Portneuf River Subbasin
Water Quality Monitoring Report
May 2000 – April 2003

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Amy Jenkins
Water Quality Analyst
IASCD
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Portneuf Soil and Water Conservation District
Caribou Soil Conservation District
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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) conducted a multiple year monitoring project on several tributaries to the Portneuf River in southeast Idaho. Two phases of the monitoring were conducted to aid in determining sources of agricultural based pollutants in the Portneuf River. This document reports on phase II of the monitoring project. The information was collected to assist the Portneuf Soil and Water Conservation District (SWCD) in determining pollutant loads of tributaries. These data will be used to plan implementation of voluntary agricultural best management practices (BMPs). IASCD worked cooperatively with Idaho State Department of Agriculture (ISDA), Portneuf SWCD, Idaho Department of Environmental Quality (DEQ) and Idaho Soil Conservation Commission (ISCC).

In 1999 the Portneuf River TMDL was completed by the Idaho DEQ. Phase I of this project provided water quality results for 18 tributaries that were monitored from May 1999 through May 2000 (Fischer 2000). The results from Phase I were used to identify sites that required further water quality monitoring and to help determine additional monitoring sites. Twelve of the original 18 sites were discontinued, while sampling continued on six of the sites (Twentyfour mile, Upper Marsh, Middle Marsh, Hawkins, Garden and Webb). Based on the findings from Phase I, five additional sites were selected for monitoring to better pinpoint stream reaches that were significantly impacted by nonpoint source pollution and to identify where pollutants may be entering the system. The additional sites were located on the North Fork of Rapid Creek, West Fork of Rapid Creek, Twentyfourmile Creek above the reservoir, Upper Hawkins Creek and Upper Garden Creek (Figure 1, Table 1). Data included in this report was collected from May 2000 to April 2003. A comparison of data collected in Phase I (prior to May 2000) and Phase II (May 2000 to 2003) was made to determine if water quality at six sites varied between sampling periods.

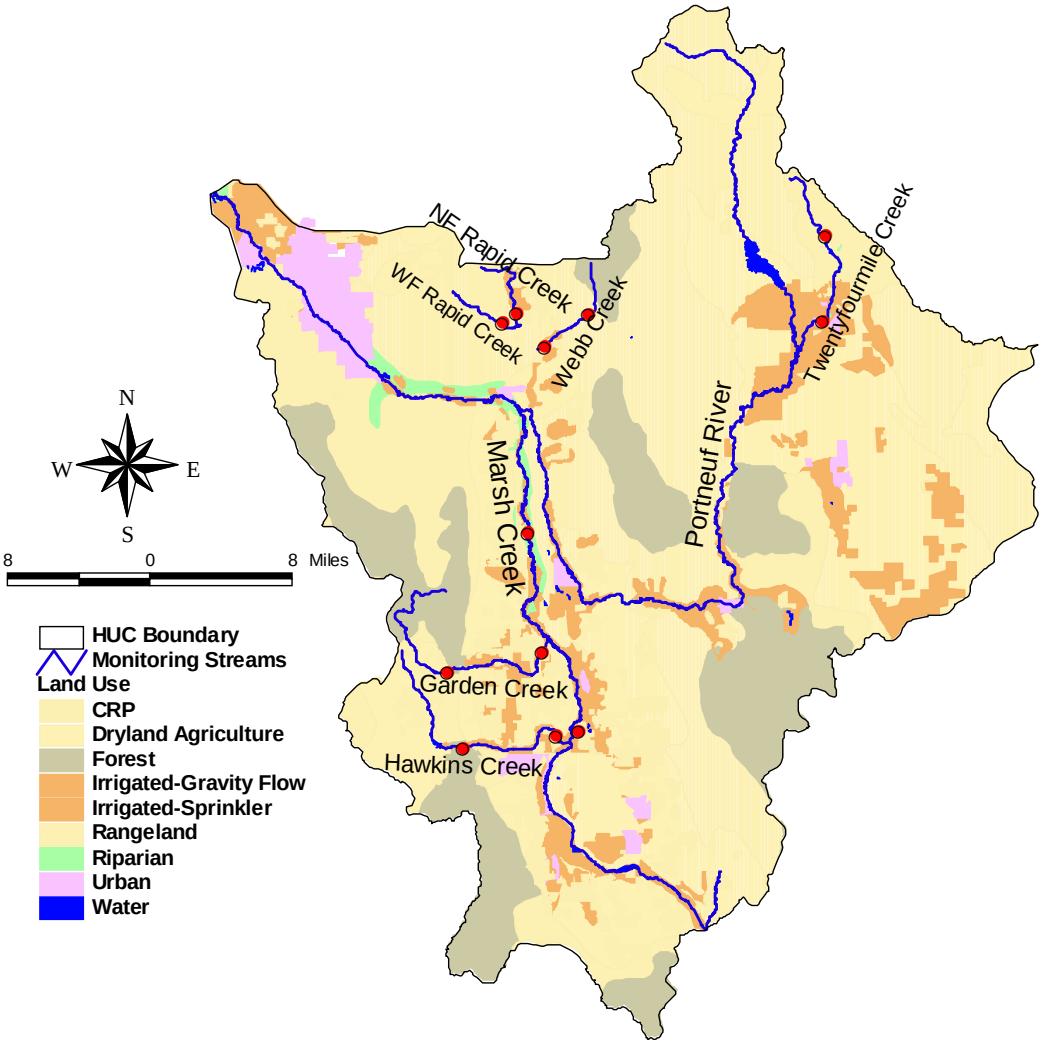

Figure 1. Site locations during Phase II of the Portneuf River monitoring sites.

Table 1. Location and pollutants of concern for the twelve sites monitored in Phase II of the project.

MONITORING SITE LOCATION AND 303(d) LISTING STATUS	POLLUTANT PARAMETERS LISTED
Twentyfourmile Creek, Twentyfourmile Creek above Reservoir (303(d) listed)	Sediment
Hawkins Creek, Upper Hawkins Creek (303(d) listed)	Sediment, nutrients
West Fork Rapid Creek (303(d) listed)	Sediment
North Fork Rapid Creek (303(d) listed)	Sediment
Garden Creek, Upper Garden Creek (303(d) listed)	Sediment
Webb Creek, Upper Webb Creek (not listed)	_____
Middle Marsh Creek, Upper Marsh Creek (303(d) listed)	Sediment, nutrients

Portneuf Total Maximum Daily Load Requirements

The Portneuf River TMDL was approved by the USEPA in April, 2001. The TMDL listed bacteria, nutrients, sediment, and flow alteration as pollutants of concern within in the Portneuf Subbasin. Based on results from Phase I of the IASCD monitoring effort and sampling by the Idaho Department of Environmental Quality (DEQ), target levels for total phosphorus (TP) and total inorganic nitrogen (TIN) were modified. Current target concentrations for TP, TIN, total suspended sediment, fecal coliform, and *Escherichia coli* are given in Table 2.

Table 2**.** Current DEQ targets levels for pollutants of concern for 303(d) listed segments in the Portneuf River TMDL (DEQ 1999, DEQ personal comm.).

Pollutant of Concern	Portneuf River TMDL Targets:
Total Phosphorus (TP)	0.05 mg/L (reduced from 0.075 mg/L)
Total Inorganic Nitrogen (TIN)	0.8 mg/L (increased from 0.3 mg/L)
Total Suspended Solids (TSS)	Below 25 mg/L – no negative affect on CWAL Below 80 mg/L – some negative impact Above 80 mg/L – definite negative impact
Fecal Coliform	500 colonies/100mLs for Primary Contact 800 colonies/100mLs for Secondary Contact
Escherichia coli (*E. coli*)	406 colonies/100mLs for one time grab 126 colonies/100 ml for geometric mean

Methods

Sample collection dates varied across sites, but only data collected after May 2001 was included in these analyses. During high flows, some streams were inaccessible (due to safety concerns) and no samples were collected.

Sample collection techniques followed approved United State Geological Survey (USGS) methods. All analytical testing followed either EPA or Standard Methods for the Examination of Water and Wastewater approved methods (Clesceri et al. 1998). Quality control samples, duplicates and blanks, comprised at least 10% of the sample load during this program. Duplicate and blank samples were stored and delivered with the normal sample load for analytical testing.

Flow Measurements

Flow measurements were collected with a Marsh McBirney Flo-Mate Model 2000 flow meter. The six-tenth-depth method (0.6 of the total depth below water surface) was used when the depth of water was less than or equal to three feet. When the water was over three feet deep, an average of water velocity measured at 0.2 and 0.8 depths was used. A transect line was set up perpendicular to flow across the width of each creek and the mid-

section method for computing cross-sectional area along with the velocity-area method was used for discharge determination. The discharge was computed by summation of the products of the partial areas of the flow cross-sections and the average velocities for each of those sections.

Water Quality

Samples for water quality analysis were collected by grab sampling directly from the stream. For shallow sites (<1 ft) grab samples were collected by hand using a clean one-liter stainless steel container. A DH-81 integrated sampler was used at sites with water depths greater than 1 foot. For each method, individual samples were collected at equal intervals across the entire width of the stream. Each discrete sample was added to a 2.5 gallon polyethylene churn sample splitter from which homogenized samples were poured off into sample containers.

Field Measurements

Field measurements for dissolved oxygen, percent saturation and water temperature were taken directly in the streams from well-mixed sections, near mid-stream at approximately mid-depth. Measurements for specific conductance, pH and dissolved solids were taken from the churn splitter composite sample, immediately following collection. Calibration of all field equipment was in accordance with the manufacturers specifications. All field measurements were recorded in a bound logbook along with pertinent observations about the site, including weather conditions, flow rates and personnel on site.

Results and Discussion

The results of this project indicate that water quality is impaired in the many of the tributaries that were monitored. Most of the streams that were monitored were listed for sediment and some were also listed for nutrients. The results confirm that these streams are impacted by these pollutants.

Monitoring Sites

<u>Twentyfourmile Creek</u>
Twentyfourmile Creek was monitored at two locations; directly above as well as 5.6 miles below Twentyfourmile reservoir. Water quality above the reservoir is more impaired than at the site below the reservoir. There was a significant decrease in TP ($p = 0.007$) and *E. coli* ($p = 0.013$) concentrations from the above reservoir site to the lower site. TSS also declined from the upstream to downstream site, although not significantly and total nitrogen levels were not different between the two sites. The reservoir appears to act as a settling pond for sediment and the decreased phosphorus concentrations are likely caused by rapid uptake of phosphorus by aquatic vegetation in the reservoir.

Hawkins Creek

Hawkins Creek was monitored at two sites; above and below Hawkins Reservoir. Water quality in Hawkins Creek is poor, as indicated from the sampling at the upstream site and downstream sites. The Lower Hawkins site exceeded DEQ targets for TSS, TP, TIN and *E. coli*. The Upper site exceeded the TP and TIN targets and narrowly met the targets for TSS and *E. coli*. Only TP levels were different between the two sites ($p = 0.002$) and were found to increase from the upstream site to the downstream site.

West Fork and North Fork Rapid Creek

During phase I of the Portneuf monitoring project, Rapid Creek was identified as a water quality impaired stream. In an effort to better pinpoint problem areas in the subwatershed we added monitoring sites on the West and North Forks of Rapid Creek. Mean concentrations of TIN and TP at both sites exceeded DEQ targets. TIN levels were higher in the North Fork of Rapid Creek ($p = 0.011$), while TP levels did not differ between the two sites. Both sites were below the targets for TSS and *E. coli*.

Garden Creek

Two locations were monitored on Garden Creek. The lowermost site was located near the town of Robin. Water quality declined significantly from the upper to the lower site on Garden Creek. At the upper site the mean concentration of TP exceeded the DEQ target and all other parameters were below target levels. The TMDL targets for TIN, TP and *E. coli* were exceeded at the lower Garden Creek site. TSS levels at the lower site were on average below the target level.

Webb Creek

Webb Creek (not 303(d) listed) was used as a reference stream throughout this monitoring project. Webb Creek has been monitored at two locations and both met most water quality standards. Only TIN at the Upper Webb Creek site was on average in excess of state standards. The elevated TIN concentration at the Upper Webb site may be misleading because it was calculated using only four samples, which were collected from May to August of 2002. All other parameters measured met DEQ targets.

Marsh Creek

Marsh Creek is the largest tributary to the Portneuf River. During phase II of this project Marsh Creek was monitored at two locations. At both sites, mean TIN and TP levels exceeded DEQ targets and concentrations were not significantly different between the two sites. TSS and *E. coli* concentrations were below state target levels.

Suspended sediment

The DEQ has set an upper and lower target for total suspended sediment concentrations (TSS) to support cold water aquatic life (CWAL). TSS concentrations below 25 mg/L will not negatively affect CWAL. Concentrations between 25 and 80 mg/L may have a negative effect on CWAL, while TSS levels above 80 mg/L are very likely to impact CWAL. Mean TSS levels at eight of the twelve sites (five streams) were above the 25 mg/L target, while only Twentyfourmile (above the reservoir) and Hawkins Creek exceeded the upper threshold of 80 mg/L (Figure 2).

Total Phosphorus
The current DEQ target for TP in the Portneuf watershed is 0.05 mg/L. At ten of the twelve sites, mean TP concentrations exceeded the target level. Only Webb Creek fell below the DEQ target. Across all sites, the percentage of samples taken that exceeded the target averaged 66% and ranged from 25% to 100% (Table 3, Figure 3).

Total Nitrogen
The current target in the Portneuf watershed for total inorganic nitrogen (TIN) is 0.8 mg/L. Mean TIN concentrations at eight of the twelve sites (five streams) exceeded the target level. In this study, sites exceeded target levels 0% to 100% of the time and on average 73% of the time (Table 3, Figure 4).

Escherichia coli
The EPA standard for secondary contact recreation for *E. coli* is 576 colonies/100mL. Mean *E. coli* levels at three of the monitoring sites (three streams) were found to exceed the standard (Figure 5). The average *E. coli* concentration at the Upper Hawkins site (574 colonies/100mL) narrowly met the EPA standard.

Table 3. Percent of samples collected over the study period that exceeded the DEQ target for total inorganic nitrogen (TIN, target: 0.8 mg/L) and total phosphorus (TP, target: 0.05 mg/L).

Monitoring Site Location	Percent exceeding TIN target	Percent exceeding TP target
Twentyfourmile Creek	13%	31%
Twentyfourmile above Reservoir	0%	90%
Hawkins Creek	75%	100%
Upper Hawkins Creek	100%	88%
West Fork Rapid Creek	90%	97%
North Fork Rapid Creek	91%	94%
Garden Creek	84%	89%
Upper Garden Creek	53%	94%
Webb Creek	47%	36%
Upper Webb Creek	75%	25%
Middle Marsh Creek	95%	53%
Upper Marsh Creek	67%	78%

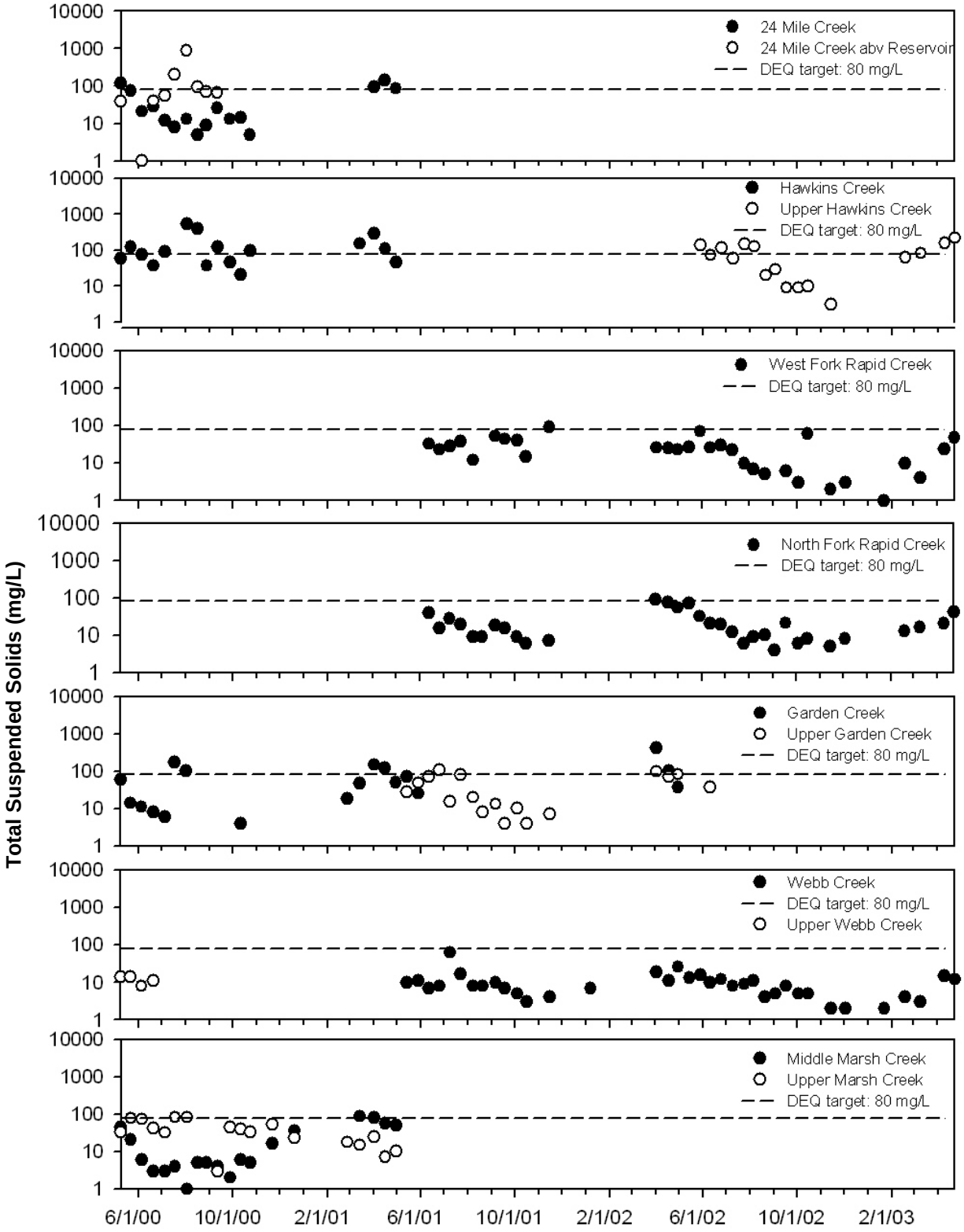

Figure 2. Total Suspended solids ($\log_{10}$) measured at each site over the study period.

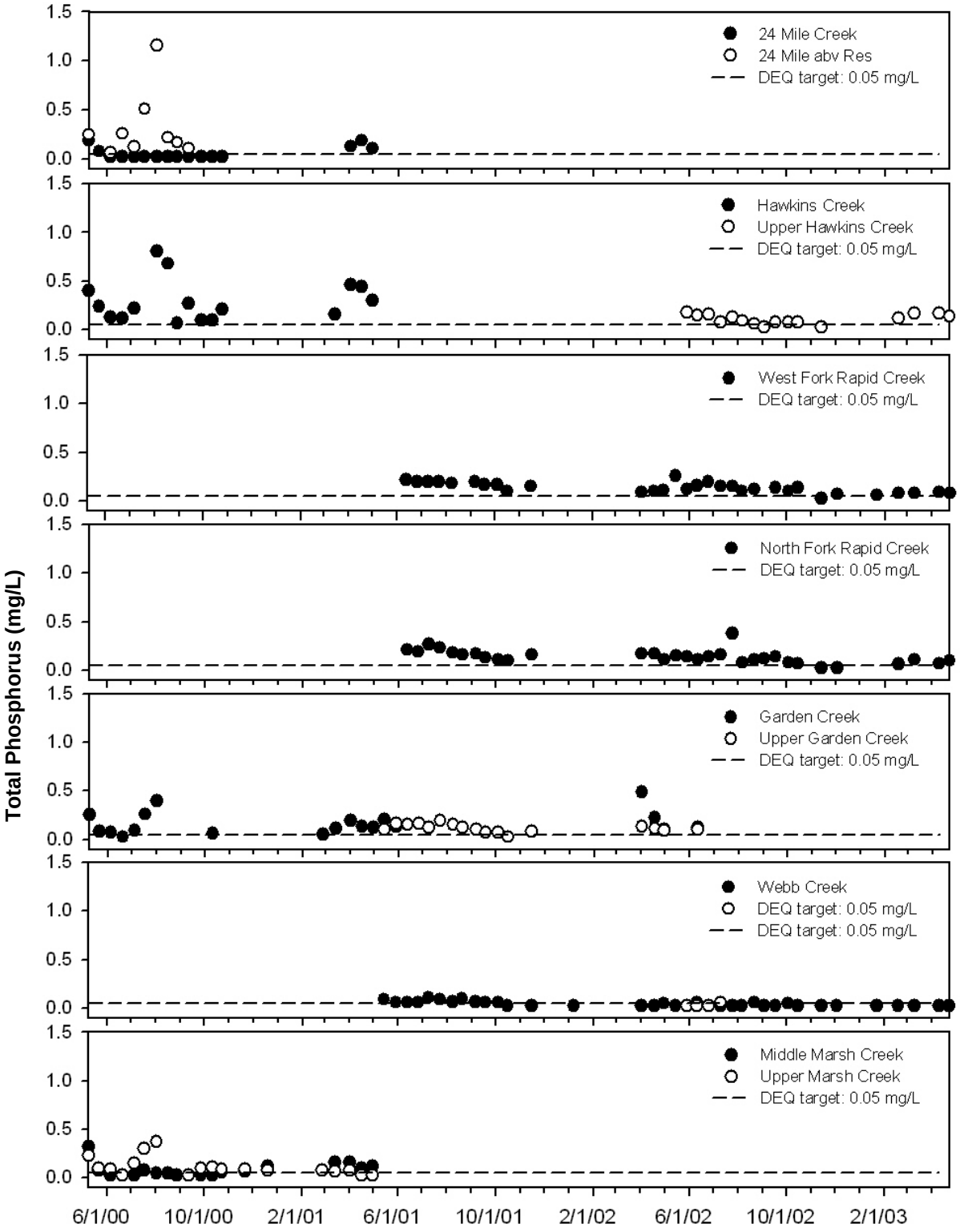

Figure 3. Total phosphorus concentrations measured at the twelve monitoring sites from May 2000 to April 2003.

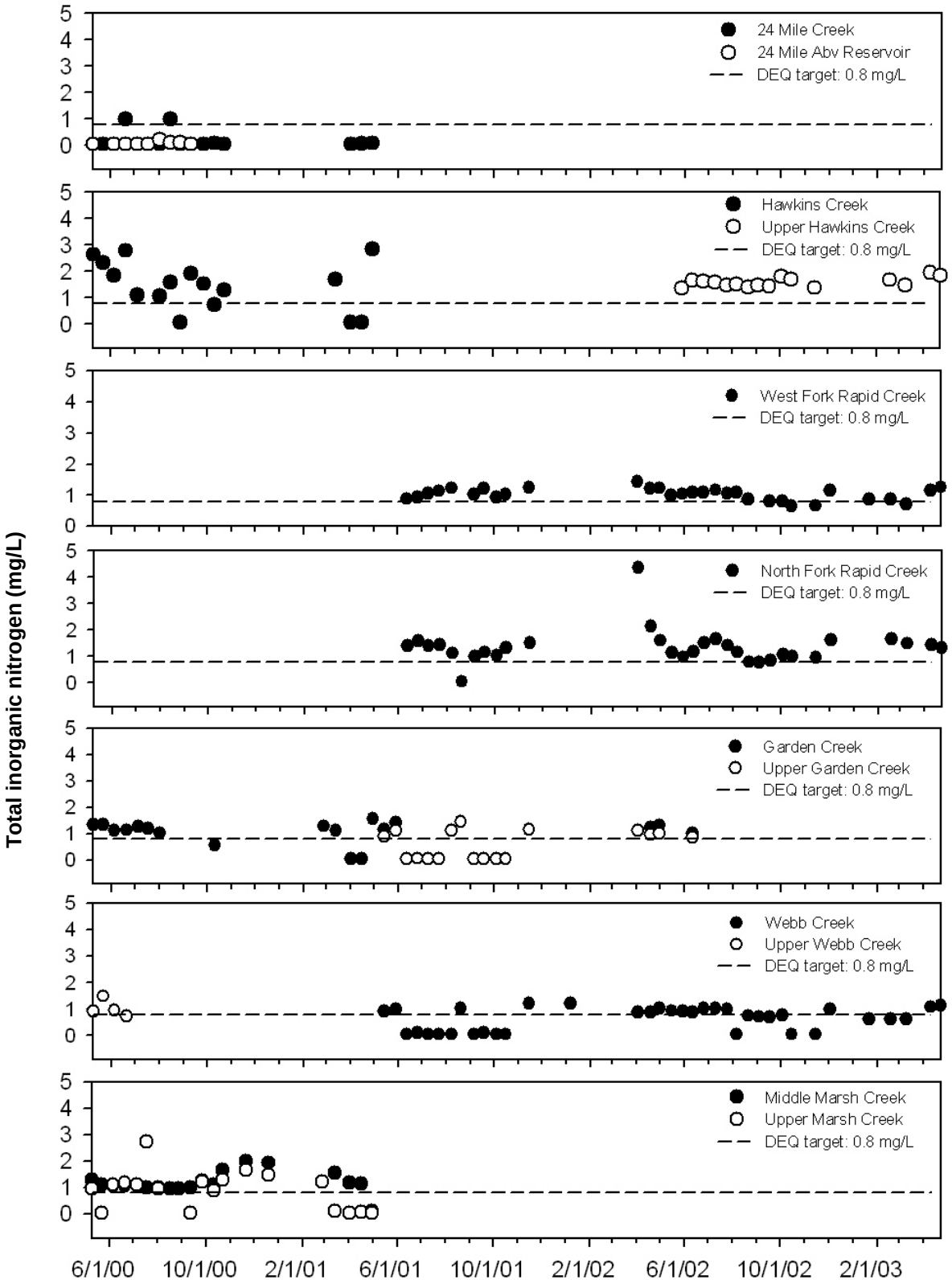

Figure 4. Total inorganic nitrogen (TIN) at each monitoring site.

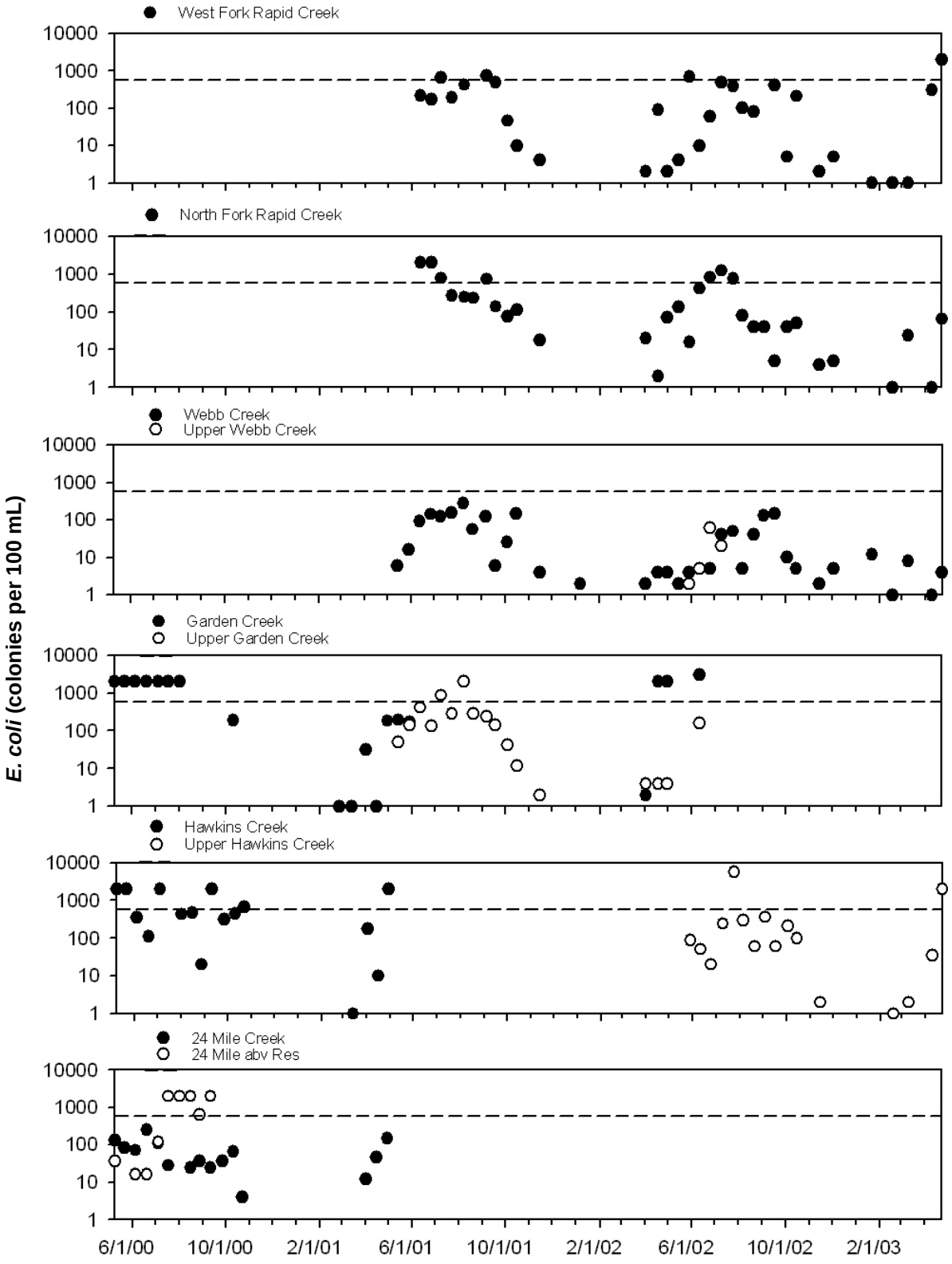

Figure 5. *E. coli* concentrations (number of colonies per 100 mL) measured at the twelve monitoring sites over the study period. The dashed line represents the EPA Standard for *E. coli* (576 colonies/100 mL).

Comparison of sample periods

While water quality was relatively consistent between Phase I and Phase II of the project (May 1999 – April 2000 versus May 2000 – April 2003), some sites did experience significant differences in pollutant concentrations. TSS declined significantly during Phase II at the Upper and Middle Marsh sites (Figure 6). TIN was significantly lower in samples collected after May 2000 at Twentyfour Mile and Webb creeks (Figure 7). At the Middle Marsh site, both TP (Figure 8) and *E. coli* (Figure 9) concentrations declined significantly during Phase II of the project. At all other sites, the concentration of pollutants did not significantly differ between the sampling periods.

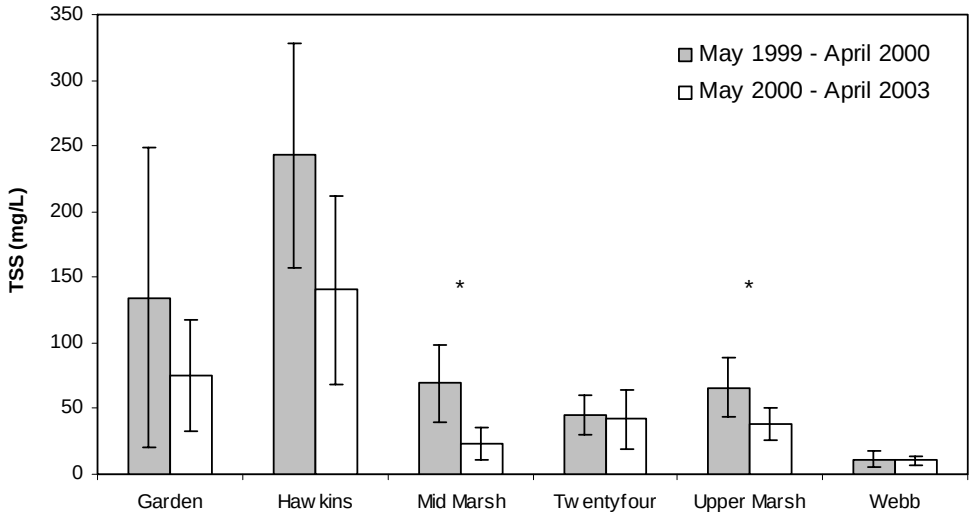

Figure 6. Mean TSS concentrations (± 95% CI) at six sites during Phase I and II of the project. The asterisk (*) represents a significant difference.

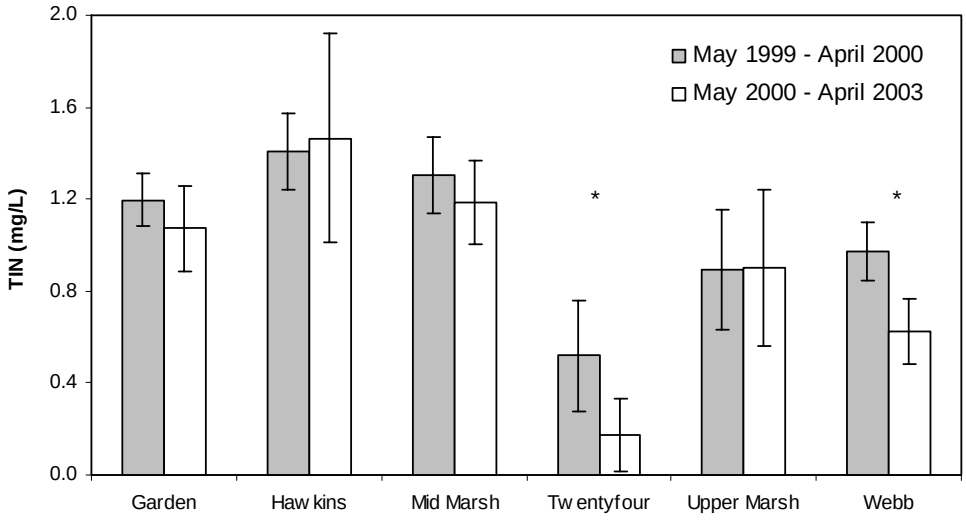

Figure 7. Mean TIN concentrations (± 95% CI) at six sites during Phase I and II of the project. The asterisk (*) represents a significant difference.

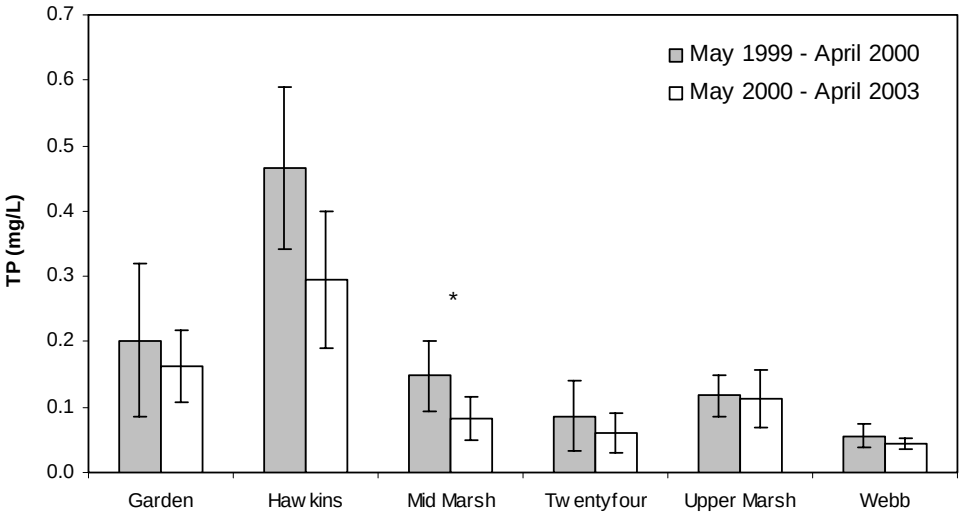

Figure 8. Mean TP concentrations (± 95% CI) at six sites during Phase I and II of the project. The asterisk (*) represents a significant difference.

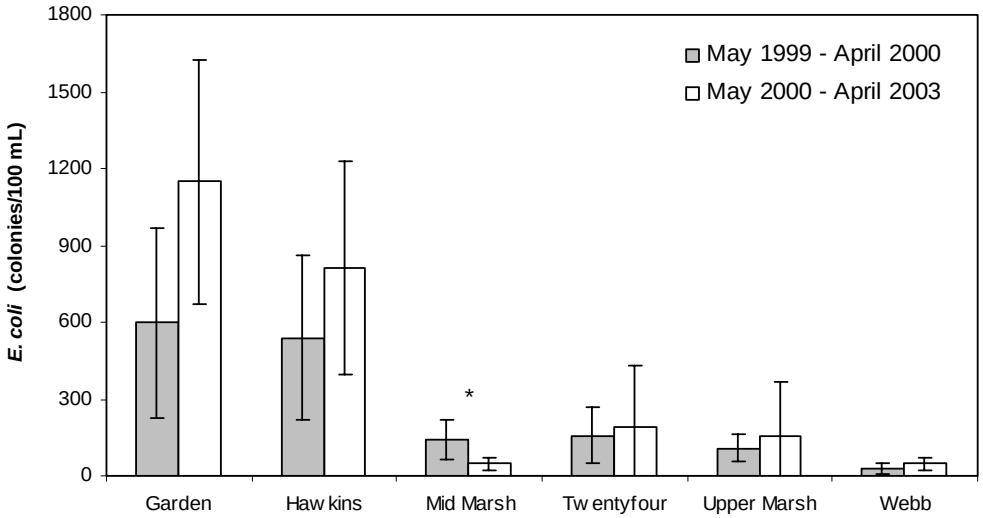

Figure 9. Mean *E. coli* concentrations (± 95% CI) at six sites during Phase I and II of the project. The asterisk (*) represents a significant difference.

Conclusions

During Phase II of the Portneuf monitoring project, many tributaries in the Portneuf Watershed exceeded DEQ targets for nutrients, suspended solids and *E. coli*. There was evidence of improvements in water quality at some monitoring sites from Phase I to Phase II of the project, but water quality at most sites did not differ significantly over time. All streams that were monitored during Phase II, with the exception of the reference stream, Webb Creek, were found to have mean TP levels above the 0.05 mg/L target. Of the six streams included in Phase II, only Twentyfourmile Creek met the TIN target of 0.8 mg/L. The TIN results for Webb Creek may be misleading because only four

measurements were collected at the upper site, where average TIN exceeded the target. Additional sampling would be required to conclude that a nitrogen problem exists at the Upper Webb Creek site. Half of the streams sampled were not able to meet the EPA standard for *E. coli* concentrations.

The monitoring sites that were added during Phase II of the project were located on streams that were found to have water quality problems during Phase I. The additional sites in Phase II allowed for the evaluation of different reaches of the study streams. For instance, the data collected at Twentyfourmile Creek above the reservoir indicated there are major water quality concerns in the upper reaches of the stream. Below the reservoir, water quality was relatively good and the data suggest that conservation efforts on Twentyfourmile Creek should focus on sections of the stream above the reservoir.

The collective evaluation of TSS, TP, TIN and *E. coli* at each site allowed us to identify sites and streams with poor water quality. Analysis of average pollutant concentrations indicated that the lower reaches of Hawkins Creek has the poorest water quality, followed by lower Garden Creek and Twentyfourmile Creek above the reservoir. Analysis of the percentage of samples that exceeded TP and TIN targets showed Hawkins, Garden, Marsh and Rapid creeks to exceed the targets greater than 50% of the time. The data presented in this report has and continues to be used to identify resource concerns, determine conservation objectives and provide baseline data for comparison with future water quality data.

Recommendations

The data collected during this project should be used to identify areas of concern for water quality and to guide the implementation of Best Management Practices (BMPs) aimed at improving water quality in the Portneuf Watershed. We have determined specific segments of three streams that are in poor condition and should be prioritized for conservation efforts. They are segments of Hawkins, Garden and Twentyfourmile creeks. Marsh and Rapid creeks also require attention because they often exceeded nutrient targets. In general, the greatest water quality concern in the Portneuf Watershed is excessive nutrient concentrations. Emphasis should be placed on BMPs that reduce nutrient loading to the streams such as nutrient management planning, irrigation water management planning and animal waste management systems.

Extensive conservation projects have occurred and are continuing in the Portneuf Watershed. Phase I and II of this project were completed prior to or during the installment of many BMPs on Rapid and Twentyfourmile creeks (Krajewski 2005). It is recommended that BMP effectiveness monitoring be conducted as BMPs are completed to determine if these practices have resulted in decreased concentrations of pollutants.

IASCD, ISCC, Caribou SCD and Portneuf SWCD should continue to evaluate landuse practices, investigate the source of nutrients in the Portneuf and implement practices that may improve water quality in the watershed. It is recommended that conservation funds

be directed towards the three problem areas in the watershed to produce the greatest change in water quality in the watershed.

Literature Cited

Cleserci, L.S., Greenberg, A.E. and A.D. Eaton. 1998. Standard Methods for the Examination of Water and Wastewater (20th Edition). American Public Health Association, the American Water Works Association and the Water Environment Federation.

Department of Environmental Quality. 1999. Water body assessment and Total Maximum Daily Load. Pocatello, ID.

Krajewski, J. 2005. Personal communication. Idaho Soil Conservation Commission.

Appendix 1. Maximum, minimum and average values (±95% confidence intervals) of each parameter measured. Numbers in red represent sites that on average exceed DEQ target levels.

W. Fork Rapid	D.O. (mg/L)	% SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	12.3	92.0	15.7	868.0	403.0	8.7	3.7	1.4	0.2	1.4	92.0	21.0	0.3	2000.0
Minimum	7.5	70.0	0.8	386.0	180.0	6.9	0.0	0.6	0.0	0.7	1.0	1.0	0.0	1.0
Mean ±95% CI	9.5±0.5	79.9±2.7	8.5±1.7	609.3±52.9	267.6±20.5	8.0±0.2	0.7±0.3	1.0±0.1	0.0±0.0	**1.0±0.1**	26.1±7.7	4.1±1.4	**0.1±0.0**	251.0±140.0
# observations	30	30	30	31	31	31	31	31	31	31	31	31	31	31

N. Fork Rapid	D.O. (mg/L)	% SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	12.8	122.7	19.4	804.0	322.0	8.7	12.5	4.3	0.1	4.4	89.0	10.0	0.4	2000.0
Minimum	4.7	47.3	0.8	104.3	46.0	6.7	0.1	0.0	0.0	0.1	4.0	1.0	0.0	1.0
Mean ±95% CI	9.6±0.6	84.0±4.9	10.0±1.9	497.3±57.1	220.2±23.5	7.7±0.2	2.3±1.2	1.3±0.2	0.0±0.0	**1.3±0.2**	22.2±7.5	3.5±0.9	**0.1±0.0**	325.3±186.1
# observations	32	32	32	32	32	32	32	32	32	32	32	32	32	32

Webb	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	11.8	91.8	17.0	225.0	94.0	8.6	27.3	1.2	0.1	1.2	63.0	15.0	0.1	274.0
Minimum	7.1	69.3	0.5	62.9	26.0	5.9	0.9	0.0	0.0	0.1	2.0	1.0	0.0	1.0
Mean ±95% CI	9.2±0.4	79.6±2.0	9.3±1.7	140.8±14.6	61.2±6.0	7.0±0.2	5.3±2.4	0.6±0.1	0.0±0.0	0.6±0.1	10.3±3.4	2.6±0.8	0.0±0.0	46.1±21.6
# observations	35	35	35	36	36	36	36	36	36	36	36	36	36	36

Upper Webb	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	9.0	87.8	16.7	135.5	62.0	7.7	15.0	1.5	0.1	1.5	14.0	4.0	0.1	60.0
Minimum	8.3	72.0	9.2	66.8	29.0	6.6	1.5	0.7	0.0	0.7	8.0	2.0	0.0	2.0
Mean ±95% CI	8.5±0.3	82.9±7.2	14.1±3.4	105.3±29.5	47.5±14.1	7.0±0.5	5.4±6.4	1.0±0.3	0.0±0.0	**1.0±0.3**	11.8±2.8	3.0±1.1	0.0±0.0	21.8±26.2
# observations	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Garden	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	11.6	101.5	20.9	924.0	445.0	8.4	6.2	1.5	0.1	1.6	407.0	50.0	0.5	3040.0
Minimum	6.7	6.3	3.8	511.0	222.0	7.3	0.0	0.0	0.0	0.1	4.0	1.0	0.0	1.0
Mean ±95% CI	8.9±0.6	77.5±8.8	11.3±2.2	697.8±56.3	326.2±28.2	8.1±0.1	1.5±0.9	1.0±0.2	0.0±0.0	**1.1±0.2**	75.4±42.5	9.3±5.4	**0.2±0.1**	**1147.7±478.1**
# observations	19	19	19	19	19	18	19	19	19	19	19	19	19	19

Upper Garden	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	11.0	90.0	17.1	920.0	420.0	8.4	12.4	1.4	0.1	1.5	104.0	13.0	0.2	2000.0
Minimum	7.2	68.0	2.5	461.0	81.0	6.9	0.1	0.0	0.0	0.1	4.0	1.0	0.0	2.0
Mean ±95% CI	8.4±0.5	75.1±2.6	10.9±2.3	623.5±60.6	279.4±38.5	8.1±0.2	2.5±1.7	0.6±0.3	0.0±0.0	0.6±0.3	41.0±16.9	5.5±1.8	**0.1±0.0**	280.4±234.3
# observations	17	17	17	17	17	17	17	17	17	17	17	17	17	17

24 Mile	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	12.9	110.0	28.1	1017.0	877.0	8.5	5.7	1.0	0.1	1.0	139.0	14.0	0.2	2000.0
Minimum	0.5	67.7	1.0	412.0	194.0	8.0	0.1	0.0	0.0	0.1	5.0	1.0	0.0	4.0
Mean ±95% CI	8.6±0.9	87.3±7.1	16.8±2.9	714.4±75.8	379.0±74.1	8.3±0.1	2.1±0.9	0.1±0.2	0.0±0.0	0.2±0.2	41.8±22.1	5.0±2.1	**0.1±0.0**	191.6±238.3
# observations	16	16	16	16	16	16	16	16	16	16	16	16	16	16

24 Mile abv Reservoir	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	8.7	88.4	26.2	573.0	274.0	8.7	0.4	0.0	0.2	0.2	879.0	124.0	1.2	2000.0
Minimum	2.9	34.2	9.6	335.0	159.0	8.1	0.0	0.0	0.0	0.1	1.0	1.0	0.1	16.0
Mean ±95% CI	6.3±1.2	69.9±11.4	21.4±3.3	480.9±47.1	230.2±21.8	8.4±0.1	0.1±0.1	0.0±0.0	0.1±0.0	0.1±0.0	**160.6±179.8**	25.2±25.0	**0.3±0.2**	**981.3±643.6**
# observations	9	9	9	9	9	9	9	9	9	9	9	9	9	9

Mid Marsh	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	11.7	106.6	24.3	1408.0	667.0	8.4	72.2	2.0	0.1	2.0	87.0	10.0	0.3	160.0
Minimum	2.4	16.3	0.2	646.0	311.0	7.9	17.5	0.0	0.0	0.1	1.0	1.0	0.0	1.0
Mean ±95% CI	8.7±0.9	80.9±9.4	13.0±3.0	938.2±107.4	448.0±51.3	8.2±0.1	44.5±6.2	1.1±0.2	0.0±0.0	**1.2±0.2**	22.9±12.5	3.3±1.4	**0.1±0.0**	48.6±24.7
# observations	19	19	19	19	19	19	19	19	19	19	19	19	19	19

Upper Marsh	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	12.2	116.6	19.9	1354.0	649.0	8.5	25.0	1.6	1.8	2.8	83.0	15.0	0.4	2000.0
Minimum	0.2	2.1	0.1	67.9	3.3	7.9	0.0	0.0	0.0	0.1	3.0	1.0	0.0	1.0
Mean ±95%CI	9.0±1.6	75.7±16.1	10.9±2.8	880.6±132.6	418.0±65.9	8.2±0.1	10.1±3.6	0.7±0.3	0.2±0.2	**0.9±0.3**	38.6±12.0	6.3±1.9	**0.1±0.0**	155.1±214.1
# observations	18	18	18	18	18	18	18	18	18	18	18	18	18	18

Hawkins	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	13.0	109.6	19.2	1587.0	778.0	8.8	2.6	2.8	0.7	2.9	540.0	38.0	0.8	2000.0
Minimum	6.3	60.5	2.6	540.0	259.0	7.9	0.0	0.0	0.0	0.1	21.0	3.0	0.1	1.0
Mean ±95% CI	9.2±1.0	82.7±6.1	11.1±2.3	1016.4±152.9	488.1±74.9	8.3±0.1	0.5±0.4	1.4±0.4	0.1±0.1	**1.5±0.5**	**140.7±71.8**	13.3±5.4	**0.3±0.1**	**812.2±415.0**
# observations	16	16	16	16	16	16	16	16	16	16	16	16	16	16

Upper Hawkins	D.O. (mg/L)	%SAT	TEMP (C)	COND (microS)	TDS (mg/L)	pH	Q (cfs)	NO_2+NO_3 (mg/L)	NH_3 (mg/L)	TIN (mg/L)	TSS (mg/L)	TVS (mg/L)	TPHOS (mg/L)	ECOLI (100mls)
Maximum	12.7	98.7	17.9	1464.0	649.0	8.4	0.6	1.9	0.1	1.9	218.0	32.0	0.2	5650.0
Minimum	7.6	75.1	2.8	727.0	338.0	7.3	0.1	1.3	0.0	1.4	3.0	1.0	0.0	1.0
Mean ±95% CI	9.8±0.7	88.3±3.9	10.9±2.7	1023.3±109.4	457.8±41.7	8.0±0.1	0.3±0.1	1.5±0.1	0.0±0.0	**1.6±0.1**	78.5±32.0	10.6±4.5	**0.1±0.0**	573.6±704.5
# observations	15	15	15	16	16	16	16	16	16	16	16	16	16	16