PORTNEUF RIVER TMDL

WATER BODY ASSESSMENT AND TOTAL MAXIMUM DAILY LOAD

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Portneuf River Subbasin at a Glance

Hydrologic Unit Code	17040208
Number of 303(d) Listed Reaches	27
Beneficial Uses Affected	Cold Water Biota, Salmonid Spawning, Primary and Secondary Contact Recreation
Listed Pollutants of Concern	Sediment, Nutrients, Bacteria, Flow Alteration, Oil and Grease, Dissolved Oxygen
Major Land Uses	Agriculture, Rangeland, Urban
Subbasin Area	1,360 square miles

1. Executive Summary

The Portneuf River subbasin drains about 1,360 square miles in southeast Idaho. The subbasin has numerous documented water quality problems which affect support of beneficial uses in water bodies listed as water quality limited. The following pollutants are found on the 1994 and 1996 303(d) list for the streams in the Portneuf River subbasin: sediment, nutrients, bacteria, flow alteration, oil and grease, and dissolved oxygen. There are 27 water quality limited segments in the subbasin which include the mainstem river, 16 tributaries, and one reservoir. All stream segments on the 303(d) list include sediment as a pollutant of concern and roughly half are listed for nutrients. The [redacted] Portneuf River also includes on its list bacteria, flow alteration, and oil and grease. Hawkins Reservoir is the only waterbody listed for dissolved oxygen.

In addition to those pollutants already identified on the 303(d) list, several other problems exist in the Portneuf River. Exceedances of state water quality standards for temperature have been documented. Information from several reports suggest that metals are at higher levels than found naturally, especially in sediments of the lower Portneuf River. The effect of these higher concentrations of metals on beneficial uses has not been determined. Anecdotal evidence indicates that low levels of dissolved oxygen may be occurring in areas other than Hawkins Reservoir. Recent sampling by the U. S. Geological Survey showed high levels of polychlorinated biphenyls (PCBs) in both fish flesh and stream sediments.

Several sources of pollutants have been identified. Agriculture has been implicated in flow alteration and contributing sediment and nutrients into the Portneuf River. Sediment can also originate from streambanks, streambeds, and natural causes. Bacteria can result from livestock, wildlife, or human sources. Urban/suburban inputs influence sediment, nutrients, bacteria, and oil and grease. Stormwater runoff typically carries sediment, nutrients, bacteria, and oil and grease. Two NPDES-permitted discharges add nutrients to the lower Portneuf River.

Some efforts, particularly within the agricultural community, have been undertaken to decrease pollutant inputs and thus improve water quality primarily in the upper Portneuf River. Both federal and state supported agricultural programs have resulted in decreases in sediment,

nutrients, and bacteria into the Portneuf River. The most successful program in terms of water quality improvement has been the Conservation Reserve Program.

Information from the Idaho Department of Environmental Quality's Beneficial Use Reconnaissance Project indicate that several streams on the 303(d) list are supporting their beneficial uses. These streams include: Gibson Jack, Mink, Walker, Bell Marsh, Goodenough, upper Garden, Dempsey, Pebble, and Toponce creeks.

Load analyses were done for bacteria, oil and grease, sediment, and nutrients. No load analysis was done for flow alteration. Data were considered insufficient to develop a load analysi for dissolved oxygen in Hawkins Reservoir although a target concentration 0.025 mg/l of total phosphorus is recommended. This target is based on the EPA "Gold Book" which recommends that total phosphates as phosphorus in lakes or reservoirs not exceed 0.025 mg/l to prevent the development of biological nuisances and to control accelerated or cultural eutrophication. Loads were allocated where sources were known and data sufficient for analyses.

Load reductions are presented in Table ES. Fecal coliform load reductions are based solely on a percentage reduction. Percent load reductions of fecal input into the mainstem Portneuf River ranged from 17% in the upper river to over an 80% reduction in the lower river.

An oil and grease load analysis was done only for stormwater runoff from the Pocatello-Chubbuck area. Although the target load capacity for oil and grease into the Portneuf River is greater than the estimated present input of 38 tons from stormwater runoff, the analysis indicates that under certain circumstances (e.g., short, intense thunderstorm after a period of dry weather) the target concentration could be exceeded. Thus, it is recommended that stormwater runoff no exceed its present estimated annual load.

The highest reduction of suspended sediment is needed in the lower Portneuf River and Marsh Creek. Estimated reductions at the USGS surface-water stations at Pocatello and Marsh Creek are about 66%. The percent reduction estimated for Topaz is 53%. The reductions by source based on land use are presented in the main text.

Highest levels of nutrients were observed in the lower Portneuf River below Pocatello. The overall reductions recommended at the Tyhee USGS surface-water station site are 86% for total inorganic nitrogen and 81% for total phosphorus. The greatest source of nutrients in the lower river are the springs followed by the Pocatello Sewage Treatment Plant (PSTP). The highest percent reductions occur at the PSTP at over 95% for both total inorganic nitrogen and total phosphorus. Reductions at the Pocatello gage site are 66% and 39% for total inorganic nitrogen and total phosphorus, respectively. Percent reductions of total inorganic nitrogen and total phosphorus at the Marsh Creek and Topaz gage sites ranged from 50-66% for total inorganic nitrogen and 15-33% for total phosphorus.

Data gaps abound for practically all Portneuf River pollutants. Information is needed o effects of pollutants on beneficial uses; links between reductions in pollutant input and support beneficial uses; long term sampling from throughout the year covering various hydrographic

Table ES. Load analyses of pollutants identified in the Portneuf River subbasin.

Site/stream reach	Estimated annual load	Mean	Target load or wasteload	Load reduction*	Percent reduction*
Fecal coliform (colonies/100 ml)**					
Kraft Road bridge		193	50		84%
Pocatello Creek to Pocatello gage		238	50		89%
Rainey Park		82	50		49%
Rainey Park to Lava Hot Springs		136	50		73%
Pebble Creek to Chesterfield Reservoir		54	50		17%
Oil and grease (tons/yr)					
Pocatello-Chubbuck stormwater runoff	38		38		0%
Suspended sediment (tons/yr)***					
Pocatello USGS surface-water station	54,346		19,263	35,083	65%
Marsh Creek USGS surface-water station	16,309		5,372	10,937	67%
Topaz USGS surface-water station	25,201		11,961	13,240	53%
Total inorganic nitrogen (tons/yr)					
Tyhee USGS surface-water station	1263			1086	86%
Stormwater - Pocatello-Chubbuck	12.1		5.1	7	58%
Pocatello USGS surface-water station	259		88	172	66%
Springs	756		80	677	89%
FMC IWW ditch	4.9		1.1	3.8	78%
Pocatello Sewage Treatment Plant	230		3	227	99%
Marsh Creek USGS surface-water station	76		26	51	66%
Topaz USGS surface-water station	118		59	60	50%
Total phosphorus (tons/yr)					
Tyhee USGS surface-water station	238			194	81%
Stormwater - Pocatello-Chubbuck	14.0		1.3	12.7	91%
Pocatello USGS surface-water station	36		22	14	39%
Springs	164		20	144	88%
FMC IWW ditch	3.5		0.3	3.2	92%
Pocatello Sewage Treatment Plant	20.5		0.7	19.8	96%
Marsh Creek USGS surface-water station	10		6	3	33%
Topaz USGS surface-water station	17		15	3	15%

*includes margin of safety

**period of primary contact recreation - May to September

***suspended sediment apportioned by land use in section 3.2.8

regimes; and identification of sources of pollutants by tributaries and other discharges (e.g., canals, NPDES permitted dischargers, springs). The loading analyses relied heavily on data collected at the USGS gaging stations which is why these sites were chosen to monitor effectiveness of efforts to reach the target load capacities.

2. Portneuf River Subbasin Description

2.1 General

The Portneuf River is a major subbasin in southeast Idaho (Figure 1). This fifth order river is approximately 100 miles long and drains an area roughly 1,360 square miles primarily in Bannock and Caribou counties but also in Bingham, Power, and Oneida counties (Figure 2). Marsh Creek is the only "major" tributary to the Portneuf River. Other creeks in the subbasin include Mink, Rapid, Garden, Hawkins, Birch, Dempsey, Pebble, Twentyfourmile, and Toponce creeks. Chesterfield Reservoir is the largest reservoir in the subbasin at 1,245 acres.

The Portneuf River lies entirely within the Northern Basin and Range Ecoregion at the northeastern extreme of the Basin and Range Physiographic province. The Northern Basin and Range Ecoregion is characterized by plains with low to high, open mountains. For the ecoregion as a whole, potential natural vegetation includes Great Basin sagebrush (*Artemisia* spp.), saltbush (*Atriplex* spp.), and greasewood (*Sarcobatus vermiculatus*). Land use of the desert and shrubland is grazing. Soils are aridisols.

The geology of the subbasin is mostly sedimentary with some basalt in the Bancroft area, along the lower reach of Marsh Creek around Inkom, and along the Portneuf River mainstem from Inkom to Pocatello (Merrell and Onstott 1965). Underlying much of the subbasin are huge deposits of gravel, a result of the "break out" of Lake Bonneville into the Snake River basin through the Marsh Creek Valley (U.S. Army Corps of Engineers 1955). Major mountain ranges within the subbasin include: Bannock Range to the west, Portneuf Range in the middle and to the south, Fish Creek Range to the south, and Chesterfield Range to the east.

Topsoils are predominantly loess and very erodible (Merrell and Onstott 1965). In the lower Portneuf River subbasin, from Lava Hot Springs downstream, the texture, structure, and slope of the predominant silt loam soils generally make them highly erosive (Figures 3, 4; McNabb 1987). McNabb (1987) cited a 1986 Soil Conservation Service (now the Natural Resources Conservation Service) Highly Erodible Lands analysis which showed that 15.5% of the area soils usable for annual crops and alfalfa are highly erodible; 57.8% are potentially highly erodible; and 26.0% are not highly erodible.

Presently there are no threatened or endangered aquatic species in the Portneuf River subbasin. The Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) is listed as a sensitive species by the Bureau of Land Management and an imperiled subspecies by Idaho Department of Fish and Game (Idaho Department of Fish and Game, internet communication). Further, the U. S. Fish and Wildlife Service has recently been petitioned to list the Yellowstone cutthroat trout as

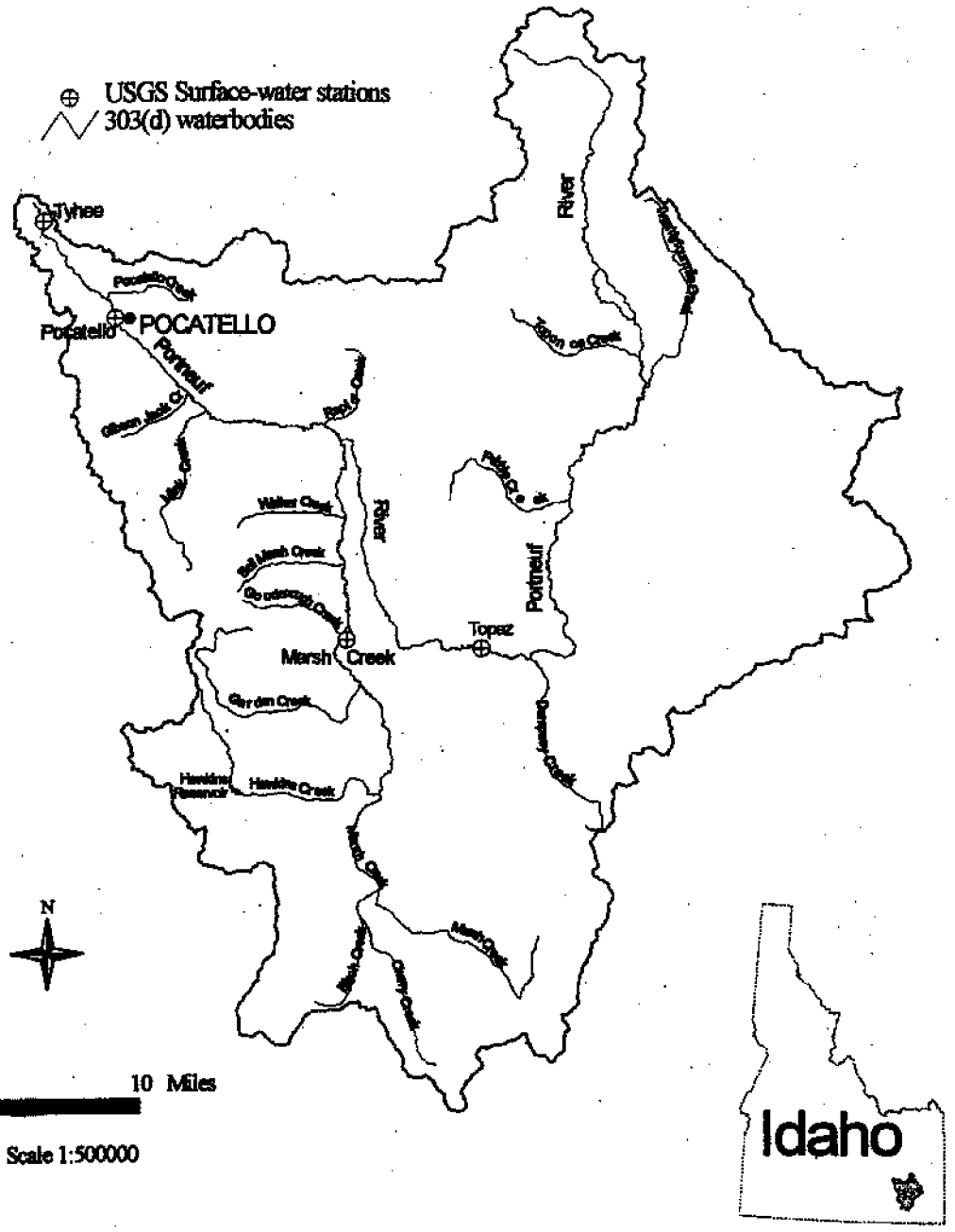


Figure 1. Portneuf River subbasin 303(d) waterbodies and USGS surface-water stations.

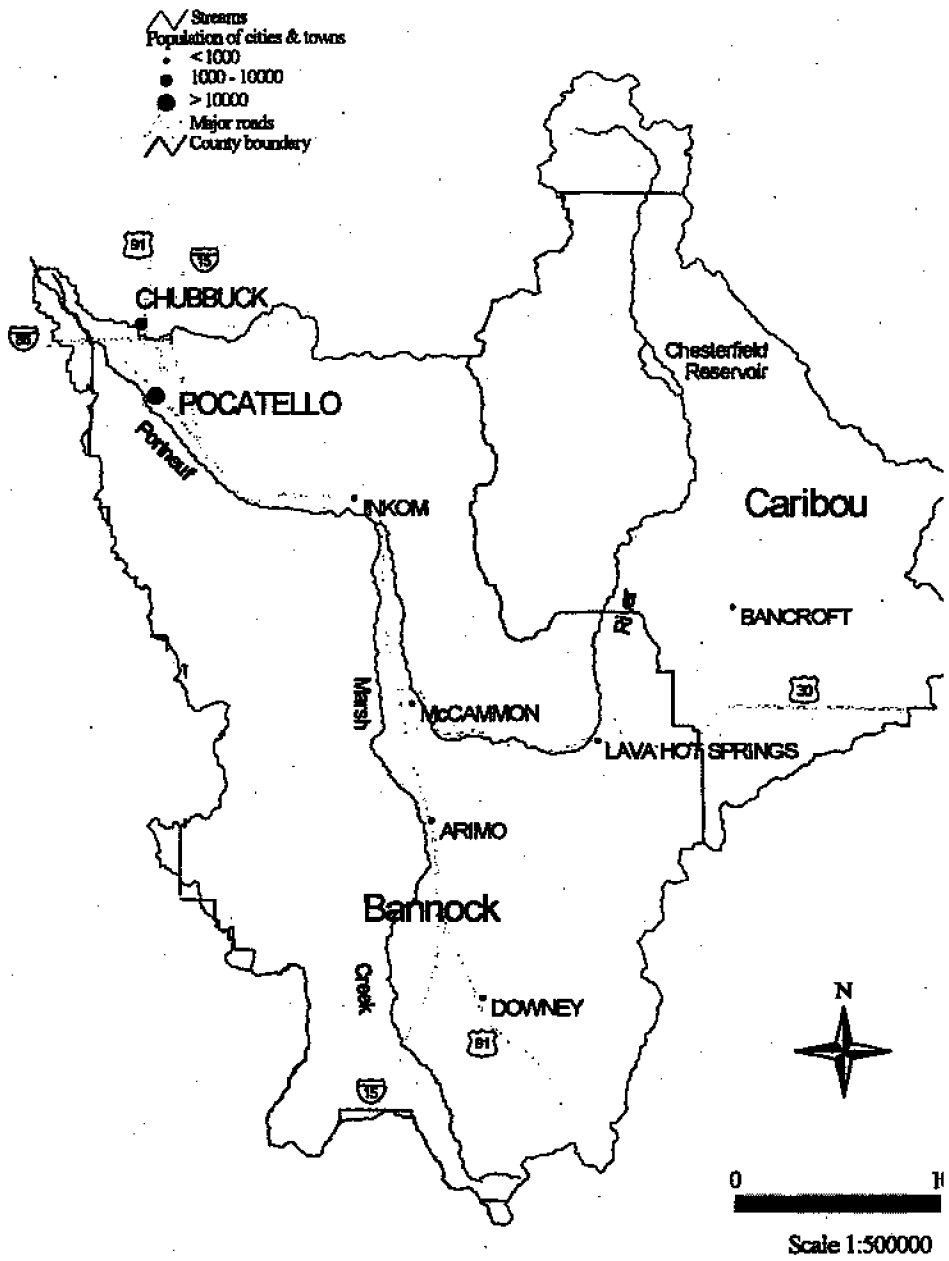


Figure 2. Portneuf River subbasin cities and towns.

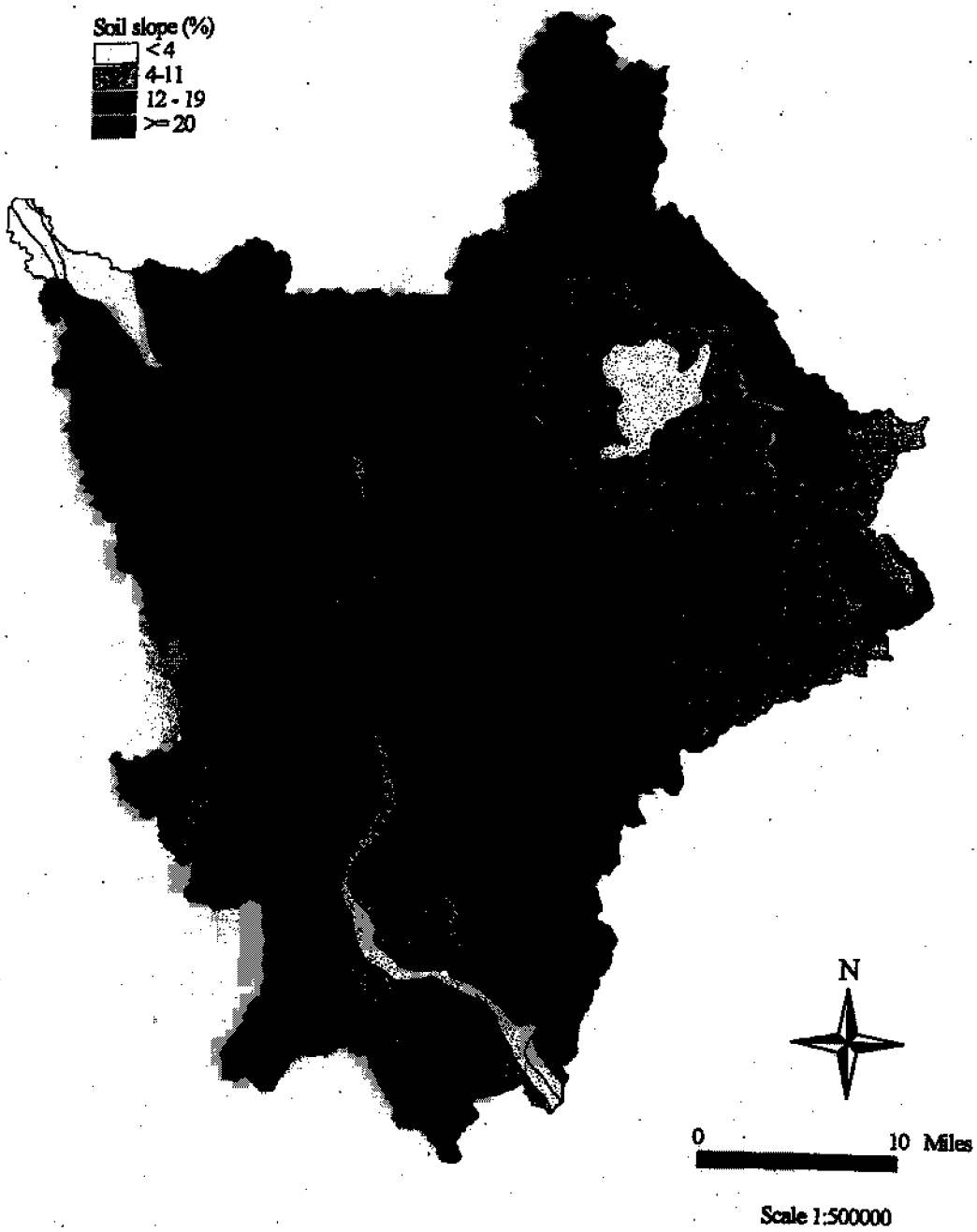


Figure 3. Weighted average soil slope in the Portneuf River subbasin.

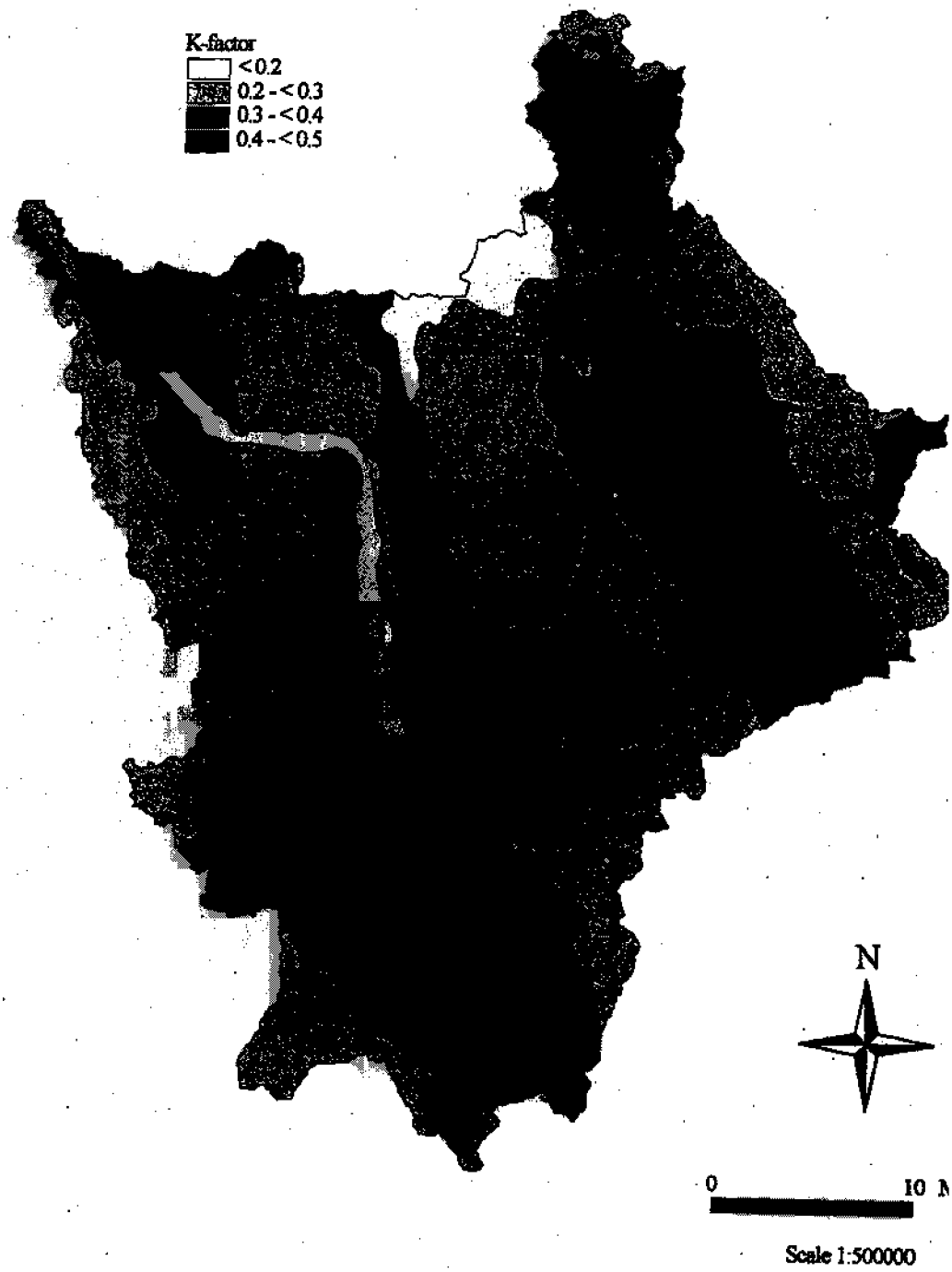


Figure 4. Weighted average K-factor (soil erosion capability) in the Portneuf River subbasin. Soil erosion capability increases as the K-factor increases.

a potentially threatened or endangered species; the decision is pending. Also on both lists (sensitive and imperiled), and possibly found in the Portneuf River subbasin, is the leatherside chub (*Gila copei*).

Elevations within the subbasin range from 9,280 ft to 4,350 ft. The average elevation is about 5,800 ft msl. Slopes on agricultural land vary from 0 to 20+ percent while rangeland slopes vary from 10 to 60 percent (Caribou Soil Conservation District 1991). Gradient in the mainstem of the Portneuf River changes from 23 feet/mile in the reach above Inkom to 6 feet/mile in the lower reach (Minshall and Andrews 1973).

The climate in the subbasin is semi-arid. Percentage of possible annual sunshine ranges from 53% to 72% with an annual average of 64% (National Weather Service, internet communication). Normal annual precipitation averages 12 inches at Pocatello. March, April, May, and November receive the highest amounts of precipitation (Table 1). Normal average temperature is 47.2°F (8.4°C) with an annual normal maximum of 59.3°F (15.2°C) and minimum of 33.4°F (0.8°C). Extreme temperatures range from -33°F (-36.1°C) to 105°F (40.6°C) (Table 2).

Vegetation in the Portneuf River subbasin is characteristic of semi-arid areas of the intermountain west. Most of the drainage is covered with grasses (*Poa* spp.), sagebrush (*Artemisia tridentata*), and juniper (*Juniperus utahensis*; Minshall and Minshall 1977). Higher elevations grow Douglas fir (*Pseudotsuga menziesii*), and aspen (*Populus tremuloides*). Willow (*Salix* spp.), dogwood (*Cornus stolonifera*), chokecherry (*Prunus virginiana*), rose (*Rosa woodsii*), and birch (*Betula occidentalis*) are common in the valleys.

Flows in the Portneuf River subbasin vary according to location but follow the general pattern of high spring flows and low flows in late summer-early fall. The hydrograph is highest in the springtime (i.e., March through June) coinciding with the melt off of snow at higher elevations (Table 3). Low flows occur from July to October. The diversion of water for irrigation affects flows throughout the irrigation season (mid-April to mid-September). Monthly mean flows for the Portneuf River at Pocatello range from 522 cfs in April to 95 cfs in August. An apparent loss of streamflow (about 87 cubic feet/second), probably to groundwater, from the Portneuf River and Marsh Creek occurs somewhere between the gaging stations at Topaz and McCammon and the gaging station at Pocatello (Norvitch and Larson 1970).

The construction of reservoirs within the subbasin, especially Chesterfield Reservoir (Figure 2) on the mainstem Portneuf River, has affected the annual hydrograph of high spring flows followed by late summer low flows. Typically, the reservoirs will be filled in the springtime decreasing the total flow during the peak runoff period. Stored water will then be released in late summer increasing the historical flow during that time period.

Some confusion exists surrounding the names of the reservoirs in the upper Portneuf River. The reservoir on the mainstem of the Portneuf River is called both the Chesterfield and Portneuf reservoir depending on the map or the person. The reservoir on Twentyfourmile Creek is called the Twentyfourmile or Chesterfield reservoir, again, depending on the map or person.

Table 1. Monthly precipitation at the National Weather Service Station - Pocatello (from National Weather Service, internet communication).

	Month											
	January	February	March	April	May	June	July	August	September	October	November	December
Normal	1.04	0.92	1.26	1.2	1.35	1.02	0.65	0.67	0.85	0.91	1.16	1.02
Maximum	4.28	2.86	4.34	3.31	3.96	3.39	3.33	3.98	3.8	3.25	2.84	3.39
Minimum	0.14	0.12	0.1	0.06	<0.01	0.02	<0.01	0	0	0	0.01	0.07

Table 2. Monthly temperatures (Fahrenheit) at the National Weather Service Station - Pocatello (from National Weather Service, internet communication).

	Month											
	January	February	March	April	May	June	July	August	September	October	November	December
Normal Mean	23.3	29.1	36.3	44.9	53.6	62.7	70.6	68.7	59	48	35.6	24.8
Maximum	57	65	75	86	94	103	105	104	98	91	71	64
Minimum	-31	-33	-12	11	20	28	34	28	18	10	-16	-29

Table 3. Flow information from USGS surface-water stations in the Portneuf River subbasin.

River	Site	Time period	Measurement	Mean monthly discharge (cfs)											
				January	February	March	April	May	June	July	August	September	October	November	December
Portneuf	Topaz	1913-1996	Mean	153	171	203	266	341	267	203	176	149	141	154	154
			Maximum	271	484	475	589	875	735	347	331	361	284	283	279
			Minimum	93.3	91	116	103	127	97.4	81.6	74.5	62.8	55.7	84.9	93.8
Marsh	nr. McCammon	1955-1996	Mean	83.7	109	121	113	107	80.8	54.9	57.5	71.7	81.2	84.3	81.3
			Maximum	224	329	196	256	309	238	117	124	129	152	158	143
			Minimum	49.8	56.1	59.6	45.1	26.6	30.2	23.6	24.5	41.1	42.7	46.7	45.3
Portneuf	Pocatello	1897-1996	Mean	272	318	405	522	515	271	102	94.9	130	197	258	268
			Maximum	513	754	1054	1251	1986	1416	416	324	480	477	479	493
			Minimum	155	167	179	62.9	27.3	26.2	14.7	11.2	25.8	70	90.5	158

Presently, most people know, and the USGS identifies, the reservoirs on the mainstem Portneuf River as Chesterfield Reservoir and on Twentyfourmile Creek as Twentyfourmile Reservoir. This report will use the same naming convention - Chesterfield and Twentyfourmile reservoirs.

2.1.1 Watershed Characteristics

Eighteen waterbodies in the Portneuf River subbasin are on the 303(d) list. In addition to the mainstem Portneuf River, other major watersheds within the subbasin include: Mink, Rapid, Marsh, Dempsey, Pebble, and Toponce creeks (Figure 1). All of these watersheds/waterbodies are on the 303(d) list (Table 4). Other waterbodies on the 303(d) list include: Pocatello, Gibson Jack, Walker, Bell Marsh, Goodenough, Garden, Hawkins, Birch, and Cherry creeks. Hawkins Reservoir is the only 303(d)-listed reservoir.

Physical changes from higher to lower elevations are similar amongst the streams. Most of the streams originate in montane areas, usually Forest Service land. Based on site data from the Division of Environmental Quality's Beneficial Use Reconnaissance Project, the higher elevation stream sections tend toward higher gradients, lower sinuosity, Rosgen A-channel types, and V-shaped valley types (Table 5). Pool to riffle ratios are low (i.e., riffles predominate) and stream substrate tends toward a cobble surface (Table 6; Crist and Holden 1988). At lower elevations, mostly private land, the streams decrease in gradient and increase in sinuosity. Rosgen channel types are usually C, F, or G, within flat or trough shaped valleys. Width to depth ratios vary substantially with lower ratios usually found at higher elevations (Table 7). The BURP effort recorded very few pools within their monitoring sites resulting in low pool to riffle ratios. Bank vegetation and stability varied by site with no obvious trend. Lower values representing less protection or stability were observed in the mainstem Portneuf in the Downey Canal section and Pocatello, Indian, Walker, Goodenough, Garden, Arkansas, Hawkins, Cherry, Robbers Roost, Harkness, Dempsey, and Twentyfourmile creeks.

Human activity has had a significant impact on the mainstem Portneuf River. In the lower Portneuf River, construction of the 1.5 mile concrete channel through the City of Pocatello in the 1960s eliminated fish and wildlife habitat and created a migration barrier for trout accessing City Creek for spawning (U. S. Army Corps of Engineers 1992). As a result of the project, channel length was reduced by 4.1 miles and riparian habitat by 144 acres. The concrete channel represents 15% of the length of the Portneuf River for the segment from Johnny Creek to Interstate 86. The upper Portneuf River runs through the 7.8 mile Downey Canal, built in conjunction with the Chesterfield Reservoir. Diversion of the river through the canal eliminated about 16 miles of the Portneuf River. An engineering survey in 1991-1992 of the Downey Canal revealed that 3,500 feet of streambank had severe stability problems, 8,000 feet had moderate stability problems, and 4,500 feet had slight stability problems (Soil Conservation Service 1993). The survey also noted that 4,300 feet of the canal had stream gradients that could lead to serious channel erosion.

A reconnaissance survey by the Natural Resources Conservation Service (NRCS) on the approximately 13.5 miles of Portneuf River between Lava Hot Springs and McCammon revealed streambank conditions to be 33% poor, 27% fair, 8% good, and 32% excellent (Portneuf Soil and

Table 4. Waterbodies in the Portneuf River subbasin on the 303(d) list.

Waterbody	Stream order*	Length (mi)	Drainage area (square miles)	Miles of stream in drainage	Listed pollutants
Portneuf	5	103.0	1360	1503.2	bacteria, nutrients, sediment, oil & grease, flow alteration
Pocatello	2	3.1		28.7	sediment
Gibson Jack	2	4.3		15.4	sediment
Mink	3	11.0	51	62.6	nutrients, sediment
Rapid	3	6.2	79	79.4	sediment
Marsh	4	52.3	410	504.8	nutrients, sediment
Walker	2	6.1		13.6	sediment
Bell Marsh	2	6.4		11.3	sediment
Goodenough	2	6.8	10	15.2	sediment
Garden	2	17.5	29	36.6	nutrients, sediment
Hawkins	2	15.1	52	66.0	nutrients, sediment
Hawkins Reservoir		67.5**		–	nutrients, dissolved oxygen
Birch	3	12.8		70.7	nutrients, sediment
Cherry	2	9.8	15	27.8	nutrients, sediment
Dempsey	4	12.6	49	41.6	sediment
Pebble	3	9.4	27	38.6	sediment
Twentyfourmile	3	12.9	33	71.6	sediment
Toponce	4	8.3	41	55.6	sediment

*based on stream channels with perennial water at a map scale of 1:24,000
**represents area of reservoir in acres

Table 5. Watershed characteristics of 303(d)-listed tributaries in the Portneuf River subbasin (from DEQ BURP data).

Waterbody	Tributary	Tributary	Tributary	Distance above mouth of Portneuf (miles)	Stream order at mouth	Elevation at mouth (ft msl)	Site elevation (ft msl)	Headwaters elevation (ft msl)	Valley type	Sinuosity	Gradient (%)	Rosgen channel type
Pocatello				15.6		4440						
							4960		Trough	Mod	2.0	G
	North Fork							6300				
	North Fork											
Gibson Jack				22.8		4470						
							5120		Flat	Mod	6.0	B
								6700				
Mink				24.5	2	4500						
							4880		U-shaped	Mod	3.5	B
							4920		Flat	Mod	1.0	B
								6000				
							4960		V-shaped	Low	2.5	B
	Kinney						5320		U-shaped	Mod	5.0	B
	East Fork						5820		V-shaped	Low	5.0	A
							5360		V-shaped	Low	4.0	A
	West Fork						5840		Trough	Mod	2.0	B
	South Fork											
Rapid				33.2		4510						
							4920		Trough	Mod	1.0	C
							5440		Trough	Mod	3.0	G
							4760		Trough	Low	2.6	B
	Jackson						5720		U-shaped	Low	4.5	A
							6040		V-shaped	Low	3.0	B
	Inman						4910		U-shaped	Mod	4.0	B
	Webb						5320		V-shaped	Mod	5.0	A
								6200				
	North Fork											
Marsh				35.1	3	4510						
							4560		Flat	Mod	1.0	C
							4630		Trough	Mod	1.0	C
							4640		Trough	Mod	1.0	F
							4650		Trough	Mod	1.0	F
							4880		V-shaped	Low	2.5	B
							5560		V-shaped	Low	3.0	B
	Left Hand Fork							7500				
	Walker			40.9	2	4560						
							4640		V-shaped	Low	3.5	G
							5200		V-shaped	Mod	3.0	B
							5560		V-shaped	Mod	2.5	B
							5680		V-shaped	Low	3.0	B

Table 5. Continued.

Waterbody	Tributary	Tributary	Tributary	Distance above mouth of Fortuna (miles)	Stream order at mouth	Elevation at mouth (ft msl)	Site elevation (ft msl)	Headwaters elevation (ft msl)	Valley type	Sinuosity	Gradient (%)	Rosgen channel type
	Bell Marsh			44.9	2	4600						
							4620		Flat	Low	3.0	B
							5660		Flat	Mod	4.0	B
								8400				
	Goodenough			50.2	2	4620						
							5240		U-shaped	Mod	3.0	B
							5600		U-shaped	Mod	5.0	A
								7400				
	Garden			56.1	2	4630						
							5480		Flat	Mod	-	G
							5500		Trough	High	2.0	C
							5600		Trough	High	2.0	B
							5920		V-shaped	Mod	2.0	B
								7400				
	Hawkins			64.5		4650						
							4680		Trough	Mod	0.5	F
							5200		Trough	Mod	1.0	C
								6200				
	Hawkins Res.			73.6		5140	-	-	-	-	-	-
	Birch			72.3		4680						
							4700		Trough	Mod	2.0	C
							5240		Trough	Mod	5.0	A
		Mill					6440		V-shaped	Mod	6.0	B
								8200				
		Cherry		75		4740						
							5030		Trough	Mod	1.0	C
							5840		V-shaped	Mod	2.7	B
			Middle Fork					7600				
Dempsey				60.1	2	4950						
							5000		Trough	Mod	1.0	C
							5140		Trough	Mod	1.7	B
							5560		V-shaped	Low	3.0	B
							5720		Flat	High	5.0	G
								7400				
Pebble				74.1		5250						
							5820		V-shaped	Low	6.0	A
								8400				
Twentyfourmile				83.5		5310						
							5760		Trough	Low	4.0	A
								6800				
Toponce				85.1	2	5320						
							5760		V-shaped	Low	3.2	A
	North Fork							8400				

Table 6. Qualitative habitat characterization of streams in the Portneuf River subbasin, September 1987 (from Crist and Holden 198

Waterbody	Site	Estimated flow (cfs)	Pool/riffle ratio	Average stream width (ft)	Maximum depth (ft)	Substrate*	Cover**
Gibson Jack	Lower	2	1:1	8	0.8	3,1	25
	Upper	2	1:0	15	1.5	1	20
Mink	Lower	2.5	1:2	10	4.0	3,1	25
	Upper	1	1:4	6	1.5	3,1	20
East Fork Mink		1-2	4:1	16	4.0	1	30
West Fork Mink		1.5	1:4	6	0.7	3,5,2	20
South Fork Mink	Lower	2	9:1	8	4.0	1	25
	Middle	2	1:3	6	1.5	3,2,1	20
	Upper	< 0.5	1:0	5	3.0	1	10
Jackson		< 0.5	1:4	3	0.7	3,2	50
Inman		1	1:2	6	1.5	3,2	20
Webb	Lower	2-3	1:3	8	1.5	3,2,1	30
	Upper	2-3	1:5	8	20.0	3,2	30
Walker		< 0.5	1:5	4	1.5	3,2	10
Bell Marsh	Lower	1.5	1:0	12	1.5	3,2	25
	Upper	1.5	1:3	6	2.5	3,4,2	30
Goodenough		1	1:4	6	0.8	3,2,1	10
Mormon Canyon		< 0.5	1:5	3	0.5	3,2	10
Birch	Lower	1	1:9	4	0.4	3,2	10
	Upper	1	1:9	4	0.4	3,2	10
Robbers Roost	Lower	0.5	1:1	4	1.5	3,1,4	30
	Upper	0.5	1:0	17	1.5	1	50
Harkness		0.5-1	1:4	3	1.0	3,2,1	30
East Bob Smith	Lower	2	2:1	8	2.5	5,1	40
	Upper	2	1:1	4	1.0	2,1	25
Clear	Lower	1	1:0	30	3.0	1	25
	Upper	1	2:1	5	2.5	1,3	20
South Fork Toponce	Lower	1-2	3:1	11	2.0	3,1	5
	Upper	1-2	9:1	18	3.5	1,3	10
Middle Fork Toponce	Lower	2	1:1	9	2.5	3,1	20
	Upper	< 0.5	1:0	30	5.0	1,3	30
North Fork Toponce		< 0.5	2:1	3	0.7	1,3	10
Little Toponce		1-2	1:1	8	2.0	3,1	25

*5=bedrock, 4=boulder, 3=cobble, 2=gravels, 1=fines; ranked in order of dominance
**percent of total surface area exhibiting any type of cover
***percent of eroding banks

Table 7. General information on waterbodies in the Portneuf River subbasin (from DEQ BURP data).

Waterbody	303(d) listed	Date	Site	Gradient	Rosgen	Valley type	Sinuosity	% fines	Embeddedness	Pool:riffle ratio	Width:depth ratio	Bank vegetation protection	Bank stabilit
Portneuf	Y												
		8/95	DC-L	1	F	Trough	Low	87.9	5	0	17.2	100	95
		8/95	DC-M	1.5	F	Trough	Low	86.3	4	0	20.2	75	0
		8/95	DC-U	1.5	F	Trough	Low	61.1	5	0	11.6	35	0
		7/97	DC-L	1	F	Trough	Low						
		7/97	DC-M	1	F	Trough	Low						
		7/97	DC-U	1	F	Trough	Low						
Pocatello	Y												
		6/95		2	G	Trough	Mod	67.3	8	0.03	6.92	64.5	60
Trail	N												
		6/96				DRY							
City	N												
		6/96	L	3.8	B	V	Low	39.3	8	0.03	11	98	99
		6/96	U	2.5	B	Flat	Low	44.6	12	0	11.3	100	100
Gibson Jack	Y												
		6/95		6	B	Flat	Mod	24.4	16	0	13.9	92.5	87.5
Mink	Y												
		7/94		1	B	Flat	Mod	32.6	18	0	3.9	94.5	97.5
		6/97		3.5	B	U	Mod						
Kinney	N												
		6/97		2.5	B	V	Low						
East Fork Mink	N												
		6/97	L	5	B	U	Mod						
		6/97	U	5	A	V	Low						
West Fork Mink	N												
		7/94		2.5	-	V	Mod	49.4	17	0	15	95	100
		6/97		4	A	V	Low						
South Fork Mink	N												
		6/97		2	B	Trough	Mod						
Indian	N												
		6/96		4	B	Trough	Mod	34.1	6	0	9.23	55	17.5
Rapid	Y												
		6/95	L	1	C	Trough	Mod	39.7	8	0.04	14	95.5	92.5
		6/95	U	3	G	Trough	Mod	82.1	4	0	3.1	99.5	92.5
Jackson	N												
		6/96	L	2.6	B	Trough	Low	42.3	13	0	47	84	93
		6/96	U	4.5	A	U	Low	34.9	13	0.13	6.21	100	97
Inman	N												
		7/97		3	B	V	Low						
Webb	N												
		7/97	L	4	B	U	Mod						
		7/97	U	5	A	V	Mod						
Marsh	Y												
		7/94	L	1	F	Trough	Mod	35	12	0	21.6	87.5	97.5
		7/94	U	2	G	Box	Mod	38.7	7	0	19.7	82.5	90
		7/97	L	1	C	Flat	Mod						
		7/97	AL	1	C	Trough	Mod						
		7/97	A	1	F	Trough	Mod						
		6/97	M	1	F	Trough	Mod						
		6/97	U	2.5	B	V	Low						
		6/97	LHF	3	B	V	Low						
Walker	Y												
		7/94	L	3.5	G	V	Low	22.6	14	0	23.8	90	100
		7/94	U	2.5	B	V	Mod	32.1	12	0	19.7	55	62.5
		6/97	L	3	B	V	Mod						
		6/97	U	3	B	V	Low						

Table 7. Continued.

Waterbody	303(d) listed	Date	Site	Gradient	Reagen	Valley type	Sinuosity	% fines	Embeddedness	Pool:riffle ratio	Width:depth ratio	Bank vegetation protection
Bell Marsh	Y											
		6/95	L	3	B	Flat	Low	9.2	16	0	16.3	77
		6/95	U	4	B	Flat	Mod	24.2	11	0	15.4	94
Goodenough	Y											
		6/95	L	3	B	U	Mod	20.4	12	0	21.2	60
		6/95	U	5	A	U	Mod	37.5	14	0	13.4	62.5
Garden	Y											
		7/94	L	-	G	Flat	Mod	37.9	10	0.05	8.4	99
		7/94	U	2	B	Flat	High	51.8	11	0.06	18.6	87.5
		7/97	L	2	C	Trough	High					
		7/97	U	2	B	V	Mod					
Arkansas	N											
		7/96		3	B	V	Mod	71.4	2	0.02	4.53	58
Hawkins	Y											
		6/95	L	0.5	F	Trough	Mod	100	0	0	3.81	100
		6/95	U	1	C	Trough	Mod	63.4	3	0	6.9	95
Hawkins Reservoir	Y											
Birch	Y											
		6/95	L	2	C	Trough	Mod	64	4	0	7.5	100
		6/95	U	5	A	Trough	Mod	46.1	14	0	12.2	100
Mill	N											
		8/94		6	B	V	Mod	22.1	15	0.05	17.9	100
Cherry	Y											
		7/94	U	5	B	Trough	Mod	23.5	13	0	16.4	97
		7/96	L	1	C	Trough	Mod	42.3	8	0.3	16.7	56.5
		6/96	U	2.7	B	V	Mod	22.8	18	0	12.3	97.5
Lower Rock	N											
		6/97		9	A	V	Low					
Upper Rock	N											
		6/97		8	A	V	Low					
Robbers Roost	N											
		8/94		5	F	V	Mod	30.3	9	0.02	17.3	70
		6/97		4	A	V	Low					
Harkness	N											
		8/94		5	B	V	Mod	20.8	11	0.09	14.3	67.5
		6/97		6	A	V	Low					
Dempsey	Y											
		7/94	L	1	C	Trough	Mod	39	11	0	15.3	72.5
		7/94	U	5	G	Flat	High	51.5	12	0	3.39	40
		6/97	L	1.7	B	Trough	Mod					
		6/97	U	3	B	V	Low					
Fish	N											
		6/97	L	2.5	G	Flat	Mod					
		6/97	U	3	B	U	Low					
Pebble	Y											
		7/96		6	A	V	Low	19.9	13	0.02	23.5	10
Twentyfourmile	Y											
		8/95		4	A	Trough	Low	59.6	11	0.07	10.1	92
Toponce	Y											
		7/96		3.2	B	V	Low	21.8	13	0.15	11.4	10

*represents area of reservoir in acres

Water Conservation District 1996). Streambanks in fair or poor condition totaled 77,520 ft (14.7 miles). The Portneuf River below Dempsey Creek to the Portneuf- Marsh Valley Canal diversion was characterized as having vertical banks, with a lack of vegetation for building banks, and lacking large woody debris for in-stream cover for fish. The river below the diversion was less impacted by bank problems than upstream.

As part of the same survey, the NRCS also evaluated the streambank condition of smaller tributaries to the Portneuf River in the Lava Hot Springs to McCammon reach. East and West Bob Smith creeks had some areas that had downcut approximately 2 ft due probably to cropped fields which have changed the hydrology of the watershed by increasing runoff. The area of the creeks within the Portneuf River watershed were severely overgrazed. In Dempsey Creek, the lower 14,000 ft of streambank was in poor condition mostly due to livestock concentration on small pastures. Middle Dempsey Creek has also been affected by livestock such that 15,600 ft of streambank is in fair to poor condition. In upper Dempsey Creek, 47,200 ft of streambank along the 59,000 ft of channel was in fair or poor condition. From a fish habitat perspective, a visual estimation on the lower four miles of Dempsey Creek revealed that 50% of the banks do not support habitat for fish.

Streambanks/riparian areas have also been evaluated in other tributaries to the Portneuf River. Gore (1986) noted that riparian areas of Marsh Creek near McCammon, Portneuf River from McCammon to Lava Hot Springs, and the Downey Canal had all been degraded. Almost two-thirds of the 1.5 miles of Twentyfourmile Creek below the dam is in poor vegetative condition due to livestock use while the remainder is in fair to good condition (Soil Conservation Service 1993).

The Caribou National Forest has evaluated the stream channel stability and fish habitat condition of numerous streams on the forest. All 303(d)-listed streams in the survey rated good to excellent except Walker Creek, South Fork Hawkins Creek, and Middle Fork Cherry Creek (Table 8; Caribou National Forest 1985). Habitat in Mink, Bell Marsh, Walker, and Cherry creeks was in stable condition, though below potential (Caribou National Forest 1992a). Fisheries habitat in the mainstem Mink Creek from Cherry Springs to the Forest Boundary was considered poor (Lee Leffert, Caribou National Forest, personal communication).

The Caribou National Forest also collected water quality and macroinvertebrate information from the late 1970s to the mid-1980s. From water quality monitoring conducted from 1977 to 1982 on the South Fork and West Fork of Mink Creek, the Forest Service tentatively concluded the following: nitrogen was not a problem; fecal coliform was present; and turbidity and suspended sediment indicated the streams are generally clean (Lee Leffert, Caribou National Forest, personal communication). Overall, water quality was considered to be "good" in South Fork and "excellent" in West Fork. Macroinvertebrate information showed some degradation of water quality as South Fork rated only "poor" to "fair" while West Fork rated "good" with indication of some organic enrichment. Although the water quality of Toponce and Pebble creeks was not monitored, the Caribou National Forest (1992b) noted that the water quality was sufficient to support and maintain a coldwater fishery.

Table 8. Stream channel stability rating for Portneuf River subbasin streams on the Caribou National Forest (from Caribou National Forest 1985).

Waterbody	Stream channel stability rating			
	Excellent	Good	Fair	Poor
Trail		X		
Cusick		X		
Dry		X		
Mink		X		
Kinney		X		
East Fork Mink		X		
Lead Draw		X		
Valve House		X		
South Fork Mink		X		
Indian		X		
Walker			X	
Bell Marsh		X		
South Fork Hawkins			X	
Potter			X	
Big		X		
Cherry		X		
Middle Fork Cherry			X	
Mill Canyon		X		
Aspen		X		
North Aspen		X		
South Fork Inman			X	
Webb		X		
Robbers Roost		X		
East Bob Smith		X		
Reed Canyon		X		
Pebble	X			
South Fork Pebble		X		
Clear		X		
North Fork Pebble		X		
Big Canyon		X		
King		X		
Toponce	X			
South Fork Toponce		X		
Bear		X		
Middle Fork Toponce		X		
Black Canyon		X		
North Fork Toponce		X		

In the late 1970s, the Bureau of Land Management (BLM) evaluated habitat conditions for fish in various creeks on BLM land including Walker, Bell Marsh, Goodenough, Garden, and Birch creeks and the Left Hand Fork of Marsh Creek (Table 9; BLM 1980). Overall, 51% of the trout habitat was in poor to fair condition in 1978.

In 1993, the BLM conducted fish habitat surveys (2 sites per stream) on those sections of Walker and Goodenough creeks which pass through BLM land (Pat Koelsch, BLM, personal communication). Walker Creek below the South Fork confluence had a stable channel with only limited signs of excessive degradation or later movement. Overall riparian condition was considered good with a stable trend. Above the South Fork confluence, the creek channel stability was rated excellent with a riparian condition of good to excellent with a stable or slow upward trend. Goodenough Creek, above Mormon Canyon, had a relatively stable channel with only limited signs of excessive degradation or lateral movement. The riparian condition was rated good to excellent with an upward trend. Conditions of Goodenough Creek above the campground were similar to those observed at the other site above Mormon Canyon.
The BLM in 1996 assessed the condition of that portion of Bell Marsh Creek flowing through BLM land. The stream was considered to be properly functioning but at risk (Geoff Hogander, BLM, unpublished data).

Some 303(d)-listed streams show evidence of unstable streambanks. Crist and Holden (1988) in their survey of streams on Ceded Lands of the Shoshone-Bannock Tribes observed over 30% eroding streambanks in South Fork Mink Creek, Walker Creek, and Toponce Creek (Table 6).

Salmonid spawning is listed as one of the beneficial uses of most of the 303(d) listed streams in the Portneuf River subbasin (Table 10). Cutthroat trout (*Oncorhynchus clarki*) and mountain whitefish (*Prosopium williamsoni*) are the only salmonids (i.e., trout, char, whitefishes) native to the Portneuf River (Simpson and Wallace 1982). Mohr (1968), in his investigation of the fishes of the Portneuf River and tributaries, found three introduced salmonid species - brown trout (*Salmo trutta*), rainbow trout (*O. mykiss*), brook trout (*Salvelinus fontinalis*).

The Portneuf River has a history of having an excellent trout fishery. In 1968 the upper Portneuf River was designated a blue ribbon river by the Idaho Department of Fish and Game (Portneuf Soil and Water Conservation District and Caribou Soil Conservation District 1988). Much of the trout fishery has been supported by rainbow trout, both wild and hatchery fish (Heimer et al. 1987).

The lower Portneuf River has not had the distinction of a blue ribbon trout fishery but nevertheless does support salmonids. Broderick et al. (1989) captured wild and hatchery rainbow trout, rainbow x cutthroat (hybrid) trout, brown trout, and mountain whitefish in the vicinity of the Pocatello waste water treatment plant.

Some tributaries may play an important role as nursery areas for mainstem trout populations. IDFG (Idaho Department of Fish and Game) found that recruitment of cutthroat and rainbow trout juveniles from Toponce, Twentyfourmile, and King creeks was virtually nonexistent

Table 9. Habitat conditions of fishery streams on Bureau of Land Managment land (from BLM 1980).

Waterbody	Miles of Stream by Condition Class			
	Excellent	Good	Fair	Po
Bell Marsh	0.2		0.5	
Birch			0.3	
Garden	0.7	2.0	0.5	
Goodenough		0.8		0.
King		0.6	0.1	
Harkness				1.
Left Hand Fork, Marsh Creek				0.
Midnight		1.3	1.1	
Moonlight			1.1	
Mormon Canyon			0.5	
Robbers Roost	0.4			
Stockton	0.5			1.
Upper Rock		0.3		
Walker		0.3	0.3	
Total	1.8	5.3	4.4	3

Table 10. Recognized beneficial uses (designated and existing) for waterbodies in the Portneuf River on the 303(d) list.

Waterbody	Water quality limited segment boundary		Beneficial uses [a]									
			Biota		Salmonid spawning	Contact recreation		Water supply			Wildlife habitat	Aesthetics
	Lower	Upper	Cold water	Warm water		Primary	Secondary	Domestic	Agricultural	Industrial		
Portneuf	American Falls Reservoir	Chesterfield Reservoir	Y		Y	Y	Y	Y	Y	Y	Y	Y
	Fort Hall Reservation Boundary	Interstate 86	Y		Y	Y	Y		Y	Y	Y	Y
	Interstate 86	Johnny Creek	Y		Y	Y	Y		Y	Y	Y	Y
	Johnny Creek	Marsh Creek	Y		Y	Y	Y		Y	Y	Y	Y
	Marsh Creek	Portneuf-Marsh Valley Canal Diversion	Y		Y	Y	Y	Y	Y	Y	Y	Y
	Portneuf-Marsh Valley Canal Diversion	Lava Hot Springs	Y		Y	Y	Y	Y	Y	Y	Y	Y
	Lava Hot Springs	Downey Canal**	Y		Y	Y	Y	Y	Y	Y	Y	Y
	Downey Canal**	Chesterfield Reservoir	Y		Y	Y	Y	Y	Y	Y	Y	Y
	Chesterfield Reservoir	Headwaters	Y		Y	Y	Y	Y	Y	Y	Y	Y
Pocatello	Portneuf River	Headwaters	Y				Y		Y	Y	Y	Y
Gibson Jack	Portneuf River	Headwaters	Y		Y		Y		Y	Y	Y	Y
Mink	Portneuf River	Headwaters	Y		Y	Y	Y		Y	Y	Y	Y
Rapid	Portneuf River	Headwaters	Y		Y		Y		Y	Y	Y	Y
Marsh	Portneuf River	Headwaters	Y		Y	Y	Y		Y	Y	Y	Y
Walker	Marsh Creek	Headwaters	Y				Y		Y	Y	Y	Y
Bell Marsh	Marsh Creek	Headwaters	Y		Y		Y		Y	Y	Y	Y
Goodenough	Marsh Creek	Headwaters	Y		Y		Y		Y	Y	Y	Y
Garden	Marsh Creek	Garden Creek Gap	Y		Y		Y		Y	Y	Y	Y
	Garden Creek Gap	Headwaters	Y		Y		Y		Y	Y	Y	Y
Hawkins	Marsh Creek	Headwaters	Y		Y		Y		Y	Y	Y	Y
Hawkins Reservoir	-	-	Y				Y		Y	Y	Y	Y
Birch	Marsh Creek	Headwaters	Y		Y		Y		Y	Y	Y	Y
Cherry	Birch Creek	Headwaters	Y		Y		Y		Y	Y	Y	Y
Dempsey	Portneuf River	Headwaters	Y		Y		Y		Y	Y	Y	Y
Pebble	Portneuf River	Headwaters	Y		Y		Y		Y	Y	Y	Y
Twentyfourmile	Portneuf River	Headwaters	Y				Y		Y	Y	Y	Y
Toponce	Portneuf River	Headwaters	Y		Y		Y		Y	Y	Y	Y

[a]beneficial use information from the Idaho Water Quality Standards and Wastewater Treatment Requirements and Beneficial Use Reconnaissance Project monitoring.
**on the 303(d) list this site is called the Chesterfield Canal; it is assumed that the site is the lower end of the canal

due to passage barriers (e.g., irrigation diversions, dewatering of the stream) or poor sp
habitat (Heimer et al. 1987). Although recruitment of salmonid juveniles from Pebble C
not documented, IDFG did emphasize the critical importance of maintaining existing tr
particularly cutthroat, populations in light of the marginal quality of spawning habitat in
mainstem Portneuf River.

Information on the presence of salmonid species is plentiful. The Shoshone-Ba
Tribes surveyed fish populations in Ceded Lands on the Caribou National Forest in 198
and Holden 1988). Twenty-one of the sampled streams contained trout; twenty stream
either dry or contained no fish (Table 11). Heimer et al. (1987) documented trout in P
Springs, King, and Toponce creeks but found no trout in Twentyfourmile Creek.

2.1.2 Cultural Characteristics

Land ownership includes private, federal, state, and tribal (Figure 5). Almost 6
land within the subbasin is privately owned (Table 12). The largest landowners in the s
are the Caribou National Forest, Shoshone-Bannock Indian Tribes, and Bureau of Land
Management.

Agricultural, range, forest, and urban are the major land uses in the subbasin (Fi
More than half of the subbasin is rangeland (Table 13). Much of the forest and rangelan
within the Caribou National Forest. Major crops grown in the Portneuf River subbasin
wheat, barley, potatoes, and hay (Ozburn and Modersitzki 1986; McNabb 1987). Beef
form the major livestock industry within the subbasin.

The majority of the Portneuf River subbasin is contained within Bannock and Ca
counties (Figure 2). Bannock County is the larger county in terms of population (Table
Both counties have shown an overall population increase since 1950 although Caribou C
experienced a population decline in the 1980s. Caribou County has a higher proportion
population as compared to Bannock County. Incorporated cites and towns, with 1996 U
Census population estimates, include: Pocatello (51,344), Chubbuck (8,876), McCamm
Inkom (787), Downey (626), Lava Hot Springs (442), Bancroft (418), and Arimo (306)

Overall per capita income measured as a percent of U.S. per capita income is low
area than the national average. There are two explanations why Bannock and Caribou c
are below the national average: relatively low wages and large family size (Benson and
1995).

Employment and earnings within the subbasin vary. For example, about two-thir
employment in Bannock County in 1992 was in the retail trade, services, and governmen
(Table 15). Sectors with the highest earnings for the county were the services, governm
transportation, communication, and public utilities. Employment is not as concentrated i
Caribou County as 10% of the jobs can be found in each of six sectors. Earnings on the
hand are concentrated in two sectors, mining and manufacturing, which account for almo
the earnings in Caribou County.

Table 11. Electrofishing results for streams on Ceded Lands of the Shoshone-Bannock Indian Tribes, September 1987 (from Crist and Holden 1988).

Waterbody	Site	Number of trout* collected	Young of year present
Gibson Jack	Lower	11	Y
	Upper	11	Y
Mink	Lower	71	Y
	Upper	8	Y
East Fork Mink		137	N
West Fork Mink		26	Y
South Fork Mink	Lower	50	N
	Middle	24	Y
	Upper	0	N
Jackson		2	Y
Inman		19	Y
Webb	Lower	71	Y
	Upper	55	Y
Walker		87	Y
Bell Marsh	Lower	51	Y
	Upper	40	Y
Goodenough		39	Y
Mormon Canyon		7	Y
Birch	Lower	29	Y
	Upper	23	Y
North Fork Green Canyon		--**	
Lower Rock		--	
Spider		--	
Upper Rock		--	
Robbers Roost	Lower	11	Y
	Upper	117	Y
Harkness		30	Y
East Bob Smith	Lower	37	Y
	Upper	22	Y
Clear	Lower	13	N
	Upper	15	Y
South Fork Toponce	Lower	48	N
	Upper	130	N
Middle Fork Toponce	Lower	109	Y
	Upper	27	N
North Fork Toponce		3	Y
Little Toponce		50	Y

*cutthroat, rainbow, cutthroat x rainbow hybrid, brook, or brown trout
**no fish collected

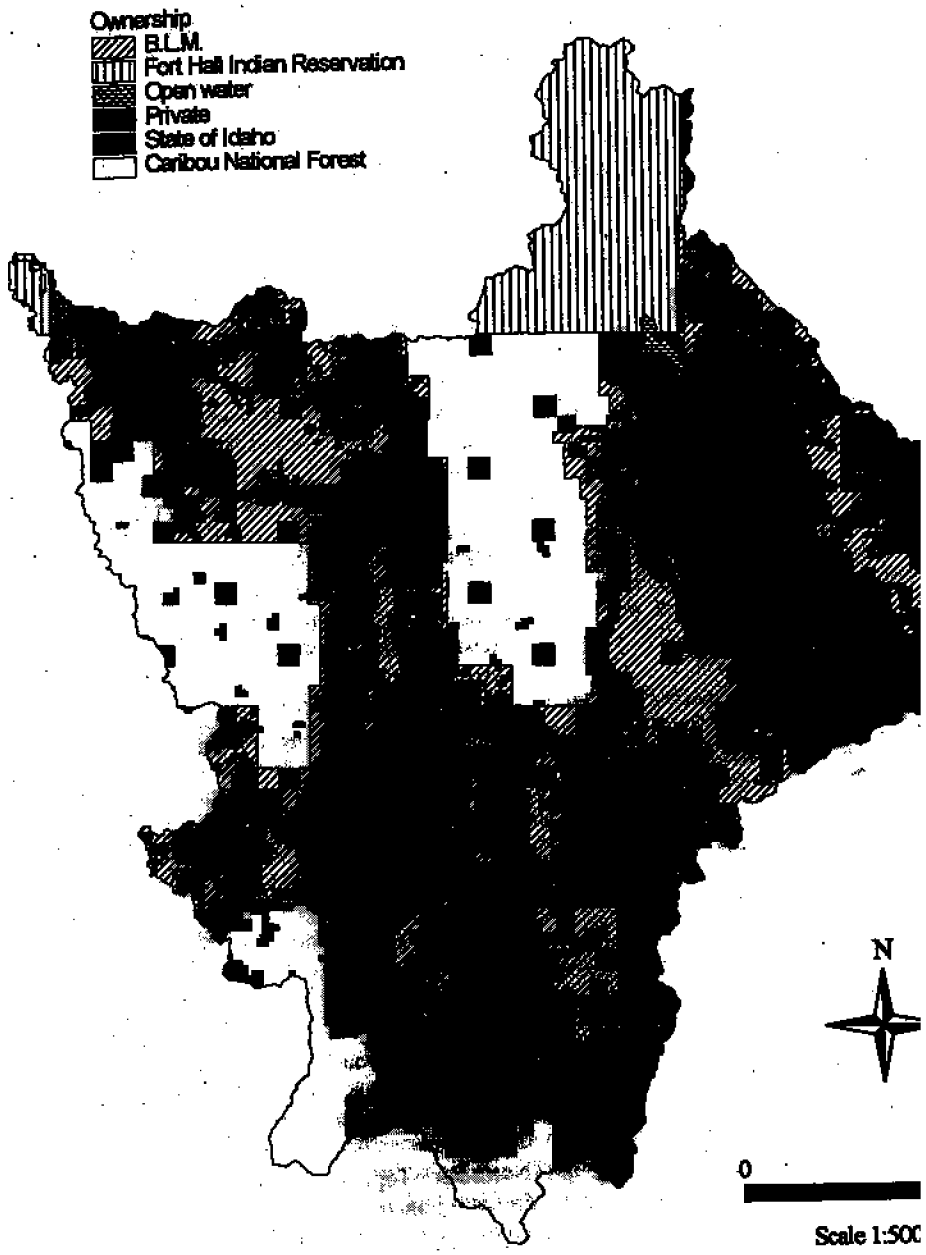


Figure 5. Land ownership in the Portneuf River subbasin.

Table 12. Land ownership in the Portneuf River subbasin.

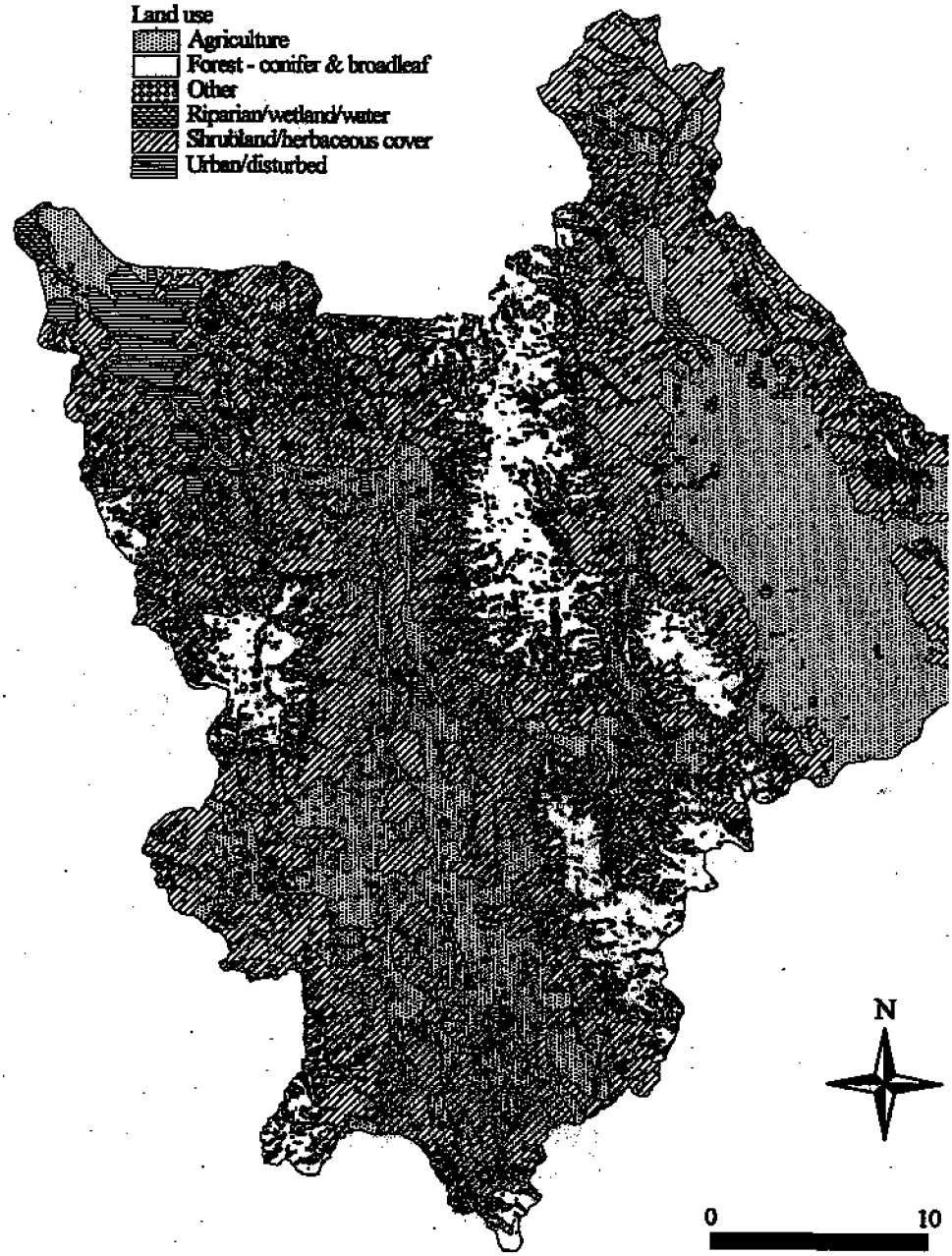
Ownership	Acres	Percent of area
Private	495,827	57.5
State of Idaho	35,834	4.2
Shoshone-Bannock Tribes	66,791	7.8
U.S. Forest Service	156,924	18.2
Bureau of Land Management	104,657	12.1
Other	1,558	0.2
Total*	861,591	

*total may differ from other area totals based on data used for analysis

Table 13. Land use in the Portneuf River subbasin (from Idaho Department of Water Resources Geographic Information System coverage about 1971).

Land use	Acres	Percent of area
Agriculture		
Dryland	255,153	29.6
Irrigated - flood	50,378	5.8
Irrigated - sprinkler	43,296	5.0
Rangeland	353,584	41.0
Forest	125,874	14.6
Riparian	8,589	1.0
Urban	23,453	2.7
Water	1,263	0.1
Total*	861,590	

*total may differ from other area totals based on data used for analysis



Scale 1:500000

Figure 6. Land use in the Portneuf River subbasin (from Idaho Department of Water Resources Geographic Information System coverage about 1998). Based on a slightly different Geographic Information System coverage than land use presented in Table 13.

Table 14. Demographic information for Bannock and Caribou counties, Idaho (summarized from Benson and Stegner 1995).

County/ state	Population		Percent population change					Avg annual pop growth (1950-1990)	Percent of population classified as rural			Per capita income 1992*
	1990	1995	1960-1970	1970-1980	1980-1990	1990-2000	2000-2010		1970	1980	1990	
Bannock	66,026	73,070	5.8%	25.3%	0.9%	17.3%	10.9%	1.2%	17.7%	18.4%	16.4%	73.8%
Caribou	6,963	8,040	9.3%	33.1%	-19.9%	27.4%	16.2%	0.6%	54.4%	53.4%	55.3%	74.6%
Idaho	1,006,749	1,130,000	6.8%	32.5%	6.7%	24.4%	14.1%	1.3%	45.9%	46.0%	42.6%	-

*per capita income as a percent of U.S. per capita income

Table 15. Total employment and real earnings by sector for Bannock and Caribou counties, Idaho, 1992 (summarized from Benson and Stegner 1995).

County	Category	Farm	Agricultural services*	Mining	Construction	Manufacturing**	TCU***	Wholesale trade	Retail trade	FIRE^	Services	Government^^
Bannock	Employment	2.2%	0.7%	0.1%	5.0%	6.3%	7.4%	5.0%	21.4%	7.2%	21.7%	22.9%
	Earnings	0.3%	0.3%	0.2%	5.6%	9.7%	16.0%	5.9%	12.4%	5.6%	18.8%	25.1%
Caribou	Employment	12.9%	2.0%	12.3%	8.6%	16.7%	3.9%	2.7%	12.0%	2.7%	11.4%	14.8%
	Earnings	2.6%	0.8%	23.0%	8.6%	33.6%	6.2%	2.0%	6.9%	0.7%	4.3%	11.2%

*includes forestry
**includes food processing
***transportation, communications, public utilities
^finance, insurance, real estate
^^includes federal, both military and civilian, state, and local

As of June 1997, there were nine facilities with National Pollution Discharge Elimination System (NPDES) permits to discharge into the Portneuf River (Table 16). All the facilities are located at or downstream of Lava Hot Springs. Most of the facilities are located in the Pocatello area (permits ID-000022-1, ID-000072-8, ID-002178-4, ID-002395-7, and ID-002716-2). Facilities include three waste water treatment plants and two fish hatcheries.

There are three current or historic Comprehensive Envi[redacted]l Response, Compensation, and Liability Act (CERCLA or Superfund) sites within the Portneuf River subbasin (Boyd Roberts, Division of E[redacted] Quality, personal co[redacted]n). All three are located in or near the city of Pocatello. The Union Pacific Railroad Sludge Pit site contained sludge contaminated by heavy metals, volatile organic compounds, and semi-volatile organic compounds. The second site, McCarty's/Pacific Hide and Fur, was [redacted] by PCBs and lead. Contaminated soils at both sites have been removed. The final site, Eastern Michaud Flats, includes the FMC and Simplot phosphate ore processing facilities. The site contains numerous [redacted]ts associated with the processing of phosphate ore including radionuclides. The Sludge Pit has been delisted and is no longer a Superfund site while the McCarty's/Pacific Hide site is in the process of being delisted (Gordon Brown, Division of Environmental Quality, personal communication).

There are several reservoirs in the Portneuf River subbasin. The largest is Chesterfield Reservoir (1,245 acres) in the upper drainage (Table 17). The reservoir and Downey Canal were built in 1908-1912 to provide a dependable source of irrigation water for Marsh Valley farms (Soil Conservation Service 1993). Also in the upper drainage is Twentyfourmile Reservoir (34 acres). Both Wiregrass (4 acres) and Hawkins (68 acres) reservoirs are in the Marsh Creek drainage. Hawkins is the only reservoir on the 303(d) list.

Over 90,000 acres in the Portneuf River subbasin are irrigated. Acreage sprinkled versus flood irrigated is roughly equal (Table 13). Ten canal companies in the subbasin have water rights ranging from 6 cfs to 176 cfs (Table 17). The Portneuf-Marsh Valley Canal Company and the Chesterfield Canal and Reservoir Company store irrigation water in the Chesterfield and Twentyfourmile reservoirs, respectively.

Numerous groups are presently working to improve water quality in the Portneuf River (Table 18). They include government, quasi-government, civic, non-profit, and volunteer organizations in addition to private companies.

2.2 Water Quality Concerns & Status

EPA through its Index of Watershed Indicators (IWI) rates the Portneuf River subbasin at 5 on a scale of 1 to 6 with a score of 6 indicating subbasins with the most serious water quality problems (EPA, internet communication). The most serious problems as identified by the IWI are attainment of beneficial uses, wetland loss, agricultural runoff, and population change.

Table 16. National Pollution Discharge Elimination System (NPDES) permits in the Portneuf River subbasin.

Permit	Permit holder	Type of activity	Location
ID-000022-1	FMC Corporation	Industrial Inorganic Chemicals	Pocatello
ID-000072-8	Papoose Springs Hatchery	Fish Hatchery	Pocatello
ID-002024-9	City of Inkom Waste Water Treatment Plant	Sewerage System	Inkom
ID-002178-4	City of Pocatello Waste Water Treatment Plant	Sewerage System	Pocatello
ID-002182-2	City of Lava Hot Springs Waste Water Treatment Plant	Sewerage System	Lava Hot Springs
ID-002395-7	Batise Springs Hatchery	Fish Hatchery	Pocatello
ID-002519-4	Riverside Inn	Hotel	Lava Hot Springs
ID-002716-2	Meadow Gold Dairies, Inc.	Fluid Milk	Pocatello
ID-002717-1	Idaho Lava Foundation	Nonclassifiable Establishment	Lava Hot Springs

Table 17. Reservoirs and irrigation canals in the Portneuf River subbasin.

Structure	Size	Location - stream dammed or diverted from	Diversion location	Date*	Total water rights (cfs)	Number of irrigators	Decreed acres irrigated**
Wiregrass Reservoir	4.1 acres	-					
Hawkins Reservoir	67.5 acres	Hawkins Creek					
Chesterfield Reservoir	1245.6 acres	Portneuf River		1912	16,410 af^		
Twentyfourmile Reservoir	34.1 acres	Twentyfourmile Creek		1928	700 af^		
McCammon Ditch Company		Portneuf River	T9S,R37E,S21	1889 & 1901	68.95	104	3448
Portneuf Irrigating Company		Portneuf River	T9S,R37E,S22	1889	55		3237
Portneuf-Marsh Valley Canal Company^^		Portneuf River	T9S,R37E,S22	1907	176.85		8842
		Toponce Creek	T6S,R38E,S33	1912	164.43		
Topaz Irrigation Company		Portneuf River	T8S,R38E,S28	1898 & 1907	39.5	22	1144
		Dempsey Creek	T9S,R38E,S33	1883	13.44		
Dempsey Irrigating Company		Portneuf River	T8S,R38E,S28	1907	20		831
Lava Irrigation Company		Portneuf River	T9S,R38E,S10	1889 & 1904	22.76		883
Fish Creek Irrigating Company		Fish Creek	T9S,R38E,S27	1893	6		
Chesterfield Canal & Reservoir Company^^^		Twentyfourmile Creek	-	1882	6	6-8	-
West Side Canal Company		Toponce Creek	T6S,R38E,S33	1905 & 1913	16.62		693
Toponce Canal Company		Toponce Creek	T6S,R38E,S34	1902	43.53		1828

*date built or date of earliest water right
**information from Union Grain and Elevator Company vs. McCammon Ditch Company et al., Book 4, Page 292, File 17-1 (Idaho 1922)
***approximate
^acre-feet
^^also has rights to all water in Chesterfield Reservoir
^^^also has rights to all water in Twentyfourmile Reservoir

Table 18. Groups working to improve water quality in the Portneuf River subbasin.

Type	Organization
Civic/volunteer/ nonprofit	Friends of the Portneuf
	Portneuf Greenway
	Groundwater Guardians
	Portneuf Watershed Council
	Portneuf Groundwater Forum
	Boy Scouts of America
	Idaho Rivers United
	Sierra Club
Quasi-government	Caribou Soil Conservation District
	Portneuf Soil and Water Conservation District
	Southeast Idaho Council of Governments
Government	City of Pocatello
	City of Chubbuck
	City of Inkom
	City of Lava Hot Springs
	City of McCammon
	City of Downey
	Bannock County
	Caribou County
	Idaho Division of Environmental Quality
	Idaho Department of Fish and Game
	Idaho Department of Lands
	Idaho Department of Water Resources
	Idaho Soil Conservation Commission
	Southeastern Idaho District Health Department
	Shoshone-Bannock Tribes
	Caribou National Forest
	Bureau of Land Management
	Natural Resources Conservation Service
	USDA Plant Materials Center
	Three Rivers Resource, Conservation, and Development
	U. S. Fish and Wildlife Service
	Army Corps of Engineers
Private companies	J. R. Simplot Company

Problems in the Portneuf River have been recognized for several years. Ozburn and Modersitzki (1986) wrote that uses of the Portneuf River for recreation, drinking water supply, agricultural water supply, and a healthy fishery are impaired by sediment, nitrogen, turbidity, phosphate, and bacteria inputs into the stream.

The effect of diminished water quality is often first realized within the local fish population. For example, cutthroat and rainbow trout are considered highly intolerant to water quality degradation, whereas common carp (*Cyprinus carpio*) have a high tolerance of degraded water quality (Chandler et al. 1993). Evermann (1896, cited in Mohr 1968) reported that in Mink Creek "we found the cutthroat trout to be quite abundant." At least by the mid-1960s cutthroat trout were "not very abundant in the Portneuf River" according to Mohr (1968) in his investigation of the fishes of the Portneuf River and tributaries.

In 1991, IDFG revisited a site in the upper Portneuf River which had been electrofished annually from 1979 to 1987 (Scully et al. 1993). The densities in 1991 of both wild cutthroat and rainbow trout were less than 0.1 fish/100 m^2, a substantial decrease from previous high densities of over 1.5 wild rainbow trout and 0.5 wild cutthroat trout per 100 m^2 collected from 1984 to 1986. The decline was attributed to a decrease in spawning success and overall survival associated with severe sedimentation and very low flow.

IDFG also electrofished 2 miles of Marsh Creek through the Arimo Ranch area. Seventy-three percent of the fish shocked were suckers (letter from Richard Scully, IDFG, to Janet Waters, Portneuf Soil and Water Conservation District, 5 June 1998). Only 13 (3%) of the 478 fish captured were trout or whitefish.

An increase in the abundance of carp is indicative of a decrease in water quality. Mohr (1968) found no carp present in his investigation of nine sites on the mainstem Portneuf River. Thirty years later, carp were abundant enough that Maret (1997) reported that the high incidence of carp in a coldwater stream like the Portneuf River to be a strong indication of habitat degradation. Degradation in the Portneuf River includes habitat changes caused by sediment (Portneuf Soil and Water Conservation District 1996).

Water quality degradation can also be seen in macroinvertebrate communities. Sampling of macroinvertebrates by Minshall and Andrews (1973) throughout the Portneuf River and by Ecology Consultants (1977) in the lower Portneuf River indicated that the fauna has been greatly influenced by irrigation activities, runoff from agricultural lands, increased sediment and turbidity, and stream alteration. A comparison of invertebrate drift in 1979 and 1988 at two sites in the upper Portneuf River showed an overall substantial decline in both numbers of individuals and taxa (Mende 1989). Ecology Consultants (1977) also sampled periphyton in 1977 and found primarily pollutant tolerant algae inhabiting the lower Portneuf River.

2.2.1 Water Quality Limited Segments Occurring in the Subbasin

The 1994 303(d) list identified 27 water quality limited segments found in 18 waterbodi in the Portneuf River subbasin (Figure 1). Three streams have multiple segments listed (Table 19). Listed segments within the mainstem Portneuf River actually overlap. One segment, the longest, stretches between Chesterfield and American Falls reservoirs. The other eight segmen cover the entire length of the Portneuf River from the headwaters to American Falls Reservoir. Garden Creek is split into two segments at the Garden Creek Gap. Both Hawkins Creek from headwaters to mouth and Hawkins Reservoir are listed.

Sediment and nutrients are the predominant pollutants on the 303(d) list for the Portne River (Table 19). All stream segments are listed for sediment and almost half of the streams ar listed for nutrients. Other recognized pollutants include dissolved oxygen in Hawkins Reservoi and bacteria, oil and grease, and flow alteration in the mainstem Portneuf River.

2.2.2 Applicable Water Quality Standards

Waterbodies (stream segments and reservoirs) are listed as water quality limited becaus they do not support one or more of their beneficial uses. There are ten recognized beneficial u by the State of Idaho which include stream biota, salmonid spawning, contact recreation, wate supply, wildlife habitat, and aesthetics (Table 10). All waterbodies are considered to support industrial water supply, wildlife habitat, and aesthetics. Coldwater biota, secondary contact recreation (e.g., fishing), and agricultural water supply are recognized and existing beneficial u for all the 303(d) listed waterbodies in the Portneuf River subbasin. Most of the waterbodies should also support salmonid spawning and some are large enough to be used for primary con recreation (e.g., swimming).

For a waterbody to support its recognized beneficial uses, it must meet certain criteria. These criteria are set forth by the State of Idaho as water quality standards (Idaho Department Health and Welfare no date available [nda]). As expected, these standards differ according to beneficial use (e.g., fecal coliform standards are more stringent for primary contact recreation for secondary contact recreation). The standards can be either numeric or narrative. Temperature, dissolved oxygen, turbidity, and fecal coliform are examples of parameters for which numeric standards exist (Table 20). Standards may differ according to the beneficial us For example, to meet the beneficial use for cold water biota, a stream should not exceed an instantaneous temperature of 71.6°F (22°C) or fall below a dissolved oxygen level of 6.0 mg/ warm water biota require instantaneous temperatures less than 91.4°F (33°C) and dissolved oxygen greater than 5.0 mg/l (Idaho Department of Health and Welfare nda). Other numeric standards have been established for pH, dissolved gas, chlorine, toxic substances, ammonia, intergravel dissolved oxygen, and radioactivity (Appendix A).

Narrative criteria exist for hazardous and deleterious materials; toxic substances; float suspended, or submerged matter; excess nutrients; oxygen-demanding materials; and sedimen (Idaho Department of Health and Welfare nda). All the narrative standards follow similar

Table 19. Water quality limited segments in the Portneuf River subbasin on the 303(d) list.

Waterbody	Water quality limited segment boundary		Listed pollutants	Source for listing**
	Lower	Upper		
Portneuf	American Falls Reservoir	Chesterfield Reservoir	bacteria, nutrients, sediment,	
	Fort Hall Reservation Boundary	Interstate 86	nutrients, sediment	DEQ, IDFG
	Interstate 86	Johnny Creek	sediment, oil and grease	DEQ, IDFG
	Johnny Creek	Marsh Creek	sediment	DEQ, IDFG
	Marsh Creek	Portneuf-Marsh Valley Canal Diversion	sediment	IDFG
	Portneuf-Marsh Valley Canal Diversion	Lava Hot Springs	nutrients, sediment	IDFG
	Lava Hot Springs	Downey Canal*	nutrients, sediment, flow alteration	DEQ, IDFG
	Downey Canal*	Chesterfield Reservoir	nutrients, sediment	DEQ, IDFG
	Chesterfield Reservoir	Headwaters	sediment	IDFG
Pocatello	Portneuf River	Headwaters	sediment	IDFG
Gibson Jack	Portneuf River	Headwaters	sediment	DEQ, IDFG
Mink	Portneuf River	Headwaters	nutrients, sediment	BLM, DEQ, IDFG
Rapid	Portneuf River	Headwaters	sediment	BLM, DEQ, IDFG
Marsh	Portneuf River	Headwaters	nutrients, sediment	BLM, DEQ, IDFG
Walker	Marsh Creek	Headwaters	sediment	DEQ
Bell Marsh	Marsh Creek	Headwaters	sediment	DEQ
Goodenough	Marsh Creek	Headwaters	sediment	DEQ
Garden	Marsh Creek	Garden Creek Gap	nutrients, sediment	BLM, DEQ, IDFG
	Garden Creek Gap	Headwaters	nutrients, sediment	BLM, DEQ, IDFG
Hawkins	Marsh Creek	Headwaters	nutrients, sediment	BLM, DEQ
Hawkins Reservoir	-	-	nutrients, dissolved oxygen	BLM, DEQ
Birch	Marsh Creek	Headwaters	nutrients, sediment	DEQ, IDFG
Cherry	Birch Creek	Headwaters	nutrients, sediment	BLM, DEQ, IDFG
Dempsey	Portneuf River	Headwaters	sediment	IDFG
Pebble	Portneuf River	Headwaters	sediment	IDFG
Twentyfourmile	Portneuf River	Headwaters	sediment	BLM, DEQ, IDFG
Toponce	Portneuf River	Headwaters	sediment	IDFG

*on the 303(d) list this site is called the Chesterfield Canal; it is assumed that the site is the lower end of the canal

**based on The 1992 Idaho Water Quality Status Report (Division of Environmental Quality 1992); BLM = Bureau of Land Management, DEQ = Division of Environmental Quality, IDFG = Idaho Department of Fish and Game

Table 20. State of Idaho water quality numeric standards (from Idaho Department of Health and Welfare Water Quality Standards and Wastewater Treatment Requirements). Max = maximum, avg = average, and min = minimum.

Beneficial use	Criteria			
	Dissolved oxygen*	Temperature	Turbidity**	Fecal coliform
Cold Water Biota	>= 6.0 mg/l, instantaneous	<= 22 C, instantaneous <= 19 C, max daily avg	<= 50 NTU, instantaneous <= 25 NTU, for > 10 consecutive days	
Warm Water Biota	>= 5.0 mg/l, instantaneous	<= 33 C, instantaneous <= 29 C, max daily avg		
Salmonid Spawning	1-day min >= the greater of 6.0 mg/l or 90% saturation	<= 13 C, instantaneous <= 9 C, max daily avg		
Primary Contact Recreation				<= 500 count/100 ml, instantaneous, <= 200 count/100 ml in >= 90% of samples over 30-day period, or <= geometric mean of 50 count/100 ml in min of 5 samples over 30-day period
Secondary Contact Recreation				<= 800 count/100 ml, instantaneous, <= 400 count/100 ml in >= 90% of samples over 30-day period, <= geometric mean of 200 count/100 ml in min of 5 samples over 30-day period
Domestic Water Supply			increase of <= 5 NTU, when background < 50 NTU, or increase of <= 10%, not to exceed 25 NTU when background > 50 NTU	

*criteria for streams, criteria for lakes and reservoirs differs
**above background

wording in that criteria exceedances occur when designated beneficial uses are impaired. Radioactive materials also have narrative criteria based on 10 CFR 20.

Sediment and nutrients are the two most recognized pollutants in southeast Idaho judging from the 303(d) list of water quality limited streams, yet neither has a numeric standard. How then can it be determined that the present level of sediment or nutrients is impacting beneficial use? Targets can be established based on literature that has examined the effect of various levels of sediment or nutrients on stream biota or salmonid spawning. As an example, DEQ has compiled sediment targets for consideration in writing total maximum daily loads (Table 21). Although some of the targets (i.e., turbidity and intergravel dissolved oxygen) actually correspond to water quality standards, it should be stressed that most of the targets are not standards and are not legally binding. For phosphorus, EPA (1986) recommended that a desired goal for the prevention of plant nuisances in streams not discharging directly to lakes or impoundments is a level not to exceed 0.10 mg/l total phosphorus: total phosphates as phosphorus should not exceed 0.05 mg/l in any stream at the point where the stream enters a lake or reservoir (e.g., Portneuf River entering American Falls Reservoir).

2.2.3 Summary and Analysis of Existing Water Quality Data

Waterbodies appear on the 303(d) list because they are considered to not support their beneficial uses. Few of the many reports on the Portneuf River speak directly to the support of beneficial uses.

Gore (1986) qualitatively evaluated the water quality in the mainstem Portneuf River from McCammon to the Downey Canal. He rated water quality from McCammon to Lava Hot Springs as poor due to land management practices; this section is also seasonally dewatered. Water quality was considered good from Lava Hot Springs upstream to the Downey Canal. In the Downey Canal reach, high turbidity and lack of riparian vegetation contribute to poor water quality.

The Division of Environmental Quality (DEQ) initiated the Beneficial Use Reconnaissance Project (BURP) in 1994 with the intention of determining whether waterbodies listed on the 303(d) list were actually supporting their beneficial uses (Division of Environmental Quality 1996a). Data collected on biological, physical, and chemical parameters were used to assess this support (Appendix B; Division of Environmental Quality 1996b). BURP monitoring confirmed that the mainstem Portneuf River, Rapid Creek, Walker Creek, Hawkins Creek, and Dempsey Creek were not supporting at least one of their beneficial uses (Table 22). Further information is needed to determine if Pocatello, Marsh, Birch, Cherry, and Twentyfourmile creeks are supporting their beneficial uses. Based on BURP analysis Gibson Jack, Mink, Bell Marsh, Goodenough, Garden, Pebble, and Toponce creeks are supporting their beneficial uses.

In addition to the 303(d) listed streams undergoing BURP monitoring, several non-listed streams were also evaluated (Table 23). Streams which are not supporting at least one beneficial use include Indian and Arkansas creeks. City and Jackson creeks require more information to determine the support status of their beneficial uses.

Table 21. Sediment targets for consideration in writing Total Maximum Daily Loads (from et al., unpublished document). Max = maximum, avg = average, and min = minimum.

Parameter	Possible target
Turbidity	<= 50 NTU, instantaneous, or <= 25 NTU for > 10 co days above background*
Light penetration	should not reduce the depth of the compensation poi photosynthetic activity by > 10% from the seasonal established norm for aquatic life
Intergravel dissolved oxygen	>= 5.0 mg/l, 1-day min, or >= 6.0 mg/l, 7-day avg me
Total suspended solids	<= 50 mg/l, avg monthly value, with max daily value <= 80 mg/l
Riffle stability	<= Riffle Stability Index of 70
Subsurface sediment	for streams with subsurface sediment < 27%, do not existing fine sediment volume level
	for streams with subsurface sediment > 27%, reduce subsurface sediment to <= 27%, 5-year avg, with n individual year > 29%
	concentration of subsurface sediment < 0.85 mm <=

*same as Idaho's water quality standard

Table 22. Status of 303(d)-listed waterbodies in the Portneuf River subbasin as to support of their beneficial uses (from DEQ BURP data).

Waterbody	Beneficial uses*	Overall waterbody status: Full	Overall waterbody status: Needs verification	Overall waterbody status: Not full	Beneficial uses not supported	Site	Year	Site status: Full	Site status: Needs verification	Site status: Not full
Portneuf	CWB, SS, PCR, SCR, DWS, AWS			X	CWB, SS, PCR, DWS	Downey Canal - Mid	1995			X
						Downey Canal - Up	1995			X
Pocatello	CWB, SCR, AWS		X			Lower	1995		X	
Gibson Jack	CWB, SS, SCR, AWS	X				Upper	1995	X		
Mink	CWB, SS, SCR, AWS	X				Upper	1994	X		
						West Fork	1994	X		
Rapid	CWB, SS, SCR, AWS			X	CWB	Lower	1995			X
						Upper	1995			X
Marsh	CWB, SS, PCR, SCR, AWS		X			Lower	1994		X	
						Upper	1994		X	
Walker	CWB, SCR, AWS			X	CWB	Lower	1994	X		
						Upper	1994			X
Bell Marsh	CWB, SS, SCR, AWS	X				Lower	1995	X		
						Upper	1995	X		
Goodenough	CWB, SS, SCR, AWS	X				Lower	1995	X		
						Upper	1995	X		
Garden (below Gap)	CWB, SS, SCR, AWS									
Garden (above Gap)	CWB, SS, SCR, AWS	X				Lower	1994	X		
						Upper	1994	X		
Hawkins	CWB, SS, SCR, AWS			X	CWB, SS	Lower	1995			X
						Upper	1995			X
Hawkins Reservoir	CWB, SCR, AWS									
Birch	CWB, SS, SCR, AWS		X			Lower	1995		X	
						Upper	1995	X		
Cherry	CWB, SS, SCR, AWS		X			Upper	1994	X		
						Lower	1996		X	
						Upper	1996			X
Dempsey	CWB, SS, SCR, AWS			X	CWB	Lower	1994			X
						Upper	1994			X
Pebble	CWB, SS, SCR, AWS	X					1996	X		
Twentyfourmile	CWB, SCR, AWS		X				1995		X	
Toponce	CWB, SS, SCR, AWS	X					1996	X		

*CWB=cold water biota, SS=salmonid spawning, PCR=primary contact recreation, SCR=secondary contact recreation, DWS=domestic water supply, AWS=agricultural water supply. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses of all waterbodies.

Table 23. Status of non-303(d)-listed waterbodies in the Portneuf River subbasin as to support of their beneficial uses (from DEQ BURP data).

Waterbody	Tributary to	Beneficial uses*	Overall waterbody status			Site	Year	Site status		
			Full	Needs verification	Not full			Full	Needs verification	Not full
Trail	Portneuf River	CWB, SCR, AWS								
City	Portneuf River	CWB, SCR, AWS		X		Lower	1996		X	
						Upper	1996	X		
Kinney	Mink Creek	CWB, SCR, AWS								
Jackson	Rapid Creek	CWB, SCR, AWS		X		Lower	1996		X	
						Upper	1996	X		
Inman	Rapid Creek	CWB, SCR, AWS								
Webb	Rapid Creek	CWB, SCR, AWS								
Indian	Portneuf River	CWB, SCR, AWS			X		1996			X
Arkansas	Marsh Creek	CWB, SCR, AWS			X		1996			X
Mill	Birch Creek	CWB, SS, SCR, AWS	X				1994	X		
Fish	Portneuf River	CWB, SCR, AWS								
Lower Rock	Portneuf River	CWB, SCR, AWS								
Upper Rock	Portneuf River	CWB, SCR, AWS								
Robbers Roost	Portneuf River	CWB, SS, SCR, AWS	X				1994	X		
Harkness	Portneuf River	CWB, SCR, AWS	X				1994	X		

*beneficial use information from the Idaho Water Quality Standards and Wastewater Treatment Requirements and Beneficial Use Reconnaissance Project monitoring. CWB=cold water biota, SS=salmonid spawning, SCR=secondary contact recreation, AWS=agricutural water supply, Industrial water supply, wildlife habitat, aesthetics are designated uses of all waterbodies.

Summer thunderstorms can influence water quality. McSorley (1977) reported that a summer thunderstorm in the Marsh Creek watershed that produced five percent of the annual precipitation increased the total solids concentration at one site to 15,000 mg/l, the highest recorded for any southeast Idaho stream to that time.

The following is a discussion by identified pollutant in the Portneuf River subbasin. For each pollutant, a summary analysis of existing data and inventory of sources is presented. Data gaps are also identified.

Flow Alteration

Summary Analysis

Flow alteration can have substantial impacts on aquatic biota. Minshall and Andrews (1973) did not look at flow alteration directly, but did note a decrease in the volume of flow in the Portneuf River with progression downstream during irrigation season. They postulated that such practices would be expected to influence stream biota by reducing habitat during an important fish production period, and increasing water temperature and decreasing dissolved oxygen content in the river at an already critical time of the year. In some years virtually all the water in the Portneuf River at the Portneuf-Marsh Valley Canal has been diverted. Loss of water along with high temperatures puts a stress on aquatic organisms in this section of the river between Topaz and Marsh Creek (McSorley 1977).

Flow alteration is a listed pollutant for the section of the Portneuf River from the downstream point of the Downey Canal (aka Chesterfield Canal) to Lava Hot Springs. However, it is DEQ's position that flow alteration, while it may adversely affect beneficial uses, is not a pollutant per section 303(d) of the Clean Water Act. There are no Idaho water quality standards for flow, nor is it suitable for estimation of load capacity or load allocations. Because of these practical limitations, TMDLs will not be developed to address flow alteration.

For many of the water quality limited waters on Idaho's 303(d) list, this position will have little effect on implementation plans. This is because concerns which resulted in a listing for flow alteration are often reflected in listed pollutants - sediment or temperature, for example. In such cases, actions taken to address these related pollutants will likely address flow as well. In other cases, alternate control strategies would be applied outside the TMDL process.

Dissolved Oxygen

Summary Analysis

Only Hawkins Reservoir has dissolved oxygen listed as a pollutant of concern (Table 19). Reservoirs, because of low flow and the presence of significant aquatic vegetation, are more prone to low levels of dissolved oxygen than streams. Often these low levels of oxygen occur at

night in lakes and reservoirs when aquatic vegetation is using oxygen rather than producing oxygen. The Idaho water quality standards recognize the difference between lotic (i.e., stream and lentic (i.e., lakes and reservoirs) through different standards: the minimum of 6.0 mg/l of dissolved oxygen for support of cold water biota does not apply to the lower depths of lakes a reservoirs (Idaho Department of Health and Welfare nda).

Data on dissolved oxygen levels in Hawkins Reservoir are limited to instantaneous information. Idaho Department of Fish and Game (IDFG) surveyed the reservoir in 1991 and found a consistent 8.0 mg/l of dissolved oxygen (Table 24), well above the cold water biota standard of 6.0 mg/l. DEQ sampling of the water column at one site in the reservoir in Augu 1997 found dissolved oxygen levels of about 4.0 mg/l near the bottom. These measurements not exceed the water quality standards as the 6.0 mg/l standard for cold water biota does not apply to the bottom 20% of water depth in natural lakes and reservoirs where depths are 35 meters or less (Idaho Department of Health and Welfare nda).

Fish kills can be an indication of low dissolved oxygen and are usually the most pronounced effect dissolved oxygen has on beneficial uses. Fish kills in Hawkins Reservoir occurred in 1989 and 1991 (Jim Mende, Idaho Department of Fish and Game, personal communication). The 1989 kill occurred in late summer while the 1991 happened in the winte Data collected by IDFG in January 1993 indicated low dissolved oxygen levels throughout the Reservoir (Table 24). According to Jim Mende, operation of the reservoir has changed in the several years as operators have tried to keep more water in the reservoir. Coincidentally or n there has been no report of a fish kill in at least the last three years.

Hawkins Reservoir was built in the early 1900s (Centennial Committee of Arimo 1990 for the purpose of providing irrigation water for downstream users (IDWA 1971). As the dar construction preceded implementation of the Clean Water Act, the dam is considered a preexisting condition. The dam exists to provide water to downstream users and will, in some water years, be drawn down. Such conditions may lead to dissolved oxygen problems.

Limited regular monitoring of streams in the Portneuf River subbasin for dissolved ox does not indicate low dissolved oxygen levels. Instantaneous dissolved oxygen levels at USG surface-water stations did not fall below 6.0 mg/l, the minimum required for support of cold v biota (Table 25). The lowest dissolved oxygen level recorded in quarterly monitoring of Minl Creek was 6.8 mg/l (Table 26). Recent sampling by the City of Pocatello in the lower Portne River has shown dissolved oxygen levels dipping below the 6.0 mg/l standard (Jim Brock, Ra Creek Research, Inc., personal communication).

Pollutant Sources

Dissolved oxygen problems in lentic waters usually stem from high levels of aquatic vegetation (macrophytes or phytoplankton) which in turn are a good indication of higher level nutrient (e.g., nitrogen and phosphorus) input. DEQ did note both emergent and submerged macrophytes throughout the reservoir in the August 1997 reconnaissance monitoring of Haw Reservoir. Although not a "source" of pollution, operation of the reservoir could set the

Table 24. Temperature and dissolved oxygen data in Hawkins Reservoir from Idaho Department of Fish and Game (IDFG) sampling in July 1991 (from Scully et al. 1993), IDFG sampling in January 1993 (Dick Scully, IDFG, personal communication), and Idaho Division of Environmental Quality (DEQ) sampling in August 1997.

Location	Depth (m)	Temperature (° C)	Dissolved oxygen (mg/l)
	IDFG Sampling - 25 July 1991		
Near dam	0.5	21	8
	3.0	20	8
Mid-reservoir	0.5	21	8
	3.0	20	8
Upper reservoir	0.5	21	8
	3.0	20	8
	IDFG Sampling - 16 January 1993*		
Near dam	top		2.73
	middle		2.23
	bottom		1.30
Mid-reservoir	top		2.27
	middle		2.33
	bottom		1.27
Upper reservoir	top		2.60
	middle		2.10
	bottom		1.43
	DEQ Sampling - 8 August 1997		
About 30 meters from dam	0.0	21.07	7.53**
	1.0	21	7.51**
	2.0	20.83	7.4**
	3.0	20.37	6.45**
	4.0	19.28	3.85**
	4.2	19.12	3.68**
	5.0	18.71	3.46**

*average of 3 samples per site

**due to concern about the levels of dissolved oxygen measured, the Hydrolab was recalibrated following the monitoring and a "correction factor" of 3.05 was added to the dissolved oxygen measurement

Table 25. Temperature and dissolved oxygen monitoring at USGS surface-water stations, 1969-1996.

Year	Date (mm/dd)	Siphon/Tybee Discharge (cfs)	Siphon/Tybee Temperature (C)	Siphon/Tybee Dissolved oxygen (mg/l)	Pyramiello Discharge (cfs)	Pyramiello Temperature (C)	Pyramiello Dissolved oxygen (mg/l)	Marsh Discharge (cfs)	Marsh Temperature (C)	Marsh Dissolved oxygen (mg/l)	Tepest Discharge (cfs)	Tepest Temperature (C)	Tepest Dissolved oxygen (mg/l)
1972	09/26	635	11.5										
	10/31	712	7.5					98	3.5		195	5	
	11/08				370	6							
	11/29	604	6										
	12/27	781	6										
1973	01/24	710	5										
	03/26							174	5		208	8.5	
	03/30				494	6							
	04/23				656	9		131	10		304	11.5	
	05/21				695	12.5		95	11.5		534	14.5	
	06/26				200	19		63	18.5				
	06/27										233	20.5	
	07/31							76	17		194	21	
	08/08				126	20							
	08/29							71	16		164	15	
	08/31				108	16							
	09/24				312	12		110	11		170	13	
	09/25				312	10							
	10/29										172	8	
	11/01				306	6							
	12/03							106	2.5		175	5	
	12/06				326	2							
1974	01/08										170	2.5	
	01/23				355	2							
	02/12							163	0		171	2.5	
	02/15				323	2.5							
	03/18				325	7		162	8				
	03/19										481	6	
	04/30							163	9		540	11	
	05/08				1150	9.5							
	06/05							74	13		376	13.5	
	06/07				455	11							
	07/09				107	18.5		50	16.5		212	18.5	
	08/12							64	18				
	08/12				116	18					202	20.5	
	08/24							77	16		159	16	
	09/25				121	15							
1975	10/28				413	5		110	5.5		237	7	
1976	01/20				508	2					159	5	
	01/22							73	0				
	03/08							88	1		181	6.5	
	04/02				667	3.5							
	04/20							170	8		404	9.5	
	06/01							75	16		471	14.5	
	06/04				526	14							
	07/13							41	20		216	22	
	07/23				88	18.5							
	08/08							63	11.5		160	15	
	09/16				158	14							
	10/19							77	7		179	9	
	10/22				296	6							
	11/30							70	1		160	4	
	12/03				294	1							
1977	01/17							64	1		168	5	
	01/25				273	0							
	03/07							78	4		164	5	
	03/11				336	4							
	04/19				163	7.5		45	7		134	12	
	05/24							74	12		192	13	
	05/26				127	13							
	07/05							46	17		198	20	
	07/07				31	24.5							
	08/16				47	22		37	20		150	22	
	08/23				118	11.5							
	09/28							67	13.5		105	16	
	11/08				210	4		70	7		130	5	
1978	03/11							38	20.5				
	03/14				42	19							
	09/28				174	15					131	14	
	11/07							63	5		136	9	
	12/18							55	4		153	4	
1979	01/22							39	1		142	4	
	03/05							82	5.5		139	8	
	03/07				312	8							
	04/18							102	8.5		221	12	
	04/28				472	9							
	05/22							44	18.5		259	18	
	05/24				258	17							
	07/10				41	21		36	20				
	07/23										198	21	
	08/21										143	19	
	08/22				107	19		53	16				

Table 25. Continued.

Year	Date (mm/dd)	Tybee Discharge (cfs)	Tybee Temperature (C)	Tybee Dissolved oxygen (mg/l)	Pocatello Discharge (cfs)	Pocatello Temperature (C)	Pocatello Dissolved oxygen (mg/l)	Marsh Discharge (cfs)	Marsh Temperature (C)	Marsh Dissolved oxygen (mg/l)	Topaz Discharge (cfs)	Topaz Temperature (C)	Topaz Dissolved oxygen (mg/l)
1979	10/24							65	10		121	12	
	10/25				164	10							
	10/31							54	5				
	12/11							56	1				
	12/13				114	0.5							
	12/17							69	3				
1980	01/15										365	5	
	02/05				275	3		84	3				
	02/14							70	1				
	03/24				361	7							
	04/17							89	10				
	05/12				915	9							
	05/15										412	14	
	05/16							174	13.5				
	06/02							179	15				
	06/24							100	20				
	07/13							55	21.5				
	07/14				110	19.5							
	07/17							34	20		191	8.5	
	08/12							47	15.5				
	09/12							87	14		141	15	
	09/18							75	14.5				
	09/22				134	15							
	10/22							81	7	8.2			
	11/05				248	8.5							
	11/06							79	8.5		144	9	
	11/12				255	7.5							
	12/11							71	2	11.5			
1981	01/06				272	3.5							
	01/08							76	2.5		131	3.5	
	02/05							84	0	11.6			
	02/23				315	3							
	02/24										143	9.5	
	02/25							116	4.5				
	04/14							59	7		139	11.5	
	04/15							59	7	11			
	04/16				254	13							
	05/07							46	6.5	8.9			
	05/18							61	10.5		203	12	
	05/20				347	14							
	06/18							70	16	9			
	07/06							35	18		209	23.5	
	07/08				51	24							
	07/12							39	18	8.1			
	08/18							42	18	7.8			
	08/19										149	20	
	08/21				35	19							
	09/21							63	11.5		88	15.5	
	09/24				50	14.5							
	09/29							61		8			
1988	10/28	349	12.5										
	11/30	491	7.5										
1989	01/09	466	6.5										
	02/10	469	2										
	03/21	494	8										
	05/02	360	11.5										
	06/14	213	16										
	07/13	110	15	8.4									
	07/25	207	16.5										
	08/14	268	15	7.5									
	09/11	369	13										
	09/18	354	15	8.7									
	11/20	480	9	8.3									
1990	01/25	468	6	8.9									
	03/15	508	8	8.2									
	05/16	239	11.5	8.3									
	07/24	194	14	6.1									
	09/13	250	13	7.2									
	11/14							64	7	9.4			
	11/15				172	5	10.3						
1991	01/15							65	2	11.8			
	01/21				182	0	13.5						
	03/14							74	6	11.2			
	05/15				265	7	10.2						
	05/16				471	13	8.9						
	05/17							91	15	8.4			
	07/08							47	21	9.1			
	07/09				62	23	8						
	09/17							66	15	16.6			
	09/18				85	15	9.8						
	11/21	448	7	10									

Table 25. Continued.

Year	Date (mm/dd)	Tyler Discharge (cfs)	Tyler Temperature (C)	Tyler Dissolved oxygen (mg/l)	Pogalitto Discharge (cfs)	Pogalitto Temperature (C)	Pogalitto Dissolved oxygen (mg/l)	Lilagh Discharge (cfs)	Lilagh Temperature (C)	Lilagh Dissolved oxygen (mg/l)	Tyrex Discharge (cfs)	Tyrex Temperature (C)	Tyrex Dissolved oxygen (mg/l)
1992	01/15	452	6	11.5									
	03/16	470	11	9.2									
	05/14	105	15	10.2									
	07/27	182	15.5	11.2									
	09/28	239	14.5	9.4									
	11/18				159	5.5	10.8	45	5	9.8			
	11/19												
1993	01/13				151	0	12.6	55	0.5	10			
	04/14							148	2	9.1			
	03/17				334	10.5	10.2				149	10	9.1
	03/18										164	9.5	10.5
	04/13										276	15.5	8.8
	04/27												
	05/11							139	17	8.4	352	17	8.1
	05/24				739	15	8.6				334	11	10.8
	05/25										196	16.5	8.2
	06/08										234	24	8.4
	06/22												
	07/15				51	22	13.1						
	07/19							42	18.5	11.8	190	19	8.1
	07/20										125	12	9.8
	08/10												
	09/14				120	13.5	12.1						
	09/22							58	14	11.4	99	10	10.5
	09/23										100	5	11.4
	10/19												
	11/16										103	4	11.7
	11/23	480	6	10							110	5.5	10.5
	12/14												
1994	01/11										106	4	10.8
	01/18	473	7	10.7							132	9.5	10
	02/11												
	03/21										131	11	9.3
	03/23	534	7.5	9.6							215	16.5	8.5
	04/12												
	05/10										172	17	8.7
	05/17	251	12.5	7.5									
	05/26										156	22	11
	05/27	134	14	7.6							166	19	9.1
	06/20												
	06/27										122	23	9.2
	07/12	96	13	7.9							82	22	8.7
	07/19										75	15	8.9
	08/16												
	09/15										57	12	6.4
	09/20	265	12.5	8							78	9	11.1
	10/07												
	11/08							35	0.5	10.3			
	11/23				195	0	12.8				98	6.5	12.
	11/28										122	5	10.
	12/13				247	3	11.2	75	2	10.1	128	8.5	10.
1995	01/18										152	9	10.
	02/22												
	03/20							115	4.5	10.9			
	03/23				437	6	11.7				156	10	9.
	03/24										231	12	8.
	04/19												
	05/11				433	13.5	8.3	92	12.5	7.4	190	17	9.
	05/17										370	11.5	1
	05/31										191	17.5	9.
	06/08												
	07/06				38	22.5	7.7	42	16.5	7.8			
	07/13				109	14.5	10	66	13.5	7.3			
	09/20							107	9.5	11.7			
1996	04/23				588	9.5	11.1				310	10	1
	04/24				1110	10.5	8						
	05/21										686	12.5	1
	05/22							160	10	8.6			
	05/23							71	17.5	12			
	06/18										228	15	1
	06/19												
	06/20				324	15	7.9	68	19	8.5	219	18	
	07/16												
	07/17				109	21	9.7	45	17	10.2	158	15.5	
	08/20												
	08/21				68	18.5	11.7						
	09/17				220	11.5	9.1	93	10.5	8.5	94	11.5	
	09/18												

Table 26. Results of monitoring Mink Creek at the Forest Service boundary and the Portneuf Road bridge, November 1997 to August 1998.

Parameter	November		February		April		August	
	Bridge	Boundary	Bridge	Boundary	Bridge	Boundary	Bridge	Boundary
Temperature (C)	6.2	6.4	4.3	4.2	8.4	7.2	14.8	14.7
pH	8.3	8.3	8.28	7.75	8.17	7.99	8.5	8.06
Dissolved oxygen (mg/l)	9.5	10.4	10.3	10.2	6.8	7.2	*	*
Conductivity (uS/cm)	510	480	520	490	320	300	510	480
Total suspended solids (mg/l)	6	3	12	13	136	107	5	6
Turbidity (NTU)	0.68	0.71	2.6	2.9	17.1	15	<1.0**	<1.0**
Total ammonia (mg/l)	< 1.0***	< 1.0***	0.7	1	1	< 1.0***	< 1.0***	< 1.0***
Total nitrate (mg/l)	0.4	0.2	0.7	0.3	0.5	0.4	0.3	0.2
Total phosphorus (mg/l)	< 2.0^	< 2.0^	<0.05^	<0.05^	0.19	0.24	<0.05^	0.07
Orthophosphate (mg/l)	ND^^	ND	ND	ND	ND	ND	ND	ND
Total sulphate (mg/l)	31	28	24	24	ND	ND	14	13
Total alkalinity (mg/l)	210	220	214	202	149	291	221	224
Hardness	271	275	275	268	203	203	274	280
Fecal coliform (colonies/100 ml)	9	5	29	27	24	1	100	90
Flow	9.47	8.83	9.4	8.14	59.89	53.82	11.77	9.84
Total metals (ppm)								
Arsenic	ND	ND	ND	ND	0.03	0.02	ND	ND
Cadmium	ND	ND	ND	ND	ND	0.001	ND	ND
Calcium	77	77	77	76	60	60	80	79
Chromium	ND	ND	ND	ND	ND	ND	ND	0.01
Copper	0.04	0.05	0.06	0.07	0.05	0.07	0.03	0.06
Iron	0.07	0.07	0.13	0.13	0.92	0.8	0.1	0.1
Lead	0.01	ND	0.19	0.18	0.01	0.02	ND	ND
Magnesium	19	20	20	19	13	13	18	20
Manganese	ND	ND	ND	0.01	0.1	0.09	0.01	0.01
Nickel	ND	ND	0.19	ND	0.01	0.01	0.01	0.01
Silver	0.01	0.02	ND	ND	ND	ND	ND	ND
Sodium	18	21	21	18	16	17	15	18
Zinc	0.01	0.01	ND	0.02	0.06	0.06	0.01	0.01

*instrument problems, no measurement
**detection level 0.1 NTU
***detection level 0.05 mg/l total ammonia
^detection level 0.05 mg/l total phosphorus
^^ND=non detect

conditions for dissolved oxygen to be a concern. It appears that changing the operation of the reservoir may have improved dissolved oxygen conditions.

Many conditions, alone or in conjunction with other factors, can result in low dissolved oxygen within the flowing reaches of the Portneuf River subbasin. In addition to abundant aquatic vegetation, these conditions include flow alteration (Minshall and Andrews 1973) and stormwater runoff (Brock 1989). Flow alteration can result in increased stream temperatures. Saturation levels of dissolved oxygen decrease as temperature increases. Stormwater runoff ca input organic material or chemicals into the stream which have an "oxygen demand" which low the oxygen level in the receiving water.

Data Gaps

The extant data on dissolved oxygen in Hawkins Reservoir is limited to instantaneous measurements. No information is available on a periodic daily, or diurnal, basis especially duri late summer - a time when low dissolved oxygen levels are most likely to occur. Information o nutrient loading into the reservoir is also sparse.

Oil and Grease

Summary Analysis

Oil and grease have been identified as pollutants for that segment (Johnny Creek to Interstate 86) of the Portneuf River which flows through Pocatello (Table 19). The Southeast Idaho Council of Governments in their study of water quality in Bannock and Caribou countie recognized oil as a major contaminant in municipal stormwater runoff directly discharged into Portneuf River (Hancock and Bybee 1978). Oil and grease are petroleum hydrocarbons whicl affect aquatic life through asphyxiation of fish through coating of gill surface or macroinvertebrates when floating masses of oil and grease coat surface debris which settles o bottom of the waterbody (EPA 1986). High levels of oil and grease can also cause fish kills f biochemical oxygen demand.

Little information on oil and grease in the Portneuf River was found. Perry et al. (197 sampled for oil and grease in the lower Portneuf River (upstream limit was Portneuf River-M Creek confluence), and although no data was presented, there was no discussion as to oil and grease being a problem in the Portneuf River. Limited monitoring of Pocatello stormwater d was conducted in 1979 (Division of Environment 1980) and in 1994 (Candy Roas, City of Pocatello, personal communication); however, in neither case was sampling or analysis done specifically test for oil and grease.

Pollutant Sources

Oil and grease are commonly found in urban/suburban runoff (Horner et al. 1994) su stormwater drains. Agricultural runoff can also be a source of petroleum hydrocarbons (Ma

1997) which are used as pesticides, herbicides, parasiticides, or carriers for other agriculture-related chemicals (Farm Chemicals Handbook 1995).

Data Gaps

More data on the amount of oil and grease input and resultant effect on water quality in the Portneuf River is needed. Monitoring should include at a minimum the mainstem Portneuf River and stormwater runoff within Pocatello.

Bacteria

Summary Analysis

Bacteria are considered a problem in the Portneuf River mainstem from Chesterfield Reservoir to American Falls Reservoir (Table 19). The major effect of bacteria on beneficial uses is through their influence on human health in primary and secondary contact recreation or domestic water supply. Both fecal coliform and fecal streptococcus can have human health concerns (APHA et al. 1995). Water quality standards in Idaho exist only for fecal coliform (Idaho Department of Health and Welfare nda). Data on bacteria, mostly fecal coliform information, dates back to the 1970s (Appendix C).

Fecal coliform counts have exceeded state water quality standards for primary contact recreation numerous times since 1990. Southeastern District Health Department (unpublished data) monitoring showed exceedances in every year from 1990 to 1994 (Table 27; Figure 7; Appendix C). Exceedances were documented at least once from Lava Hot Springs to below Pocatello during the five-year period. Sampling by DEQ in September of 1991 also confirmed exceedances (downstream of Custer Street) in the Portneuf River within the city of Pocatello but found no exceedances in one day of monitoring the city's groundwater collection system and an actively discharging stormwater drain (DEQ, unpublished data). Most of the water quality exceedances were instantaneous exceedances. Instantaneous fecal coliform counts at USGS surface-water stations exceeded water quality standards in 1995 and 1996 at the Marsh Creek and Pocatello stations (Figure 8; Appendix C). The cause of these exceedances is unknown.

DEQ monitoring in 1998 documented exceedances of the fecal coliform standard for primary contact recreation in Mink Creek and lower Portneuf River, and for secondary contact recreation in Pocatello Creek (Appendix C). Although quarterly monitoring in Mink Creek indicated no instantaneous exceedances, further sampling following the August sample indicated exceedances of the 50 colonies/100 ml geometric mean standard. Samples in both Pocatello Creek and the Portneuf River through Pocatello showed exceedances of the instantaneous standard, the 10% standard, and the geometric mean standard in August and September monitoring.

There are no state water quality standards for fecal streptococci. USGS monitoring documented counts as high as 2,100 colonies/100 ml (Figure 9; Appendix C).

Table 27. Exceedances of fecal coliform standards for primary contact recreation in the Portneuf River subbasin (from Southeastern District Health Department, unpublished data).

	Number and location of exceedances				
Criteria (colonies/100 ml)	1990	1991	1992	1993	1994
> 500 (instantaneous)	1 - LHS*	20 - Poky**	2 - Poky	4 - Poky 1 - LHS to M***	1 - Poky
> 200 in > 10% of samples over 30-day period	1 - LHS	4 - Poky 1 - I to RP^ 1 - McCammon	1 - Poky	2 - Poky 1 - LHS to M	1 - Poky 1 - LHS to M
> 50 (geometric mean) from minimum of 5 samples over 30-day period	1 - LHS	4 - Poky 2 - I to RP 1 - LHS	2 - Poky	1 - LHS to M	

*near Lava Hot Springs
**through and below Pocatello
***near Lava Hot Springs to McCammon
^Inkom to Rainey Park

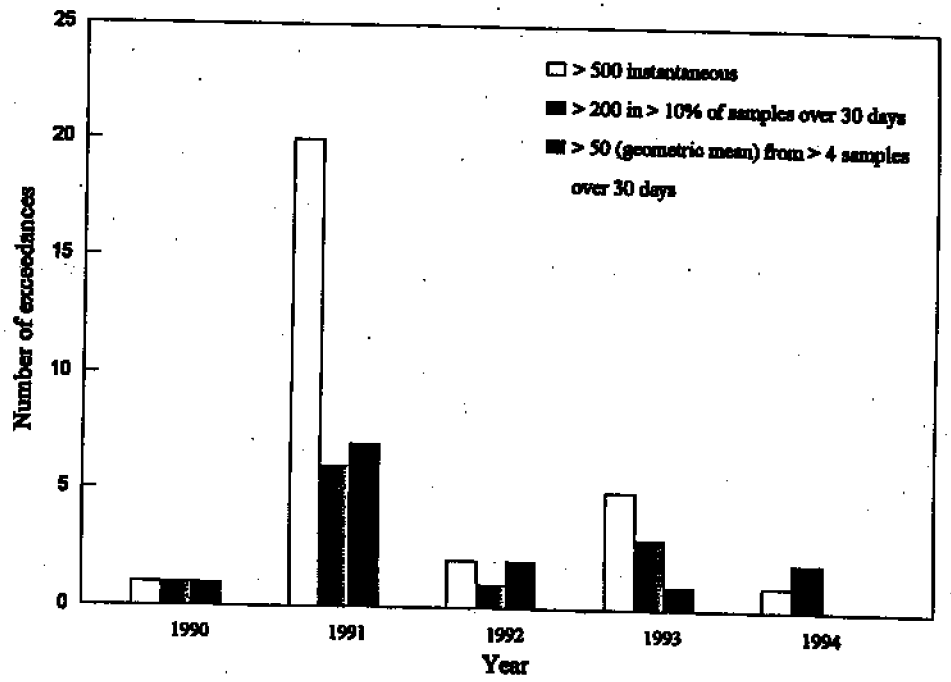
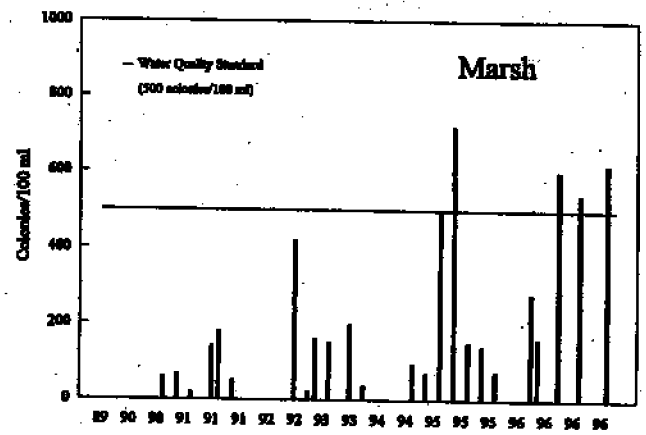
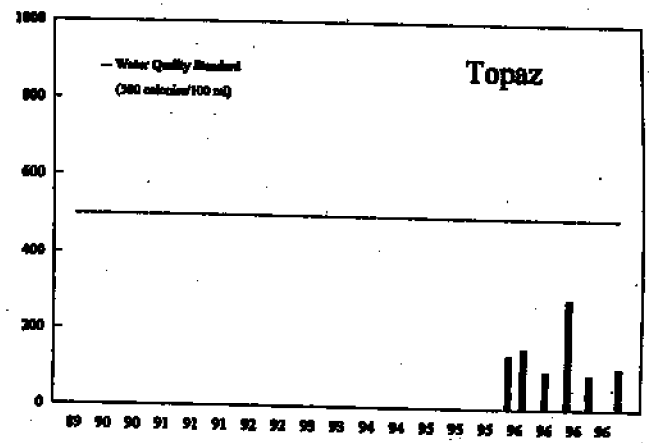
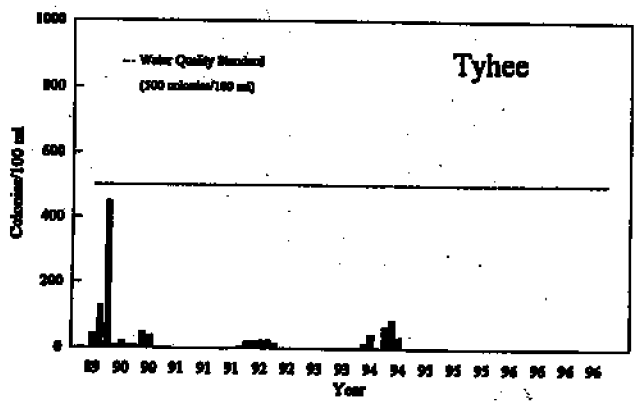
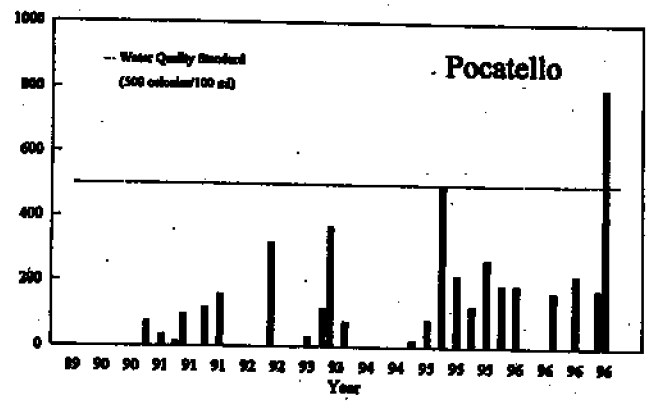


Figure 7. Exceedances of fecal coliform standards for primary contact recreation in the Portneuf River subbasin, 1990-1994 (from Southeastern District Health Department, unpublished data).


Marsh
Water Quality Standard
(500 colonies/100 ml)
Colonies/100 ml
0
200
400
600
800
1000
89 90 90 91 91 91 92 92 93 93 94 94 95 95 95 96 96 96 96


Topaz
Water Quality Standard
(500 colonies/100 ml)
0
200
400
600
800
1000
89 90 90 91 91 91 92 92 93 93 94 94 95 95 95 96 96 96 96


Tyhee
Water Quality Standard
(500 colonies/100 ml)
Colonies/100 ml
0
200
400
600
800
1000
89 90 90 91 91 91 92 92 93 93 94 94 95 95 95 96 96 96 96
Year


Pocatello
Water Quality Standard
(500 colonies/100 ml)
0
200
400
600
800
1000
89 90 90 91 91 91 92 92 93 93 94 94 95 95 95 96 96 96 96
Year

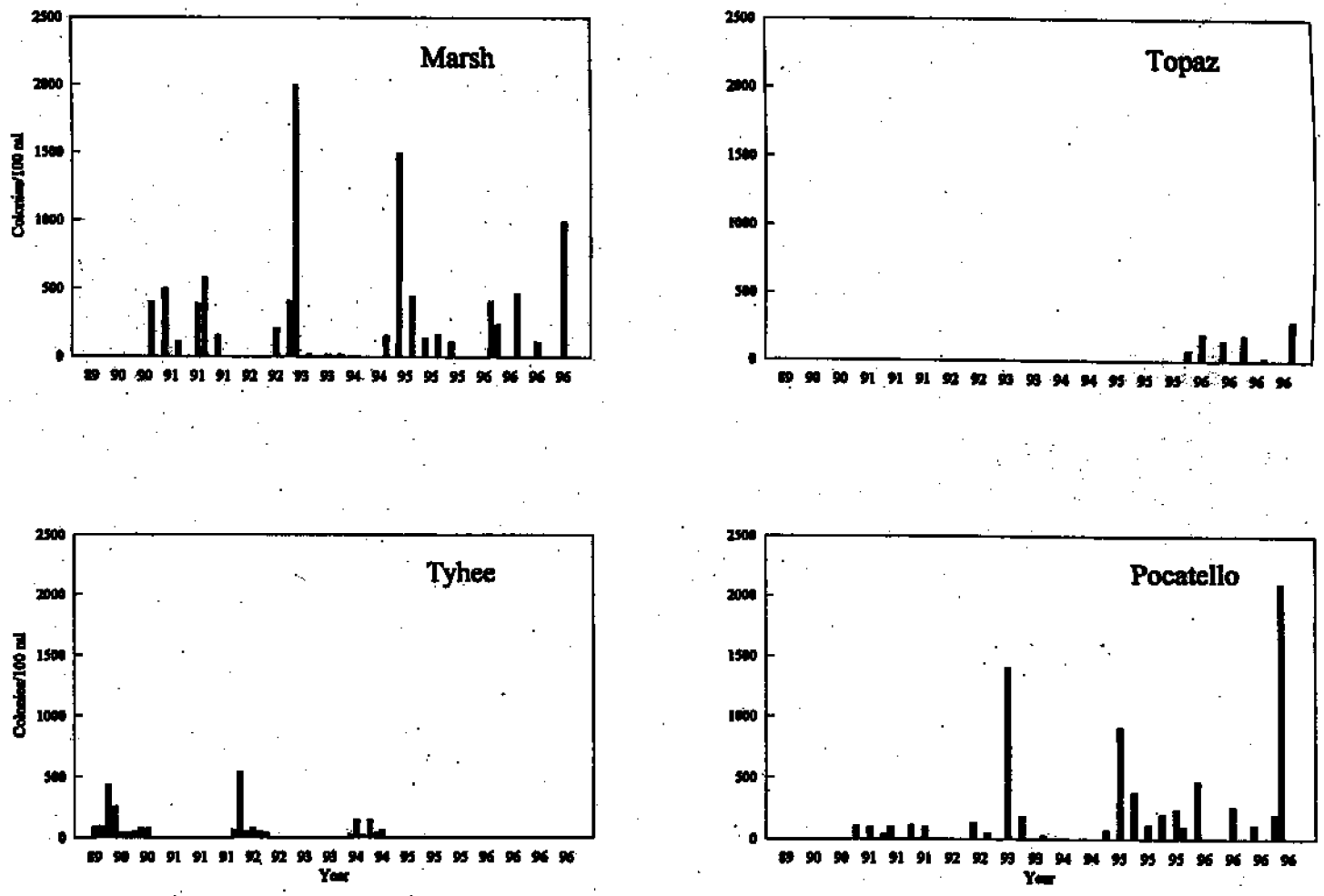


Figure 9. Fecal streptococci monitoring at USGS surface-water stations, 1989-1996.

Pollutant Sources

Several reports have identified sources of bacteria input into the Portneuf River. Hancoc and Bybee (1978) noted that fecal coliform was a major contaminant in Pocatello's stormwater runoff into the Portneuf River. Livestock has also been recognized as a source of bacteria (Hoover 1985; Drewes 1987; Caribou Soil Conservation District 1991; Soil Conservation Servi 1993). Marsh Creek has also been a source of bacteria into the Portneuf River (Perry et al. 197 McSorley 1977; Frenzel and Jones 1985). Levels of bacteria exceeding state water quality standards were documented by Hoover (1985) in the mainstem Portneuf River below the Down Canal, Twentyfourmile Creek, Eighteenmile Creek, Toponce Creek. Hoover attributed all the bacterial pollution to livestock and waterfowl. Drewes (1987) found high levels of fecal colifor in Pocatello, Rapid, Jackson, and Indian creeks as well as runoff from several canyons (Appendi C) - all sources which could still be contributing bacteria to the Portneuf River. Sampling by DEQ in 1998 indicated that Mink Creek and, especially, Pocatello Creek contributed to the bacterial load in the Portneuf River (Appendix C).

Data Gaps

Information on fecal coliform input into the Portneuf River is more prevalent than information on fecal streptococci. Existing fecal streptococci data did not separate the enterococcus group, a more specific indicator of fecal contamination. Separation of the enterococcus group in future monitoring would provide an additional tool in evaluating fecal bacterial impacts.

Although substantial information does exist on bacteria loading in the Portneuf River, there is little data which points to input sources, a common "problem" in non-point source pollution. A sampling strategy which would help identify sources of bacterial contamination would be beneficial.

Sediment

Summary Analysis

Sediment is a significant problem in the Portneuf River. Suspended sediment and associated pollutants cause the major water quality problems in the Portneuf River and its tributaries (Ozburn and Modersitzki 1986). Mohr (1968) commented that the Portneuf River below Pocatello "is usually turbid year round."

Both tributaries and the mainstem are sources of sediment in the upper Portneuf River Heimer and Ratzlaff (1987) contended that overland and streambank erosion were significant sources of silt into the Portneuf River. They looked at channel stability of sections of the upp Portneuf River (including the channelized section known locally as the Downey Canal), Topo Creek, and Twentyfourmile Creek. All the sections, except one, were rated as poor or fair (T 28). In the same area, the Forest Service (Caribou National Forest 1985) estimated that sedir

Table 28. Channel stability evaluation of sections of the upper Portneuf River, Toponce Creek, and Twentyfourmile Creek (from Heimer and Ratzlaff 1987).

Waterbody	Section	Reach*	Reach length (miles)	Channel stability rating
Portneuf	Pebble Creek to Chesterfield Reservoir	11	2.14	fair-
		10	1.57	fair-
		9	0.86	fair
		8**	1.86	poor-
		7**	1.71	poor-
		6**	1.57	poor+
		5**	0.71	poor+
		4**	0.29	poor-
		3**	0.57	poor+
		2**	0.43	poor+
		1**	0.57	fair
Portneuf	Big Jimmy Creek to Chesterfield Reservoir	16	2.00	poor-
		15	1.71	fair+
		14	1.00	fair
		13	0.43	poor+
		12	2.00	good
Twentyfourmile	mouth to Twentyfourmile Reservoir	7	1.14	fair-
		6	1.00	fair
		5	1.57	fair-
		4	1.00	poor+
		3	1.00	poor+
		2	0.57	poor+
		1	0.43	fair
Toponce	Forest Service boundary mouth	5	0.86	poor+
		4	0.86	fair
		3	1.00	poor
		2	0.71	fair
		1	1.00	fair-

*reaches listed downstream to upstream
**reaches within the channelized section of the Portneuf River (i.e., Downey Canal)

delivery in Toponce and Pebble Creek tributaries was 23 tons/year (0.002 tons/acre/year) and 20 tons/year (0.002 tons/acre/year), respectively. Hoover (1985) in his study of the upper Portneuf River watershed reported that Twentyfourmile Creek contributed the most sediment of any tributary by a factor of two. In two of the three tributaries that he monitored (Eighteenmile, and Toponce creeks), sediment yield doubled between upstream and downstream sites. Month of highest transport was in April with the greatest discharge of sediment at 378 tons/day measured in the mainstem Portneuf River just below the Downey Canal.

Sediment can degrade streams through deposition on streambed surfaces. Mende (1989) found depth fines (percentage of substrate by volume < 6.3 mm) at five sites in the upper Portneuf River to range from 32.9% to 82.2% with a median of 41.3%. Scully et al. (1993) examined the physical habitat of two mainstem Portneuf River sites in 1991. Both sites (upper site - between Pebble Creek and the downstream end of the Downey Canal; lower site - just downstream of Pebble Creek) had high levels of fines in the substrate composition and runs/pools were predominant. Maret and Ott (1997) sampled streambed sediment at both Pocatello (1992) and Topaz (1992-1994) surface-water stations. All samples were comprised of particles < 2 mm (i.e., sand, silt, or clay). Royer and Minshall (1997) observed a mean embeddedness level of 88% (SD=25%) at one mainstem Portneuf River site between Lava Hot Springs and Pebble Creek.

The Caribou National Forest estimated erosion for all the watersheds on the forest (Caribou National Forest 1985). Marsh Creek had the highest erosion rate on the forest. Rates on the upper and lower Portneuf were only slightly lower (Table 29).

The primary sources of sediment in Marsh Creek are tributaries streams on the west bench. Merrell and Onstott (1965) observed that the area west of Marsh Creek between Garden Creek and Marsh Creek's confluence with the Portneuf River has eroded much more severely than any other part of the Portneuf River subbasin (Table 30). McSorley (1977) estimated that during the 15-day runoff period in 1976 over 92,000 tons of total solids, which includes suspended sediment, were carried into Marsh Creek by the 19 west bench streams. As only 9,000 tons were estimated to have been carried into the Portneuf River during the runoff period, 83,000 remained in the Marsh Creek stream channel and floodplain. Walker, Bell Marsh, Garden, Hawkins, and Cherry creeks all showed high turbidity and calculated total suspended solids (TSS) values during the 1976 spring runoff period although most of the sediment input came from smaller streams (Table 31). During the remainder of the year, Marsh Creek contributed another 75,000 tons of sediment to the Portneuf River, much of which could have been the sediment previously deposited during the runoff period.

In addition to Marsh Creek, three other creeks - Rapid, Dempsey, and Pocatello -are also significant contributors of sediment to the Portneuf River (Drewes 1987). Monitoring data from November 1985 to July 1986 indicated that the three creeks contributed on the average 41.0, 31.3, and 10.0 tons/day of suspended sediment, respectively (Table 32; Appendix D). North Fork and South Fork Pocatello Creek had the highest average suspended sediment concentrations over the sampling period at 266 and 249 mg/l, respectively. The highest instantaneous concentration of suspended sediment was 1,690 mg/l in South Fork Pocatello Creek on 18 November 1985.

Table 29. Sediment input into the Portneuf River subbasin.

Location	Date	Site	Tons/acre/year	Tons/day	Tons/year	Inherent* tons/year	Source
Bell Marsh Creek	May 82	Lower		0.95			Geoff Hogander, BLM, personal communication
	May 82	Upper		0.75			
	Sept 82	Lower		0.14			
	Sept 82	Upper		0.04			
Upper Portneuf East (Toponce, Pebble)			0.006		298	284	Caribou National Forest 1985
Upper Portneuf West (Inman, Webb)			0.008		207	204	Caribou National Forest 1985
Marsh Creek (Walker, Bell Marsh, Cherry, Mill Canyon)			0.01		502	495	Caribou National Forest 1985
Lower Portneuf (Mink, Gibson Jack)			0.009		421**	410	Caribou National Forest 1985
Upper Portneuf River watershed (upstream of Portneuf-Marsh Valley Canal)			17***				Osburn and Modesitzki 1986
Upper Portneuf River (upstream of Lava Hot Springs)		Uplands			1,298,000		Soil Conservation Service 1993
		Streambanks			4,176		
		Canals/ditches			171		
		Portneuf River			180		
		Downey Canal			2,410		
		Twentyfourmile Creek			714		
		Eighteenmile Creek			70		
		King Creek			20		
		Toponce Creek			48		
		Pebble Creek			563		

*natural
**includes Project Work Inventory Watershed 21 - Rattlesnake
***represents soil loss, not necessarily soil delivery to stream

Table 30. Estimated erosion and sedimentation from agricultural land in Portneuf River subbasin (from Merrell and Onstott 1965).

Watershed	Tons/year	Acre feet/ year	Delivery rate (%)	Tons/yr delivered	Delivery point
Pocatello	210,500	138	25	52,625	Canals and residential areas
Lower Portneuf	759,000	498	40	303,600	Portneuf River
Upper Portneuf	110,000	72	10	11,000	Chesterfield Reservoir
Portneuf-Marsh Valley	1,292,000	848	55	710,600	Portneuf River and irrigation canals
Bancroft	554,500	364	5	27,725	Town of Bancroft
McCammon	334,000	219	50	167,000	Portneuf River
Marsh Creek	2,330,000	1,530	60	1,398,000	Canals, farmlands, roads, and Marsh Creek bottom
Total	5,590,000	3,669		2,670,550	

Table 31. Annual mean, standard deviation (SD) and range of turbidity and Total Suspended Solids (TSS) in Portneuf River and Marsh Creek, 1976 (from McSorley 1977).

Waterbody	Site	Turbidity (JTU)			TSS (mg/l)		
		Mean	SD	Range	Mean	SD	Range
Portneuf	Below Marsh Creek	33.2	30.7	7.2-100	144.0	84.0	54-365
	Above Marsh Creek	25.0	34.0	2.0-100	117.0	81.0	32-365
	Near Robbers Roost Creek	19.6	29.6	2.1-97	97.0	99.0	31-355
	Below McCammon	25.0	42.0	2.3-140	114.0	141.0	36-500
	Below Lava Hot Springs	18.0	25.0	2.1-85	90.8	84.0	32-316
	Above Lava Hot Springs	17.3	19.9	1.7-65	87.2	70.0	20-249
	Near downstream end of Downey Canal	21.1	19.7	3.3-53	102.0	68.0	35-210
Marsh	Mouth	51.3	34.2	23-110			
	Above Bell Marsh Creek	28.2	17.6	8-66			
	Above Goodenough Creek	31.2	13.65	10-58			
	Above Garden Creek	39.5	39.1	10-150			
	Above Hawkins Creek	68.2	68.61	16-210			
	Above Downey	36.7	51	7-188			
Birch		164.6	421.6	18-1500			

Table 32. Mean suspended sediment and sediment loading from cropland in subwatersheds in the lower Portneuf River subbasin, November 1985 to July 1986 (from Drewes 1987).

Subwatershed	Suspended sediment (mg/l)	Sediment (tons/day)	Sediment (tons/acre)	Acres of cropland	Total for period* (tons)
North Fork Pocatello Creek	266	10.0	1.09	2,125	2,316
South Fork Pocatello Creek	249	0.7	5.00	31	155
Sorrell Canyon	131	0.5	0.23	403	93
Indian Creek	112	0.9	0.28	921	258
Rapid Creek	101	41.0	0.77	12,273	9,450
Jackson Creek	110	1.6	0.68	549	373
Dempsey Creek	123	31.3	6.00	1,211	7,266

*sampling period 232 days

Highest loss of sediment from cropland was in Dempsey Creek at 6 tons/acre and South Fork Pocatello Creek at 5 tons/acre.

Quarterly monitoring in Mink Creek showed higher levels of total suspended solids during spring runoff as compared to other times of the year. TSS exceeded 100 mg/l in April compared to less than 15 mg/l in November, February, or August (Table 26).

Pollutant Sources

Sources of sediment input into streams in the Portneuf River subbasin include cropland and streambank erosion (Hoover 1985; Ozburn and Modersitzki 1986; Soil Conservation Service 1993) and municipal stormwater runoff (Hancock and Bybee 1978). About 80% of the dry cropland in the lower Portneuf River subbasin (downstream of Lava Hot Springs) has slopes over 12% with erosion rates at four times the maximum soil loss rate recommended for these soils (McNabb 1987). The predominant dryland crop rotation of grain/fallow which leaves the surface exposed during the fallow year can result in excessive erosion rates, especially on slopes greater than 20% (Portneuf Soil and Water Conservation District 1996). Erosion is also a problem in irrigated land with slopes that meet or exceed 4%. Sediment input from croplands has been monitored at least since the 1960s when Merrell and Onstott (1965) reported that sediment production in the Portneuf River subbasin is primarily from sloping, non-irrigated cropland. Roberts (1977) stated that non-irrigated cropland is the largest single contributor of sediment to waters in Bannock and Caribou counties adding 76% and 65%, respectively. The Soil Conservation Service (1979) estimated that of the 75,800 acres in dry cropland in Bannock County at that time, 67,200 acres (89%) exceeded the tolerable soil loss. In the Portneuf River subbasin above Topaz (between McCammon and Lava Hot Springs), essentially all of the cropland (about 33% of the area) has been identified as critical areas for sources of agricultural nonpoint source pollution (Portneuf Soil and Water Conservation District and Caribou Soil Conservation District 1988). Grazing activities also contribute to sediment problems in the Portneuf River subbasin (BLM 1980; Hoover 1985; Portneuf Soil and Water Conservation District and Caribou Soil Conservation District 1988; Soil Conservation Service 1993).

Other sources of sediment include occurrences of severe and rapid erosion on tributaries and draining of Chesterfield Reservoir, which acts as a sediment trap for all waters draining into it (Portneuf Soil and Water Conservation District and Caribou Soil Conservation District 1988). Rapid erosion events occurred in the Downey Canal in 1984 and in Twentyfourmile Creek in 1985 (Scully et al. 1993). Draining of Chesterfield Reservoir and subsequent input of sediment into the Portneuf River took place in 1986 and 1992.

Roads can often be a source of sediment into streams. The Caribou National Forest, including areas of the forest outside the Portneuf River subbasin, has an estimated average road density of 1.07 miles of road/mi^2 (Randy Tate, Caribou National Forest, personal communication). However, this value includes all roads. If only roads classified as open roads are considered, there are 0.76 miles of road/mi^2.

Sediment produced in one subbasin can affect downstream subbasins. For example significant quantities of total solids are exported from Marsh Creek to the lower Portneuf R (Perry et al. 1977). In turn, sediment produced in the Portneuf River subbasin eventually m into American Falls Reservoir. Bechtel Environmental (1996) estimated that the Portneuf R contributes less than 10% of the sediment load into the reservoir.

Control of sediment input into streams will also control other contaminants. Nutrien such as nitrogen and phosphate, and bacteria (Roberts 1977) as well as metals and pesticides (Terrene Institute 1994) from nonpoint sources often reach the stream attached to soil partic

Data Gaps

Much information is available on sedimentation in the Portneuf River subbasin for both mainstem Portneuf River and tributaries. Most of the data, however, is more than 10 years old Current information is available from USGS but is limited to surface-water stations (i.e., Portn River at Pocatello and Topaz and Marsh Creek). The lack of recent data, for example, the last five years, does not account for changes (e.g., implementation of agricultural best management practices) which have reduced nonpoint source pollution since the last round of monitoring. Roberts (1977) reported that sediment yields from non-irrigated cropland, irrigated cropland, an rangeland and woodland in Bannock and Caribou counties were annually being reduced by 1.7% 3.7%, and 2.1%, respectively. Such reductions, if seen year after year, would, after 20 years (i.e 1997), have a substantial impact on the reduction of sediment into the Portneuf River and tributaries.

Nutrients

Summary Analysis

Nutrients affect beneficial uses directly (e.g., un-ionized ammonia can be toxic to fish) and indirectly (e.g., high concentrations of nitrogen and phosphorus, especially phosphate, can result in excessive aquatic growth). Nitrogen in the form of un-ionized ammonia can also be toxic to fish and other aquatic life. Brock (1989) documented an exceedance of state water quality standards for un-ionized ammonia in the Portneuf River below the Pocatello Sewage Treatment Plant's effluent discharge outfall. Excessive plant growth can lead to eutrophication which in turn affects drinking water, aquatic life, recreation, and aesthetics. During his 1988 and 1989 sampling of the lower Portneuf River, Brock (1989) observed fluctuations in dissolved oxygen levels over a 24-hour period. During the day when photosynthetic activity was high, dissolved oxygen levels were well above the state water quality standard of 6.0 mg/l for cold water biota. At night, however, when plants respire, dissolved oxygen levels in 1989 dropped below the 6.0 mg/l standard. Although, there are numerous factors which affect the concentration of oxygen in the lower Portneuf River, aquatic vegetation plays an important role. Campbell et al. (1992) concluded that high concentrations of phosphate in the Portneuf River have resulted in marked eutrophication in slow moving parts of the river and American Falls Reservoir.

Minshall and Andrews (1973) examined nutrient levels in the Portneuf River from Chesterfield Reservoir to below Pocatello. Nitrate values were highest during the winter, became reduced during the period of spring runoff, and declined progressively during the summer. Phosphate concentrations showed less of a seasonal trend but generally increased gradually from September through March and then declined during the growing season. Both nutrients, although phosphate to a lesser extent, followed the same general pattern of a downstream increase in concentrations. At certain times of the year (e.g., fall), nitrate appears to be the limiting factor for growth of aquatic vegetation as opposed to phosphate or carbon dioxide.

McSorley (1977) monitored nutrients in Marsh Creek. He found that total phosphorus and nitrates increased during the runoff period in 1976 to a greater extent than ortho phosphate or total Kjeldahl nitrogen (sum of organic nitrogen and ammonia nitrogen). He also noted that nitrates and ammonia decreased considerably between 1969 and 1975, most likely a result of the implementation of better farming practices in the area.

In the upper Portneuf River subbasin (upstream of Lava Hot Springs), the primary period of nutrient loss occurs during periods of increased overland runoff and snowmelt (Hoover 1985). The flow weighted average pounds per day of nitrate and phosphorus loss for the upper Portneuf River subbasin were 517 and 46 pounds/day, respectively, in 1985 (Table 33).

Watersheds in the lower Portneuf River monitored from November 1985 to July 1986 showed high levels of nutrient contributions into the Portneuf River (Drewes 1987). Phosphorus levels exceeded 0.1 mg/l of total phosphorus and 0.05 mg/l of ortho phosphate consistently throughout the sampling period. Drewes concluded that nitrogen compounds from these streams are not only a major pollutant in the creek of origin, but could also, under high flow conditions, such as summer thunderstorms, have a great impact on the Portneuf River and American Falls Reservoir.

Campbell et al. (1992) compared concentrations of ortho phosphate in the Portneuf River between 1972 and 1990-1991 and, generally, overall levels of ortho phosphate had not changed (Table 34). Levels of ortho phosphate in the Portneuf River increased as the river flowed through Pocatello. The authors suggested that an increase in ortho phosphate concentrations at the furthest downstream site (Siphon Bridge) is indicative of a new source of ortho phosphate in the reach such as the Pocatello Sewage Treatment Plant, Batise Springs, or phosphate-saturated bottom sediments. They concluded that the section of the Portneuf River at Siphon Road is experiencing significant eutrophication.

Monitoring in Mink Creek showed relatively consistent levels of total nitrate throughout the monitoring period while total phosphorus increased substantially during spring runoff (Table 26). Total nitrate levels ranged from 0.2 to 0.7 mg/l for the November 1997 to August 1998 period. Total phosphorus increased from less than 0.05 to 0.07 mg/l in February and August 1998 to about 0.2 mg/l in April of 1998 (November 1997 was ignored as the procedure was unable to detect levels less than 2.0 mg/l).

Table 33. Flow-weighted average pounds/day for nutrients by yearly average flow in the upper Portneuf River subbasin, March to October 1985 (from Hoover 1985).

Station	Nutrients in pound/day			
	Nitrate	Total Kjeldahl nitrogen	Total phosphorus	Ortho-phosphate
Portneuf River below Downey Canal	517.00	336.0	46.00	16.00
Downey Canal between Toponce Creek & downstream end	82.00	327.0	44.00	12.00
Downey Canal below Chesterfield Reservoir	54.00	365.0	42.00	11.00
Eighteenmile Creek - lower site	19.00	18.0	3.00	0.38
Eighteenmile Creek - upper site	3.00	3.0	0.30	0.05
Twentyfourmile Creek - lower site	16.60	23.4	7.20	0.50
Twentyfourmile Creek - middle site	6.50	16.0	6.50	0.99
Twentyfourmile Creek - upper site	0.42	1.5	0.19	0.01
Toponce Creek - lower site	6.50	25.0	3.70	0.80
Toponce Creek - upper site	9.30	20.5	2.80	0.81

Table 34. Ortho phosphate (mg/l) monitoring in the Portneuf River, 1972 and 1991 (from Campbell et al. 1992).

Site	1972*		1990-1991**	
	Mean	Standard deviation	Mean	Standard deviation
Siphon Bridge	0.91	0.48	2.88	3.83
near Pocatello STP***			4.43	5.10
Batise Bridge West	1.50	2.40	1.07	1.23
Batise Bridge Middle			0.92	1.11
Batise Bridge East			0.61	0.92
Effluent pipe	20.00	34.00	4.43	4.77
Highway 30 Bridge	0.20	0.07	0.62	0.82
Inkom			0.27	0.10
McCammon			0.07	0.04

*sampling was once per week for the entire year
**sampling interval 260 days
***STP=sewage treatment plant

Hawkins Reservoir was sampled for nutrients in 1997 as part of DEQ's Beneficial U Reconnaissance Project. Total Kjeldahl nitrogen measured 0.74 mg/l at a shallow depth site 0.90 mg/l at the deep depth site. At the two sites, total phosphorus was 0.09 mg/l in shallov water and 0.17 mg/l in deeper water. A concentration of total phosphorus of 0.09 mg/l plac Hawkins Reservoir in Carlson's eutrophic range (Brian Hoelscher, Division of Environments Quality, personal communication). However, chlorophyll a levels were low at 2.1 $\mu g/l$ and v clarity was good at 5.5 meters (Secchi depth). Both the chlorophyll level and water clarity a typical of a eutrophic waterbody.

Pollutant Sources

Rupert (1996) recognized several sources of nitrogen in his investigation of the upper Snake River basin. For the entire basin which includes the Portneuf River, 93% of the total nitrogen input was produced by cattle manure, fertilizer, and legume crops. Input of nitrogen similar for cattle manure, fertilizer, legume crops, and precipitation in the southeastern countie the study area (including Bannock and Caribou counties).

Several other sources contribute nutrients to Portneuf River. Sampling of nearby sprin and the mainstem Portneuf River in the Pocatello area in 1992 and 1993 by Bechtel Environmental, Inc. (1996) generally found high levels of nitrates, ortho phosphates, and total phosphorus when compared to upstream sites (Table 35). Perry and Clark (1990) sampled fou spring "systems" in the lower Portneuf River and noted that Batise Spring System is nutrient ri and probably impacted by anthropogenic activity south of the springs. Total phosphorus and ortho phosphate were also found in mainstem river sediments. In addition to springs, Campbell al. (1992) suggested that the Pocatello Sewage Treatment Plant and river bottom soil which had reached its saturation level for phosphates could be sources of ortho phosphates into the Portne River. Die-off of algae in Chesterfield Reservoir (Hoover 1985), and other reservoirs, can also increase nitrogen in downstream sections of the Portneuf River. Stormwater runoff into the Portneuf River can also be a source of nitrogen and phosphorus (Division of Environment 1980)

In 1988 and 1989, Brock (1989) studied the Portneuf River in the vicinity of the Pocatell waste water treatment plant. He found that the plant was generally discharging effluent that had higher concentration (up to 100 times higher) of ammonia than the receiving Portneuf River water. Un-ionized ammonia, which can be toxic to fish, exceeded EPA's water quality standard during some days in August 1989. Macroinvertebrate sampling indicated a community of toxic-tolerant organisms and a reduction in species richness below the plant's effluent (Minshall and Robinson 1989).

Data Gaps

Most nutrient data is for the mainstem Portneuf River with only some information accumulated in the last five years. Some information is available on many of the tributaries but is, for the most part, more than ten years old.

Table 35. Water quality monitoring in the lower Portneuf River, July 1992 to May 1993 (Rosland Environmental, Inc. 1996). Sampling dates are approximate.

Location description*	Site	Nitrate 07/92**	Nitrate 10/92***	Nitrate 02/93^	Nitrate 05/93^^	Ammonia (NH3) 07/92**	Ammonia (NH3) 10/92***	Ammonia (NH3) 02/93^	Ammonia (NH3) 05/93^^	Total phosphorus 07/92**	Total phosphorus 10/92***	Total phosphorus 02/93^	Total phosphorus 05/93^^	Ortho phosphate 07/92**	Ortho phosphate 10/92***	Ortho phosphate 02/93^	Ortho phosphate 05/93^^	TSS^^^ 07/92**	TSS^^^ 02/93^
River Mile 10	1	2.8	2.69	2.07	1.47	1	0.2	0.5	0.5	0.58	0.38	0.43	0.392	0.58	0.48	0.44	0.293	4	4
Eastern Springs	2	1.4	1.58	1.45	1.45	0.2	0.2	0.2	0.5	0.02	0.12	0.05	0.118	0.02	0.03	0.02	0.02	32	10
River at Siphon Road	3	2.7	2.49	2.12	1.25	0.9	0.5	0.9	0.5	0.78	0.42	0.48	0.416	0.62	0.58	0.43	0.302	4	4
Springs at Siphon Road	4	1.3	1.6	1.44	1.25	0.2	0.2	0.2	0.5	0.04	0.02	0.13	0.032	0.03	0.05	0.03	0.02	22	4
River at Fish Farm	5	2.5	2.29	2.67	1.21	0.2	0.3	0.2	0.5	0.04	0.28	0.08	0.461	0.02	0.27	0.08	0.355		4
Pond at Fish Farm	6	2.5	2.15	2.76	1.14	0.2	0.2	0.2	0.5	0.03	0.02	0.05	0.05	0.02	0.02	0.03	0.09	0.4	4
Springs at Fish Farm	7	2.7	3.35	2.97	2.91	0.5	0.2	0.2	0.5	0.02	0.02	0.04	0.02	0.02	0.03	0.02	0.02		4
River at FMC Park	8	1.4	2.66	2.29	1.37	0.2	0.8	1.2	0.7	0.16	0.38	0.53	0.456	0.12	0.59	0.53	0.33	0.4	28
Springs at FMC Park	9	1.6	3.95	2	1.64	0.2	0.2	0.2	0.5	0.02	0.05	0.02	0.061	0.02	0.03	0.03	0.02	0.4	4
River at Batiss Springs discharge	10	1.9	2.3	2.09	1.35	0.2	1.1	1.7	0.7	0.87	0.71	0.7	0.48	0.05	0.73	0.63	0.37	4	6
Batiss Springs at Creamery	11	0.38	2.33	1.62	3.62	0.2	0.2	0.3	0.5	0.03	0.08	0.24	1.57	0.02	0.06	0.19	1.55	4	9
River above STP discharge	12	2.7	2.44	1.9	1.31	0.6	0.2	0.2	6.2	1.2	0.8	0.74	1.45	1.2	0.24	0.7	1.19	5	8
Springs near STP	13	3.93	3.33	2.59	3.87	0.2	0.2	0.2	0.5	0.04	0.07	0.02	0.045	0.03	0.05	0.05	0.045	6	4
Batiss Springs	14	2	2.43	2.33	11	0.2	0.2	0.2	0.5	0.6	0.69	0.81	0.75	0.51	0.76	0.79	7.37	4	4
Springs near Batiss Road	15	2.8	2.37	2.92	2.47	0.5	0.2	0.2	0.5	1.2	1.52	0.9	0.436	1.1	1.36	1.07	0.427	4	4
River at Batiss Road	16	0.93	0.47	1.24	0.65	0.2	0.2	0.2	0.5	0.18	0.1	0.12	0.163	0.14	0.04	0.08	0.03	12	6
River at FMC discharge	17	1.1	1.62	1.47	0.96	0.2	0.2	0.2	0.5	0.92	0.49	0.76	0.481	0.39	0.35	0.42	0.103	6	4
River at old FMC discharge	18		0.31				0.2				0.02				0.02				
River near gypsum stack	19	0.05	0.33	0.95	0.69	0.1	0.2	0.2	0.5	0.05	0.02	0.06	0.218	0.02	0.02	0.03	0.028	14	16
River near gypsum stack	20	0.05	0.16	1.02	0.63	0.2	0.2	0.2	0.5	0.05	0.04	0.07	0.09	0.02	0.02		0.028	30	14
River upstream of gyp stack	21	0.05	0.17		0.66	0.2	0.2		0.5	0.04	0.02		0.271	0.03	0.02		0.032	52	
River Mile 15	22	0.05	0.15	1.15	0.66	0.2	0.2	0.2	0.5	0.04	0.02	0.02	0.123	0.02	0.02	0.03	0.03	19	15
River downstream of RR sites	23	0.05	0.19	0.94	0.65	0.2	0.2	0.2	0.5	0.06	0.02	0.05	0.129	0.09	0.03	0.02	0.032	14	4
River upstream of RR sites	24	0.05	0.21	1.17	0.67	0.3	0.3	0.2	0.5	0.03	0.02	0.2	0.143	0.02	0.02	0.02	0.032	14	10
River upstream of Pocatello	25	0.05	0.2	1.03	0.68	0.2	0.2	0.2	0.5	0.02	0.02	0.03	0.154	0.02	0.02	0.03	0.03	6	12

*STP=sewage treatment plant, RR=railroad
**dates may include 07/28/92, 07/29/92, 07/30/92, 07/31/92, 08/01/92, 08/02/92
***dates may include 10/26/92, 10/27/92, 10/28/92, 11/05/92
^dates may include 02/02/93, 02/03/93, 02/04/93, 02/04/93, 02/06/93, 02/07/93
^^dates may include 04/27/93, 04/28/93, 04/29/93, 04/30/93, 05/01/93
^^^TSS=total suspended solids

Organic Compounds

Summary Analysis

High levels of human-made organic compounds can be deleterious to human health. F example, ingestion of polychlorinated biphenyls (PCB) by humans may have an incremental increase in the risk of developing cancer over a person's lifetime (EPA 1986). PCBs can affec cold water biota beneficial use as they can be toxic to aquatic life (Great Lakes Regional Environmental Information System, internet communication). U. S. production of PCBs cease in 1977 (GE Corporate Environmental Programs, internet communication). The threat to huma health posed by these organic compounds is long term due to their persistence in the environme (Maret & Ott 1997).

Fish, especially bottom-feeders, can be good indicators of contaminants (e.g., organic compounds) in aquatic habitats. USGS sampling of fish in the Portneuf River indicated the presence of human-made organic compounds (Maret and Ott 1997; Brennan et al. 1997). Levels of PCBs exceeding National Academy of Sciences and National Academy of Engineering Health Standards have been documented in fish tissue (Utah sucker, *Catostomus ardens*) in the lower Portneuf River (Maret and Ott 1997). This site was the only site studied in the upper Snake Rive Basin at which organochlorine compounds were higher in the bed sediments than in fish tissue. Additional organic compounds detected included: cis-chlordane, trans-nonachlor, p,p'DDD, p,p'DDE, p,p'DDT, total chlordane, and total DDT. Usually, compounds accumulate at higher levels in the tissue of organisms than in surrounding water or sediment (known as bioaccumulation); however, that was not found to be the case in the Portneuf River for organochlorine compounds.

Pollutant Sources

Common sources of PCBs include heat transfer, hydraulic fluids, lubricants, and insecticides (Sax and Lewis 1989). Thus, sources within the Portneuf River subbasin could have agricultural, industrial, or residential origins.

Data indicating historical sources of PCBs into the Portneuf River were not found. However, Maret and Ott (1997) in their study of organochlorine compounds in the upper Snake River stated that the source of PCBs at the Portneuf River site in Pocatello ". . . may have urban and industrial sources. . .". Two Superfund sites within the city have already been documented as having been contaminated with organic compounds - volatile and semi-volatile organic compounds at the Union Pacific Railroad Sludge Pit site and PCBs at the McCarty's/Pacific Hide and Fur site.

Data Gaps

The extent of organic compound contamination of the Portneuf River streambed is unknown. Although many organic compounds (e.g., organochlorine) are no longer in use, it is not clear if there continues to be input of organic compounds from those still in use or from

historically contaminated areas. To determine if beneficial uses are presently being impaired by organochlorine compounds, more data are needed. It is recommended that water quality monitoring of the Portneuf River, its tributaries, and other sources of water into the Portneuf River (e.g., stormwater drains) include analysis for PCBs, and other organochlorine compounds such as those mentioned earlier.

Metals

Summary Analysis

The presence of metals, primarily in the vicinity of Pocatello, are a concern in the Portneuf River subbasin. Ecology and Environment (1995) listed six contaminants of concern in the Portneuf River downstream of Pocatello. The contaminants of greatest concern in the sediments of the Portneuf River and nearby springs were cadmium, fluoride, mercury, and selenium because of their potential toxicity to fish and wildlife and their tendency to bioaccumulate. Four elements were considered to be a potential concern in surface water in the same section of stream: mercury, selenium, silver, and vanadium. All four were detected at elevated levels at various springs and Portneuf River locations. Mazanowski (1992) also detected high levels of cadmium in the streambed sediments of the Portneuf River just downstream of Pocatello.

No data were reviewed that would indicate metals are impairing beneficial uses in the Portneuf River. Of the metals recognized as a concern by Ecology and Environment (1995), only cadmium was found at substantially higher elevations than background (upstream of Michaud Flats area and adjacent to Pocatello) in Portneuf River delta sediments. Despite these high levels, Ecology and Environment noted that the potential risks of sediment contamination on benthic life are expected to be minimal as the cadmium was found to be strongly bound in the sediment and not bioavailable.

Metals have also been documented in other streams within the Portneuf River subbasin. McSorley (1977) noted high concentrations of iron and manganese in Marsh Creek, probably from a non-point source. He concluded that the metals are probably not toxic due to the buffering capacity and hardness of the Marsh Creek water. Several metals have been detected in Mink Creek (Table 26). However, due to the sampling protocol used, water samples were tested for total metals, not dissolved metals for which water quality standards are written. No data exists, or is readily available, to indicate metals are affecting any beneficial use in Marsh or Mink creeks.

Pollutant Sources

All sources of metals input into the lower Portneuf River are unknown, but are most likely to be urban in origin. For example, sampling in 1979 (Division of Environment 1980) and 1994 (Candy Ross, City of Pocatello, personal communication) confirmed the presence of metals in Pocatello stormwater runoff. FMC's NPDES-permitted discharge (Industrial Waste Water ditch) contributes a small amount of metals to the Portneuf River (Bechtel Environmental, Inc. 1996).

In Mink Creek, differences in metal concentrations between the upper site, which drain predominantly Caribou National Forest, and the lower site, above which includes the forest but also substantial home development, are slight (Table 26). Thus, it appears that the sources of metals are above the Forest Service boundary and could be from natural sources.

Data Gaps

Additional monitoring of metals as to present loading and beneficial use impairment in t Portneuf River is needed. Such monitoring should include levels of metals contributed to the ri by stormwater runoff. Monitoring in Mink Creek should be done to determine if dissolved leve of, for example, copper and lead are exceeding water quality standards. Further study should al look at any current impairment of beneficial use by levels of metals found within the subbasin.

Temperature

Summary Analysis

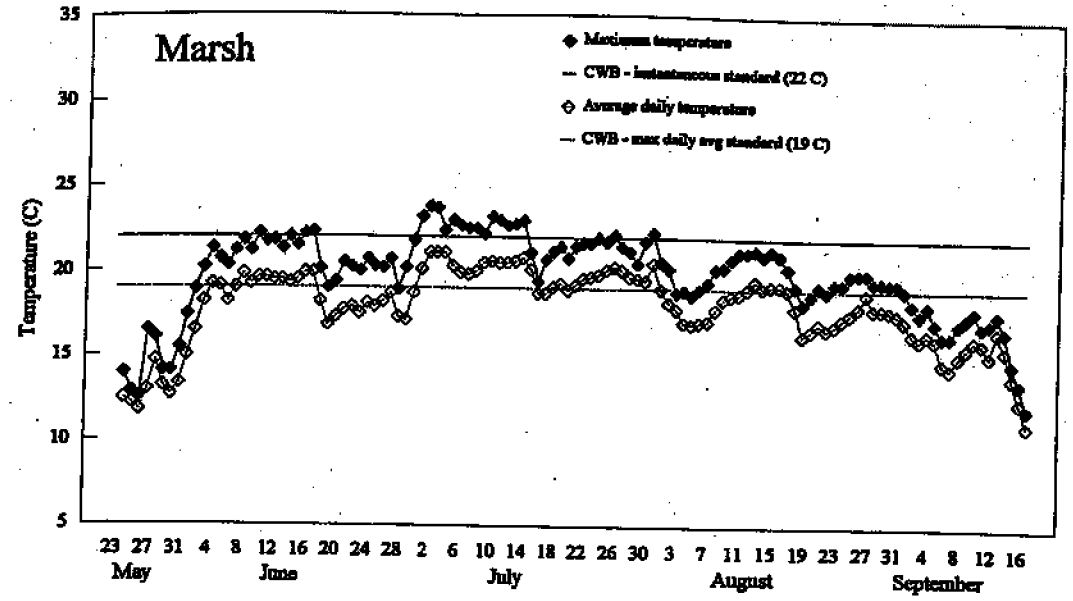
No stream segments in the Portneuf River have temperature listed as a pollutant. However, state water quality standards for cold water biota and salmonid spawning have been exceeded in the Portneuf River, including the Downey Canal, and Marsh Creek (Table 36). Exceedances of instantaneous temperature criteria for cold water biota and, possibly, salmonid spawning have occurred in both the Portneuf River and Marsh Creek (Figures 10, 11; Appendix A). Temperature monitoring at USGS surface-water stations since late 1988 indicates that the instantaneous temperature standard for cold water biota of 71.6°F (22°C) was exceeded in the Portneuf River in Pocatello in July of 1991 and 1995. The same standard was exceeded in the Topaz area of the Portneuf River in July of 1993 and 1994. The highest temperature recorded was 76.1°F (24.5°C). The instantaneous temperature criteria for salmonid spawning was exceeded at all four USGS surface-water stations in the Portneuf River and Marsh Creek. Temperatures higher than the standard of 55.4°F (13°C) were observed in the period from May to September. As cutthroat trout spawn in April or May, depending on water temperatures, and brown trout and mountain whitefish in the October to December period (Simpson and Wallace 1982), such temperatures as seen in the Portneuf River and Marsh Creek may have no effect on spawning by salmonids.

Temperature information from Mink Creek indicates that the stream is supporting its beneficial uses. Both instantaneous and long-term monitoring from July 1997 to April 1998 showed no exceedances of the cold water biota temperature requirement (Table 26; Figures 12, 13). The salmonid spawning temperature requirement was also not exceeded during the time when salmonids in Mink Creek would most likely be spawning, i.e., outside the July to September period.

Table 36. Exceedances of state water quality standards for temperature in the Portneuf River subbasin since 1991.

Waterbody	Reach/site	Year	Month	Exceedance: Cold water biota: Instantaneous	Exceedance: Cold water biota: Daily average	Exceedance: Salmonid spawning*: Instantaneous	Exceedance: Salmonid spawning*: Daily average	Source
Portneuf	above & below concrete channel	1998	July	X	X			Idaho Division of Environmental Quality
			August	X	X			Idaho Division of Environmental Quality
			September		X			Idaho Division of Environmental Quality
Portneuf	Downey Canal	1997**	June	X				Rudel 1998
Portneuf	Pocatello surface-water station	1996	July	X	X			Brennan et al. 1997
			August	X	X			Brennan et al. 1997
Marsh	Marsh Creek surface-water station	1996	June	X	X			Brennan et al. 1997
			July	X	X			Brennan et al. 1997
			August		X			Brennan et al. 1997
Portneuf	Topaz surface-water station	1996	June	X				Brennan et al. 1997
			July	X	X			Brennan et al. 1997
			August	X	X			Brennan et al. 1997
Portneuf	Downey Canal	1996**	June	X				Brennan et al. 1997
			July	X				Rudel 1998
			October			X		Rudel 1998
Portneuf	Pocatello surface-water station	1995**	July	X				Rudel 1998
Portneuf	Topaz surface-water station	1995**	July	X				Brennan et al. 1996
			August	X				Brennan et al. 1996
			September	X				Brennan et al. 1996
Portneuf	Downey Canal	1995**	April			X		Brennan et al. 1996
			July	X				Rudel 1998
			August	X				Rudel 1998
Portneuf	Topaz surface-water station	1994**	June	X				Rudel 1998
			July	X				Brennan et al. 1995
			August	X				Brennan et al. 1995
Portneuf	Topaz surface-water station	1993**	July	X				Brennan et al. 1995
			August	X				Harenberg et al. 1994
Portneuf	Pocatello surface-water station	1991**	July	X				Harenberg et al. 1994
								Harenberg et al. 1992

*salmonid spawning considered to occur outside the May to September period
**daily average temperature information not available



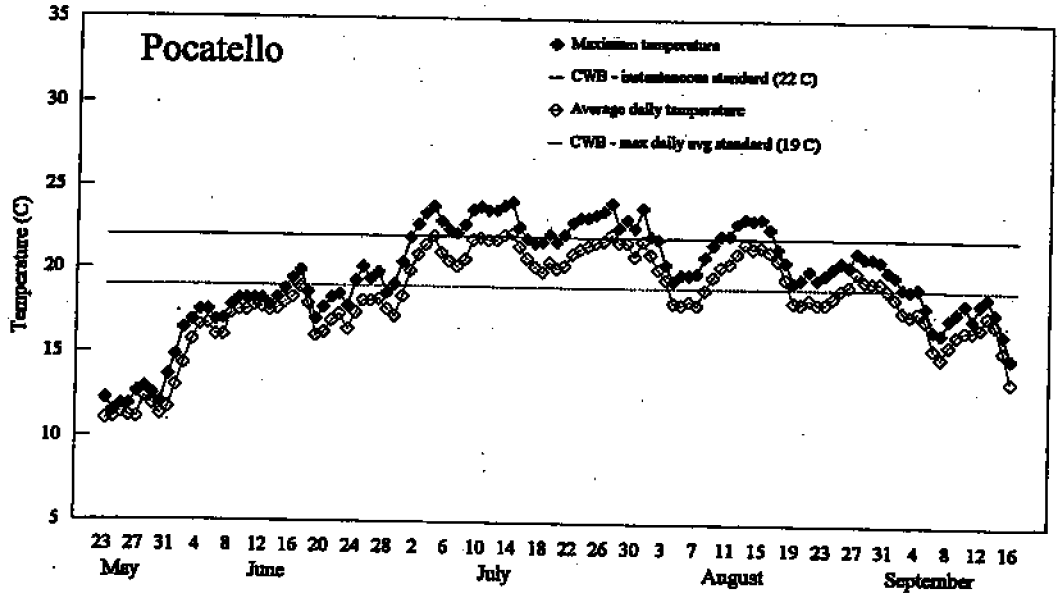


Figure 10. Temperature monitoring at the Marsh and Pocatello USGS surface-water stations, 1996.

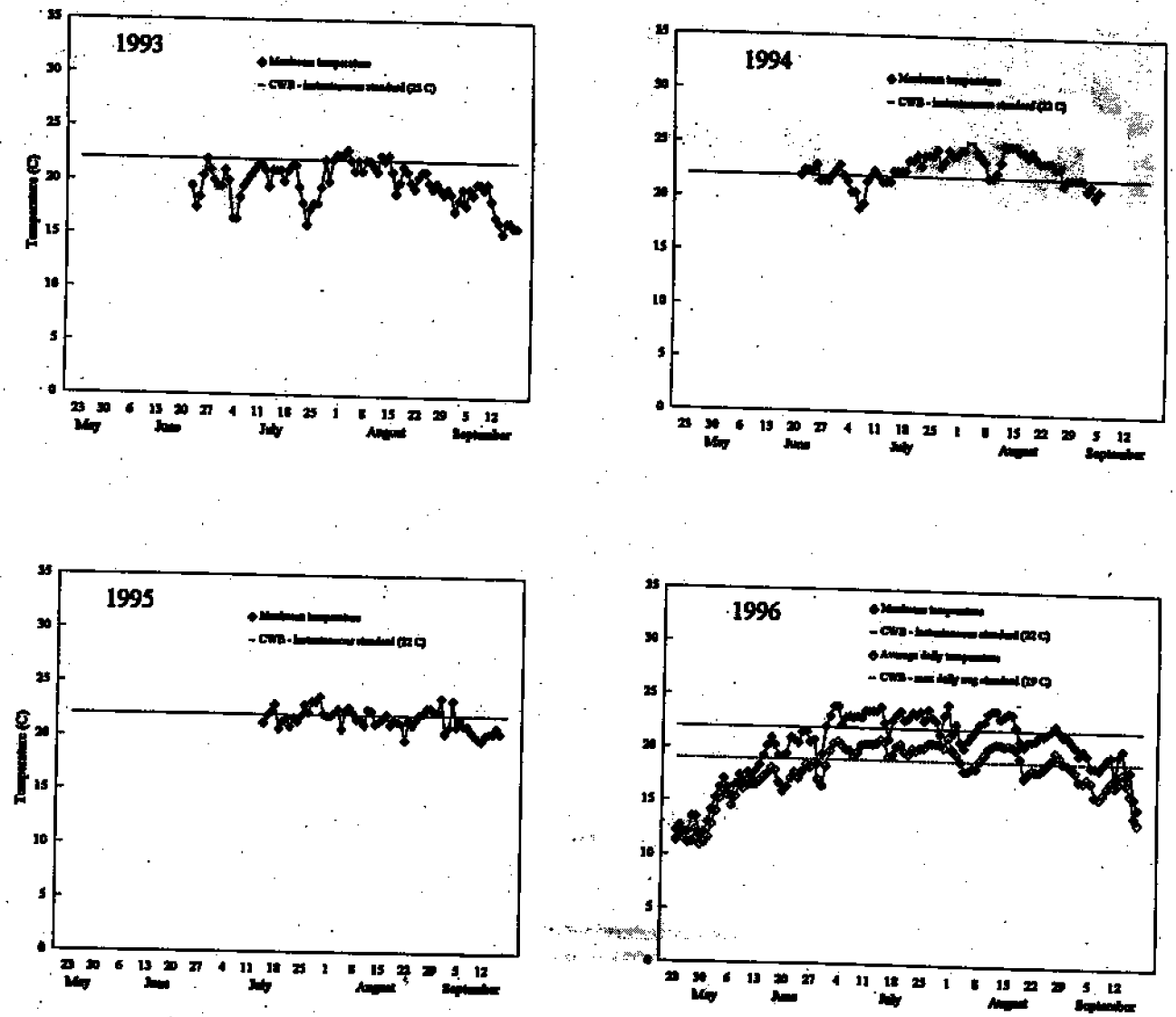


Figure 11. Temperature monitoring at the Topaz USGS surface-water station, 1993-1996.

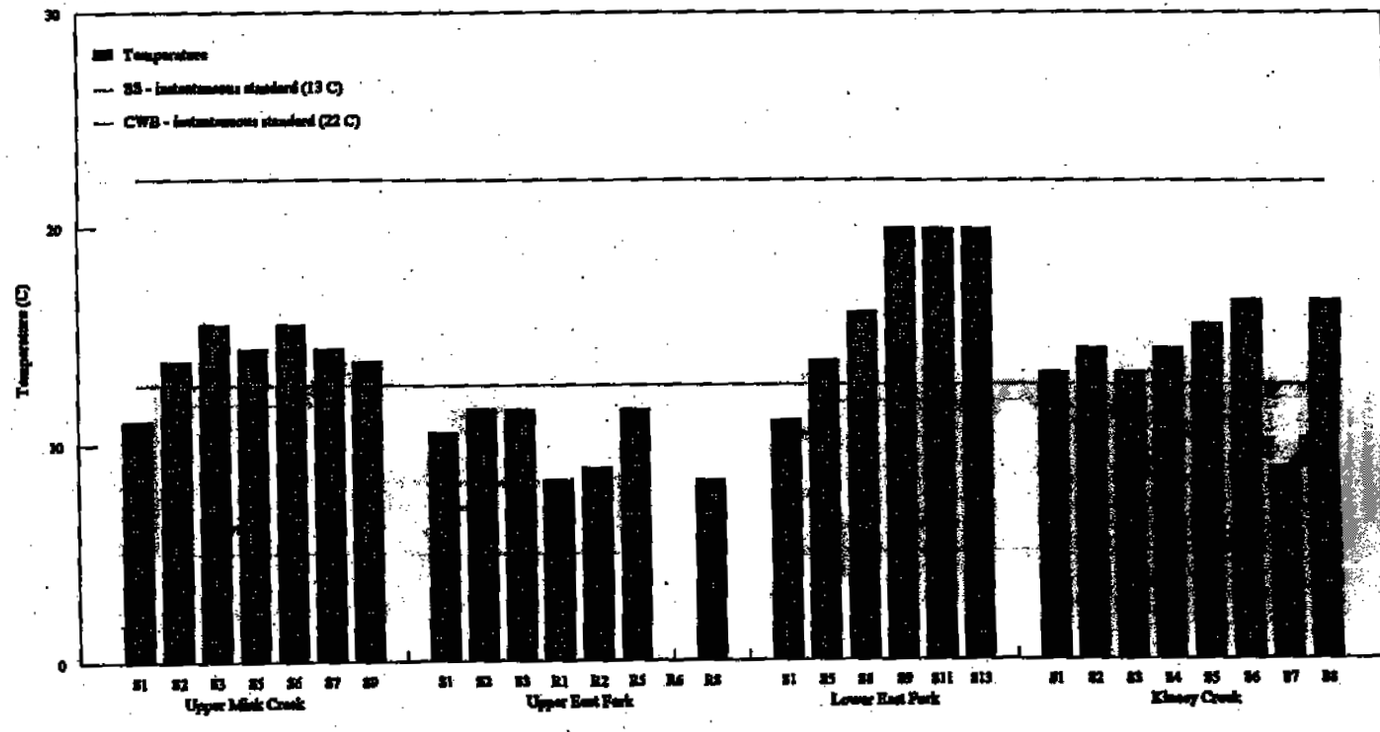


Figure 12. Instantaneous temperature sampling at various sites in the Mink Creek watershed, 26 July 1997.

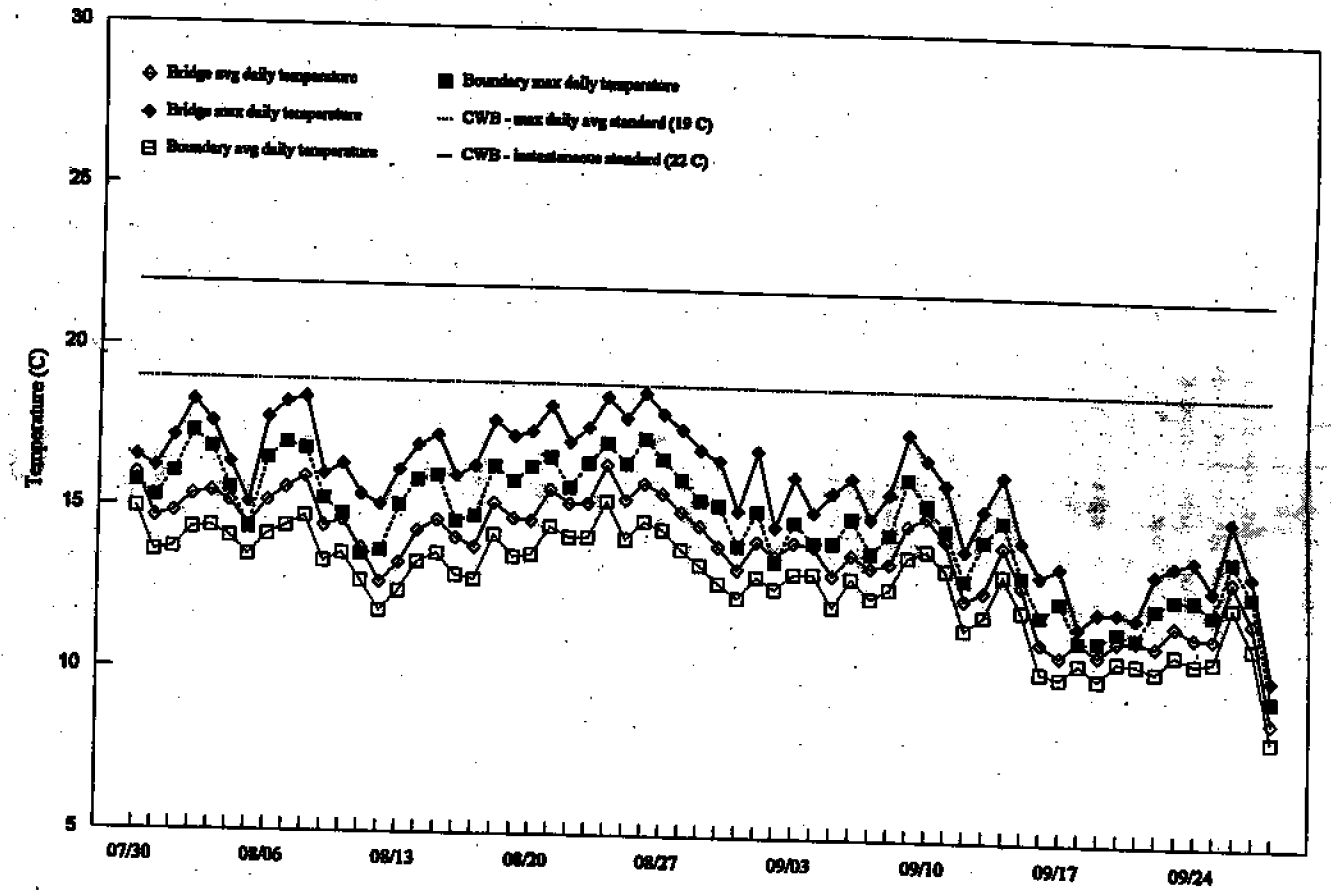


Figure 13. Temperatures recorded (every 48 minutes) by ministure temperature loggers at two sites, Forest Service boundary and Portneuf Road bridge, in the Mink Creek watershed, July to September 1997.

Pollutant Sources

Various human activities can result in elevation of stream temperatures. Habitat modification, such as removal of riparian cover which provides shade to the stream, will result i increasing stream temperatures (Platts et al. 1983, Bjorn and Reiser 1991). Other factors whic can influence stream temperature are stream width and stream flow (Bartholow 1989). As strea width increases or stream flow decreases, temperatures increase (Brown 1969). Bank slumping caused by degraded streambanks can lead to increased channel width and decreased channel dep (Bauer and Burton 1993).

Human activities which have contributed to increased stream temperatures in the Portneu River subbasin vary according to location. When channelization of streams, as has happened to sections of both the upper and lower Portneuf River, results in the permanent removal of shade-providing vegetation, solar radiation, and thus temperature, increases. Possible influences on temperatures above the Topaz and Marsh Creek gages include riparian modification by agricultu (McSorley 1977, Soil Conservation Service 1993, Portneuf Soil and Water Conservation District 1996) and irrigation withdrawals, especially above the Topaz station (McSorley 1977).

Data Gaps

Additional data should be collected to verify the extent to which temperature exceedance affect beneficial uses in the Portneuf River subbasin. This information is especially important to determine what, if any, effects instantaneous exceedances impair beneficial uses.

2.2.4 Streams Fully Supporting Beneficial Uses

Several streams within the Portneuf River subbasin are fully supporting their beneficial uses (Table 22). From information gathered as part of the Beneficial Use Reconnaissance Project the following streams from headwater to mouth are fully supporting their beneficial uses: Gibson Jack Creek, Mink Creek, Walker Creek, Bell Marsh Creek, Goodenough Creek, Dempsey Creek, Pebble Creek, and Toponce Creek. Garden Creek from the headwaters to the Garden Creek Gap was deemed to be supporting its beneficial uses.

2.3 Summary of Past and Present Pollution Control Efforts

Several programs and projects have been undertaken since the mid-1980s in the Portneuf River subbasin to improve water quality. In addition to the efforts of private individuals and non-profit groups, projects have been undertaken by city, county, state, tribal, and federal governments under several funding programs. Probably the largest program to benefit water quality has been the State Agricultural Water Quality Program (SAWQP). Five watershed areas have benefitted from SAWQP treating about 30,000 acres (Table 37). As part of the Upper Portneuf River SAWQP project, gradient control structures were built in the Downey Canal to control stream energy and its erosive effects on the canal banks. The Natural Resources Conservation Service (NRCS) oversees three federal programs - Agricultural Conservation

Table 37. Water quality projects in the Portneuf River subbasin.

Project	Project type*	303(d) waterbodies involved	Total area**	Amount treated**	Completion date***	Activities
Arkansas Basin	SAWQP	Marsh Creek	6,500 acres	4,085 acres	Comp	implementation of conservation tillage practices, construction of water & sediment control structures
Lone Pine	SAWQP	Marsh Creek	22,484 acres	5,196 acres	Comp	implementation of conservation tillage practices, construction of water & sediment control structures
Bancroft	SAWQP	Portneuf River	70,691 acres	7,565 acres	2000	implementation of conservation tillage practices, construction of water & sediment control structures
Upper Rapid Creek	SAWQP	Rapid Creek	17,650 acres	4,087 acres	2004	implementation of conservation tillage practices, construction of water & sediment control structures
Upper Portneuf	SAWQP	Portneuf River, Toponce Creek, Twentyfourmile Creek	206,766 acres	9,105 acres	2006	implementation of conservation tillage practices, construction of water & sediment control structures, fencing, construction of instream gradient control structures
Idaho Department of Fish and Game	319	Portneuf River		0.5 miles	1997	fencing, willow planting, revetment work
	319	Marsh Creek		4.5 miles	Comp	fencing, willow planting, revetment work
Friends of the Portneuf	319	Portneuf River		4.4 miles	Comp	fencing, willow planting, off-site water development
City of Pocatello	319	Portneuf River	2 acres	960 acres	2000	engineered wetlands to treat storm water runoff

*SAWQP = State Agricultural Water Quality Program
**acreage figures are approximate in some cases
***Comp = completed

Program (ACP), Food Security Act (FSA), and Conservation Reserve Program (CRP) - which have worked to improve water quality in the subbasin. The number of acres enrolled in CRP in Bannock County increased from 57,000 acres in 1988 to 63,000 acres in 1997 while CRP acres Caribou County went from 28,557 to 42,589 acres for the same time period. Sign-up of land in CRP is for ten years. Additional efforts have included fencing projects of the Friends of the Portneuf and the Idaho Department of Fish and Game. The only non-agriculture-related projec has been a 319-funded engineered wetlands project by the City of Pocatello to treat a portion (~20-25%) of the city's stormwater runoff prior to its entry into the Portneuf River.

How successful most of these programs have been is unknown. Unfortunately, many of the state programs did not have an adequate monitoring plan set up to document the benefits of implementation. Drewes (1991) in his evaluation of Best Management Practices on dryland far in Marsh stated that, based on the parameters studied, there appeared to be some improvement i pollution loading, but data sets for treatment analysis were too small to determine a statistically significant improvement. Ron Davidson (NRCS, personal communication) estimated that erosic control programs of FSA, CRP, and SAWQP have combined to save almost 3 million tons of to soil annually in Bannock County. There is also anecdotal evidence of improvement. Bannock County in 1994 spent $30,000 on flood damage to roads, an 80% reduction from $150,000 spe 10 years previous on road maintenance (letter from Bill Aller, Bannock County Highway Department, to Portneuf Soil and Water Conservation District, 23 February 1995). Much of tha savings was attributed to water conservation projects implemented by agriculture.

The existing status of the river is evidence that current practices will not improve water quality to the degree that all beneficial uses will be supported in the very near future. Implementation of appropriate best management practices could, conceivably, result in the reduction in some pollutants (e.g., oil and grease) in a relatively short time (e.g., five years). However, control of sediment will require a much longer time frame.

3. Portneuf River Loading Analysis

3.1 General

To assist in the support of beneficial uses and the improvement of water quality in the Portneuf River and its tributaries, the following recommendations are made to control the pollutants of concern into 303(d)-listed streams. The pollutants of concern include sediment, nutrients, bacteria, flow alteration, oil and grease, and dissolved oxygen.

Loading analyses are beneficial especially for those pollutants for which no numerical water quality standards exist. Many of these pollutants are addressed in narrative standards, whereby, if beneficial uses are impaired, pollutant loads are too high. A load analysis helps establish the point at which a pollutant load impairs beneficial uses. Load, and where applicable wasteload, allocations are proposed for bacteria, oil and grease, sediment, and nutrients (i.e., nitrogen and phosphorus).

Although the Portneuf River has been evaluated through many reports, little monitoring data exist at the same location in the same manner over a long period of time (e.g., 5 years). The load allocations in this report are primarily based on information from the United States Geological Survey (USGS) surface-water stations (i.e., gages) at Tyhee/Siphon, Pocatello, Marsh, and Topaz (Figure 1). Although not collected randomly and consistently, the USGS information was the only data set available which included information from the same place(s) over an extended period of time (e.g., flow information back to 1912 at Pocatello and nitrogen information back to mid-1960s). The information from USGS gaging stations (Appendices D, E) can be split into two periods. The first period began in mid-1960s ending in early 1980s. The period from about 1981 to 1986 marked a time when little water quality information was gathered. Information started flowing again in late 1980s. Calculations were made using only latter data at three upper sites as this information is more representative of present conditions due to advent of improved agricultural practices and Conservation Reserve Program (CRP) in mid-1980s. Examination of mean concentrations between the two periods confirms a general decrease in concentrations of suspended sediment, nitrates, total inorganic nitrogen, and total phosphorus (Table 38). These differences were significant for many of the parameters (Table 39).

The gaging stations will be sites at which load reductions in mass per unit time will be monitored. Reductions on tributaries will be measured by concentrations (e.g., mg/l of suspended sediment) or volume percentages (i.e., depth fines [volume of fine sediment in the streambed]).

Available data were limited in various ways. For example, USGS monitoring at their gaging stations have taken measurements of the following forms of nitrogen: nitrate, nitrate+nitrite, total nitrate, total nitrite, dissolved nitrate, dissolved nitrite, total nitrate+nitrite, dissolved nitrite+nitrate, total ammonia, dissolved ammonia, total ammonia+organic nitrogen, organic nitrogen, dissolved organic nitrogen, total Kjeldahl nitrogen, and total nitrogen. Where feasible, the different forms were lumped together such as summing dissolve nitrate plus dissolved nitrite to equal total nitrate (Appendix E). As nitrite tends to be in very low concentrations in the Portneuf River, nitrite concentrations were added to nitrate and considered all nitrate.

Table 38. Descriptive statistics summary for sediment and nutrients monitored at USGS surface-water stations.

Parameter	Time period	Number	Mean	Standard error
	Tyhee			
Suspended solids	1971-1972	4	75.75	32.86
	1989-1994	17	19.59	5.39
	1971-1994	21	30.29	8.60
Nitrate	1970-1975	11	1.30	0.18
	1987-1994	24	2.16	0.06
	1970-1994	35	1.89	0.10
Total inorganic nitrogen	1972-1975	6	2.04	0.43
	1989-1994	22	2.66	0.06
	1972-1994	28	2.53	0.11
Total phosphorus	1970-1973	10	0.50	0.06
	1989-1994	22	0.46	0.03
	1970-1994	32	0.48	0.03
Total ortho phosphorus	1972-1975	6	0.35	0.05
	1989-1994	22	0.43	0.03
	1972-1994	28	0.42	0.02
	Pocatello			
Suspended solids	1974-1981	7	181.29	72.35
	1990-1996	18	148.17	32.92
	1974-1996	25	157.44	30.47
High flow (Feb - May)	1991-1996	8	232.13	36.79
Low flow (Jun - Jan)	1990-1996	10	81.00	41.41
Nitrate	1965-1981	49	2.43	0.37
	1990-1996	24	0.54	0.08
	1965-1996	73	1.81	0.27
Total inorganic nitrogen	1990-1996	24	0.60	0.09
Total phosphorus	1971-1981	21	0.20	0.06
	1990-1996	24	0.08	0.01
	1971-1996	45	0.13	0.03
Total ortho phosphorus	1971	3	0.09	0.03
	1990-1996	24	0.03	0.00
	1971-1996	27	0.03	0.01

Table 38. Continued.

Parameter	Time period	Number	Mean	Standard error
	Marsh Creek			
Suspended solids	1979-1981	18	92.28	41.69
	1990-1996	18	114.22	31.82
	1979-1996	36	103.25	25.91
High flow (Feb - May)	1991-1996	8	195.13	58.24
Low flow (Jun - Jan)	1990-1996	10	49.50	16.85
Nitrate	1970-1981	32	1.24	0.33
	1990-1996	24	0.78	0.09
	1970-1996	56	1.04	0.19
Total inorganic nitrogen	1980-1981	9	0.94	0.16
	1990-1996	24	0.89	0.11
	1980-1996	33	0.90	0.09
Total phosphorus	1970-1981	39	0.52	0.31
	1990-1996	24	0.08	0.01
	1970-1996	63	0.35	0.19
Total ortho phosphorus	1971-1981	12	0.05	0.01
	1990-1996	24	0.04	0.00
	1971-1996	36	0.04	0.00
	Topaz			
Suspended solids	1993-1996	40	75.68	11.22
High flow (Apr - Jun)	1993-1996	18	112.83	20.91
Low flow (Jul - Mar)	1993-1996	22	45.27	6.16
Nitrate	1967-1981	29	1.93	0.60
	1993-1996	40	0.66	0.05
	1967-1996	69	1.20	0.26
Total inorganic nitrogen	1993-1996	40	0.70	0.05
Total phosphorus	1970-1981	21	0.14	0.05
	1993-1996	40	0.05	0.01
	1970-1996	61	0.08	0.02
Total ortho phosphorus	1971	3	0.04	0.01
	1993-1996	40	0.02	0.00
	1971-1996	43	0.02	0.00

Table 39. Results of F-tests and t-tests between early and late periods for sediment and nutrients monitored at USGS surface-water stations.

Parameter*	Degrees of freedom (early)	Degrees of freedom (late)	F-distribution**	Significant***	t-distribution	t-test^	Significant***
			Tyhee				
SS	3	16	0.08	NO	0.06	0.16	NO
Nitrate	9	23	0.00	YES	0.06	0.00	YES^^
TIN	5	21	0.00	YES	0.06	0.19	NO
TP	9	21	0.21	NO	0.06	0.30	NO
TOP	5	21	0.82	NO	0.03	0.14	NO
			Pocatello				
SS	6	17	0.85	NO	0.06	0.28	NO
Nitrate	48	23	0.57	NO	0.05	0.00	YES
TIN^^^	0	23					
TP	20	23	0.64	NO	0.05	0.02	YES
TOP	2	23	0.01	YES	0.11	0.08	YES
			Marsh Creek				
SS	17	17	0.47	NO	0.06	0.28	NO
Nitrate	31	23	0.22	NO	0.05	0.06	NO
TIN	8	23	0.70	NO	0.06	0.33	NO
TP	38	23	0.00	YES	0.05	0.01	YES
TOP	11	23	0.91	NO	0.11	0.05	YES
			Topaz				
SS^^^	0	39					
Nitrate	28	39	0.00	YES	0.05	0.01	YES
TIN^^^	0	39					
TP	20	39	0.25	NO	0.05	0.01	YES
TOP	2	39	0.14	NO	0.05	0.00	YES

*SS=suspended sediment, TIN=total inorganic nitrogen, TP=total phosphorus, TOP=total ortho phosphorus

**used to test for equal variances

***significance at 95% confidence level

^if variances tested as not equal used t-test for unequal variances; used one-tail test except for nitrates, total inorganic nitrogen, and total inorganic phosphorus at Tyhee and sediment at Marsh Creek

^^denotes a significant increase from the early to the late period

^^^no early period values prevents analysis

Commonly accepted names are used for nutrients. In actuality, the following apply when discussing concentrations as expressed in milligrams per liter (mg/l): nitrate is NO^3 as N, ammonia is NH^3 as N, ortho phosphate is PO^4 as P, and total phosphorus is expressed as P.

In some cases, values for the pollutant of concern were not available. For example, the Pocatello Sewage Treatment Plant (PSTP) did not consistently keep records of nitrate in their effluent. They did, however, keep records of ammonia. A conversion factor based on one-day sample was used to calculate total inorganic nitrogen. For sediment, total suspended solids and suspended sediment were considered equivalents, although they are based on different methodology and do not usually produce the same result for a given sample.

Limitations of the data generally precludes identification of pollutant sources. Identification of sources was made wherever feasible.

3.1.1 Reasonable Assurance

The U. S. Environmental Protection Agency (EPA) requires that Total Maximum Daily Loads (TMDL) with a combination of point and nonpoint sources and with waste load allocations dependent on nonpoint source controls, provide reasonable assurance that the nonpoint source controls will be implemented and effective in achieving the load allocation (EPA 1991). If reasonable assurance that nonpoint source reductions will be achieved is not provided, the entire pollutant load will be assigned to point sources.

In the Portneuf River, a situation of point and nonpoint sources of pollutants holds true for nutrients, fecal coliform, and sediment. Nonpoint source reductions listed in the Portneuf River TMDL will be achieved through state authority within the Idaho Nonpoint Source Management Program.

Section 319 of the Federal Clean Water Act requires each state to submit to EPA a management plan for controlling pollution from nonpoint sources to waters of the state. The plan must: identify programs to achieve implementation of best management practices (BMPs); provide a schedule containing annual milestones for utilization of program implementation methods; certification by the attorney general of the state that adequate authorities exist to execute the plan for implementation of best management practices; and, include a listing of available funding sources for these programs. The current Idaho Nonpoint Source Management Program has been approved by EPA as meeting the intent of section 319 of the Clean Water Act.

As described in the Idaho Nonpoint Source Management Plan, Idaho Water Quality Standards require that if monitoring indicates water quality standards are not met due to nonpoint source impacts, even with the use of current best management practices, the practices will be evaluated and modified as necessary by the appropriate agencies in accordance with provisions of the Administrative Procedure Act (IDAPA). If necessary, injunctive or other judicial relief may be initiated against the operator of a nonpoint source activity in accordance with authority of the Director of Health and Welfare provided in Section 39-108, Idaho Code (IDAPA 16.01.02.350). Idaho Water Quality Standards list designated agencies responsible for reviewing and revising

nonpoint source BMPs based on water quality monitoring data as is generated through the state's water quality monitoring program. Designated agencies are: Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities; Soil Conservation Commission for grazing and agricultural activities; Transportation Department for public road construction; Department of Agriculture for aquaculture; and the Division of Environmental Quality for all other activities (IDAPA 16.01.02.003). Existing authorities and programs for assuring implementation of BMPs to control nonpoint sources of pollution in Idaho are as follows:

State Agricultural Water Quality Program
Wetlands Reserve Program
Environmental Quality Improvement Program
Idaho Forest Practices Act
Water Quality Certification For Dredge and Fill
Nonpoint Source 319 Grant Program
Conservation Reserve Program
Resource Conservation and Development
Agricultural Pollution Abatement Plan
Stream Channel Protection Act

The Idaho Water Quality Standards direct appointed watershed advisory groups to recommend specific actions needed to control point and nonpoint sources affecting water quality limited waterbodies. Upon approval of this TMDL by EPA Region 10, the existing Portneuf River Watershed Advisory Group, with the assistance of appropriate local, state, tribal, and federal agencies, will begin formulating specific pollution control actions for achieving water quality targets listed in the Portneuf River Total Maximum Daily Load. The Plan is scheduled to be completed within eighteen months of finalization and approval of the TMDL by EPA.

3.2 Pollutant Standards/Targets and Load Analysis

3.2.1 Flow Alteration

Target

None

Discussion

Flow alteration is a listed pollutant for the section of the Portneuf River from the downstream point of the Downey Canal (aka Chesterfield Canal) to Lava Hot Springs (Table 19). A TMDL will not be developed for flow alteration. It is DEQ's position that flow alteration is not a pollutant per section 303(d) of the Clean Water Act nor are there water quality standards for flow. However, those water bodies for which flow alteration is listed as a pollutant often have other pollutants (e.g., sediment or temperature). Actions taken to remedy these pollutants may also address flow.

Loading Analysis

None

3.2.2 Dissolved Oxygen

Standards

Cold water biota - minimum of 6.0 mg/l except in the bottom 20% of water depth in reservoirs where depths are 35 meters or less (*Water Quality Standards and Wastewater Treatment Requirements 250.02.c.i.(1)-(3)* [Idaho Department of Health and Welfare nda])

Discussion

Only Hawkins Reservoir has dissolved oxygen listed as a pollutant of concern (Table 19). Fish kills have been reported in both summer and winter. Limited data indicated that summer dissolved oxygen levels in July of 1991 and August of 1997 met state water quality standards while levels measured in January of 1993 did not (Table 24).

Hawkins Reservoir predates the implementation of the Clean Water Act and thus is considered a pre-existing condition. It is entirely possible that, while trying to support its beneficial use as agricultural water supply, in low water years operation of the reservoir may result in low dissolved oxygen situations. Cooperation with owners on operation of the dam to maintain a minimum pool, in addition to the proposed reduction in nutrient loadings (thereby minimizing excessive plant growth), should decrease the occurrence of low dissolved oxygen. It is expected that the dissolved oxygen standard will continue to apply to Hawkins Creek below the reservoir and that operation of the reservoir will not reduce dissolved oxygen in the creek below the standards for support of cold water biota and salmonid spawning.

Loading Analysis

The data, especially winter information, are insufficient to develop a loading analysis. It is anticipated that meeting the total phosphorus target in the reservoir will reduce aquatic vegetative growth which, in turn, will reduce the chances of low dissolved oxygen conditions. At the same time, reductions in sediment, total phosphorus, and total inorganic nitrogen in Hawkins Creek should improve dissolved oxygen conditions in the reservoir.

3.2.3 Bacteria

Standard

Primary Contact Recreation - 1 May to 30 September (*Water Quality Standards and Wastewater Treatment Requirements 250.01.a.i.-iii.* [Idaho Department of Healt and Welfare nda])

- 500 colonies/100 ml at any time, or
- 200 colonies/100 ml in more than 10% of the total samples taken over a 30-day period, or
- Geometric mean of 50 colonies/100 ml or greater based on a minimum of 5 samples over a 30-day period

Secondary Contact Recreation (*Water Quality Standards and Wastewater Treatment Requirements 250.01.b.i.-iii.* [Idaho Department of Health and Welfare nda])

- 800 colonies/100 ml at any time, or
- 400 colonies/100 ml in more than 10% of the total samples taken over a 30-day period, or
- Geometric mean of 200 colonies/100 ml or greater based on a minimum of 5 samples over a 30-day period

Discussion

Only the mainstem Portneuf River has bacteria listed as a pollutant of concern (Table 19). However, many tributaries within the subbasin have exceeded state water quality standards for fecal coliform, for example, Pocatello and Mink creeks, and North Fork of Pebble Creek in 1998 (Table 40). Origins of fecal coliform include livestock, wildlife, and human. Stormwater runoff from Pocatello has also been mentioned as a source of fecal coliform into the Portneuf River (Hancock and Bybee 1978).

All streams within the Portneuf River subbasin must at least meet secondary contact recreation standards for fecal coliform. Streams which have primary contact recreation as a beneficial use must meet a more strict fecal coliform requirement for primary contact recreation from 1 May to 30 September.

Additional data are needed to identify specific sources of bacteria into the Portneuf River. For example, regular monitoring of tributaries at the mouth would indicate those areas which are sources of bacteria input. The most extensive data are from 1 May to 30 September - the period in which primary contact recreation is considered to occur. Regular sampling to document exceedances of secondary contact recreation standards is also essential.

Table 40. Exceedances of state water quality standards for fecal coliform in the Portneuf River subbasin since 1990.

Stream	Reach/site	Year	Contact recreation*	Exceedance			Source
				Instantaneous	10% of samples	ometric mean	
Portneuf River	concrete channel to Kraft Road bridge	1998	P/S	X	X	X	Idaho Division of Environmental Quality
Pocatello Creek	below Parks Road	1998	S	X	X	X	Idaho Division of Environmental Quality
Mink Creek	West Fork to mouth	1998	P/S		X	X	Idaho Division of Environmental Quality
Pebble Creek	North Fork	1998	S	X			Idaho Division of Environmental Quality
Portneuf River	Downey Canal	1997	P/S	X	X	X	Rudel 1998
Portneuf River	Pocatello surface-water station	1996	P/S	X			Brennan et al. 1997
Portneuf River	Downey Canal	1996	P/S	X	X	X	Rudel 1998
Portneuf River	Downey Canal	1995	P/S	X	X	X	Rudel 1998
Marsh Creek	Marsh Creek surface-water station	1996	P/S	X			Brennan et al. 1997
Marsh Creek	Marsh Creek surface-water station	1995	P/S	X			Brennan et al. 1996
Portneuf River	through and below Pocatello	1994	P/S	X	X		Southeastern District Health Department
Portneuf River	Lava Hot Springs to McCammon	1994	P/S		X		Southeastern District Health Department
Portneuf River	through and below Pocatello	1993	P/S	X	X		Southeastern District Health Department
Portneuf River	Lava Hot Springs to McCammon	1993	P/S	X	X	X	Southeastern District Health Department
Portneuf River	through and below Pocatello	1992	P/S	X	X	X	Southeastern District Health Department
Portneuf River	through and below Pocatello	1991	P/S	X	X	X	Southeastern District Health Department
Portneuf River	Inkom to Rainey Park	1991	P/S		X	X	Southeastern District Health Department
Portneuf River	McCammon	1991	P/S		X		Southeastern District Health Department
Portneuf River	Lava Hot Springs	1991	P/S		X		Southeastern District Health Department
Portneuf River	Lava Hot Springs	1990	P/S	X	X	X	Southeastern District Health Department

*P=primary contact recreation, S=secondary contact recreation

Loading Analysis

The load analysis is based on the geometric mean (geomean) as this was the criterion most often violated and the geomean represents a chronic water quality problem compared to instantaneous measurements. Secondary contact recreation standards were not exceeded in the Portneuf River based on data used in this analysis (Appendix C). The geometric mean standard for primary contact recreation is 50 colonies/100 ml.

Data sufficient to develop a loading analysis in the Portneuf River from Chesterfield Reservoir to American Falls Reservoir varies according to location. The most recent data available are from sampling events in August and September 1998 in the lower Portneuf River through Pocatello. In the reach of river from the upstream end of the City of Pocatello (Rainey Park) to Lava Hot Springs, data from 1990 to 1996 were used. No recent (since 1990) information on bacteria in the Portneuf River from Pebble Creek to Lava Hot Springs was available, hence no load was calculated for this stretch of stream. Above Pebble Creek to Chesterfield Reservoir, fecal coliform sampling was done from 1995 to 1997.

Based on 1998 data, with some support from other fecal coliform sampling since 1989, a coarse loading analysis was developed for the section of Portneuf River through Pocatello to Tyhee gage. The loading analysis is for 1 May to 30 September for primary contact recreation as outlined in the State of Idaho Water Quality Standards (Idaho Department of Health and Welfare nda). State water quality standards for fecal coliform for primary contact recreation waters were considered the loading, or assimilative, capacity of the Portneuf River.

It appears that most of the fecal coliform input occurs downstream of the Pocatello USGS gage site (Table 41). One sample taken at Rainey Park, at the upstream end of the river through the City of Pocatello, in September 1998 showed a fecal coliform count of 82 colonies/100 ml. Earlier data (e.g., July 1991) documented over 100 colonies/100 ml above Rainey Park. The 1998 data indicate that Mink Creek is a source of input into the section of the Portneuf River above Rainey Park. The extent of contribution from Mink Creek to the river is unknown. However, for this analysis a fecal coliform load of 82 colonies/100 ml at Rainey Park was used. No information was collected in 1998 between Rainey Park and the Pocatello gage site. From instantaneous sampling at the gage site from 1991 to 1996, it appears that the load of fecal coliform increases through this concrete channelized reach indicating a source of input (e.g., tributaries, stormwater). In 1998, the load of fecal coliform between the Pocatello gage and Pocatello Creek was a geometric mean of 238 colonies/100 ml. Pocatello Creek with a geometric mean of 442 colonies/100 ml in 1998 appears to be a serious source of fecal coliform into the Portneuf River. Discharge measurements were not taken during the sampling for bacteria so dilution effect of Portneuf River water on heavily laden fecal coliform water from Pocatello Creek is unknown. As the geometric mean below Pocatello Creek to Kraft Road bridge (about 0.5 miles) was only 193 colonies/100 ml some dilution may be occurring. However, the mean, based on only two samples, may be artificially low. Two other samples were unusable as number of colonies were not countable or too numerous to count (Appendix C). Once the river reaches the interstate, 2.5 miles downstream of Kraft Road bridge, numerous springs add to the river flow potentially diluting fecal coliform concentrations. Data from Tyhee gage site from 1990 to 1994

Table 41. Fecal coliform information, instantaneous and geometric mean (geomean), from Southeastern District Health Department (unpublished data), Idaho Division of Environmental Quality, and USGS surface-water stations at Pocatello and Tyhee (USGS water resources data). All averages are geometric means of colonies/100 ml.

Site	Year	Number of samples/month					Colonies/100 ml*					All sample geomean** (1998 only)
		May	June	July	August	September	May	June	July	August	September	
Portneuf River - Inkom to Rainey Park	1991			9	11	3			83	108	37	
	1992			3					58			
Mink Creek	1991				2	1				1,257	90	
	1998				4	4				116	77	94
Rainey Park	1994			1					10			
	1998					1					82	
Portneuf River - through & below Pocatello	1991			10	10	21			641	1,192	265	
	1992			5					532			
	1993			1					97			
	1994			2					406			
Portneuf River at Pocatello gage	1991	1		1		1	100		120		160	
	1993	1		1		1	120		370		80	
	1995	1		1		1	220		130		270	
	1996	1	1	1	1	1	190	170	220	180	800	
Portneuf River - upstream of Pocatello Creek	1998				5	1				224	320	238
Pocatello Creek	1998				1	5				1,560	343	442
Portneuf River - downstream of Pocatello Creek	1998				1	1				620	60	193
Tyhee gage	1989			1	1	1			44	130	450	
	1990	1		1		1	8		51		39	
	1992	1		1		1	25		25		16	
	1994	1		1		1	68		88		35	

*when only 1 sample was collected, the value is an instantaneous value; when 2 or more samples taken during the month, the value is a geometric mean. Geometric means were calculated only on a monthly basis not a 30-day period

**geomean calculated from a pool of all data for 1998 by location. No geomean was estimated at Rainey Park because only one sample was taken.

show relatively low levels of fecal coliform although a 1989 sample indicates that fecal coliform may occasionally be high.

Although six years of data were available, only data from 1990, 1991, 1993, and 1996 were employed in the load analysis for fecal coliform in the Portneuf River reach from Lava Hot Springs to about the upstream edge of the City of Pocatello. In the other two years, less than four samples were collected and thus were not used in the analysis (Table 42). All samples from May to September, the period in which primary contact recreation standard applies, were pooled to calculate a geometric mean. The average geometric mean for the four years was 136 colonies/100 ml.

Sampling in the Downey Canal reach (Pebble Creek to Chesterfield Reservoir) of the Portneuf River occurred at six sites from 1995 to 1997. Rather than treat each site individually all six sites were pooled to estimate fecal coliform concentration in the Downey Canal reach although the downstream site, P6, was below the confluence of the canal with the old river channel. Geometric means for all 30-day periods from May to September for three years ranged from 19 to 141 (Appendix C). The average geometric mean for three years was 54 colonies/100 ml.

Load reductions are based strictly on percentage reduction due to lack of more extensive data. Although all numbers presented do not represent a geometric mean based on at least five samples, they were treated as such. Reduction in loads were determined by subtraction of estimated load from the geometric mean standard for primary contact recreation. An additional 10% was added on each load as a margin of safety. These reductions are proposed for 1 May to 30 September.

The greatest reduction in fecal coliform input is in the lower Portneuf River. Proposed load reductions range from 17% in the Downey Canal reach to 80% for the reach of river between the Pocatello gage to Pocatello Creek (Table 43).

The loads were not apportioned by source. Data were considered either non-existent (i.e., contribution by livestock, wildlife, or human nonpoint sources), incomplete (i.e., not all tributaries were monitored), or too old (i.e., collected over 10 years ago) to reflect current conditions in the Portneuf River. Historic contributors of fecal coliform into the Portneuf River, include: Jenkins Canyon, Sorrell Canyon, Jackson Creek, Indian Creek, and South Fork Pocatello Creek (Drewes 1987); Eighteenmile Creek, Twentyfourmile Creek, and Toponce Creek (Hoover 1985); and Marsh Creek (Frenzel and Jones 1985, Perry et al. 1977, and McSorley 1977).

No wasteload allocations are recommended. Discharge Monitoring Reports (DMRs) for FMC or Batise Springs Hatchery do not include any monitoring of fecal coliform. DMRs from the cities of Pocatello, Inkom, Lava Hot Springs do not indicate that these dischargers are major contributors of fecal coliform into the Portneuf River. Since November of 1997, data from the Pocatello STP indicate the highest average fecal coliform count was 42 colonies/100 ml while the maximum recorded was 90 colonies/100 ml. At low flow, the Pocatello STP discharge represents about 6% of flow in the Portneuf River at its effluent discharge point (Brock 1989). The highest average fecal coliform count documented on DMRs from the Inkom STP since November 1997

Table 42. Geometric mean of fecal coliform (colonies/100 ml) in the Portneuf River (from Southeastern District Health Department [unpublished data] and USGS water resources data).

Year	Pocatello to Tyhee Gage Area		Lava Hot Springs to about Pocatello		Chesterfield Reservoir to Pebble Creek	
	Geometric mean	Number of samples	Geometric mean	Number of samples	Geometric mean	Number of samples
1989	137	3	-	-	-	-
1990	25	3	161	7	-	-
1991	124	3	95	42	-	-
1992	22	3	58	3	-	-
1993	153	3	165	7	-	-
1994	59	3	112	2	-	-
1995	198	3	-	-	60	48
1996	252	5	136	5	47	35
1997	-	-	-	-	56	28
Average	121		121		54	

Table 43. Load reductions for fecal coliform in the lower Portneuf River.

Site	Fecal coliform (colonies/100 ml)				
	Geometric mean*	Standard load	Percent reduction to standard	Margin of safety	Percent load reduction
Kraft Road bridge	193	50	74%	10%	84%
Kraft Road bridge to Pocatello Creek	Unknown				
Pocatello Creek to Pocatello gage	238	50	79%	10%	89%
Pocatello gage to Rainey Park	Unknown				
Rainey Park	82	50	39%	10%	49%
Rainey Park to Lava Hot Springs	136	50	63%	10%	73%
Pebble Creek to Chesterfield Reservoir	54	50	7%	10%	17%

*may not represent a geometric mean of at least 5 samples collected within a 30-day period; see Table 41 and Appendix C

was 13 colonies/100 ml. For the same period, Lava Hot Springs STP reported an average high of 22 colonies/100 ml. Effluent from Inkom and Lava Hot Springs sewage treatment plants accounts for about 0.05% of flow in the Portneuf River at point of discharge. Based on low numbers of fecal coliform in the three sewage treatment plant effluents and low percentage of overall flow in the river these discharges represent, no wasteloads for fecal coliform are proposed.

Margin of Safety

Load reductions for the Portneuf River were determined by subtracting the estimated load from the geometric mean standard for primary contact recreation. To allow for a margin of safety, an additional 10% was added on to each load (see Table 43).

Data Gaps

The load reductions are not apportioned by source because information was deemed either too old or sampling was instantaneous only. More information is needed as to frequency and timing of exceedances, input sources, etc., before a more complete loading analysis can be attempted.

3.2.4 Oil and Grease

Target

oil and grease content not to exceed 5 mg/l

Discussion

The lower Portneuf River in vicinity of the City of Pocatello is the only stream segment that has oil and grease listed as a pollutant of concern. There was no information found as to extent to which oil and grease are affecting beneficial uses in the Portneuf River. In addition, no data were seen which would indicate amounts of oil and grease discharged into the Portneuf River. Oil and grease into the Portneuf River can come from both agricultural and urban inputs, however, Pocatello and Chubbuck are most likely the source of loads into this listed segment of stream.

To estimate the oil and grease contributed to the Portneuf River by Chubbuck and Pocatello, land use information from the cities (Surface and Wessel 1995) was entered into a model based on stormwater pollutant information from urban areas throughout the United States (Table 44). The model estimated the annual total stormwater runoff of oil and grease at 75,948 pounds (38 tons).

To determine if beneficial uses are presently being impaired by oil and grease, more data are needed. It is recommended that water quality monitoring of the Portneuf River, its tributaries,

Table 44. Estimated total suspended solids and oil and grease loads from stormwater runoff from the Pocatello-Chubbuck urban area (land use information from Surfface and Wessel 1995; modeling done by Todd Maguire, Division of Environmental Quality).

Land use categories	Land use area (acres)	Percent impervious	Runoff coefficient (Rv)	Avg annual precipitation (in/yr)	Fraction of avg annual precipitation available for runoff	Annual storm runoff calculated avg volume (ft3/yr)	Event mean concentration (mg/l)		Annual pollutant loads (lbs)	
							Total suspended solids	Oil & grease	Total suspended solids	Oil & grease
Residential										
Low density	3,370	20	0.23	12.0	0.90	30,387,020	67	1.7	127,144	3,226
Medium density	1,161	30	0.32	12.0	0.90	14,565,070	67	1.7	60,942	1,546
High density	561	60	0.59	12.0	0.90	12,976,132	67	1.7	54,294	1,378
Commercial	761	90	0.86	12.0	0.90	25,657,450	159	9	254,767	14,421
Industrial	833	80	0.77	12.0	0.90	25,145,838	150	3	235,554	4,711
Public	4,318	50	0.50	12.0	0.90	84,641,436	159	9	840,451	47,573
Recreation	20,237	20	0.38	12.0	0.90	301,481,112	200	0.1	3,765,499	1,883
Transportation	1,606	80	0.77	12.0	0.90	48,480,450	140	0	423,865	1,211
Total	32,847					543,334,509			5,762,516	75,948

and other sources of water into the Portneuf River (e.g., stormwater drains) include analysis for oil and grease (or a derivative such as total petroleum hydrocarbons).

Load Analysis

Until more information is gathered as to whether oil and grease are affecting beneficial uses in the Portneuf River, a target concentration of oil and grease content not to exceed 5 mg/l is recommended. A limited search for water quality standards or targets for oil and greases yielded a water quality standard of 10 mg/l from the State of Wyoming (Department of Environmental Quality, State of Wyoming, internet communication). To allow for a margin of safety, the Wyoming standard was decreased by half to account for lack of data on effects of oil and grease on beneficial uses. No targets or standards for oil and grease above which an aesthetic beneficial use is impaired were unearthed.

The maximum allowable load based on a target concentration of 5 mg/l and an estimated annual flow below the area of impact of 168,003 cfs (Table 45) is about 2,268 tons per year:

5 mg/l x 168,003 cfs x 0.0027 [conversion factor to tons/yr] = 2,268 tons/year.

No information was available to estimate the load of oil and grease from other nonpoint sources and there was no indication that any point source was contributing to the load of oil and grease in the Portneuf River.

The estimated current load of 38 tons/yr is substantially less than the allowable load of 2,268 tons/yr. However, at times (e.g., an intense summer rainstorm following weeks of no rain) the estimated load may actually approach the target load. Assuming that the estimated annual load of 38 tons of oil and grease from stormwater runoff is evenly distributed throughout the year, then a three week dry spell, not unusual for July or August, would mean an accumulation of 2.2 tons of oil and grease (3 weeks ÷ 52 weeks x 38 tons) in the city. A summer storm occurred on 10 July 1998 that dropped 0.23 inches of rain at the National Weather Service (NWS) monitoring station about eight miles west of the City of Pocatello (National Weather Service, internet communication). Such a storm would produce about 11.5 million cubic feet of stormwater runoff assuming similar precipitation patterns between the monitoring station and the Pocatello-Chubbuck urban area. This would create a spike in loading to the Portneuf River as well as an increase in load capacity due to increased stream flow.

Flow information at the Pocatello USGS surface-water station from 8-15 September and 29 September-6 October 1998 (USGS, internet communication) was examined to determine an empirical relationship between stream flow and short-term precipitation. Two storm events, 10 and 30 September (recordings of 0.35 and 0.09 inches of precipitation at the NWS monitoring station, respectively [National Weather Service, internet communication]) each resulted in an increase in flow at the Pocatello USGS surface-water station of about 100 cfs. Visual inspection of the two events indicated about 85% of the increase in flow occurred in about 4.5 hours.

Table 45. Estimated monthly load and target load of oil and grease in the Portneuf River.

	Month												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Mean flow (cfs)*	501	561	682	659	552	287	194	283	338	457	507	506	5,527
Total monthly flow	15,531	15,848	21,142	19,770	17,112	8,610	6,014	8,773	10,140	14,167	15,210	15,686	168,003
Target load (tons)	210	214	285	267	231	116	81	118	137	191	205	212	2,268
Estimated load (tons)**	3	3	3	3	3	3	3	3	3	3	3	3	38

*USGS Tyhee surface-water station, Water Years 1985-1994

**total load of 38 tons of oil and grease from stormwater runoff equally divided between the 12 months

Using the above empirical relationship, then the stormwater runoff from a storm producing 0.23 inches would contribute about 600 cfs to the river both above and below the Pocatello gage ([11,571,013 ft^3 of stormwater runoff x 0.85] ÷ [4.5 hours x 3600 seconds/hour] = 607 cfs). Adding this flow to a late summer low flow at the Tyhee USGS surface-water station of 136 cfs (July 1990 [USGS water resources data]) yields a total flow of 743 cfs. A target load for oil and grease at this flow is 1.9 tons/4.5 hours (743 cfs x 5 mg/l x 0.000112 [conversion factor to tons/hr] x 4.5 hours = 1.87 tons/4.5 hours). Assuming that 90% of the 2.2 tons of accumulated oil and grease is delivered to the river within the 4.5 hour period, then the input of 2.0 tons of oil and grease would exceed the 4.5 hour load of 1.9 tons at a target of 5 mg/l. Assuming runoff from the storm entered the Portneuf River within 24 hours, the 1.9 ton load of oil and grease would not exceed the daily target of 3.6 tons (11,571,013 ft^3 of stormwater runoff ÷ [24 hours x 3600 seconds/hour] = 134 cfs; [134 cfs + 136 cfs] x 5 mg/l x 0.0027 = 3.6 tons).

The loading analysis indicates that conditions could be such that the target load capacity could be exceeded on a short term basis. Until such time that data indicate otherwise, it is recommended that there be no increase in the present input of oil and grease into the Portneuf River.

Margin of Safety

The input of oil and grease into the Portneuf River and its effect on water quality is unknown. The Wyoming standard was decreased by half, from 10 mg/l to 5 mg/l, as a margin of safety to account for the lack of data on the effects of oil and grease on beneficial uses.

Data Gaps

Numerous assumptions were part of the foregoing scenario - an indication that much more information is needed on oil and grease in the Portneuf River. In addition, there was no accounting for effect of the soon-to-be-online engineered wetlands for treating storm water runoff in the City of Pocatello. Data should be collected to determine if there is a load of oil and grease into the river, and what, if any, impact such a load is having on beneficial uses.

3.2.5 Sediment

Standard

> Sediment - shall not exceed quantities specified in Section 250, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350.02.b (*Water Quality Standards and Wastewater Treatment Requirements 200.08.*[Idaho Department of Health and Welfare N.A.])

Target

Suspended Sediment
High flow - not to exceed a 14-day average of greater than 80 mg/l
Low flow - not to exceed a 28-day average of greater than 50 mg/l

Depth Fines
Subsurface streambed sediment less than 6.25 mm not to exceed a 5-year mean of greater than 25% by volume in riffles
Subsurface streambed sediment less than 0.85 mm not to exceed a 5-year mean of greater than 10% by volume in streams with salmonid spawning as a beneficial use in riffles

Discussion

All streams on the 303(d) list in the Portneuf River have sediment listed as a pollutant of concern (Table 19). Major sources of sediment include agricultural, both farming and grazing, and urban activities (Hancock and Bybee 1978; Hoover 1985; Ozburn and Modersitzki 1986; Soil Conservation Service 1993). Streambanks have also been identified as substantial sources of sediment in the Portneuf River (Heimer and Ratzlaff 1987; Portneuf Soil and Water Conservation District 1996).

Sediment loads within the Portneuf River subbasin have been estimated by various authors (Table 46). From 1965 to 1977, the estimated annual sediment load in the Portneuf River decreased from 2.6 million tons to about 1 million tons. During the same period, estimated sediment loads decreased by two-thirds in Marsh Creek. The reason for this estimated decrease in sediment loads is unknown.

Present loads, along with an estimate of natural sediment input, were calculated based on sediment yield from various types of land uses above the Pocatello, Marsh Creek, and Topaz USGS surface-water stations (Tables 47, 48, 49, 50: Appendix D). About 77,500 acres in the southeast area of the subbasin, south and east of Bancroft, were not used in the calculations as it appears that any drainage/ runoff from this area does not reach any major tributary or the Portneuf River. Sediment input from streambanks was calculated on a tons/mile segregated by stream size rather than riparian area. Sediment loads ranged from about 125,000 tons for the area above Topaz to 400,000 tons for the subbasin above Pocatello. These loads seem reasonable compared to previous estimates based on improvement in land use practices on agricultural land in the subbasin and transfer of cropland into the Conservation Reserve Program.

Sediment delivery curves were used to estimate suspended sediment loads above three gage sites (Figure 14). Loads were calculated from daily flow information at three gaging stations using a simple linear regression model (Appendix F). Daily loads were summed to get the total annual load from 1955 (first full year of operation for Marsh Creek gage) to 1995 (Appendix D). Loads based on target concentrations were made by multiplying the appropriate concentration (Table 51) by average daily flow per month by number of days in the month. Loads by month

Table 46. Estimated sediment loads in the Portneuf River subbasin.

Area	Year	Sampling period (days)	Sediment load (tons/yr)*	Source
Portneuf River subbasin	1965	365	2,670,550	Merrell and Onstott 1965
Marsh Creek watershed	1965	365	1,398,000	Merrell and Onstott 1965
Portneuf River subbasin	1975-1976	365	929,282	Roberts 1977
Marsh Creek watershed	1975-1976	365	447,840	Roberts 1977
Portneuf River above Pebble Creek, below Downey Canal	1975-1976	365	59,702	McSorley 1977
Portneuf River just below Dempsey Creek	1975-1976	365	163,608	McSorley 1977
Portneuf River above Upper Rock Creek	1975-1976	365	154,845	McSorley 1977
Portneuf River just above Rapid Creek	1975-1976	365	234,029	McSorley 1977
to Portneuf River from Marsh Creek	1975-1976	365	79,000	McSorley 1977
North Fork Pocatello Creek	1985-1986	232**	2316	Drewes 1987
South Fork Pocatello Creek	1985-1986	232**	155	Drewes 1987
Sorrell Canyon	1985-1986	232**	93	Drewes 1987
Indian Creek	1985-1986	232**	258	Drewes 1987
Rapid Creek	1985-1986	232**	9,450	Drewes 1987
Jackson Creek	1985-1986	232**	373	Drewes 1987
Dempsey Creek	1985-1986	232**	7,266	Drewes 1987
Portneuf River at Downey Canal	1995-1997	215***	1,909	Rudel 1998
Portneuf River above Pebble Creek	1995-1997	215***	1,041	Rudel 1998

*Merrell and Onstott and Drewes estimates based on agricultural land
**sampling period 18 Nov 1985 to 8 July 1986
***average from years 1995-1997; sampling period 15 March to 15 October

Table 47. Estimated sediment load above the Pocatello USGS surface-water station.

Land use*	Acres	Stream miles	Sediment yield (tons/ac/yr)	Sediment yield (tons/mi/yr)	Sediment load (tons/yr)	Percent contribution
Dryland agriculture	118,309		1.95		230,703	55.8%
SAWQP-treated land	12,891		0.78		10,055	2.4%
CRP land	78,619		0.01		786	0.2%
Irrigated agriculture - gravity	39,436		1		39,436	9.5%
Irrigated agriculture - sprinkler	36,350		1		36,350	8.8%
Rangeland	308,632		0.258		79,627	19.3%
Forest	124,613		0.00825		1,028	0.2%
Riparian**	8,566					
Downey Canal		7.8		300	2,340	0.6%
Upper canals/ditches					27	0.0%
Portneuf R. bel. Downey Canal		63.3		40.1	2,538	0.6%
Marsh Creek		37.4		40.1	1,499	0.4%
Tributaries		187.5		33.9	6,356	1.5%
Water	1,263				0	0.0%
Urban - Pocatello & Chubbuck	32,847***				2,881	0.7%
Total	728,679	296			413,626	

*based on Idaho Department of Water Resources Geographic Information System land use coverage. SAWQP=State Agricultural Water Quality Program, CRP=Conservation Reserve Program

**input of sediment from streambanks based on stream length rather than riparian area

***includes acreage both upstream and downstream of the site; see Table 44

Table 48. Estimated sediment load above the Marsh Creek USGS surface-water station.

Land use*	Acres	Stream miles	Sediment yield (tons/ac/yr)	Sediment yield (tons/mi/yr)	Sediment load (tons/yr)	Percent contribution
Dryland Agriculture	78,802		1.95		153,664	75.7%
SAWQP-treated land	4,989		0.78		3,891	1.9%
CRP land	35,183		0.01		352	0.2%
Irrigated agriculture - gravity	13,467		1		13,467	6.6%
Irrigated agriculture - sprinkler	17,161		1		17,161	8.5%
Rangeland	42,590		0.258		10,988	5.4%
Forest	39,257		0.01		393	0.2%
Riparian**	112					
Mainstem Marsh Creek		21.3		40.1	855	0.4%
Tributaries		67.5		33.9	2,288	1.1%
Urban***	3,390				0	0.0%
Total	234,951				203,058	

*based on Idaho Department of Water Resources Geographic Information System land use coverage. SAWQP= State Agricultural Water Quality Program, CRP=Conservation Reserve Program

**input of sediment from streambanks based on stream length rather than riparian area

***unknown

Table 49. Estimated sediment load above the Topaz USGS surface-water station.

Land use*	Acres	Stream miles	Sediment yield (tons/ac/yr)	Sediment yield (tons/mi/yr)	Sediment load (tons/yr)	Percent contribution
Dryland agriculture	24,086		1.95		46,968	37.4%
SAWQP-treated land	7,902		0.78		6,164	4.9%
CRP land	32,170		0.01		322	0.3%
Irrigated agriculture - gravity	13,683		1		13,683	10.9%
Irrigated agriculture - sprinkler	16,253		1		16,253	13.0%
Rangeland	139,976		0.258		36,114	28.8%
Forest	54,238		0.006		325	0.3%
Riparian	0					
Downey Canal		7.8		300	2,340	1.9%
Upper canals/ditches					27	0.0%
Portneuf R. bel. Downey Canal		23.5		40.1	944	0.8%
Tributaries		68.3		33.9	2,315	1.8%
Water	1,263				0	0.0%
Urban***	2,206				0	0.0%
Total	291,777				125,454	

*based on Idaho Department of Water Resources Geographic Information System land use coverage. SAWQP=State Agricultural Water Quality Program, CRP=Conservation Reserve Program

**input of sediment from streambanks based on stream length rather than riparian area

***unknown but considered minimal based on McSorley (1977)

Table 50. Estimated natural sediment load in the Portneuf River subbasin.

Site	Acres	Sediment load uplands* (tons/yr)	Portneuf River		Marsh Creek		Tributaries		Total sediment yield* (tons/yr)
			Stream miles**	Sediment load*** (tons/yr)	Stream miles**	Sediment load*** (tons/yr)	Stream miles**	Sediment load*** (tons/yr)	
Portneuf River subbasin	846,026	5,076	84.1	3,883	37.4	1,229	203.1	3,127	13,315
above Pocatello gage	816,651	4,900	73.5	3,394	37.4	1,229	187.5	2,887	12,410
above Topaz gage	369,155	2,215	34.1	1,575			68.3	1,051	4,841
Marsh Creek watershed	271,642	1,630			37.4	1,229	86.7	1,335	4,193
above Marsh Creek gage	234,951	1,410			21.3	686	67.5	1,039	3,135

*based on a sediment yield of 0.006 tons/ac/yr (Caribou National Forest 1985)

**stream miles: Portneuf River - mouth to Toponce Creek; Marsh Creek - mouth to Birch Creek

***sediment load = length of stream x bank height x 1 in of bank assuming 70 lbs of soil per cubic foot (Merrell and Onstott 1965); Portneuf River bank height = 3 ft, Marsh Creek bank height = 2 ft, tributaries bank height = 1 ft

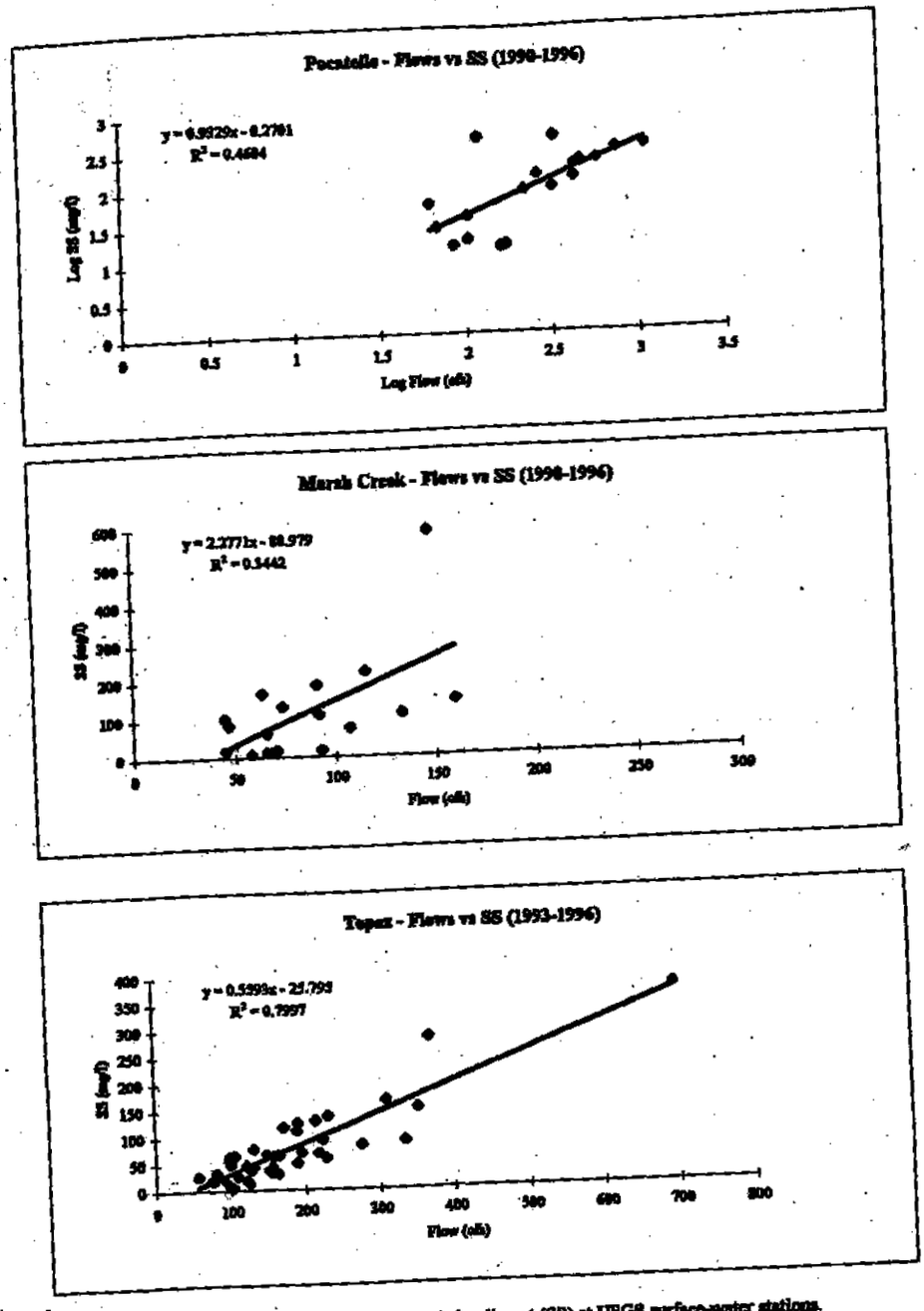


Figure 14. Regressions between flow and suspended sediment (SS) at USGS surface-water stations.

Table 51. Suspended sediment (SS) target concentrations at USGS surface-water stations and percentile rank of target concentrations within the range of concentrations observed at the stations during the respective time periods. For example, at the Marsh Creek surface-water station during low flows from June to January, 64% of the measured concentrations of suspended sediment since 1988 have been at or below 50 mg/l. It must be remembered that the target concentrations are not instantaneous but are 14-day or 28-day averages.

Site	Hydrographic period*	Time period	SS target (mg/l)	Percentile rank**
Pocatello	High flow	February - May	80	< 1
	Low flow	June - January	50	62
	Annual	January - December	66	37
Marsh Creek	High flow	February - May	80	3
	Low flow	June - January	50	64
	Annual	January - December	63	36
Topaz	High flow	April - June	80	46
	Low flow	July - March	50	62
	Annual	January - December	61	51

*chosen based on mean discharge per month for period of record
**based on data since 1988

were summed to get the total annual load (Appendix D). Average annual loads for all estimates were derived from total loads from years 1955 to 1995.

In-stream suspended sediment loads as estimated at the gage sites were substantially less than those estimates from land use sediment yield (Tables 47, 48, 49, 52). Some difference might be expected at Pocatello and Marsh Creek as the correlation index (R^2 - a measurement of the intensity of association between two variables) are 0.27 and 0.34, respectively. However, flow and sediment have a much closer relationship at Topaz where the R^2 value is 0.80. First it should be pointed out that sediment yield was delivery of sediment to a stream. Retention of sediment in adjacent streams which does not reach the mainstem would explain some of the difference between sediment yield and suspended sediment as measured at gage sites on Portneuf River or Marsh Creek. Another possible reason for difference is that the regression equations may substantially underestimate the amount of sediment moving during spring runoff. Sampling at the sites was limited during spring runoff. Finally, sediment which moves along the streambed (bedload) rather than suspended in the water column would not be included in the estimates of suspended sediment loads. No data have been reviewed that gave any values for bedload in the Portneuf River. Information on size of suspended sediment (Appendix D) indicates that particle size is primarily less than 0.062 mm (88% - overall median from the four gaging stations, 1980-1995) possibly indicating larger particles are moving as bedload. Sediment targets and load reductions were based on suspended sediment with the assumption that decreases in suspended sediment would mean concurrent reductions in other forms of sediment (e.g., bedload).

Load Analysis

Suspended Sediment

Targets to establish the load reduction were based on effects of sediment in the water column (suspended sediment) and when it settles out (depth fines). Conditions less than or equa to the recommended targets will result in improving support of beneficial uses within the subbasi

Site-specific targets for suspended sediment in the Portneuf River were not attempted. N information was reviewed on site-specific levels of suspended sediment or total suspended solid needed to support beneficial uses in the Portneuf River. Loading, or assimilative, capacity was not estimated because of a paucity of data. For purposes of the loading analysis, assimilative capacity was considered to be equal to the target load.

The targets for suspended sediment are: 1) outside the spring runoff period not to excee a 28-day average of 50 mg/l, and 2) during spring runoff not to exceed a 14-day average of 80 mg/l. The European Inland Fisheries Advisory Commission (EIFAC 1964) in their review of suspended solids in relation to fisheries concluded that concentrations less than 25 ppm have no harmful effect on fisheries; concentrations of 25-80 ppm will have some effect but it is possible maintain good to moderate fisheries; concentrations of 80-400 ppm are unlikely to support goo fisheries; and, concentrations greater than 400 ppm will at best result in poor fisheries.

Table 52. Estimated reductions in load (tons/year) for suspended sediment at USGS surface-water stations.

Site	Natural load*	Present suspended sediment load**	Confidence interval***	Target load^	Load reduction^^	Percent reduction from present load
Pocatello	12,410	54,346	± 16,399	19,263	35,083	65%
Marsh Creek	3,135	16,309	± 4,467	5,372	10,937	67%
Topaz	4,841	25,201	± 6,605	11,961	13,240	53%

*see Table 50

**average annual load from 1955 to 1995, except 1986-1993 at Tyhee. Annual load derived by summing daily suspended sediment loads estimated from flow:suspended sediment linear regression models of data collected at the gage sites since 1990 (Pocatello, Marsh Creek) or 1993 (Topaz); see Figure 14.

***95% confidence interval for present suspended sediment load estimate

^average annual load from 1955 to 1995, except 1986-1993 at Tyhee. Annual load derived from the sum of the monthly loads calculated by multiplying the appropriate target concentration by the average flow per month by the number of days per month.

^^difference between present and target loads

Newcombe and MacDonald (1991) argued that duration of the event must also be considered in addition to concentration of suspended sediment.

Evaluating recommended targets using models suggested by Newcombe and Jensen (1996) showed mixed results. The recommended targets fall below the lethal and paralethal range as determined by concentration-duration tables for juvenile and adult salmon (Models 1-3; Table 53). Both targets at the recommended duration of either 14 days or 28 days would fall within the lethal and paralethal range for eggs and larvae of salmonids and non-salmonids and for adult freshwater nonsalmonids based on Newcombe and Jensen's Models 4 and 6, respectively. The durations which would have to be met to fall "below" the lethal/paralethal range (sublethal) are about 1 day at both 50 and 80 mg/l for eggs and larvae of salmonids and non-salmonids (Table 54). For adult freshwater nonsalmonids, the lethal range duration thresholds are less than 5 days at 50 mg/l and 4 days at 80 mg/l. It is unknown whether at certain times of the year (e.g., spring runoff or intense summer rainstorms) the Portneuf River may have naturally exceeded these concentrations of 50 and 80 mg/l for durations of greater than 5 days.

Targets for the Portneuf River are congruent with other "local" standards and targets. Nevada has a state standard of 25 and 80 mg/l depending on the water body classification. Targets have been set at 56 mg/l in tributaries and return drains in the Yakima River in Washington (Joy and Patterson 1997); 35 mg/l for smaller streams, 90 mg/l for larger streams in the Bear River in Utah (Ecosystem Research Institute 1995); and 50 mg/l and 80 mg/l for the lower Boise River (Division of Environmental Quality 1998).

The suspended sediment targets are recommended despite modeling which indicates that the targets may have lethal or paralethal effects on the fish community in the Portneuf River. Considering that good to moderate fisheries can be maintained at these target concentrations (EIFAC 1964) and that natural conditions may have exceeded sublethal durations at target concentrations, the decision was made to recommend the two targets. The targets will be subject to change based on information indicating the natural concentrations of suspended sediment and the duration exposure on fish or information indicating proposed targets do not support beneficial uses.

Effectiveness monitoring sites were set at Pocatello, Marsh Creek, and Topaz USGS surface-water stations. Tyhee was not chosen because the area between Tyhee and Pocatello gages is an area of deposition of sediment (compare mean concentrations and flow:suspended sediment regression equation since 1989 in Table 38 and Appendix F, respectively; Bechtel Environmental, Inc. 1994) and, therefore, would be a less accurate measure of sediment load than the Pocatello gage site.

Total load reductions of suspended sediment are presented in Table 52. The present suspended load is the average annual load from 1955 to 1995 based upon the flow:suspended sediment regression equation. Target load capacities were also the average annual load for the same time period calculated from the monthly load summed on an annual basis. The difference between the present load and target load represents the load reduction. Load reductions ranged from 53% at Topaz to 67% at Marsh Creek.

Table 53. Severity of ill effect (SEV) from target loads of suspended sediment for high flows and low flows in the Portneuf River subbasin (based on Newcombe and Jensen 1996). Ranges of severity of ill effect are nil effect (SEV=0), behavioral effects (SEV=1-3), sublethal effects (SEV=4-8), and lethal and paralethal effects (SEV=9-14). Target loads at high flow are not to exceed a mean of 80 mg/l over a 14-day period. Target loads at low flow are not to exceed a mean of 50 mg/l over a 28-day period.

	Model*				
	1	2	3	4	6
High flow	8	8	8	11	9
Low flow	8	8	8	12	10

*models 1-3 are for juvenile and/or adult salmonids in streams where particle size ranges from fine (predominantly < 75 um) to coarse (75-250 um). Model 4 is for eggs and larvae of salmonids and nonsalmonids and fine particle sizes. Model 6 is for adult freshwater nonsalmonids and fine particle sizes.

Table 54. Duration of exposure (days) at suspended sediment concentrations of 50 and 80 mg/l which results in a severity of ill effect below the lethal and paralethal class (SEV<=8) for eggs and larvae of salmonids and nonsalmonids and adult freshwater nonsalmonids (based on Newcombe and Jensen 1996).

	Model*	
	4	6
High flow	0.92	3.60
Low flow	1.05	4.34

*model 4 is for eggs and larvae of salmonids and nonsalmonids and fine particle sizes. Model 6 is for adult freshwater nonsalmonids and fine particle sizes.

Loads of suspended sediment were apportioned by source based on estimated percentage of sediment yield by land use (Tables 47, 48, 49). The burden of load reduction is on agriculture, primarily dryland agriculture (Table 55). Other major sources of sediment into the Portneuf River subbasin streams include rangeland and the streams themselves, either through streambank erosion or scouring of streambed sediment during high flow events. Please note that natural loads were considered part of the target loads, not in addition to the target loads.

As flow information is limited on the tributaries, no load reductions were estimated. However, targets will remain the same as at the gaging stations. For streams above Topaz station, the high flow target of suspended sediment not to exceed 80 mg/l will be applicable from April to June and the low flow target of 50 mg/l from July to March. For all other streams (e.g., Portneuf River below Pocatello gage site), the high and low flow targets will be applicable from February to March and April to January, respectively (Table 51).

Discharge of total suspended solids from four NPDES-permitted dischargers for which information is available has been less than the target suspended sediment concentrations (Table 56). The permit requirements for total suspended solids at Pocatello and Lava Hot Springs sewage treatment plants are a 7-day average not to exceed 45 mg/l and a 30-day average not to exceed 30 mg/l. The two STPs have averaged 12 and 7 mg/l of TSS, respectively, for the last full year of available data. The Batise Springs Hatchery's permit for total suspended solids requires the daily average not to exceed 5 mg/l with the daily maximum no greater than 15 mg/l. The permit for Inkom STP limits total suspended solids in effluent to maximum 7-day and 30-day averages of 105 and 70 mg/l, respectively; average TSS concentration from November 1997 to October 1998 was 22 mg/l. Although permit limits exceed the recommended target concentration, STP limitations are for total suspended solids not suspended sediment. At present input levels, there is no need for a reductions in wasteloads for the three STPs and Batise Springs Hatchery. Therefore, no wasteload reduction is proposed, but it is recommended and consistent with state policy that current input of total suspended solids not increase.

Margin of Safety

The chosen targets allow for a margin of safety well within the range of suspended sediment which is required to maintain good to moderate fisheries. The targets, which are seasonally based, result in an annual average of 62 to 64 mg/l (Table 51), well within the range of 25 to 80 mg/l required to maintain good to moderate fisheries (EIFAC 1964).

As an additional margin of safety, the average suspended sediment load from 1955 to 1995 was used in the load analysis. The average annual loads represented the 69th, 67th, and 68th percentile of all loads estimated during the time period at the Pocatello, Marsh Creek, and Topaz surface-water stations. In other words, the average annual loads at all three gage sites were in about the upper 30% of all the estimated loads. Therefore, total reductions in suspended sediment load are greater using the annual average than had the median annual load been used.

The load allocation of total suspended solids from Pocatello-Chubbuck storm water runoff also included a margin of safety. The estimated target load capacity was reduced by 5%.

Table 55. Suspended sediment load reductions by source based on percentage of sediment yield by land use.

Source	Estimated % of sediment input	Suspended sediment load reduction (tons/year)
Pocatello		
Dryland agriculture	55.8%	19,568
SAWQP-treated land	2.4%	853
CRP land	0.2%	67
Irrigated agriculture - gravity	9.5%	3,345
Irrigated agriculture - sprinkler	8.8%	3,083
Rangeland	19.3%	6,754
Forest	0.2%	87
Riparian		
Downey Canal	0.6%	198
Upper canals/ditches	0.0%	2
Portneuf R. bel. Downey Canal	0.6%	215
Marsh Creek	0.4%	127
Tributaries	1.5%	539
Water	0.0%	0
Urban - Pocatello & Chubbuck	0.7%	244
Total		35,083
Marsh Creek		
Dryland Agriculture	75.7%	8,277
SAWQP-treated land	1.9%	210
CRP land	0.2%	19
Irrigated agriculture - gravity	6.6%	725
Irrigated agriculture - sprinkler	8.5%	924
Rangeland	5.4%	592
Forest	0.2%	21
Riparian		
Mainstem Marsh Creek	0.4%	46
Tributaries	1.1%	123
Urban	0.0%	0
Total		10,937
Topaz		
Dryland agriculture	37.4%	4,957
SAWQP-treated land	4.9%	650
CRP land	0.3%	34
Irrigated agriculture - gravity	10.9%	1,444
Irrigated agriculture - sprinkler	13.0%	1,715
Rangeland	28.8%	3,811
Forest	0.3%	34
Riparian		
Downey Canal	1.9%	247
Upper canals/ditches	0.0%	3
Portneuf R. bel. Downey Canal	0.8%	100
Tributaries	1.8%	244
Water	0%	0
Urban	0%	0
Total		13,240

Table 56. Concentrations of total suspended solids discharged into the Portneuf River by NPDES-permitted facilities in the last 12 months for which information was available (from Discharge Monitoring Reports).

		Total suspended solids (mg/l)							
		LHS STP*		Inkom STP		Pocatello STP		Batise Springs Hatchery	
Month	Year	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
November	1997	0.5		10				0.5	
December		ND**		5		16.2	19	3.7	
January	1998	ND		15		14.1	17	0.4	
February		ND		15		11.2	12	1.5	
March		8		26		11.2	12.4	0.6	
April		ND		43		13	16	0.7	
May		ND		18		12.8	14.4	1.2	
June		11		30		12.3	18.8	-0.1	
July		ND		26		8.5	10.5	1	
August		ND		15		6.8	7.4	0.5	
September				14		9.3	11	1.2	
October				52		12.7	13.7	1.2	
November						16.6	20.6		
December									
Average		7		22		12	14	1	

*LHS=Lava Hot Springs, STP=sewage treatment plant
**no discharge to River

Data Gaps

Additional information would help to improve the TMDL in future years. For example, sediment input from canals and ditches in the upper Portneuf River was estimated but no information was located on the contribution from canals and ditches in Marsh Creek or the lower Portneuf River. Little information is available on urban input of sediment in the subbasin such as from construction sites or the fraction of suspended sediment in the total suspended solids input from sewage treatment plants . The effect of increased snowpack and resultant runoff from cloud seeding is unknown. Past effects of sediment input from drawdown of Chesterfield Reservoir are difficult to quantify. At a minimum, regular monitoring at the mouth of tributaries, canals/ditches, storm water drains, etc., would help quantify the contribution these sources make to sediment loading in the Portneuf River. Additional monitoring during spring runoff might narrow down differences in sediment loading based on land use and concentrations of suspended sediment at the surface-water stations.

Depth Fines

No loads for volume of streambed subsurface sediment were estimated for lack of information. In addition, no information was available to establish a linkage between reduction in suspended sediment loads and corresponding reductions in streambed subsurface sediment. As previously stated, it is assumed that in setting a load reduction of suspended sediment, there is an expected concomitant reduction in all sediment to streams in the Portneuf River subbasin. To ensure that such a decrease is occurring, targets are set for subsurface streambed sediment (depth fines) less than 6.25 mm not to exceed a 5-year mean of 25% by volume, and depth fines less than 0.85 mm not to exceed a 5-year mean of 10% by volume in all streams supporting, or designated to support, salmonid spawning in the Portneuf River subbasin. Both targets are recommended for riffle areas only, primarily those sections conducive to salmonid spawning.

Numerous agencies have set targets for depth fines to support primarily salmonid fisheries. The Salmon and Challis National Forest bases subsurface sediment standards on watershed geology (Betsy Rieffenberger, Salmon and Challis National Forest, personal communication). In granitic, volcanic, and sedimentary drainages, streams in good, fair, and poor condition will have < 25%, 25-30%, and > 30% fines, respectively. Montana recognized a subsurface sediment standard in their Deep Creek TMDL of 30% fines < 6.35 mm (Endicott and McMahon 1996). The Idaho Division of Environmental Quality (Division of Environmental Quality 1991) set two targets for the South Fork Salmon River: 1) for those streams with subsurface sediment less than 27%, maintain the existing sediment volume level; and, 2) for streams that exceed the 27% threshold, reduce subsurface sediment to a 5-year mean not to exceed 27% with no individual year to exceed 29%. Based on Burton et al. (1990) work in southern Idaho (e.g., Rock Creek near Twin Falls), a 27% target for subsurface sediment would be applicable to the Portneuf River. To include a margin of safety, the target was set at 25% for depth fines.

Several reports have proposed that smaller sediment (< 0.85 mm) is especially harmful to salmonids during the incubation and emergence period (Hall 1986; Reiser and White 1988). To support salmonid spawning, the depth fines < 0.85 mm target is recommended.

Due to variability of sediment transport in the Portneuf River, targets are set over a 5-year time period. This recommendation is similar to the TMDL established in the South Fork of the Salmon River (Division of Environmental Quality 1991).

Margin of Safety

As mentioned above, a 27% target for subsurface sediment less than 6.25 mm by volume would be applicable (Burton et al. 1990). The target was set at 25% to allow a margin of safety.

Data Gaps

The link between suspended sediment reductions and reduction in depth fines is unknown. Monitoring of reductions in both parameters may help deduce such a relationship.

3.2.6 Nutrients

Standard

Un-ionized ammonia - not to exceed criteria for cold water biota and salmonid spawning (in streams with salmonid spawning as a designated or existing beneficial use) (*Water Quality Standards and Wastewater Treatment Requirements 250.02.c.iii.*[Idaho Department of Health and Welfare N.A.])

Excess nutrients - surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses (*Water Quality Standards and Wastewater Treatment Requirements 200.06.*[Idaho Department of Health and Welfare N.A.])

Target

Nitrogen not to exceed 0.3 mg/l of nitrogen as total inorganic nitrogen

Phosphorus

Rivers - not to exceed 0.075 mg/l of phosphorus as total phosphorus

Hawkins Reservoir - not to exceed 0.025 mg/l of phosphorus as total phosphorus

Discussion

About half of the water bodies on the 303(d) list in the Portneuf River subbasin have nutrients identified as a pollutant, including the entire Portneuf River from Chesterfield Reservoir to American Falls Reservoir (Table 19). Major inputs of nutrients above the City of Pocatello

include agriculture, both cropland and livestock (McSorley 1977; Hoover 1985; Drewes 1987; Rupert 1996). Point source pollution in the upper Portneuf River is insignificant in comparison with nonpoint source pollution (McSorley 1977). Within and below the urban areas of Pocatello and Chubbuck, major nonpoint sources of nutrients are of urban (Perry and Clark 1990, Campbell et al. 1992) and agricultural origins (Drewes 1987; Rupert 1996). Point sources of nutrients in the lower Portneuf include springs (Perry et al. 1977; Perry and Clark 1990) and the City of Pocatello's sewage treatment plant (Perry et al. 1977; Brock 1989).

Estimates of nutrient loading in the Portneuf River subbasin have been limited (Table 57). Hoover (1985) estimated annual nitrate, total phosphorus, and ortho phosphate loads from the Portneuf River drainage above Pebble Creek at 94.4, 8.4, and 2.9 tons/yr, respectively. Estimates made by Rudel (1998) for the same area seem to indicate that nutrient loadings, especially for nitrogen, have diminished in the last 20 years.

Targets are recommended for both nitrogen and phosphorus. Minshall and Andrews (1973) reported that at certain times of the year nitrogen in the form of nitrate is limiting. Generally, the ratio of nitrogen to phosphorus within phytoplankton is somewhere in the range of 10:1 to 17:1 (Mackenthun 1973). A rudimentary look at the ratio of total inorganic nitrogen (TIN) to total ortho phosphorus (a form of phosphorus most readily available for nutrient uptake than total phosphorus), indicates that, based on ratio of means at the gaging sites (Table 38), nitrogen appears to be limiting in the lower Portneuf River near the Tyhee site.

In addition to problems of beneficial use support within a subbasin, the effect of nutrients on downstream subbasins is a further concern (e.g., mid-Snake River near Twin Falls). The control of both nitrogen and phosphorus is necessary for protection of beneficial uses not only in the Portneuf River subbasin but in areas downstream such as American Falls Reservoir (Perry et al. 1977). Campbell et al. (1992) remarked that nutrient input in the lower Portneuf River has resulted in ". . . marked eutrophication in slow moving parts of the [Portneuf] river and American Falls River [sic] downstream."

Loads were calculated for total inorganic nitrogen and total phosphorus. TIN was not measured directly but derived by summing nitrate, nitrite (when measured), and ammonia. TIN was chosen for two reasons: 1) it best represents the nitrogen available for uptake by algae and aquatic vegetation and, 2) it includes nitrogen in the form of ammonia which becomes important in the lower Portneuf River. For phosphorus, total phosphorus was used as it was consistently measured by the USGS (Appendix E). For the upper three surface-water stations, only data since 1988 were used, because of decline, sometimes significantly, in nutrient levels between the two periods (Tables 38, 39). At the Tyhee gage site, however, data from both the early and late periods were used. This decision was based on a significant increase in nitrate levels between the two periods and no significant decrease in phosphorus (Tables 38, 39). Furthermore, Campbell et al. (1992) reported an overall increase in ortho phosphate from 1972 to 1991.

Two methods were used to estimate present loads (Appendix G). Loads were calculated by using flow:nutrient regression equations (Figures 15, 16; Appendix F) at the four surface-water stations and by multiplying average nutrient concentration (Table 38) by average daily flow per

Table 57. Estimated nutrient loads in the Portneuf River subbasin.

Area	Year	Nutrient	Sampling period (days)	load (tons/yr)	load (tons/day)	Source
Portneuf River at Downey Canal	1995-1997	Total inorganic nitrogen	215[a]	2.1		Rudd 1998
		Total phosphorus	215[a]	3.1		Rudd 1998
Portneuf River above Pebble Creek	1995-1997	Total inorganic nitrogen	215[a]	8.5		Rudd 1998
		Total phosphorus	215[a]	2.7		Rudd 1998
Portneuf River above Pebble Creek	1985	Nitrate	365	94.4		Hoover 1985
		Total Kjeldahl nitrogen	365	61.3		Hoover 1985
		Total phosphorus	365	8.4		Hoover 1985
		Ortho phosphate	365	2.9		Hoover 1985
Portneuf River at Downey Canal	1985	Nitrate	365	15.0		Hoover 1985
		Total Kjeldahl nitrogen	365	90.7		Hoover 1985
		Total phosphorus	365	8.0		Hoover 1985
		Ortho phosphate	365	2.2		Hoover 1985
Twenty-mile Creek	1985	Nitrate	365	3.0		Hoover 1985
		Total Kjeldahl nitrogen	365	4.3		Hoover 1985
		Total phosphorus	365	1.3		Hoover 1985
		Ortho phosphate	365	0.1		Hoover 1985
Eighteen-mile Creek	1985	Nitrate	365	1.5		Hoover 1985
		Total Kjeldahl nitrogen	365	3.3		Hoover 1985
		Total phosphorus	365	0.5		Hoover 1985
		Ortho phosphate	365	0.1		Hoover 1985
Toponce Creek	1985	Nitrate	365	1.2		Hoover 1985
		Total Kjeldahl nitrogen	365	4.6		Hoover 1985
		Total phosphorus	365	0.7		Hoover 1985
		Ortho phosphate	365	0.1		Hoover 1985
Portneuf River above Pebble Creek, below Downey Canal	1975-1976	Total nitrogen	February		0.54	McSorley 1977
			May		1.70	McSorley 1977
			September		0.78	McSorley 1977
Portneuf River just below Dempsey Creek	1975-1976	Total nitrogen	February		1.22	McSorley 1977
			May		2.45	McSorley 1977
			September		0.44	McSorley 1977
Portneuf River above Upper Rock Creek	1975-1976	Total nitrogen	February		1.39	McSorley 1977
			May		4.20	McSorley 1977
			September		0.14	McSorley 1977
Portneuf River just above Rapid Creek	1975-1976	Total nitrogen	February		1.49	McSorley 1977
			May		5.87	McSorley 1977
Marsh Creek	1975-1976	Nitrate	Runoff		1.75	McSorley 1977
		Ammonia			0.06	McSorley 1977
		Total Kjeldahl nitrogen			0.97	McSorley 1977
		Total phosphorus			0.30	McSorley 1977
		Ortho phosphate			0.20	McSorley 1977
	1975-1976	Nitrate	After runoff		0.00	McSorley 1977
		Ammonia			0.09	McSorley 1977
		Total Kjeldahl nitrogen			0.08	McSorley 1977
		Total phosphorus			0.08	McSorley 1977
		Ortho phosphate			0.13	McSorley 1977

[a]average from years 1995-1997: sampling period 15 March to 15 October

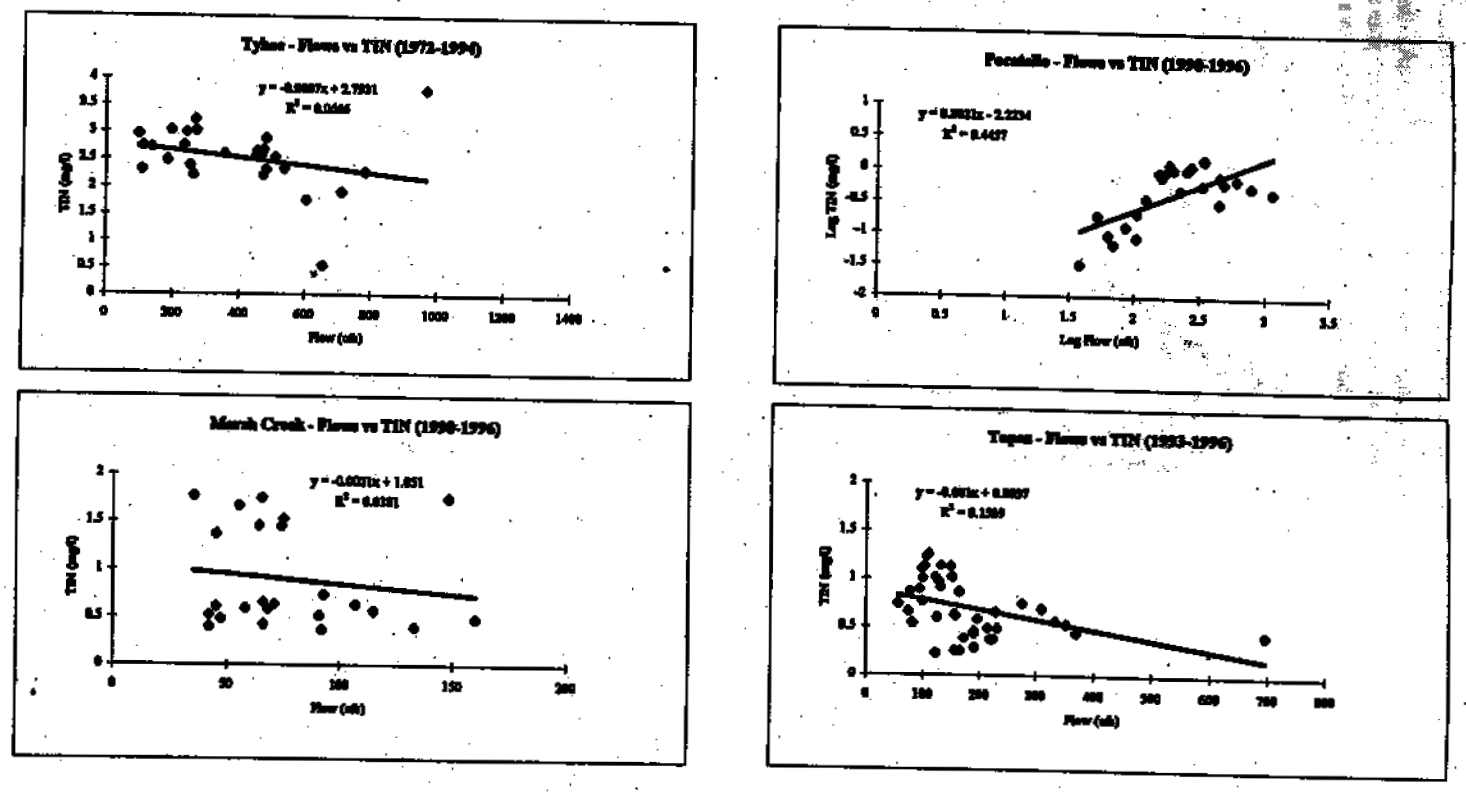


Figure 15. Regressions between flow and total inorganic nitrogen (TIN) at USGS surface-water stations.

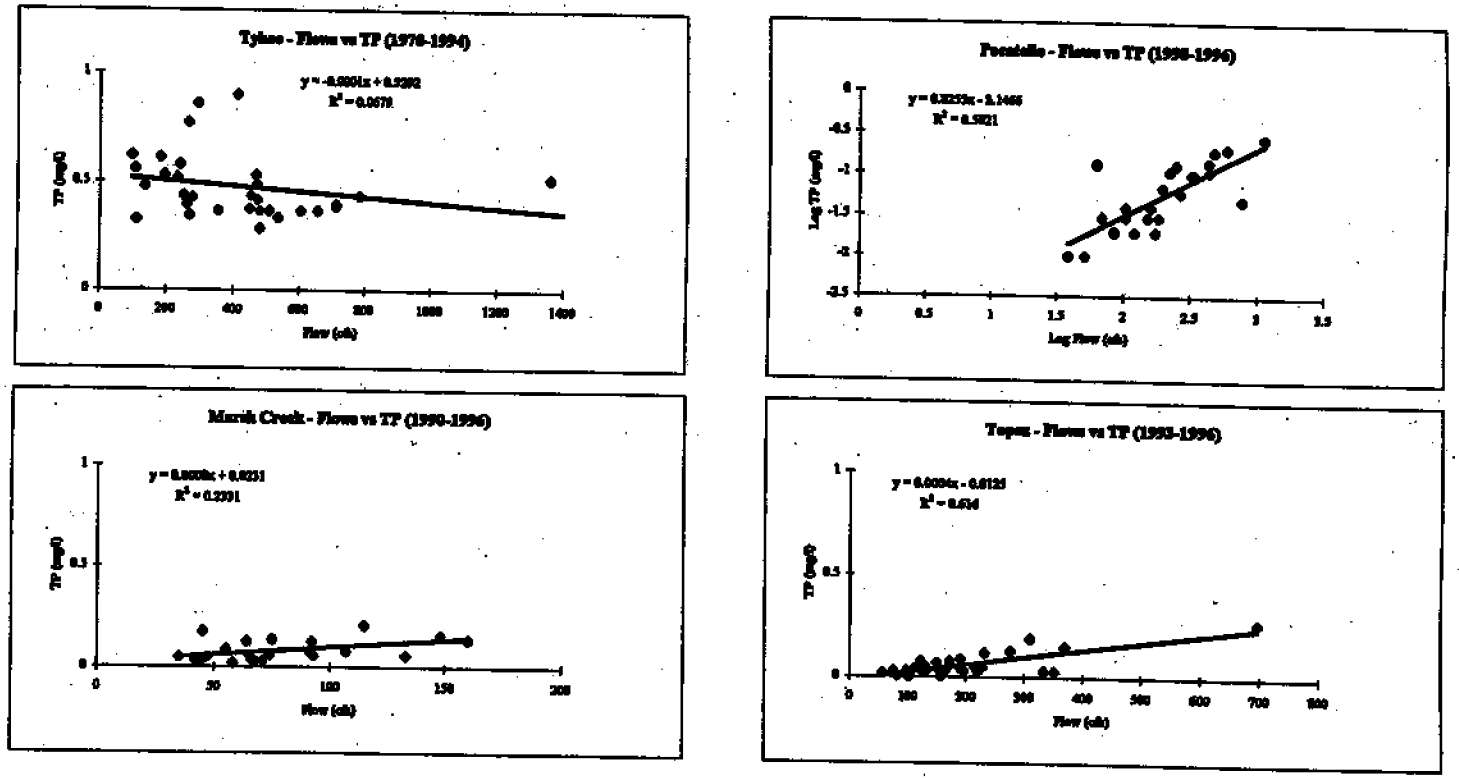


Figure 16. Regressions between flow and total phosphorus (TP) at USGS surface-water stations.

month (Appendix G). Secondly, load capacities based on target concentrations were calculated by multiplying the target concentrations of 0.3 mg/l for TIN and 0.075 mg/l total phosphorus by the average daily flow per month (Appendix G).

The estimated loads between the two methods were generally similar (Table 58). Estimated load values based on flow:nutrient regressions (Appendix G) were used except where the relationships were not significant at the 95% confidence level (i.e., TIN and total phosphorus at Tyhee and TIN at Marsh Creek). Values used for the estimated annual load represented at least the 60th percentile for the range of annual loads over the time period except for TIN at the Topaz gage site (Table 59). Michaud South Main Canal diverts water from the Portneuf River above the Tyhee gage site. Estimated loss of nutrients from the river to the canal (Appendix G) were added to the estimated loads at the Tyhee gage.

Hawkins Reservoir

Hawkins Reservoir is listed for both dissolved oxygen and nutrients (Table 19). As previously discussed, no load analysis was done for dissolved oxygen. It is assumed that control of nutrients into the reservoir should reduce aquatic vegetative growth which in turn would decrease opportunities for dissolved oxygen to fall below the state standards.

Water quality information from Hawkins Reservoir is minimal. The only data compiled, other than temperature or dissolved oxygen measurements, was from DEQ monitoring of the reservoir in August of 1997. At that time DEQ sampled for total phosphorus, chlorophyll *a* (a measure of algal density), and water clarity (as measured by a Secchi disk).

Based on the data collected by DEQ, Hawkins Reservoir has characteristics of both eutrophic and non-eutrophic waters. Carlson (1977) developed three indexes for determining the trophic (i.e., eutrophic to oligotrophic) state of lakes and reservoirs. He indexed trophic state of a body of water to water clarity (based on Secchi disk monitoring), chlorophyll *a*, and total phosphorus using the following formulas

TSI (Secchi Disk) = 10*(6-(lnSD/ln2))
TSI (Chlorophyll *a*) = 10*(6-((2.04-(0.68*lnChl))/ln2))
TSI (Total phosphorus) = 10*(6-(ln(48/TP)/ln2))

where TSI = trophic state index, ln = natural logarithm, SD = Secchi disk depth in m, Chl = chlorophyll a concentration in mg/m^3, and TP = total phosphorus in mg/m^3. The level of chlorophyll *a* (2.1 mg/m^3) and the water clarity (Secchi disk reading = 5.5 m) result in TSIs of 38 and 35, respectively, indicating Hawkins Reservoir is mesotrophic (having a medium amount of nutrients and biotic productivity). The total phosphorus concentration (130 mg/m^3), however, resulted in a TSI of 74 which would put Hawkins Reservoir in the eutrophic category.

Table 58. Nutrient loads at USGS surface-water stations estimated from flow:nutrient regression analysis for daily flows and mean concentration (from data after 1989) and average monthly flows, 1955-1995.

Gage site	Total inorganic nitrogen (tons/yr)				Total phosphorus (tons/yr)			
	Regression*	95% confidence interval	Mean**	95% confidence interval	Regression*	95% confidence interval	Mean**	95% confidence interval
Tyhee	1,055***	± 281	1,144	± 357	201***	± 54	216	± 67
Pocatello	259	± 72	176	± 26	36	± 10	24	± 4
Marsh Creek	68***	± 5	76	± 8	10	± 2	7	± 1
Topaz	114	± 7	136	± 14	17	± 4	11	± 1

*average annual load from 1955 to 1995, except 1986-1993 at Tyhee. Annual load derived by summing daily nutrient (total inorganic nitrogen or total phosphorus) loads estimated from flow:nutrient linear regression models of data collected at the gage sites since 1972 (Tyhee), 1990 (Pocatello, Marsh Creek), or 1993 (Topaz); see Figures 15 and 16.

**average annual load from 1955 to 1995, except 1986-1993 at Tyhee. Annual load derived from the sum of the monthly loads calculated by multiplying the appropriate target concentration by the average flow per month by the number of days per month.

***not significant ($p>0.05$)

Table 59. Mean and median for nutrient loading estimates (tons/year) at USGS surface-water stations in the Portneuf River.

Site	Time period	Mean	Percentile*	Median
		Total inorganic nitrogen		
Tyhee	1986-1993	1,144	70%	1,038
Pocatello	1955-1995	259	67%	181
Marsh Creek	1955-1995	76	60%	68
Topaz	1955-1995	114	48%	114
		Total phosphorus		
Tyhee	1986-1993	216	70%	196
Pocatello	1955-1995	36	68%	25
Marsh Creek	1955-1995	10	64%	7
Topaz	1955-1995	17	67%	12

*percentile rank of mean within range of all annual loads estimated during time period

Load Analysis

Site-specific targets for nitrogen and phosphorus in the Portneuf River were not attempted. No information was reviewed on site-specific levels for either nutrient necessary to support beneficial uses. In addition, loading, or assimilative, capacity was not estimated also due to lack of data. For the purposes of the loading analysis, the assimilative capacity was considered to be equal to the target load.

The nitrogen target was set for total inorganic nitrogen because it represents the nitrogen most readily available for algae and plant uptake. As total inorganic nitrogen includes nitrate plus nitrite and ammonia, the target accounts for those forms of nitrogen most often measured. Total inorganic nitrogen facilitates comparison of loads from various contributors. For example, in the upper Portneuf River, nitrates tend to be higher than ammonia whereas at the sewage treatment plant, the opposite is true. The 0.3 mg/l threshold for TIN is much less than the State of Utah's indicator of 4.0 mg/l for nitrates (Jim Christensen, Utah Division of Water Quality, personal communication). The TIN target was based on work by Sawyer (1947) who reported 0.3 mg/l of inorganic nitrogen as the threshold value for nuisance aquatic plant growth problems in lakes around Madison, Wisconsin. Imhoff (1955) cited Muller (1953) who stated that excessive plant growth in streams and lakes does not occur if total nitrate nitrogen is below 0.3 mg/l, or total nitrogen is below 0.6 mg/l.

As a margin of safety, a target of 0.3 mg/l for total inorganic nitrogen, per Sawyer (1947), was chosen over 0.3 mg/l of total nitrate as recommended by Muller (1953). Furthermore, a target of 0.3 mg/l of TIN increases the assurance that levels of available nitrogen to phosphorus stay below 10:1.

Even a level of 0.3 mg/l of total inorganic nitrogen may be too high to control nuisance aquatic growth. Bothwell (1992) reported that in a nitrogen-limited stream, kraft mill effluent with a dissolved inorganic nitrogen concentration of about 0.25 mg/l almost doubled the specific growth rate of algae. In setting any target it must be remembered that the TMDL is a dynamic process, i.e., targets can be changed, either higher or lower, based on monitoring.

The form of phosphorus in the Portneuf River differs substantially based on location. Ortho phosphate, which is dissolved, is readily available for plant uptake. Data indicate (Table 38) that ortho phosphorus represents a much higher percentage of the total phosphorus as measured at the Tyhee gage (87% based on mean concentrations from 1970 to 1994) as contrasted to the upper three gage sites (31% to 47% since 1990).

The targets for phosphorus are based on EPA (1986) "Gold Book" which makes recommendations of thresholds for total phosphorus and total phosphates as phosphorus. EPA recommended that total phosphorus (based on Mackenthun [1973]) not exceed a concentration of 0.1 mg/l for prevention of nuisance aquatic growth in streams or flowing waters not discharging directly to lakes or reservoirs. For prevention of nuisance aquatic growth and control of eutrophication in downstream lakes or reservoirs, total phosphates as phosphorus should not exceed 0.05 mg/l in any stream at the point it enters any lake or reservoir. The State of Utah has

a state indicator of 0.05 mg/l of phosphate (Jim Christensen, Utah Division of Water Quality, personal communication).

Some evidence indicates that these phosphorus recommendations may not be low enough to limit algal production via phosphorus. Bothwell (1989) reported that phosphorus was no longer limiting to the peak areal biomass of periphytic diatom communities in experimental troughs in the South Thompson River, British Columbia, at phosphate concentrations of > 0.03-0.05 mg/l. Diatom peak areal biomass was 70% of the maximum attainable biomass from phosphorus enrichment at only 0.001 mg/l of ortho phosphate. Sonzogni et al. (1982) argued that reducing total phosphorus may have little impact, especially in lotic waters, when the portion of phosphorus reduced is not bioavailable (e.g., land runoff is often high in particulate phosphorus, significant portions of which cannot be immediately utilized in the growth of algae and aquatic macrophytes).

The recommended target of 0.075 mg/l total phosphorus allows for a 25% margin of safety from Mackenthun's (1973) recommendation. This concentration also corresponds with the target set in the mid-Snake River TMDL (Division of Environmental Quality 1997).

Natural levels of nitrogen and phosphorus are unknown. The natural input of nitrogen into the Portneuf River is assumed to be low as, except for precipitation and mineralization of organic nitrogen from detritus, there are no known major sources of naturally occurring nitrate (Rupert 1996). An examination of lower values recorded within the subbasin (Table 60) show concentrations of TIN as low as 0.012 and 0.0255 mg/l in the upper Portneuf River and 0.03 mg/l in the lower Portneuf River. Concentrations of total phosphorus levels were as low as 0.003 mg/l in upper Marsh Creek and 0.005 mg/l in the Portneuf River at Topaz. However, numerous TIN and total phosphorus data, both minimum and mean concentrations, exceeded the recommended target concentrations. The extent to which human activities have contributed to these nutrients levels has not been assessed.

The three upper gaging stations (Pocatello, Marsh Creek, and Topaz) along with the Siphon Road bridge will be effectiveness monitoring sites for total inorganic nitrogen and total phosphorus in the Portneuf River. Siphon Road was chosen because the Tyhee gage has been abandoned and, although the bridge is upstream about a mile, it is downstream of the major springs influencing nutrient loads historically measured at the Tyhee gage. The bridge is also just slightly above the pump which diverts water for the Michaud South Main Canal.

Load reductions for nitrogen and phosphorus were not apportioned in the Portneuf River subbasin above Pocatello. Although nutrient information since the late 1980s is minimal, as mentioned previously, agriculture practices (e.g., confining livestock close to the stream, loss of fertilizers from fields) have been identified as contributing to the nutrient load in the Portneuf River. Based on sediment:nutrient regression relationships (Appendix F), sediment reduction at the upper stations should result in a decrease in nutrients, especially total phosphorus. No data were reviewed that indicate urban areas, other than Pocatello-Chubbuck, are significant contributors of nutrients into the Portneuf River. No NPDES-permitted facility upriver of Pocatello collected information on discharge of nitrogen or phosphorus as reported on their

Table 68. Selected low concentrations of nutrients in the Portneuf River subbasin.

Site	Year(s)	Time period	Minimum concentration (mg/l)	Mean concentration (mg/l)	Source
			Total inorganic nitrogen		
Portneuf River - Tyhee USGS gage	1972-1975		0.55	2.04	USGS Water Resources Data reports
	1989-1994		2.23	2.66	USGS Water Resources Data reports
Portneuf River - Pocatello USGS gage	1990-1996		0.03	0.6	USGS Water Resources Data reports
Pocatello Creek - North Fork	1985-1986		1.75	2.1	Drewes 1987
Pocatello Creek - South Fork	1985-1986		0.72	1.19	Drewes 1987
Sorrell Canyon	1985-1986		0.24	1.38	Drewes 1987
Indian Creek	1985-1986		0.88	1.4	Drewes 1987
Rapid Creek	1985-1986		0.21	0.88	Drewes 1987
Jackson Creek	1985-1986		0.37	1.29	Drewes 1987
Dempsey Creek	1985-1986		0.19	0.54	Drewes 1987
Mink Creek	1997-1998		< 1.2		Idaho Division of Environmental Quality
Marsh Creek - USGS gage	1980-1981		0.47	0.94	USGS Water Resources Data reports
	1990-1996		0.37	0.89	USGS Water Resources Data reports
Marsh Creek - upper	1987-1988	Mar - May	0.163	1.029	Drewes 1991
	1987-1988	Jun - Jul	0.307	0.882	Drewes 1991
Marsh Creek	1980-1981		0.14	0.77	USGS Water Resources Data reports
Portneuf River - Topaz gage	1990-1996		0.23	0.7	USGS Water Resources Data reports
Portneuf River at Downey Canal	1995-1997		0.0255	0.77	Rudel 1998
Portneuf River above Pebble Creek	1995-1997		0.012	0.278	Rudel 1998
			Total phosphorus		
Portneuf River - lower.	1992-1993		0.02	0.32	Bechtel Environmental, Inc. 1994
Portneuf River - Tyhee USGS gage	1970-1973		0.36	0.5	USGS Water Resources Data reports
	1989-1994		0.29	0.46	USGS Water Resources Data reports
Portneuf River - Pocatello USGS gage	1971-1981		0.02	0.2	USGS Water Resources Data reports
	1990-1996		0.01	0.08	USGS Water Resources Data reports
Mink Creek	1997-1998		< 0.05		Idaho Division of Environmental Quality
Pocatello Creek - North Fork	1985-1986		0.07	0.43	Drewes 1987
Pocatello Creek - South Fork	1985-1986		0.1	0.24	Drewes 1987
Sorrell Canyon	1985-1986		0.16	0.3	Drewes 1987
Indian Creek	1985-1986		0.08	0.29	Drewes 1987
Rapid Creek	1985-1986		0.06	0.22	Drewes 1987
Jackson Creek	1985-1986		< 0.03	0.19	Drewes 1987
Dempsey Creek	1985-1986		< 0.03	0.16	Drewes 1987
Marsh Creek - USGS gage	1970-1981		0.01	0.51	USGS Water Resources Data reports
	1990-1996		0.02	0.08	USGS Water Resources Data reports
Marsh Creek - upper	1987-1988	Mar - May	0.050	0.397	Drewes 1991
	1987-1988	Jun - Jul	0.003	0.071	Drewes 1991
Marsh Creek	1980-1981		0.01	0.1	USGS Water Resources Data reports
Marsh Creek - mouth	1976			0.31	McSorley 1977
Marsh Creek - above Bell Marsh Creek	1976			0.17	McSorley 1977
Marsh Creek - above Goodenough Creek	1976			0.19	McSorley 1977
Marsh Creek - above Gordon Creek	1976			0.56	McSorley 1977
Marsh Creek - above Hawkins Creek	1976			0.54	McSorley 1977
Marsh Creek - above Downey	1976			0.27	McSorley 1977
Birch Creek	1976			1.77	McSorley 1977
Portneuf River - below Marsh Creek	1976			0.21	McSorley 1977
Portneuf River - above Mink Creek	1976			0.12	McSorley 1977
Portneuf River - near Robbers Roost Creek	1976			0.12	McSorley 1977
Portneuf River - below McCammon	1976			0.15	McSorley 1977
Portneuf River - below Lava Hot Springs	1976			0.12	McSorley 1977
Portneuf River - above Lava Hot Springs	1976			0.16	McSorley 1977
Near downstream end of Downey Canal	1976			0.17	McSorley 1977
Portneuf River - Topaz gage	1970-1981		0.01	0.14	USGS Water Resources Data reports
	1990-1996		0.005	0.05	USGS Water Resources Data reports
Portneuf River at Downey Canal	1995-1997		0.025	0.097	Rudel 1998
Portneuf River above Pebble Creek	1995-1997		0.025	0.089	Rudel 1998

Table 60. Continued.

Site	Year(s)	Time period	Maximum concentration (mg/l)	Mean concentration (mg/l)	Source
			Orthophosphate		
Portneuf River - lower	1992-1993		ND[a]	0.24	Bechtel Environmental, Inc. 1994
Mink Creek	1997-1998		ND[a]		Idaho Division of Environmental Quality
Portneuf River - Inkom	1990-1991			0.27	Campbell et al. 1992
Pocatello Creek - North Fork	1985-1986		0.03	0.06	Drewes 1987
Pocatello Creek - South Fork	1985-1986		0.02	0.07	Drewes 1987
Sorrell Canyon	1985-1986		0.07	0.09	Drewes 1987
Indian Creek	1985-1986		0.03	0.05	Drewes 1987
Rapid Creek	1985-1986		0.01	0.04	Drewes 1987
Jackson Creek	1985-1986		0.02	0.05	Drewes 1987
Dempsey Creek	1985-1986		0.01	0.02	Drewes 1987
Marsh Creek - upper	1987-1988	Mar - May	0.002	0.010	Drewes 1991
	1987-1988	Jun - Jul	0.001	0.004	Drewes 1991
Marsh Creek	1980-1981		0.06	0.22	USGS Water Resources Data reports
Marsh Creek - south	1976			0.16	McSorley 1977
Marsh Creek - above Bell Marsh Creek	1976			0.03	McSorley 1977
Marsh Creek - above Goodnaugh Creek	1976			0.05	McSorley 1977
Marsh Creek - above Garden Creek	1976			0.13	McSorley 1977
Marsh Creek - above Hawkins Creek	1976			0.2	McSorley 1977
Marsh Creek - above Downey	1976			0.03	McSorley 1977
Birch Creek	1976			0.15	McSorley 1977
Portneuf River - below Marsh Creek	1976			0.11	McSorley 1977
Portneuf River - above Marsh Creek	1976			0.06	McSorley 1977
Portneuf River - near Robbins Roost Creek	1976			0.08	McSorley 1977
Portneuf River - below McCammon	1976			0.14	McSorley 1977
Portneuf River - below Lava Hot Springs	1976			0.08	McSorley 1977
Portneuf River - above Lava Hot Springs	1976			0.06	McSorley 1977
Near downstream end of Downey Canal	1976			0.08	McSorley 1977
Portneuf River - McCammon	1990-1991			0.07	Campbell et al. 1992
Portneuf River at Downey Canal	1995-1997		0.006	0.021	Rudel 1998
Portneuf River above Pebble Creek	1995-1997		0.0025	0.022	Rudel 1998

Discharge Monitoring Reports. Even though the contribution of nutrients by NPDES-permitted discharges above the gages is unknown, such input would be included within the overall target load.

The input of total inorganic nitrogen and total phosphorus on a seasonal basis was considered. Minshall and Andrews (1973) found seasonal variation in both nitrogen as nitrate and phosphorus as phosphate. Values for nitrate were highest in the winter, decreased during spring runoff, and declined progressively through the summer, a time of plant uptake. Phosphate concentrations showed less seasonal variation but did exhibit an increase from September through March with a subsequent decline during the growing season. The extent to which either nitrogen or phosphorus exceeds seasonal load capacity is unknown. The tendency for the uptake of phosphorus as phosphates by sediment allows phosphorus availability throughout the growing season regardless of the time of input. Nitrogen on the other hand tends to remain dissolved and will "flow through" in lotic, or stream, systems. If only the Portneuf River were to be considered, seasonal variation in nutrient concentrations would be applied. However, the Portneuf River flows into American Falls Reservoir. Lentic waters (e.g., lakes and reservoirs) act as sinks for both phosphorus and nitrogen, increasing the availability time for uptake by aquatic vegetation. Thus, nitrogen or phosphorus which entered the stream in February could be bioavailable to aquatic vegetation in the reservoir in July when conditions are conducive to algae or macrophytic growth. Due to concern about American Falls Reservoir, it is listed on the 303(d) list for nutrients, no allowance for seasonal variation in nutrient loading is made.

Nutrient contributing sources were identified for the lower Portneuf River below the Pocatello gage site near Carson Street. In addition to upstream input as measured at the Pocatello gage, three other major sources impact nutrient loading in the lower Portneuf River. These other sources include storm water runoff from Pocatello-Chubbuck urban area, Pocatello Sewage Treatment Plant (PSTP) discharge, and numerous springs that drain into the Portneuf River from Carson Street to Siphon Road. Perry and Clark (1990) grouped the springs according to water chemistry: Swanson Road System, Batise (also spelled Batiste) Spring System, East Side Springs, and Papoose Springs System. An "other" category has been included in the loading analysis to primarily account for additional springs and groundwater input into the lower Portneuf River (see Appendix G). No data were reviewed on contribution of nutrients from Batise Springs Hatchery, a NPDES-permitted discharge, as monitoring of nutrient input is not included in the Discharge Monitoring Reports regularly submitted to EPA. The load at Tyhee gage site was based on loads at the Pocatello gage site plus urban storm water runoff, PSTP effluent concentrations, and springs input (Appendix G).

One concern with including the springs is uncertainty of natural nutrient levels. Bechtel Environmental, Inc. (1994) compiled concentrations of various parameters from monitoring of wells and springs in Eastern Michaud Flats, generally west of the lower Portneuf River (Table 61). Examination of the information would indicate that target levels of nutrients may well be less than concentrations from representative groundwater and upgradient wells reported by Bechtel Environmental, Inc. . However, it must be remembered that these nutrient levels were observed in groundwater which has already been influenced by human activity (Goldstein 1981, Jacobson

Table 61. Potential sources of concentrations (mg/l) of parameters in springs in the lower Portneuf River reach (from Bechtel Environmental, Inc. 1994).

Source	Nitrate (NO_3-N)	Ammonia (NH_3-N)	Total phosphorus	Ortho phosphate (PO_4-P)
Representative groundwater	ND* to 4.5	ND to 0.8	ND to 3.1	ND to 1.8
Upgradient wells - Bannock Range**	0.3-1.7	ND to 0.2	ND to 0.31	ND to 0.33
Upgradient wells - Portneuf River**	0.9-4.3	ND to 0.9	ND to 0.13	ND to 0.39

*ND=non detect
**hydrogeochemical regimes

1982, Perry and Clark 1990, Bechtel Environmental, Inc. 1994) and does not represent natural background levels of nutrients in the groundwater of Eastern Michaud Flats.

The three upper surface-water stations show a need for some reduction in nitrogen and phosphorus loads (Table 62). As a margin of safety, the 60th percentile value of 118 tons/year was used as the estimated load of total inorganic nitrogen at Topaz rather than the average of 114 tons/year. Load reductions at the upper three gaging stations ranged from 50-66% for TIN and 15-39% for total phosphorus.

The greatest source of nutrients in the lower Portneuf River is the springs (Table 63). It is estimated the springs contribute over half the total inorganic nitrogen and total phosphorus. Background, as measured at the Pocatello gage represents about 25% of the load for both nutrients. The PSTP contributes about 20% of the total inorganic nitrogen to the river and 14% of the total phosphorus. Storm water contributed 6% or less of TIN or total phosphorus to the Portneuf River.

Total inorganic nitrogen and total phosphorus load estimates based on source input (source-based; Table 63) were less than loads estimated based on flow and nutrient concentrations measured at the USGS surface-water stations plus Michaud Canal removal (site-based; Table 64). The TIN annual load estimate of 1,172 tons/yr falls within the 95% confidence interval of the load estimate from the mean nutrient concentration (TIN lower limit [1,144-357 tons/yr] plus Michaud Canal removal [119 tons/yr] = 906 tons/yr) whereas the total phosphorus load of 148 tons/yr does not (total phosphorus lower limit [216-67 tons/yr] plus Michaud Canal removal [22 tons/yr] = 171 tons/yr). The difference in total phosphorus estimates may, in part, be a result of sediment-bound phosphorus being released, as phosphate, into the water column (Campbell et al. 1992) or input from unknown sources, but is more likely to be an underestimate of the contribution of nutrients from identified sources.

Values derived from both methods, site- and source-based, were used to calculate annual load reductions in nutrients. As the annual loads estimated at Tyhee were greater than the source-based load estimates, the site-based figures were used to estimate load reductions - a difference of 91 tons/yr of TIN and 90 tons/yr of total phosphorus. To account for these increases in TIN and total phosphorus annual loads, the contribution from the sources, except at the Pocatello gage, were adjusted. The majority of the increases were assigned to the springs, 12.5% for total inorganic nitrogen and 100% for total phosphorus as both flows and concentrations may have been underestimated (Appendix G). The estimated input from storm water was increased 7.5% for TIN and 75% for total phosphorus. The non-local runoff coefficients used in the Simple Model to estimate total annual loads from storm water runoff appeared to underestimate both TIN and phosphorus concentrations based on the limited data available (Division of Environment 1980). Increases of 7.5% and 100% for TIN and total phosphorus, respectively, for the FMC IWW ditch were based on the documentation of a high nutrient concentration event at the discharge (Appendix G). Both storm water and FMC IWW ditch input represent less than 2% of TIN loading and 7% of total phosphorus loading. The annual loads at the PSTP were increased only 2.5%, respectively, as the amount of data on flow and nutrient concentration was greater than for any other source. The nutrient loads at the Pocatello gage site were not adjusted for two

Table 62. Estimated reduction in loads (tons/yr) for nutrients at the Pocatello, Marsh Creek, and Topaz USGS surface-water stations.

Site	Present estimated load*	Target load**	Load reduction***	Percent reduction
Total inorganic nitrogen				
Pocatello	259	88	172	66%
Marsh Creek	76	26	51	66%
Topaz^	118	59	60	50%
Total phosphorus				
Pocatello	36	22	14	39%
Marsh Creek	10	6	3	33%
Topaz	17	15	3	15%

*from Table 58 except TIN at Topaz

**average annual load from 1955 to 1995. Annual load derived from the sum of the monthly loads calculated by multiplying the appropriate target concentration by the average flow per month by the number of days per month.

***difference between present and target loads

^present estimated load represents the 60th percentile of the range of estimated annual loads

Table 63. Estimated annual loads (tons/yr) from sources that contribute to nutrient loads at the Tyhee USGS surface-water station.

Site	Present estimated load*	Percent of present estimated load
Total inorganic nitrogen		
Stormwater - Pocatello-Chubbuck	11	1.0%
Pocatello gage**	259	22.1%
Springs	672	57.4%
FMC IWW ditch	5	0.4%
Pocatello Sewage Treatment Plant	225	19.2%
Total	1172	
Total phosphorus		
Stormwater - Pocatello-Chubbuck	8	5.4%
Pocatello gage**	36	24.4%
Springs	82	55.5%
FMC IWW ditch	2	1.2%
Pocatello Sewage Treatment Plant	20	13.5%
Total	148	

*present estimated loads, except for Pocatello gage, derived by multiplying the mean observed concentration by the average flow projected to an annual load; see Appendix G

**see Table 58

Table 64. Estimated reduction in loads (tons/yr) from sources that contribute to nutrient loads at the Tyhee USGS surface-water station.

Site	Present estimated load*	Percent of present estimated load	Target waste load**	Target load**	Load reduction***	Percent reduction
Total inorganic nitrogen						
Stormwater - Pocatello-Chubbuck	12.1	1.0%		5.1	7.0	58%
Pocatello gage	259	20.5%		88	172	66%
Springs	756	59.9%		80	677	89%
FMC IWW ditch	4.9	0.4%	1.1		3.8	78%
Pocatello Sewage Treatment Plant	230	18.2%	3		227	99%
Total (as estimated at Tyhee gage)^	1263				1086	
Total phosphorus						
Stormwater - Pocatello-Chubbuck	14.0	5.9%		1.3	12.7	91%
Pocatello gage	36	15.1%		22	14	39%
Springs	164	68.9%		20	144	88%
FMC IWW ditch	3.5	1.5%	0.3		3.2	92%
Pocatello Sewage Treatment Plant	20.5	8.6%	0.7		19.8	96%
Total (as estimated at Tyhee gage)^^	238				194	

*from Table 63 plus additional load (168 tons/yr of total inorganic nitrogen and 92 tons/yr of total phosphorus) to account for differences between estimated annual load calculated at Tyhee and the source-based estimate of annual loads

**target waste loads and loads derived by multiplying the appropriate target concentration by the average flow projected to an annual load

***difference between present and target loads

^present estimated load at Tyhee of 1144.0 tons/yr (from Table 58) + 119.3 tons/yr lost via Michaud South Main Canal

^^present estimated load at Tyhee of 215.7 tons/yr + 22.5 tons/yr lost via Michaud South Main Canal

reasons: 1) the average annual load represented the 67th and 68th percentiles for the range of estimated annual loads from 1955-1995 of TIN and total phosphorus, respectively, and 2) the percentage of total phosphorus as ortho phosphate is much greater as measured at Tyhee compared to Pocatello gage site indicating sources higher in ortho phosphate. For target load capacities source-based estimates were used because data were available to apportion nutrient load by source.

Based on a target concentration of 0.3 and 0.075 mg/l, respectively, total load reduction for TIN is 1086 tons/yr and for total phosphorus is 194 tons/yr (Table 64). The TIN load reduction represents 86% of the estimated present load. The load reduction for total phosphorus is 82% of the estimated present load. The springs account for the greatest reduction in load. The highest percentage reduction in load is at the Pocatello Sewage Treatment Plant for both TIN and total phosphorus.

As both nutrient and flow information is limited on the listed tributaries (Table 19), no load reductions were estimated. However, the targets (0.3 mg/l of TIN, 0.075 mg/l of TP) will remain the same as at the gaging stations.

Margin of Safety

As mentioned earlier, margins of safety are recommended for both nitrogen and phosphorus targets. The nitrogen target of 0.3 mg/l for total inorganic nitrogen, per Sawyer (1947), allows for less nitrogen than a target of 0.3 mg/l of total nitrate as recommended by Muller (1953), because TIN also includes other forms of nitrogen (e.g., nitrite and ammonia). The target of 0.075 mg/l total phosphorus is a 25% reduction from a recommended 0.1 mg/l for prevention of nuisance aquatic growth in streams or flowing waters not discharging directly to lakes or reservoirs (Mackenthun 1973).

An additional margin of safety was provided based on the estimated annual load used in the nutrient analyses. All load estimates except TIN at Topaz were in the upper 40% (60th percentile or greater) of all annual load estimates (Table 59). The average annual load of TIN at Topaz was estimated at 114 tons/year from 1955 to 1995. To allow for a margin of safety, 118 tons/year which represented the 60th percentile value for that time period was used. Use of the higher estimated annual load from the Tyhee gage site rather than the annual load based estimated input by source also imparts a margin of safety into the load reduction estimates.

Data Gaps

The need for additional data cannot be overemphasized. Information which will help to improve the TMDL in future years includes, but is not limited to, nutrient load from tributaries (e.g., Pocatello Creek), natural background nutrient levels of springs and tributaries, additional nutrient concentration and flow information from the springs, and contribution from other sources (e.g., NPDES-permitted discharges other than FMC and the City of Pocatello) in the lower Portneuf River reach.

Hawkins Reservoir

A target of 0.025 mg/l of total phosphorus in Hawkins Reservoir is recommended. This target is based on the EPA "Gold Book" (1986) which recommends that total phosphates as phosphorus in lakes or reservoirs not exceed 0.025 mg/l to prevent the development of biological nuisances and to control accelerated or cultural eutrophication. No target for nitrogen is proposed. It must be remembered that total inorganic nitrogen and total phosphorus targets are recommended for Hawkins Creek above the reservoir. Reductions in TIN and total phosphorus in Hawkins Creek should decrease the amount of aquatic vegetation in the reservoir.

No load analyses for nutrients were done for Hawkins Reservoir. Part of the reluctance to analyze nutrient loads is due to a lack of data. For example, only a single sampling event for nutrients in August of 1997 (DEQ, unpublished data) is known. No data on nutrient or chlorophyll levels from winter monitoring were located. No nutrient information on Hawkins Creek above the reservoir is known to exist. As a loading analysis was not performed, no margin of safety is suggested.

Data Gaps

More data on Hawkins Reservoir are needed. The discrepancies between the Trophic State Indices, calculated from only one sampling event, do not allow for an accurate characterization of the reservoir. Additional information is essential before attempting a load analysis of nutrients in Hawkins Reservoir. Nutrient sampling in the reservoir and creek throughout the year is needed. Most of Hawkins Creek watershed above the reservoir is dryland agriculture or rangeland and the contribution of nutrients from these land uses along with input from natural sources are unknown.

303(d) list - section 303(d) of the Clean Water Act requires states submit to the Environmental Protection Agency every two years a list of streams within the state that are water quality limited.

ab - above

ac - acre

ACP - Agricultural Conservation Program

ag - agriculture

aka - also known as

Algae - generally, simple aquatic plants, small to microscopic in size, which may be attached to the stream bottom (e.g., filamentous) or found floating in the water column (e.g., phytoplankton).

Anthropogenic - human caused.

avg - average

AWS - agricultural water supply

Bedload - material, including sediment, which moves along or in close proximity to the streambed.

BEI - Bechtel Environmental, Inc.

bel - below

Bio accumulate - when the concentration of a substance (e.g., organic compound, metal) increases in organisms at increasingly higher levels of the food chain.

Bioavailable - when a substance (e.g., organic compound, metal) is available for uptake by an organism.

Biota - the plants, animals, etc., of a system.

BLM - Bureau of Land Management

BMP - best management practice

BURP - Beneficial Use Reconnaissance Project

°C - degrees centigrade. The following formula can be used to convert centigrade C to Fahrenheit (F): (Cx9/5)+32=F.

cfs - cubic feet per second

Char - a member of the salmon family closely related to the trouts. Lake trout, brook trout, bull trout, dolly Virden are examples of char.

Chl - chlorophyll a

CRP - Conservation Reserve Program

CWB - cold water biota

Depth fines - amount of sediment by volume in the upper layer (usually < 24 inches) of the streambed.

DEQ - Division of Environmental Quality

Drift - organisms moving in the water column with the current.

DWS - domestic water supply

Embeddedness - the extent to which streambed cobble or rocks are surrounded by sediment. A low level of embeddedness results in greater interstitial space conducive to the production of macroinvertebrates preferred as food by salmonid and other fish species.

EPA - U. S. Environmental Protection Agency

Erosion rate - soil which is lost from an area via wind or precipitation, for example, top soil lost from an agricultural field following a summer rainstorm. Soil lost may or may not be deposited in a body of water.

Eutrophic - a term referring to waterbodies which are characterized by high levels of nutrients and high biotic productivity.

°F - degrees Fahrenheit. The following formula can be used to convert Fahrenheit (F) to centigrade (C): (F-32)x5/9=C.

FSA - Food Security Act

ft - feet

Geometric mean - a mean calculated by finding the *n*th root of the product of multiplying the measurements in *n* samples. For example, the measurements of 3 samples were 8, 5, and 11. The product of those measurements is 8x5x11=440. The cube root of 440 is $\sqrt[3]{440}=7.6$. Therefore the geometric mean of 8, 5, and 11 is 7.6.

Hydrograph - how the flow of a stream changes over the year. The hydrograph of a typical undammed Idaho stream is high flows in the spring time associated with snow melt followed by decreasingly lower flows through the early fall after which flows will increase due to increased precipitation.

IDAPA - Idaho Administrative Procedure Act

IDFG - Idaho Department of Fish and Game

Intergravel dissolved oxygen - dissolved oxygen in water flowing through the upper layers of the streambed. Intergravel dissolved oxygen is essential for the survival of salmonid eggs buried in the subsurface gravels.

IWW - industrial waste water

l - liter

Lentic - non-flowing water (e.g., lakes and reservoirs).

LHS - Lava Hot Springs

ln - natural logarithm

Load - total amount of a pollutant usually in reference to the amount which reaches a waterbody.

Load allocation - amount of pollutant usually expressed as a mass per unit time (e.g., tons/day) allocated to a non-point source which, if not exceeded, should result in the support of beneficial uses within a waterbody.

Loading - total amount of a pollutant entering a waterbody usually expressed in mass per unit time (e.g., tons/day). Loading is calculated by multiplying the concentration by flow.

Lotic - flowing water (e.g., streams).

m - meter

m^2 - square meter

m^3 - cubic meter

Macroinvertebrates - small animals (e.g., insects, snails, worms) which inhabit the surface and below surface areas in a stream.

Macrophyte - rooted and floating aquatic vegetation.

Margin of safety - an amount by which a load is reduced to account for any uncertainty often caused by a lack of data.

max - maximum

Mesotrophic - a term referring to waterbodies which are characterized by levels of nutrients and biotic productivity somewhere between eutrophic and oligotrophic.

mg - milligram

mg/l - milligrams per liter, also is equivalent to parts per million

mi^2 - square miles

min - minimum

ml - milliliter

msl - mean sea level

ND - no discharge; non detect

nda - no date available

NPDES - National Pollution Discharge Elimination System

NRCS - Natural Resources Conservation Service

NTU - nephelometric turbidity units - a measure of turbidity in the water.

NWS - National Weather Service

Oligotrophic - a term referring to waterbodies which are characterized by low levels of nutrients and low biotic productivity; oligotrophic lakes are sometime referred to as "sterile" lakes

Organic compound - carbon-based compounds which can be natural (e.g., fecal material) or human made (e.g., polychlorinated biphenyl) in origin.

Organochlorine compound - organic compounds which include chlorine most of which are hum made (e.g., polychlorinated biphenyl).

PCB - polychlorinated biphenyl

PCR - primary contact recreation

Periphyton - organisms, e.g., microscopic plants and animals, which are attached to submerged objects such as plant stems, rocks, etc.

Phytoplankton - tiny floating plants (e.g., algae, diatoms).

Poky - Pocatello

ppm - parts per million

Primary Contact Recreation - water-related activities (e.g., swimming) where ingestion of water may be common.

PSTP - Pocatello Sewage Treatment Plant

R - river

R^2 - correlation index; a measurement of the relationship between two variables in a correlation analysis. R^2 ranges from 0 to 1 with the values closest to 1 indicating the strongest relationship.

Regression - the comparison of two parameters to determine if a relationship exists. For example, a positive relationship exists between an individual's height and the length of their leg.

Riparian - that area next to a stream that is heavily influenced by the stream through the availability of water. Examples of vegetation associated with riparian areas include sedges, rushes, and willows.

Salmonids - those members of the salmon family of fishes including trout, char, salmon, whitefish.

SAWQP - State Agricultural Water Quality Program

SCR - secondary contact recreation

SD - Secchi disk - around black and white disk used to measure the clarity of water.

SD - standard deviation

SE - standard error

Secondary Contact Recreation - water-related activities (e.g., fishing) where ingestion of water is unlikely.

Sediment delivery rate - rate (percentage) of erosion that is deposited in a body of water.

Sediment load - mass per unit time (e.g., tons/year) of sediment within a waterbody.

Sediment yield - rate of sediment lost from an area of land or length of stream that is deposited in a water body expressed in mass per area or length per time (e.g., tons/acre/year, tons/mile/year).

Sinuosity - the curving back and forth of a stream (i.e., deviation from a straight line).

spp. - species

SS - suspended sediment; salmonid spawning

Standards - an amount of pollutant beyond which a waterbody will not support its beneficial use. A standard is found in official state and federal rules or regulations.

STP - sewage treatment plant

Suspended sediment - sediment which is suspended in the water column.

Target - an amount of pollutant beyond which a waterbody will not support its beneficial use. A target is not included in official state rules or regulations. Targets are often associated with narrative state water quality standards and reflect the most current scientific understanding.

TIN - total inorganic nitrogen - the inorganic component of nitrogen in a system which is most readily available for uptake by plants or algae; includes nitrate + nitrite + ammonia.

TMDL - total maximum daily load - maximum amount of pollutant which can be inputted on a daily basis into a waterbody without affecting beneficial use of the waterbody.

TP - total phosphorus

TSI - trophic state index - a method to classify the trophic (generally - the amount of nutrients) state of lakes developed by Carlson (1977).

TSS - total suspended solids. Total suspended solids include an organic component not found in measurements of suspended sediment.

Turbidity - the ability of water to pass light. Higher turbidities result in less light passing into the water.

μg/l - micrograms per liter, 1000 μg/l = 1 mg/l, also is equivalent to parts per billion

um - microns (micrometers), 1000 microns = 1 mm

USGS - U. S. Geological Survey

Waste load allocation - amount of pollutant usually expressed as a mass per unit time (e.g., tons/day) allocated to a point source (e.g., an NPDES-permitted discharge) which, if not exceeded, should result in the support of beneficial uses within a waterbody.

Waterbody - stream, lake, or reservoir.

yr - year

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Appendix A

State of Idaho water quality standards

Table A-1. State of Idaho water quality numeric standards (from Idaho Department of Health and Welfare Water Quality Standards and Wastewater Treatment Requirements). Max = maximum, avg = average, and min = minimum.

Beneficial use	Criteria						
	pH	Dissolved gas*	Chlorine**	Toxic substances***	Ammonia	Integrated dissolved oxygen	Radioactivity
Cold Water Biota	>= 6.5 and <= 9.5	<= 110% saturation	19.0 ug/l, 1-hr avg 11.0 ug/l, 4-day avg	<= CMC or CCC <= Human Health criteria^^	varies^		
Warm Water Biota	>= 6.5 and <= 9.5	<= 110% saturation	19.0 ug/l, 1-hr avg 11.0 ug/l, 4-day avg	<= CMC or CCC <= Human Health criteria^^	varies^		
Salmonid Spawning	>= 6.5 and <= 9.5	<= 110% saturation	19.0 ug/l, 1-hr avg 11.0 ug/l, 4-day avg	<= CMC or CCC <= Human Health criteria^^	varies^	>= 5.0 mg/l, 1-day min >= 6.0 mg/l, 7-day avg mean	
Primary & Secondary Contact Recreation				<= Human Health criteria^^			
Domestic Water Supply				<= Human Health criteria^^^			varies~

*at atmospheric pressure at point of collection
**total residual chlorine
***criteria from 40 CFR 131.36(b)(1) as modified by Section 250.07 of the Water Quality Standards and Wastewater Treatment Requirements; CMC (Criteria Maximum Concentration) - maximum concentration for one hour, CCC (Criteria Continuous Concentration) - maximum concentration for four days
^varies according to temperature and pH
^^for consumption of organisms only
^^^for consumption of water and organisms
~varies based on results; criteria from Idaho Department of Health and Welfare (sic) Idaho Rules for Public Drinking Water Systems based on 40 CFR 141.15 and 16

Appendix B

Results of Beneficial Use Reconnaissance Project Monitoring

Table B-1. Status of waterbodies in the Portneuf River subbasin as to support of their beneficial uses (information from Beneficial Use Reconnaissance Project monitoring).

Waterbody	Waterbody status*	Or. 1996 303(d)	Site	Site status*	Year	Index** MBI***	Index** FII^	Index** RIBI	Individual support status: Cold water biota Use^^	Cold water biota Support^	Salmonid spawning Use^^	Salmonid spawning Support^	Primary contact recreation Use^^	Primary contact recreation Support^	Secondary contact recreation Use^^	Secondary contact recreation Support^	Domestic water supply Use^^	Domestic water supply Support^	Agricultural water supply Use^^	Agricultural water supply Support^	Industrial water supply Use^^	Industrial water supply Support^	Wildlife habitat Use^^	Wildlife habitat Support^	Aesthetics Use^^	Aesthetics Support^	Assessments cause^^^	Criteria exceedances
Cherry	NV	Y	Upper	FS	1994	4.69	86		E	FS					D/E	FS			E	FS	D	FS	D	FS	D	FS		
Dempsey	NFS	Y	Lower	NFS	1994	4.06	54		E	NFS					D/E	NA			E	NA	D	FS	D	FS	D	FS		
		Y	Upper	NFS	1994	4.92	66	NI	E	FS	E	NFS			D/E	FS			E	FS	D	FS	D	FS	D	FS	Salmonid spawning status has been modified due to criteria exceedances. IDFG verification based on RIBI.	T>13 C
Gardena	FS	Y	Lower	FS	1994	3.78	83	NI	E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	IDFG verification based on RIBI.	
		Y	Upper	FS	1994	3.79	65	NI	E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	IDFG verification based on RIBI.	
Hawkins	FS			FS	1994	4.72	76	NI	E	FS					D/E	FS			E	FS	D	FS	D	FS	D	FS	IDFG verification based on RIBI.	
Marsh	NV	Y	Lower	NV	1994	3.63	70		D/E	NV	D	NA	D	NA	D	NA			D/E	NA	D	FS	D	FS	D	FS		
		Y	Upper	NV	1994	4.29	67		D/E	NV	D	NA	D	NA	D/E	NA			D/E	NA	D	FS	D	FS	D	FS		
Mill	FS			FS	1994	5.22	96		E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR.	
Mink	FS	Y	West Fork	FS	1994	4.59	93		E	FS	E	NA			D/E	FS			E	FS	D	FS	D	FS	D	FS		
		Y	Upper	FS	1994	3.53	105		E	FS	E	NA			D/E	FS			E	FS	D	FS	D	FS	D	FS		
Robbers Roost	FS			FS	1994	6.06	78	NI	E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	IDFG verification based on RIBI.	
Walker	NFS	Y	Lower	FS	1994	4.59	86		E	FS					D/E	FS			E	FS	D	FS	D	FS	D	FS		
		Y	Upper	NFS	1994	5.26	48		E	NFS					D/E	NA			E	NA	D	FS	D	FS	D	FS		
Bell Marsh	FS	Y	Lower	FS	1995	4.31	81		E	FS	E	FS			D	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR.	
		Y	Upper	FS	1995	4.47	86		E	FS	E	FS			D	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR.	
Birch	NV	Y	Lower	NV	1995	2.95	59		E	NV					D	NA			E	NA	D	FS	D	FS	D	FS		
		Y	Upper	FS	1995	3.82	101		E	FS	E	NA			D	FS			E	FS	D	FS	D	FS	D	FS		
Gibson Jack	FS	Y	Upper	FS	1995	4.73	109		E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR.	
Goodenough	FS	Y	Lower	FS	1995	4.77	77	NI	E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR. IDFG verification based on RIBI.	
		Y	Upper	FS	1995	4.83	89	NI	E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR. IDFG verification based on RIBI.	
Hawkins	NFS	Y	Lower	NFS	1995	1.95	41		E	NFS					D	NA			E	NA	D	FS	D	FS	D	FS	Stream morphology probably produces salmonid spawning in Lower Hawkins Creek.	
			Upper	NFS	1995	2.71	64		E	NV	E	NFS			D/E	NA			E	NA	D	FS	D	FS	D	FS		T>13 C
Portneuf	NV	Y	Lower	NV	1995	2.70	65		E	NV					D/E	NA			E	NA	D	FS	D	FS	D	FS		
	NFS	Y	DC-Mid	NFS	1995	1.61	37		D/E	NFS	D/E	NFS	D	NFS	D/E	NA	D	NFS	D/E	NA	D	FS	D	FS	D	FS	FCR status has been modified due to criteria exceedance.	T>13 C FC>200
		Y	DC-Upper	NFS	1995	2.95	42		D/E	NFS	D/E	NFS	D	NA	D	NA	D	NA	D/E	NA	D	FS	D	FS	D	FS	Salmonid spawning status has been modified due to criteria exceedance.	T>13 C
Rapid	NFS	Y	Lower	NFS	1995	2.22	94		E	NV	E	NA			D	NA			E	NA	D	FS	D	FS	D	FS	SM produces PCR.	
		Y	Upper	NFS	1995	1.64	68		E	NFS					D	NA			E	NA	D	FS	D	FS	D	FS		
Twenty-Seven Mile	NV	Y		NV	1995	2.88	73		E	NV					D/E	NA			E	NA	D	FS	D	FS	D	FS		T>13 C
Ashanee	NFS			NFS	1996	2.99	41.0		E	NFS					D/E	NA			E	NA	D	FS	D	FS	D	FS		
Cherry	NV	Y	Lower	NV	1996	3.37	39.0		E	NV					D/E	NA			E	NA	D	FS	D	FS	D	FS	No additional information	
		Y	Upper	FS	1996	4.85	107.0		E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR.	
City	NV		Lower	NV	1996	3.26	90.0		E	NV					D/E	NA			E	NA	D	FS	D	FS	D	FS		
			Upper	FS	1996	5.22	97.0		E	FS					D/E	FS			E	FS	D	FS	D	FS	D	FS		
Indian	NFS			NFS	1996	3.25	53.0		E	NFS					D/E	NA			E	NA	D	FS	D	FS	D	FS		
Jackson	NV		Lower	NV	1996	4.34	69.0		E	NV					D/E	NA			E	NA	D	FS	D	FS	D	FS		
			Upper	FS	1996	4.69	120.0		E	FS					D/E	FS			E	FS	D	FS	D	FS	D	FS		
Pebble	FS	Y		FS	1996	4.71	97.0		E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR.	
Toponce	FS	Y		FS	1996	3.72	103.0		E	FS	E	FS			D/E	FS			E	FS	D	FS	D	FS	D	FS	SM produces PCR.	

*FS=full support, NV=needs verification, NFS=not full support
**MBI=Macroinvertebrate Biotic Index, FII=Fish Index, RIBI=Reconnaissance Index of Biotic Integrity, NI=not impaired
***MBI value >= 3.5 = FS, < 3.5 to >= 2.5 = NV, < 2.5 = NFS
^FII value > 85 = FS, 57 to 85 = NV, < 57 = NFS
^^D=designated use, E=existing use
^^^IDFG=Idaho Department of Fish and Game, RIBI=Reconnaissance of Biotic Integrity, SM=stream morphology, PCR=primary contact recreation
~T=temperature, FC=fecal coliform

Appendix C

Additional bacteria information

Table C-1. Fecal coliform (colonies/100 ml) information from the Portneuf River subbasin (from Southeastern District Health Department, unpublished data).

			Colonies/100 ml by site*						
Year	Month	Day	Thru & below Pocatello	Rainey Park	Mink Creek	Inkom to Rainey Park	Near McCammon	Near LHS to McCammon	Near LHS
1990	7	5							80
	7	16							150
	8	15							560
	8	21							300
	8	21							140
	8	21							140
	8	21							70
1991	6	13	290						
	6	17					83		100
	6	17							88
	6	17							130
	6	17							93
	6	17							95
	6	17							98
	6	17							110
	6	17							110
	6	19	340						
	6	28	360						
	7	3	350						
	7	8	400						
	7	15	810						
	7	16	560			100	140		49
	7	16				80	250		42
	7	16							64
	7	23	860			80			
	7	23	1600			60			
	7	23	700			150			
	7	29	440			100			
	7	29	520			55			
	7	29	840			54			
	7	29				110			
	8	5	340			250			
	8	5	1500			200			
	8	5	1200			150			
	8	5				230			
	8	19	670		9300	90	130		170
	8	19	570			66	190		170
	8	19	1200			79			150
	8	19				120			
	8	26	14000		170	60			
	8	26	2500			82			
	8	26	1600			50			
	8	26	370						

Table C-1. Continued.

			Colonies/100 ml by site*						
Year	Month	Day	Thru & below Pocatello	Rainey Park	Mink Creek	Inkom to Rainey Park	Near McCammon	Near LHS to McCammon	Near LH
1991	9	3	400		90	37			
	9	3	380			22			
	9	3	500			60			
	9	3	300						
	9	3	100						
	9	9	540						
	9	9	470						
	9	9	650						
	9	9	580						
	9	9	260						
	9	18	130						
	9	18	160						
	9	18	120						
	9	18	620						
	9	18	120						
	9	23	82						
	9	23	122						
	9	23	120						
	9	23	416						
	9	23	** 500						
	9	23	302						
1992	4	26	24						
	4	26	33						
	4	26	30						
	4	26	55						
	4	26	35						
	4	26	16						
	4	28	52						
	4	28	98						
	4	28	54						
	4	28	58						
	4	28	130						
	4	28	50						
	5	3	21						
	5	3	27						
	5	3	16						
	5	3	7						
	5	3	11						
	5	3	27						
	5	5	280						
	5	5	51						
	5	5	21						
	5	5	36						
	5	5	31						
	5	5	20						

Table C-1. Continued.

Year	Month	Day		Colonies/100 ml by site*						
				Thru & below Pocatello	Rainey Park	Mink Creek	Inkom to Rainey Park	Near McCammon	Near LHS to McCammon	Near LHS
1992	5	10		120						
	5	10		180						
	5	10		210						
	5	10		130						
	5	10		140						
	5	10		190						
	5	13		120						
	5	13		180						
	5	13		210						
	5	13		130						
	5	13		140						
	5	13		190						
	6	22		340						
	6	29		1800						
	7	20		460			96			
	7	20		1100			69			
	7	20		400			30			
	7	20		490						
	7	20		430						
1993	5	18		700					600	
	5	18		600					300	
	6	8		900						
	6	8		1400						
	6	21		350						
	6	28							69	
	6	28							170	
	7	20		97						
	7	21							160	
	7	21							100	
	7	21							100	
1994	6	20		106	13					
	6	20		293						
	6	21	**^						200	
	6	21							13	
	7	12		150	10					
	7	12		1100						
	8	11							79	
	8	11							160	

*LHS=Lava Hot Springs
**actual number exceeds number listed
^count(s) of *Escherichia coli*

Table C-2. Fecal coliform (colonies/100 ml) information from the Portneuf River subbasin (from USGS water resources data).

					Colonies/100 ml by site			
Year	Month	Day	Discharge		Tyhee	Pocatello	Marsh	Topaz
1989	7	18	110		44			
1989	8	14	268	*	130			
1989	9	18	354		450			
1989	11	20	480	•	9			
1990	1	25	468	*	20			
1990	3	15	508	*	12			
1990	5	16	259	•	8			
1990	7	24	194		51			
1990	9	13	250		39			
1990	11	14	64				60	
1990	11	15	172			78		
1991	1	15	65				69	
1991	1	21	182			36		
1991	3	14	74				20	
1991	3	15	265	*		14		
1991	5	16	471			100		
1991	5	17	91	*			140	
1991	7	8	47				180	
1991	7	9	62	*		120		
1991	9	17	66				51	
1991	9	18	85			160		
1991	11	21	448	•	6			
1992	1	15	452		23			
1992	3	16	470		22			
1992	5	14	105		25			
1992	7	27	182		25			
1992	9	28	239	*	16			
1992	11	18	159	*		320		
1992	11	19	45				420	
1993	1	13	151	•		2		
1993	1	14	55	*			22	
1993	3	17	148				160	
1993	3	18	334	*		31		
1993	5	24	133				150	
1993	5	25	759			120		
1993	7	19	51			370		
1993	7	20	42				200	

Table C-2. Continued.

Year	Month	Day	Discharge		Colonies/100 ml by site			
					Tyhee	Pocatello	Marsh	Topaz
1993	9	22	120	*		80		
1993	9	23	58	*			38	
1993	11	23	480	*	15			
1994	1	18	473		43			
1994	3	23	534	*	2			
1994	5	17	231		68			
1994	7	12	96		88			
1994	9	20	265		35			
1994	11	23	35				93	
1994	11	28	195			21		
1995	1	18	75				71	
1995	1	18	247			86		
1995	3	23	115				500	
1995	3	24	437			500		
1995	5	17	92				720	
1995	5	17	433			220		
1995	7	13	42	*			150	
1995	7	13	38	*		130		
1995	9	20	66				140	
1995	9	20	103			270		
1996	4	23	107	*			75	
1996	4	24	588			190		
1996	4	24	310					140
1996	5	21	1110			190		
1996	5	22	696					160
1996	5	23	160				280	
1996	6	18	71				160	
1996	6	19	228					100
1996	6	20	324			170		
1996	7	16	68				600	
1996	7	16	219					290
1996	7	17	103			220		
1996	8	20	45				540	
1996	8	20	158					91
1996	8	21	68			180		
1996	9	17	220			800		
1996	9	18	93				620	
1996	9	18	94					110

*results based on counts outside ideal colony range

Table C-3. Fecal streptococci (colonies/100 ml) information from the Portneuf River subbasin (from USGS water resources data).

					Colonies/100 ml by site			
Year	Month	Day	Discharge		Tyhee	Pocatello	Marsh	Topaz
1989	7	18	110		89			
1989	8	14	268		98			
1989	9	18	354		440			
1989	11	20	480		260			
1990	1	25	468		40			
1990	3	15	508		41			
1990	5	16	259		48			
1990	7	24	194		79			
1990	9	13	250		77			
1990	11	14	64	*			400	
1990	11	15	172			104		
1991	1	15	65	•			500	
1991	1	21	182			93		
1991	3	14	74	*			110	
1991	3	15	265			39		
1991	5	16	471			100		
1991	5	17	91	*			390	
1991	7	8	47				580	
1991	7	9	62	•		110		
1991	9	17	66				160	
1991	9	18	85			95		
1991	11	21	448		63			
1992	1	15	452	•	540			
1992	3	16	470		50			
1992	5	14	105		79			
1992	7	27	182		47			
1992	9	28	239		36			
1992	11	18	159			130		
1992	11	19	45				210	
1993	1	13	151			44		
1993	1	14	55				410	
1993	3	17	148				2000	
1993	3	18	334			1400		
1993	5	24	133	•			17	
1993	5	25	759			180		
1993	7	19	51			4		
1993	7	20	42	*			15	
1993	9	22	120	*		27		
1993	9	23	58	•			17	

Table C-3. Continued.

Year	Month	Day	Discharge		Colonies/100 ml by site			
					Tyhee	Pocatello	Marsh	Topaz
1993	11	23	480		27			
1994	1	18	473		150			
1994	3	23	534		22			
1994	5	17	231		150			
1994	7	12	96		41			
1994	9	20	265		64			
1994	11	23	35				160	
1994	11	28	195			70		
1995	1	18	75	*			1500	
1995	1	18	247			910		
1995	3	23	115				450	
1995	3	24	437			380		
1995	5	17	92				140	
1995	5	17	433	*		110		
1995	7	13	42	•			170	
1995	7	13	38	•		200		
1995	9	20	66				110	
1995	9	20	103			240		
1996	4	24	588			100		
1996	4	24	310					80
1996	5	21	1110			470		
1996	5	22	696					200
1996	5	23	160				410	
1996	6	18	71				240	
1996	6	19	228					150
1996	6	20	324			260		
1996	7	16	68				470	
1996	7	16	219					190
1996	7	17	103	•		110		
1996	8	20	45				110	
1996	8	20	158	•				21
1996	8	21	68			200		
1996	9	17	220	*		2100		
1996	9	18	93				1000	
1996	9	18	94					300

*results based on counts outside ideal colony range
^actual number exceeds number listed

Table C-4. Bacteria counts (colonies/100 ml) in the Portneuf River subbasin, November 1985 to July 1986 (from Drewes 1987).

			Location*							
Year	Date	Count	Dempsey Cr	Jenkins Canyon	Jackson Cr	Rapid Cr	Indian Cr	Sorrell Canyon	South Fork Pocatello Cr	North Fork Pocatello Cr
1985	18 Nov	Fecal coliform	<10	-	100	10	550	20	10	<10
		Fecal streptococcus	60	-	310	180	8200	1200	610	700
1986	25 Feb	Fecal coliform	<10	1300	20	70	40	950	10	30
		Fecal streptococcus	330	930	480	7500	430	890	270	270
	10 Mar	Fecal coliform	10	-	10	20	330	<10	210	<10
		Fecal streptococcus	960	-	520	650	2900	270	1300	830
	24 Mar	Fecal coliform	40	-	120	20	40	100	120	10
		Fecal streptococcus	220	-	170	230	460	50	180	4100
	11 Apr	Fecal coliform	170	-	40	40	50	80	170	10
		Fecal streptococcus	1000	-	660	670	600	500	610	2100
	22 Apr	Fecal coliform	60	-	140	40	40	30	180	10
		Fecal streptococcus	490	-	1300	640	1400	820	850	2400
	6 May	Fecal coliform	150	-	350	50	180	640	180	10
		Fecal streptococcus	100	-	380	230	580	290	220	820
	20 May	Fecal coliform	200	-	1100	500	630	2300	100	10
		Fecal streptococcus	300	-	550	340	2000	270	110	150
	6 Jun	Fecal coliform	220	-	150	100	120	1100	350	110
		Fecal streptococcus	240	-	300	190	20000	600	3300	740
	17 Jun	Fecal coliform	180	-	610	300	1410	2900	920	100
		Fecal streptococcus	170	-	2190	530	3200	970	4200	760
	8 Jul	Fecal coliform	40	-	370	140	1200	6700	1400	150
		Fecal streptococcus	240	-	2200	70	6300	48000	2500	1400

*Cr=creek

Table C-5. Bacteria counts (colonies/100 ml) in the Portneuf River subbasin in the vicinity of Pocatello, August 1977 (from Ecology Consultants 1977).

		Location*						
Coliform count	Sample	Cheyenne Ave bridge	US Hwy 30 bridge	Upstream Simplot discharge	Downstream Simplot discharge	Nr Frontage Rd bridge	Downstream Rowland's Dairy	Spring nr Frontage Rd bridge
Fecal	1	170	85	50	1070	85	60	< 2
	2	-	100	50	1600	60	50	< 2
Total	1	330	850	670	1200	690	520	75
	2	-	1000	490	2500	1000	1820	80

*Hwy=highway, Nr=near, Rd=road

Table C-6. Fecal coliform sampling in Mink Creek, lower Portneuf River, and Pocatello Creek, August to October 1998.

Stream	Date	Site	Fecal coliform colonies/100 ml	
Mink Creek	8/18/98	FS boundary	90	
	8/18/98	Portneuf Road bridge	100	
	8/24/98	FS boundary	200	
	8/24/98	Portneuf Road bridge	100	
	9/3/98	West Fork	52	
	9/3/98	above East Fork	68	
	9/3/98	East Fork	120	
	9/3/98	Portneuf Road bridge	82	
Portneuf River	9/3/98	Rainey Park	82	
	10/15/98	Rainey Park*	86	
	10/15/98	Rainey Park*	62	
	8/18/98	downstream of concrete channel	110	
	8/18/98	North City Park	260	
	8/18/98	North Main Bridge	210	
	8/18/98	North North Main Bridge	180	
	8/18/98	confluence with Pocatello Creek	TNTC**	
	8/18/98	Kraft Road Bridge	NC***	
	8/24/98	above Pocatello Creek	520	
	8/24/98	Kraft Road Bridge	620	
	9/3/98	above Pocatello Creek	320	^
	9/3/98	Kraft Road Bridge	60	^
Pocatello Creek	8/24/98	RR culvert	1560	
	9/3/98	Parks Road	660	
	9/3/98	Fire Station	140	^
	9/3/98	mouth	140	
	9/22/98	Parks Road	540	
	9/22/98	mouth	680	

*collected by Pocatello High School students
**too numerous to count
***not countable
^estimate

Table C-7 . Fecal coliform concentrations at six sites (P1 to P6 - upstream to downstream) in the Downey Canal reach of the Portneuf River, 1995-1997 (from Rudel 1998). Primary contact recreation standards apply from May to September.

Date	Colonies/100 ml by site						Rolling geometric mean*
	P1	P2	P3	P4	P5	P6	
			1995				
10-Apr	23	4	1	62	10	320	
24-Apr	3	26	13	90	14	100	19
8-May	1	30	22	33	130	180	28
22-May	720	170	280	180	330	100	83
5-Jun	1	410	460	600	560	640	108
19-Jun	3	50	80	80	280	210	141
17-Jul	2	10	30	110	440	120	49
11-Aug	7	20	45	80	130	90	41
28-Aug	3	20	50	60	210	80	40
12-Sep	2	40	20	60	400	35	36
			1996				
2-Apr	1	100	50	30	20	30	
14-Apr	0.5	7	NS**	40	50	40	
28-Apr	2	20	NS	20	30	60	17
27-May	8	20	NS	190	170	250	66
24-Jun	20	420	NS	350	330	430	118
22-Jul	1	20	NS	40	70	150	72
6-Aug	20	10	NS	30	20	30	22
20-Aug	350	10	NS	0.5	20	10	19
4-Sep	5	16	NS	80	610	170	25
18-Sep	46	98	NS	180	84	111	41
			1997				
15-Apr	1	30	NS	150	20	4	
29-Apr	3	40	NS	300	330	260	32
13-May	1	20	10	150	290	520	41
25-Jun	4	50	NS	50	70	90	36
30-Jul	30	50	150	200	10	100	60
27-Aug	5	5	NS	290	1000	430	68
10-Sep	5	20	90	220	300	480	80
7-Oct	0.5	80	30	30	70	70	24

*the geometric mean is for the preceding 30-day period inclusive
**NS=not sampled

Appendix D

Additional sediment information

Table D-1. Suspended sediment (SS) from tributaries in the lower Portneuf River, November 1985 to July 1986 (from Drewes 1987).

		SS (mg/l) by site*							
Year	Date	North Fork Pocatello Cr	South Fork Pocatello Cr	Sorrell Canyon	Indian Creek	Rapid Creek	Jackson Creek	Jenkins Canyon	Dempsey Creek
1985	18 Nov	8	1680	34	24	2	<2		6
1986	22 Feb	896	30	472	560	288	200	228	74
	23 Mar	126	54	58	44	106	76		50
	11 Apr	696	208	224	110	230	228		192
	22 Apr	300	216	142	90	104	144		184
	6 May	222	112	66	152	86	140		184
	20 May	176	98	154	54	118	204		226
	3 June	114	46	52	50	56	74		246
	17 June	78	36	42	28	18	38		64
	8 July	42	10	72	4	6	2		2

*Cr=creek

Table D-2. Continued.

Year	Date (mm/dd)	Tybee Discharge (cfs)	Tybee Turbidity (NTU/FTU)	Tybee SS (mg/l)	Tybee SS (tons/day)	Tybee % SS <0.062 mm	Pocatello Discharge (cfs)	Pocatello Turbidity (NTU)	Pocatello SS (mg/l)	Pocatello SS (tons/day)	Pocatello % SS (<0.062 mm)	Marsh Discharge (cfs)	Marsh Turbidity (NTU)	Marsh SS (mg/l)	Marsh SS (tons/day)	Marsh % SS (<0.062 mm)	Topaz Discharge (cfs)	Topaz Turbidity (NTU)	Topaz SS (mg/l)	Topaz SS (tons/day)	Topaz % SS (<0.062 mm)
1989	07/18	110		11																	
	08/14	268		10																	
	09/18	354		8																	
	11/20	480		19	25																
1990	03/15	508		61	84																
	05/16	259		10	7																
	09/13	250		6	4.1																
	11/14											64		160	29						
	11/15						172		16	7.4											
1991	03/14											74		131	26						
	03/15						265		124	96											
	05/16						471		199	253											
	05/17											91		187	46						
	07/08											47		84	11						
	07/09						62		58	9.7											
	09/17											66		82	11						
	09/18						85		16	3.7											
	11/21	448		10	12																
1992	03/16	479		40	51																
	05/14	105		7	2																
	07/27	182		2	0.98																
	09/28	239		3	1.9																
	11/18						159	2.8	15	6.4											
	11/19											45	25	102	12						
1993	03/17											148	90	586	234						
	03/18						334	96	430	388											
	04/13																149		65	26	67
	04/27																164		39	13	92
	05/11																276		82	61	93
	05/24											133	22	110	40						
	05/25						759	40	284	582							352		150	145	89
	06/08																334		89	80	79
	06/22																196		48	37	70
	07/13																224		92	38	84
	08/10																190		56	26	76
	09/14																125		14	4.7	48
	09/22						128	2.4	445	144											
	09/23											58	1.7	7	1.1						
	10/19																99		62	17	81
	11/16																100		49	13	87
	11/23	480	1.7	11	14																
	12/14																103		5	1.4	71

Table D-2. Turbidity and suspended sediment (SS) monitoring at USGS surface-water stations, 1980-1996 (from USGS Water Resources Data reports).

Year	Date (mm/dd)	Tybee Discharge (cfs)	Tybee Turbidity (NTU/FTU)	Tybee SS (mg/l)	Tybee SS (tons/day)	Tybee % SS <0.062 mm	Pocotalio Discharge (cfs)	Pocotalio Turbidity (NTU)	Pocotalio SS (mg/l)	Pocotalio SS (tons/day)	Pocotalio % SS (<0.062 mm)	Marsh Discharge (cfs)	Marsh Turbidity (NTU)	Marsh SS (mg/l)	Marsh SS (tons/day)	Marsh % SS (<0.062 mm)	Topaz Discharge (cfs)	Topaz Turbidity (NTU)	Topaz SS (mg/l)	Topaz SS (tons/day)	Topaz % SS (<0.062 mm)
1971	08/11	275		36	26.7																
1972	05/16	1340		170	624																
	07/20	293		26	20.6																
	08/03	291		71	55.8																
	09/26	635	3*																		
	10/31	712	8*																		
	11/29	604	10*																		
	12/27	781	10*																		
1973	01/24	710	5*																		
1974	06/07						435		159	195											
	09/25						121		53	17											
1975	06/25						713		210	404											
1977	05/26						127			60											
	11/08						210		152	86											
1979	16/31											54		15	2.2						
	12/17											60		22	3.6						
1980	02/14											70		36	6.8						
	04/17											89		581	140						
	05/12						915		580	1460											
	06/02											179		573	277						
	06/24											100		50	13						
	07/15											55		15	2.2						
	08/12											47		19	2.4						
	09/18											73		20	4						
	10/22											81	1.1	40	8.7	95					
	12/11											71	7.3	23	4.4	91					
1981	02/05											84	24	70	16	89					
	04/15											59	17	40	6.4	96					
	05/07											46	1.4	27	3.4	96					
	05/20						247		85	57											
	06/18											70	12	39	7.4	92					
	07/09						51		21	2.9											
	07/12											39	9.9	31	3.3	96					
	08/18											42	8.1	29	3.3	97					
	09/29											68	13	31	5.7	90					

Table D-3. Continued.

Year	Date (yyyy/dd)	Tybee Discharge (cfs)	Tybee Turbidity (NTU/FTU)	Tybee SS (mg/l)	Tybee SS (tons/day)	Tybee % SS <0.062 mm	Poodiebiddie Discharge (cfs)	Poodiebiddie Turbidity (NTU)	Poodiebiddie SS (mg/l)	Poodiebiddie SS (tons/day)	Poodiebiddie % SS (<0.062 mm)	Marsh Discharge (cfs)	Marsh Turbidity (NTU)	Marsh SS (mg/l)	Marsh SS (tons/day)	Marsh % SS (<0.062 mm)	Tigers Discharge (cfs)	Tigers Turbidity (NTU)	Tigers SS (mg/l)	Tigers SS (tons/day)	Tigers % SS (<0.062 mm)
1994	01/11																110		25	7.4	82
	02/11																166		64	18	84
	03/21																132		74	37	55
	03/23	334	5.8	32	84	85															
	04/12																131		42	15	75
	05/10																315		128	74	84
	05/17	251	0.3	88	42	53															
	05/26																172		116	54	70
	05/27	134		8	3.9	84															
	06/28																156		32	13	78
	06/27																166		64	28	31
	07/19																122		46	15	88
	08/16																82		33	7.3	99
	09/15																75		19	3.8	98
	09/20	203	6.3	1	0.72	100															
	10/07																97		26	4	71
	11/08																78		56	4.2	92
	11/25																				
	11/28																				
	12/13						193	5.1				35	32	–	–	–					
1995	01/18																				
	02/22																				
	03/20																98		55	13	78
	03/23																122		18	5.9	97
	05/24																128		36	12	88
	04/19						437	36	175	206	96	113	36	223	69	94	152		37	15	94
	05/11																				
	05/17																				
	05/31						435	22	119	130	96	92	27	109	27	98	156		43	18	88
	06/02																231		136	85	80
	07/06																				
	08/20																190		110	56	75
1996	04/23						103	6.1	39	11	91	86	2.6	12	2.1	93	370		282	282	77
	04/24											107	14	73	21		191		124	64	79
	05/21						588	36	284	334											
	05/22						1110	97	312	935											
	05/23																316	34	164	137	
	06/18											160	34	143	82		696	71	370	695	
	06/19											71	4.9	17	3.2						
	06/20																				
	07/16						324	20	90	79							228	9.1	58	36	
	07/17																				
	08/29						103	2.2	19	5.3		68	2.3	11	2		219	6.4	67	40	
	08/31																				
	09/17						68	2.8	28	5.1		45	3.4	17	2.1		158	3.8	62	26	
	09/18						230	25	84	50											
												93	3	17	4.3		94	1.6	15	3.8	

*FTU

Table D-3. Turbidity and Total Suspended Solids (TSS) monitoring in streams in the Portneuf River subbasin.

Waterbody	Date	Site	Turbidity (NTU)	TSS mg/l	Source
Bell Marsh	May 82	Lower	2.9	18	Geoff Hogander, BLM, personal communication
		Upper	2.5	11	
	Sept 82	Lower	4.5	31	
		Upper	2.2	8	
	July 83	Lower	1.1	1.5	
		Upper	0.7	<2	
Marsh	Apr 96	Bridge W of McCammon	25	116	Richard Scully, IDFG, personal communication
		Bridge W of Arimo	12		
	May 96	Bridge W of McCammon	23	176	
		Bridge W of Arimo	24		
		Below mouth of Walker Cr		144	
	June 96	Bridge W of McCammon	15	134	
		Bridge W of Arimo	10		
		Below mouth of Walker Cr		78	
	July 96	Bridge W of McCammon	15	79	
		Bridge W of Arimo	10		
		Below mouth of Walker Cr		56	
	Aug 96	Bridge W of McCammon	7	67	
		Below mouth of Walker Cr		29	
Portneuf	Oct 96	near old Hwy 30 bridge	3.2		Royer and Minshall 1997

Table D-4. Sediment delivery resulting from streambank erosion for streams in the upper Portneuf River subbasin (from Soil Conservation Service 1993).

Waterbody	Length (miles)	Sediment yield (tons/year)	Sediment delivery ratio	Sediment delivered to river (tons/year)	Sediment delivered to river per mile (tons/year)
Portneuf		180	100	180	
Pebble	20.5	625	90	563	27.5
Downey Canal	8	2410	100	2410	301.3
King	19	100	20	20	1.1
Twentyfourmile	17	1190	60	714	42.0
Eighteenmile		175	40	70	
Toponce	31.5	60	80	48	1.5
Canals/ditches	11	285	60	171	15.5

Table D-5. Mean annual computed sediment discharge at the USGS Tyhee and Pocatello surface-water stations, 1950-1989 (from Bechtel Environmental, Inc. 1996).

Year	Discharge (tons/year)	
	Pocatello	Tyhee
1950	65,600	
1951	31,500	
1952	48,000	
1953	28,500	
1954	16,400	
1955	13,400	
1956	24,000	
1957	36,800	
1958	33,800	
1959	18,600	
1960	18,600	
1961	12,600	
1962	49,600	
1963	31,300	
1964	38,500	
1965	49,500	
1966	19,800	
1967	27,200	
1968	22,900	
1969	60,400	
1970	33,900	
1971	107,600	
1972	107,900	
1973	51,800	
1974	81,100	
1975	98,700	
1976	83,700	
1977	14,000	
1978	42,400	
1979	22,100	
1980	69,300	
1981	26,900	
1982	85,800	
1983	171,400	
1984	239,000	
1985	70,700	7,770
1986	161,200	33,250
1987	25,800	9,000
1988	15,000	6,490
1989	26,400	6,460

Table D-6. Mean computed sediment discharge by month at two sites on the Portneuf River (from Bechtel Environmental 1996).

Site	Time period	Discharge (tons/month)												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Pocatello	1950-1989	2,920	4,350	6,500	10,930	15,670	5,800	630	460	850	1,540	2,270	2,620	54,500
Tyhee	1985-1989	1,030	1,510	2,540	2,840	2,070	480	200	360	600	920	980	980	14,510

Table D-7. Turbidity monitoring at 10 sites in the Portneuf River, 1969-1971 (from Minshall and Andrews 1973).

		Turbidity (JTUs) by site*									
Year	Month	Siphon Road bridge	Batise Road bridge	Within Pocatello	Above Pocatello	Below Inkom	Below McCammon	Below Lava Hot Springs	Above Lava Hot Springs	Pebble Creek	Chesterfield Dam
1968	September	8	30	39	36	56	0	0	--	4	8
1969	February	49	61	44	49	64	61	49	61	68	22
	September	8	36	39	42	39	8	4	20	8	42
1970	February	153	172	168	137	120	109	49	61	26	20
1971	February	61	80	81	86	77	44	56	47	61	--

*sites are very general and proceed upstream left to right

Table D-8. Rates used to estimate sediment loads for the Portneuf River subbasin.

Land use	Erosion rate (tons/ac/yr)	Sediment delivery rate	Sediment yield (tons/ac/yr)	Sediment yield (tons/mi/yr)	Sediment load (tons/yr)	Source
Dryland	13	15%	1.95			Justin Krajewski (SCC), Carrie Jensen-Smith and Terril Stevenson (NRCS)
SAWQP land	5.2	15%	0.78			Justin Krajewski (SCC), Carrie Jensen-Smith and Terril Stevenson (NRCS)
CRP land	1		0.01			ER - Portneuf Soil and Water Conservation District 1996, SDR - Marsh Creek value from Caribou National Forest 1985
Irrigated ag land - gravity			1			SDR - Roberts 1977
Irrigated ag land - sprinkler			1			SDR - Roberts 1977
Rangeland	1.2	22%	0.258			ER - BLM 1987, SDR - average from Osborn & Medenitzki 1986
Forest - above Pocatello			0.00825			SD - Caribou National Forest 1985
above Topaz			0.006			SD - Caribou National Forest 1985
above Marsh			0.01			SD - Caribou National Forest 1985
Riparian*						
Downey Canal				300		Soil Conservation Service 1993, Rudel 1998
Upper canals/ditches					26.9	Soil Conservation Service 1993
Portneuf River				40.1		Soil Conservation Service 1993
Marsh Creek				40.1		Estimated based on Portneuf River figure
Tributaries				33.9		Tributary average from Soil Conservation Service 1993
Water						
Urban - Pocatello			0.09			Todd Maguire (DEQ, personal communication)

*input of sediment from riparian areas (i.e., streambanks) based on stream length rather than riparian area

Table D-9. Daily suspended sediment loads based on the regression equation (logSS=0.953(log$flow$)-0.278) summed by month, Pecatonica USGS surface-water station, 1955-1995.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1955	1,587	1,491	2,255	2,825	1,861	353	62	143	168	363	1,633	2,360	14,295
1956	3,004	2,086	4,774	8,165	3,066	218	31	86	132	372	1,651	2,874	25,558
1957	1,643	5,989	5,013	3,422	13,627	3,581	118	142	256	691	2,875	2,614	39,111
1958	2,425	3,430	5,771	8,895	7,416	261	65	168	257	492	1,959	2,825	35,964
1959	2,829	2,884	4,885	4,251	1,018	173	68	55	357	882	1,590	1,712	19,894
1960	1,684	1,857	6,797	6,477	612	62	17	108	123	275	487	1,388	19,887
1961	1,368	2,703	3,084	1,951	271	35	12	35	316	864	1,454	1,368	13,568
1962	1,235	24,590	8,319	10,602	4,190	255	58	62	92	410	1,178	1,580	52,564
1963	1,257	12,342	2,327	4,116	6,255	2,659	101	43	274	540	1,621	1,739	33,253
1964	1,683	1,540	1,814	8,812	11,152	5,431	511	108	135	480	1,862	7,504	40,953
1965	4,689	6,239	4,213	11,889	15,082	2,461	979	551	1,157	1,399	2,386	2,467	52,711
1966	2,409	2,857	6,286	6,595	1,145	83	13	25	37	235	844	1,472	21,148
1967	1,672	1,887	3,143	4,064	7,884	5,551	1,207	184	212	921	1,431	1,326	29,052
1968	1,468	3,536	5,188	4,222	2,480	1,439	188	986	471	819	1,900	1,394	24,395
1969	5,549	2,923	5,187	24,968	16,563	2,882	706	252	253	1,162	2,696	2,447	64,105
1970	4,902	3,080	5,473	3,355	10,449	5,821	237	210	982	1,386	2,355	2,496	36,106
1971	2,856	3,548	8,921	21,098	46,098	16,169	1,188	368	1,863	9,883	3,940	4,229	114,828
1972	5,250	5,067	23,687	27,303	31,279	8,484	835	770	1,506	3,233	3,768	3,187	114,370
1973	3,809	3,272	4,965	13,139	15,714	1,171	602	415	2,183	2,846	5,658	3,358	55,132
1974	3,462	3,802	14,708	23,747	28,844	3,939	419	413	499	1,764	3,168	2,598	86,059
1975	3,313	3,168	7,417	8,573	36,242	30,581	2,515	1,311	1,161	3,129	3,497	3,883	104,699
1976	2,781	2,649	6,143	24,008	39,074	4,328	395	673	1,807	2,638	2,590	2,451	88,728
1977	2,522	2,142	2,823	1,392	351	542	71	189	262	820	1,625	2,421	14,961
1978	2,537	2,763	6,425	13,274	12,065	2,256	179	154	611	1,898	1,825	1,888	45,076
1979	1,908	2,612	5,048	6,387	4,506	293	42	151	131	451	1,102	1,154	23,785
1980	7,587	9,484	4,995	9,573	23,481	11,578	471	180	455	1,584	1,596	2,366	73,508
1981	2,187	2,759	2,958	3,012	8,661	4,436	88	52	89	638	1,541	2,354	28,716
1982	1,828	3,388	6,692	14,614	39,172	11,281	1,927	552	1,796	3,529	3,538	3,627	91,054
1983	4,390	4,690	16,736	21,847	64,377	39,323	4,306	2,806	3,490	5,447	6,621	7,296	181,379
1984	7,838	6,588	10,673	24,815	113,881	56,406	5,691	3,296	4,961	5,395	6,523	6,812	252,280
1985	6,821	5,936	7,851	30,498	11,808	1,708	454	391	1,055	3,199	3,623	3,778	75,695
1986	3,899	17,428	31,437	42,368	39,369	9,309	1,228	2,354	6,758	6,823	5,485	4,330	170,695
1987	4,012	4,230	7,059	2,896	1,274	772	281	202	385	1,230	2,576	2,491	27,505
1988	2,596	2,666	4,353	3,082	545	129	79	65	73	213	778	1,535	16,823
1989	1,270	1,193	7,222	13,102	1,689	441	161	178	182	486	908	1,384	28,062
1990	1,825	1,646	3,848	2,447	655	382	74	78	284	354	983	1,206	12,894
1991	1,081	1,364	2,655	1,964	4,839	1,814	109	105	172	461	1,166	1,252	16,171
1992	1,124	1,757	1,708	643	32	27	34	5	26	189	707	883	7,955
1993	778	805	4,309	5,688	19,314	4,994	419	592	492	1,150	1,380	1,437	41,216
1994	1,470	2,428	3,199	2,104	442	119	9	14	46	428	736	1,010	12,821
1995	1,641	2,164	3,665	3,050	5,190	4,718	321	118	328	910	1,482	1,356	23,444
											Annual average		54,346

Table D-10. Daily suspended sediment loads based on the regression equation (SS=1.277(flow)-60.979) summed by month, Monk Creek USGS surface-water station, 1955-1995.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1955	397	311	774	585	158	163	27	163	146	332	304	395	3,906
1956	1,344	245	2,362	585	181	33	8	35	215	420	335	816	6,771
1957	291	2,680	1,085	583	2,847	642	179	288	420	888	1,184	1,115	12,154
1958	699	1,176	2,953	1,556	687	232	74	215	411	773	1,089	1,166	14,851
1959	548	1,151	797	471	246	89	151	79	690	676	364	363	5,585
1960	363	548	4,635	1,272	82	30	16	164	81	208	269	267	7,915
1961	222	930	688	271	35	0	8	16	288	197	224	276	3,168
1962	831	33,857	5,330	1,303	159	183	25	91	198	292	697	477	43,294
1963	315	6,298	571	834	673	777	43	35	369	335	415	374	11,200
1964	310	248	565	3,545	918	1,844	371	80	259	599	798	4,889	14,417
1965	2,079	1,891	1,185	2,798	2,692	809	734	639	671	356	1,313	816	16,618
1966	744	642	3,986	962	218	53	5	9	108	270	365	387	7,641
1967	608	566	368	598	473	1,862	474	135	231	514	551	467	6,241
1968	358	2,349	1,387	572	282	576	187	882	488	590	737	685	8,955
1969	3,023	982	7,687	7,962	1,127	732	439	299	522	1,237	1,816	950	26,036
1970	2,278	1,128	955	515	837	398	294	238	992	1,883	1,091	950	10,745
1971	999	1,673	4,996	4,580	7,762	2,864	510	547	1,162	1,585	1,319	1,584	28,778
1972	2,220	2,974	4,387	4,847	3,145	1,088	541	584	759	1,196	1,060	1,086	23,286
1973	988	664	3,518	2,483	1,579	382	571	408	1,354	943	1,380	1,186	15,576
1974	1,237	748	6,081	2,778	2,598	381	152	347	296	885	1,184	953	17,525
1975	964	1,086	3,649	1,746	4,971	2,643	664	416	569	1,007	676	811	19,202
1976	705	967	4,008	7,346	3,991	680	108	387	434	481	679	525	20,090
1977	452	376	776	197	347	239	47	193	394	384	695	943	5,063
1978	826	1,085	1,491	3,214	1,388	137	9	178	608	411	388	263	9,913
1979	358	2,283	4,338	1,170	273	83	57	150	374	318	289	346	10,219
1980	17,696	10,561	1,696	1,253	5,047	3,481	273	147	396	583	920	1,008	43,043
1981	996	1,648	862	482	1,894	1,500	30	47	199	735	984	812	9,391
1982	175	2,031	2,160	2,642	7,902	2,183	888	656	1,770	2,268	2,289	1,820	26,323
1983	2,157	3,294	6,087	3,584	18,611	8,739	1,790	2,255	1,888	3,211	3,390	3,884	58,218
1984	2,880	1,768	5,162	6,890	16,591	9,242	1,894	2,070	2,263	3,402	2,479	1,576	55,416
1985	1,505	1,291	3,148	12,391	1,847	573	394	347	961	1,333	1,527	1,453	26,770
1986	1,260	18,235	6,131	6,941	6,329	1,785	913	1,119	2,098	2,565	2,177	1,678	51,227
1987	1,337	1,896	3,045	737	930	583	448	527	986	1,023	1,110	922	13,085
1988	835	1,126	1,743	692	323	147	44	55	113	385	420	210	6,014
1989	198	252	4,119	1,275	366	352	118	207	417	668	598	456	8,909
1990	667	518	758	424	482	357	104	58	178	334	526	186	4,296
1991	236	487	711	420	1,151	330	51	85	589	308	424	264	4,824
1992	177	714	287	98	1	39	10	0	48	60	99	88	1,613
1993	280	200	2,238	1,057	2,358	853	116	488	339	390	311	917	8,858
1994	439	1,471	848	148	34	24	0	16	91	128	113	192	3,490
1995	877	1,114	883	353	937	1,171	95	97	298	362	365	509	6,981
											Annual average		16,309

Table D-11. Daily suspended sediment loads based on the regression equation (lld=0.559(flow)-23.795) summed by month, Topeka USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	527	462	516	834	1,234	1,382	560	294	228	384	495	711	7,489
1956	715	518	1,731	2,989	2,141	1,969	1,417	569	362	356	530	681	13,785
1957	480	4,874	1,072	968	4,150	2,210	1,573	1,419	783	437	598	716	19,259
1958	628	1,042	1,408	2,894	3,862	1,785	1,804	1,210	597	311	551	743	15,176
1959	638	615	1,265	1,362	1,591	1,407	920	201	248	397	413	425	9,418
1960	442	475	1,647	1,877	1,323	1,537	524	194	124	158	317	374	9,131
1961	358	606	721	499	504	725	181	143	170	188	388	445	4,928
1962	765	38,834	3,686	2,537	1,515	1,469	1,140	1,300	639	251	372	413	44,241
1963	614	14,986	378	990	1,850	1,534	1,104	1,078	526	288	555	500	24,602
1964	478	394	378	2,171	3,286	3,399	1,681	1,239	489	312	561	5,830	20,223
1965	2,177	1,291	1,053	2,919	7,896	3,488	1,944	1,402	684	635	809	655	24,972
1966	686	681	1,379	1,845	1,569	1,463	923	583	264	203	363	520	10,400
1967	444	388	1,180	1,045	2,547	2,871	887	1,137	583	506	495	494	12,500
1968	554	397	1,418	886	1,467	2,376	1,391	982	413	520	613	591	12,859
1969	3,468	801	1,520	10,417	10,992	2,891	1,569	1,637	801	491	583	655	35,266
1970	1,363	814	1,871	865	5,175	5,009	1,469	1,203	708	584	672	713	19,728
1971	880	1,068	4,284	7,797	27,308	9,556	2,270	2,136	1,975	1,630	1,394	1,396	62,256
1972	1,394	1,558	8,710	10,464	17,017	7,021	2,379	1,899	1,697	1,601	2,012	1,960	58,708
1973	1,630	1,371	1,625	4,995	8,819	2,401	1,632	1,119	984	859	1,165	1,095	27,676
1974	1,135	925	5,128	8,061	14,149	3,513	1,748	1,690	1,069	729	1,091	1,017	40,249
1975	1,088	939	1,897	2,392	9,746	12,343	2,097	1,555	1,301	1,741	1,169	1,172	37,619
1976	738	751	1,465	12,126	19,075	4,860	1,860	1,698	931	1,091	894	966	46,426
1977	987	805	985	916	1,384	1,196	1,151	689	341	349	561	772	10,255
1978	501	549	2,188	4,558	7,986	3,303	1,252	1,136	661	487	644	684	23,819
1979	590	544	980	1,710	2,112	1,744	1,153	837	291	553	516	426	11,171
1980	1,423	4,767	1,177	1,984	6,188	3,664	1,214	914	694	640	633	542	23,939
1981	462	356	615	827	3,814	1,818	1,308	743	441	224	345	475	11,627
1982	409	732	1,618	3,834	19,823	5,450	2,132	1,422	1,382	1,391	1,143	958	39,494
1983	1,844	952	4,526	6,179	22,891	15,698	3,265	2,278	2,207	2,008	1,983	2,151	68,174
1984	2,752	2,529	3,649	5,441	38,748	24,346	5,822	2,984	2,634	3,176	3,838	3,042	96,160
1985	2,158	2,393	3,149	12,287	6,042	2,455	1,892	1,274	1,312	1,446	1,332	1,184	37,463
1986	916	4,848	8,440	14,962	14,270	6,199	2,721	4,449	3,158	2,959	1,628	1,634	67,775
1987	1,471	1,768	2,618	1,622	2,094	1,145	918	1,601	669	675	882	887	16,351
1988	810	757	1,171	1,119	1,473	1,136	516	255	176	228	448	542	8,617
1989	533	343	1,809	3,241	2,342	1,727	1,161	784	369	321	548	572	13,644
1990	600	549	993	812	1,573	1,122	1,363	254	146	155	355	476	8,197
1991	442	411	839	623	1,442	1,356	1,033	667	172	208	471	446	8,111
1992	414	588	576	273	1,020	527	137	99	68	26	193	210	4,082
1993	206	173	792	936	5,329	2,869	1,377	882	459	271	319	347	13,159
1994	368	910	881	649	1,337	893	621	269	54	39	170	249	6,439
1995	384	669	836	841	1,952	3,318	1,387	917	282	164	358	449	11,539
											Annual average		25,201

Table D-12. Target suspended sediment loads based on the monthly average x target concentration (high flow months are in bold), Pocatello USGS surface-water station, 1955-1995.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1955	940	1,392	1,795	1,592	1,119	283	164	230	280	418	938	1,123	18,881
1956	1,291	1,633	2,545	3,451	1,944	294	117	207	253	429	935	1,054	14,153
1957	954	2,489	2,612	2,198	4,376	1,228	209	263	358	602	1,862	1,216	17,565
1958	1,169	2,371	2,982	3,589	3,102	349	173	298	346	504	1,827	1,255	17,277
1959	1,267	1,931	2,439	2,458	1,806	281	168	182	388	684	911	988	12,647
1960	941	1,572	3,060	2,987	757	165	79	230	244	376	497	878	11,785
1961	871	1,791	2,890	1,570	585	108	67	201	376	671	896	868	10,085
1962	794	4,471	3,284	3,885	2,253	339	159	175	201	458	781	936	17,754
1963	816	3,128	1,830	2,401	3,809	1,201	144	136	351	532	933	987	15,469
1964	971	1,433	1,613	3,567	4,087	1,631	428	233	254	458	986	1,851	17,551
1965	1,681	2,810	2,497	3,971	4,744	1,049	679	523	768	882	1,127	1,178	21,829
1966	1,168	1,641	2,954	3,844	1,066	191	68	97	157	312	640	901	12,299
1967	957	1,535	2,116	2,414	3,318	1,731	691	508	326	695	878	859	15,826
1968	985	2,061	2,778	2,454	1,828	820	225	588	473	638	1,017	1,832	14,804
1969	1,613	1,968	2,639	4,161	4,805	1,805	565	562	353	783	1,878	1,177	22,409
1970	1,608	1,906	2,258	2,184	3,899	1,336	529	330	507	840	1,134	1,183	17,644
1971	1,240	2,165	3,438	5,649	8,536	2,838	749	427	598	1,476	1,685	1,554	30,653
1972	1,722	2,625	6,065	6,457	6,978	2,181	651	630	839	1,348	1,438	1,341	32,314
1973	1,471	2,087	2,708	4,367	4,788	771	494	468	1,066	1,275	1,425	1,387	22,308
1974	1,397	1,996	4,892	5,953	6,524	1,380	469	468	488	959	1,319	1,295	26,941
1975	1,374	2,050	3,335	3,512	7,383	4,115	1,148	825	788	1,328	1,378	1,491	28,709
1976	1,259	1,901	2,977	5,990	7,824	1,499	429	582	724	1,225	1,195	1,180	26,789
1977	1,148	1,677	2,838	1,268	614	504	175	268	347	666	931	1,167	10,793
1978	1,195	1,985	3,808	4,439	4,279	1,885	283	265	534	776	987	1,890	19,707
1979	1,836	1,832	2,709	3,841	2,386	374	127	247	225	458	766	798	13,998
1980	1,749	3,152	2,705	3,540	6,864	2,353	465	297	475	894	1,044	1,128	23,869
1981	1,091	1,847	2,888	2,042	2,972	1,376	203	168	209	539	969	1,140	14,566
1982	1,804	2,808	3,162	4,526	7,921	2,456	1,017	531	944	1,423	1,399	1,314	27,607
1983	1,577	2,482	5,064	5,671	10,128	4,625	1,519	1,212	1,385	1,782	1,989	2,864	39,449
1984	2,147	3,038	5,881	6,027	13,297	5,734	1,743	1,354	1,663	1,775	1,927	2,005	44,588
1985	1,879	2,742	5,213	6,744	4,154	869	489	453	732	1,343	1,432	1,472	25,513
1986	1,498	4,560	7,068	8,169	7,910	2,088	779	1,147	1,942	1,994	1,749	1,583	40,420
1987	1,523	2,374	3,289	1,971	1,364	611	381	318	442	806	1,191	1,185	15,274
1988	1,213	1,594	2,529	2,038	886	252	191	179	179	332	611	925	11,171
1989	839	1,221	3,181	4,371	1,384	471	222	280	299	585	691	877	14,342
1990	1,089	1,457	2,104	1,826	872	417	182	181	314	427	723	816	18,227
1991	776	1,523	1,912	1,655	2,608	644	232	227	285	487	788	826	11,764
1992	787	1,478	1,564	877	183	106	124	47	105	293	687	662	6,832
1993	648	1,088	2,261	2,839	5,317	1,574	451	540	487	788	863	895	17,872
1994	906	1,595	2,106	1,713	747	228	62	77	138	466	630	745	9,412
1995	928	1,636	2,273	2,868	2,754	1,551	575	217	402	705	893	1,011	14,814
											Annual average		19,263

No. 1. 86 in original

Table D-14. Target suspended sediment loads based on the monthly-average x target concentration (high flow months are in bold), Topeka USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	451	492	345	1,094	1,343	1,282	550	441	390	447	508	610	8,892
1956	621	525	817	1,756	1,587	1,361	830	781	466	478	545	598	10,278
1957	531	932	726	1,094	2,870	1,860	863	828	622	512	568	622	10,937
1958	590	669	814	1,325	1,862	1,439	923	775	551	451	548	630	10,778
1959	594	550	777	1,255	1,388	1,291	661	387	405	493	491	506	8,796
1960	514	507	827	1,465	1,361	1,351	511	340	324	357	442	482	8,483
1961	475	531	614	843	833	979	374	347	358	377	479	515	6,743
1962	575	1,830	895	1,674	1,388	1,289	754	888	565	486	478	501	11,126
1963	520	1,173	569	1,110	1,489	1,346	744	737	532	437	550	559	9,758
1964	527	475	485	1,909	1,917	1,900	895	781	528	458	535	1,040	11,850
1965	816	724	731	1,719	2,892	1,926	958	822	599	593	640	680	13,821
1966	612	546	774	1,433	1,375	1,318	689	570	484	382	464	545	9,117
1967	514	459	725	1,146	1,659	1,776	673	755	545	541	527	537	9,849
1968	562	633	828	1,065	1,342	1,611	820	682	498	547	573	576	9,735
1969	963	613	766	3,144	3,336	1,703	851	834	627	532	563	599	14,531
1970	775	618	735	1,056	2,184	2,177	850	772	614	575	592	628	11,567
1971	666	690	1,205	2,811	5,286	2,918	1,020	995	948	885	810	819	19,047
1972	821	825	1,989	3,249	4,154	2,639	1,044	944	879	875	941	952	18,332
1973	882	775	881	2,234	3,841	1,637	877	750	692	671	747	743	13,927
1974	754	652	1,430	2,833	3,797	1,874	989	896	716	623	728	720	15,933
1975	738	656	968	1,630	3,059	3,448	975	860	808	907	746	761	15,548
1976	630	683	848	3,337	4,364	2,549	934	897	681	742	669	705	16,669
1977	711	615	710	1,075	1,362	1,210	759	605	456	469	548	628	9,149
1978	538	526	934	2,183	2,874	1,812	785	758	587	533	583	610	12,716
1979	576	524	680	1,485	1,573	1,425	758	657	429	478	535	586	9,538
1980	666	927	764	1,407	2,636	1,889	777	686	524	582	581	557	11,996
1981	523	524	585	1,023	1,748	1,416	798	632	488	398	456	529	9,115
1982	499	977	876	1,741	4,486	2,359	989	831	802	822	741	702	15,415
1983	726	660	1,389	2,522	4,755	3,756	1,198	1,023	991	963	944	995	19,923
1984	1,106	993	1,095	2,373	5,859	4,764	1,452	1,136	1,072	1,190	1,146	1,167	23,353
1985	1,135	900	1,125	3,416	2,559	1,646	941	792	786	857	794	743	15,774
1986	688	1,262	1,871	3,815	3,844	2,400	1,100	1,387	1,462	1,138	866	881	20,715
1987	844	842	1,078	1,382	1,570	1,185	637	873	590	608	666	680	10,975
1988	653	612	761	1,175	1,344	1,168	526	419	361	403	508	557	8,483
1989	553	436	874	1,866	1,613	1,419	761	644	468	454	548	569	10,199
1990	579	525	712	1,085	1,280	1,166	816	419	341	395	463	529	8,189
1991	514	478	651	923	1,317	1,272	722	600	359	391	516	516	8,249
1992	502	544	578	667	1,140	849	342	312	268	233	344	393	6,149
1993	390	344	594	1,084	2,330	1,510	819	676	500	428	446	469	9,990
1994	479	545	649	936	1,274	1,070	581	414	254	251	356	416	7,225
1995	476	546	654	1,040	1,516	1,846	821	688	410	362	463	513	9,335
											Annual average		11,961

Table E-1. Mean values for surface water parameters measured at 16 sites in the Portneuf River in the Pocatello area in July and October, 1992 and February and April, 1993 (from Bechtel Environmental 1996).

Value	Total suspended solids (mg/l)	Ammonia NH3 as N (mg/l)	Nitrate NO3 as N (mg/l)	Ortho-phosphate PO4 as P (mg/l)	Total phosphorus (mg/l)
Mean*	14.5	0.5	1.2	0.26	0.34
Number of sites	14	16***	16	16	16
Range**	4.0-52.0	0.3-3.4	0.42-2.26	0.03-0.97	0.06-1.05

*average of all values for all sampling periods and all sampling sites
**range of mean values by sampling site
***ammonia not detected at 10 sites which were assumed to be 0 mg/l for averaging

Table B-2. Continued.

Year	Date	Discharge (cfs)	Total nitrate/nitrite		Total ammonia		Total Kjeldahl nitrogen**	Total phosphorus	Total ortho phosphorus		Total ortho phosphate	
							Pentable					
1965	10/03	220	2.0	●								
	12/13	303	4.6	●								
1966	01/19	272	4.0	●								
	02/24	281	4.5	●								
	05/26	551	3.3	●								
	05/02	340	1.9	●								
	06/10	51	1.1	●								
	07/15	45	1.3	●								
	09/29	49	1.1	●								
	12/09	223	3.4	●								
1967	01/15	235	4.2	●								
	02/14	261	0.7	●								
	03/16	277	3.7	●								
	04/21	368	3.4	●								
	06/14	432	2.7	●								
	06/29	545	2.7	●								
	07/27	76	3.2	●								
	08/31	79	2.1	●								
	10/04	116	2.5	●								
1968	02/01	230	4.8	●								
	08/22	286	2.7	●							0.59	)
	12/05	239	3.7	●							0.26	)
1969	04/05	1020	5.0	●							0.06	)
	12/19	270	4.9	●							0.08	)
1970	06/12	379	2.7	●							0.83	)
	08/19	107	1.3	●							0.01	)
	10/06	180	5.30	/								
1971	04/08	840	1.0	/				1.10	0.15			
	07/09	243	0.02	/				0.10	0.07			
	10/15	307	0.79	*				0.190	0.050	+		
1972	04/12	1070	0.95	*				0.410				
	08/19	432	0.69	*				0.260				
	11/05	370	1.10	*				0.130				
1973	05/21	485	0.54	*				0.330				
	09/24	312	0.47	*				0.040				
1974	05/07	455	9.00	*								
	09/25	121	0.38	*				0.060				
1975	06/27	713	0.33	*				0.140				
	08/23	208	0.36	*				0.050				
1976	07/25	81	0.28	*				0.080				
	10/22	296	2.60	*				0.050				
1977	07/07	31	0.08	*				0.020				
	11/08	210	15.00	*				0.050				
1978	07/14	42	0.02	*				0.040				
1979	05/24	258	0.13	*				0.060				
	10/25	164	0.68	*				0.080				
1980	05/22	915	1.90	*				0.810				
	11/05	248	0.16	*				0.050				
1981	07/08	51	0.08	*				0.050				
1990	11/15	172	0.90		0.070		0.970	0.030	0.010			
1991	01/21	192	1.20		0.060		1.200	0.050	0.050			
	05/15	265	1.10		0.080		1.100	0.060	0.040			
	05/16	471	0.60		0.050		0.650	0.190	0.050			
	07/09	62	0.05	:	0.070		0.095	0.130	0.020			
	09/18	85	0.10		0.030		0.130	0.020	0.005	/		
1992	11/18	159	0.75	*	0.050	-	0.700	0.040	0.010	+		
1993	04/13	151	0.85	*	0.080	-	0.930	0.080	0.020	+		
	05/18	394	1.10	*	0.370	-	1.470	0.100	0.050	+		
	05/25	759	0.32	*	0.040	-	0.360	0.050	0.050	+		
	07/19	51	0.15	*	0.040	-	0.190	0.005	0.005	\		
	09/22	120	0.31	*	0.050	-	0.360	0.020	0.005	\		
1994	11/28	195	0.98	*	0.050	-	1.030	0.070	0.010	+		
1995	01/18	247	0.89	*	0.130	-	1.020	0.130	0.070	+		
	05/24	437	0.77	*	0.040	-	0.810	0.110	0.040	+		
	05/17	455	0.31	*	0.008	<	0.318	0.140	0.050	+		
	07/13	38	0.05	(	0.008	<	0.058	0.005	0.005	\		
	09/20	105	0.08	*	0.008	<	0.088	0.040	0.010	+		
1996	04/24	398	0.71	*	0.020	-	0.730	0.210	0.070	+		
	05/21	1110	0.41	*	0.060	-	0.470	0.200	0.040	+		
	06/20	324	0.56	*	0.030	-	0.590	0.100	0.030	+		
	07/17	120	0.18	*	0.030	-	0.210	0.030	0.005	\		
	08/21	68	0.06	*	0.008	<	0.068	0.030	0.005	\		
	09/17	220	0.49	*	0.008	<	0.498	0.110	0.050	+		

Table 3-2. Continued.

Year	Date	Discharge (cfs)	Total alkalinity		Total ammonia		Total inorganic nitrogen*	Total phosphorus		Total ortho phosphorus		Total ortho phosphate
							Tons					
1967	10/12	131	1.4	●								
1968	04/15	170	2.6	●								
	10/30	134	2.7	●								
1969	04/01	736	3.7	●								
1970	01/14	132	3.9	●								
	05/19	310	3.6	●								
	09/18	184	1.4	●								
	10/22	120	0.25	▲				0.05				
1971	06/08	302	0.43	▲				0.14	'	0.05		
	07/08	201	0.48	▲				0.08		0.05	.	
	10/14	104	0.70	▪				0.070		0.020	+	
1972	04/10	313	0.71	▪				0.340				
	04/30	270	0.56	▪				0.120				
	10/31	195	1.60	▪				0.050				
1973	04/27	233	0.30	▪				0.070				
	09/24	170	0.34	▪				0.340				
1974	06/05	372	17.40	▪								
	09/24	159	0.30	▪				0.020				
1975	04/22	436	0.50	▪				0.090				
	09/17	204	0.72	▪				0.350				
1976	05/03	471	0.40	▪				0.130				
	10/19	170	0.57	▪				0.010				
1977	05/24	102	0.56	▪				0.040				
	11/08	150	1.30	▪				0.020				
1979	05/22	239	0.73	▪				0.020				
	10/24	151	0.88	▪				0.030				
1980	05/15	413	0.40	▪				0.370				
	11/05	144	1.10	▪				0.030				
1981	05/04	200	0.31	▪				0.090				
1983	04/13	149	1.10	▪	0.05	▪	1.13	0.07		0.04	+	
	04/27	151	0.82	▪	0.03	▪	0.87	0.08		0.01	+	
	05/11	236	0.71	▪	0.04	▪	0.75	0.13		0.03	+	
	05/23	232	0.50	▪	0.04	▪	0.54	0.05		0.02	+	
	06/06	534	0.34	▪	0.03	▪	0.37	0.06		0.02	+	
	06/22	186	0.55	▪	0.04	▪	0.59	0.08		0.02	+	
	07/13	224	0.54	▪	0.04	▪	0.58	0.04	<	0.02	+	
	08/10	180	0.43	▪	0.03	▪	0.46	0.08		0.02	+	
	09/14	122	0.58	▪	0.03	▪	0.61	0.08		0.01	+	
	10/19	99	0.75	▪	0.02	▪	0.77	0.02	<	0.01	+	
	11/16	100	1.06	▪	0.08	▪	1.01	0.005	=	0.005	\	
	12/14	103	1.18	▪	0.04	▪	1.14	0.002	=	0.02	+	
1984	01/11	119	1.30	▪	0.04	▪	1.26	0.04		0.03	+	
	02/11	108	1.30	▪	0.04	▪	1.26	0.03		0.02	+	
	03/21	125	1.10	▪	0.04	▪	1.14	0.03		0.04	+	
	04/12	224	0.80	▪	0.03	▪	0.82	0.03	<	0.01	+	
	05/16	215	0.46	▪	0.05	▪	0.49	0.03		0.02	+	
	05/24	172	0.56	▪	0.03	▪	0.59	0.03		0.01	+	
	06/20	156	0.34	▪	0.03	▪	0.36	0.03		0.003	\	
	06/27	168	0.34	▪	0.02	▪	0.36	0.04	<	0.01	+	
	07/10	122	0.21	▪	0.02	▪	0.23	0.04		0.01	+	
	08/14	83	0.50	▪	0.04	▪	0.54	0.005	=	0.005	\	
	09/15	73	0.61	▪	0.05	▪	0.66	0.03	<	0.005	\	
	10/07	77	0.70	▪	0.04	▪	0.74	0.03		0.02	+	
	11/08	78	0.84	▪	0.03	▪	0.87	0.02	<	0.01	+	
	12/13	98	1.10	▪	0.01	▪	1.12	0.03		0.03	+	
1985	01/10	132	0.94	▪	0.11	▪	1.05	0.06		0.05	+	
	02/22	120	0.84	▪	0.04	▪	0.88	0.08		0.03	+	
	03/20	132	0.80	▪	0.05	▪	1.02	0.04		0.03	+	
	04/19	150	0.48	▪	0.02	▪	0.49	0.005	=	0.005	\	
	05/11	221	0.46	▪	0.03	▪	0.49	0.12		0.02	+	
	05/31	390	0.41	▪	0.03	▪	0.43	0.03	<	0.01	+	
	06/06	370	0.41	▪	0.04	▪	0.45	0.15	<	0.02	+	
	07/06	191	0.27	▪	0.03	▪	0.30	0.04		0.01	+	
1986	04/24	210	0.65	▪	0.05	▪	0.70	0.10		0.02	+	
	05/22	490	0.39	▪	0.05	▪	0.44	0.27		0.03	+	
	06/19	220	0.03	▪	0.04	▪	0.08	0.05		0.03	+	
	07/16	210	0.30	▪	0.03	▪	0.30	0.03		0.02	+	
	08/20	170	0.30	▪	0.03	▪	0.33	0.03		0.02	+	
	09/18	94	0.88	▪	0.02	▪	0.90	0.03		0.03	+	

*calculated by adding total alkalinity and total ammonia
*dissolved chloride + chloride
*calculated by adding total dissolved chloride + total dissolved chloride
=dissolved ammonia
+dissolved ortho phosphorus
>dissolved ortho phosphate
●alkalinity only
▲phosphate
▪alkalinity + chloride
total alkalinity < 0.05, used 1/2 of value (0.025) for analysis purposes
total ortho phosphorus concentration < 0.010, used 1/2 of value (0.005) for analysis purposes
total phosphorus concentration < 0.010, used 1/2 of value (0.005) for analysis purposes
dissolved ortho phosphorus concentration < 0.010, used 1/2 of value (0.005) for analysis purposes
< dissolved ammonia concentration < 0.015, used 1/2 of value (0.0075) for analysis purposes
dissolved chloride/chloride < 0.05, used 1/2 of value (0.025) for analysis purposes
calculated by adding total chloride + total chloride
*dissolved ammonia concentration < 0.02, used 1/2 of value (0.01) for analysis purposes

Table E-4. Continued.

Site	Date	Total ammonia (mg/l)	Total nitrate/nitrite (mg/l)	Total Kjeldahl nitrogen (mg/l)	Total phosphorus (mg/l)	Ortho-phosphate (mg/l)
Indian	18 Nov 85		2.120	0.29	0.08	0.059
	22 Feb 86	0.061	2.377	1.56	0.9	0.093
	10 Mar 86	0.110		2.72	1.1	0.095
	23 Mar 86	0.021	1.713	0.36	0.1	0.060
	11 Apr 86	0.095	0.822	0.39	0.2	0.030
	22 Apr 86	0.086	0.790	0.47	0.2	0.035
	6 May 86	0.101	0.829	0.57	0.2	0.036
	20 May 86	0.026	0.850	0.49	0.1	0.030
	3 June 86	0.018	1.028	0.49	0.1	0.033
	17 June 86	0.021	1.926	0.34	0.1	0.034
	8 July 86	0.043	1.836	0.33	0.1	0.044
Rapid	18 Nov 85		1.120	1.12	0.06	0.039
	22 Feb 86	0.088	1.783	1.00	0.5	0.050
	10 Mar 86	0.070		1.07	0.3	0.049
	23 Mar 86	0.034	0.179	0.90	0.2	0.054
	11 Apr 86	0.160	0.693	0.67	0.3	0.037
	22 Apr 86	0.110	0.704	0.55	0.2	0.033
	6 May 86	0.045	0.648	0.35	0.1	0.021
	20 May 86	0.022	0.454	0.56	0.2	0.023
	3 June 86	0.018	0.46	0.37	0.1	0.013
	17 June 86	0.026	1.211	0.99	0.4	0.127
	8 July 86	0.020	1.287	0.36	0.1	0.041
Jackson	18 Nov 85		2.320	0.10	<0.05	0.047
	22 Feb 86	0.025	1.869	0.84	0.3	0.071
	10 Mar 86	0.087		1.02	0.2	0.047
	23 Mar 86	0.550	1.297	0.78	0.2	0.061
	11 Apr 86	0.305	0.872	0.55	0.2	0.028
	22 Apr 86	0.118	0.765	0.72	0.3	0.032
	6 May 86	0.105	0.632	0.56	0.2	0.032
	20 May 86	0.027	0.425	0.83	0.3	0.034
	3 June 86	0.008	0.364	0.44	0.1	0.018
	17 June 86	0.050	0.959	0.27	0.1	0.045
	8 July 86	0.055	3.160	0.53	0.2	0.107
Jenkins Canyon	22 Feb 86	0.434	4.410	1.98	0.9	0.402
Dempsey	18 Nov		0.266	0.13	<0.05	0.013
	22 Feb	0.024	1.170	0.53	0.1	0.006
	10 Mar	0.050		1.20	0.3	0.034
	23 Mar	0.025	0.580	0.60	0.1	0.039
	11 Apr	0.489	0.497	0.67	0.2	0.015
	22 Apr	0.094	0.253	0.91	0.2	0.020
	6 May	0.153	0.342	0.80	0.2	0.030
	20 May	0.023	0.167	0.99	0.3	0.024
	3 June	0.038	0.159	0.89	0.2	0.010
	17 June	0.021	0.304	0.33	0.1	0.010
	8 July	0.037	0.478	0.68	0.1	0.019

Table E-6. Nitrate (mg/l) monitoring at 10 sites in the Portneuf River, 1969-1971 (from Minshall and Andrews 1973).

		Nitrate (as N) by site*									
Year	Month	Siphon Road bridge	Batise Road bridge	Within Pocatello	Above Pocatello	Below Inkom	Below McCammon	Below Lava Hot Springs	Above Lava Hot Springs	Pebble Creek	Chesterfield Dam
1967	September	2.0	3.8	0.0	0.4	1.2	0.2	0.5	0.7	0.3	0.5
1969	February	1.8	1.9	1.6	1.5	1.5	1.3	1.4	1.6	1.6	0.7
	September	0.7	0.0	0.2	0.2	0.8	0.0	0.0	0.0	0.6	0.0
1970	February	2.6	3.6	3.1	1.1	1.8	1.3	1.1	1.3	1.5	1.1
1971	February	2.0	2.1	1.5	1.5	1.4	1.5	1.3	1.6	1.4	–

*sites are very general and proceed upstream left to right

Appendix F

Summary of regression/correlation statistics

Table F-1. Regression/correlation statistics summary for sediment and nutrients monitored at USGS surface-water stations.

Independent variable X*	Independent variable Y*	Time period	Degrees of freedom	Slope	Standard error slope	Y-intercept	Standard error Y-intercept	Correlation index (R^2)	p-value
				Tyler					
Flow	SS	1971-1972	2	0.12	0.03	10.77	18.23	0.92	0.043
		1989-1994	15	0.07	0.03	-3.27	11.79	0.23	0.050
		1971-1994	19	0.12	0.02	-13.45	8.71	0.67	0.000
Flow	Nitrate	1970-1975	9	0.00	0.00	1.69	0.38	0.13	0.285
		1987-1994	22	0.00	0.00	2.46	0.12	0.26	0.010
		1970-1994	33	0.00	0.00	2.42	0.12	0.45	0.000
Flow	TIN	1972-1975	4	0.01	0.00	-3.28	1.51	0.76	0.023
		1989-1994	20	0.00	0.00	2.84	0.14	0.09	0.170
		1972-1994	26	0.00	0.00	2.79	0.22	0.07	0.185
Flow	TP	1970-1973	8	0.00	0.00	0.66	0.13	0.18	0.220
		1989-1994	20	0.00	0.00	0.58	0.05	0.22	0.026
		1970-1994	30	0.00	0.00	0.53	0.04	0.07	0.150
Flow	TOP	1970-1973	4	0.00	0.00	-0.41	0.07	0.96	0.000
		1989-1994	20	0.00	0.00	0.58	0.06	0.29	0.010
		1970-1994	26	0.00	0.00	0.51	0.05	0.15	0.042
SS**	Nitrate	1971-1972	1	-0.30	0.30	1.32	1.21	0.50	0.502
		1989-1994	15	-0.08	0.02	0.96	0.06	0.52	0.001
		1971-1994	18	-0.16	0.04	1.09	0.11	0.50	0.001
SS**	TIN	1989-1994	15	-0.05	0.02	1.04	0.06	0.13	0.151
SS**	TP	1971-1972	1	-0.14	0.33	0.05	1.33	0.16	0.734
		1989-1994	15	-0.13	0.05	-0.53	0.12	0.33	0.017
		1971-1994	18	-0.06	0.05	-0.62	0.15	0.08	0.232
TP	TOP	1972-1975	9	1.45	0.44	-0.28	0.17	0.78	0.046
		1989-1994	20	1.06	0.05	-0.05	0.08	0.95	0.000
		1972-1994	25	1.12	0.07	-0.10	0.08	0.91	0.000
				Pecatonica					
Flow**	SS	1974-1981	5	0.99	1.15	-0.35	0.36	0.50	0.401
		1990-1996	16	0.93	0.25	-0.27	0.60	0.46	0.002
		1974-1996	23	0.96	0.18	-0.31	0.43	0.56	0.000
Flow**	Nitrate	1963-1981	47	0.65	0.21	-1.40	0.50	0.17	0.003
		1990-1996	22	0.92	0.21	-2.57	0.49	0.47	0.000
		1963-1996	71	0.81	0.17	-1.95	0.41	0.24	0.000
Flow**	TIN	1990-1996	22	0.80	0.19	-2.22	0.44	0.45	0.000
Flow**	TP	1971-1981	19	0.85	0.14	-3.09	0.34	0.65	0.000
		1990-1996	22	0.83	0.15	-3.15	0.35	0.58	0.000
		1971-1996	43	0.87	0.11	-3.15	0.25	0.61	0.000
Flow**	TOP	1971	1	0.74	0.39	-3.03	1.01	0.79	0.304
		1990-1996	22	0.83	0.14	-3.66	0.33	0.61	0.000
		1971-1996	23	0.92	0.14	-3.81	0.33	0.63	0.000
SS**	Nitrate	1974-1981	4	1.26	0.76	-2.62	1.62	0.41	0.170
		1990-1996	16	0.37	0.21	-1.19	0.42	0.16	0.098
		1974-1996	22	0.62	0.24	-1.56	0.49	0.23	0.019
SS**	TIN	1990-1996	16	0.35	0.18	-1.08	0.35	0.20	0.064
SS**	TP	1974-1981	3	0.76	0.31	-2.52	0.65	0.67	0.091
		1990-1996	16	0.41	0.15	-1.97	0.30	0.32	0.014
		1974-1996	21	0.50	0.13	-2.11	0.27	0.40	0.001
TP**	TOP	1971	1	0.38	0.23	-0.87	0.17	0.73	0.344
		1990-1996	22	0.69	0.11	-0.87	0.15	0.63	0.000
		1971-1996	23	0.71	0.09	-0.83	0.12	0.69	0.000
Turbidity**	SS	1992-1996	11	0.52	0.18	1.34	0.24	0.48	0.009

Table F-1. Continued.

Independent variable X*	Independent variable Y*	Time period	Degrees of freedom	Slope	Standard error slope	Y-intercept	Standard error Y-intercept	Correlation index (R^2)	*p*-value
				Marsh Creek					
Flow	SS	1979-1981	16	4.11	0.93	-201.92	73.96	0.54	0.001
		1990-1996	16	2.28	0.79	-80.98	72.40	0.34	0.010
		1979-1996	34	3.04	0.69	-135.51	51.29	0.43	0.000
Flow	Nitrate	1970-1981	30	0.00	0.01	1.37	0.12	0.00	0.956
		1990-1996	22	0.00	0.00	1.04	0.22	0.07	0.198
		1970-1996	54	0.00	0.01	1.17	0.48	0.00	0.771
Flow	TIN	1980-1981	7	0.02	0.01	-0.28	0.51	0.46	0.044
		1990-1996	22	0.00	0.00	1.09	0.27	0.02	0.533
		1980-1996	31	0.00	0.00	0.94	0.23	0.00	0.078
Flow	TP	1970-1981	37	0.01	0.01	-0.51	0.72	0.06	0.120
		1990-1996	22	0.00	0.00	0.02	0.02	0.23	0.017
		1970-1996	61	0.01	0.01	-0.39	0.46	0.05	0.078
Flow	TOP	1971-1981	10	0.00	0.00	0.04	0.01	0.14	0.239
		1990-1996	22	0.00	0.00	0.02	0.01	0.08	0.195
		1971-1996	34	0.00	0.00	0.05	0.01	0.09	0.081
SS	Nitrate	1980-1981	7	0.01	0.01	0.98	0.48	0.06	0.515
		1990-1996	16	0.00	0.00	0.57	0.09	0.11	0.184
		1980-1996	25	0.00	0.00	0.46	0.09	0.02	0.462
SS	TIN	1980-1981	7	0.01	0.01	0.62	0.49	0.06	0.520
		1990-1996	16	0.00	0.00	0.55	0.11	0.36	0.008
		1980-1996	25	0.00	0.00	0.69	0.10	0.15	0.044
SS	TP	1979-1981	16	0.00	0.00	0.02	0.06	0.76	0.000
		1990-1996	16	0.00	0.00	0.06	0.01	0.40	0.284
		1979-1996	34	0.00	0.00	0.01	0.04	0.49	0.000
TP	TOP	1971-1981	10	0.14	0.07	0.04	0.01	0.28	0.079
		1990-1996	22	0.19	0.09	0.02	0.01	0.18	0.087
		1971-1996	34	0.18	0.06	0.05	0.01	0.24	0.002
Turbidity	SS	1990-1996	11	6.33	0.33	-19.79	10.39	0.97	0.000
				Tupper					
Flow	SS	1993-1996	38	0.56	0.05	-25.80	9.68	0.80	0.000
Flow	Nitrate	1967-1981	27	0.00	0.00	1.02	1.22	0.03	0.397
		1993-1996	38	0.00	0.00	0.85	0.08	0.16	0.010
		1967-1996	67	0.00	0.00	0.59	0.48	0.03	0.146
Flow	TIN	1993-1996	38	0.00	0.00	0.88	0.08	0.15	0.012
Flow	TP	1970-1981	19	0.00	0.00	0.06	0.11	0.04	0.407
		1993-1996	38	0.00	0.00	-0.01	0.01	0.62	0.000
		1970-1996	59	0.00	0.00	0.08	0.03	0.14	0.008
Flow	TOP	1971	1	0.00	0.00	0.02	0.03	0.39	0.570
		1993-1996	38	0.00	0.00	0.02	0.00	0.08	0.070
		1971-1996	41	0.00	0.00	0.02	0.00	0.08	0.076
SS	Nitrate	1993-1996	38	0.00	0.00	0.79	0.06	0.15	0.015
SS	TIN	1993-1996	38	0.00	0.00	0.82	0.06	0.15	0.015
SS	TP	1993-1996	38	0.00	0.00	0.01	0.01	0.64	0.000
TP	TOP	1971	1	0.16	0.36	0.05	0.04	0.16	0.740
		1993-1996	38	0.04	0.03	0.02	0.80	0.04	0.191
		1971-1996	41	0.04	0.03	0.02	0.00	0.07	0.078
Turbidity	SS	1996	4	4.77	0.31	22.64	10.18	0.98	0.000

*SS=suspended sediment, TIN=total inorganic nitrogen, TP=total phosphorus, TOP=total inorganic phosphorus
**log-log transformed

Appendix G

Methods to estimate nutrient loads

Estimated Present Load Based on USGS Data

Present loads were estimated at each surface-water station using information (i.e., flow and nutrient concentrations) collected by the U. S. Geological Survey. Some of the information from the Tyhee site includes information gathered at Siphon Road from September 1972 to March 1975 (5 dates). Siphon Road is upstream of Tyhee about one river mile. As mentioned in the main text, daily flow information was used to estimate nutrient concentration from the regression equation (the regression method). For example, flow for 1 November 1955 at the Topaz surface-water station was 110 cfs. Putting this value into the flow:total phosphorus (TP) regression equation (Appendix F),

$$\text{TP Concentration} = 0.000367(110)-0.01252,$$

yields a total phosphorus concentration in mg/l of 0.028. To convert mg/l into tons/day, the concentration is multiplied by the flow and by 0.0027 (a conversion factor),

$$\text{Tons/day of TP} = (\text{TP mg/l}) \times (\text{Flow cfs}) \times 0.0027,$$

or 0.008 tons/day. Each daily load was then summed to yield the annual load (total inorganic nitrogen - Tables G-1, G-2, G-3, G-4; total phosphorus - Tables G-5, G-6, G-7, G-8). The average annual load was estimated from annual loads from 1955 to 1995.

Each flow:nutrient regression equation was tested for significance to determine if flow could actually explain any of the variance in nutrient concentrations. The 95% confidence limit was used to determine significance.

For comparison purposes, loads were also calculated based on average monthly load and mean nutrient concentration (the mean method). To continue with the Topaz example, the average flow for November 1955 was 126 cfs. The mean concentration for total phosphorus based on 40 samples collected at the Topaz gage from 1993 to 1996 was 0.054 mg/l (Table 38). The numbers are then put into the following equation:

$$\text{Tons/day of TP} = (\text{Mean Concentration}) \times (\text{Mean Monthly Flow}) \times 30 \text{ days/month} \times 0.0027.$$

Based on this method, there was a total phosphorus load for November 1955 of 0.55 tons/yr versus 0.34 tons/yr using the regression method. Each monthly load was then summed to yield the annual load (total inorganic nitrogen - Tables G-9, G-10, G-11, G-12; total phosphorus - Tables G-13, G-14, G-15, G-16). The average annual load was estimated from annual loads from 1955 to 1995.

Targets

The mean method was used to calculate target loads. The target concentration (0.3 mg/l total inorganic nitrogen and 0.075 total phosphorus) was substituted for the mean concentration (total inorganic nitrogen - Tables G-17, G-18, G-19, G-20; total phosphorus - Table G-21, G-22, G-23, G-24).

Confidence limits

Confidence limits were calculated for the average annual loads estimated by both methods for both nutrients (Table 58). A 95% confidence level was used.

Estimated Loads from Nutrient Sources in the Lower Portneuf River

Several possible sources of nutrients contributing to nutrient loads as measured at the Tyhee surface-water station were identified. The first source, which can also be looked at as a background source, is the load at the Pocatello gage site. The methods used to estimate nutrient loads at the gage were discussed above.

Stormwater

Information on land use from the cities of Pocatello and Chubbuck was used in a model to estimate pollutant inputs into the Portneuf River from stormwater runoff. Land use designations and attendant areas were taken from Surface and Wessel (1995). The model generates pollutant loads from area of land use, precipitation (estimated to be 12 inches for the urban area) and several factors which are based on the type of land use, i.e., percent impervious surface area, runoff coefficient, and the fraction of average annual precipitation available as runoff. As no local land use dependent factors were available, factors from other cities with similar circumstances to Pocatello were used. Todd Maguire, Idaho Division of Environmental Quality, set up and ran the model for the TMDL. The results are presented in Table G-25.

It should be noted that some nutrient input from the city of Pocatello has the potential to be counted twice - once in the model as stormwater runoff and then again at the Pocatello gage. Such a scenario would occur if monitoring at the gages was done at a time of stormwater runoff (e.g., spring snowmelt or warmer weather thunderstorms). However, this double counting was felt to have a minimal effect on the numbers generated and was ignored.

Pocatello Sewage Treatment Plant Effluent

The Pocatello Sewage Treatment Plant (PSTP) routinely monitors their effluent output and accompanying nutrient constituents as part of their NPDES permit requirements. Information on total and mean monthly effluent flow and mean monthly nutrient concentrations since 1986 was provided by PSTP personnel (Brent Hokanson and Candy Ross). Only ammonia and ortho phosphate levels were consistently monitored. During some years ortho phosphate was sampled

while in other years total ortho phosphate was measured, all ortho phosphate numbers were lumped together for the load estimate.

Based on ammonia and total ortho phosphate data, total inorganic nitrogen and total phosphorus loads from the PSTP were estimated. From December to May, total inorganic nitrogen was considered equal to the ammonia concentration in the effluent. However, in the warmer months (June through November), the PSTP often manipulates the form of nitrogen in their discharge effluent through nitrification (conversion of ammonia to nitrate or nitrite). Consequently, any measurement of ammonia in that time period would underestimate the total inorganic nitrogen load (TIN = ammonia + nitrate + nitrite). To account for TIN in the warmer months, an average concentration of ammonia estimated from those months (December through May) when nitrification does not occur was used in the total load calculation. Eric Stewart (Idaho Division of Environmental Quality/Pocatello, personal communication) sampled PSTP effluent on 24, 25 June 1998. The 24-hour sampling indicated that ortho phosphate (0.327 mg/l as phosphorus) represented 79.9% of the total phosphorus (1.30 mg/l as phosphorus) measured.

From information provided by the city, mean daily flow per month and mean daily concentrations of ammonia and ortho phosphate were averaged by month from January 1986 to July 1998. The average mean daily flow per month (1986-1998) was multiplied by the average mean daily concentration (1986-1998), the days per month, and 0.0027 to produce the monthly load. Sum of the monthly loads was the estimated load to the Portneuf River from the PSTP. To convert load from ortho phosphate to total phosphorus, the estimated load was divided by 0.799 based on Stewart's results (Table G-26).

Springs

Numerous springs are found along the lower Portneuf River from Pocatello downstream. Information was not available from each spring. However, various authors have grouped the springs into systems based on water chemistry (Goldstein 1981; Perry and Clark 1990). For this evaluation, Perry and Clark's grouping of four systems was used. The systems generally going from upstream to downstream were: Swanson Road System, Batise Spring System, East Side Springs, and Papoose Springs System. By lumping springs into groups, data on individual springs were not needed when values for the groups were available.

To project load, flow and nutrient concentrations were required. For some springs, average flow was based on only three measurements, e.g., Swanson Road, East Side, and Papoose springs groups (Table G-27). Batise Springs had the largest number of measurements with flow ranging from 5.73 to 60 cfs. All measurements except a 7.2 cfs observation questioned by Balmer and Noble (1979) were used to get average flow of 28.9 cfs at Batise Springs (Table G-28). Of nine measurements used to estimate flow from Batise Springs, only a three measurement-average of 5.73 cfs were less than 20 cfs. If, for example, these values were not indicative of typical flows emanating from Batise Springs, then the average without these lower flows would increase to 38.8 cfs. Such an increase of almost 10 cfs would substantially raise the estimated input of nutrients from the Springs to the Portneuf River. To estimate flow out of Batise Springs group, 2.08 cfs (the difference in flow as measured by Perry and Clark [1990]

between Batise Springs and the Batise Spring group) was added to the average flow out of Batise Springs.

Flows in the lower Portneuf River are influenced not only by springs but also by groundwater (Jacobson 1982, Bechtel Environmental, Inc. 1994). Brock (1989) estimated additional flow input into this river reach at 143.5 cfs from the Pocatello USGS gage site near Carson Street to Rowlands and 128.3 cfs from the PSTP effluent to Siphon Road. Although, these estimates were made at low flows (September 1988 and June to August 1989) during a time period of low precipitation, Brock's numbers were used in the loading analysis. In the loading analysis, 129.7 cfs is contributed to the PSTP effluent to Siphon reach by Batise Spring, East Side, and Papoose Springs groups (Table G-28). Although, the current estimate is almost exactly what Brock estimated, he included Perry's (1981) E4 spring in his calculation, whereas, for the current calculation, the E4 spring was included in the Swanson Road group. Nevertheless, no additional springs or groundwater input was estimated for the reach from the PSTP effluent to Siphon Road. For the upper reach, however, the Swanson Road group input of 17.8 cfs and the estimated flow from the FMC IWW ditch of 3.7 cfs were subtracted from Brock's estimated figure of 143.5 cfs to yield an additional flow input of 122 cfs for the upper reach from Carson Street to Rowlands. It should be noted that this flow of 122 cfs also includes input from Pocatello Creek.

Data compiled on nutrient concentrations are presented in Table G-29. Nutrient concentrations used in the load analysis were based on information gathered by Bechtel Environmental, Inc. (1996). From a visual examination of Table G-29 it would appear that the Bechtel numbers (Table G-30) might underestimate nutrient concentrations in the springs, especially TIN and total phosphorus from Batise Spring group. Nevertheless, Bechtel data were used for three reasons: 1) sampling was done quarterly; 2) data was gathered from all four springs groups; and 3) data was relatively recent (1992-1993). Only data from spring sites that were sampled quarterly and drain into the Portneuf River above the Tyhee gage site were used. Springs monitored by Bechtel Environmental were assigned to a springs groups based on Perry and Clark (1990). Mean concentrations of springs sites with assigned groups are presented in Table G-30. For lack of better data, nutrient concentrations for the Swanson Road group were used for all springs, groundwater, and Pocatello Creek input from Carson Street to Rowlands. All concentrations that were not detected or below the detectable limit were treated as 0 mg/l.

To complete the load estimate, the mean method, as described previously, was used. The average flow was multiplied by the mean concentration, 0.0027, and 365 days/year. The estimated loads due to springs are found in Table G-31.

FMC IWW Ditch

The FMC IWW ditch is an NPDES-permitted discharge located just above the Interstate 86 bridge. The average discharge since January of 1993 is 3.7 cfs (Kelly Packard, FMC, personal communication). Little information was found on nutrient input by the IWW ditch. For the analysis, concentrations (Table G-31) measured in July of 1993 by Bechtel Environmental, Inc. (1996) were used although these numbers may be low based on the other limited information

available (Table G-29). Waste load contributions to the Portneuf River by the IWW ditch are 4.53 and 1.74 tons/year for total inorganic nitrogen and total phosphorus, respectively (Table G-31).

Michaud Canal

Just above the Tyhee gage, water is diverted from the Portneuf River into the Michaud South Main Canal from 1 May to 1 October. Average flow from 1978 to 1993 (a time period which more closely aligns with the period of record at the Tyhee gage) was 114 cfs (34,700 acre-feet of water over a 153-day season; Alan Oliver, Bureau of Indian Affairs, personal communication). Concentrations of TIN and total phosphorus observed at the Tyhee gage from the early 1970s to 1994 were used to calculate average annual loads for TIN and total phosphorus for water entering the Michaud South Main Canal (Table 38). Total estimated average annual loads of TIN and total phosphorus leaving the system via the Michaud South Main Canal (i.e., not counted as part of the load at the Tyhee gage) were 119.27 tons/yr and 22.48 tons/yr, respectively.

Targets

Flows and target concentrations were used to calculate target loads. Target loads for the springs, PSTP, and FMC IWW ditch were calculated from average flows multiplied by the target concentration (0.3 mg/l total inorganic nitrogen and 0.075 total phosphorus) and the results converted to annual loads. For stormwater, the target load concentrations were substituted for estimated concentrations to figure the annual load.

Table G-1. Daily total inorganic nitrogen loads based on the regression equation (TIN=-0.001(flow)+2.793) summed by month, Tyhee USGS surface-water station, 1986-1993.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1986	124.6	157.8	211.9	221.7	220.4	123.0	69.3	106.1	136.2	149.7	137.1	131.6	1,789.4
1987	126.0	114.3	141.6	100.8	68.4	53.2	57.9	65.9	70.5	93.6	109.3	112.9	1,114.2
1988	113.4	109.2	125.7	108.2	58.9	27.7	18.1	36.7	42.6	70.5	84.6	100.0	895.6
1989	92.7	85.7	139.7	155.0	81.7	43.9	31.4	56.0	64.7	86.4	98.7	100.2	1,036.2
1990	101.8	90.3	108.7	91.1	55.4	39.6	29.1	28.3	56.5	80.2	90.0	86.1	857.0
1991	96.2	92.7	114.4	103.3	119.0	50.7	22.8	36.2	55.7	80.0	92.2	95.4	958.7
1992	94.2	96.6	101.4	62.3	1.8	13.4	8.8	1.3	40.2	69.7	76.5	81.1	647.4
1993	75.9	67.3	110.0	125.6	180.1	108.7	47.5	74.3	68.4	93.5	91.8	95.9	1,139.1
											Annual average		1,054.7

Table G-2. Daily total inorganic nitrogen loads based on the regression equation (logTIN=0.802(logflow)-2.223) summed by month, Pocatello USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	8.7	8.2	12.0	14.8	5.9	2.1	0.4	0.9	1.0	2.2	8.9	12.5	77.6
1956	15.7	10.7	24.0	39.9	15.8	1.3	0.2	0.6	0.8	2.2	8.9	11.1	131.3
1957	9.0	28.6	25.1	17.7	69.9	17.9	0.7	0.9	1.6	4.0	11.1	13.8	194.3
1958	12.9	26.8	28.9	43.2	36.0	1.6	0.4	1.1	1.6	2.9	10.5	14.8	180.8
1959	14.9	15.0	21.0	21.7	5.5	1.1	0.4	0.4	2.1	5.0	8.6	9.3	105.0
1960	8.8	10.0	33.4	32.0	3.4	0.4	0.1	0.7	0.8	1.7	2.9	7.7	101.9
1961	7.6	14.0	16.1	10.3	1.7	0.2	0.1	0.6	1.9	4.9	8.0	7.6	72.9
1962	6.8	104.5	39.9	50.7	21.0	1.6	0.4	0.4	0.6	2.4	6.5	8.6	243.6
1963	6.9	54.5	12.4	21.0	31.1	14.0	0.6	0.3	1.7	3.2	8.8	9.5	164.0
1964	9.2	8.4	9.8	42.8	53.4	26.9	2.9	0.7	0.9	2.4	10.0	35.9	203.3
1965	23.7	30.6	21.6	32.9	70.7	12.8	5.4	3.2	6.4	7.7	12.6	13.1	260.8
1966	12.8	11.0	30.8	32.6	6.2	0.5	0.1	0.2	0.4	1.4	4.8	8.1	108.9
1967	9.1	9.7	16.4	20.9	37.0	27.7	6.5	1.2	1.3	5.2	7.9	7.4	150.2
1968	8.1	18.0	26.2	21.6	12.9	7.8	0.7	5.0	2.8	4.6	10.3	10.3	128.1
1969	27.2	15.3	25.9	113.2	76.5	10.7	4.0	1.6	1.6	6.5	11.2	13.0	306.5
1970	24.6	15.6	18.0	17.4	50.1	19.4	1.5	1.3	3.0	7.2	12.5	13.2	184.0
1971	14.9	18.3	42.8	96.8	200.5	74.7	6.5	2.2	10.1	19.6	20.3	21.6	528.2
1972	26.4	25.5	107.9	123.1	139.8	41.1	4.7	4.4	8.3	16.8	19.4	16.6	534.1
1973	19.6	17.0	25.2	62.0	73.2	6.5	3.4	2.5	11.6	15.0	18.9	17.5	272.4
1974	18.0	15.6	69.0	107.8	125.9	19.9	2.5	2.5	2.7	9.5	16.4	15.4	405.3
1975	17.3	16.4	36.6	41.7	159.6	135.5	13.2	7.2	6.5	16.3	17.7	20.0	488.0
1976	14.7	14.0	30.6	109.0	171.9	21.8	2.4	3.9	5.7	14.0	13.7	13.0	414.5
1977	12.4	11.4	14.9	7.5	2.1	3.1	0.5	1.2	1.6	4.7	8.9	12.9	81.1
1978	13.5	14.5	31.7	42.8	57.5	11.8	1.1	1.0	3.5	6.2	9.9	10.2	223.7
1979	10.3	13.7	25.5	31.8	21.8	1.8	0.3	0.9	0.8	2.6	6.2	6.5	122.2
1980	35.5	44.2	25.3	45.7	107.2	54.2	2.8	1.1	2.7	8.6	10.7	12.1	350.0
1981	11.3	14.3	15.5	15.7	40.5	22.0	0.6	0.4	0.6	3.6	8.4	12.5	145.6
1982	9.9	17.3	33.2	68.2	172.8	53.2	10.4	3.2	9.6	18.3	17.3	15.9	429.3
1983	22.4	23.6	78.1	99.6	273.8	171.0	21.8	14.6	18.1	27.5	32.9	36.0	819.4
1984	38.5	32.6	48.6	112.1	463.6	240.7	28.3	17.1	25.1	27.2	32.4	33.8	1,100.0
1985	30.1	27.7	34.8	136.0	56.1	9.0	2.7	2.4	5.9	16.7	18.7	19.5	359.6
1986	20.1	79.1	140.7	185.4	173.4	44.1	6.7	12.5	33.4	33.8	27.2	22.2	778.7
1987	20.6	21.5	34.8	15.5	7.0	4.4	1.7	1.3	2.3	6.8	13.6	13.2	142.9
1988	13.8	14.0	22.3	15.7	3.2	0.8	0.5	0.4	0.5	1.3	4.4	8.4	85.3
1989	7.1	6.6	35.4	61.9	8.6	2.6	0.7	1.1	1.1	2.9	5.2	7.7	140.8
1990	9.9	8.9	16.0	12.9	3.7	2.3	0.5	0.5	1.5	2.1	5.5	6.7	70.4
1991	6.1	7.5	13.9	10.6	24.4	5.5	0.7	0.7	1.1	2.7	6.5	6.9	86.7
1992	6.3	9.4	9.3	8.7	0.2	0.2	0.2	0.0	0.2	1.2	4.1	4.6	39.5
1993	4.4	4.6	21.5	28.1	88.7	24.9	2.5	3.2	2.9	6.4	7.6	7.9	202.8
1994	8.1	12.4	16.6	11.3	2.6	0.8	0.1	0.1	0.3	2.5	4.3	5.7	64.9
1995	8.9	11.4	18.9	15.9	26.2	29.7	1.9	0.7	2.0	5.2	8.1	10.0	133.0
											Annual average		259.3

Table G-5. Daily total inorganic nitrogen loads based on the regression equation (TIN=-0.002(flow)+1.051) summed by month, Marsh Creek USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	5.1	4.2	6.0	5.4	4.0	3.8	2.1	3.9	3.9	4.9	4.6	5.3	53.2
1956	6.3	4.2	7.8	5.5	4.1	1.9	0.1	2.9	4.2	5.2	5.4	5.5	53.0
1957	4.5	6.5	6.6	5.5	8.0	5.4	4.2	4.6	5.0	6.4	6.8	6.8	70.3
1958	5.9	7.7	7.9	7.4	5.7	4.3	3.5	4.4	4.9	6.2	6.5	6.7	71.0
1959	5.5	5.8	6.1	5.2	4.4	3.3	4.0	3.5	5.3	5.8	4.9	5.0	58.8
1960	5.0	5.1	8.6	6.4	1.6	0.6	1.8	2.5	3.5	4.3	4.5	4.6	48.5
1961	4.4	5.1	5.7	4.5	3.3	0.0	0.0	1.2	4.1	4.2	4.3	4.5	41.3
1962	4.3	-6.3	8.5	6.7	5.5	3.6	1.7	3.6	5.4	4.7	5.7	5.2	44.7
1963	4.4	5.4	5.6	6.1	5.8	5.9	2.2	2.7	4.8	4.9	5.6	5.0	58.4
1964	4.6	4.2	5.4	8.4	6.1	7.4	4.8	3.6	4.4	5.7	6.1	7.2	68.0
1965	6.8	7.2	6.8	8.6	8.5	5.9	6.0	5.7	6.2	6.3	7.0	6.2	81.4
1966	6.1	5.4	8.7	6.3	4.3	3.3	1.5	1.3	3.6	4.6	4.9	5.0	55.0
1967	5.6	5.2	5.6	5.6	5.3	6.3	5.2	3.9	4.3	5.5	5.5	5.3	63.3
1968	4.9	6.5	7.1	5.5	4.6	5.2	4.2	5.8	5.3	5.7	5.9	5.7	66.4
1969	7.9	6.1	7.1	10.0	6.4	5.6	5.2	4.7	5.3	7.1	6.5	6.6	78.5
1970	7.5	6.4	6.5	5.3	6.3	4.9	4.6	4.4	6.4	6.8	6.6	6.5	72.2
1971	6.3	6.7	8.3	9.4	10.8	7.9	5.3	5.4	6.8	7.5	7.0	7.1	88.6
1972	7.3	6.8	10.0	9.9	9.0	6.5	4.9	5.6	6.0	7.0	6.6	6.4	85.9
1973	6.2	5.4	9.1	8.4	7.3	4.6	5.4	5.1	6.9	6.5	7.1	7.0	79.0
1974	6.7	5.7	9.3	8.6	8.4	4.5	4.0	4.9	4.6	6.3	6.8	6.5	76.3
1975	6.3	6.3	9.3	7.6	9.9	8.2	5.8	5.1	5.5	6.6	5.8	6.2	82.7
1976	6.0	6.2	8.7	10.2	9.3	5.4	3.6	3.0	3.1	5.9	5.8	5.5	76.8
1977	5.3	4.6	6.0	3.8	4.4	4.2	2.7	2.8	4.9	5.1	5.6	6.3	55.6
1978	6.1	6.1	7.3	9.0	7.2	3.3	1.3	3.2	5.6	5.1	4.9	4.5	63.5
1979	4.9	6.4	9.2	6.8	3.9	1.8	3.1	4.0	4.9	4.8	4.4	4.8	59.0
1980	2.3	5.9	7.6	6.8	10.1	8.6	4.3	3.0	4.8	5.6	6.3	6.5	71.7
1981	5.7	6.3	6.3	5.2	5.8	6.6	2.8	2.1	4.1	6.0	5.5	5.9	62.3
1982	3.6	6.3	8.3	8.5	10.7	7.8	6.3	5.7	7.4	8.3	8.2	7.9	89.0
1983	7.9	8.2	10.2	9.2	11.1	10.2	7.7	8.1	7.7	9.2	9.3	9.0	107.9
1984	8.2	7.5	9.7	10.2	10.3	10.4	7.9	8.2	8.2	9.4	8.4	7.6	106.0
1985	7.5	6.7	8.6	9.0	7.9	5.4	5.1	4.9	6.3	7.2	7.4	7.2	83.2
1986	6.9	5.1	10.5	10.4	10.6	7.5	6.4	6.8	7.9	8.7	8.2	7.7	96.7
1987	7.2	7.4	8.9	5.8	6.1	5.2	5.1	5.5	5.5	6.7	6.7	6.4	76.6
1988	6.3	6.5	7.7	5.8	4.7	3.9	1.9	2.6	3.1	4.8	5.0	4.3	56.7
1989	4.1	4.0	8.7	6.9	5.0	4.7	3.8	4.3	5.0	5.9	5.6	5.3	63.2
1990	5.8	5.1	5.9	4.8	4.9	4.6	3.6	2.0	4.1	4.9	4.7	3.9	54.2
1991	4.4	4.8	5.5	4.9	6.7	4.6	2.6	2.7	4.9	4.8	5.0	4.6	55.4
1992	4.2	5.3	4.6	3.3	0.2	1.7	0.9	0.1	2.9	3.4	3.6	3.6	33.8
1993	4.3	4.0	7.1	6.5	8.3	5.8	3.8	5.3	4.7	5.1	4.7	4.8	64.3
1994	5.2	5.2	5.7	3.7	2.7	1.8	0.0	0.9	3.6	5.8	5.7	4.2	40.5
1995	5.6	5.3	6.0	4.8	6.5	6.4	3.6	5.0	4.6	4.9	4.8	5.4	61.0
											Annual average		67.7

Table G-4. Daily total inorganic nitrogen loads based on the regression equation (TIN=-0.001(flow)+0.884) summed by month, Topsy USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	8.3	6.9	8.2	9.5	10.7	10.9	5.7	6.8	6.1	6.9	7.7	8.9	96.5
1956	9.1	7.8	10.5	13.2	12.7	6.5	0.4	9.0	7.0	7.2	8.1	8.8	100.4
1957	8.0	6.8	10.2	9.7	14.1	12.3	11.6	11.3	9.0	7.8	8.4	9.1	118.1
1958	8.7	9.3	11.0	12.2	13.9	11.8	12.2	10.8	8.1	7.0	8.2	9.2	122.3
1959	8.8	8.1	10.7	10.7	11.6	10.2	9.4	6.1	6.3	7.5	7.5	7.7	104.5
1960	7.8	7.6	10.8	11.9	4.5	2.3	3.8	3.3	5.2	5.7	6.8	7.4	77.2
1961	7.3	7.8	9.0	7.9	7.7	0.0	0.0	2.0	5.7	6.0	7.3	7.8	68.3
1962	8.2	0.0	9.3	12.9	10.0	11.0	5.4	11.0	7.0	6.4	7.2	7.6	96.0
1963	7.6	0.0	8.5	9.8	12.2	11.3	6.7	8.4	7.9	6.8	8.2	8.1	95.4
1964	7.7	7.2	7.4	11.8	13.6	13.7	11.9	10.8	7.8	7.0	8.2	6.7	113.8
1965	9.7	9.8	10.3	12.6	15.8	13.8	12.4	11.2	8.8	8.8	9.2	8.8	131.2
1966	9.0	8.0	10.4	11.6	11.5	11.1	4.9	3.7	6.3	6.1	7.1	8.2	98.0
1967	7.8	7.0	10.1	10.0	12.7	13.3	9.6	10.5	8.0	8.1	7.9	8.1	113.2
1968	8.4	9.0	11.3	9.5	11.4	12.5	11.2	9.8	7.4	8.2	8.5	8.6	115.6
1969	9.8	8.8	10.0	13.8	14.8	13.1	11.5	11.3	9.0	8.0	8.3	8.8	127.3
1970	10.5	8.9	10.3	9.5	13.4	13.6	11.5	10.7	8.9	8.5	8.7	9.1	123.5
1971	9.5	9.6	12.3	15.2	4.2	13.1	12.9	12.7	12.1	11.8	11.0	11.2	135.6
1972	11.2	11.0	15.5	14.9	12.3	15.0	13.1	12.3	11.6	11.7	12.1	12.3	153.0
1973	11.8	10.4	11.8	14.3	15.7	12.7	11.7	10.5	9.8	9.7	10.4	10.4	139.1
1974	10.5	9.2	14.6	14.9	13.9	13.2	12.0	11.9	10.0	9.1	10.2	10.2	139.7
1975	10.4	9.3	12.4	12.7	14.2	15.5	12.5	11.6	11.0	12.0	10.4	10.6	140.5
1976	9.2	8.8	11.4	12.7	11.0	14.6	11.8	11.9	9.7	10.4	9.6	10.0	131.1
1977	10.1	8.8	10.1	8.8	10.7	10.5	8.3	5.1	7.0	7.2	8.1	9.1	103.8
1978	8.1	7.8	11.8	14.5	15.5	11.4	4.6	7.2	8.6	8.0	8.6	9.0	115.1
1979	8.6	7.8	9.7	11.6	10.8	4.9	9.7	9.5	6.6	7.2	7.7	7.7	101.8
1980	8.5	6.8	10.6	11.2	15.6	13.1	10.4	6.9	7.9	8.6	8.6	8.3	116.4
1981	7.9	7.7	8.7	9.2	10.5	11.5	9.8	5.4	7.4	6.3	7.0	7.6	98.9
1982	6.4	8.3	11.7	12.7	10.8	14.5	12.7	11.3	10.9	11.2	10.3	10.0	130.7
1983	10.2	9.3	15.0	15.1	7.9	10.6	14.1	12.9	12.6	12.5	12.2	12.7	145.0
1984	13.5	12.4	13.5	14.9	0.0	5.3	15.1	13.5	13.1	14.1	13.6	14.0	143.0
1985	13.8	12.2	15.2	13.4	15.7	12.7	12.3	10.9	10.8	11.4	10.8	10.4	147.6
1986	9.8	12.2	15.9	13.3	14.1	13.8	13.6	13.1	13.0	13.6	11.5	11.8	159.6
1987	11.4	11.2	13.3	11.5	12.6	10.3	9.0	11.7	8.6	8.9	9.5	9.8	127.8
1988	9.5	8.9	10.6	10.3	11.4	10.1	4.8	4.9	4.7	6.5	7.6	8.3	97.4
1989	8.0	6.5	11.3	13.6	12.8	11.7	10.6	9.4	7.0	7.0	8.2	8.5	114.5
1990	8.6	7.8	10.1	9.0	10.9	10.1	10.9	5.6	5.4	5.7	7.1	7.2	96.4
1991	7.8	7.1	9.4	8.2	11.1	10.8	7.7	6.2	5.7	6.2	7.8	7.8	95.8
1992	7.6	8.0	8.3	5.8	0.6	3.5	1.7	0.2	3.6	3.9	5.5	6.2	55.0
1993	6.2	5.4	8.5	9.6	14.6	12.0	11.2	9.7	7.5	6.7	6.9	7.2	105.5
1994	7.3	7.5	9.2	8.6	8.5	5.4	0.0	1.6	4.2	4.1	5.6	6.5	68.6
1995	7.3	7.9	9.4	9.3	12.3	13.2	11.2	7.8	6.3	5.7	7.1	7.8	105.5
											Annual average		113.9

Table G-5. Daily total phosphorus loads based on the regression equation (TP=-0.0001(flow)+0.529) summed by month, Tybee USGS surface-water station, 1986-1993.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1986	23.8	30.4	41.0	43.1	42.7	23.5	13.2	20.2	26.0	28.7	26.2	25.2	344.0
1987	24.1	21.8	27.1	19.2	13.0	10.1	11.0	12.5	13.4	17.8	20.8	21.5	212.5
1988	21.6	20.8	24.0	20.6	11.2	5.3	3.4	7.0	8.1	13.4	16.1	19.1	170.6
1989	17.7	16.3	26.7	29.7	15.6	8.3	6.0	10.6	12.3	16.5	18.8	19.1	197.6
1990	19.4	17.2	20.7	17.4	10.5	7.5	5.5	5.4	10.7	15.3	17.1	16.4	163.2
1991	18.3	17.7	21.8	19.7	22.7	9.6	4.3	6.9	10.6	15.2	17.6	18.2	182.6
1992	17.9	18.4	19.3	11.9	0.3	2.6	1.7	0.2	7.6	13.3	14.6	15.4	123.2
1993	14.4	12.8	21.0	24.0	34.7	20.8	9.0	14.1	13.0	17.8	17.5	18.3	217.4
											Annual average		201.4

Table G-5. Daily total phosphorus loads based on the regression equation (logTP=0.825(logflow)-3.147) summed by month, Pocatello USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	1.2	1.1	1.6	2.0	0.8	0.3	0.1	0.1	0.1	0.3	1.2	1.7	10.5
1956	2.1	1.5	3.3	5.5	2.2	0.2	0.0	0.1	0.1	0.3	1.2	1.5	18.0
1957	1.2	4.0	3.5	2.4	8.9	2.5	0.1	0.1	0.2	0.5	1.5	1.9	26.8
1958	1.8	3.7	4.0	6.0	5.0	0.2	0.1	0.1	0.2	0.4	1.4	2.0	24.9
1959	2.0	2.1	2.9	3.0	0.7	0.1	0.1	0.0	0.3	0.7	1.2	1.3	14.3
1960	1.2	1.4	4.6	4.4	0.5	0.1	0.0	0.1	0.1	0.2	0.4	1.0	14.0
1961	1.0	1.9	2.2	1.4	0.2	0.0	0.0	0.1	0.3	0.7	1.1	1.0	9.9
1962	0.9	14.8	5.5	7.0	2.9	0.2	0.1	0.1	0.1	0.3	0.9	1.2	34.0
1963	0.9	7.7	1.7	2.9	4.3	1.9	0.1	0.0	0.2	0.4	1.2	1.3	22.6
1964	1.2	1.1	1.3	5.9	7.4	3.7	0.4	0.1	0.1	0.3	1.4	3.0	28.0
1965	3.3	4.2	3.0	7.3	9.8	1.7	0.7	0.4	0.9	1.0	1.7	1.8	36.0
1966	1.7	1.5	4.2	4.5	0.8	0.1	0.0	0.0	0.1	0.2	0.6	1.1	14.9
1967	1.2	1.3	2.2	2.9	5.1	3.8	0.9	0.2	0.2	0.7	1.1	1.0	20.6
1968	1.1	2.5	3.6	3.0	1.8	1.1	0.1	0.7	0.4	0.6	1.4	1.4	17.5
1969	3.8	2.1	3.6	15.9	10.7	1.5	0.5	0.2	0.2	0.9	1.5	1.8	42.5
1970	3.4	2.1	2.5	2.4	6.9	2.7	0.2	0.2	0.4	1.0	1.7	1.8	25.2
1971	2.0	2.5	5.9	13.5	28.3	10.4	0.9	0.3	1.4	2.7	2.8	3.0	73.7
1972	3.6	3.5	15.1	17.3	19.6	5.7	0.6	0.6	1.1	2.3	2.7	2.3	74.4
1973	2.7	2.3	3.5	8.6	10.2	0.9	0.5	0.3	1.6	2.0	2.6	2.4	37.6
1974	2.5	2.1	9.6	15.1	17.7	2.7	0.3	0.3	0.4	1.3	2.2	2.1	56.4
1975	2.4	2.2	5.0	5.8	22.5	19.1	1.8	1.0	0.9	2.2	2.4	2.7	68.0
1976	2.0	1.9	4.2	15.3	24.2	3.0	0.3	0.5	0.8	1.9	1.9	1.8	57.7
1977	1.7	1.6	2.0	1.0	0.3	0.4	0.1	0.2	0.2	0.6	1.2	1.8	11.0
1978	1.8	2.0	4.4	8.7	8.0	1.6	0.1	0.1	0.5	0.8	1.3	1.4	30.8
1979	1.4	1.9	3.5	4.4	3.0	0.2	0.0	0.1	0.1	0.4	0.8	0.9	16.7
1980	4.9	6.2	3.5	6.3	15.0	7.6	0.4	0.2	0.4	1.2	1.5	1.6	48.6
1981	1.5	2.0	2.1	2.1	5.6	3.0	0.1	0.0	0.1	0.5	1.1	1.7	20.0
1982	1.3	2.4	4.6	9.5	24.3	7.4	1.4	0.4	1.3	2.5	2.4	2.2	59.7
1983	3.1	3.3	10.9	13.9	38.8	24.1	3.0	2.0	2.5	3.8	4.5	5.0	114.9
1984	5.5	4.5	6.7	15.7	66.2	34.1	3.9	2.3	3.4	3.7	4.5	4.7	155.1
1985	4.2	3.8	4.8	19.1	7.8	1.2	0.4	0.3	0.8	2.3	2.6	2.7	49.9
1986	2.8	11.1	19.8	26.1	24.4	6.1	0.9	1.7	4.6	4.7	3.7	3.0	109.0
1987	2.8	3.0	4.8	2.1	0.9	0.6	0.2	0.2	0.3	0.9	1.9	1.8	19.5
1988	1.9	1.9	3.1	2.1	0.4	0.1	0.1	0.1	0.1	0.2	0.6	1.1	11.6
1989	1.0	0.9	4.9	3.6	1.2	0.3	0.1	0.1	0.2	0.4	0.7	1.0	19.4
1990	1.3	1.2	2.2	1.8	0.5	0.3	0.1	0.1	0.2	0.3	0.7	0.9	9.5
1991	0.8	1.0	1.9	1.4	3.4	0.8	0.1	0.1	0.1	0.4	0.9	0.9	11.8
1992	0.9	1.3	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.6	5.3
1993	0.6	0.6	3.0	3.9	12.4	3.4	0.3	0.4	0.4	0.9	1.0	1.1	28.0
1994	1.1	1.7	2.3	1.5	0.3	0.1	0.0	0.0	0.0	0.3	0.6	0.8	8.8
1995	1.2	1.6	2.6	2.2	3.6	3.3	0.3	0.1	0.3	0.7	1.1	1.4	18.2
											Annual average		36.0

Table G-7. Daily total phosphorus loads based on the regression equation (TP=0.001(flow)+0.023) summed by month, Marsh Creek USGS surface-water station, 1955-1995.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1955	0.4	0.3	0.6	0.5	0.3	0.3	0.1	0.3	0.3	0.4	0.4	0.5	4.2
1956	0.8	0.3	1.3	0.5	0.3	0.1	0.0	0.2	0.3	0.4	0.5	0.6	5.3
1957	0.3	1.3	0.7	0.8	1.5	0.5	0.3	0.3	0.4	0.7	0.8	0.8	8.2
1958	0.6	2.4	1.2	1.0	0.6	0.3	0.2	0.9	0.4	0.6	0.7	0.8	9.0
1959	0.5	0.7	0.6	0.4	0.3	0.2	0.3	0.2	0.5	0.6	0.4	0.4	5.1
1960	0.4	0.5	2.2	0.8	0.1	0.0	0.1	0.2	0.2	0.3	0.3	0.3	5.5
1961	0.3	0.6	0.6	0.3	0.2	0.0	0.0	0.1	0.3	0.3	0.3	0.3	3.3
1962	0.5	12.5	2.5	0.8	0.2	0.2	0.1	0.2	0.2	0.4	0.6	0.4	18.7
1963	0.3	2.6	0.5	0.6	0.6	0.6	0.1	0.1	0.4	0.4	0.5	0.4	7.2
1964	0.4	0.3	0.5	1.8	0.7	1.1	0.4	0.2	0.3	0.5	0.6	2.2	8.9
1965	1.1	1.1	0.8	1.5	1.5	0.6	0.6	0.5	0.6	0.6	0.9	0.6	10.5
1966	0.6	0.5	1.9	0.7	0.3	0.2	0.1	0.1	0.2	0.3	0.4	0.4	5.7
1967	0.5	0.5	0.5	0.5	0.5	0.7	0.4	0.3	0.3	0.5	0.5	0.4	5.6
1968	0.4	1.2	0.9	0.5	0.3	0.5	0.3	0.6	0.5	0.5	0.6	0.5	6.8
1969	1.5	0.7	3.3	3.5	0.8	0.6	0.4	0.4	0.5	0.8	0.7	0.7	13.9
1970	1.3	0.8	0.7	0.5	0.6	0.4	0.3	0.3	0.7	0.8	0.8	0.7	7.8
1971	0.7	1.0	2.3	2.2	3.5	1.2	0.5	0.5	0.8	1.0	0.9	1.0	15.4
1972	1.2	1.1	2.4	2.3	1.7	0.7	0.4	0.5	0.6	0.8	0.7	0.7	13.2
1973	0.7	0.5	1.8	1.4	1.0	0.3	0.5	0.4	0.9	0.7	0.9	0.8	9.9
1974	0.8	0.6	2.8	1.5	1.4	0.3	0.3	0.4	0.3	0.7	0.8	0.7	10.5
1975	0.7	0.7	1.9	1.0	2.4	1.4	0.6	0.4	0.5	0.7	0.6	0.6	11.5
1976	0.6	0.7	2.0	3.3	1.8	0.5	0.2	0.4	0.4	0.6	0.6	0.5	11.5
1977	0.4	0.4	0.6	0.3	0.4	0.3	0.2	0.2	0.4	0.4	0.5	0.7	4.8
1978	0.6	0.7	0.9	1.7	0.9	0.2	0.1	0.2	0.5	0.4	0.4	0.3	7.0
1979	0.4	1.2	2.2	0.8	0.3	0.1	0.2	0.3	0.4	0.4	0.3	0.4	6.9
1980	6.8	4.3	1.0	0.8	2.4	1.8	0.3	0.2	0.4	0.5	0.7	0.7	20.0
1981	0.5	0.9	0.6	0.4	1.0	0.9	0.2	0.1	0.3	0.6	0.5	0.6	6.7
1982	0.2	1.1	1.2	1.4	3.4	1.2	0.7	0.5	1.0	1.3	1.3	1.1	14.5
1983	1.2	1.7	2.8	1.8	4.6	3.8	1.1	1.3	1.1	1.7	1.8	1.6	24.5
1984	1.2	1.1	2.5	3.1	6.8	4.0	1.1	1.2	1.3	1.8	1.4	1.0	26.4
1985	1.0	0.8	1.6	3.2	1.1	0.5	0.4	0.4	0.7	0.9	1.0	0.9	14.4
1986	0.8	7.2	2.9	3.2	2.9	1.1	0.7	0.8	1.2	1.4	1.2	1.0	24.3
1987	0.9	1.1	1.6	0.6	0.7	0.5	0.4	0.5	0.5	0.7	0.8	0.7	8.9
1988	0.6	0.8	1.1	0.6	0.4	0.3	0.1	0.2	0.2	0.4	0.4	0.3	5.2
1989	0.3	0.3	2.0	0.8	0.4	0.4	0.2	0.3	0.4	0.6	0.5	0.4	6.6
1990	0.5	0.5	0.6	0.4	0.4	0.4	0.2	0.1	0.3	0.4	0.4	0.3	4.4
1991	0.3	0.4	0.6	0.4	0.8	0.4	0.2	0.2	0.4	0.4	0.4	0.3	4.7
1992	0.3	0.5	0.9	0.2	0.0	0.1	0.1	0.0	0.2	0.2	0.2	0.2	2.3
1993	0.3	0.3	1.2	0.7	1.3	0.6	0.2	0.5	0.4	0.4	0.4	0.4	6.6
1994	0.4	0.8	0.6	0.2	0.1	0.1	0.0	0.1	0.2	0.2	0.2	0.3	3.4
1995	0.6	0.7	0.6	0.4	0.7	0.8	0.2	0.2	0.3	0.4	0.4	0.5	5.8
											Annual average		9.6

Table G-8. Daily total phosphorus loads based on the regression equation (TP=-0.0004(flow)-0.013) summed by month, Topeka USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr.	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	0.4	0.3	0.4	0.6	0.9	1.0	0.3	0.2	0.2	0.2	0.3	0.5	5.4
1956	0.5	0.4	1.2	1.9	1.5	0.7	0.0	0.6	0.3	0.3	0.4	0.5	8.3
1957	0.4	3.3	0.8	0.7	2.8	1.5	1.1	1.0	0.6	0.3	0.4	0.5	13.4
1958	0.5	0.7	1.0	1.4	2.1	1.2	1.3	0.9	0.4	0.2	0.4	0.5	10.7
1959	0.5	0.5	0.9	0.9	1.1	0.9	0.7	0.2	0.2	0.3	0.3	0.3	6.7
1960	0.3	0.4	1.2	1.3	0.4	0.2	0.1	0.1	0.1	0.1	0.2	0.3	4.8
1961	0.3	0.4	0.5	0.4	0.4	0.0	0.0	0.0	0.1	0.2	0.3	0.3	3.0
1962	0.6	20.4	2.1	1.8	1.0	1.0	0.4	0.9	0.4	0.2	0.3	0.3	29.2
1963	0.4	9.9	0.4	0.7	1.3	1.1	0.5	0.6	0.4	0.2	0.4	0.4	16.4
1964	0.3	0.3	0.3	1.5	2.2	2.3	1.2	0.9	0.4	0.2	0.4	3.9	14.0
1965	1.5	0.9	0.8	2.0	5.3	2.4	1.4	1.0	0.5	0.5	0.6	0.5	17.3
1966	0.5	0.4	1.0	1.3	1.1	1.0	0.4	0.2	0.2	0.2	0.3	0.4	6.9
1967	0.3	0.3	0.8	0.7	1.8	2.0	0.6	0.8	0.4	0.4	0.4	0.4	8.9
1968	0.4	0.6	1.0	0.6	1.0	1.6	1.0	0.7	0.3	0.4	0.5	0.4	8.6
1969	2.4	0.6	1.1	7.0	7.4	1.8	1.1	1.0	0.6	0.4	0.4	0.5	24.1
1970	1.0	0.6	0.8	0.6	3.5	3.4	1.1	0.9	0.6	0.4	0.5	0.5	13.8
1971	0.6	0.8	2.9	5.3	18.6	6.4	1.6	1.5	1.4	1.2	1.0	1.0	42.2
1972	1.0	1.1	6.5	7.0	11.4	4.7	1.7	1.3	1.2	1.1	1.4	1.4	39.9
1973	1.1	1.0	1.1	3.4	5.9	1.7	1.1	0.8	0.7	0.6	0.8	0.8	19.1
1974	0.8	0.7	3.5	5.4	9.5	2.4	1.2	1.2	0.8	0.5	0.8	0.7	27.5
1975	0.8	0.7	1.4	1.7	6.6	8.3	1.5	1.1	1.0	1.2	0.8	0.8	25.8
1976	0.5	0.5	1.0	8.1	12.7	3.3	1.3	1.2	0.7	0.8	0.6	0.7	31.5
1977	0.7	0.6	0.7	0.6	1.0	0.9	0.7	0.3	0.3	0.3	0.4	0.6	6.8
1978	0.4	0.4	1.5	3.1	5.4	2.1	0.4	0.5	0.5	0.4	0.5	0.5	15.6
1979	0.4	0.4	0.6	1.2	1.2	0.5	0.8	0.6	0.2	0.3	0.4	0.3	7.0
1980	1.0	3.2	0.8	1.3	4.4	2.5	0.8	0.5	0.4	0.3	0.5	0.4	16.3
1981	0.5	0.4	0.5	0.6	2.6	1.3	0.9	0.3	0.3	0.2	0.3	0.3	7.9
1982	0.3	0.5	1.1	2.1	13.2	3.7	1.5	1.0	1.0	1.0	0.8	0.7	26.9
1983	0.7	0.7	3.1	4.2	15.3	10.5	2.2	1.6	1.5	1.4	1.4	1.5	44.1
1984	1.9	1.6	1.8	3.7	25.7	16.2	3.4	2.1	1.8	2.2	2.1	2.1	64.7
1985	2.0	1.7	2.2	8.2	4.1	1.7	1.3	0.9	0.9	1.0	0.9	0.8	25.7
1986	0.7	3.3	5.7	9.8	9.6	4.2	1.9	3.0	3.5	2.0	1.1	1.1	45.9
1987	1.0	1.2	1.8	1.1	1.5	0.8	0.7	1.1	0.5	0.5	0.6	0.6	11.5
1988	0.6	0.6	0.8	0.8	1.0	0.8	0.3	0.2	0.1	0.2	0.3	0.4	6.1
1989	0.4	0.3	1.3	2.2	1.6	1.2	0.8	0.6	0.3	0.3	0.4	0.4	9.7
1990	0.4	0.4	0.7	0.6	1.0	0.8	0.9	0.1	0.1	0.1	0.3	0.3	5.8
1991	0.3	0.3	0.6	0.4	1.0	1.0	0.6	0.3	0.1	0.2	0.4	0.3	5.6
1992	0.3	0.4	0.4	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.2	2.0
1993	0.2	0.1	0.6	0.7	3.6	1.4	1.0	0.6	0.3	0.2	0.2	0.3	9.3
1994	0.3	0.6	0.6	0.5	0.7	0.4	0.0	0.0	0.1	0.0	0.1	0.2	3.6
1995	0.3	0.5	0.6	0.6	1.3	2.3	1.0	0.5	0.2	0.1	0.3	0.3	8.1
											Annual average		17.1

Table G-9. Total inorganic nitrogen loads based on the average monthly flow x average site concentration (1972-1994), Tybee USGS surface-water station, 1986-1993.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1986	132.1	194.0	277.5	314.0	302.2	136.0	69.2	109.2	149.0	166.3	149.7	141.2	2,140.5
1987	133.9	121.5	155.3	105.0	67.7	51.5	56.0	64.2	69.3	94.8	113.6	117.5	1,150.2
1988	118.0	114.2	133.5	112.5	57.7	25.8	36.8	46.7	48.2	69.2	84.9	101.9	949.5
1989	97.1	89.9	153.0	176.6	81.7	41.8	29.6	53.9	63.1	86.6	101.0	102.2	1,076.4
1990	104.1	92.1	112.4	92.5	53.7	37.7	28.7	46.7	54.5	79.6	90.8	95.5	888.3
1991	97.6	94.9	119.5	110.6	125.5	49.5	29.6	48.2	53.8	79.4	93.4	96.7	998.7
1992	95.2	99.2	103.7	65.8	19.6	21.1	35.5	41.9	43.7	68.2	75.8	80.6	750.3
1993	74.8	66.2	116.3	134.4	219.1	116.7	45.5	73.3	67.1	94.7	93.0	97.2	1,198.3
											Annual average		1,144.0

Table G-10. Total inorganic nitrogen loads based on the average monthly flow x average site concentration (1990-1996), Pocatello USGS surface-water station, 1955-1995.

	Load (tons)												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	11.3	10.5	13.5	15.0	8.4	4.6	2.0	3.0	3.4	5.0	11.3	13.5	101.6
1956	15.5	12.3	19.1	26.0	14.6	3.5	1.4	2.5	3.1	5.2	11.3	12.7	127.2
1957	11.5	18.7	19.7	16.5	32.9	14.7	2.5	3.2	4.3	7.2	12.8	14.6	158.7
1958	14.1	19.3	21.8	27.0	23.3	4.2	2.1	3.5	4.2	6.1	12.4	15.1	153.1
1959	15.3	14.5	18.4	18.3	7.6	3.4	1.9	2.0	4.7	8.2	11.0	11.8	117.0
1960	11.3	11.8	23.0	22.5	5.7	2.0	1.0	2.8	2.9	4.5	6.0	10.6	104.1
1961	10.5	13.5	15.7	11.8	4.4	1.3	0.8	2.4	4.5	8.1	10.7	10.5	94.2
1962	9.6	33.6	34.7	29.2	17.0	4.1	1.9	2.1	2.4	5.5	9.4	11.3	150.8
1963	9.8	23.5	13.8	18.1	22.6	14.5	1.7	1.6	4.2	6.4	11.2	11.9	139.4
1964	11.7	10.8	12.1	26.8	30.8	19.9	5.2	2.8	3.1	5.5	11.9	22.3	162.8
1965	19.3	21.1	18.8	29.9	35.7	12.6	8.2	6.3	9.3	10.6	13.6	14.2	199.5
1966	14.1	12.4	22.2	22.9	8.0	2.3	0.8	1.2	1.9	3.8	7.7	10.8	108.1
1967	11.5	11.5	15.9	18.2	25.0	20.8	8.3	3.7	3.9	8.4	10.6	10.3	148.2
1968	10.9	15.5	20.8	18.5	13.8	9.9	2.7	7.1	5.7	7.6	12.2	12.4	137.1
1969	19.4	14.8	19.9	46.4	36.2	12.1	6.8	4.4	4.2	9.4	12.9	14.2	200.6
1970	19.4	15.0	17.0	16.4	29.3	16.6	4.0	4.0	6.1	10.1	13.6	14.3	165.8
1971	14.9	16.3	25.9	42.5	64.2	35.4	9.0	5.1	12.0	17.8	17.9	18.7	279.7
1972	20.7	19.7	45.6	48.6	52.5	25.9	7.8	7.6	10.8	16.2	17.5	16.1	289.2
1973	17.7	15.7	20.4	32.9	36.0	9.3	5.9	5.6	12.8	15.4	17.2	16.7	205.5
1974	16.8	15.0	35.3	44.8	49.1	16.6	5.6	5.6	5.9	11.5	15.9	15.6	237.8
1975	16.5	15.4	25.1	26.4	55.6	49.5	13.7	9.9	9.5	15.9	16.6	17.9	272.2
1976	15.2	14.3	22.4	45.1	58.9	18.0	5.3	7.0	8.7	14.8	14.4	14.2	238.1
1977	13.8	12.6	15.3	9.5	4.6	6.1	2.1	3.2	4.2	8.0	11.2	14.0	104.7
1978	14.4	14.3	22.6	33.4	32.2	12.1	3.4	3.2	6.4	9.3	12.0	12.4	175.8
1979	12.5	13.8	20.4	22.9	18.0	4.5	1.5	3.0	2.7	5.5	9.2	9.6	123.5
1980	21.1	23.7	20.4	26.6	45.6	28.4	5.6	3.6	5.7	10.8	12.6	13.6	217.6
1981	13.1	13.9	15.7	15.4	22.4	16.6	2.4	1.9	2.5	6.5	11.0	13.7	135.0
1982	12.1	15.1	23.8	34.1	59.6	29.6	12.2	6.4	11.4	17.1	16.4	15.8	253.6
1983	19.0	18.7	38.1	42.7	76.2	55.7	18.3	14.6	16.7	21.5	23.3	24.9	369.6
1984	25.8	22.9	29.2	45.4	100.1	69.0	21.0	16.3	20.0	21.4	23.2	24.1	418.4
1985	22.6	20.6	24.2	50.7	31.3	10.5	5.9	5.5	8.8	16.2	17.1	17.7	231.1
1986	18.0	34.3	53.1	61.0	59.5	25.1	9.4	13.8	23.4	24.0	21.1	19.1	361.9
1987	18.3	17.9	24.1	14.8	9.5	7.4	4.6	3.8	5.3	9.7	14.3	14.3	144.1
1988	14.6	14.3	19.0	15.4	6.1	3.0	2.3	2.2	2.2	4.0	7.4	11.1	101.6
1989	10.1	9.2	23.9	32.9	10.4	5.7	2.7	3.4	3.6	6.1	8.3	10.6	126.8
1990	12.1	11.0	15.8	13.7	6.6	5.0	2.2	2.2	3.8	5.1	8.7	9.8	96.1
1991	9.3	10.0	14.4	12.5	19.6	7.8	2.8	2.7	3.4	5.9	9.5	9.9	107.8
1992	9.5	11.1	11.8	6.6	1.4	1.3	1.5	0.6	1.3	3.5	7.3	8.0	63.7
1993	7.8	7.6	17.0	21.4	40.0	19.0	5.4	6.5	5.9	9.5	10.4	10.8	161.2
1994	10.9	12.0	15.8	12.9	5.6	2.7	0.7	0.9	1.7	5.6	7.6	9.0	85.5
1995	11.2	12.3	17.1	15.6	20.7	18.7	4.5	2.6	4.8	8.5	10.8	12.2	138.9
											Annual average		175.8

Table G-11. Total inorganic nitrogen loads based on the average monthly flow x average site concentration (1990-1996), Marsh Creek USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	4.9	4.2	6.1	5.4	3.8	3.6	2.8	3.7	3.7	4.7	4.5	5.4	52.6
1956	6.8	4.0	9.1	5.5	3.9	2.8	2.4	3.0	4.0	5.1	5.3	5.7	57.5
1957	4.3	8.1	6.8	5.5	9.6	5.5	3.9	4.5	4.9	6.6	7.2	7.1	74.1
1958	6.0	11.3	8.9	8.0	5.8	4.1	3.3	4.1	4.8	6.3	6.7	7.0	76.3
1959	5.5	6.2	6.2	5.1	4.2	3.2	3.8	3.3	3.4	5.9	4.7	4.8	58.4
1960	4.8	5.1	11.7	6.9	3.0	2.4	2.7	3.4	3.2	4.1	4.3	4.4	55.9
1961	4.2	5.4	5.8	4.3	3.1	2.2	2.1	2.5	4.0	4.0	4.1	4.3	46.1
1962	4.6	22.2	12.2	7.2	3.7	3.3	2.8	3.4	3.5	4.5	5.8	5.2	78.3
1963	4.3	10.0	5.6	6.3	5.8	6.0	2.9	2.9	4.7	4.8	5.6	4.9	63.8
1964	4.5	4.0	5.4	10.6	6.4	8.3	4.7	3.3	4.2	5.7	6.2	10.6	74.0
1965	7.9	8.1	7.1	10.2	10.0	6.1	6.1	5.7	6.4	6.5	7.5	6.4	87.9
1966	6.1	5.5	11.2	6.5	4.1	3.0	2.6	2.6	3.4	4.4	4.7	4.9	59.1
1967	5.6	5.2	5.6	5.6	5.3	6.6	5.2	3.7	4.1	5.4	5.4	5.2	62.9
1968	4.8	7.9	7.6	5.5	4.5	5.3	4.0	5.9	5.2	5.6	6.0	5.7	67.9
1969	9.7	6.3	12.8	15.7	6.8	5.7	5.1	4.5	5.3	7.5	6.8	6.8	93.0
1970	8.7	6.8	6.7	5.3	6.4	4.8	4.5	4.2	6.6	7.1	7.0	6.7	74.7
1971	6.6	7.5	11.7	12.4	16.2	8.9	5.3	5.4	7.1	8.1	7.5	7.8	104.5
1972	8.4	7.9	13.2	13.0	18.8	6.8	4.7	5.6	6.1	7.4	6.9	6.7	97.5
1973	6.5	5.5	11.2	9.7	8.0	4.4	5.4	5.0	7.4	6.7	7.6	7.3	84.7
1974	7.1	5.8	13.5	10.2	9.8	4.3	3.8	4.8	4.4	6.5	7.2	6.7	84.0
1975	6.6	6.6	11.5	8.4	13.1	9.6	5.9	5.0	5.5	6.9	5.8	6.3	91.2
1976	6.0	6.5	11.3	15.4	11.4	5.4	3.4	4.9	5.0	6.0	5.8	5.4	86.6
1977	5.2	4.5	6.1	3.8	4.4	4.0	3.0	3.7	4.8	4.9	5.7	6.6	56.7
1978	6.2	6.4	7.9	10.8	7.7	3.4	2.6	3.7	5.6	5.0	4.8	4.3	68.4
1979	4.8	7.7	12.2	7.1	4.1	2.9	3.1	3.8	4.8	4.6	4.3	4.7	64.1
1980	16.7	14.1	8.3	7.2	13.4	10.7	4.2	3.5	4.7	5.6	6.5	6.7	101.7
1981	5.6	7.1	6.5	5.1	7.1	7.2	2.9	2.9	3.9	6.1	5.5	6.1	66.0
1982	3.7	7.4	9.3	9.9	15.9	8.9	6.5	5.7	8.2	9.4	9.4	8.7	103.2
1983	9.1	10.2	14.3	11.4	18.9	16.3	8.3	9.2	8.6	11.1	11.4	10.6	139.8
1984	9.2	8.3	13.1	13.0	23.1	17.1	8.7	9.2	9.3	11.4	9.7	8.2	142.3
1985	8.1	7.1	10.4	18.5	8.8	5.4	4.9	4.7	6.5	7.7	8.0	7.8	97.9
1986	7.4	19.7	14.6	15.2	14.9	8.3	6.6	7.1	9.0	10.1	9.2	8.4	130.4
1987	7.7	8.3	10.6	5.9	6.3	5.2	5.0	5.4	5.5	6.9	7.0	6.6	80.6
1988	6.4	6.8	8.5	5.9	4.6	3.7	2.8	3.1	3.4	4.6	4.9	4.1	58.7
1989	4.0	3.9	11.3	7.4	4.8	4.6	3.5	4.1	4.9	5.9	5.5	5.2	65.2
1990	5.8	5.0	6.0	4.8	4.8	4.5	3.5	2.8	3.8	4.7	4.6	3.9	54.2
1991	4.2	4.8	5.6	4.9	7.1	4.4	3.0	3.2	4.8	4.6	4.9	4.4	55.9
1992	4.0	5.4	4.4	3.3	2.0	2.5	2.4	1.8	3.0	3.2	3.4	3.4	38.7
1993	4.1	3.8	8.3	6.8	8.5	5.9	3.5	5.3	4.6	4.9	4.5	4.6	65.9
1994	5.1	5.9	5.9	3.5	3.0	2.7	1.8	2.5	3.3	3.6	3.5	4.0	44.8
1995	5.9	5.8	6.1	4.7	6.7	6.8	3.4	3.3	4.4	4.8	4.7	5.3	61.2
											Annual average		76.3

Table G-12. Total inorganic nitrogen loads based on the average monthly *flow* x average site concentration (1993-1996), Topsy USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	7.7	6.9	7.6	9.0	10.8	11.2	7.7	6.2	5.4	6.2	7.1	8.5	94.3
1956	8.7	7.3	11.4	15.3	13.8	11.9	11.6	9.8	6.4	6.6	7.6	8.3	118.7
1957	7.4	13.1	10.1	9.6	18.1	13.6	12.1	11.5	8.7	7.1	7.9	8.7	127.9
1958	8.2	9.3	11.4	15.3	16.2	12.6	12.9	10.8	7.7	6.3	7.6	8.8	125.2
1959	8.5	7.7	10.9	10.9	12.1	11.3	9.2	5.4	5.6	6.9	6.9	7.1	102.2
1960	7.2	7.1	11.6	12.8	11.9	11.8	7.1	4.7	4.5	5.0	6.2	6.7	96.6
1961	6.6	7.4	8.6	7.4	7.4	8.5	5.2	4.8	5.0	5.3	6.7	7.2	80.1
1962	8.0	25.5	12.5	14.6	11.8	11.3	10.5	11.2	7.9	5.7	6.6	7.0	132.7
1963	7.3	16.4	7.9	9.7	13.0	11.7	10.4	10.3	7.4	6.1	7.7	7.5	115.5
1964	7.4	6.6	6.8	13.2	16.7	16.6	12.5	10.9	7.3	6.3	7.7	14.5	126.4
1965	11.4	10.1	10.2	15.0	25.2	16.8	13.4	11.5	8.4	8.3	8.9	8.4	147.5
1966	8.5	7.6	10.8	12.5	12.0	11.5	9.6	8.0	5.6	5.4	6.5	7.6	105.7
1967	7.2	6.4	10.1	9.9	14.5	15.5	9.4	10.5	7.6	7.5	7.4	7.5	113.5
1968	7.8	8.8	11.6	9.3	11.7	14.1	11.5	9.6	6.8	7.6	8.0	8.0	114.9
1969	13.5	8.6	10.7	27.4	29.1	14.9	11.9	11.6	8.8	7.4	7.9	8.4	160.0
1970	10.8	8.6	10.3	9.2	19.1	19.0	11.9	10.8	8.6	8.0	8.3	8.7	133.1
1971	9.3	9.6	16.8	34.5	46.1	25.5	14.2	13.9	13.1	12.3	11.3	11.4	208.2
1972	11.5	11.5	27.8	28.4	36.2	25.2	14.6	13.2	12.3	12.2	13.1	13.5	217.2
1973	12.3	10.8	12.3	19.5	26.5	14.3	12.2	10.5	9.7	9.4	10.4	10.4	158.2
1974	10.5	9.1	20.0	24.7	33.1	16.4	12.7	12.5	10.0	8.7	10.2	10.1	177.9
1975	10.3	9.2	13.4	14.2	26.7	30.1	13.6	12.0	11.3	12.7	10.4	10.6	174.5
1976	8.8	8.4	11.7	29.1	38.2	19.6	13.0	12.5	9.5	10.4	9.3	9.8	180.5
1977	9.9	8.6	9.9	9.4	11.9	10.6	10.6	8.4	6.4	6.5	7.6	8.8	108.6
1978	7.5	7.3	13.0	19.0	25.1	15.8	11.0	10.5	8.2	7.4	8.1	8.5	141.6
1979	8.0	7.3	9.5	12.3	13.7	12.4	10.6	9.2	6.0	6.6	7.5	7.1	110.1
1980	9.3	12.9	10.7	12.5	23.0	16.5	10.8	9.6	7.3	8.1	8.1	7.8	136.4
1981	7.3	7.3	8.2	8.9	15.3	12.4	11.1	8.8	6.8	5.6	6.4	7.3	105.3
1982	7.0	6.1	12.2	15.2	39.2	20.4	13.8	11.6	11.2	11.5	10.3	9.8	170.3
1983	10.1	9.2	19.4	22.0	41.5	32.8	16.7	14.3	13.8	13.5	13.2	13.9	228.4
1984	15.4	13.9	15.3	20.7	51.1	41.6	20.3	15.9	15.0	16.6	16.0	16.3	258.0
1985	15.8	13.8	15.8	29.8	22.3	14.4	13.1	11.1	11.0	11.7	11.1	10.4	180.3
1986	9.6	17.6	26.1	33.3	33.5	20.9	15.4	19.4	20.4	15.9	12.1	12.3	236.5
1987	11.8	12.0	15.1	12.1	13.7	10.3	8.9	12.2	8.2	8.5	9.3	9.5	131.5
1988	9.1	8.5	10.6	10.3	11.7	10.3	7.3	5.9	5.0	5.6	7.0	7.8	99.1
1989	7.7	6.1	12.2	16.3	14.1	12.4	10.6	9.0	6.4	6.3	7.7	7.9	116.7
1990	8.1	7.3	9.9	8.8	11.2	10.2	11.4	5.8	4.8	5.0	6.5	7.4	96.3
1991	7.2	6.6	9.1	8.0	11.5	11.1	10.1	8.4	5.0	5.5	7.2	7.2	96.8
1992	7.0	7.6	8.0	5.8	9.9	7.4	4.8	4.4	3.6	3.3	4.8	5.5	71.0
1993	5.4	4.8	8.3	9.5	20.3	13.2	11.4	9.4	7.0	6.0	6.2	6.5	108.1
1994	6.7	7.6	9.1	8.2	11.1	9.3	8.1	5.8	3.5	3.5	5.0	5.8	83.7
1995	6.6	7.6	9.1	9.1	13.2	16.1	11.5	9.6	5.7	5.0	6.5	7.2	107.3
										Annual average			136.3

Table G-13. Total phosphorus loads based on the average monthly flow x average site concentration (1970-1994), Tybee USGS surface-water station, 1986-1993.

	Load (tons)												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1986	24.9	36.6	52.3	59.2	57.0	25.6	13.1	20.6	28.1	31.3	28.2	26.6	403.5
1987	25.2	22.9	29.3	19.8	12.8	9.7	10.6	12.1	13.1	17.9	21.4	22.1	216.8
1988	22.3	21.5	25.2	21.2	10.9	4.9	6.9	8.8	9.1	13.0	16.0	19.2	179.0
1989	18.3	16.9	28.8	33.3	15.4	7.9	5.6	10.2	11.9	16.3	19.0	19.3	202.9
1990	19.6	17.4	21.2	17.4	10.1	7.1	5.4	8.8	10.3	15.0	17.1	18.0	167.5
1991	18.4	17.9	22.5	20.9	23.7	9.3	5.6	9.1	10.1	15.0	17.6	18.2	188.3
1992	18.0	18.7	19.5	12.4	3.7	4.0	6.7	7.9	8.2	12.9	14.3	15.2	141.4
1993	14.1	12.5	21.9	25.3	41.3	22.0	8.6	13.8	12.6	17.9	17.5	18.3	225.9
											Annual average		215.7

Table G-14. Total phosphorus loads based on the average monthly flow x average site concentration (1990-1996), Pocatello USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	1.5	1.4	1.8	2.0	1.1	0.6	0.3	0.4	0.5	0.7	1.5	1.8	13.8
1956	2.1	1.7	2.6	3.5	2.0	0.5	0.2	0.3	0.4	0.7	1.5	1.7	17.3
1957	1.6	2.6	2.7	2.3	4.5	2.0	0.3	0.4	0.6	1.0	1.7	2.0	21.6
1958	1.9	2.6	3.0	3.7	3.2	0.6	0.3	0.5	0.6	0.8	1.7	2.1	20.9
1959	2.1	2.0	2.5	2.5	1.0	0.5	0.3	0.3	0.6	1.1	1.5	1.6	15.9
1960	1.5	1.6	3.1	3.1	0.8	0.3	0.1	0.4	0.4	0.6	0.8	1.4	14.2
1961	1.4	1.8	2.1	1.6	0.6	0.2	0.1	0.3	0.6	1.1	1.5	1.4	12.8
1962	1.3	4.6	3.4	4.0	2.3	0.6	0.3	0.3	0.3	0.8	1.3	1.3	20.5
1963	1.3	3.2	1.9	2.3	3.1	2.0	0.2	0.2	0.6	0.9	1.5	1.6	19.0
1964	1.6	1.5	1.7	3.7	4.2	2.7	0.7	0.4	0.4	0.8	1.6	3.0	22.2
1965	2.6	2.9	2.6	4.1	4.9	1.7	1.1	0.9	1.3	1.4	1.8	1.9	27.2
1966	1.9	1.7	3.0	3.1	1.1	0.3	0.1	0.2	0.3	0.5	1.0	1.5	14.7
1967	1.6	1.6	2.2	2.5	3.4	2.8	1.1	0.5	0.5	1.1	1.4	1.4	20.2
1968	1.5	2.1	2.8	2.5	1.9	1.3	0.4	1.0	0.8	1.0	1.7	1.7	18.7
1969	2.6	2.0	2.7	6.3	4.9	1.6	0.9	0.6	0.6	1.3	1.8	1.9	27.3
1970	2.6	2.0	2.3	2.2	4.0	2.3	0.5	0.5	0.8	1.4	1.9	1.9	22.6
1971	2.0	2.2	3.5	5.8	8.7	4.8	1.2	0.7	1.6	2.4	2.4	2.5	38.1
1972	2.8	2.7	6.2	6.6	7.2	3.5	1.1	1.0	1.3	2.2	2.4	2.2	39.4
1973	2.4	2.1	2.8	4.5	4.9	1.3	0.8	0.8	1.7	2.1	2.3	2.3	28.0
1974	2.3	2.0	4.8	6.1	6.7	2.3	0.8	0.8	0.8	1.6	2.2	2.1	32.4
1975	2.3	2.1	3.4	3.6	7.6	6.7	1.9	1.4	1.3	2.2	2.3	2.4	37.1
1976	2.1	1.9	3.1	6.1	8.0	2.4	0.7	1.0	1.2	2.0	2.0	1.9	32.4
1977	1.9	1.7	2.1	1.3	0.6	0.8	0.3	0.4	0.6	1.1	1.5	1.9	14.3
1978	2.0	2.0	3.1	4.5	4.4	1.6	0.5	0.4	0.9	1.3	1.6	1.7	23.9
1979	1.7	1.9	2.8	3.1	2.4	0.6	0.2	0.4	0.4	0.8	1.3	1.3	16.8
1980	2.9	3.2	2.8	3.6	6.2	3.9	0.8	0.5	0.8	1.5	1.7	1.8	29.6
1981	1.8	1.9	2.1	2.1	3.0	2.3	0.3	0.3	0.3	0.9	1.5	1.9	18.4
1982	1.6	2.1	3.2	4.6	8.1	4.0	1.7	0.9	1.5	2.3	2.2	2.2	34.5
1983	2.6	2.5	5.2	5.8	10.4	7.8	2.5	2.0	2.3	2.9	3.2	3.4	50.3
1984	3.5	3.1	4.0	6.2	13.6	9.4	2.9	2.2	2.7	2.9	3.2	3.3	57.0
1985	3.1	2.8	3.3	6.9	4.3	1.4	0.8	0.7	1.2	2.2	2.3	2.4	31.5
1986	2.5	4.7	7.2	8.3	8.1	3.4	1.3	1.9	3.2	3.3	2.9	2.6	49.3
1987	2.5	2.4	3.3	2.0	1.3	1.0	0.6	0.5	0.7	1.3	2.0	1.9	19.6
1988	2.0	2.0	2.6	2.1	0.8	0.4	0.3	0.3	0.3	0.5	1.0	1.5	13.8
1989	1.4	1.3	3.3	4.5	1.4	0.8	0.4	0.5	0.5	0.8	1.1	1.4	17.3
1990	1.7	1.5	2.2	1.9	0.9	0.7	0.3	0.3	0.5	0.7	1.2	1.3	13.1
1991	1.3	1.4	2.0	1.7	2.7	1.1	0.4	0.4	0.5	0.8	1.3	1.4	14.7
1992	1.3	1.5	1.6	0.9	0.2	0.2	0.2	0.1	0.2	0.5	1.0	1.1	8.7
1993	1.1	1.0	2.3	2.9	5.4	2.6	0.7	0.9	0.8	1.3	1.4	1.5	22.0
1994	1.5	1.6	2.2	1.8	0.8	0.4	0.1	0.1	0.2	0.8	1.0	1.2	11.6
1995	1.5	1.7	2.3	2.1	2.8	2.5	0.6	0.4	0.7	1.2	1.5	1.7	18.9
											Annual average		23.9

Table G-15. Total phosphorus loads based on the average monthly flow x average site concentration (1990-1996), Marsh Creek USGS surface-water station, 1955-1995.

	Load (tons)												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	0.5	0.4	0.6	0.5	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	4.8
1956	0.6	0.4	0.8	0.5	0.4	0.3	0.2	0.3	0.4	0.5	0.5	0.5	5.3
1957	0.4	0.7	0.6	0.5	0.9	0.5	0.4	0.4	0.5	0.6	0.7	0.7	6.8
1958	0.6	1.0	0.8	0.7	0.5	0.4	0.3	0.4	0.4	0.6	0.6	0.6	7.0
1959	0.5	0.6	0.4	0.5	0.4	0.3	0.3	0.3	0.5	0.5	0.4	0.4	5.4
1960	0.4	0.5	1.1	0.6	0.3	0.2	0.2	0.3	0.3	0.4	0.4	0.4	5.1
1961	0.4	0.5	0.5	0.4	0.3	0.2	0.2	0.2	0.4	0.4	0.4	0.4	4.2
1962	0.4	2.0	1.1	0.7	0.5	0.3	0.3	0.3	0.3	0.4	0.5	0.5	7.2
1963	0.4	0.9	0.5	0.6	0.5	0.6	0.3	0.3	0.4	0.4	0.5	0.4	5.9
1964	0.4	0.4	0.5	1.0	0.6	0.8	0.4	0.3	0.4	0.5	0.6	1.0	6.8
1965	0.7	0.7	0.7	0.9	0.9	0.6	0.6	0.5	0.6	0.6	0.7	0.6	8.1
1966	0.6	0.5	1.0	0.6	0.4	0.3	0.2	0.2	0.3	0.4	0.4	0.5	5.4
1967	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.4	0.5	0.5	0.5	5.8
1968	0.4	0.7	0.7	0.5	0.4	0.5	0.4	0.5	0.5	0.5	0.6	0.5	6.2
1969	0.9	0.6	1.2	1.4	0.6	0.5	0.5	0.4	0.5	0.7	0.6	0.6	8.6
1970	0.8	0.6	0.6	0.5	0.6	0.4	0.4	0.4	0.6	0.6	0.6	0.6	6.9
1971	0.6	0.7	1.1	1.1	1.5	0.8	0.5	0.5	0.7	0.7	0.7	0.7	9.6
1972	0.8	0.7	1.2	1.2	1.0	0.6	0.4	0.5	0.6	0.7	0.6	0.6	9.0
1973	0.6	0.5	1.0	0.9	0.7	0.4	0.5	0.5	0.7	0.6	0.7	0.7	7.8
1974	0.7	0.5	1.2	0.9	0.9	0.4	0.3	0.4	0.4	0.6	0.7	0.6	7.7
1975	0.6	0.6	1.1	0.8	1.2	0.9	0.5	0.5	0.5	0.6	0.5	0.6	8.4
1976	0.6	0.6	1.0	1.4	1.1	0.5	0.3	0.5	0.5	0.5	0.5	0.5	8.0
1977	0.5	0.4	0.6	0.5	0.4	0.4	0.3	0.3	0.4	0.5	0.5	0.6	5.2
1978	0.6	0.6	0.7	1.0	0.7	0.3	0.2	0.3	0.5	0.5	0.4	0.4	6.3
1979	0.4	0.7	1.1	0.7	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.4	5.9
1980	1.5	1.3	0.8	0.7	1.2	1.0	0.4	0.3	0.4	0.5	0.6	0.6	9.4
1981	0.5	0.7	0.6	0.5	0.7	0.7	0.3	0.3	0.4	0.6	0.5	0.6	6.1
1982	0.3	0.7	0.9	0.9	1.5	0.8	0.6	0.5	0.8	0.9	0.9	0.8	9.5
1983	0.8	0.9	1.3	1.0	1.7	1.5	0.8	0.9	0.8	1.0	1.0	1.0	12.9
1984	0.8	0.8	1.2	1.4	2.1	1.6	0.8	0.8	0.9	1.0	0.9	0.8	13.1
1985	0.7	0.7	1.0	1.7	0.8	0.5	0.5	0.4	0.6	0.7	0.7	0.7	9.0
1986	0.7	1.8	1.3	1.4	1.4	0.8	0.6	0.7	0.8	0.9	0.8	0.8	12.0
1987	0.7	0.8	1.0	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.6	7.4
1988	0.6	0.6	0.8	0.5	0.4	0.3	0.3	0.3	0.3	0.4	0.5	0.4	5.4
1989	0.4	0.4	1.0	0.7	0.4	0.4	0.3	0.4	0.5	0.5	0.5	0.5	6.0
1990	0.5	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.4	5.0
1991	0.4	0.4	0.5	0.4	0.7	0.4	0.3	0.3	0.4	0.4	0.5	0.4	5.1
1992	0.4	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	3.6
1993	0.4	0.3	0.8	0.6	0.9	0.5	0.3	0.5	0.4	0.5	0.4	0.4	6.1
1994	0.5	0.5	0.5	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.4	4.1
1995	0.5	0.5	0.6	0.4	0.6	0.6	0.5	0.3	0.4	0.4	0.4	0.5	5.7
											Annual average		7.0

Table G-16. Total phosphorus loads based on the average monthly flow x average site concentration (1993-1996), Topaz USGS surface-water station, 1955-1995.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1955	0.6	0.5	0.6	0.7	0.8	0.9	0.6	0.5	0.4	0.5	0.5	0.7	7.3
1956	0.7	0.6	0.9	1.2	1.1	0.9	0.9	0.8	0.5	0.5	0.6	0.6	9.2
1957	0.6	1.0	0.8	0.7	1.4	1.1	0.9	0.9	0.7	0.6	0.6	0.7	9.9
1958	0.6	0.7	0.9	1.0	1.3	1.0	1.0	0.8	0.6	0.5	0.6	0.7	9.7
1959	0.6	0.6	0.8	0.8	0.9	0.9	0.7	0.4	0.4	0.5	0.5	0.5	7.9
1960	0.6	0.5	0.9	1.0	0.9	0.9	0.6	0.4	0.4	0.4	0.5	0.5	7.5
1961	0.5	0.6	0.7	0.6	0.6	0.7	0.4	0.4	0.4	0.4	0.5	0.6	6.2
1962	0.6	2.0	1.0	1.1	0.9	0.9	0.8	0.9	0.6	0.4	0.5	0.5	10.3
1963	0.6	1.3	0.6	0.7	1.0	0.9	0.8	0.8	0.6	0.5	0.6	0.6	8.9
1964	0.6	0.5	0.5	1.0	1.3	1.3	1.0	0.8	0.6	0.5	0.6	1.1	9.8
1965	0.9	0.8	0.8	1.2	2.0	1.3	1.0	0.9	0.6	0.6	0.7	0.6	11.4
1966	0.7	0.6	0.8	1.0	0.9	0.9	0.7	0.6	0.4	0.4	0.5	0.6	8.2
1967	0.6	0.5	0.8	0.8	1.1	1.2	0.7	0.8	0.6	0.6	0.6	0.6	8.8
1968	0.6	0.7	0.9	0.7	0.9	1.1	0.9	0.7	0.5	0.6	0.6	0.6	8.9
1969	1.0	0.7	0.8	2.1	2.3	1.1	0.9	0.9	0.7	0.6	0.6	0.6	12.4
1970	0.8	0.7	0.8	0.7	1.5	1.5	0.9	0.8	0.7	0.6	0.6	0.7	10.3
1971	0.7	0.7	1.3	1.9	3.6	2.0	1.1	1.1	1.0	1.0	0.9	0.9	16.1
1972	0.9	0.9	2.1	2.1	2.8	1.8	1.1	1.0	0.9	0.9	1.0	1.0	16.8
1973	1.0	0.8	1.0	1.5	2.1	1.1	0.9	0.8	0.7	0.7	0.8	0.8	12.2
1974	0.8	0.7	1.5	1.9	2.6	1.3	1.0	1.0	0.8	0.7	0.8	0.8	13.8
1975	0.8	0.7	1.0	1.1	2.1	2.3	1.1	0.9	0.9	1.0	0.8	0.8	13.5
1976	0.7	0.7	0.9	2.3	3.0	1.5	1.0	1.0	0.7	0.8	0.7	0.8	14.0
1977	0.8	0.7	0.8	0.7	0.9	0.8	0.8	0.7	0.5	0.5	0.6	0.7	8.4
1978	0.6	0.6	1.0	1.5	1.9	1.2	0.8	0.8	0.6	0.6	0.6	0.7	11.0
1979	0.6	0.6	0.7	0.9	1.1	1.0	0.8	0.7	0.5	0.5	0.6	0.5	8.5
1980	0.7	1.0	0.8	0.9	1.8	1.3	0.8	0.7	0.6	0.6	0.6	0.6	10.6
1981	0.6	0.6	0.6	0.7	1.2	1.0	0.9	0.7	0.5	0.4	0.5	0.6	8.1
1982	0.5	0.6	0.9	1.2	3.0	1.6	1.1	0.9	0.9	0.9	0.8	0.8	13.2
1983	0.8	0.7	1.5	1.7	3.2	2.5	1.3	1.1	1.1	1.0	1.0	1.1	17.1
1984	1.2	1.1	1.2	1.6	4.0	3.2	1.6	1.2	1.2	1.3	1.2	1.3	20.0
1985	1.2	1.1	1.2	2.3	1.7	1.1	1.0	0.9	0.8	0.9	0.9	0.8	13.9
1986	0.7	1.4	2.0	2.6	2.6	1.6	1.2	1.5	1.6	1.2	0.9	1.0	18.3
1987	0.9	0.9	1.2	0.9	1.1	0.8	0.7	0.9	0.6	0.7	0.7	0.7	10.2
1988	0.7	0.7	0.8	0.8	0.9	0.8	0.6	0.5	0.4	0.4	0.5	0.6	7.7
1989	0.6	0.5	0.9	1.3	1.1	1.0	0.8	0.7	0.5	0.5	0.6	0.6	9.0
1990	0.6	0.6	0.8	0.7	0.9	0.8	0.9	0.5	0.4	0.4	0.5	0.6	7.4
1991	0.6	0.5	0.7	0.6	0.9	0.9	0.8	0.6	0.4	0.4	0.6	0.6	7.5
1992	0.5	0.6	0.6	0.5	0.8	0.6	0.4	0.3	0.3	0.3	0.4	0.4	5.6
1993	0.4	0.4	0.6	0.7	1.6	1.0	0.8	0.7	0.5	0.5	0.5	0.5	8.4
1994	0.5	0.6	0.7	0.6	0.9	0.7	0.6	0.4	0.3	0.3	0.4	0.4	6.5
1995	0.5	0.6	0.7	0.7	1.0	1.2	0.9	0.7	0.4	0.4	0.5	0.6	8.3
											Annual average		10.5

Table G-17. Target total inorganic nitrogen loads based on the monthly average x target concentration, Tyhee USGS surface-water station, 1986-1993.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1986	15.7	23.1	33.0	37.3	35.9	16.2	8.2	13.0	17.7	19.8	17.8	16.8	254.3
1987	15.9	14.4	18.5	12.5	8.0	6.1	6.6	7.6	8.2	11.3	13.5	14.0	136.7
1988	14.0	13.6	15.9	13.4	6.9	3.1	4.4	5.5	5.7	8.2	10.1	12.1	112.8
1989	11.5	10.7	18.2	21.0	9.7	5.0	3.5	6.4	7.5	10.3	12.0	12.1	127.9
1990	12.4	10.9	13.4	11.0	6.4	4.5	3.4	5.6	6.5	9.5	10.8	11.3	105.5
1991	11.6	11.3	14.2	13.1	14.9	5.9	3.5	5.7	6.4	9.4	11.1	11.5	118.7
1992	11.3	11.8	12.3	7.8	2.3	2.5	4.2	5.0	5.2	8.1	9.0	9.6	89.1
1993	8.9	7.9	13.8	16.0	26.0	13.9	5.4	8.7	8.0	11.3	11.1	11.5	142.4
											Annual average		135.9

Table G-18. Target total inorganic nitrogen loads based on the monthly average x target concentration, Pocomoke USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	5.6	5.2	6.7	7.5	4.2	2.3	1.0	1.5	1.7	2.5	5.6	6.7	50.6
1956	7.7	6.1	9.5	12.9	7.3	1.8	0.7	1.2	1.5	2.6	5.6	6.5	63.4
1957	5.7	9.3	8.8	8.2	16.4	7.3	1.3	1.6	2.1	3.6	6.4	7.3	79.1
1958	7.0	9.6	10.9	15.5	11.6	2.1	1.0	1.7	2.1	3.0	6.2	7.5	76.3
1959	7.6	7.2	9.1	9.1	3.8	1.7	1.0	1.0	2.3	4.1	5.5	5.9	58.3
1960	5.6	5.9	11.5	11.2	2.8	1.0	0.5	1.4	1.5	2.5	3.0	5.3	51.9
1961	5.2	6.7	7.8	5.9	2.2	0.7	0.4	1.2	2.3	4.0	5.3	5.2	46.9
1962	4.8	16.8	12.3	14.6	8.4	2.0	1.0	1.0	1.2	2.8	4.7	5.6	75.1
1963	4.9	11.7	6.9	9.0	11.3	7.2	0.9	0.8	2.1	3.2	5.6	5.9	69.5
1964	5.8	5.4	6.0	13.4	15.5	9.9	2.6	1.4	1.5	2.8	5.9	11.1	81.1
1965	9.6	10.5	9.4	14.9	17.8	6.3	4.1	3.1	4.6	5.3	6.8	7.1	99.4
1966	7.0	6.2	11.1	11.4	4.0	1.1	0.4	0.6	0.9	1.9	5.8	5.4	53.8
1967	5.7	5.8	7.9	9.1	12.4	10.4	4.1	1.8	2.0	4.2	5.3	5.2	73.8
1968	5.4	7.7	10.4	9.2	6.9	4.9	1.4	3.5	2.8	3.8	6.1	6.2	68.3
1969	9.7	7.4	9.9	23.1	18.0	6.0	3.4	2.2	2.1	4.7	6.4	7.1	100.0
1970	9.6	7.5	8.5	8.2	14.6	8.3	2.0	2.0	3.0	5.0	6.8	7.1	82.6
1971	7.4	8.1	12.9	21.2	32.0	17.6	4.5	2.6	6.0	8.9	8.9	9.3	159.4
1972	10.3	9.8	22.7	24.2	26.2	12.9	3.9	3.8	5.4	8.1	8.7	8.0	144.1
1973	8.8	7.8	10.2	16.4	17.9	4.6	3.0	2.8	6.4	7.7	8.6	8.3	102.4
1974	8.4	7.5	17.6	22.3	24.5	8.3	2.8	2.8	2.9	5.8	7.9	7.8	118.5
1975	8.2	7.7	12.5	13.2	27.7	24.7	6.8	4.9	4.7	7.9	8.3	8.9	135.6
1976	7.6	7.1	11.2	22.5	29.3	9.0	2.6	3.5	4.3	7.4	7.2	7.1	118.7
1977	6.9	6.3	7.6	4.8	2.3	3.0	1.1	1.6	2.1	4.0	5.6	7.0	52.2
1978	7.2	7.1	11.5	16.6	16.0	6.8	1.7	1.6	3.2	4.7	6.0	6.2	87.6
1979	6.2	6.9	10.2	11.4	8.9	2.3	0.8	1.3	1.3	2.8	4.6	4.8	61.6
1980	10.5	11.8	10.1	13.3	22.7	14.1	2.8	1.8	2.8	5.4	6.3	6.8	108.4
1981	6.5	6.9	7.8	7.7	11.1	8.3	1.2	1.0	1.3	3.2	5.5	6.8	67.3
1982	6.0	7.5	11.9	17.0	29.7	14.7	6.1	3.2	5.7	8.5	8.2	7.9	126.4
1983	9.5	9.3	19.0	21.3	38.0	27.7	9.1	7.3	8.3	10.7	11.6	12.4	184.2
1984	12.9	11.4	14.6	22.6	49.9	34.4	10.5	8.1	10.0	10.6	11.6	12.0	208.5
1985	11.3	10.3	12.0	25.3	15.6	5.2	2.9	2.7	4.4	8.1	8.5	8.8	115.2
1986	9.0	17.1	26.5	30.4	29.7	12.5	4.7	6.9	11.7	12.0	10.5	9.5	190.3
1987	9.1	8.9	12.0	7.4	4.7	3.7	2.3	1.9	2.7	4.8	7.1	7.1	71.8
1988	7.3	7.1	9.5	7.7	3.0	1.3	1.1	1.1	1.1	2.0	3.7	5.6	50.6
1989	5.0	4.6	11.9	16.4	5.2	2.8	1.3	1.7	1.8	3.0	4.1	5.3	63.2
1990	6.1	5.5	7.9	6.8	3.3	2.5	1.1	1.1	1.9	2.6	4.3	4.9	47.9
1991	4.7	5.0	7.2	6.2	9.8	3.9	1.4	1.4	1.7	2.9	4.7	5.0	53.7
1992	4.7	5.5	5.9	3.3	0.7	0.6	0.7	0.3	0.6	1.8	3.6	4.0	31.8
1993	3.9	3.8	8.5	10.6	19.9	9.4	2.7	3.2	2.9	4.7	5.2	5.4	80.3
1994	5.4	6.0	7.9	6.4	2.8	1.4	0.4	0.5	0.8	2.8	3.8	4.5	42.6
1995	5.6	6.1	8.5	7.8	10.3	9.3	2.2	1.3	2.4	4.2	5.4	6.1	69.2

Table G-19. Target total inorganic nitrogen loads based on the monthly average x target concentration, Marsh Creek USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	1.7	1.4	2.0	1.8	1.3	1.2	0.9	1.3	1.2	1.6	1.5	1.8	17.7
1956	2.3	1.4	3.1	1.8	1.3	0.9	0.8	1.0	1.3	1.7	1.8	1.9	19.4
1957	1.5	2.7	2.3	1.9	3.2	1.8	1.3	1.5	1.7	2.2	2.4	2.4	24.9
1958	2.0	3.8	3.0	2.7	2.0	1.4	1.1	1.4	1.6	2.1	2.3	2.4	25.7
1959	1.9	2.1	2.1	1.7	1.4	1.1	1.3	1.1	1.8	2.0	1.6	1.6	19.6
1960	1.6	1.7	3.9	2.3	1.0	0.8	0.9	1.1	1.1	1.4	1.4	1.5	18.8
1961	1.4	1.8	2.0	1.4	1.0	0.7	0.7	0.8	1.3	1.4	1.4	1.5	15.5
1962	1.5	7.5	4.1	2.4	1.2	1.1	0.9	1.1	1.2	1.5	2.0	1.7	26.4
1963	1.4	3.4	1.9	2.1	2.0	2.0	1.0	1.0	1.6	1.6	1.9	1.6	21.5
1964	1.3	1.4	1.8	3.6	2.2	2.8	1.6	1.1	1.4	1.9	2.1	3.6	24.9
1965	2.7	2.7	2.4	3.4	3.4	2.0	2.0	1.9	2.2	2.2	2.5	2.1	29.6
1966	2.1	1.8	3.8	2.2	1.4	1.0	0.9	0.9	1.1	1.5	1.6	1.7	19.9
1967	1.9	1.8	1.9	1.9	1.8	2.2	1.7	1.2	1.4	1.8	1.8	1.8	21.2
1968	1.6	2.6	2.6	1.8	1.3	1.8	1.3	2.0	1.7	1.9	2.0	1.9	22.9
1969	3.3	2.1	4.3	3.3	2.3	1.9	1.7	1.5	1.8	2.5	2.3	2.3	31.3
1970	2.9	2.3	2.3	1.8	2.2	1.6	1.5	1.4	2.2	2.4	2.3	2.2	25.1
1971	2.2	2.5	3.9	4.2	5.5	3.0	1.8	1.8	2.4	2.7	2.5	2.6	35.2
1972	2.8	2.7	4.4	4.4	3.6	2.3	1.6	1.9	2.0	2.5	2.5	2.2	32.8
1973	2.2	1.8	3.8	3.3	2.7	1.5	1.8	1.7	2.5	2.3	2.6	2.5	28.5
1974	2.4	1.9	4.5	3.4	3.3	1.5	1.3	1.6	1.5	2.2	2.4	2.3	28.3
1975	2.2	2.2	3.9	2.8	4.4	3.2	2.0	1.7	1.8	2.3	2.0	2.1	30.7
1976	2.0	2.2	3.8	3.2	3.8	1.8	1.2	1.7	1.7	2.0	2.0	1.8	29.2
1977	1.7	1.5	2.1	1.3	1.5	1.4	1.0	1.2	1.6	1.7	1.9	2.3	19.1
1978	2.1	2.1	2.7	3.6	2.6	1.1	0.9	1.2	1.9	1.7	1.6	1.4	23.0
1979	1.6	2.6	4.1	2.4	1.4	1.8	1.1	1.3	1.6	1.6	1.5	1.6	21.6
1980	3.6	4.7	2.8	2.4	4.3	3.6	1.4	1.2	1.6	1.9	2.3	2.3	34.2
1981	1.9	2.4	2.2	1.7	2.4	2.4	1.8	1.0	1.3	2.1	1.9	2.1	22.2
1982	1.3	2.5	3.1	3.3	5.4	3.0	2.2	1.9	2.8	3.2	3.2	2.9	34.7
1983	3.0	3.4	4.8	3.8	6.4	5.5	2.9	3.1	2.9	3.7	3.8	3.6	47.1
1984	3.1	2.8	4.4	5.1	7.8	5.8	2.9	3.1	3.1	3.8	3.3	2.8	47.9
1985	2.7	2.4	3.5	6.2	2.9	1.8	1.7	1.6	2.2	2.6	2.7	2.6	33.0
1986	2.5	6.6	4.9	5.1	5.0	2.8	2.2	2.4	3.0	3.4	3.1	2.8	43.9
1987	2.6	2.8	3.6	2.0	2.1	1.7	1.7	1.8	1.9	2.3	2.4	2.2	27.1
1988	2.2	2.3	2.9	2.0	1.5	1.2	1.0	1.0	1.1	1.5	1.7	1.4	19.8
1989	1.3	1.3	3.8	2.5	1.6	1.5	1.2	1.4	1.7	2.0	1.9	1.8	21.9
1990	2.0	1.7	2.0	1.6	1.6	1.5	1.2	1.0	1.3	1.6	1.5	1.3	18.2
1991	1.4	1.6	1.9	1.6	2.4	1.5	1.0	1.1	1.6	1.5	1.7	1.5	18.8
1992	1.3	1.8	1.5	1.1	0.7	0.8	0.8	0.6	1.0	1.1	1.1	1.1	13.0
1993	1.4	1.3	2.8	2.3	3.2	2.0	1.2	1.8	1.5	1.7	1.5	1.6	22.2
1994	1.7	2.0	2.0	1.2	1.0	0.9	0.6	0.8	1.1	1.2	1.2	1.4	15.1
1995	2.0	2.0	2.1	1.6	2.2	2.3	1.1	1.1	1.5	1.6	1.6	1.8	20.8
											Annual average		25.7

Table G-20. Target total inorganic nitrogen loads based on the monthly average x target concentration, Topeka USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	3.3	3.0	3.3	3.9	4.7	4.8	3.3	2.6	2.3	2.7	3.0	3.7	40.5
1956	3.7	3.2	4.9	6.6	6.8	5.1	5.0	4.2	2.8	2.8	3.9	3.6	51.0
1957	3.2	5.6	4.4	4.1	7.8	5.8	5.2	5.0	3.7	3.1	3.4	3.7	55.0
1958	3.5	4.0	4.9	5.7	7.0	5.4	5.5	4.7	3.3	2.7	3.3	3.8	53.8
1959	3.6	3.3	4.7	4.7	5.2	4.8	4.0	2.3	2.4	3.0	2.9	3.0	43.9
1960	3.1	3.0	5.8	5.5	5.1	5.1	3.1	2.0	1.9	2.1	2.7	2.9	41.5
1961	2.8	3.2	3.7	3.2	3.2	3.7	2.3	2.1	2.1	2.3	2.9	3.1	34.4
1962	3.5	11.0	5.4	6.3	5.1	4.9	4.5	4.8	3.4	2.4	2.8	3.0	57.0
1963	3.1	7.1	3.4	4.2	5.6	5.0	4.5	4.4	3.2	2.6	3.3	3.2	49.6
1964	3.2	2.8	2.9	3.7	7.2	7.1	5.4	4.7	3.1	2.7	3.3	6.2	54.3
1965	4.9	4.3	4.4	6.4	10.8	7.2	5.7	4.9	3.6	3.6	3.8	3.6	63.4
1966	3.7	3.3	4.6	5.4	3.2	4.9	4.1	3.4	2.4	2.3	2.8	3.3	45.4
1967	3.1	2.8	4.3	4.3	6.2	6.7	4.0	4.5	3.3	3.2	3.2	3.2	48.8
1968	3.4	3.8	5.0	4.0	5.0	6.0	4.9	4.1	2.9	3.3	3.4	3.5	49.4
1969	5.8	3.7	4.6	11.8	12.5	6.4	5.1	5.0	3.8	3.2	3.4	3.6	68.8
1970	4.7	3.7	4.4	4.0	8.2	8.2	5.1	4.6	3.7	3.4	3.6	3.7	57.2
1971	4.0	4.1	7.2	10.5	19.8	10.9	6.1	6.0	5.6	5.3	4.9	4.9	89.5
1972	4.9	4.9	11.9	12.2	15.6	10.0	6.5	5.7	5.3	5.3	5.6	5.7	93.4
1973	5.3	4.6	5.5	8.4	11.4	6.1	5.3	4.5	4.1	4.0	4.5	4.5	68.0
1974	4.5	3.9	8.6	10.6	14.2	9.0	5.5	5.4	4.3	3.7	4.4	4.3	76.5
1975	4.4	3.9	5.8	6.1	11.5	12.9	5.8	5.2	4.8	5.4	4.5	4.6	75.0
1976	3.8	3.6	5.0	12.5	16.4	8.4	5.6	5.4	4.1	4.5	4.0	4.2	77.6
1977	4.3	3.7	4.3	4.0	5.1	4.5	4.6	3.6	2.7	2.8	3.3	3.8	46.7
1978	3.2	3.2	5.6	8.2	10.8	6.8	4.7	4.5	3.5	3.2	3.5	3.7	60.8
1979	3.5	3.1	4.1	5.3	5.9	5.3	4.5	3.9	2.6	2.8	3.2	3.0	47.3
1980	4.8	5.6	4.6	5.3	9.9	7.1	4.7	4.1	3.2	3.5	3.5	3.3	58.6
1981	3.1	3.1	3.5	3.8	6.6	5.3	4.8	3.8	2.9	2.4	2.7	3.1	45.3
1982	3.0	3.5	5.3	6.5	16.9	8.8	5.9	5.0	4.8	4.9	4.4	4.2	73.2
1983	4.4	4.0	8.3	9.5	17.8	14.1	7.2	6.1	5.9	5.8	5.7	6.0	94.7
1984	6.6	6.0	6.6	8.9	22.0	17.9	8.7	6.8	6.4	7.1	6.9	7.0	110.9
1985	6.8	5.9	6.8	12.8	9.6	6.2	5.6	4.8	4.7	5.0	4.8	4.5	77.5
1986	4.1	7.6	11.2	14.3	14.4	9.0	6.6	8.3	8.8	6.8	5.2	5.3	101.7
1987	5.1	3.2	6.5	5.2	5.9	4.4	3.8	3.2	3.5	3.6	4.0	4.1	56.5
1988	3.9	3.7	4.6	4.4	5.0	4.4	3.2	2.5	2.2	2.4	3.0	3.3	42.6
1989	3.3	2.6	5.2	7.0	6.0	5.3	4.6	3.9	2.8	2.7	3.3	3.4	50.2
1990	3.5	3.1	4.3	5.8	4.8	4.4	4.9	2.5	2.0	2.1	2.8	3.2	41.4
1991	3.1	2.8	3.9	3.5	4.9	4.8	4.3	3.6	2.2	2.5	3.1	3.1	41.6
1992	3.0	3.3	3.4	2.5	4.5	3.2	2.0	1.9	1.6	1.4	2.1	2.4	30.9
1993	2.3	2.1	3.6	4.1	8.7	5.7	4.9	4.1	3.0	2.6	2.7	2.8	46.5
1994	2.9	3.5	3.9	3.5	4.8	4.0	3.5	2.5	1.5	1.5	2.1	2.5	36.0
1995	2.9	3.3	3.9	3.9	5.7	6.9	4.9	4.1	2.5	2.2	2.8	3.1	46.1
											Annual average		51.6

Table G-21. Target total phosphorus loads based on the monthly average x target concentration, Tyhee USGS surface-water station, 1986-1993.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1986	3.9	5.8	8.2	9.3	9.0	4.0	2.1	3.2	4.4	4.9	4.4	4.2	63.6
1987	4.0	3.6	4.6	3.1	2.0	1.5	1.7	1.9	2.1	2.8	3.4	3.5	34.2
1988	3.5	3.4	4.0	3.3	1.7	0.8	1.1	1.4	1.4	2.1	2.5	3.0	28.2
1989	2.9	2.7	4.5	5.2	2.4	1.2	0.9	1.6	1.9	2.6	3.0	3.0	32.0
1990	3.1	2.7	3.3	2.7	1.6	1.1	0.9	1.4	1.6	2.4	2.7	2.8	26.4
1991	2.9	2.8	3.5	3.3	3.7	1.5	0.9	1.4	1.6	2.4	2.8	2.9	29.7
1992	2.8	2.9	3.1	2.0	0.6	0.6	1.1	1.2	1.3	2.0	2.3	2.4	22.3
1993	2.2	2.0	3.5	4.0	6.5	3.5	1.4	2.2	2.0	2.8	2.8	2.9	35.6
											Annual average		34.0

Table G-22. Target total phosphorus loads based on the monthly average x target concentration, Pocatello USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	1.4	1.3	1.7	1.9	1.0	0.6	0.2	0.4	0.4	0.6	1.4	1.7	12.7
1956	1.9	1.5	2.4	3.2	1.8	0.4	0.2	0.3	0.4	0.6	1.4	1.6	15.8
1957	1.4	2.3	2.5	2.1	4.1	1.8	0.3	0.4	0.5	0.9	1.6	1.8	19.8
1958	1.8	2.4	2.7	3.4	2.9	0.5	0.3	0.4	0.5	0.8	1.5	1.9	19.1
1959	1.9	1.8	2.3	2.3	0.9	0.4	0.2	0.2	0.6	1.0	1.4	1.5	14.6
1960	1.4	1.5	2.9	2.8	0.7	0.2	0.1	0.3	0.4	0.6	0.7	1.5	13.0
1961	1.3	1.7	2.0	1.5	0.5	0.2	0.1	0.3	0.6	1.0	1.3	1.3	11.7
1962	1.2	4.2	3.1	3.6	2.1	0.5	0.2	0.3	0.3	0.7	1.2	1.4	18.8
1963	1.2	2.9	1.7	2.3	2.8	1.8	0.2	0.2	0.5	0.8	1.4	1.5	17.4
1964	1.5	1.3	1.5	3.3	3.8	2.5	0.6	0.3	0.4	0.7	1.5	2.8	20.3
1965	2.4	2.6	2.3	3.7	4.4	1.6	1.0	0.8	1.2	1.3	1.7	1.8	24.9
1966	1.8	1.5	2.8	2.9	1.0	0.3	0.1	0.1	0.2	0.5	1.0	1.4	13.5
1967	1.4	1.4	2.0	2.3	3.1	2.6	1.0	0.5	0.5	1.0	1.3	1.3	18.5
1968	1.4	1.9	2.6	2.3	1.7	1.2	0.3	0.9	0.7	0.9	1.5	1.5	17.1
1969	2.4	1.8	2.5	5.8	4.5	1.5	0.8	0.5	0.5	1.2	1.6	1.8	23.0
1970	2.4	1.9	2.1	2.0	3.7	2.1	0.3	0.5	0.8	1.3	1.7	1.8	20.7
1971	1.9	2.0	3.2	5.3	8.0	4.4	1.1	0.6	1.5	2.2	2.2	2.3	34.8
1972	2.6	2.5	5.7	6.1	6.5	3.2	1.0	0.9	1.3	2.0	2.2	2.0	36.0
1973	2.2	2.0	2.5	4.1	4.5	1.2	0.7	0.7	1.6	1.9	2.1	2.1	25.6
1974	2.1	1.9	4.4	5.6	6.1	2.1	0.7	0.7	0.7	1.4	2.0	1.9	29.6
1975	2.1	1.9	3.1	3.3	6.9	6.2	1.7	1.2	1.2	2.0	2.1	2.2	33.9
1976	1.9	1.8	2.8	5.6	7.3	2.2	0.7	0.9	1.1	1.8	1.8	1.8	29.7
1977	1.7	1.6	1.9	1.2	0.6	0.8	0.3	0.4	0.5	1.0	1.4	1.7	13.0
1978	1.8	1.8	2.8	4.2	4.0	1.5	0.4	0.4	0.8	1.2	1.5	1.5	21.9
1979	1.6	1.7	2.5	2.9	2.2	0.6	0.2	0.4	0.3	0.7	1.1	1.2	15.4
1980	2.6	3.0	2.5	3.3	5.7	3.5	0.7	0.4	0.7	1.3	1.6	1.7	27.1
1981	1.6	1.7	2.0	1.9	2.8	2.1	0.3	0.2	0.3	0.8	1.4	1.7	16.8
1982	1.5	1.9	3.0	4.2	7.4	3.7	1.5	0.8	1.4	2.1	2.0	2.0	31.6
1983	2.4	2.3	4.7	5.3	9.5	6.9	2.3	1.8	2.1	2.7	2.9	3.1	46.0
1984	3.2	2.8	3.6	5.7	12.5	8.6	2.6	2.0	2.5	2.7	2.9	3.0	52.1
1985	2.8	2.6	3.0	6.3	3.9	1.5	0.7	0.7	1.1	2.0	2.1	2.2	28.8
1986	2.2	4.3	6.6	7.6	7.4	3.1	1.2	1.7	2.9	3.0	2.6	2.4	45.1
1987	2.3	2.2	3.0	1.8	1.2	0.9	0.6	0.5	0.7	1.2	1.8	1.8	18.0
1988	1.8	1.8	2.4	1.9	0.8	0.4	0.3	0.3	0.3	0.5	0.9	1.4	12.7
1989	1.3	1.1	3.0	4.1	1.3	0.7	0.5	0.4	0.4	0.8	1.0	1.3	15.8
1990	1.5	1.4	2.0	1.7	0.8	0.6	0.3	0.3	0.3	0.6	1.1	1.2	12.0
1991	1.2	1.3	1.8	1.6	2.4	1.0	0.3	0.3	0.4	0.7	1.2	1.2	13.4
1992	1.2	1.4	1.5	0.8	0.3	0.2	0.2	0.1	0.2	0.4	0.9	1.0	7.9
1993	1.0	0.9	2.1	2.7	5.0	2.4	0.7	0.8	0.7	1.2	1.3	1.3	20.1
1994	1.4	1.3	2.0	1.6	0.7	0.3	0.1	0.1	0.2	0.7	0.9	1.1	10.7
1995	1.4	1.5	2.1	1.9	2.6	2.3	0.6	0.3	0.6	1.1	1.3	1.5	17.3
											Annual average		21.9

Table G-23. Target total phosphorus loads based on the monthly average x target concentration, Marsh Creek USGS surface-water station, 1955-1995.

Year	Load (tons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1955	0.4	0.4	0.5	0.5	0.3	0.3	0.2	0.3	0.3	0.4	0.4	0.5	4.4
1956	0.6	0.3	0.8	0.5	0.3	0.2	0.2	0.2	0.3	0.4	0.4	0.5	4.8
1957	0.4	0.7	0.6	0.5	0.8	0.5	0.3	0.4	0.4	0.6	0.6	0.6	6.2
1958	0.5	1.0	0.7	0.7	0.5	0.5	0.3	0.3	0.4	0.5	0.6	0.6	6.4
1959	0.5	0.5	0.5	0.4	0.4	0.3	0.5	0.3	0.5	0.5	0.4	0.4	4.9
1960	0.4	0.4	1.0	0.6	0.3	0.2	0.2	0.3	0.3	0.3	0.4	0.4	4.7
1961	0.4	0.5	0.5	0.4	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.4	3.9
1962	0.4	1.9	1.0	0.6	0.3	0.3	0.2	0.3	0.3	0.4	0.5	0.4	6.6
1963	0.4	0.8	0.5	0.5	0.5	0.5	0.2	0.2	0.4	0.4	0.5	0.4	5.4
1964	0.4	0.3	0.5	0.9	0.5	0.7	0.4	0.3	0.4	0.5	0.5	0.9	6.2
1965	0.7	0.7	0.6	0.9	0.8	0.5	0.5	0.5	0.5	0.5	0.6	0.5	7.4
1966	0.5	0.5	0.9	0.5	0.3	0.3	0.2	0.2	0.3	0.4	0.4	0.4	5.0
1967	0.5	0.4	0.5	0.5	0.4	0.6	0.4	0.3	0.3	0.5	0.5	0.4	5.3
1968	0.4	0.7	0.6	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.5	0.5	5.7
1969	0.8	0.5	1.1	1.5	0.6	0.5	0.4	0.4	0.4	0.6	0.6	0.6	7.8
1970	0.7	0.6	0.6	0.4	0.5	0.4	0.4	0.4	0.6	0.6	0.6	0.6	6.3
1971	0.6	0.6	1.0	1.0	1.4	0.7	0.4	0.5	0.6	0.7	0.6	0.7	8.8
1972	0.7	0.7	1.1	1.1	0.9	0.6	0.4	0.5	0.5	0.6	0.6	0.6	8.3
1973	0.5	0.5	0.9	0.8	0.7	0.4	0.5	0.4	0.6	0.6	0.6	0.6	7.1
1974	0.6	0.5	1.1	0.9	0.8	0.4	0.3	0.4	0.4	0.5	0.6	0.6	7.1
1975	0.6	0.6	1.0	0.7	1.1	0.8	0.5	0.4	0.5	0.6	0.5	0.5	7.7
1976	0.5	0.5	1.0	1.3	1.0	0.5	0.5	0.4	0.4	0.5	0.5	0.5	7.5
1977	0.4	0.4	0.5	0.3	0.4	0.3	0.2	0.3	0.4	0.4	0.5	0.6	4.8
1978	0.5	0.5	0.7	0.9	0.7	0.3	0.2	0.3	0.5	0.4	0.4	0.4	5.8
1979	0.4	0.6	1.0	0.6	0.3	0.2	0.3	0.3	0.4	0.4	0.4	0.4	5.4
1980	1.4	1.2	0.7	0.6	1.1	0.9	0.4	0.3	0.4	0.5	0.5	0.6	8.6
1981	0.5	0.6	0.5	0.4	0.6	0.6	0.2	0.2	0.3	0.5	0.5	0.5	5.6
1982	0.3	0.6	0.8	0.8	1.3	0.8	0.5	0.5	0.7	0.8	0.8	0.7	8.7
1983	0.8	0.9	1.2	1.0	1.6	1.4	0.7	0.8	0.7	0.9	1.0	0.9	11.8
1984	0.8	0.7	1.1	1.3	1.9	1.4	0.7	0.8	0.8	1.0	0.8	0.7	12.0
1985	0.7	0.6	0.9	1.6	0.7	0.5	0.4	0.4	0.5	0.6	0.7	0.7	8.2
1986	0.6	1.7	1.2	1.3	1.3	0.7	0.6	0.6	0.8	0.8	0.8	0.7	11.0
1987	0.6	0.7	0.9	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.6	6.8
1988	0.5	0.6	0.7	0.5	0.4	0.3	0.2	0.3	0.3	0.4	0.4	0.3	4.9
1989	0.3	0.3	1.0	0.6	0.4	0.4	0.3	0.3	0.4	0.5	0.5	0.4	5.5
1990	0.5	0.4	0.5	0.4	0.4	0.4	0.3	0.2	0.3	0.4	0.4	0.3	4.6
1991	0.4	0.4	0.5	0.4	0.6	0.4	0.2	0.3	0.4	0.4	0.4	0.4	4.7
1992	0.3	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	3.3
1993	0.3	0.3	0.7	0.6	0.8	0.5	0.3	0.4	0.4	0.4	0.4	0.4	5.5
1994	0.4	0.5	0.5	0.3	0.2	0.2	0.1	0.2	0.3	0.3	0.3	0.3	3.8
1995	0.5	0.5	0.5	0.4	0.6	0.6	0.3	0.3	0.4	0.4	0.4	0.4	5.2
											Annual average		6.4

Table G-24. Target total phosphorus loads based on the monthly average x target concentration, Topeka USGS surface-water station, 1955-1995.

Year	Load (tons)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1955	0.8	0.7	0.8	1.0	1.2	1.2	0.8	0.7	0.6	0.7	0.8	0.9	10.1
1956	0.9	0.8	1.2	1.6	1.5	1.3	1.2	1.1	0.7	0.7	0.8	0.9	12.8
1957	0.8	1.4	1.1	1.0	1.9	1.5	1.3	1.2	0.9	0.8	0.9	0.9	13.7
1958	0.9	1.0	1.2	1.4	1.7	1.3	1.4	1.2	0.8	0.7	0.8	0.9	13.5
1959	0.9	0.8	1.2	1.2	1.3	1.2	1.0	0.6	0.6	0.7	0.7	0.8	11.0
1960	0.8	0.8	1.2	1.4	1.3	1.3	0.8	0.5	0.5	0.5	0.7	0.7	10.4
1961	0.7	0.8	0.9	0.8	0.8	0.9	0.6	0.5	0.5	0.6	0.7	0.8	8.6
1962	0.9	2.7	1.3	1.6	1.3	1.2	1.1	1.2	0.8	0.6	0.7	0.8	14.5
1963	0.8	1.8	0.9	1.0	1.4	1.3	1.1	1.1	0.8	0.7	0.8	0.8	12.4
1964	0.8	0.7	0.7	1.4	1.8	1.8	1.3	1.2	0.8	0.7	0.8	1.6	13.6
1965	1.2	1.1	1.1	1.6	2.7	1.8	1.4	1.2	0.9	0.9	1.0	0.9	15.9
1966	0.9	0.8	1.2	1.3	1.5	1.2	1.0	0.9	0.6	0.6	0.7	0.8	11.4
1967	0.8	0.7	1.1	1.1	1.6	1.7	1.0	1.1	0.8	0.8	0.8	0.8	12.2
1968	0.8	0.9	1.2	1.0	1.3	1.5	1.2	1.0	0.7	0.8	0.9	0.9	12.3
1969	1.4	0.9	1.1	2.9	3.1	1.6	1.3	1.3	0.9	0.8	0.8	0.9	17.2
1970	1.2	0.9	1.1	1.0	2.0	2.0	1.3	1.2	0.9	0.9	0.9	0.9	14.3
1971	1.0	1.0	1.8	2.6	5.0	2.7	1.5	1.5	1.4	1.3	1.2	1.2	22.4
1972	1.2	1.2	3.0	3.0	3.9	2.5	1.6	1.4	1.3	1.3	1.4	1.4	23.3
1973	1.3	1.2	1.3	2.1	2.9	1.5	1.3	1.1	1.0	1.0	1.1	1.1	17.0
1974	1.1	1.0	2.1	2.7	3.6	1.8	1.4	1.3	1.1	0.9	1.1	1.1	19.1
1975	1.1	1.0	1.4	1.5	2.9	3.2	1.5	1.3	1.2	1.4	1.1	1.1	18.7
1976	0.9	0.9	1.3	3.1	4.1	2.1	1.4	1.3	1.0	1.1	1.0	1.1	19.4
1977	1.1	0.9	1.1	1.0	1.3	1.1	1.1	0.9	0.7	0.7	0.8	0.9	11.7
1978	0.8	0.8	1.4	2.0	2.7	1.7	1.2	1.1	0.9	0.8	0.9	0.9	15.2
1979	0.9	0.8	1.0	1.3	1.5	1.3	1.1	1.0	0.6	0.7	0.8	0.8	11.8
1980	1.0	1.4	1.1	1.3	2.5	1.8	1.2	1.0	0.8	0.9	0.9	0.8	14.7
1981	0.8	0.8	0.9	1.0	1.6	1.3	1.2	0.9	0.7	0.6	0.7	0.8	11.3
1982	0.7	0.9	1.3	1.6	4.2	2.2	1.5	1.2	1.2	1.2	1.1	1.1	18.3
1983	1.1	1.0	2.1	2.4	4.5	3.5	1.8	1.5	1.5	1.4	1.4	1.5	23.7
1984	1.7	1.5	1.6	2.2	5.5	4.5	2.2	1.7	1.6	1.8	1.7	1.8	27.7
1985	1.7	1.5	1.7	3.2	2.4	1.5	1.4	1.2	1.2	1.3	1.2	1.1	19.4
1986	1.0	1.9	2.8	3.6	3.6	2.2	1.7	2.1	2.2	1.7	1.3	1.3	25.4
1987	1.3	1.3	1.6	1.3	1.5	1.1	1.0	1.3	0.9	0.9	1.0	1.0	14.1
1988	1.0	0.9	1.1	1.1	1.3	1.1	0.8	0.6	0.5	0.6	0.8	0.8	10.7
1989	0.8	0.7	1.3	1.7	1.5	1.3	1.1	1.0	0.7	0.7	0.8	0.9	12.5
1990	0.9	0.8	1.1	0.9	1.2	1.1	1.2	0.6	0.5	0.5	0.7	0.8	10.3
1991	0.8	0.7	1.0	0.9	1.2	1.2	1.1	0.9	0.5	0.6	0.8	0.8	10.4
1992	0.8	0.8	0.9	0.6	1.1	0.8	0.5	0.5	0.4	0.3	0.5	0.6	7.7
1993	0.6	0.5	0.9	1.0	2.2	1.4	1.2	1.0	0.7	0.6	0.7	0.7	11.6
1994	0.7	0.8	1.0	0.9	1.2	1.0	0.9	0.6	0.4	0.4	0.5	0.6	9.0
1995	0.7	0.8	1.0	1.0	1.4	1.7	1.2	1.0	0.6	0.5	0.7	0.8	11.5
											Annual average		14.6

Table G-25. Estimated nutrient loads from stormwater runoff from the Pocatello-Chubbuck urban area (land use information from Surface and Wessel 1995; modeling done by Todd Maguire, Division of Environmental Quality).

Land use categories	Land use area (acres)	Percent impervious	Runoff coefficient (fr)	Avg annual precipitation (ft/yr)	Fraction of avg annual precipitation available for runoff	Annual storm runoff calculated avg volume (ft^3/yr)	Event mean concentration (mg/l)					Annual pollutant load (lbs)				
							Total nitrogen	Nitrate + nitrite	Ammonia	Total Phosphorus	Ortho Phosphorus	Total nitrogen	Nitrate + nitrite	Ammonia	Total Phosphorus	Ortho Phosphorus
Residential																
Low density	3,370	20	0.23	12.0	0.90	90,387,028	3.89	0.65	0.18	0.42	0.31	7,982	1,283	342	797	588
Medium density	1,161	30	0.32	12.0	0.90	14,565,070	3.89	0.65	0.18	0.42	0.31	3,538	591	164	382	282
High density	561	60	0.59	12.0	0.90	12,976,132	3.89	0.65	0.18	0.42	0.31	3,152	527	146	340	251
Commercial	761	90	0.86	12.0	0.90	25,657,450	4.6	0.96	0.18	1	0.58	7,371	1,538	288	1,602	929
Industrial	839	80	0.77	12.0	0.90	25,145,836	4.6	0.91	0.14	0.75	0.13	7,224	1,429	228	1,178	204
Public	4,318	50	0.50	12.0	0.90	84,641,436	6.8	0.96	0.18	0.98	0.58	35,944	5,074	951	4,652	3,066
Recreation	28,237	20	0.38	12.0	0.90	301,481,112	1.2	0.50		0.34	0.12	22,593	9,414	0	6,401	2,259
Transportation	1,686	80	0.77	12.0	0.90	48,480,450	2.64	0.19		0.44	0.19	7,993	575	0	1,332	575
Total	32,847					543,334,509						95,196	20,382	2,111	16,685	8,155

Table G-26. Estimated nutrient loads from the Pocatello Sewage Treatment Plant to the Portneuf River (average mean monthly data based on flow and nutrient information from the PSTP).

Factor	Estimate	Load (tons)												Annual load (tons/yr)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Flow (cfs)	Avg mean monthly flow (cfs), 1986-1998	10.72	10.49	10.78	10.55	8.87	6.1	7.68	9.93	9.84	10.51	10.49	10.31	
Ammonia (mg/l)	Avg mean monthly concentration (mg/l), 1986-1998*	23.31	22.43	23.22	26.03	24.03	23.52	23.52	23.52	23.52	23.52	23.52	22.09	
TIN	Load (tons)	20.92	17.95	20.95	22.24	17.84	11.62	15.12	19.55	18.75	20.69	19.98	19.06	224.66
Total ortho phosphate (mg/l)**	Avg mean monthly concentration (mg/l), 1986-1998	1.84	2.16	2.4	2.39	1.84	2.44	1.71	0.69	1.25	0.83	1.34	1.47	
Total phosphorus	Load (tons)***	2.07	2.16	2.71	2.56	1.71	1.51	1.38	0.72	1.25	0.91	1.43	1.59	19.98

*average mean monthly concentrations for June to November based on average of average mean monthly concentrations from December to May to account for nitrification

**includes measurements for ortho phosphate and total ortho phosphate

***converted to total phosphorus by multiplying the average mean monthly flow x average mean monthly concentration x days/month x 0.0027 all divided by 0.799.

Table G-27. Reported flows from springs in the lower Portneuf River subbasin.

Spring	Date	Flow (cfs)	Source
E4	1979	12.7	Perry 1981
Swanson Road group	3/78, 9/80,11/80	17.81	Perry and Clark 1990
Springs between Carson Street & Rowlands	9/88, 6/89, 7/89, 8/89	143.5	Brock 1989
Batise	6/10/70	46	USGS Water-Resources Data reports
	10/6/70	32	USGS Water-Resources Data reports
	9/29/70	7.2*	USGS Water-Resources Data reports
	1975	47	Perry et al. 1977
	4/2/78	38	Goldstein 1981
	1979	60	Perry 1981
	3/27/80	20.7	Jacobson 1982
	11/11/80	27.8	Jacobson 1982
	3/78, 9/80,11/80	5.73**	Perry and Clark 1990
Batise group	3/78, 9/80,11/80	7.81	Perry and Clark 1990
East Side group	3/78, 9/80,11/80	26.47	Perry and Clark 1990
Papoose	4/2/78	47	Goldstein 1981
	11/11/80	30.4	Jacobson 1982
Papoose group	3/78, 9/80,11/80	72.2	Perry and Clark 1990
Springs between PSTP effluent & Siphon Road	9/88, 6/89, 7/89, 8/89	128.25	Brock 1989

*eliminated from analysis based on Balmer and Noble 1979 who thought the value in error
**average flow from three sampling events

Table G-28. Estimated flows from springs in the lower Portneuf River subbasin.

Spring/group	Flow (cfs)	Source
E4	12.7	4
Swanson Road group	17.8	7
Springs - Carson gage to Rowlands	143.5	6
Batise	28.9	1, 2, 3, 4, 5, 7
Batise group	31.0	1, 2, 3, 4, 5, 7
East Side group	26.5	7
Papoose group	72.2	7
Papoose	38.7	3, 5
Springs - Effluent to Siphon Road	128.3	6

1 USGS Water-Resources Data reports
2 Perry et al. 1977
3 Goldstein 1981
4 Perry 1981
5 Jacobson 1982
6 Brock 1989
7 Perry and Clark 1990

Table G-29. Monitoring of nutrient sources in the lower Portneuf River (includes only springs judged to be draining into the Portneuf River above the Tyhee USGS surface-water station).

Site*	Month/year	Nitrogen: Nitrate (mg/l)	Nitrogen: Ammonia (mg/l)	Phosphorus: Total (mg/l)	Phosphorus: Total ortho phosphate (mg/l)	Source
Swanson Road System	1977-1978	2.6	0.1	0.2	0.2**	Goldstein 1981***
	3/78-11/80	2.54	0.05	0.07	0.04**	Perry and Clark 1990
Swanson Road Spring	1992-1993	2.64	0.4	1.05	0.59	Bechtel Environmental, Inc. 1996
Batiss Springs	Jun-70	15			2.6^	USGS Water-Resources Data reports
	Oct-70	3.3^^		1.2		USGS Water-Resources Data reports
	Jul-71	4.3^^		2.1		USGS Water-Resources Data reports
	Sep-71	3^^		1.6		USGS Water-Resources Data reports
	12/75-12/77	5.48	1.35		5.97**	Balmer and Noble 1979
	Apr-78	9.1^^^		4.5		USGS Water-Resources Data reports
	Aug-87			2.6		Ecology & Environment, Inc. 1988
	Jul-88	1.9^^^		0.72		USGS Water-Resources Data reports
	1992-1993	4.44	ND	2.71	2.36	Bechtel Environmental, Inc. 1996
Batiss Springs System	1977-1978	5.9	10.8	3.7	3.5**	Goldstein 1981***
	3/78-11/80	5.58	6.19	2.06	1.9**	Perry and Clark 1990
	1980	2	0.06	0.03	0.06**	Jacobson 1982***
	1981-1982	8	5.4	2.4	4.6**	Jacobson 1984***
	1982-1987	9	NM	3.43	NM	Jacobson 1989***
	1992-1993	1.99	0.3	0.48	0.59	Bechtel Environmental, Inc. 1996
Springs near STP	1992-1993	3.41	ND	0.05	0.04	Bechtel Environmental, Inc. 1996
Spring-fed pond at FMC Park	1992-1993	2.3	ND	0.04	0.03	Bechtel Environmental, Inc. 1996
East Side Springs	3/78-11/80	2.1	0.22	0.14	0.1**	Perry and Clark 1990
Papoose Springs	12/75, 1/76	1.13			0.18**	Balmer and Noble 1979
	1992-1993	2.98	0.5	ND	0.03	Bechtel Environmental, Inc. 1996
Papoose Springs System	1977-1978	1.5	0.04	0.03	0.01**	Goldstein 1981***
	3/78-11/80	1.43	0.08	0.07	0.03**	Perry and Clark 1990
	1992-1993	2.14	ND	0.04	0.03	Bechtel Environmental, Inc. 1996
Papoose Spring Drainage Channel	Apr-93	2.47	ND	0.05	0.03	Bechtel Environmental, Inc. 1996
	Apr-93	2.56	ND	ND	ND	Bechtel Environmental, Inc. 1996
Papoose Springs Discharge-	1992-1993	2.15	0.04	0.22	0.24	Bechtel Environmental, Inc. 1996
Siphon Road	Jan-76	0.8			0.12**	Balmer and Noble 1979
Siphon Road Spring	1992-1993	1.4	ND	0.07	0.04	Bechtel Environmental, Inc. 1996
FMC IWW ditch	Sep-92	18.4	288	2590	2210**	Bechtel Environmental, Inc. 1996
	7/93---	1.225	0.0225	0.48	0.4**	Bechtel Environmental, Inc. 1996
	3/94-9/94				3.8**	Bechtel Environmental, Inc. 1996

*STP--sewage treatment plant, IWW--industrial waste water
**ortho phosphate
***cited in Bechtel Environmental, Inc. 1996
^phosphate
^^nitrite + nitrate
^^^dissolved nitrite + nitrate
--also listed as a river station
---composite of 6 samples

Table G-30. Mean concentrations of nutrients sampled in springs in the lower Portneuf River, July 1992 to May 1993 (Bechtel Environmental, Inc. [BEI] 1996).

Location description	BEI site	Assigned springs group	Mean concentrations (mg/l)			
			Nitrate	Ammonia	TIN*	TP**
Springs near Batise Road	15	Swanson Rd	2.64	0.40	3.04	1.05
Springs near STP	13	Swanson Rd***	3.41	0.00	3.41	0.05
Batise Springs	14	Batise	4.44	0.00	4.44	2.71
Batise Springs at Creamery	11	Batise	1.99	0.30	2.29	0.48
Springs at FMC Park	9	East Side	2.30	0.00	2.30	0.04
Springs at Fish Farm	7	Papoose	2.98	0.50	3.48	0.00
Pond at Fish Farm	6	Papoose	2.14	0.00	2.14	0.04
Springs at Siphon Road	4	Papoose	1.40	0.00	1.40	0.07

*TIN=total inorganic nitrogen, not measured directly, sum of nitrate + ammonia
**TP=total phosphorus
***assigned to East Side Group by BEI

Table G-31. Estimated annual nutrient loads for lower Portneuf River springs (grouping based on Perry and Clark 1990) and FMC IWW ditch (concentrations from Bechtel Environmental, Inc. 1996).

Spring/group	Flow (cfs)	Nutrient concentration (mg/l)		Load (tons/yr)	
		Total inorganic nitrogen	Total phosphorus	Total inorganic nitrogen	Total phosphorus
Swanson Road Group*	17.8	3.23	0.55	56.60	9.61
Additional flow - Pocatello gage to Rowlands**	100.5	3.23	0.55	319.48	54.24
Batise Group***	31.0	2.29	0.48	69.81	14.65
Eastside Group^	26.5	2.30	0.04	59.93	0.98
Papoose Group^^^	72.2	2.34	0.04	166.44	2.55
Total Springs	247.97			672.27	82.02
FMC IWW ditch	3.7	1.25	0.48	4.53	1.74

*average of BEI sites 13 and 15, see Table G-30
**includes flows from springs, groundwater, and Pocatello Creek
***BEI site 11, see Table G-30
^see Table G-30
^^average of BEI sites 4, 6, and 7, see Table G-30