Jim Ford Creek Water Quality Monitoring Report 2003-2004

Developed for:

Clearwater Soil and Water Conservation District
Idaho Soil Conservation Commission
Idaho State Department of Agriculture
Idaho Department of Environmental Quality

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IASCD
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Technical Results Summary KPC-JF-05

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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) collected water quality data from Jim Ford Creek and several of its tributaries from April 2003 through July 2004.

This monitoring project was initiated to evaluate water quality in the Jim Ford Creek watershed. The Total Maximum Daily Load (TMDL) for the Jim Ford Creek Watershed was finalized in March of 2000.

This report reviews monitoring results for the following parameters:

- -Total Phosphorus (TP)
- -Orthophosphorus (OP)
- -Bacteria (*Escherichia coli)*
- -Nitrogen Components—NO_2, NO_3, NH_3
- -Total Suspended Solids (TSS)
- -Instantaneous Water Temperature
- -Turbidity
- -Dissolved Oxygen (DO)
- -Percent (%) Saturation
- -Total Dissolved Solids (TDS)

The University of Idaho Analytical Science Laboratory (UIASL) conducted all inorganic parameter testing and Anatek Labs, Inc. performed bacteria analysis. Ken Clark performed all other measurements.

Jim Ford Creek Subbasin

Jim Ford Creek is a third order tributary to the Clearwater River and drains a 65,838 acre watershed in southern Clearwater County. The watershed can be divided into two distinct portions. In the upper portion, Jim Ford Creek originates in rolling, forested uplands and then flows through the Weippe prairie until it reaches the City of Weippe. In the lower portion of the watershed, the creek flows northwest from the City of Weippe and enters into a narrow, steep basalt canyon nearly fourteen miles in length. A 65 foot waterfall at the top of the canyon prevents fish passage upstream. Primary land uses in the watershed consist of timber production, grazing, and recreation throughout the entire watershed and dryland agriculture on the Weippe prairie. The City of Weippe is the only urban area within the watershed, and a small hydropower facility crosses the creek just downstream of the city.

Three point sources are permitted to discharge in the Jim Ford Creek watershed: the Weippe wastewater treatment plant (WWTP), the Timberline High School wastewater treatment plant, and Hutchins Lumber, Inc. which operates a sawmill and log yard. The City of Weippe WWTP typically discharges into Jim Ford Creek from January to mid-June each year, when instream flows are deemed high enough to provide sufficient dilution.

The primary non-point sources of pollutants in the watershed are grazing, timber harvest activities, non-irrigated croplands, urban runoff, land development activities and the hydropower unit.

Background

Water quality monitoring was done by the Idaho Department of Environmental Quality (IDEQ), the Nez Perce Tribe (NPT), and the US Environmental Protection Agency (EPA) as part of TMDL development in 1998. The Jim Ford Creek TMDL was finalized in May, 2000.

Some key assumptions of the TMDL were:

- Fine sediment is not degrading water quality in Jim Ford Creek.
- Coarse sediment is impairing salmonid spawning and rearing in lower Jim Ford Creek.
- Temperature exceedances are common throughout the watershed.
- Jim Ford Creek is impaired by excess nutrients, which negatively affect dissolved oxygen levels in the stream.
- Pathogen levels exceed water quality standards during summer months.

The Jim Ford Creek Watershed Advisory Group and supporting agencies created a TMDL implementation plan consisting of a Watershed Restoration Strategy (WRS). The WRS provided the framework necessary to implement BMPs aimed at improving water quality through practices such as riparian restoration, bank stabilization, animal waste systems, grassed waterways, conservation cropping and tillage practices, and livestock exclusion.

Table 1 lists specific pollutant targets identified in the TMDL as necessary to improve water quality to the degree where beneficial uses are being achieved. State of Idaho Water Quality Standards apply where no target is specifically designated.

Table 1. Pollutant targets for streams identified in the Jim Ford Creek TMDL

Pollutant of Concern	Pollutant Targets for Jim Ford Creek TMDL
Temperature	22 ^oC instantaneous and 19 ^oC daily average above the falls; 13 ^oC instantaneous and 9 ^oC daily average during salmonid spawning period below the falls
Total Phosphorus	0.075 mg/L from April-October
Total Suspended Solids (TSS)	80 mg/L instantaneous and 50 mg/L monthly average

Monitoring Site Descriptions

The seven monitoring sites selected for this project were sites where data were initially collected for TMDL development in 1998. Below is a general description of site locations; these sites are also illustrated graphically in Figure 1.

JF-1 Jim Ford Creek (mouth)

JF-2 Winter Creek (below agricultural influence)

JF-3 Jim Ford Creek (downstream of City of Weippe WWTP)

JF-4 Grasshopper Creek (mouth)

JF-5 Jim Ford Creek (upstream of City of Weippe WWTP)

JF-6 Heywood Creek (mouth)

JF-7 Miles Creek (mouth)

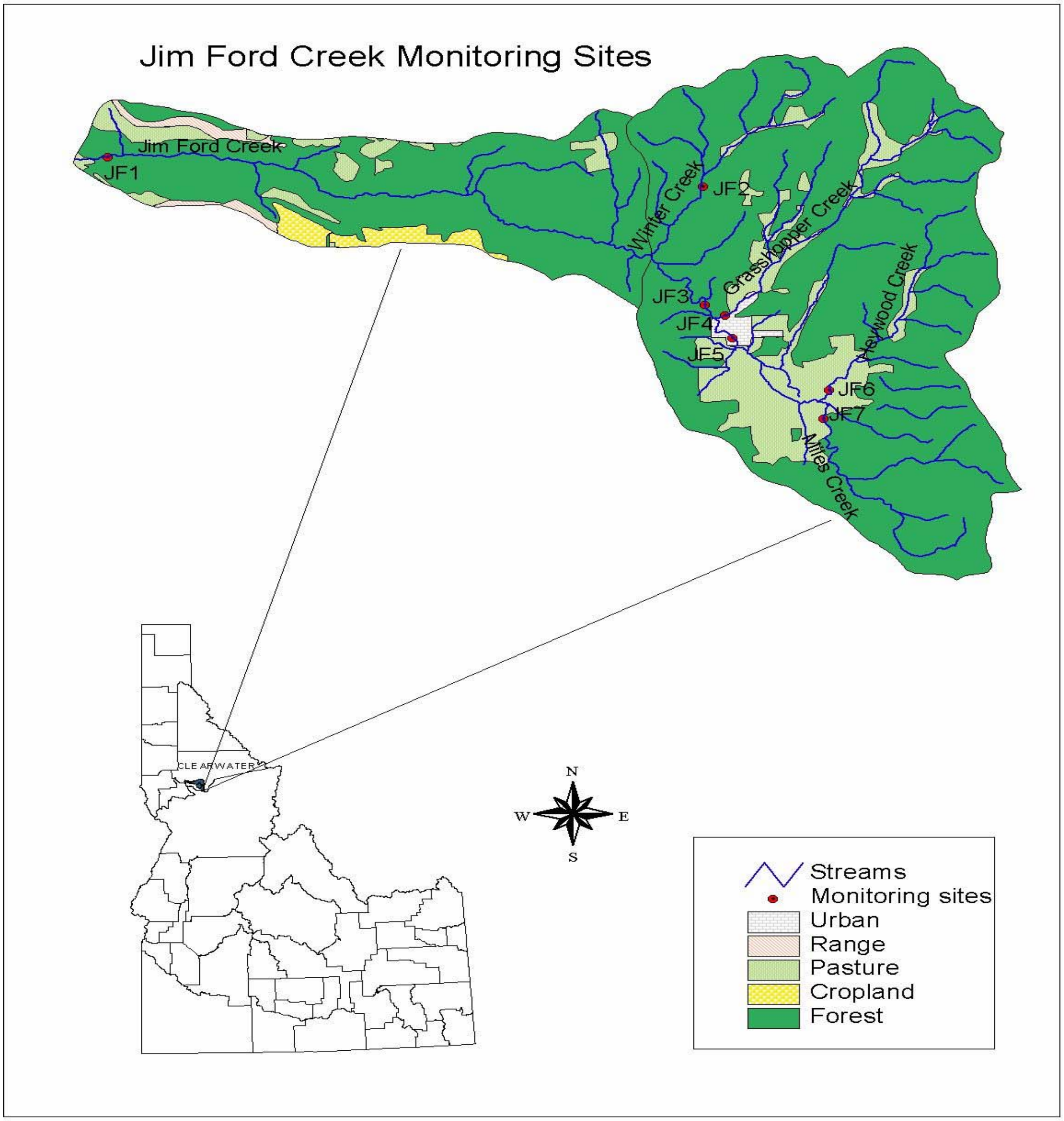

Figure 1. Jim Ford Creek watershed and IASCD monitoring sites.

Methods and Materials

Water Quality Limited Segments

The Clean Water Act (CWA) requires restoration and maintenance of the chemical physical, and biological integrity of the nation's water (Public Law 92-500 Federal Water Pollution Control Act Amendments of 1972). Section §303 (d) of the CWA establishes requirements for states to identify and prioritize waterbodies that are water quality limited (i.e. do not meet water quality standards). All of the streams in this study are listed as water quality limited on the Idaho §303 (d) list.

Sampling Protocols

Approximately 4 liters of stream water were collected at each site, using a DH-81 depth-integrating suspended-sediment sampler. The samples were collected and transferred into a 2.5-gallon polyethylene churn sample splitter. The polyethylene churn splitter was rinsed with ambient water at each location prior to sample collection. The resultant composite sample was thoroughly homogenized before filling the appropriate sample containers. Water samples requiring preservation (NO_2+NO_3, NH_3, and TP) were transferred into preserved (H_2SO_4 pH <2) 500 mL sample containers. Water quality samples (TSS, NO_2+NO_3, NH_3, and TP) were then analyzed at the UIASL in Moscow, Idaho.

Bacteriological samples (total coliform and *E. coli*) were collected directly from the thalweg into sterile sample containers. The samples were delivered to Anatek Labs, Inc. in Moscow for analysis. Most probable number (MPN) multiple tube fermentation was used to determine fecal coliform and *E. coli* levels in the water sample.

A list of parameters, sample sizes, preservation, holding times, and analytical methods are displayed in Table 2. All sample containers were labeled with waterproof markers with the following information: station location, sample identification, date of collection, and time of collection. Samples were placed on ice and transported to the laboratory the same day as collection. Chain-of-custody forms accompanied each sample shipment.

Table 2. Water Quality Parameters

Parameters	Sample Size	Preservation	Holding Time	Method
Non Filterable Residue (TSS)	1L	Cool 4°C	7 Days	EPA 160.2
Nitrogen Components: NO_3+NO_2 Ammonia	60 mL 60 mL	Cool 4°C, H_2SO_4 pH < 2	28 Days	EPA 353.2 EPA 350.1
Total Phosphorus	100 mL	Cool 4°C, H_2SO_4 pH < 2	28 Days	EPA 365.4
Escherichia coli	100 mL	Cool 4°C	30 Hours	MPN

Field Measurements

At each location, field parameters for dissolved oxygen, specific conductance, pH, temperature, turbidity, and total dissolved solids were measured. Calibration of all field equipment was in accordance with the manufacturer specifications. Field measurement parameters, equipment and calibration techniques are shown in Table 3.

Table 3. Field Measurements

Parameters	Instrument	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55 StowAway temperature logger Model XTI 02	Centigrade thermometer Centigrade thermometer
Conductance & TDS	Orion Model 115	Specific Conductance (25^{o}C standard)
pH	Orion Model 210A	Standard buffer (7,10) bracketing for linearity
Turbidity	Hach Model 2100P	Formazin Primary Standard

All field measurements were recorded in a field notebook along with any pertinent observations about the site, including weather conditions, flow rates, personnel on site, and any problems observed that might affect water quality.

Flow Measurements

Flow measurements were collected at each site using a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenths depth method (0.6 of the total depth from the surface of the water surface) was used. A transect line was established at each monitoring station, across the width of the stream at an angle perpendicular to the flow, for the calculation of cross-sectional area. The discharge was computed by summing the products of the partial areas (partial sections) of the flow cross-sections and the average velocities for each of those sections. Stream discharge was reported as cubic feet per second (cfs).

Quality Assurance and Quality Control (QA/QC)

The UIASL utilizes methods approved and validated by the Environmental Protection Agency (EPA). A method validation process, including precision and accuracy performance evaluations and method detection limit studies, is an element of UIASL Standard Methods. Method performance evaluations include quality control samples analyzed with a batch to ensure sample data integrity. Internal laboratory spikes and duplicates are part of UIASL's quality assurance program. Laboratory QA/QC results generated from this project can be provided upon request.

QA/QC procedures from the field-sampling portion of this project included a duplicate sample and a blank sample (one set per sampling day). The field blanks consisted of laboratory-grade deionized water, transported to the field and poured off into the appropriate sample containers. The blank sample was used to determine the integrity of the field teams handling of samples, the condition of the sample containers and deionized water supplied by the laboratory and the accuracy of the laboratory methods. Duplicate samples were obtained by filling two sets of sample containers with homogenized composite water from the same sampling site. The duplicate and blank samples were not identified as such to laboratory personnel to ensure laboratory precision.

Data Handling

All of the field data and analytical data generated from each survey were reviewed in the Moscow field office and then submitted to the Idaho State Department of Agriculture (ISDA) in Boise for review. These reviews ensured that all necessary observations, measurements, and analytical results were properly recorded. The analytical results were evaluated for completeness and accuracy. Any suspected errors were investigated and resolved, if possible. The data were then stored electronically and made available to any interested entity upon request.

Analysis

Analysis of the data was done, and descriptive statistics such as maximum, minimum, median, and mean values for each parameter measured were determined. The number of exceedances per year was calculated based on the number of sampling events whose respective values exceeded TMDL targets or State of Idaho water quality standards, whichever was more restrictive. These descriptive statistics are presented per subwatershed, as are statistical comparisons between the 1998 and 2004 data sets, when possible.

Most of the data collected during these monitoring projects do not fit a normal distribution, and contain numerous instances of censored data and outliers. Censored data can cause problems when using parametric methods of statistical analysis because these methods often require that all data have numerical values. Nonparametric methods often deal with the ranking of the data, not the data themselves. For example, with data "below the detection limit," any value that is less than the smallest value of all the data being analyzed can be assigned. This assignment does not affect the ranking of the data even though the exact value of the "below the detection limit" is unknown. Nonparametric procedures are also less affected by outliers (Spooner, 1994).

Data sets were first tested for normality using the Kolmogorov-Smirnov test. If the data were normally distributed, an unpaired *t*-test was performed; if the data were not normally distributed, a Mann-Whitney Rank Sum test was employed. The Rank Sum test ranks all the observations from smallest to largest without regard to which group each observation comes from. The ranks for each group are summed and the rank sums compared. If there is no difference between the two groups, the mean ranks should be approximately the same. If they differ by a large amount, one may conclude that there is a statistically significant difference between the groups that is not attributable to random sample variation. The Mann-Whitney Rank Sum test generates a T Statistic, which is the sum of the ranks in the smaller sample group. This value is then compared to the population of all possible rankings to determine the possibility of this T occurring. The p value is then generated to determine the probability of falsely rejecting the null hypothesis, or committing a Type I error, based on T. The smaller the p value, the greater the possibility that the samples are drawn from different populations (i.e. if $p<0.05$, there is a significant difference between the two data sets).

The null hypothesis (H_o) for each parameter tested is that there is no statistical difference between pre-BMP implementation data collected in 1998 by the DEQ and post-BMP implementation data collected in 2003-2004 by the IASCD. The hypothesis (H_1) is that there is a statistical difference between the two data sets.

The 1998 DEQ data set was incomplete. For that reason, only parameters with enough data points were comparatively analyzed in this report. Analysis was done for each individual monitoring site.

Results and Discussion

Subwatershed Current and Comparative Analysis

Winter Creek (JF-2)

Winter Creek drains 7,282 acres of land, of which 6,936 acres are forested and 346 acres are pastureland. Winter Creek enters Jim Ford Creek below the 65 foot waterfall and must therefore meet the more stringent instantaneous water temperature of 13 ^{o}C.

Table 4. Descriptive statistics for Winter Creek monitoring site, 2003-2004.

JF-2	D.O. (mg/L)	% Sat (%)	Temp (^{o}C)	Cond (µS/cm^{2}@25^{o}C)	TDS (mg/L)	pH (H^{+})	Turbidity (NTU)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	*E-coli* (coli/100mL)
Maximum	12.14	99.00%	22.10	58.10	31.10	7.60	45.80	0.03	0.11	40.00	2419.20
Minimum	6.35	66.30%	0.10	19.50	9.10	6.60	4.84	0.01	0.014	4.00	4.00
Mean	9.86	84.71%	9.02	30.50	15.27	7.21	21.71	0.01	0.044	7.05	307.71
Median	10.25	81.50%	9.00	27.00	13.05	7.20	20.90	0.01	0.044	4.00	14.20
# exceedance	0.0		7.0			0.0		0	1	0.0	2.00
% exceedance	0.0%		33.3%			0.0%		0.0%	4.8%	0.0%	11.8%

Several BMPs were implemented in the Winter Creek subwatershed, including:

- construction of six miles of four-strand barbed wire fence
- installation of two cattle guards
- construction of one pond for offsite livestock watering
- the planting of 3000 ponderosa and lodgepole pine seedlings.

These BMPs were designed primarily to lower bacteria counts and sediment contributions by mitigating the impacts of cattle grazing on water quality in Winter Creek.

Below is a comparison of *E. coli* data sets from 1998 and 2004. Listed are the results of the Kolmogorov-Smirnov test for normality, the statistical interpretation, and accompanying graphical illustrations. The dashed red line in Figures 2 and 3 indicates the applicable 576 organisms/ 100m/L criteria set by the IDEQ for secondary contact recreation (SCR).

<u>*E. coli* for Winter Creek</u>

Mann-Whitney Rank Sum Test

Normality Test: Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
1998-E.coli	12	0	71.000	19.500	175.000
2003-2004-E.coli	20	0	14.200	10.400	25.100

T = 239.000 n(small)= 12 n(big)= 20 (P = 0.115)

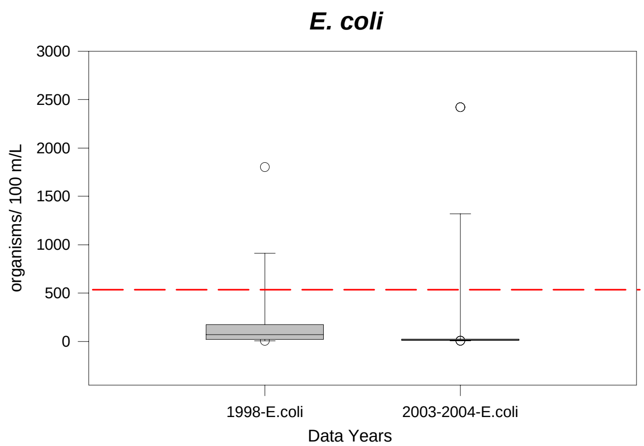

Figure 2. Comparison of Winter Creek *E. coli* data with extreme outliers included. The dashed red line indicates the applicable 576 organisms/100m/L criteria.

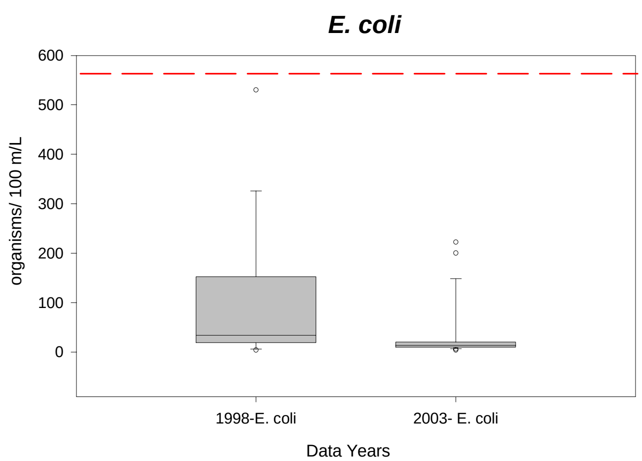

Figure 3. Comparison of Winter Creek *E. coli* data with extreme outliers removed. The dashed red line indicates the applicable 576 organisms/100m/L criteria for SCR.

The difference in the median *E. coli* values between the 1998 and 2004 data is not great enough to exclude the possibility that the difference is due to random sampling variability. Therefore, a statistically significant difference cannot be shown between the two groups. It should be noted, however, that an 80% decrease in the median level of *E. coli* from 1998 to 2004, indicates that substantial progress has been made. When the extreme outliers were removed from each data set, the *T* Statistic *p* value became 0.051; traditionally, you can conclude there is a significant difference when $p<0.05$.

Table 5. Statistical comparison of 1998 and 2003/2004 data for Winter Creek.

Parameters	Median		Minimum		Maximum		+/- 95% CI	
	1998	2003	1998	2003	1998	2003	1998	2003
pH	6.0	7.2	5.5	6.6	7.0	7.6	0.193	0.123
TP (mg/L)	0.05	0.044	0.05	0.014	0.07	0.11	0.004	0.009
E. coli (cfu/ 100mL)	71.0	14.2	4.0	4.0	1800.0	2419.2	323.223	344.538
TSS (mg/L)	5.0	4.0	2.0	2.0	8.0	40.0	1.090	3.918
Turbidity	19.2	20.9	6.0	4.84	25.2	45.8	3.019	4.550

Winter Creek Summary:

- Winter Creek had no flow from 7/7/03 – 12/2/03.
- The 13 ^{o}C instantaneous temperature standard was violated seven times (33.3%) during the 2003-2004 sampling period, although it did not cause DO levels to drop below the 6.0 mg/L water quality standard.
- TSS concentrations never exceeded the 80 mg/L target and the 2004 TSS median was 20 % lower than the 1998 median.
- OP and TP were in the expected range, with the only reading to exceed the 0.075 mg/L TMDL target occurring during the highest turbidity event on 12/2/03. A Pearson product moment correlation test run on the 2004 TP and turbidity data clearly showed that there was a strong association between the two variables (correlation coefficient: 0.786). Overall, there was a 76% reduction in median TP levels from 1998 to 2004.
- Although the instantaneous bacteria target was violated twice during this study the median *E. coli* count was reduced by 80 % from 1998 to 2004.

Grasshopper Creek (JF-4)

Grasshopper Creek drains 10,586 acres of land, of which 8,829 acres is forested, 1,640 acres are pastureland and 117 acres are considered urban. The creek flows through a portion of the City of Weippe where it then enters Jim Ford Creek just upstream of the small hydropower unit.

Table 6. Descriptive statistics for Grasshopper Creek monitoring site, 2003-2004.

JF-4	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm^2@25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	*E-coli* (coli/100mL)
Maximum	12.39	94.60%	29.80	1230.00	620.00	8.10	37.20	0.06	0.09	24.00	1553.10
Minimum	3.53	45.90%	0.10	24.50	12.30	6.60	9.38	0.01	0.036	4.00	4.00
Mean	8.84	78.77%	12.16	294.62	147.51	7.40	16.90	0.01	0.054	8.25	145.53
Median	9.21	79.30%	11.80	87.80	43.40	7.40	13.80	0.01	0.048	6.00	36.00
# exceedance	2.0		5.0			0.0		0	5	0.0	3.00
% exceedance	6.7%		16.7%			0.0%		0.0%	16.7%	0.0%	10.0%

No data collected from Grasshopper Creek during the 2004 monitoring effort showed a statistically significant difference from data collected during the 1998 project. A nominal number of BMPs were implemented within this watershed, including:

- a stream access ramp for livestock
- one spring development
- one cattle watering facility
- one roof runoff structure

Table 7. Statistical comparison of 1998 and 2003 data for Grasshopper Creek.

Parameters	Median		Minimum		Maximum		+/- 95% CI	
	1998	2003	1998	2003	1998	2003	1998	2003
pH	6.45	7.40	5.1	6.6	10.0	8.1	.355	.157
TP (mg/L)	0.060	0.048	.05	.036	.1	.093	.004	.006
E. coli (cfu/ 100mL)	29.0	36.0	5.0	4.0	860.0	1553.1	138.293	121.641
TSS (mg/L)	3.0	6.0	1.0	2.0	14.0	24.0	1.210	2.194
Turbidity (NTU)	13.8	13.8	4.9	9.38	23.7	37.2	1.63	2.851

DO levels fell below the 6.0 mg/L standard twice during 2003, during summer months when flows were very minimal, although no increase in nutrients or aquatic growth was present as a result. High temperatures are a concern in this catchment, with temperatures exceeding the TMDL target of 22 ^{o}C several times during the late summer months (see Fig. 4). There was a 24 % increase in temperature levels from 1998 to 2004.

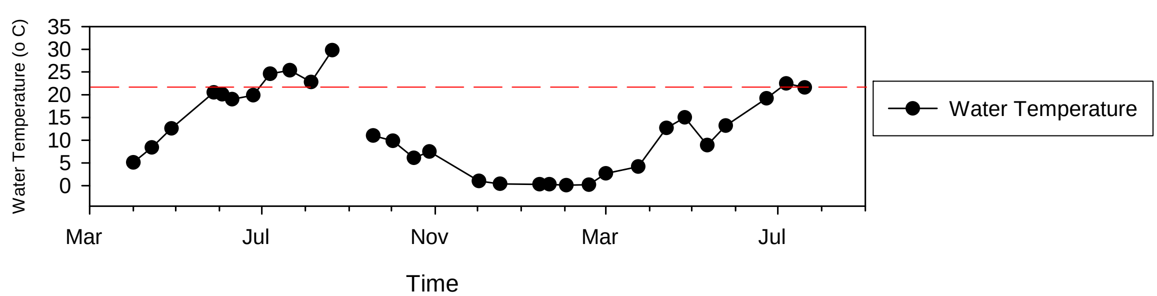

Figure 4. Instantaneous temperature in Grasshopper Creek, 2003. The dashed red line indicates the applicable 22 ^{o} C instantaneous temperature criteria.

Grasshopper Creek Summary:

- This site experienced elevated TDS and Conductivity readings throughout the study, likely as a result of seepage from the Weippe wastewater treatment plant.
- Turbidity and TSS do not appear to be limiting water quality at this site.
- TP was consistently below the EPA Gold Book criterion of 0.1 mg/L but exceeded the 0.075 mg/L TMDL target three times during the growing season of April through October, as illustrated in Figure 5. There was a 20% decrease overall in median TP levels from 1998 to 2004.

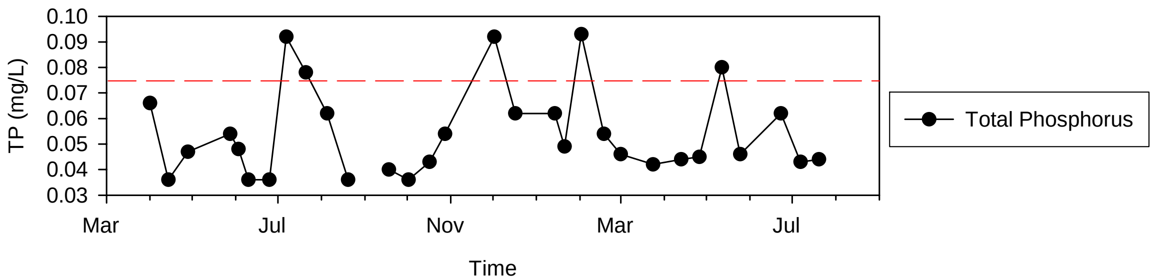

Figure 5. TP in Grasshopper Creek, 2003-2004. The dashed red line indicates the 0.075 mg/L target set by the Jim Ford Creek TMDL.

Miles Creek (JF-7)

Miles Creek is one of two creeks that join to form the headwaters of Jim Ford Creek; the other is Heywood Creek. Miles Creek drains 8,167 acres of which 288 acres are pastureland and 7,879 acres are forested.

Table 8. Descriptive statistics for Miles Creek monitoring site, 2003-2004.

JF-7	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm²@25°C)	TDS (mg/L)	pH (H⁺)	Turbidity (NTU)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	*E-coli* (coli/100mL)
Maximum	11.37	95.10%	24.00	91.90	45.90	7.80	70.80	0.08	0.18	41.00	2419.20
Minimum	5.27	48.30%	0.10	22.10	10.50	6.60	20.20	0.01	0.055	9.00	9.70
Mean	8.15	74.06%	12.31	42.67	20.81	7.34	38.07	0.02	0.115	23.13	264.74
Median	8.12	72.15%	12.65	38.60	19.30	7.30	35.35	0.02	0.11	20.50	48.45
# exceedance	4.0		2.0			0.0		1	15	0.0	2.00
% exceedance	22.2%		11.1%			0.0%		7.1%	83.3%	0.0%	11.1%

The Idaho Department of Lands (IDL) owns natural meadow land along Miles Creek which they lease to a local cattlemen's association that is responsible for livestock management and control, as well as fence maintenance.

Numerous BMPs were installed within the Miles Creek watershed. These include:

- road rocking and culvert installation
- 33,191 feet of riparian fencing

- 9800 willow cuttings planted
- 3300 lodgepole pine seedlings planted
- 1100 dogwood seedlings planted
- 2500 hawthorne seedlings planted
- 100 alders, 100 cottonwoods, 200 spirea planted
- 4 off-stream livestock watering facilities
- 1 livestock waste storage facility
- 1 pond for livestock watering
- 8 stream access ramps for livestock (heavy use area protection)

The primary goal of these BMPs is to mitigate the impact of livestock on water quality throughout this reach. Streambank fencing, in particular, is a BMP designed to reduce suspended sediment and nutrient inputs to streams by removing cattle access, eliminating streambank trampling, and promoting revegetation and stabilization of streambanks.

Below is a comparison of *E. coli* data sets from 1998 and 2004. Listed are the results of the Kolmogorov-Smirnov test for normality, the statistical interpretation, and accompanying graphical illustrations.

***E. coli* for Miles Creek**

Mann-Whitney Rank Sum Test

Data source: Data 1 in Miles Creek.SNB

Normality Test: Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
E Coli-1998	12	0	195.000	77.500	640.000
E-Coli-2003	18	0	48.450	25.000	130.000

T = 248.500 n(small)= 12 n(big)= 18 (P = 0.009)

The difference in the median values between these two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.009).

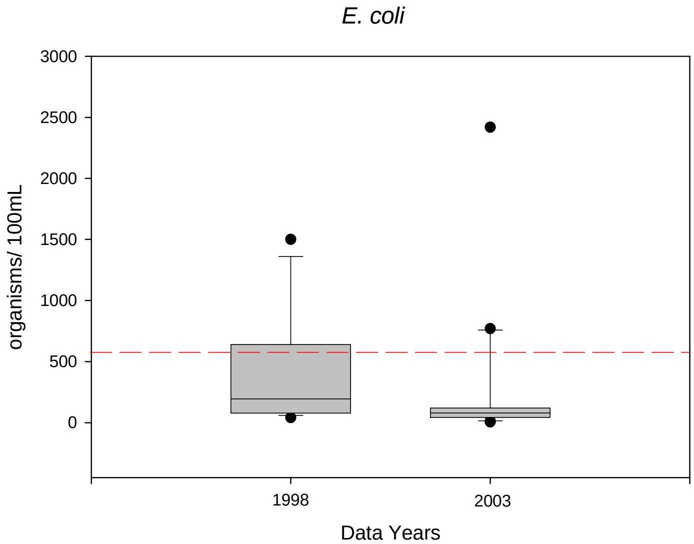

Figure 6. Comparison of *E. coli* data. The dashed red line indicates the applicable 576 organisms/ 100m/L criteria for SCR.

Table 9. Statistical comparison of 1998 and 2003/2004 data for Miles Creek.

Parameters	Median		Minimum		Maximum		+/- 95% CI	
	1998	**2003**	**1998**	**2003**	**1998**	**2003**	**1998**	**2003**
pH	6.15	7.30	5.5	6.6	6.5	7.8	0.182	0.135
TP (mg/L)	0.080	0.11	.07	.055	0.16	0.18	0.015	0.019
E. coli (cfu/ 100mL)	195.0	48.45	40.0	9.7	1500.0	2419.2	318.660	299.151
TSS (mg/L)	9.0	20.5	3.0	9.0	143.0	41.0	22.745	5.006
Turbidity (NTU)	20.10	35.35	4.6	20.2	42.9	70.8	5.002	7.691

Miles Creek Summary:

- The stream was dry from early July until December.
- DO levels fell below the numeric water quality standards only when flows fell below one cfs.
- Multiple exceedances of the 0.075 mg/L TP standard were observed. TP readings in Miles creek were somewhat higher than those from Heywood Creek, with a high of 0.19 mg/L on 6/3/04. Median TP levels during this study were 38% higher than in 1998, which may correlate to the increases in TSS and turbidity that were observed.
- Turbidity and TSS are consistently elevated, with turbidity readings exceeding 50 NTU during both low and high flows.
- Median *E. coli* readings were 75% lower than those observed in 1998.

- Temperatures were high throughout the summer months and violations of the temperature standard occurred frequently.

Heywood Creek (JF-6)

Heywood Creek is one of two creeks that join to form the headwaters of Jim Ford Creek. The creek drains 7,337 acres, of which 1,244 acres are pastureland and 6,093 acres are forested.

Several BMPs have been installed in the Heywood Creek watershed, including:

- 14.1 acres of riparian forest buffer
- 1,300 feet of riparian fencing
- 2 animal waste management systems
- 2 waste storage facilities
- 1 animal watering facility
- 1 roof runoff structure
- 650 feet of corral fence
- 5,020 assorted trees and shrub plantings

Table 10. Descriptive statistics for Heywood Creek monitoring site, 2003-2004.

JF-6	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm^2@25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	*E-coli* (coli/100mL)
Maximum	12.61	121.20%	24.80	85.70	42.80	8.00	42.80	0.06	0.12	50.00	2419.20
Minimum	5.63	65.40%	0.00	21.10	9.90	7.00	15.50	0.01	0.038	7.00	6.30
Mean	9.89	87.80%	11.12	40.81	20.44	7.48	28.09	0.02	0.091	18.81	274.76
Median	10.74	85.85%	10.55	38.60	19.10	7.40	27.35	0.01	0.094	18.00	79.10
# exceedance	1.0		3.0			0.0		0	14	0.0	3.00
% exceedance	5.6%		16.7%			0.0%		0.0%	77.8%	0.0%	16.7%

Table 11. Statistical comparison of 1998 and 2003/2004 data for Heywood Creek.

Parameters	Median		Minimum		Maximum		+/- 95% CI	
	1998	2003	1998	2003	1998	2003	1998	2003
pH	5.9	7.4	5.7	7.0	6.2	8.0	0.094	0.139
TP (mg/L)	0.090	0.094	0.07	0.038	0.16	0.12	0.015	0.011
E. coli (cfu/ 100mL)	64.5	79.1	40.0	6.3	1500.0	2419.2	318.660	288.354
TSS (mg/L)	6.0	18.0	3.0	7.0	143.0	50.0	22.745	5.463
Turbidity (NTU)	16.40	27.35	4.6	15.5	42.9	42.8	5.002	4.125

Heywood Creek Summary:

- TP readings were consistently elevated at this site, violating the 0.075 mg/L TMDL target over 77% of the time.
- TSS readings never exceeded the 80 mg/L target. TSS and turbidity were moderately high throughout the study, however, and were likely responsible for the elevated TP measurements.
- *E. coli* levels were relatively low, although they exceeded the water quality standards twice during the study.
- Temperatures were high from late May until the creek dried up and violated the water quality standard a number of times.

Jim Ford Creek (JF-5, JF-3, & JF-1)

Three monitoring sites were located directly on the mainstem of Jim Ford Creek. The two upper sites, JF-5 and JF-3, are located above and below the City of Weippe WWTP, respectively. JF-1 is located near the mouth of Jim Ford Creek, and is accessible to anadromous fish. Below is an analysis of the data collected for each site in 2003-2004, as well as a comparison between that data and data collected by the DEQ in 1998.

JF-5

This monitoring station was located on the main stem of Jim Ford Creek, above the City of Weippe and directly upstream of the bridge on state highway 11, which leads into Weippe.

A number of BMPs were put in on the main stem of Jim Ford Creek from its headwaters to the monitoring site, JF-5. These include:

- 15,609 feet of riparian fencing
- 139.3 acres of pasture/hay land planting
- 38 culvert replacements
- 5 grade stabilization structures
- 14 stream access ramps for livestock
- 2 off-stream watering facilities for livestock
- 3 ponds
- 2350 feet of subsurface drain tile
- 62 feet of stream channel stabilization
- 105 acres of riparian forest buffer
- 1,336 feet of rock rip-rap for bank stabilization
- 25 acre wetland creation

Table 12. Descriptive statistics for Jim Ford Creek monitoring site (JF-5) above Weippe waste water treatment plant, 2003-2004.

JF-5	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm^2@25°C)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	*E-coli* (coli/100mL)
Maximum	15.04	105.70%	25.60	233.00	114.00	8.00	70.70	0.075	0.15	36.00	1986.30
Minimum	2.72	32.90%	0.10	22.90	11.40	7.10	13.20	0.006	0.068	9.00	6.40
Mean	8.71	78.69%	12.66	83.25	41.40	7.47	28.82	0.02	0.098	17.91	144.83
Median	8.60	84.20%	13.40	47.45	24.05	7.40	27.70	0.012	0.091	15.00	42.00
# exceedance	4.00		8.00			0.00		0	20	0.00	1.00
% exceedance	16.0%		32.0%			0.0%		0.0%	80.0%	0.0%	4.0%

Table 13. Statistical comparison of 1998 and 2003/2004 data for Jim Ford Creek monitoring site (JF-5), above Weippe waste water treatment plant.

	Median		**Minimum**		**Maximum**		**+/- 95% CI**	
Parameters	**1998**	**2003**	**1998**	**2003**	**1998**	**2003**	**1998**	**2003**
TP (mg/L)	0.100	0.091	0.050	0.068	0.18	0.15	0.008	0.010
E. coli (cfu/ 100mL)	59.5	42.0	1.0	6.4	3800.0	1986.3	499.463	167.601
TSS (mg/L)	10.0	15.0	3.0	9.0	43.0	36.0	2.262	3.324
Turbidity (NTU)	29.9	27.7	6.3	13.2	50.7	70.7	3.313	4.810

JF-5 Summary:

- There was no flow in the stream from 9/2/03 until 10/28/03. However, large pools formed in places and many fish were observed in them until flow resumed with the fall rains.
- DO levels were low during the summer months but only when flow was less than 1 cfs, so the numeric criteria do not apply.
- TP exceeds the TMDL target at this site and is a reflection of elevated TP levels upstream. However, the median TP level was 9 % lower in 2004 than in 1998, suggesting that water quality may be improving.
- Turbidity and TSS levels are relatively high and water clarity was poor throughout the year.
- Temperatures were high at the site from late May until flow stopped in late August.
- One exceedance of the *E. coli* standard occurred on 5/12/04; overall, the median *E. coli* level was 29% lower than observed in 1998.

JF-3

This monitoring station was located on the main stem of Jim Ford Creek, directly upstream of the small hydropower plant and downstream of the waste water treatment plant and Grasshopper Creek.

Several BMPs were put in along the reach between JF-3 and JF-5. These include:

- 2,790 feet of riparian fence
- 1 off-stream livestock watering facility
- 1 pond
- 1,275 assorted trees and shrubs

Table 14. Descriptive statistics for Jim Ford Creek monitoring site (JF-3) below Weippe waste water treatment plant and mouth of Grasshopper Creek, 2003-2004.

JF-3	D.O. (mg/L)	% Sat (%)	Temp (^oC)	Cond ($\mu S/cm^2@25^oC$)	TDS (mg/L)	pH (H^+)	Turbidity (NTU)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	*E-coli* (coli/100mL)
Maximum	13.71	100.90%	25.10	452.00	228.00	8.60	45.30	0.08	0.15	28.00	1986.30
Minimum	4.12	46.80%	0.10	24.70	12.30	7.10	6.43	0.01	0.016	4.00	2.00
Mean	8.76	82.06%	13.43	158.27	79.80	7.49	20.28	0.02	0.079	12.39	117.04
Median	8.56	84.90%	12.55	58.40	29.10	7.40	19.95	0.01	0.074	10.00	27.00
# exceedance	2.0		5.0			0.0		2	11	0.0	1.00
% exceedance	7.1%		17.9%			0.0%		8.3%	39.3%	0.0%	3.6%

Table 15. Statistical comparison of 1998 and 2003/2004 data for Jim Ford Creek monitoring site (JF-3), below Weippe waste water treatment plant.

Parameters	Median		Minimum		Maximum		+/- 95% CI	
	1998	2003	1998	2003	1998	2003	1998	2003
TP (mg/L)	0.090	0.074	0.050	0.016	0.14	0.15	0.007	0.012
E. coli (cfu/ 100mL)	31.5	27.0	7.0	2.0	1800.0	1986.3	235.816	139.356
TSS (mg/L)	6.0	10.0	1.0	4.0	34.0	28.0	1.842	2.906
Turbidity (NTU)	25.35	19.95	4.30	6.43	43.2	45.3	3.15	3.99

TP levels decreased substantially from 1998 to 2003-2004. The Mann-Whitney Rank Sum test below confirms that the decrease in TP is greater than would be expected by chance, leading one to infer that BMPs in the watershed have had a positive effect on water quality.

Mann-Whitney Rank Sum Test

Data source: Data 1 in Notebook 1

Normality Test: Failed ($P < 0.050$)

Group	N	Missing	Median	25%	75%
TP-1998	38	0	0.0900	0.0800	0.110
TP-2003	28	0	0.0735	0.0660	0.0940

T = 747.000 n(small)= 28 n(big)= 38 ($P = 0.013$)

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference ($P = 0.013$)

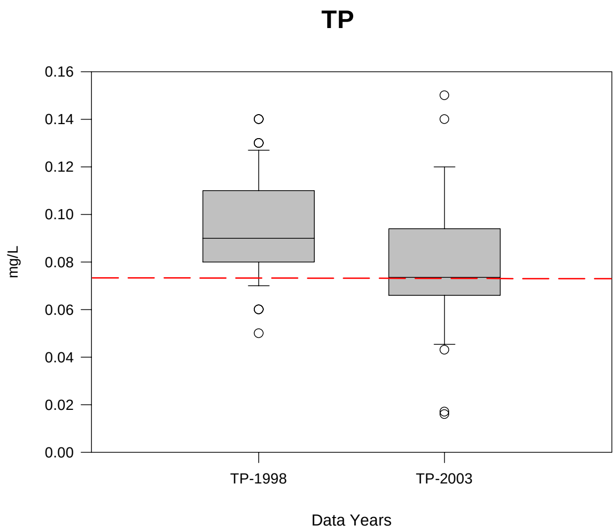

Figure 7. Comparison of TP data at JF-3. The dashed red line indicates the applicable 0.075 TMDL target.

JF-3 Summary:

- TP levels decreased somewhat as compared to JF-5, likely due to dilution from Grasshopper Creek and the WWTP discharge. Levels were still elevated, however, and exceeded the 0.075 mg/L target nearly 40% of the time. The median TP level was 18% lower than observed in 1998.
- Flows were less than 1 cfs for most of July and August, which likely contributed to high stream temperatures noted during that time frame.
- One violation of the *E. coli* standard occurred during this study; the median *E. coli* level was 14% lower than observed in 1998.

JF-1

This monitoring station was located on the main stem of Jim Ford Creek, approximately ¼ mile upstream from its confluence with the Clearwater River.

Table 16. Descriptive statistics for Jim Ford Creek monitoring site (JF-1) located near the confluence with the Clearwater River, 2003-2004.

JF-1	D.O. (mg/L)	% Sat (%)	Temp (°C)	Cond (µS/cm²@25°C)	TDS (mg/L)	pH (H⁺)	Turbidity (NTU)	OP (mg/L)	TP (mg/L)	TSS (mg/L)	*E-coli* (coli/100mL)
Maximum	13.48	110.30%	23.40	171.50	81.50	8.40	40.70	0.06	0.13	21.00	1413.60
Minimum	7.02	78.80%	1.30	28.20	13.90	6.90	2.85	0.01	0.021	4.00	5.20
Mean	10.13	94.19%	12.38	89.81	44.39	7.44	12.71	0.02	0.051	5.34	94.69
Median	10.04	93.40%	11.90	80.25	39.90	7.20	8.45	0.02	0.044	4.00	23.00
# exceedance	0.0		12.0			0.0		0	4	0.0	1.00
% exceedance	0.0%		38.7%			0.0%		0.0%	12.9%	0.0%	3.4%

Table 17. Statistical comparison of 1998 and 2003/2004 data for Jim Ford Creek monitoring site (JF-1).

Parameters	Median		Minimum		Maximum		+/- 95% CI	
	1998	2003	1998	2003	1998	2003	1998	2003
TP (mg/L)	0.080	0.044	0.025	0.021	0.14	0.13	0.011	0.008
E. coli (cfu/ 100mL)	19.5	23.0	3.0	5.2	80.0	1413.6	9.214	99.812
TSS (mg/L)	4.0	2.0	1.0	2.0	27.0	21.0	1.614	1.545
Turbidity (NTU)	22.00	8.45	0.82	2.85	45.9	40.7	3.677	3.848

JF-1 Summary:

- Water quality is generally very good at this site.
- DO was consistently over 7.0 mg/L and pH levels are well within the expected range.
- Turbidity was moderately high, but the median was 62% lower than in 1998.
- TSS rates were quite low overall and the median level dropped 50% from the 1998 level.
- *E. coli* was below the water quality standard nearly all of the time, with the only violation occurring on 5/12/04 (it should be noted that samples collected at all sites that day were abnormally high, leaving open the possibility of contamination at the lab).
- Water temperatures exceeded the salmonid spawning instantaneous criteria during late April and May and exceeded the cold water aquatic life criteria in July.
- TP levels in 2003-2004 were significantly lower than levels in the 1998 study, with a 45% decrease in median levels, although they still exceeded the 0.075 mg/L TMDL target four times during the study. The Mann-Whitney Rank Sum Test was done to determine whether a statistically significant reduction in phosphorus levels had occurred; results follow.

Total Phosphorus

Mann-Whitney Rank Sum Test

Data source: Jim Ford Creek (mouth)

Group	N	Missing	Median	25%	75%
TP-1998	43	0	0.0800	0.0500	0.1000
TP-2003	31	0	0.0440	0.0380	0.0550

T = 880.500 n(small)= 31 n(big)= 43 (P = 0.002)

The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.002)

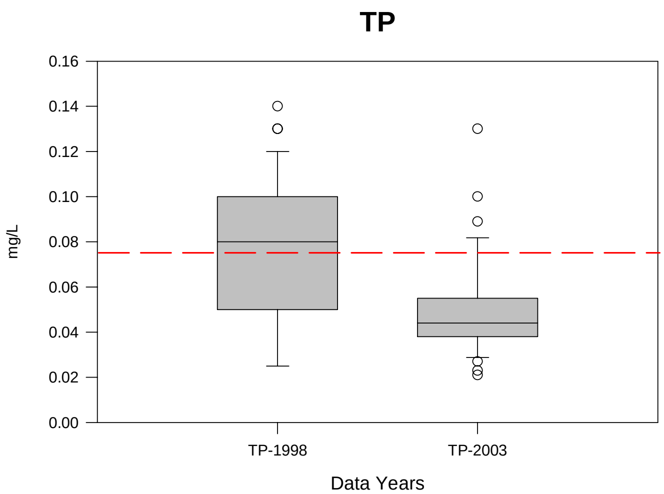

Figure 8. Comparison of TP data. The dashed red line indicates the applicable 0.075 TMDL target.

Loadings

A TMDL or Total Maximum Daily Load is the calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. In the Jim Ford Creek TMDL, existing loads and the total load capacity were estimated. The difference between the two determined the necessary load reductions per subwatershed. Existing loads are often calculated by multiplying instream concentration by flow data. Load capacity is calculated using a water quality target or standard, rather than actual instream concentration, and flows.

TMDLs are inherently difficult to develop due to limited data and monitoring, unknown or legacy sources of pollutants, as well as the overall complexity of watershed systems.

The Jim Ford Creek TMDL does not call for a load reduction in fine sediment or nitrogen. Load reductions for pathogens were recommended for fecal coliform levels, but standards have since changed and the criteria are now based on *E. coli* levels. *E. coli* concentrations were determined during the course of this more recent study, to best evaluate conditions under current criteria, so load comparisons between the 1998 and current data sets is not possible.

Total Phosphorus is the only parameter where loads can reasonably be compared from the 1998 and 2003-2004 data sets, but some challenges exist there as well. In the 1998 DEQ study, discharge was estimated for streams in the watershed using regional regression equations developed by Kjelstrom (1998), rather than having direct discharge measurements taken. The 84th percentile TP concentration was then calculated for each month and then the mean of these values was calculated. Of concern, however, is the percent difference noted in the report between calculated and measured instream nutrient loads, which ranged from -40 to 67%. The authors attributed this disparity on a lack of data and recommended that future efforts be based on instream sampling of nutrients and manual measurements of stream discharge (DEQ Jim Ford Creek TMDL, Table J-2).

The more complete data set associated with the 2003-2004 monitoring effort allowed for a more straightforward calculation to determine pollutant loads. The equation used was:

$$L = f * c * d$$

where L = load
f = units conversion factor (mg/ L to lb/ day = 5.39)
c = concentration of pollutant
d = discharge

Table 18 lists the 1998 load estimate and capacity as well as the 2003-2004 load estimates per subwatershed for TP. There is some question as to which set of loading values in the TMDL are correct, as Table 28 (TMDL Loading Analysis Results for TP) and Table J-1 (TMDL Loading Analysis Results for TP) in the TMDL have different values; likely due to an oversight in editing. For the sake of this comparison, numbers from the Executive Summary Loading Table (1-7) were used. As different methodologies were used to produce the given values, one should be very cautious in interpreting these comparisons.

Table 18. Comparison of TP loadings from 1998 to 2003-2004 (units in lbs/month).

Subwatershed	1998 Load Capacity	1998 Load Estimate	2004 Load Estimate	Reduction Called For	Reduction Observed
Miles	198	267	232	26 %	13 %
Heywood	161	238	206	32 %	13 %
Upstream Weippe	534	793	381	33 %	52 %
Grasshopper	233	244	257	5%	+ 5%
Downstream Weippe	593	737	517	24%	30 %
Winter	161	113	83	0%	27 %
Lower Jim Ford	1801	2353	562	26%	76 %

Conclusions

The monitoring program for the main stem and tributaries of Jim Ford Creek was successfully carried out as planned. Protocols were followed, QA/QC standards were met, and specific information per parameter for each sub-watershed was collected.

Improvements in water quality are noticeable in a number of streams assessed during this study and water quality generally improves as one moves downstream from the headwaters to the mouth of Jim Ford Creek. It is likely that intensive land use on the Weippe prairie accounts for the elevated numbers seen in the data set, while the relatively untouched, rugged canyon lands found in the middle section of Jim Ford Creek may allow pollutants to settle out, assimilate and/or be diluted, thereby accounting for the improved water quality observed at the mouth.

Contrary to the conclusions of the TMDL, fine sediment appears to be an issue in the headwater tributaries as well as the upper section of Jim Ford Creek itself. While TSS levels never exceeded the instantaneous target of 80 mg/L, it appears that sediment levels are high enough to partially account for the high levels of phosphorus observed in the upper watershed.

Excessive stream temperature is a major concern throughout the Jim Ford Creek watershed. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Aquatic insects are sensitive to temperature and will move in a stream to find their optimal temperature. Temperature is also critical for fish spawning and embryo development. If stream temperatures are outside of optimal levels for prolonged periods of time, organisms become stressed and may die or be unable to reproduce. Temperature typically has an inverse relationship with DO. DO levels throughout the system are low during the months when water temperatures are high and flows are minimal.

Total phosphorus loading is more of an issue in the upper watershed, likely as a result of fine sediment loading, but violations also occur at the mouth albeit much less frequently.

Bacteria levels in 2004 were noticeably lower than in 1998 throughout the watershed, likely due to the implementation of livestock exclusions, and manure management practices.

An abbreviated summary for each site follows.

Winter Creek

- Several BMPs, aimed primarily at mitigating the impacts of livestock, were implemented in the watershed.
- The 13 ^{o}C instantaneous temperature standard was violated seven times (33.3%) during the 2003-2004 sampling period, although it did not cause DO levels to drop below the 6.0 mg/L water quality standard.
- TSS concentrations never exceeded the 80 mg/L target and the 2004 TSS median was 20 % lower than the 1998 median.
- OP and TP were in the expected range, with the only reading to exceed the 0.075 mg/L TMDL target occurring during the highest turbidity event on 12/2/03. Overall, there was a 76% reduction in median TP levels from 1998 to 2004.

- Although the instantaneous bacteria target was violated twice during this study the median *E. coli* count was reduced by 80 % from 1998 to 2004.

Grasshopper Creek:

- A nominal number of BMPs were implemented in this watershed.
- Elevated TDS and Conductivity readings were evident at this site, likely due to seepage from the Weippe wastewater treatment plant.
- TP was consistently below the EPA Gold Book criterion of 0.1mg/L, but exceeded the 0.075 mg/L TMDL target three times during the growing season of April through October.

Miles Creek:

- Numerous BMPs were implemented within this watershed, including fencing, revegetation, and livestock management structures.
- DO levels fell below numeric water quality standard only when flows fell below one cfs.
- Multiple exceedances of the 0.075 mg/L TP standard were observed. Median TP levels have increase by 38% since 1998, likely due to increase bank and instream erosion.
- Median *E. coli* readings were 75% lower than those observed in 1998.
- Temperatures were consistently elevated during the summer months and frequently violated the temperature standard.

Heywood Creek:

- Several BMPs have been implemented in the watershed, including fencing, forest buffer, revegetation and livestock management structures.
- TP readings were consistently elevated at this site and violated the TMDL target 77% of the time.
- *E. coli* levels were relatively low, although they exceeded the water quality standard twice during the study.
- Temperatures were high during the summer months and violated the water quality standard a number of times.

JF-5 (main stem, above City of Weippe)

- Numerous BMPs were implemented, including revegetation, grade stabilizations, wetland creation, and livestock management structures.
- DO levels fell below numeric water quality standard only when flows fell below one cfs.
- TP consistently exceeded the TMDL target at this site, although median levels were 9% lower in 2004 than in 1998.
- Temperatures violated state criteria throughout the summer months.

- Median *E. coli* level was 29% lower than observed in 1998.

JF-3 (main stem, below City of Weippe)

- Several BMPs were implemented, including revegetation, fencing, and an off-site watering facility for livestock.
- TP levels exceeded the TMDL target nearly 40% of the time, although median TP levels were 18% lower than in 1998.
- Median *E. coli* level was 14% lower than in 1998.

JF-1 (main stem, mouth)

- Water Quality is generally very good at this site.
- The median turbidity was 62% lower than in 1998.
- Median TSS level dropped 50% from the 1998 level.
- Water Temperatures exceeded the salmonid spawning instantaneous criteria during late April and May and exceeded the cold water aquatic life criteria in July.
- Median TP level was 45% lower than in 1998 although levels still exceeded the TMDL target four times during the study.

Recommendations

Significant erosion is currently evident along a number of streams, and treatment should be applied to streams that are already undergoing the most severe erosion. Based on visual assessments, TSS rates, and turbidity levels, the greatest erosion problems seem to be located on the main stem of Jim Ford creek above Weippe and on Miles and Heywood creeks. TP levels were also much higher in these streams but would likely be reduced as sediment levels are decreased. DO levels would likely increase as reductions of TP and TSS occurred. The revegetation of stream banks will help reduce sediment transport in problem areas, as healthy riparian vegetation is effective in reducing bank erosion. Riparian vegetation will also filter sediment transported in surface water runoff.

Excessive stream temperatures are a widespread problem within this watershed and will be a difficult problem to overcome. Perhaps the most effective strategy would be to work toward the establishment of natural full potential canopy shade. Reducing sediment loads within critical reaches will assist in reducing stream temperatures as well, since suspended particles tend to absorb more heat.

Significant reductions in bacteria levels have already been observed in watersheds where livestock exclusion via fencing has been used. Continuing to fence cattle away from creeks and developing off-stream watering facilities is apt to be the most cost-effective method to reduce bacteria levels and sediment levels in problem areas.

BMP placement in this watershed has improved overall water quality and continued implementation of targeted stream improvements to reduce sediment loads, lower temperatures, and lower nutrient levels will be important.

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Glossary

§303(d)	Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of waterbodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.
Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic biota, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
Catchment	Land area that contributes runoff (drains) to a given point in a stream or river. Synonymous with watershed and drainage or river basin.

Censored Data

Sample observations for which the complete distribution is not known. Censored data often appear in laboratory reports when the concentration being analyzed is lower than the detection limit or higher than the allowable range for a particular type of laboratory equipment or procedure.

Conductivity

The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.

Criteria

In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. EPA develops criteria guidance; states establish criteria.

Cubic Feet per Second

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, one cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Discharge

The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

Dissolved Oxygen

The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

E. coli	Short for *Escherichia Coli, E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.
Exceedance	A violation of the pollutant levels permitted by water quality criteria.
Mean	Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.
Median	The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; and 6 is the median of 1, 2, 5, 7, 9, 11.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as

nitrogen and phosphorus, which usually limit growth.

pH — The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Point Source — A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant — Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Riffle — A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Sediments — Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

Subbasin — A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions.

Surface Runoff	Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.
Suspended Sediments	Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.
Thalweg	The center of a stream's current, where most of the water flows.
Total Suspended Solids (TSS)	A measure of the suspended organic and inorganic solids in water. Measured in mg/L or ppm.
Tributary	A stream feeding into a larger stream or lake.
Turbidity	A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.
Water Quality Limited	A label that describes waterbodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.

Water Quality Standards	State-adopted and EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.
Watershed	1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a waterbody.