WATER QUALITY STATUS REPORT ● REPORT NO. 66

STOCKNEY CREEK
1985-86

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ABSTRACT

A water quality monitoring study was conducted on Stockney Creek to: 1) determine the baseline water quality, 2) document the effects that spring and storm runoff from agricultural lands have on water quality, 3) determine whether implementation of BMP's through a cost-share program would significantly improve water quality.

The study plan was designed such that local Soil Conservation Service personnel collected water samples and gathered ambient data near the mouth of Stockney Creek. Two additional stations were added for the second sampling season which enabled us to isolate about a third of the upper watershed into discrete subdrainages.

Precipitation during the spring of 1985 averaged 75% of the 30-year norm, thereby reducing the normal nutrient and sediment loads. The spring of 1986 had more normal precipitation except for a 10 year frequency storm event on February 23rd.

Four hundred tons of sediment were estimated as being discharged from the drainage during the length of the study. Ninety percent of the load was calculated from data collected from the storms in mid and late February. The nutrient loads estimated for the study period included 20 tons of organic nitrogen almost seven (7) tons of inorganic nitrogen and 2.5 tons of total phosphorus. Ninety five percent of the organic nitrogen, eighty four percent of the inorganic nitrogen, and forty eight percent of the total phosphorus loads were estimated from the data collected from the February storms.

Ratios of fecal coliform to fecal streptococcus indicate that animal wastes from cattle are a probable source of coliform bacteria contamination. Cattle also contribute to the degradation of bank stability.

Findings of the study concluded that the beneficial uses of Stockney Creek would not significantly improve with successful implementation of BMP's in the watershed. Reducing the ammonia and orthophosphate loads from above St.#2, restricting the access of cattle to sensitive riparian areas, and stabilization of fragile banks, would improve the water quality of Stockney Creek and subsequently Cottonwood Creek and the Clearwater River.

Acknowledgements

I would like to acknowledge the assistance of Tom Yankey, Miki Wemhoff and other staff of the Idaho County Soil Conservation Service for collecting water samples and data, sometimes under less than pleasant circumstances. Others who have made this study possible are the Idaho SCD Board and its chairman, Denis Long, and the landowners who allowed access to sampling sites. A special thank you to John Moeller and Steve Bauer for technical assistance and editorial review.

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INTRODUCTION

Stockney Creek was identified by the Division of Environment (DOE) and the Idaho Soil and Water Conservation District (SWCD) as a first priority stream segment under the Agricultural Nonpoint Source Pollution Abatement Program. This designation made the watershed eligible for a planning grant to evaluate the suitability of the drainage for a grant to implement cost-shared Best Management Practices (BMPs). The ultimate goal is to reduce the impact that agricultural practices have on the water quality and the beneficial uses of the stream.

The Idaho SWCD board signed a planning grant with the DOE in January of 1985. We then designed a water quality monitoring project to assess the condition of Stockney Creek. Monitoring began in mid-March of 1985.

PROJECT AREA DESCRIPTION

Stockney Creek, also known locally as Stock Creek, is a second order tributary to Cottonwood Creek in northwest Idaho county, Idaho (Figure 1). Stockney Creek originates at an elevation of 4400 feet, flows 15 miles easterly to its mouth at 3000 feet elevation. There are two subdrainages that converge 6 miles from the mouth, and half a dozen more subwatersheds that subsequently enter. Current uses of the stream are as an agricultural water supply, and for occasional secondary contact recreation.

Eighty-one landowners manage the 20,250 acres in the watershed. Eighty percent of the land is under the plow, with the major dryland crops being winter wheat, peas, and barley. Pasture land is used year-round, and is located mostly on the riparian areas to provide access for stock watering. There are 24 feedlots, four dairies and 6 hog farms in the drainage. Some woodlots are located in the higher elevations near the headwaters of the drainage. Land use acreages above each monitoring station are summarized in Table 1.

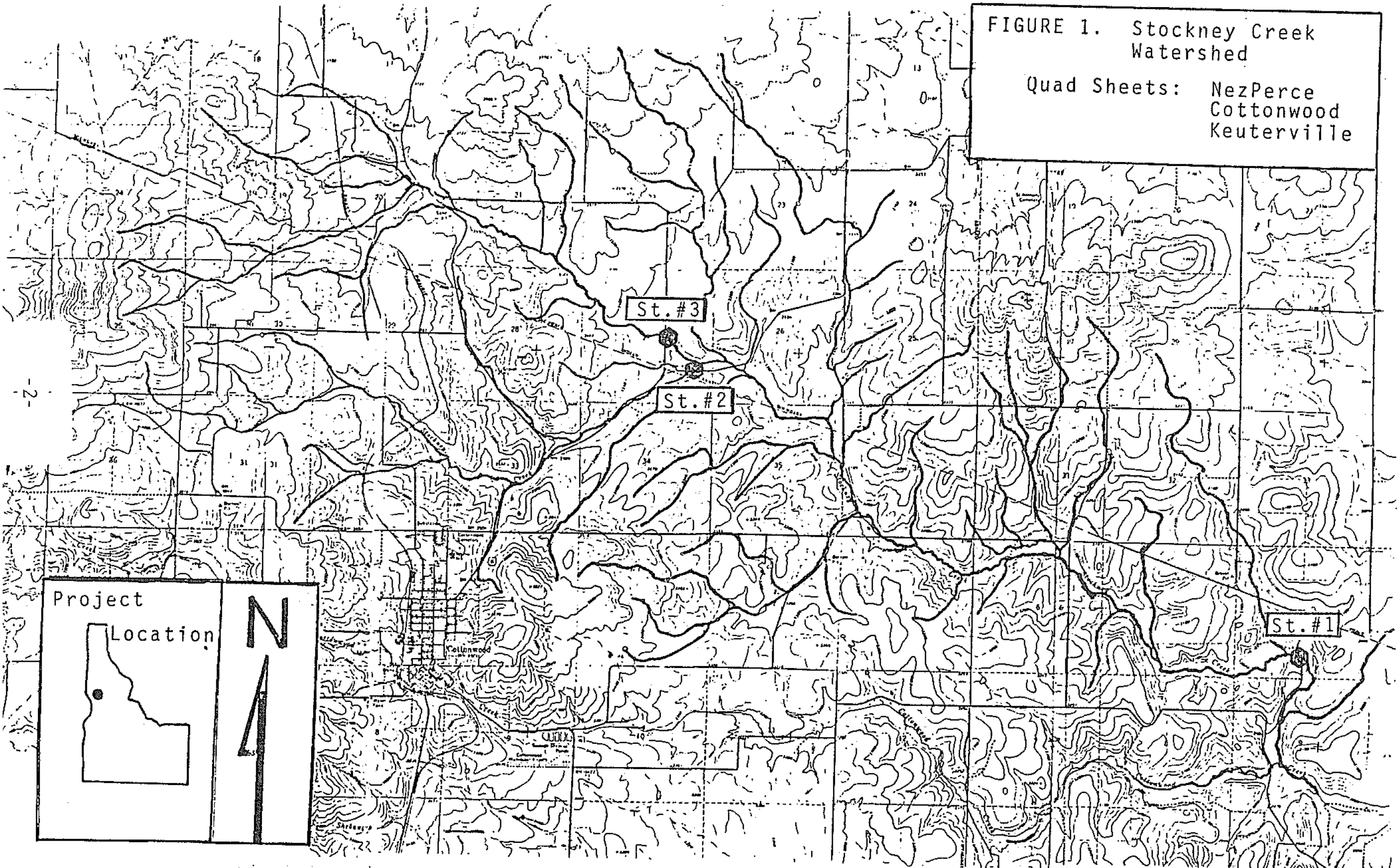


FIGURE 1. Stockney Creek Watershed

Quad Sheets: NezPerce
Cottonwood
Keuterville

Table 1. Land Use in Total Drainage Areas Above Each Monitoring Site* (Acres)

St.	STORET	Station Description	Dryland Ag.	Pasture	Wood-land	Total Acres	Dairy	Hog Operations
1	2020255	Stockney Creek Near Mouth	16,200	3,440	610	20,250	4	6
2	2020256	South Fork Stockney Creek	1,810	770	30	2,610	2	2
3	2020257	North Fork Stockney Creek	2,280	740	410	3,430	1	1

* Courtesy of Idaho Soil Conservation Service

The region has warm to hot summers and cold winters. Snow cover is usually present from November through March. Annual precipitation is nearly 24 inches, with approximately half of the total coming during the growing season. Snow is often melted by chinook wind and rains, causing rapid snowmelt and high runoff. Intense thunderstorms, which may drop over an inch of rain in an hour, do occur.

METHODS AND MATERIALS

Study Objectives

The objectives of the planning study were to: (1) determine baseline water quality in various reaches and subwatersheds; (2) document the effects of storm event runoff on water quality in Stockney Creek.

Sample Collection

Methods of sample collection, preservation, and analysis followed Standard Methods (APHA, 1985), or EPA guidelines (EPA, 1979). Water samples were drawn with a DH-48 sampler at 0.6 times the stream depth, and collected in a churn splitter from which separate samples were drawn. Grab samples were taken by SCS personnel from turbulent stream reaches that provided mixing of laminar flows. Samples collected by the SCS and DOE were preserved appropriately and shipped on ice to Boise the same day as collected.

Sample Sites

Stockney Creek was suspected of contributing significantly to the sediment and nutrient loads of Cottonwood Creek and subsequently to the Clearwater River. Three water quality monitoring sites were chosen to evaluate the contributions to the discharge and solute loads by specific subdrainages of Stockney Creek (Figure 1).

All stations were located at bridge crossings to facilitate access. The upper stations are approximately 6 miles from the mouth.

a). Station #1 is located 1/2 mile from the confluence of Stockney Creek and Cottonwood Creek. This site includes most of the watershed.

b). Station #2 is on the south fork of Stockney Creek, 300 yards from the confluence with the north fork. Thirteen percent of the total watershed is in this subwatershed.

c). Station #3 is on the north fork of Stockney Creek, 1/3 mile from the confluence with the south fork. This drainage contains 17 percent of the total land area.

Sample Frequency

This study was designed to monitor water quality when the maximum influx of nutrients and suspended sediment typically occurs. These peak events usually occur when chinook winds deliver driving rains, which melt the snowpack, and during the intense thunderstorms.

A sample schedule was established that provided flexibility to respond to storm events as they occurred. Intermediate data were gathered approximately every two weeks to provide information on water quality during "normal" spring flows. Two additional samples were taken in the late spring to characterize ambient conditions at low flows. Twenty-nine sample sets were taken at Station#1 in 1985-86, and eight sets were taken at the two subdrainage sites in 1986.

Parameters

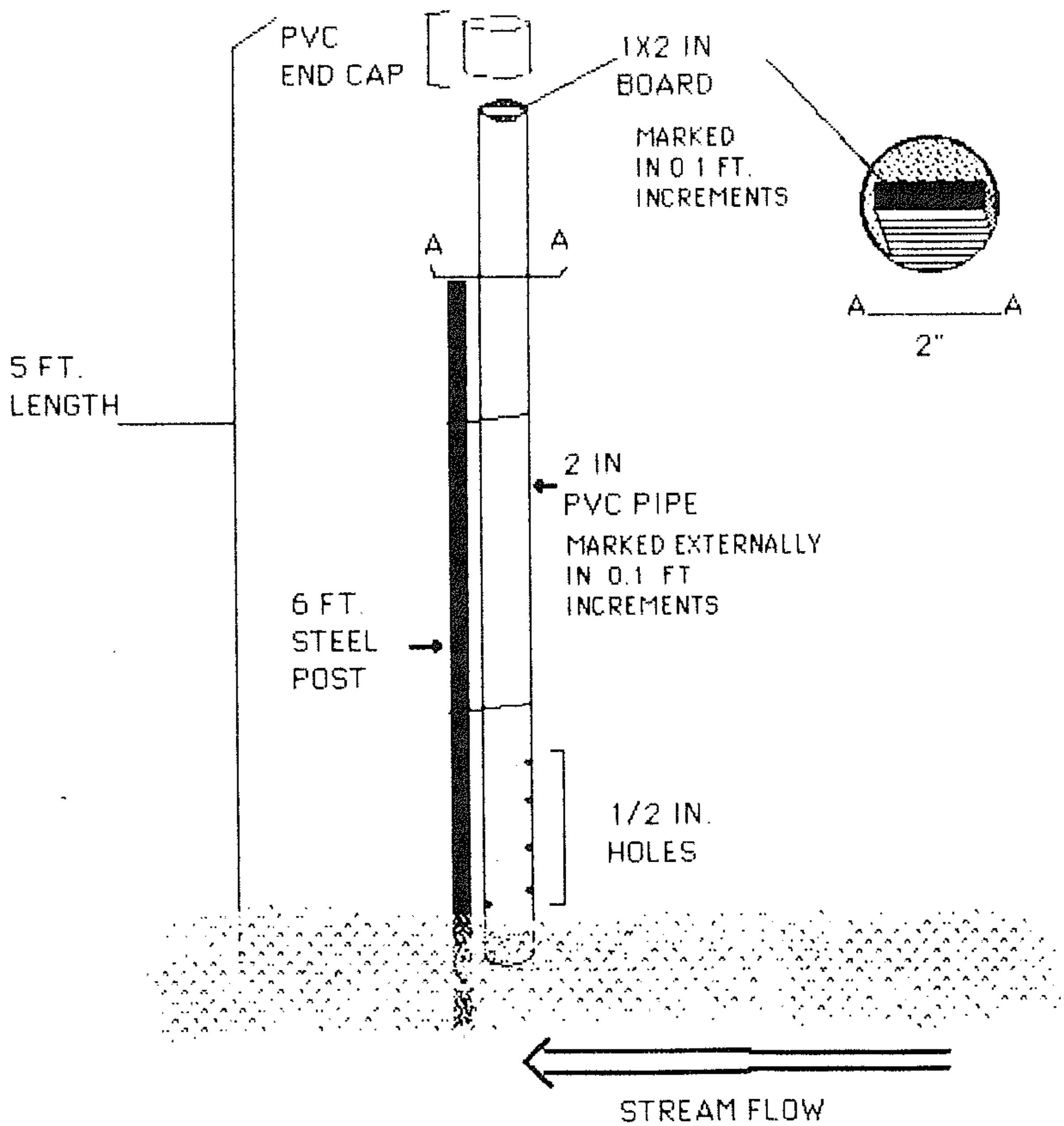
Agricultural practices were suspected to contribute substantially to the sediment and nutrient loading of Stockney Creek, and subsequently to the Clearwater River. Some of the sampled parameters provide an indication of nutrients typically leached or eroded from farm fields. Other parameters are general indicators of water quality which highlight changes in designated beneficial uses (Table 2).

Table 2. Sample Parameters for the Stockney Creek Water Quality Study

Parameter	Unit	STORET #
Stream Discharge	cfs	00061
Crest Gauge	ft	None
Water Temperature	°C	00010
pH	S.U.	00400
Turbidity	NTU	00076
Specific Conductivity	µmhos/cm	00665
Suspended Sediments	mg/L	80154
Total Phosphorus as P (T.P.)	mg/L	00665
Total Hydrolyzable Phosphorus as P (T.H.P.)	mg/L	00669
Dissolved Orthophosphate as P (O'PO_4) (field filtered)	mg/L	00671
Orthophosphate as P (O'PO_4) (lab filtered, SCS sampled)	mg/L	70507
Total Kjeldahl Nitrogen as N (TKN)	mg/L	00625
Total Nitrite + Nitrate as N (NO_2+NO_3)	mg/L	00630
Total Ammonia as N (NH_3)	mg/L	00610
Fecal Coliform	#/100 ml	31616
Fecal Streptococcus	#/100 ml	31679

FIGURE 2. STREAM CREST GAUGE

NOTE GROUND CORK IS PLACED IN THE GAUGE. AS THE WATER RECEDES THE CORK ADHERES TO THE MEASURING ROD



Discharge

The methods used to determine discharge in this study were as outlined by the U.S. Geological Survey (U.S.G.S., 1977). Instantaneous discharge at a given point was calculated from the cross-sectional area of the stream and the stream velocity. Direct measurements of velocity were made with a Marsh McBirney, Model 201, current meter whenever possible. The Manning equation was used to determine the peak discharges of storm events (U.S.G.S., 1977).

Evidence of peak discharges were gathered by use of crest gauges anchored in the stream bed (Figure 2). The crest gauges were calibrated to discharges by correlating the instantaneous discharge with the ambient stream stage.

pH

The pH of water is a measure of its hydrogen ion concentration. Many chemical reactions are affected by the pH. On-site pH measurements were obtained with a Corning, Model #103, pH meter. The pH of samples collected by the SCS were measured at the Bureau of Laboratories in Boise, Idaho.

Conductivity and Temperature

Conductivity is a numerical expression of the ability of water to carry an electrical current. It is dependent on the concentrations of the total dissolved solids and salts, and temperature (APHA, 1985). Conductivity and temperature measurements were made in the field with a YSI, Model 33, S-C-T meter. SCS samples were measured at the Boise laboratory.

Suspended Sediment

Suspended sediment concentrations are one of the prime indicators of nonpoint source pollution. Suspended sediment consists of soil particles that are entrained in the water column from three inches above the stream bottom to the top of the water column (Clark, 1985).

Nitrogen

Total organic nitrogen concentrations were determined by the Total Kjeldahl Nitrogen (TKN) process which does not distinguish between organic nitrogen and ammonia. The organic fraction may be estimated by subtracting the ammonia concentration from the TKN concentration. The inorganic nitrogen fraction includes the ammonia and nitrite + nitrate concentrations. All samples analyzed for the nitrogen fractions were preserved with 2 ml. of sulfuric acid and shipped on ice to the laboratory for analysis.

Phosphorus

The three major forms of phosphorus that were monitored during this study were total phosphorus, dissolved orthosphosphate, and hydrolyzable phosphorus. Total phosphorus represents all the forms of phosphorus present in the sample. Total hydrolyzable phosphorus includes the phosphorus easily hydrolyzed to the dissolved state; sources include organically bound phosphorus and some fertilizers. Orthophosphate is the dissolved fraction, and is the form most available for plant uptake.

The total and hydrolyzable phosphorus samples were preserved with 2 ml. of concentrated sulfuric acid. The samples collected by the DOE for dissolved orthophosphate analysis were filtered on site through a 0.45 µm filter and sent on ice to the laboratory for analysis. Water samples collected by the SCS to be tested for orthophosphate were filtered by the Boise laboratory.

Bacteria

Samples for bacterial analysis were collected in sterile, 250 ml. bottles. The samples were refrigerated until analyzed by the Regional Laboratory at Lewiston, or the Boise laboratory.

Quality Assurance

This project served as part of a series of quality assurance checks by the DOE on precision and accuracy of sampling procedures.

Duplicate and spiked samples were collected from various stations and on different dates. The data on accuracy were pooled for several monitoring projects and the results were compiled (Bauer, 1985). The methods used to estimate the average relative range for precision followed the methods outlined by Bauer.

RESULTS

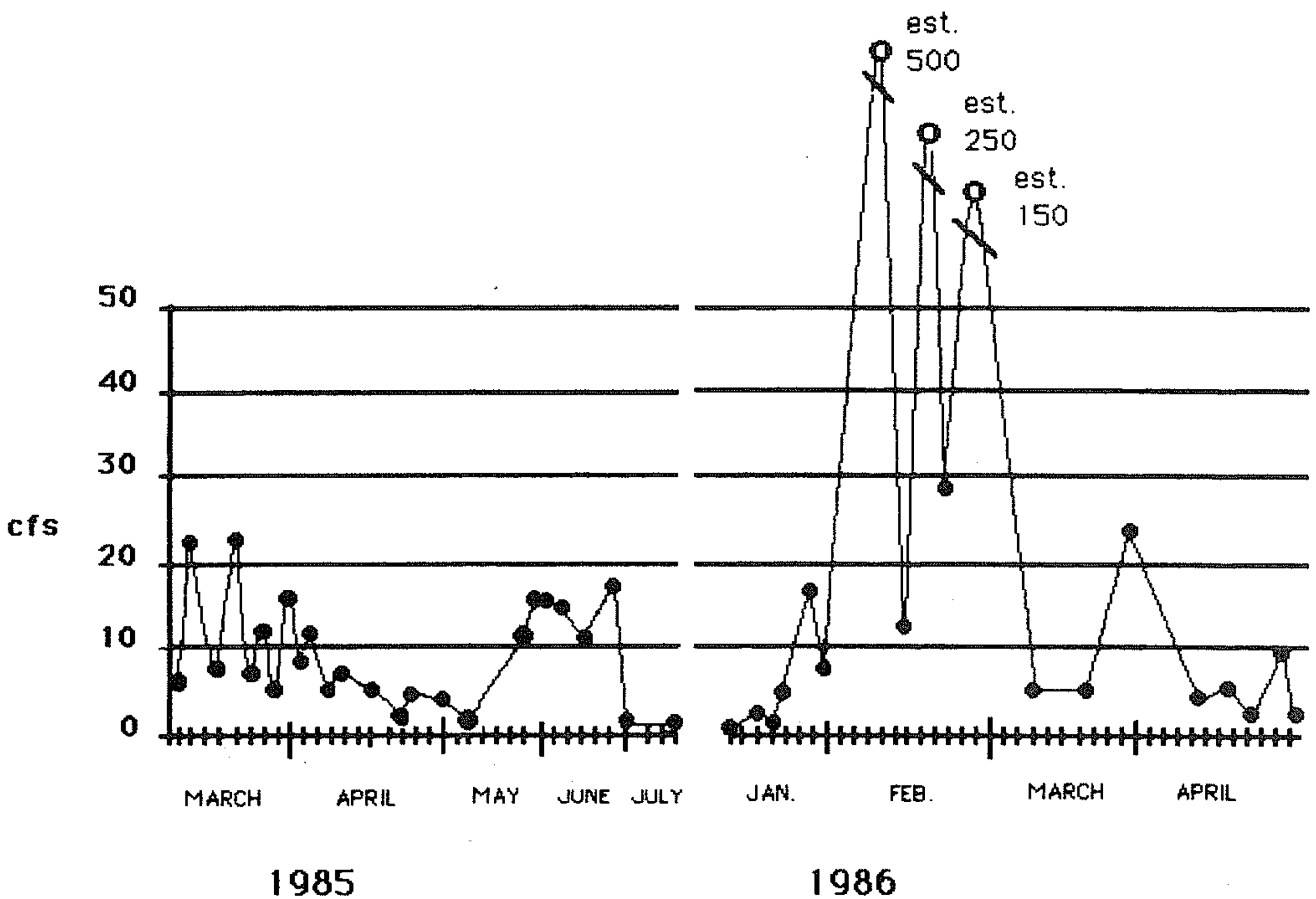
Discharge

Data collection began on March 13, 1985. No prior discharge records for the stream were available. Snowmelt provided the peak recorded discharge in 1985 at 22 cubic feet per second (cfs) (Figure 3). Flows tapered off through the spring except for spikes provided by the occasional rain storms. A particularly heavy rain in mid-May brought the stream levels to above 15 cfs for two weeks. Discharges were minimal (<0.1 cfs) throughout the rest of the summer, and for much of the winter.

Discharge data collection on Stockney Creek for 1986 followed several light rains on the snowpack, and a slight warming trend in late January (N.O.A.A. 1986). A five day rainy period in mid-February resulted in 1.3 to 1.8 inches of precipitation, which produced a peak estimated discharge of 500 cfs. On February 23, 0.8 to 1.3 inches of rain that fell in 24 hours produced an estimated peak of 250 cfs. The next peak of 150 cfs, came after several days of warm weather which melted the last of the snow, around March 17.

Two forks, near the headwaters of the stream were monitored in the spring of 1986 to determine the contributions from their respective watersheds. Station #2, located at the mouth of the southern fork, contributed an average of 15 percent of the spring flows. The north fork, as monitored at Station#3, contributed an average of 13 percent of the runoff flows. The upper reaches of Stockney Creek dry up during the summer months.

FIGURE 3. HYDROGRAPH OF 1985-86 SPRING DISCHARGE AT ST.#1



Suspended Sediment

Concentrations of suspended sediment in the stream fluctuated from a low of 4 mg/l in late October 1985 to 186 mg/l on February 19,1986. The mean concentration of the 28 samples from Station#1 was 61 mg/l (Appendices A1-3). The 1986 data for Station#1 had a mean concentration of 82 mg/l. This compares with a mean of 41 mg/l at Station#2 and 76 mg/l at Station#3. Station#2 had a greater concentration of suspended sediment than Station#3 or Station#1 only on April 17, 1986.

The total nutrient and suspended sediment loads for a single day were deduced by assuming that an individual sample represented the whole day. Different subwatersheds or stations were compared to each other by using only those data collected on the same day at each station. Thus, data from the same climatological events could be compared.

Overall, 43 tons of supended sediment were recorded as being discharged past Station#1 during the study. An estimated 22 tons were recorded at Station#1 in 1986. During the same period of time, 1.3 tons came past Station #2, and 3.2 tons passed Station #3 (Appendix B1-3). These represent 6 percent and 15 percent, respectively, of the total suspended sediment loads recorded in 1986. These figures do not include the estimates of the loads lost during the peaks of the spring runoff due to lack of data from the upper stations. Loads calculated from the estimated discharges and the suspended sediment concentrations of samples, taken after the peak of the discharge, yielded estimated daily loads of 250 tons of sediment on February 18, and 100 tons on February 23, 1986.

Nitrogen

The various species of nitrogen indicate that each drainage has unique characteristics (Table 3). Each drainage has varying proportions of the nitrogenous compounds in the organic and inorganic loads (Table 4).

The sum of the total recorded organic and inorganic nitrogen loads and their components are provided in the data summaries of Appendix

B. These do not include estimates during the peaks of runoff. Station #2 had 13 percent of the organic nitrogen, 17 percent of the inorganic nitrogen and 39 percent of the ammonia loads of Station#1. The proportions of Station #3 to Station #1 for the same parameters were 17 percent, 17 percent, and 8 percent, respectively. Most of the nitrogen load was delivered after rainstorms. Fifty-four percent of the organic nitrogen load at Station #1 came from the data taken two days after the February 23, 1986 storm. Sixty percent of the inorganic nitrogen load was recorded on that same day. Station#2 and Station #3 reflected similar contributions on that same sampling date.

An estimate of 11.5 tons of inorganic and 2.2 tons of organic nitrogen were carried by the runoff of the February 18th storm. The February 23rd storm discharged another 7.5 tons of inorganic and 2.3 tons of organic nitrogen.

Phosphorus

Total phosphorus concentrations ranged from 0.11 mg/l to 0.97 mg/l with a downward seasonal trend. The largest concentrations of total phosphorus were at Station #1 and Station #2., (Appendices A1-3). Orthophosphate concentrations showed the same seasonal trend with slightly greater concentrations at Station #2. Total hydrolyzable phosphorus concentrations were the greatest at the mouth, Station #1.

The composition of the total phosphorus concentrations between the stations for the spring of 1986 were similar, 63 percent of it was orthophosphate and 20 percent hydrolyzable phosphorus at Station #1, 65 percent and 10 percent for each at Sation #2, and 59 percent and 16 percent respectively at Station #3. For the whole study at Station #1, 60 percent of the total phosphorus was as orthophosphate and 30% percent was hydrolyzable.

The loads calculated for Stockney Creek are provided in Appendices B1-3, but do not included peak load due to lack of data. Station #2 had 17 percent of the total phosphorus, 6 percent of the

Table 3. Organic and Inorganic Nitrogen Concentrations (mg/L)

		Organic Nitrogen (TKN - NH3)		Inorganic Nitrogen (NO2 +NO3 and NH3)	
St.#	n	Mean	Range	Mean	Range
1	28	1.12	0.09 - 2.04	4.70	0.14 - 16.0
1Δ	7	1.33	0.68 - 2.01	5.93	0.71 - 11.3
2	7	1.10	0.07 - 1.58	6.30	1.61 - 10.3
3	7	1.19	0.77 - 2.00	5.80	3.17 - 10.9

n = Number of samples
1Δ = Sample sets 22-29 (1986)

Table 4. Percent Composition of Organic and Inorganic Nitrogen Complexes (%)

St.#	% Organic Nitrogen (TKN- NH_3) of TKN Fraction	Inorganic Nitrogen	
		$NO_2 + NO_3$	NH_3
1	78%	94%	6%
1Δ	82%	96%	4%
2	62%	91%	9%
3	90%	98%	2%

Δ Sample sets 22-29 (1986)

hydrolyzable and 21 percent of the orthophosphate loads. Station #3 had percentages of 15 percent, 7 percent, and 16 percent respectively for the various phosphorus loads. The runoff on February 18th carried an estimate of 1600 lbs of total phosphorus, of which 960 pounds were orthophosphate and 290 pounds were hydrolyzable phosphorus. The February 23rd storm runoff had 800 pounds of total phosphorus, comprised of 550 pounds orthophosphate and 190 pounds of hydrolyzable phosphorus.

Bacteria

Only three samples collected from Station #1 had less than 50 fecal coliform colonies. The other two stations each had 1 sample with less than 50 colonies. Station #1 had a mean count of 162 colonies for the study and 229 for 1986. Station #2 had a mean of 143 while Station #3 averaged 97 colonies.

The geometic mean of the ratios of fecal coliform to fecal streptococcus at Station #1 was 0.9 for the whole study period and 0.6 for sample dates comparable to Station #2 and Station #3. Station #2 had a mean ratio of 0.6, while Station #3 had a ratio of 1.1.

Quality Assurance

Percent recovery, or accuracy, for suspended sediment, dissolved orthophosphate, total nitrate, and total Kjeldahl nitrogen were within five percent of the true value (Table 5). Methods used to determine hydrolyzable phosphorus tended to underestimate concentrations by twenty percent. Total phosphorus was overestimated by twelve percent and total ammonia overestimated by twenty percent.

Precision estimates are expressed by the average relative range of the samples (Table 6). Estimates of the suspended sediment, total phosphorus, total nitrite + nitrate, total Kjeldahl nitrogen and turbidity were good to excellent. Orthophosphate, total hydrolyzable phosphate, and total ammonia exhibited poorer precision (Bauer, 1985).

Table 5. Accuracy Estimates of Monitored Parameters*

STORET*	Parameter	n	Average % Recovery	95% CI
80154	Suspended Sediment	13	95.4	1.2
00665	Total Phosphorus as P	13	112.8	2.9
70507	Orthophosphate as P	13	99.0	6.3
00669	Total Hydrolyzable Phosphorus as P	13	80.0	4.5
00620	Total Nitrate as N	13	103.9	3.8
00610	Total Ammonia as N	13	120.1	11.8
00625	Total Kjeldahl Nitrogen as N	13	104.0	9.0

* From Bauer (1985)
n Number of samples
CI Confidence Interval

Table 6. Precision Estimates of Monitored Parameters

STORET	Parameter	n	Average Relative Range (%)
80154	Suspended Sediment	6	4.4
00665	Total Phosphorus as P	6	6.6
70507	Orthophosphate as P	6	16.6
00669	Total Hydrolyzable Phosphorus as P	6	70.2
00630	Total Nitrite + Nitrate as N	6	9.7
00610	Total Ammonia as N	6	89.7
00625	Total Kjeldahl Nitrogen as N	6	8.5
00076	Turbidity	6	3.2

n Number of samples

DISCUSSION

Discharge

The discharges of Stockney Creek are influenced mostly by climatological events. The melting winter snowpack and occasional intense thunderstorms are the cause of the peak flows. Mean monthly precipitation data for the spring months of 1985 and 1986 at Grangeville, Idaho are provided on Table 7.

According to the precipitation data, 1985 was relatively dry. The discharge data can therefore be expected to reflect that trend and be lower than the norm. The precipitation for the spring of 1986 was near normal except for the influence of a storm on February 23rd. Between 0.8 and 1.3 inches of rain fell on this one day which brought the monthly total to well above the 30-year norm. Discharge data collected during 1986 should reflect more normal conditions.

The crest gauges provided valuable data on the interim peak discharges on Stockney Creek. They also proved to be useful in estimating the stream stages when high flows made it difficult to obtain direct measurements. The data were used with the Manning equation to estimate the peak discharges.

Suspended Sediment

The total measured suspended sediment load for the 1985/1986 study was 43 tons. This represents less than 10 percent of the sediment load which was estimated as being exported from the drainage during the study period from extrapolation of discharge data. At least 300 tons of sediment were exported during the 1986 sampling period. Most of this load was delivered during or shortly after the peak runoffs, as anticipated.

These results are considered to be 'typical' but may still underestimate the total yearly loads. Each factor used in computing the loads, such as discharge and concentrations, may be affected by several factors. These include: variability in sampling techniques;

Table 7 Precipitation Data for January thru June of 1985 and January thru April of 1986*

Month	Precip. (inches)	Mean (30-yr.)	% of Norm
1985			
January	0.62	1.70	36
February	0.54	1.24	43
March	1.64	2.07	79
April	1.99	2.73	73
May	2.43	3.43	71
June	2.37	2.90	82
1986			
January	1.52	1.70	89
February	3.31	1.24	267
March	2.23	2.07	108
April	2.90	2.73	106

*NOAA 1986

source of discharge - since snowmelt may suspend less soil particles than rainwater; stream velocity - which affects settling time or resuspension of particles; timing of sample collection - since more sediment is carried before the peak than after; and the lack of data from peak events. Some of these factors are accounted for in the precision estimates. Others, such as timing of the sample collection, require an educated "guesstimate", as to the loads which are carried.

All of the sediment load does not originate from land surfaces. At least 5 percent may come from erosion of the stream banks. This is dependent upon the morphology and stability of the stream channel (U.S.G.S. 1980). Stream reach inventories assess the susceptibility of the stream channel and banks to erosion.

A range of 77-114 is considered to be 'fair' indicating that stream is not able to withstand sudden fluctuations in discharge without channel scouring and the bank sloughing. The 'poor' rating, greater than 114, indicates that cutting and redeposition of the channel and banks are common (U.S.D.A., 1975). Three stream reach and channel stability surveys were conducted on Stockney Creek. The two surveys completed on the lower end concluded that the channel is in fair shape with index numbers of 93 and 114. The other survey assessed a "typical" section of the channel on the southern fork characteristic of the numerous tributaries of the stream. An index of 123 was compiled for this section.

Numerous cutbanks exist along all sections of Stockney Creek. These steep denuded slopes are subject to undercutting and sloughing, particularly during moderate to high flows. The contribution of the cutbanks to the sediment load of Stockney Creek was not assessed.

The sediment load of the northern watershed was 15 percent of the total monitored load. This is appromimately equal to the proportion of watershed contained in the drainage. The smaller drainage, above Station #2, didn't make the same contribution in proportion to its land area; 6 percent of the sediment load from 13 percent of the land. There are several factors that may explain this observed disparity. The most obvious are the physical characteristics of the watershed: soil types, field gradients, the presence of stock ponds, stream length and morphology. Other factors such as land management, and condition of the riparian areas also affect the amount of sediment being transported.

There are stock watering impoundments built on almost every tributary of the stream. These not only act as settling ponds, but also provides direct access of cattle to the water. This affects the chemical composition of the water by increasing the amount of animal wastes directly added to the stream.

Nitrogen

Sources of nitrogen in surface waters include nitrogen fixing algae, decomposing plant material, animal wastes, nitrogenous fertilizers, and domestic wastewater disposal. The proportion of the inorganic nitrogen form is dependent upon pH, temperature, and oxygen content of the water. The reduction of nitrogen to ammonia occurs under anaerobic conditions and is accelerated by a pH greater than 8.0 and/or increased temperatures. Aerobic conditions will convert ammonia to nitrite and then nitrate.

Concentrations of TKN in natural waters range from 0.05 to 2.0 mg/l (U.S.G.S. 1977). Samples taken from Stockney Creek exhibited values within this range. The southern drainage had a lower range of TKN values than the northern watershed. Greater TKN values generally coincided with runoff. This correlation is tempered by several factors: a) source of runoff - because percolated snowmelt does not usually carry the organic debris in the runoff as that created by rainfall; b) chemical reactions in soil and water are temperature and pH sensitive; c) the amount of nitrogen and organic debris available for transport will decrease through successive runoff events.

Animal wastes and organic debris are the major sources of organic nitrogen in watersheds where agriculture is the major land use. There are twenty-four livestock operations on Stockney Creek.

Most of the operators take advantage of the creek for watering and pasturing their stock. The southern drainage has eight feedlots along its length, the north fork has four feedlots.

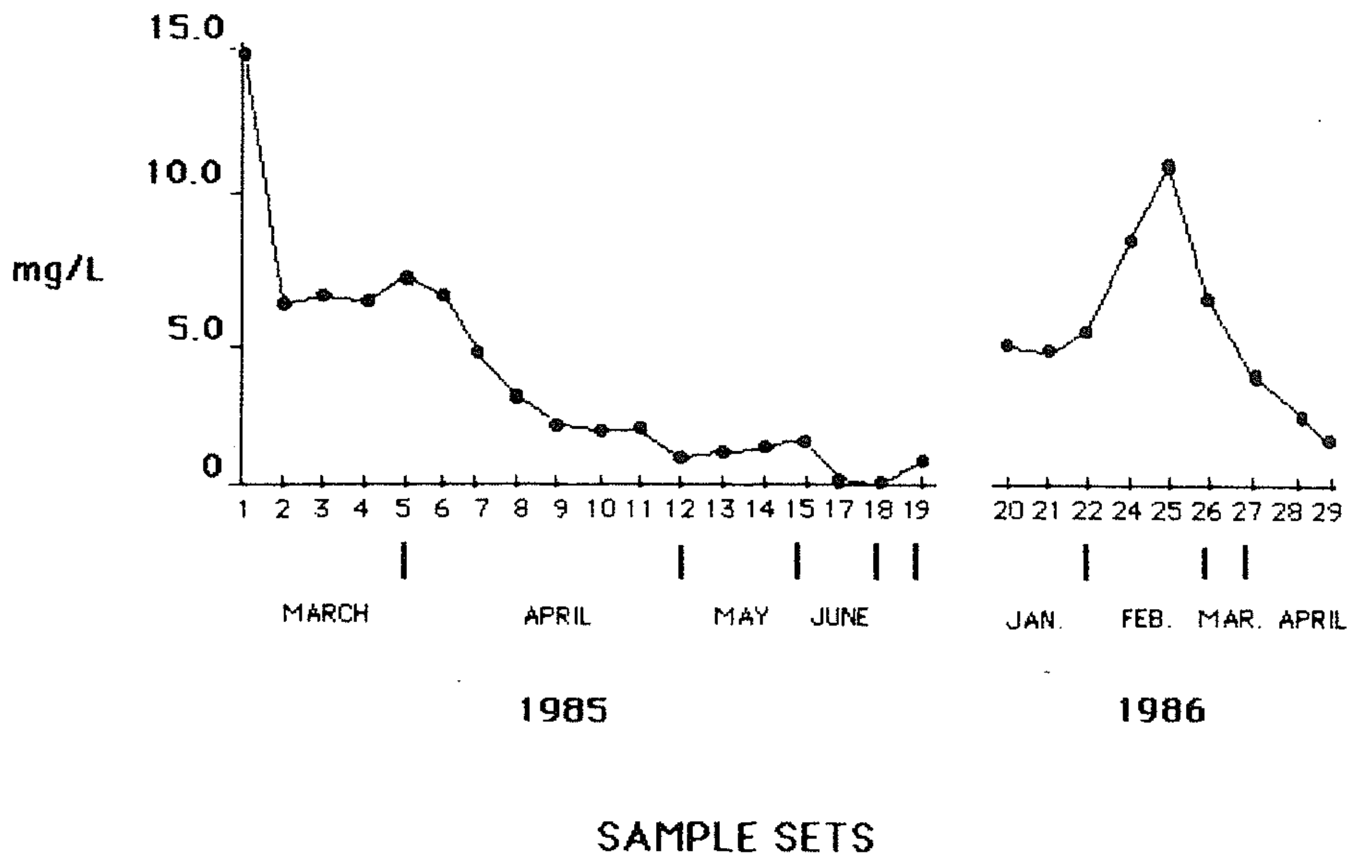
Sources of inorganic nitrogen in surface waters are from fertilizers and ammonia from animal wastes. The management techniques used in agricultural activities, such as type of fertilizer and of timing application will directly influence concentrations of inorganic nitrogen in a stream. This effect was most noticable at Station #1, near the mouth, which displayed the widest range of values. A downward trend in the nitrite + nitrate data of Station #1 is evident (Figure 4). A logical explanation is that the nutrient is of a surface origin, each subsequent runoff event will remove or leach the nitrogen until groundwater levels are reached. If the rate of loss may be assumed to be the same for each watershed, it then appears from the data that the northern drainage has a higher groundwater concentration.

Ammonia represents a large portion of the TKN fraction, and the inorganic nitrogen from the southern fork at Station #2. In addition, the southern fork had 39 percent of the ammonia load of Stockney Creek, which is further indication that the source of the ammonia is from the feedlots because 40 percent of the feedlots in the drainage are above Station #2.

Phosphorus

Phosphorus is an essential element to plant growth, and, if not present in sufficient quantities, is a limiting factor to maximum plant production. Sources of phosphorus are natural deposits, fertilizers, animal wastes, domestic wastewater, and decomposing organic material. Orthophosphate is the form most available for plant utilization because it is soluble in water. Hydrolyzable phosphorus can be thought of as a reserve pool consisting of organically bound phosphorus which may be converted to orthophosphate. These comprise most of the forms in the total phosphorus concentrations.

FIGURE 4. NITRITE + NITRATE CONCENTRATIONS AT STOCKNEY CREEK



An instream goal of 0.1 mg/l total phosphorus has been suggested to prevent nuisance growth in flowing waters not discharging directly to lakes or impoundments (Mackenthun, 1973). This criterion was exceeded with each sample taken (Appendices A1-3).

The differences in proportions of the various phosphorus components may be related to the concentrations of suspended sediment. Organic particles are a source of hydrolyzable phosphorus. If a sample has less suspended particles, then less hydrolyzable phosphorus is present, and dissolved orthophosphate represents a larger proportion of the total phosphorus.

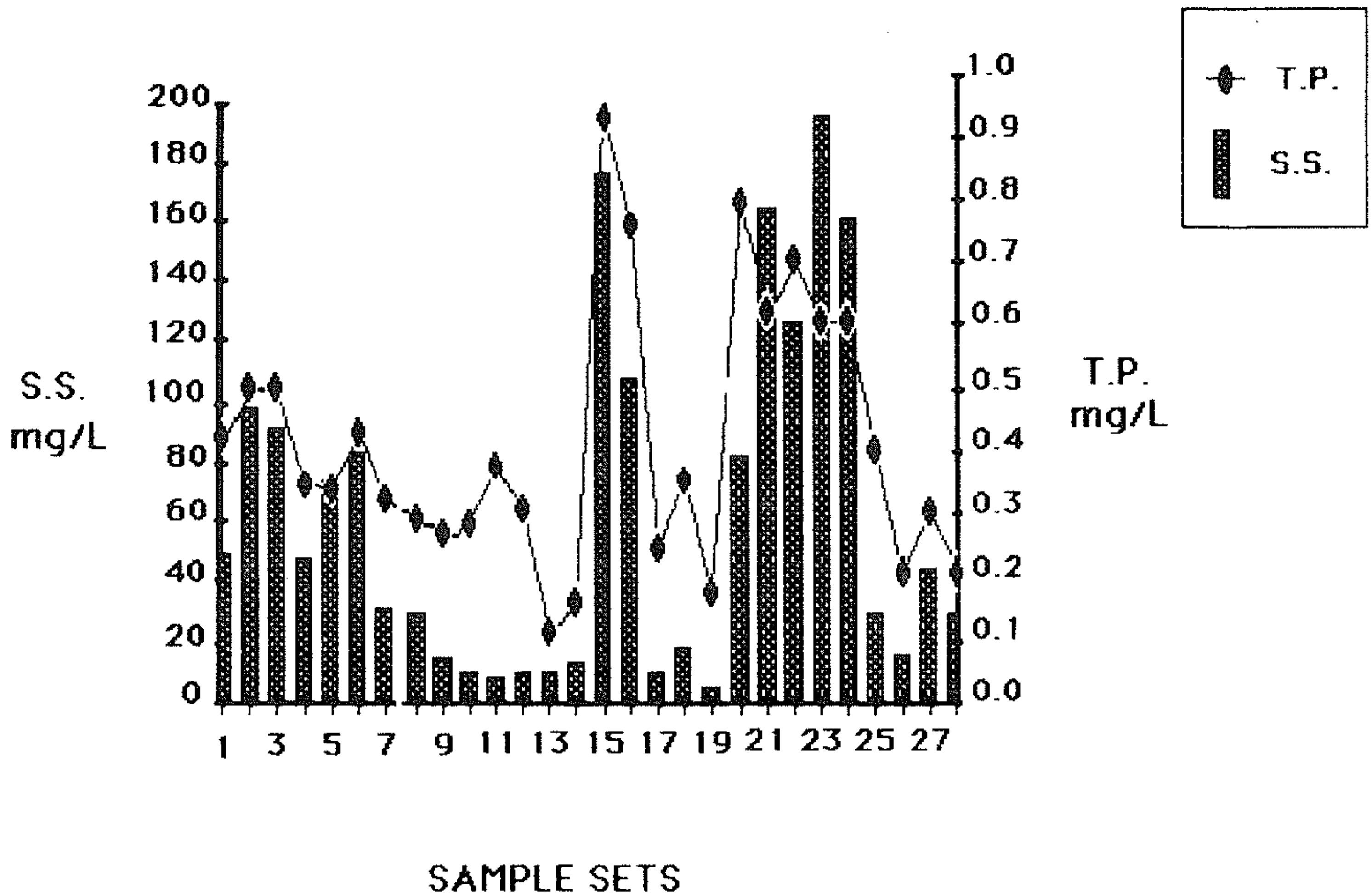
The orthophosphate ion has an affinity for positively charged soil particles, particularly clays. The erosion of the soil then transports the phosphorus to the stream. As expected, an increase in suspended sediment concentrations was associated with increased total phosphorus concentrations (Figure 5).

Orthophosphate concentrations follow a pattern typical of a topically applied chemical. Concentrations, which early in the spring are relatively high, taper off as the ions are leached from the soil. The concentrations increase slightly during the lowest flows, because groundwater levels are not diluted. The high percentage of orthophosphate in the total phosphorus concentrations suggest that applied fertilizers are leached from the fields. The drainage above Station#2 yielded the higher concentrations and loads of orthophosphates of the two upper drainages.

The difference in the methodology in collection and handling of the orthophosphate samples may affect the reported concentrations. DOE collected samples were filtered on site while samples collected by the SCS were shipped to Boise before they were filtered. The time lapse allowed chemical reactions to occur in the samples, thereby changing the proportions of components.

The southern drainage delivered 1.2 mg of total phosphorus for each gram of sediment. The more northern drainage had 0.5 mg/g and Stockney Creek near the mouth had 0.5 mg/g. This indicates that the southern drainage contributes a larger proportion of phosphorus for the sediment load delivered.

FIGURE 5. SUSPENDED SEDIMENT IN RESPONSE TO TOTAL PHOSPHORUS CONCENTRATIONS



Hydrolyzable phosphorus showed an accumulative effect as concentrations were twice those of the upper stations. It is not possible to pinpoint the source of phosphorus in solution, but a concurrent rise in the organic nitrogen and hydrolyzable phosphorus indicates that organic debris may play a part in the elevated nutrient concentrations.

Bacteria

Monitoring for bacterial contamination has been a standard water quality procedure to indicate potential contamination and possible presence of other disease-causing organisms. Two factors that may elevate the number of colonies present in samples are heavy runoff from areas where livestock are contained and warm water temperatures that will accelerate the growth rate of bacteria. Both of these factors were present, therefore the high bacteria counts were not a surprise.

Waters designated as usable for secondary contact recreation are not to exceed fecal coliform colonies greater than 800/100 ml at any time or a geometric mean of 200/100 ml based on five samples/30 days (IDHW-DOE, 1985). The single day criterion was exceeded four times on Stockney Creek.

Ratios of FC/FS indicate that fecal contamination from cattle is the most likely source of bacteria. Ratios greater than 0.7 were usually exceeded only during periods of runoff, indicating that the runoff from pastures and feedlots are probably the source. There are numerous established feedlots and pastures along all forks of Stockney Creek. About half of the feedlots and dairies have animal waste systems in place to help control offsite impacts.

CONCLUSIONS

1. Stockney Creek is used as an agricultural water supply and occasionally for secondary contact recreation. These uses are occasionally impaired by suspended sediment, nutrient loads, and bacterial contamination.

2. Runoff and storm events in the drainage deliver most of the nutrient and sediment loads.

3. The southern drainage, as monitored at Station #2, provided 39 percent of the ammonia load exhibited at the mouth. The greatest concentrations of orthophosphate were recorded at Station #2.

4. Small water impoundments along many of the tributaries help to mitigate some of the effects of sediment loads contributed by the watersheds.

5. Cattle are the most likely source of the fecal coliform bacterial contamination of the stream. Animal waste from the many pastures and feedlots located in the drainage also provide a large portion of the ammonia and organic nitrogen loads exhibited in the stream.

6. Water quality of Cottonwood Creek, and subsequently the Clearwater River are adversely impacted by contributions of nutrients and sediments from the Stockney Creek drainage.

RECOMMENDATIONS

1. Implementation of agricultural BMP's in the Stockney Creek drainage would have a positive effect on water quality of the stream, but the minimal flows of the stream and the lack of significant detriment to beneficial uses of Stockney Creek by agricultural may not justify such a program.

2. Restriction of access by cattle to sensitive riparian areas would improve the bank stability of the channel and reduce the direct erosion from this source. Further actions such as bank sloping, riprapping, and replanting are necessary to stabilize badly damaged areas.

3. BMP's designed to reduce ammonia and orthophosphates should be targeted for implemenation throughout the project area as needed, but specifically to the southern drainage, above Station #2, where the largest concentrations of nutrients were found.

4. The reduction of animal wastes being added to the stream would reduce the amount of organic chemicals such as ammonia and organic nitrogen, plus reduce the fecal bacteria counts.

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APPENDIX A1. WATER QUALITY DATA FOR STATION #1, AT STOCKNEY CREEK NEAR THE MOUTH

STORET # 2020255

DATE	TEMP. °C	FLOW cfs	COND. @ 25° µhos/cm	pH S.U.	NH3 mg/L	NO2 +NO3 mg/L	TKN mg/L	O'PO4 mg/L	T.H.P. mg/L	T.P. mg/L	TURB. NTU	S.S. mg/L	FECAL COLI. #/.1L	FECAL STREP. #/.1L
03/13/85	4.0	6.5	321	8.0	1.27	14.80	1.40	0.229	0.156	0.44	52	48	120	10
03/15/85	AAA	AAA	272	8.0	0.156	6.27	1.75	0.176	0.148	0.52	78	98	AAA	AAA
✓03/15/85	AAA	AAA	357	7.8	0.365	6.30	1.78	0.181	0.140	0.51	76	96	AAA	AAA
*03/15/85	3.0	5.8	315	7.9	0.260	6.28	1.76	0.178	0.144	0.52	77	97	30	350
§03/20/85	7.0	7.6	330	7.4	0.234	6.54	1.80	0.205	0.194	0.52	70	92	370	180
03/26/85	4.0	6.3	319	7.9	0.444	6.36	1.23	0.149	0.204	0.36	33	47	150	140
§03/28/85	5.0	4.7	394	7.5	0.138	7.21	1.17	0.175	0.142	0.35	41	73	110	110
§04/03/85	9.0	8.0	306	6.0	0.080	6.57	1.50	0.149	0.207	0.45	60	83	440	230
04/09/85	11.4	5.2	319	8.2	0.138	4.33	1.15	0.104	0.20	0.33	23	31	89	60
§04/11/85	12.0	4.1	365	7.9	0.291	3.05	0.95	0.146	0.12	0.30	22	29	420	440
§04/17/85	13.0	1.9	377	8.0	0.060	2.07	0.73	0.188	0.032	0.28	10	15	90	80
04/23/85	9.8	4.5	337	8.7	0.676	1.91	0.77	0.098	0.15	0.29	10	10	80	1310
§04/25/85	6.0	3.2	383	8.4	0.322	1.86	0.76	0.141	0.06	0.39	10	8	600	320
§05/01/85	15.0	1.7	392	7.8	0.221	1.01	0.83	0.213	0.05	0.32	3	10	90	40
§05/09/85	11.0	0.9	399	8.6	0.051	1.14	0.61	0.068	0.07	0.11	4	10	830	30
§05/15/85	14.0	1.4	407	8.6	0.103	1.24	0.85	0.094	0.07	0.16	5	12	500	100
§05/30/85	9.0	15.6	351	7.8	0.397	1.72	1.25	0.648	0.227	0.97	84	176	>8000	>8000
§06/06/85	14.0	11.4	367	8.2	0.218	AAA	2.26	0.602	0.08	0.79	72	108	>6000	3100
06/27/85	19.0	0.7	359	8.4	0.056	0.22	0.66	0.155	0.06	0.25	4	9	290	270
§07/23/85	AAA	0.1	438	8.2	0.082	0.06	0.82	0.323	0.13	0.37	7	17	200	400
§10/22/85	AAA	◊0.1	410	7.6	0.082	0.785	0.79	0.128	0.09	0.18	7	4	900	750

AAA UNREPORTED DATA

◊ ESTIMATED

£ LOGARTHMIC MEAN

* MEAN FOR ALL DATA COLLECTED THAT DAY

✓ QUALITY ASSURANCE SAMPLE

§ SAMPLE COLLECTED BY SCS

APPENDIX A1. WATER QUALITY DATA FOR STATION #1, AT STOCKNEY CREEK NEAR THE MOUTH

STORET # 2020255

DATE	TEMP. °C	FLOW cfs	COND. @ 25° µhos/cm	pH S.U.	NH3 mg/L	NO2 +NO3 mg/L	TKN mg/L	O'PO4 mg/L	T.H.P. mg/L	T.P. mg/L	TURB. NTU	S.S. mg/L	FECAL COLI. #/.1L	FECAL STREP. #/.1L
§01/20/86	0	◊2.0	339	7.3	1.40	4.79	3.07	0.512	0.28	0.79	36	78	550	770
[illegible]/24/86	1	4.8	369	7.6	0.571	4.61	2.43	0.565	<0.01	0.62	75	156	20	470
§01/30/86	1	7.5	362	7.3	0.662	5.43	2.67	0.452	0.046	0.7	74	120	300	1700
§02/18/86	2	◊500	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
§02/19/86	0	12.6	332	7.3	0.437	8.25	2.12	0.358	0.106	0.6	110	186	200	550
§02/25/86	7.5	28.9	290	7.3	0.341	11.0	2.31	0.409	0.141	0.6	115	154	150	310
§03/17/86	6	5.0	392	8.0	0.255	6.44	1.28	0.192	0.062	0.4	26	28	100	AAA
§04/03/86	7	3.9	429	8.2	0.075	4.06	0.79	0.119	0.038	0.2	7	14	AAA	AAA
§04/17/86	7	2.4	453	7.8	0.051	2.88	1.17	0.113	0.102	0.3	16	42	>200	150
§04/30/86	7	1.9	416	7.9	0.053	1.66	0.73	0.124	0.092	0.2	7	28	100	200

SUMMARY OF 1985-1986 DATA

	TEMP.	FLOW	COND.	pH	NH3	NO2+NO3	TKN	O'PO4	T.H.P.	T.P.	TURB.	S.S.	FECAL COLI.	FECAL STREP.
MEAN	8	7.7	366	£7.8	0.321	4.38	1.36	0.242	0.12	0.4	39	61	£229	£275
MINIMUM	0	0.1	272	6.0	0.051	0.06	0.61	0.068	<0.01	0.11	3	4	30	10
MAXIMUM	19	◊80	453	8.7	1.40	14.80	3.07	0.648	0.280	0.97	115	186	<8000	<8000

SUMMARY OF 1986 DATA

	TEMP.	FLOW	COND.	pH	NH3	NO2+NO3	TKN	O'PO4	T.H.P.	T.P.	TURB.	S.S.	FECAL COLI.	FECAL STREP.
MEAN	5	18	382	£7.7	0.268	5.67	1.58	0.252	0.084	0.4	51	82	£162	£387
MINIMUM	0	1.9	290	7.3	0.051	1.66	0.73	0.113	0.046	0.2	7	14	100	150
MAXIMUM	7.5	80	453	8.2	0.662	11.0	2.67	0.452	0.141	0.7	115	186	300	1700

AAA UNREPORTED DATA
◊ ESTIMATED
£ LOGARTHMIC MEAN

* MEAN FOR ALL DATA COLLECTED THAT DAY
✓ QUALITY ASSURANCE SAMPLE
§ SAMPLE COLLECTED BY SCS

APPENDIX A2. WATER QUALITY DATA FOR STATION #2, AT THE SOUTH FORK OF STOCKNEY CREEK

STORET # 2020256

DATE	TEMP. °C	FLOW cfs	COND. @ 25° µhos/cm	pH S.U.	NH3 mg/L	NO2 +NO3 mg/L	TKN mg/L	O'PO4 mg/L	T.H.P. mg/L	T.P. mg/L	TURB. NTU	S.S. mg/L	FECAL COLI. #/.1L	FECAL STREP. #/.1L
§01/30/86	0	◊1	377	7.3	0.449	6.53	1.99	0.334	0.010	0.5	16	18	540	540
§02/18/86	3	14.6	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
§02/19/86	◊0	◊2	323	7.7	1.64	8.13	2.50	0.548	0.077	0.7	48	60	60	490
§02/25/86	8	5.1	263	7.3	0.807	9.5	2.39	0.508	0.044	0.6	80	58	160	310
§03/17/86	8	1.1	328	8.4	0.728	6.00	2.05	0.239	0.043	0.4	13	18	40	AAA
§04/03/86	8	1.0	355	7.9	0.128	5.43	1.15	0.173	0.096	0.3	18	82	AAA	AAA
§04/17/86	7	<0.1	394	7.8	0.730	2.78	1.7	0.236	0.077	0.5	12	24	>200	160
§04/30/86	5	<0.1	376	7.9	0.042	1.57	0.11	0.252	0.020	0.4	17	30	210	600

SUMMARY OF DATA

MEAN	5	6.0	371	£7.7	0.65	5.7	1.7	0.327	0.052	0.5	29	41	£143	£380
MINIMUM	3	<0.1	263	7.3	0.042	1.57	0.11	0.173	0.010	0.3	12	18	40	160
MAXIMUM	8	14.6	394	8.4	1.64	9.5	2.50	0.548	0.120	0.7	80	82	540	600

AAA UNREPORTED DATA
◊ ESTIMATED
£ LOGARTHMIC MEAN
* MEAN FOR ALL DATA COLLECTED THAT DAY
✓ QUALITY ASSURANCE SAMPLE
§ SAMPLE COLLECTED BY SCS

APPENDIX A3. WATER QUALITY DATA FOR STATION #3, AT THE NORTH FORK OF STOCKNEY CREEK

STORET # 2020257

DATE	TEMP. °C	FLOW cfs	COND. @ 25° µhos/cm	pH S.U.	NH3 mg/L	NO2 +NO3 mg/L	TKN mg/L	O'PO4 mg/L	T.H.P. mg/L	T.P. mg/L	TURB. NTU	S.S. mg/L	FECAL COLI. #/.1L	FECAL STREP. #/.1L
§01/30/86	3	0.8	377	7.4	0.248	3.67	1.23	0.252	0.020	0.4	17	30	100	280
§02/18/86	2	2.7	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA	AAA
§02/19/86	0	2.1	353	7.3	0.209	10.7	2.21	0.417	<.001	0.5	60	188	100	120
§02/25/86	7	6.3	276	7.3	0.172	8.73	1.87	0.289	0.061	0.5	54	90	20	20
§03/17/86	7	1.4	324	8.0	0.123	5.92	1.23	0.170	0.066	0.3	18	60	140	AAA
§04/03/86	9	0.4	355	8.1	0.120	4.19	0.89	0.142	0.065	0.2	13	38	AAA	AAA
§04/17/86	8	<0.1	367	8.0	0.080	3.67	1.06	0.207	0.087	0.4	19	80	>200	75
§04/30/86	6	<0.1	359	8.0	0.033	3.14	0.83	0.186	0.144	0.3	11	44	150	80

SUMMARY OF DATA

MEAN	5.9	5.0	344	£7.7	0.140	5.71	1.33	0.237	0.063	0.4	27	76	£97	£83
MINIMUM	3.0	<0.1	276	7.3	0.033	3.14	0.83	0.170	<0.00	0.2	11	30	20	20
MAXIMUM	9	14.0	377	8.1	0.280	10.70	2.21	0.648	0.144	0.50	60.0	188.	>200	280

AAA UNREPORTED DATA
◊ ESTIMATED
£ LOGARTHMIC MEAN

* MEAN FOR ALL DATA COLLECTED THAT DAY
✓ QUALITY ASSURANCE SAMPLE
§ SAMPLE COLLECTED BY SCS

APPENDIX B1. NUTRIENT LOADS FROM ST.#1, AT STOCKNEY CREEK NEAR THE MOUTH

STORET # 2020255

DATE	FLOW cfs	S.S. TONS/DAY	T.P. LBS/DAY	T.H.P. LBS/DAY	O'PO4 LBS/DAY	TKN LBS/DAY	NH3 LBS/DAY	NO2+NO3 LBS/DAY	ORGANIC NITROGEN LBS/DAY	INORGANIC NITROGEN LBS/DAY
03/13/85	6.5	0.8	15	5	8	49	44	520	5	560
*03/15/85	5.8	1.5	16	5	6	55	4	200	47	210
§03/20/85	7.6	1.9	21	8	8	74	10	270	64	280
03/26/85	6.3	0.8	12	7	5	42	15	220	27	240
§03/28/85	4.7	0.9	9	4	4	30	3	180	27	180
§04/03/85	8.0	1.8	19	9	6	65	3	280	62	280
04/09/85	5.2	0.4	9	6	3	32	4	120	28	120
§04/11/85	4.1	0.3	7	3	3	21	6	67	15	73
§04/17/85	1.9	<0.1	3	0.3	2	7	0.6	21	6	22
04/23/85	4.5	0.1	7	4	2	19	16	46	3	62
§04/25/85	3.2	<0.1	7	1	2	13	6	32	7	38
§05/01/85	1.7	<0.1	3	0.4	2	8	2	9	6	11
§05/09/85	0.9	<0.1	0.5	0.3	0.3	3	0.2	6	3	6
§05/15/85	1.4	<0.1	1	0.5	0.7	6	0.8	9	5	10
§05/30/85	15.6	7.4	82	19	54	100	33	140	67	170
§06/06/85	11.4	3.3	49	5	37	140	13	AAA	130	13
06/27/85	0.7	<0.1	0.9	0.2	0.6	2	0.2	0.8	2	1
§07/23/85	0.1	<0.1	0.2	<0.1	0.2	0.4	<0.1	0.1	0.4	0.1
§10/22/85	◊0.1	<0.1	0.1	<0.1	<0.1	0.4	<0.1	0.4	0.4	0.4
§01/20/86	◊2.0	0.4	8	3	5	33	15	52	18	67

AAA UNREPORTED DATA
◊ ESTIMATED

APPENDIX B1. NUTRIENT LOADS FROM ST.#1, AT STOCKNEY CREEK NEAR THE MOUTH

STORET # 2020255

DATE	FLOW cfs	S.S. TONS/DAY	T.P. LBS/DAY	T.H.P. LBS/DAY	O'PO4 LBS/DAY	TKN LBS/DAY	NH3 LBS/DAY	NO2+NO3 LBS/DAY	ORGANIC NITROGEN LBS/DAY	INORGANIC NITROGEN LBS/DAY
§01/24/86	4.8	2.0	16	0.3	15	63	15	120	48	140
§01/30/86	7.5	2.4	28	2	18	110	27	220	83	250
§02/19/86	12.6	6.3	41	7	24	140	30	560	110	590
§02/25/86	28.9	12.0	93	22	64	360	53	1700	310	1800
§03/17/86	5.0	0.4	11	2	5	34	7	170	27	180
§04/03/86	3.9	0.1	4	0.8	3	17	2	85	15	87
§04/17/86	2.4	0.3	4	1	1	15	0.7	37	14	38
§04/30/86	1.9	0.1	2	9	1	7	0.5	17	6	18

SUMMARY OF 1985-1986 DATA

TOTAL		43.2	470	120	280	1400	310	5100	1100	5400
MINIMUM	0.1	<0.1	0.1	<0.1	<0.1	0.4	<0.1	0.1	0.4	0.1
MAXIMUM	◊80	12.0	93	22	64	360	53	1713	307	1766

SUMMARY OF 1986 DATA

TOTAL		21.7	180	44	120	680	120	2800	560	2900
MINIMUM	1.9	0.1	2	0.8	1	7	0.5	17	6	18
MAXIMUM	80	12.0	93	22	64	360	53	1700	310	1800

AAA UNREPORTED DATA
◊ ESTIMATED

APPENDIX B2. NUTRIENT LOADS FROM ST.#2, AT THE SOUTH FORK OF STOCKNEY CREEK

STORET # 2020256

DATE	FLOW cfs	S.S. TONS/ DAY	T.P. LBS/ DAY	T.H.P. LBS/ DAY	O'PO4 LBS/ DAY	TKN LBS/ DAY	NH3 LBS/ DAY	NO2+NO3 LBS/ DAY	ORGANIC NITROGEN LBS/ DAY	INORGANIC NITROGEN LBS/ DAY
§01/30/86	◊1	<0.1	3	<0.1	2	11	2	35	9	37
§02/19/86	◊2	0.3	8	0.8	6	27	18	88	9	106
§02/25/86	5.1	0.8	16	1	14	66	22	261	44	283
§03/17/86	1.1	<0.1	2	0.3	1	12	4	36	8	40
§04/03/86	1.0	0.2	2	0.5	0.9	6	0.7	29	5	30
§04/17/86	<0.1	<0.1	<0.2	<0.1	<0.1	<0.9	<0.4	<1	<0.5	<0.6
§04/30/86	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.8	<0.1	<0.8

SUMMARY OF DATA

MINIMUM	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.8	<0.1	0.8
MAXIMUM	14.6	<0.1	16	1	14	66	22	261	44	283

AAA UNREPORTED DATA
◊ ESTIMATED

APPENDIX B3. NUTRIENT LOADS FROM ST.#3, AT THE NORTH FORK OF STOCKNEY CREEK

STORET # 2020257

DATE	FLOW cfs	S.S. TONS/DAY	T.P. LBS/DAY	T.H.P. LBS/DAY	O'PO4 LBS/DAY	TKN LBS/DAY	NH3 LBS/DAY	NO2+NO3 LBS/DAY	ORGANIC NITROGEN LBS/DAY	INORGANIC NITROGEN LBS/DAY
§01/30/86	0.8	<0.1	2	<0.1	1	5	1	16	4	17
§02/19/86	2.1	1.1	6	<0.1	5	25	2	121	23	123
§02/25/86	6.3	1.5	17	2	10	63	6	296	57	302
§03/17/86	1.4	0.2	2	0.5	1	9	0.9	45	8	46
§04/03/86	0.4	<0.1	0.4	0.1	0.3	2	0.3	9	2	9
§04/17/86	<0.1	<0.1	<0.2	<0.1	<0.1	<0.6	<0.1	<2	<0.6	<2
§04/30/86	<0.1	<0.1	<0.2	<0.1	<0.1	<0.4	<0.1	<2	<0.4	<2

SUMMARY OF DATA

TOTAL		2.9	28	3	18	105	10	491	95.0	501
MINIMUM	<0.1	<0.1	<0.2	<0.1	<0.1	<0.4	<0.1	2	<0.4	2
MAXIMUM	14.0	1.5	17	2	10	63	6	296	57	302

AAA UNREPORTED DATA
◊ ESTIMATED