mL collected on 97/12/17.

◊ Willapa River (24B090) - Two samples exceeded the temperature criterion and three the fecal coliform "10 percent" criterion. The highest count was 1800 colonies/100mL on 97/10/29. This system has recently been monitored more intensively through an EPA grant to Ecology and is currently under investigation for a Total Maximum Daily Load assessment for bacteria and oxygen.

# Literature Cited


Ecology, 1988. *Quality Assurance Manual*. Manchester Environmental Laboratory. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Manchester, WA.

------, 1994. *Manchester Environmental Laboratory Users Manual*. D. Huntamer and J. Hyre, ed. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

------, 1996. *1996 Statewide Water Quality Assessment*, Section 305(b). Washington State Department of Ecology, Water Quality Program, Olympia, WA.

Ehinger, W., 1995. *Freshwater Ambient Water Quality Monitoring Final Quality Assurance Project Plan*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA. March 1996, 23 pp. + appendices.

Ehinger, W., J. S. Golding, J. Parsons, R. Plotnikoff, D. Hallock, R. Garrigues, A. Johnson, and K. Smith, 1997. *Watershed Briefing Paper for the Spokane Water Quality Management Area*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA. 52 pp.

Erickson, K., D. Davis, M. Dutch, W. Ehinger, D. Erickson, B. Hopkins, G. Hoyle-Dodson, J. Newton, J. Parsons, R. Plotnikoff, and K. Smith, 1997. *Watershed Briefing Paper for the Cedar/Green Water Quality Management Area*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA. 62 pp.

Hallock, D., 1996. *Spokane Basin Data Analysis Report Little Spokane Sub-Basin*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA. Publication No. 96-329, June 1996, 12 pp. + appendices.

Hallock, D., W. Ehinger, and B. Hopkins, 1998. *River and Stream Ambient Monitoring Report for Water Year 1996*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA. Publication No. 98.317, 34 pp. + appendices.

Henderson, D., 1998. *Rain or shine, wind or calm, '97 had it all*. Seattle Times, Friday, Jan. 2, 1998.

Hopkins, B., 1996. *Ambient Metals Project Proposal - Final Quality Assurance Project Plan*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA. March 1996, 19 pp. + appendices.

Joy, J., W. Ehinger, J. Cubbage, S. Golding, and D. Erickson, 1996. *Watershed Briefing Paper for the Upper and Lower Yakima Watersheds*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program Olympia, WA. 37 pp.

Lilly, D., 1999. *Last year's weather changed from Nino mild to Nina wild*. Seattle Times, Sunday, Jan. 3, 1999.

Norton, D., J. Newton, B. Carey, P. Marti, P. Pickett, S. Golding, W. Ehinger, J. Parsons, R. Plotnikoff, and K. Smith, 1997. *Watershed Briefing Paper for the Eastern Olympic Watershed Water Quality Management Area*. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA. 57 pp.

Wrye, D., 1993. *Basin Approach to Water Quality Management: Program Description*. Washington State Department of Ecology, Olympia, WA.

# Appendix A

Station description and period of record
for Ecology's river and stream
ambient monitoring program

This appendix is not available in electronic form.
For a printed copy, call Dave Hallock at
360-407-8881.

# Appendix B

Historical changes in sampling and laboratory procedures, and large-scale environmental changes potentially affecting water quality

This appendix is intended to record changes in methods and procedures used by the Ambient Monitoring Section to collect and analyze river and stream water quality data. Other environmental changes that may potentially affect water quality over a large area are also recorded here. Many of the changes listed below are anecdotal and may or may not have affected data quality. Comments prior to October 1989 are based on interviews with individuals involved with the earlier program. Comments after that date have usually been recorded as the changes occurred.

**GENERAL**

Jun to Sep 1985: Laboratory moved from SWRO to Manchester.

Oct 1988: Implemented QA/QC program (Source: Memo from Hallock, D, October 17, 1988)

Prior to WY91: Samples were sent to contract labs from time to time. These occurrences are not all recorded here. Records are confusing and only available from bench sheets archived by Manchester Environmental Laboratory.

1994: The use of Polyacrilamide (PAM) to control erosion from rill irrigation is becoming widespread in eastern Washington. Water quality affects are unknown.

1996: Began monitoring discharge at some stations ourselves (mostly basin stations), rather than contracting with USGS.

1997: Contracts for about 80% of the 1.045 million acres in Washington in the Conservation Reserve Program are scheduled to expire. (See http://pnwsteep.wsu.edu)

**NUTRIENTS**

General: Prior to 1980, samples were analyzed by USGS labs.

1966-1969: One gallon of sample was collected in glass jars and held at room temperature for indefinite periods without preservative.

1970-1973: Unknown methods; may have been preserved with HgCl. Filtered in field.

1973: Lab moved from Tacoma to Salt Lake City.

1973-1974: Chilled, no preservative. Held as long as one week. Filtered in field; kept in brown poly bottle.

1972-1974?: For a short time, TP and NO3 may have been added by filters (probably 72-74). Source: Joe Rinnella, USGS.

9/30/78: Lab moved to Arvada, CO.

~1978: Chilled. Brown poly bottle (the brown poly bottle may have been introduced later). 30 day holding time for NO2+NO3 implemented (status of other nutrients is unknown). (Source of methods prior to 1979: pers. comm. Joe Rinnella, USGS, and Skinner, Earl L. "Chronology of Water Resources Division activities that may have affected water quality values of selected constituents in Watstore, 1970-86. Provisional Report Feb 1989.)

1979: For a while, the USGS lab reported nutrient results to the nearest 0.01 units. Therefore, values below 0.005 would be reported as 0.00. USGS decided to change all Watstore data = 0 to 0.01K back to 1973 for NO2+NO3. Decision on other nutrients is unknown but they may also have been changed. Most of the null data in our database have been converted to 0.01K (K-below the detection limit) but a few null values remain in the older data.

6/1/80 to 1986: Nutrients analyzed by Pat Crawford at SWRO.

1980: USGS requires NO2+NO3 be preserved with HgCl. Status of other nutrients is unknown. Ecology requirements are unknown.

Aug 1985: High phosphate values, presumably a result of lab error. (Coded '9-do not use' in our database). Source: Trends in PS, 1988, Tetra Tech, App. B.

1986 to Apr 1987: Analyzed by various people, mostly Helen Bates, Steve Twiss, and Wayne Kraft at Manchester.

June, 1985: Switched from Technicon to Rapid Flow Analysis (Alpkem) autoanalyzers

Apr 1987 to present: Analyzed by various people, mostly Dave Thomson at Manchester.

Jan 1987 to Jul 1987: NO3, NH3, and TP analyzed by contract lab,

Mar 1990: Began using MFS cellulose acetate filters for field filtration of nutrients. Previously use Millipore, type HA (cellulose nitrate?).

17 Sep 90-12 Oct 90: All nutrient samples were contracted out.

Oct 1990: Dissolved ammonia (P608) and dissolved nitrate+nitrite (P631) were added to the Marine network. Totals (P610 and P630) were dropped.

Feb 1991: All nutrients went to contract lab.

Mar 1991: All nutrients went to contract lab.

~1993: Began collecting nutrients in acid-washed poly-bottle passenger rather than in the stainless-steel bucket used for oxygen determinations.

Jul 1994: The phosphorus content in detergents is restricted statewide (SSB 5320). Phosphorus use had been limited in Spokane County 1? year earlier.

**TOTAL SUSPENDED SOLIDS**

General: Filters were usually used, but sometimes Gooch crucibles were used.

Feb 1978: Began collecting as passenger to oxygen sampler (was previously collected as aliquot of oxygen sampler). (Source: memo from Bill Yake, Jan 30, 1978)

Mid-1985 Amount filtered change from 250? to 500 ml.

17 Sep 90-12 Oct 90: Suspended sediment samples were contracted out.

Apr 1991: Began collecting 1000 ml of sample.

**CONDUCTIVITY**

Feb 1978: Began calibrating twice monthly using 40, 70, 140, and 200 µmho/cm standards. (Source: memo from Bill Yake, Jan 30, 1978)

Oct 1991:All meters were re-calibrated Oct 11, 1991. One conductivity meter was not calibrated above 500 µmhos/cm (and could not be calibrated). This meter had last been calibrated about 1 year earlier. Most meters read higher than the 100 µmhos/cm standard.

Oct 1994: Switched from Beckman model Type RB-5 (which could not be field calibrated) to Orion Model 126 meter which is calibrated daily.

1998: Orion meter calibration began drifting during the day. Sometimes meter could only be calibrated to within 4 µmhos of the standard. When this occurred, some samplers would correct the data, others would not.

**FECAL COLIFORM BACTERIA**

General: For some period in the early 1980s, some samples may have been analyzed by field personnel

Oct 7, 1975 to Nov 1981: fecal data from eastern Washington may be questionable during this period.

1980 to Mar 1988: No changes; analyzed by Nancy Jensen.

Mar 1988: Switched to new filter with slightly better recovery.

**TURBIDITY**
1970s: EPA specified a 2100A turbidimeter. Formerly, turbidity units were FTU
Sept 1993: Lab began using a new turbidimeter, Hach model "Ratio X/R."

**FIELD PH**
Oct 7, 1975 to Nov 1981: pH data from eastern Washington are questionable during this period.
Feb 1978: Began calibrating meter twice monthly. Previous procedures unknown. (Source: memo from Bill Yake, Jan 30, 1978)
1986: Changed to Beckman digital pH meter with gel probe.
Dec 91: Changed to Orion model 250A meter with "spare water" liquid probe (uses 1M KCl, rather than 4M). Calibrate daily and check calibration thrice daily.

**TEMPERATURE**
Feb 1978: Switched from thermometer in bucket to thermistor in river. (Source: memo from Bill Yake, Jan 30, 1978)
Spring 1994: Switched to YSI 300 meter (accuracy +/- 0.4C)

**OXYGEN**
Oct 1, 1977 Began measuring barometric pressure to calculate percent saturation. Previous saturation calculations were presumably based on elevation.
March 1989: Began applying correction factor to results of Winkler analyses based on titration with sodium biodate to correct sodium thiosulfate normality to 0.025. Previously, thiosulfate was standardized upon preparation, but not during use.

**BAROMETRIC PRESSURE**
___ 1995: Began calibrating barometer prior to each run using an on-site mercury barometer rather than pressure as reported by the Olympia airport.

**CHLOROPHYLL**
15 Mar 90: Switched to fluorometric method (from spectrophotometric). New method has lower detection limit (0.02 µg/L) but less accuracy. (Source: Memo from Despina Strong, April 12, 1990)
HARDNESS
7/1/91: Began using 125 ml bottle with HNO3 as preservative. (Previously, aliquot from unpreserved general chemistry bottle was used.)

**METALS**
May, 1994: Implemented low-level dissolved metals monitoring at selected stations.

# Appendix C

Number of results for Water Year 1998 river and stream ambient monitoring stations outside acceptable ranges specified in water quality criteria.

Number of results for Water Year 1998 river and stream ambient monitoring stations outside acceptable ranges specified in water quality criteria. For each variable, the total number of samples, the number of samples that exceeded the criterion, and the percent of samples exceeding criteria are shown. For fecal coliform bacteria, the "Exceed" and "Pct" columns are the number and percent of individual samples exceeding the "10 percent not to exceed" criterion; the "GM" column is the number of individual samples exceeding the geometric mean criterion. Stations in basins scheduled for more intensive data collection in WY 1998 are shown in bold. (Some "basin stations" were outside the Water Quality Management Areas ("basins") designated for data collection in 1998.)

## CENTRAL REGION

| STATION | | | TEMPERATURE | | | OXYGEN | | | pH | | | FECAL COLIFORM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Name | Class | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | GM |
| Long-term Stations | | | | | | | | | | | | | | | |
| 31A070 | Columbia R @ Umatilla | A | 11 | 2 [a] | 18 | 11 | 1 [c] | 9 | 11 | 1 | 9 | 11 | | | |
| 36A070 | Columbia R nr Vernita | A | 12 | 1 [a] | 8 | 12 | | | 11 | 4 | 36 | 12 | | | |
| 37A090 | Yakima R @ Kiona | A | 12 | 2 [b] | 17 | 12 | 2 | 17 | 11 | 1 | 9 | 12 | | | 2 |
| 37A205 | Yakima R @ Knob Hill | A | 11 | [b] | | 11 | | | 11 | | | 11 | | | 3 |
| **39A090** | **Yakima R nr Cle Elum** | **AA** | **12** | **1** | **8** | **12** | **2** | **17** | **12** | | | **12** | | | |
| 45A070 | Wenatchee R @ Wenatchee | A | 12 | 3 | 25 | 12 | | | 11 | 3 | 27 | 12 | | | |
| 45A110 | Wenatchee R nr Leavenworth | AA | 11 | 1 | 9 | 10 | 2 | 2 | 10 | | | 11 | | | |
| 46A070 | Entiat R nr Entiat | A | 12 | 1 | 8 | 12 | | | 10 | 3 | 30 | 12 | | | |
| 48A070 | Methow R nr Pateros | A | 12 | 1 | 8 | 12 | | | 11 | 2 | 18 | 12 | | | |
| 48A140 | Methow R @ Twisp | A | 12 | | | 12 | | | 10 | | | 12 | | | |
| 49A070 | Okanogan R @ Malott | A | 11 | 3 | 27 | 11 | 2 | 18 | 11 | | | 11 | | | |
| 49A190 | Okanogan R @ Oroville | A | 12 | 3 | 25 | 12 | 2 | 17 | 11 | 5 | 45 | 12 | | | 1 |
| 49B070 | Similkameen R @ Oroville | A | 12 | 2 | 17 | 12 | | | 11 | 1 | 9 | 12 | | | |
| 53A070 | Columbia R @ Grand Coulee | A | 12 | 2 [a] | 17 | 12 | 1 | 8 | 12 | | | 11 | | | |
| Basin Stations | | | | | | | | | | | | | | | |
| **38A050** | **Naches R @ Yakima on US 97** | **A** | **11** | **1** | **9** | **7** | | | **11** | **2** | **18** | **0** | | | |
| **39A050** | **Yakima R @ Harrison Bridge** | **A** | **11** | **1 [a]** | **18** | **11** | | | **11** | **2** | **18** | **11** | **1** | **9** | **2** |
| **39A060** | **Yakima R @ Ellensburg** | **A** | **11** | [a] | | **11** | | | **11** | | | **11** | | | |
| 45C070 | Chumstick Cr nr Leavenworth | A | 12 | | | 12 | | | 11 | | | 12 | | | 3 |
| 45D070 | Brender Cr nr Cashmere | A | 12 | 2 | 17 | 12 | | | 11 | | | 12 | 8 | 67 | 1 |
| 45E070 | Mission Cr nr Cashmere | A | 12 | 2 | 17 | 12 | | | 11 | 1 | 9 | 12 | 2 | 17 | 3 |

[a]Special temperature criterion: "shall not exceed 20°C."
[b]The lower Yakima has a special temperature criterion: "shall not exceed 21°C."
[c]Additional oxygen criterion, "dissolved oxygen shall exceed 90 percent of saturation."

## EASTERN REGION

| STATION | | | TEMPERATURE | | | OXYGEN | | | pH | | | FECAL COLIFORM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Name | Class | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | GM |
| Long-term Stations | | | | | | | | | | | | | | | |
| 32A070 | Walla Walla R nr Touchet | B | 12 | 3 | 25 | 12 | | | 12 | 2 | 17 | 12 | 1 | 8 | 2 |
| 33A050 | Snake R nr Pasco | A | 12 | 3 [a] | 25 | 12 | 1 | 8 | 11 | | | 12 | | | |
| 34A070 | Palouse R @ Hooper | B | 12 | 2 | 17 | 12 | | | 12 | 6 | 50 | 12 | 1 | 8 | 2 |
| 34A170 | Palouse R @ Palouse | A | 12 | 2 [a] | 17 | 12 | 2 | 17 | 12 | | | 12 | 2 | 17 | 3 |
| 34B110 | SF Palouse R @ Pullman | A | 12 | 1 | 8 | 12 | 3 | 25 | 12 | | | 12 | 4 | 33 | 9 |
| 35A150 | Snake R @ Interstate Br | A | 12 | 1 [a] | 8 | 12 | 1 | 8 | 12 | | | 12 | | | |
| 35B060 | Tucannon R @ Powers | A | 12 | 3 | 25 | 12 | | | 12 | 4 | 33 | 12 | 2 | 17 | 7 |
| **41A070** | **Crab Cr nr Beverly** | **B** | **12** | **3** | **25** | **12** | | | **11** | **6** | **55** | **12** | | | **1** |
| 54A120 | Spokane R @ Riverside StPk | A | 12 | [a] | | 12 | | | 11 | 1 | 9 | 12 | 3 | 25 | 4 |
| 55B070 | Little Spokane R nr Mouth | A | 12 | | | 12 | | | 12 | | | 12 | | | |
| 56A070 | Hangman Cr @ Mouth | A | 12 | 4 | 33 | 12 | | | 12 | 3 | 25 | 12 | 1 | 8 | 2 |
| 57A150 | Spokane R @ Stateline Br | A | 12 | 3 [a] | 25 | 12 | 1 | 8 | 10 | | | 12 | | | |
| 60A070 | Kettle R nr Barstow | AA | 12 | 3 | 25 | 12 | 3 | 25 | 12 | | | 11 | 1 | 9 | 2 |
| 61A070 | Columbia R @ Northport | AA | 12 | 2 | 17 | 11 | 1 | 9 | 12 | | | 11 | | | 1 |
| 62A150 | Pend Oreille R @ Newport | A | 12 | 1 [a] | 8 | 12 | 1 | 8 | 12 | | | 10 | | | |
| Basin Stations | | | | | | | | | | | | | | | |
| **41A110** | **Crab Cr nr Moses Lake** | **B** | **12** | | | **12** | **1** | **8** | **12** | **1** | **8** | **12** | | | |
| **41D070** | **Rocky Ford Creek @ Hwy 17** | **A** | **12** | **3** | **25** | **12** | **4** | **33** | **12** | **1** | **8** | **12** | | | **2** |
| **41E070** | **Sand Hollow Creek Hwy 26** | **A** | **12** | **3** | **25** | **12** | | | **12** | **5** | **42** | **12** | | | **2** |
| **41F100** | **Rocky Ford Coulee Drain** | **A** | **12** | **3** | **25** | **12** | **2** | **17** | **12** | **1** | **8** | **12** | **2** | **17** | **5** |
| 62A090 | Pend Oreille @ Metaline Falls | A | 11 | 1 [a] | 8 | 11 | 1 | 9 | 11 | 1 | 9 | 10 | | | |

[a]Special temperature criterion: "shall not exceed 20°C."

## NORTHWEST REGION

| STATION | | | TEMPERATURE | | | OXYGEN | | | pH | | | FECAL COLIFORM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Name | Class | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | GM |
| Long-term Stations | | | | | | | | | | | | | | | |
| 01A050 | Nooksack R @ Brennan | A | 12 | | | 12 | | | 12 | | | 12 | | | 1 |
| 01A120 | Nooksack R @ No Cedarville | A | 12 | | | 12 | | | 12 | | | 12 | | | |
| 03A060 | Skagit R nr Mount Vernon | A | 12 | | | 12 | | | 12 | | | 12 | 1 | 8 | 1 |
| 03B050 | Samish R nr Burlington | A | 12 | | | 12 | | | 12 | | | 12 | 3 | 25 | 7 |
| 04A100 | Skagit R @ Marblemount | AA | 12 | | | 12 | | | 12 | | | 12 | | | |
| 05A070 | Stillaguamish R nr Silvana | A | 12 | 1 | 8 | 12 | | | 12 | | | 12 | | | |
| 05A090 | SF Stillaguamish @ Arlington | A | 12 | 1 | 8 | 12 | | | 12 | | | 12 | | | 2 |
| 05A110 | SF Stilly nr Granite Falls | AA | 12 | 1 | 8 | 12 | | | 12 | | | 12 | | | 1 |
| 05B070 | NF Stillaguamish @ Cicero | A | 12 | 1 | 8 | 12 | | | 12 | | | 12 | | | 1 |
| 05B110 | NF Stilly nr Darrington | A | 12 | | | 12 | | | 12 | 1 | 8 | 12 | | | |
| 07A090 | Snohomish R @ Snohomish | A | 12 | | | 12 | | | 12 | | | 12 | | | 2 |
| 07C070 | Skykomish R @ Monroe | A | 12 | | | 12 | | | 12 | | | 12 | | | |
| 07D050 | Snoqualmie R nr Monroe | A | 12 | | | 12 | | | 12 | | | 12 | 2 | 17 | 4 |
| 07D130 | Snoqualmie R @ Snoqualmie | A | 12 | | | 12 | | | 12 | | | 12 | | | |
| 08C070 | Cedar R @ Logan St/Renton | A | 12 | | | 12 | | | 12 | | | 12 | 1 | 8 | 3 |
| 08C110 | Cedar R nr Landsburg | AA | 11 | | | 11 | | | 11 | | | 11 | | | |
| 09A080 | Green R @ Tukwila | A | 12 | 1 | 8 | 12 | 1 | 8 | 12 | | | 12 | 1 | 8 | 1 |
| 09A190 | Green R @ Kanaskat | AA | 12 | | | 12 | | | 12 | 2 | 17 | 12 | | | |
| Basin Stations | | | | | | | | | | | | | | | |
| **15A070** | **Dewatto R nr Dewatto** | **A** | **12** | | | **12** | | | **12** | | | **12** | | | |
| **15B050** | **Chico Cr nr Chico** | **A** | **12** | | | **12** | | | **12** | | | **12** | **1** | **8** | **1** |
| **15C070** | **Clear Cr @ Silverdale** | **A** | **12** | | | **12** | | | **12** | | | **12** | **4** | **33** | **5** |
| **15D090** | **Tahuya R nr Belfair** | **A** | **12** | | | **12** | | | **12** | | | **12** | | | |
| **15E070** | **Union R nr Belfair** | **A** | **12** | | | **12** | | | **12** | | | **12** | **2** | **17** | **4** |

## SOUTHWEST REGION

| STATION | | | TEMPERATURE | | | OXYGEN | | | pH | | | FECAL COLIFORM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Name | Class | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | No | Exceed | Pct | GM |
| Long-term Stations | | | | | | | | | | | | | | | |
| 10A070 | Puyallup R @ Meridian St | A | 12 | | | 12 | | | 12 | | | 12 | 4 | 33 | 4 |
| 11A070 | Nisqually R @ Nisqually | A | 12 | | | 12 | | | 12 | | | 12 | | | |
| 13A060 | Deschutes R @ E St Bridge | A | 12 | | | 12 | 1 | 8 | 12 | | | 12 | | | |
| 16A070 | Skokomish R nr Potlatch | AA | 12 | | | 12 | 1 | 8 | 12 | | | 12 | | | |
| 16C090 | Duckabush R nr Brinnon | AA | 12 | | | 12 | | | 12 | | | 12 | | | |
| 18B070 | Elwha R nr Port Angeles | AA | 12 | 1 | 8 | 12 | | | 12 | | | 12 | | | |
| 20B070 | Hoh R @ DNR Campground | AA | 12 | | | 12 | | | 12 | | | 12 | | | 1 |
| 22A070 | Humptulips R nr Humptulips | A | 12 | 1 | 8 | 12 | | | 12 | | | 12 | | | |
| 23A070 | Chehalis R @ Porter | A | 12 | 1 | 8 | 12 | 1 | 8 | 12 | | | 12 | | | 2 |
| 23A160 | Chehalis R @ Dryad | A | 12 | 1 | 8 | 12 | | | 12 | | | 12 | 1 | 8 | 1 |
| **24B090** | **Willapa R nr Willapa** | **A** | **12** | **2** | **17** | **12** | | | **12** | | | **12** | **3** | **25** | **5** |
| **24F070** | **Naselle R nr Naselle** | **A** | **12** | **1** | **8** | **12** | | | **12** | | | **12** | **1** | **8** | **1** |
| **26B070** | **Cowlitz R @ Kelso** | **A** | **12** | | | **12** | | | **12** | | | **12** | **1** | **8** | **2** |
| 27B070 | Kalama R nr Kalama | A | 12 | 1 | 8 | 12 | | | 12 | | | 12 | | | |
| 27D090 | EF Lewis R nr Dollar Corner | A | 12 | 2 | 17 | 12 | | | 12 | | | 12 | 1 | 8 | 1 |
| Basin Stations | | | | | | | | | | | | | | | |
| **24D070** | **North R nr Raymond** | **A** | **11** | **1** | **9** | **11** | **1** | **9** | **11** | | | **11** | | | |
| **25B070** | **Grays R nr Grays River** | **A** | **12** | | | **12** | | | **12** | | | **12** | **1** | **8** | **1** |
| **25C070** | **Elochoman R nr Cathlamet** | **A** | **12** | | | **12** | | | **12** | | | **12** | **1** | **8** | **2** |
| **26C070** | **Coweeman R @ Kelso** | **A** | **12** | **1** | **8** | **12** | **1** | **8** | **12** | | | **12** | | | **2** |
| **26C080** | **Coweeman R av Goble Cr** | **A** | **12** | **1** | **8** | **12** | | | **12** | | | **12** | | | |
| 28B110 | Washougal R blw Canyon Ck | A | 12 | 1 | 8 | 12 | | | 12 | | | 12 | 1 | 8 | 1 |

# Appendix D

Water Year 1998 raw data for Ecology's
river and stream ambient monitoring program

Data listed in this appendix are available in electronic format by contacting

| | |
|---|---|
| Central Region: | Bill Ehinger (360 407-6682; wehi461@ecy.wa.gov) |
| Eastern Region: | Dave Hallock (360 407-6681; daha461@ecy.wa.gov) |
| Northwest Region: | Bill Ward (360 407-6621; bwar461@ecy.wa.gov) |
| Southwest Region: | Rob Plotnikoff (360 407-6687; rplo461@ecy.wa.gov) |

Ambient monitoring data from the most recent complete Water Year is available over the Internet on Ecology's web pages (http://www.ecy.wa.gov/). Look under "Conditions and Trends" and then "Watersheds."

The first two digits of each station number is the Water Resource Inventory Area (WRIA) number. This number can be used to identify which Water Quality Management Areas (WQMA) or "basin" each station is in, according to the table, below:

| Basin | WRIAs | Basin | WRIAs |
|---|---|---|---|
| Cedar/Green | 8-9 | Nooksack/San Juan | 1-2 |
| Columbia Gorge | 27-29 | Okanogan | 48-53 |
| Eastern Olympics | 13-14, 16-19 | Puyallup/Nisqually | 10-12 |
| Esquatzel/Crab Creek | 36, 42-43 | Skagit/Stillaguamish | 3-5 |
| Horseheaven/Klickitat | 30-31 | Spokane | 54-57 |
| Island/Snohomish | 6-7 | Upper and Lower Snake | 32-35 |
| Kitsap | 15 | Upper Columbia/Pend Oreille | 58-62 |
| Lower Columbia | 24-26 | Upper Yakima | 38-39 |
| Lower Yakima | 37 | Wenatchee | 40, 44-47 |
| Mid Columbia | 41 | Western Olympics | 20-23 |

Remarks codes are interpreted as follows:

| | |
|---|---|
| B,V | Analyte was found in the blank indicating possible contamination. |
| E | Result is an estimate due to interference |
| G, L | True result is equal to or greater than reported value |
| H | Sample was analyzed over holding time |
| J | The reported result is an estimate |
| K, U | The analyte was not detected at or above the reported result |
| N | Spike sample recovery outside control limits |
| P | Result is between the detection limit and the min. quantitation limit (applied to metals) |
| S | Spreader: one or more bacteria colonies were smeared, possibly obscuring other colonies |
| X | High background count of non-target bacteria, possibly obscuring additional colonies |

# Appendix E

Water Year 1998 six-year summary statistics
for long-term stations in Ecology's river and stream
ambient monitoring program

This appendix is not available in electronic form.
For a printed copy, call Dave Hallock at
360-407-8881.

# Appendix F

Data collected by continuous recording devices in Water Year 1998

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For a printed copy, call Dave Hallock at
360-407-8881.