ENVI 102 Rebecca Edwards

Study of Water Quality of North Branch, Birch Brook

May 10, 1991

As a hiker, I frequently find myself debating about whether I should drink from a natural body of water without purifying it first. Although iodine is relatively quick and effective as a water purifier, it does not taste good, and is probably not too healthy. While natural bodies of water at lower elevations are most likely polluted, natural waters at higher elevations, especially those that are remote from human impacts, are particularly tempting to drink. One day I found myself wondering if I could drink from the upper part of Birch Brook, from the North Branch, where the Birch Brook trail is located. By studying the headwaters of Birch Brook, where no human impact other than that caused by hikers is allowed, I would be able to learn about natural sources and indirect sources (such as precipitation) of pollution (if it existed), the sources that are not obvious to the eye. Perhaps some of my conclusions would provide me with guidelines that could be applied to other natural bodies of water at higher elevations, especially those that receive low levels of human impact. Good intro.!

Methods

The samples were collected on Sunday, April 21, 1991. All of the samples with an "FL" in their name were collected from the approximate middle of the main flow, above where I stood, in order to prevent myself from contaminating the sample before it entered the bottle. The samples with "ST" in their names were taken from stagnant pools located towards the sides of the brook. These were taken with a forward scooping motion so to prevent my hand from contaminating the water before it entered the sample bottle. The samples were then refrigerated as soon as I returned home.

your Cl values will tell you if this worked

Over the course of the following three weeks, the samples were analyzed for total coliform bacteria count, fecal coliform bacteria count, pH, acid neutralizing capacity (ANC), cation content and anion content (Ca, Mg, K, Na, F, SO_4, NO_3, and Cl). The two coliform tests were done about 24 hours after collecting the samples. The pH and ANC were not done until nine days after collecting the samples. The anion and cation testing was done in the second and third weeks of analysis to filtered samples.

will have changed — stable

The methods used for all of these tests were the same as the methods used in labs.

Sample Site Description

Samples were collected at sites along the North Branch of Birch Brook, starting at its origins and ending just below its intersection with the Middle and South Branches of Birch Brook. The western-most end of the North Branch is divided into two veins, the northern vein and southern vein. (tributaries???) (NNB = northern vein of North Branch; SNB = southern vein of North Branch) Thus, I sampled two origins of the North Branch by following each of these veins to the points at which they diverged into multiple capillaries. Sample #1N FL came from the highest distinguishable point on the NNB (at an elevation of about 1850 ft.), and sample #1S FL was taken at the highest distinguishable point on the SNB (at an elevation of about 1880 ft.). The next sample, #2 FL, was taken at a point just below the intersection of NNB and SNB, at an approximate elevation of 1650 feet. Samples #3 FL and #3 ST were collected further down the North Branch at an approximate elevation of 1470 feet. At the point where the Hopkins Memorial Forest Loop Trail intersects with the North Branch, at approximately 1290 feet in elevation, sample #5 FL was taken. Samples #6 FL and #6 ST were collected in the Moon Lot, at about 1080 feet in elevation. Sample #7 FL was also taken in the Moon Lot, at an elevation of about 1040 feet. Sample #8 FL was taken just above the intersection of the North Branch with the Middle and South Branches, at an approximate elevation of 960 feet, and sample #9 FL was taken just below this intersection, at the same elevation. (see Appendix 1)

Results (see Appendix 2)

All of the ions I tested for, I found, with the exception of F, which was present in insignificant concentrations. The data that I obtained shows some general as well as specific trends, in addition to some exceptions to these trends. Specifically, there were some relationships amongst the concentrations of various this a nice, readily interpreted data set

ions. The concentrations of Ca and Mg were proportionate to each other. (see Appendix 3) Both tended to increase with a decrease (or distance downstream) in elevation, especially between the sample sites at 1040 feet and 960 feet. Also, the concentrations of Na and Cl highly correlated to each other, but remained relatively constant with elevation change. (see Appendix 4) The concentrations of NO_3 and SO_4 were inversely related: as one increased, the other decreased approximately the same amount. While nitrate concentration slightly decreased with decreased elevation, sulfate slightly increased with elevation decrease. (see Appendix 5)

The pH of the samples tended to increase with elevation decrease, and ranged from 5.12 at site #1N FL to 6.97 at site #8 FL. (see Appendix 2) In many cases, the samples with higher pH's often had higher acid neutralizing capacities, however, this trend did not occur consistently. The concentration of sulfates tended to correlate with the pH values inversely: the higher pH values tended to have lower sulfate values and vice-versa. (see Appendix 6) The acid neutralizing capacity, although it tended to fluctuate, was consistently higher at lower elevations, and was related to Ca concentrations. (see Appendix 7) Some exceptions to the trends mentioned above are the ST samples, and the sample taken at the origin of the SNB, sample #1S FL. Sample #1S FL acted very unusually. It had significantly higher concentrations of Ca, Mg, K, Na, Cl, and NO_3 than the other samples collected at higher elevations. Also, it had a significantly lower concentration of SO_4 than the other samples taken at higher elevations. Furthermore, it did not behave as if it were taken at a lower elevation. One might assume that both ST samples, #3 ST and #6 ST, would behave differently than the other points at their elevations, and similarly to each other. However, I did not collect enough data at stagnant sites to draw any conclusions. Sample #3 ST tended to behave similarly to other points at similar elevations. Perhaps the stagnant water where I collected the sample was still receiving significant water flow despite its appearance. Sample #6 ST, however, behaved unusually. It had significantly higher concentrations of Na, Cl, and SO_4, and a significantly lower concentration of NO_3 than the other samples collected at nearby elevations.

The concentrations of total coliform and fecal coliform tended to be somewhat arbitrary, and they did not relate to each other. (see Appendix 2) However, the water sampled at the two stagnant sites, especially at #6 ST, had some of the higher levels of coliform bacteria, and #6 ST had the highest concentration of fecal coliform.

My samples were all collected on a rainy day, and since Birch Brook is a "flashy"[1] brook, it tends to react quickly to rainfall, its flow rapidly increasing on rainy days. Thus, the outflow of Birch Brook was relatively high on the day I collected my samples. (see Appendix 8) Data collected by Prof. David Dethier and Sandy Brown at the monitoring station below the

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1 Dethier and Brown. "Birch Brook Studies," A Journal;Center for Environmental Studies, Vol. 7, 1990, p.39.

intersection of Birch Brook with Buxton Brook (see Appendix 2 and 9) indicated no trends in ion concentrations with increased precipitation/outflow levels. However, this data is inconclusive because it only contains monthly sampling, and does not take into account weather conditions of previous but recent days. However, the ion concentrations measured at the monitoring station were higher than the concentrations that I measured at the lowest sample site. Furthermore, while most of the ion concentrations at the monitoring station were higher than the concentrations that I measured, they all increased or decreased at consistent rates with elevation changes.

Some other observations that should be noted are that the rocks that line the brook at higher elevations are primarily phyllites, while those at lower elevations, especially in the Moon Lot, ~~are primarily~~ marbles.

Conclusions

The concurrent increase in both Ca and Mg concentrations can be explained by the fact that they both are ionized from the marble at the bottom of the brook as it runs through the Moon Lot. Thus, as the water runs over this part of the brook, the concentrations increase. The Na and Cl concentrations are proportionate because they come from similar types of rocks. However, because few of these rocks exist, their concentrations do not change as the brook decreases in elevation. The increase in sulfate as the brook decreases with elevation can be explained by two factors. First, sulfate could be picked up from ~~ionizing~~ weathering phyllite rocks found at the higher elevations lining Birch Brook. Or, the sulfates could increase due to their presence in rainwater, and increasing volumes of runoff as one gets further on down the brook. Probably the increase in SO4 as elevation decreases can be attributed to a combination of these two factors. The decrease in nitrate with elevation change can be explained for different reasons. More nitrogen producing activity such as decay could be occurring at higher elevations. Or, while similar amounts of decay could be occurring at all elevations, more nitrogen could be being absorbed at lower elevations where there is more plant volume, and so most of the nitrogen is fixed by plants before it runs off into the brook. Thus, the nitrates that initially entered the brook are diluted by water with lower concentrations of nitrate as the brooks decreases in elevation. I cannot find an explanation for the almost perfect inverse relationship of nitrate and sulfate concentrations. Perhaps it is a random occurrence in data, but the accuracy with which the nitrate curve can be reflected to get the sulfate curve should be noted.

The lower pH's at higher elevations could be explained by the acid neutralizing capacity level changes. ANC was consistently higher at lower elevations. Thus, when the brook water reached lower elevations its pH raised due to higher ANC's. The relationship between sulfate concentrations and pH's is typical, because with increases in sulfate are increases in sulfuric acid, which will tend to decrease the pH of the sample. The unusual pH values for the highest two samples, #1N FL and #1S FL could be explained by the presence of unknown groundwater springs that could be significantly changing the pH's of these samples. However, the sulfate concentrations were inversely related to the pH values measured, and the sulfate concentrations at these two highest points were also unusual. Thus, perhaps groundwater sources exist at these elevations that are contributing to ion concentrations, especially that of sulfate. However, while sample #1N FL behaved rather normally in other respects, sample #1S FL was completely abnormal, suggesting that the presence of an unknown groundwater spring exists near this sample site. The increase of ANC over decreasing elevations, as well as its correlation to Ca concentration, can be explained by its dependence of carbonate (CO_3) concentrations. ANC increases with CO_3 concentrations, and Ca often is attached to CO_3 as calcium carbonate.

The behavior of the sample #6 ST can be explained by its stagnancy. Because it is not flowing, it had a chance to accumulate higher concentrations of most ions as it sat, and H_2O evaporated. Its low level of nitrate, however, can be explained by the higher amount of plant/algal growth in still water, and the plants will absorb the nitrogen.

At this point, the fact that my highest ion concentrations were lower than those obtained at the monitoring station further down the brook needs to be addressed. My initial assumption was *you need to demonstrate this quantitatively.*

that the increased precipitation on the day that I collected samples would dilute the brook water so as to lower the concentrations of most ions. However, after comparing various data, this trend was not clear. Thus, while my samples could in fact have been slightly diluted by the rain, I would guess that the reason for the higher concentrations of most ions at the monitoring station is that the water traveled further down in elevation, and in the process, picked up more ions from the rocks it ran over, or from possible human pollution sources near the lower parts of Birch Brook, like runoff from Petersburg Road. My guess is that the change in ion concentrations between my lowest sample sites and the monitoring station site is caused by a combination of these factors. Nevertheless, because the pattern of increase/decrease of these ion concentrations did not change significantly, I would not suspect any unusual processes to be interfering with the brook water for the most part.

both could be true

Finally, the variance in total and fecal coliform measurement can be explained by animal activity. Whichever sites had been recently visited by an animal would be likely to have higher coliform counts.

since this is an important new contribution to what we know about Birch Brook it really deserves quite a lot of discussion – totals, remember, are animal & soil, fecals are animal – which ones?

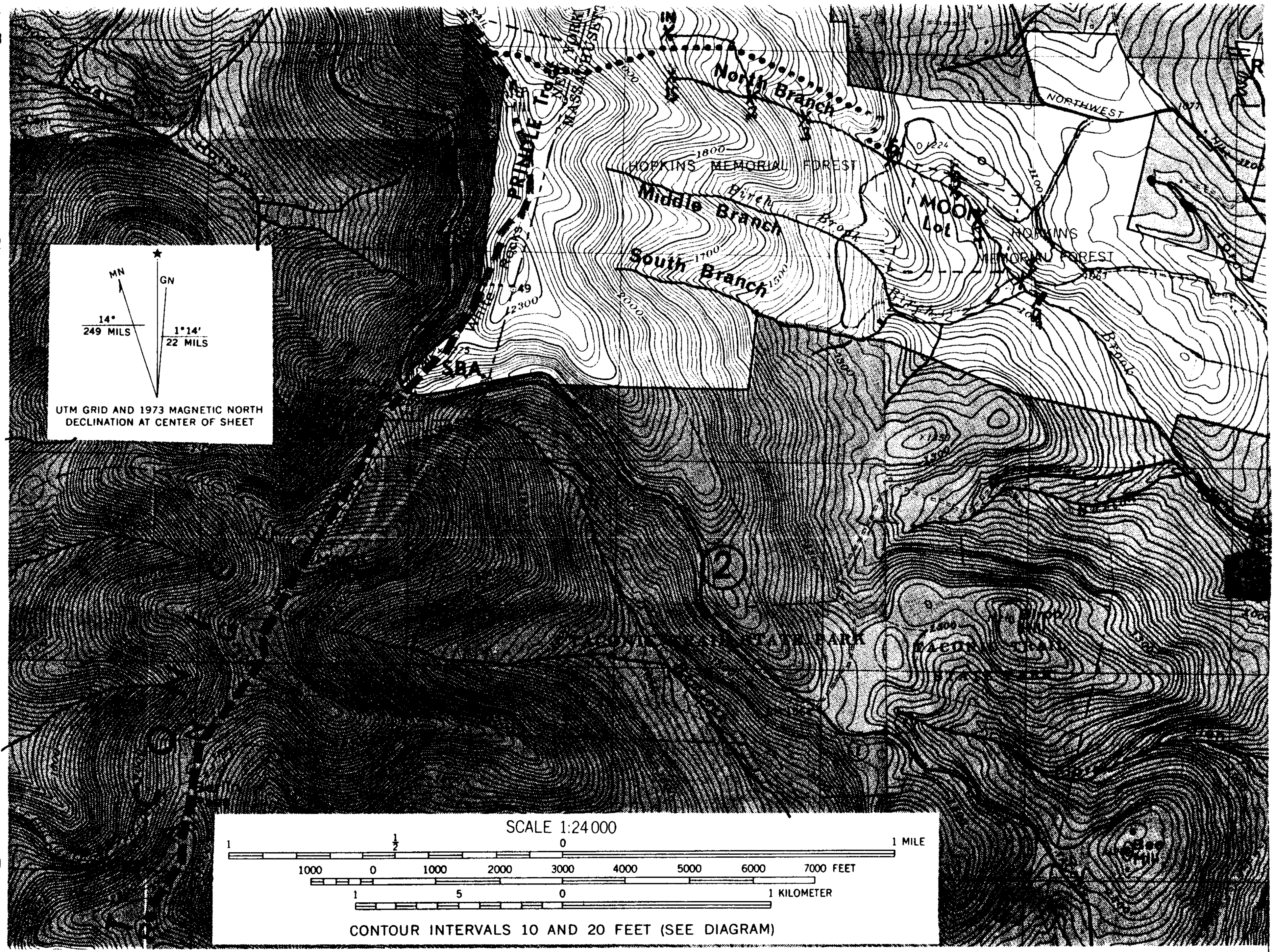
<u>Conclusions</u>

The ion concentrations in the brook were never excessive, and should not prohibit the drinking of the brook water. However, in some cases, the total or fecal coliform counts were somewhat high and in excess of federal primary drinking water

how? why?

standards. Thus, I would not recommend drinking this water. However, overall, it is very healthy, and if one wanted to drink this water, especially at higher elevations, one would be risking at most a stomach virus. No chance of toxic poisoning exists here, fortunately.

Appendix I



X = Sample sites

Loop Trail

Horse Trail

Birch Brook Trail

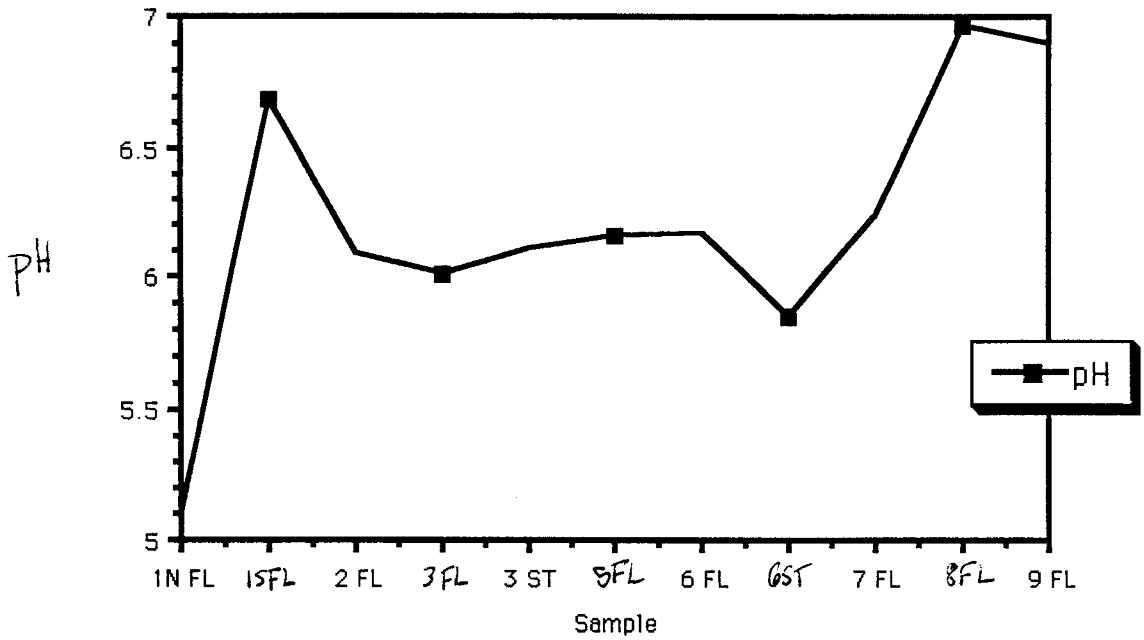
Taconic Crest Trail

Appendix 2

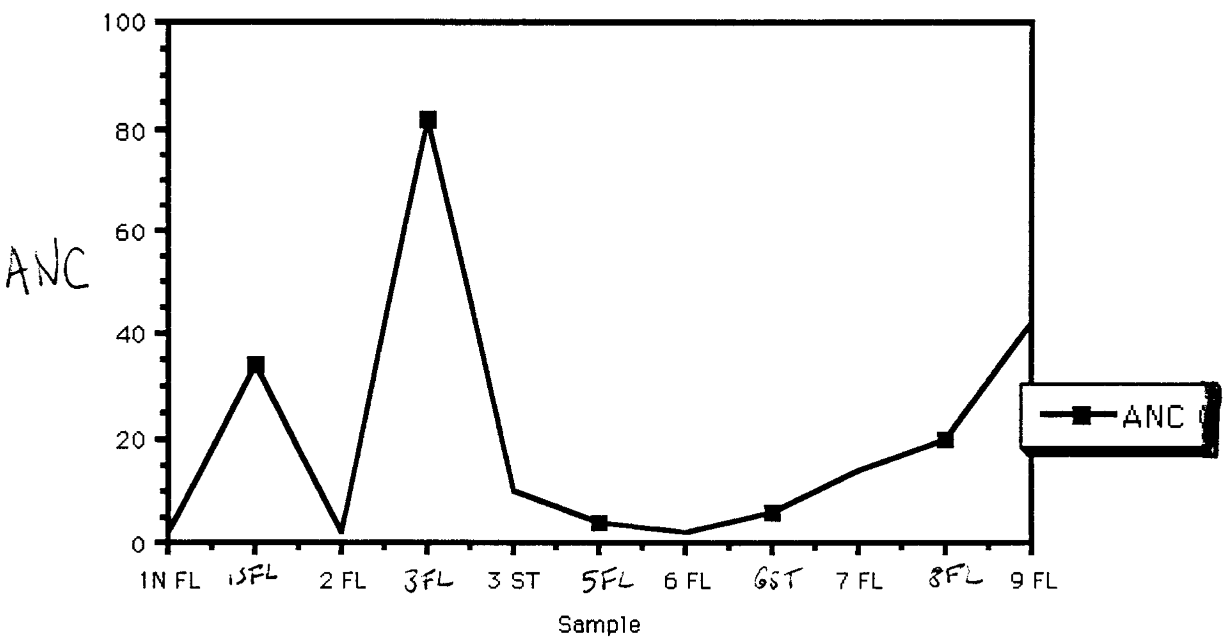
Sample	pH	ANC	Total Coliform (# colonies / 100 mL)	Fecal Coliform (# colonies / 100 mL)	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)
1N FL	5.12	2.00	130.00	3.00	1.88	0.61
1S FL	6.69	34.00	140.00	5.00	2.81	0.79
2 FL	6.09	2.00	100.00	0.00	2.30	0.69
3 FL	6.01	~~82.00~~	50.00	0.00	2.25	0.66
3 ST	6.11	10.00	80.00	1.00	2.32	0.68
5 FL	6.16	4.00	40.00	0.00	2.26	0.66
6 FL	6.17	2.00		0.00	2.25	0.63
6 ST	5.85	6.00	100.00	32.00	2.42	0.61
7 FL	6.24	14.00	80.00	19.00	2.32	0.63
8 FL	6.97	20.00	0.00	0.00	4.07	0.91
9 FL	6.90	42.00	30.00	19.00	3.40	0.89

Na^{+} (mg/L)	K^{+} (mg/L)	F^{-} (mg/L)	Cl^{-} (mg/L)	NO_3^{-} (mg/L)	SO_4^{-2} (mg/L)
0.39	0.07		0.44	0.89	5.63
0.54	0.28	0.00	0.49	2.75	4.46
0.38	0.08		0.45	1.40	5.21
0.44	0.13	0.01	0.34	1.30	5.22
0.38	0.10	0.00	0.33	1.26	5.28
0.37	0.08	0.00	0.33	0.93	5.63
0.46	0.11		0.49	0.87	5.63
1.04	0.10	0.02	0.96	0.05	6.23
0.43	0.08	0.00	0.32	0.67	5.77
0.47	0.11	0.01	0.32	0.43	6.03
0.42	0.08	0.00	0.31	0.72	5.47

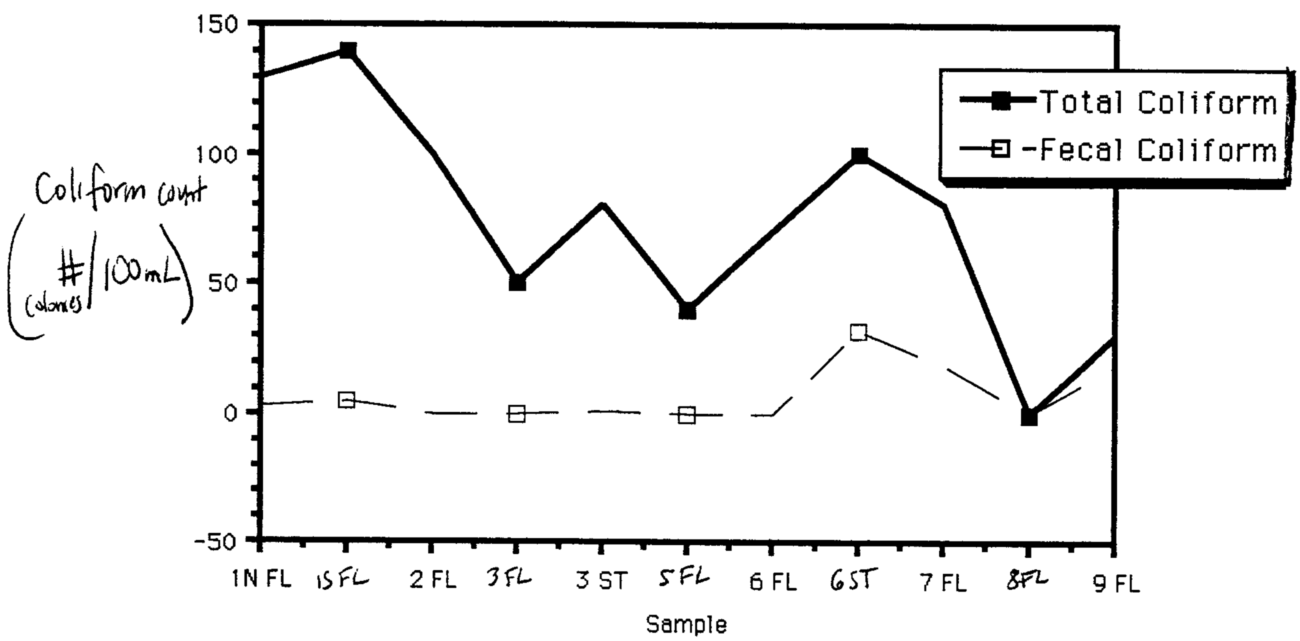
pH's for All Samples

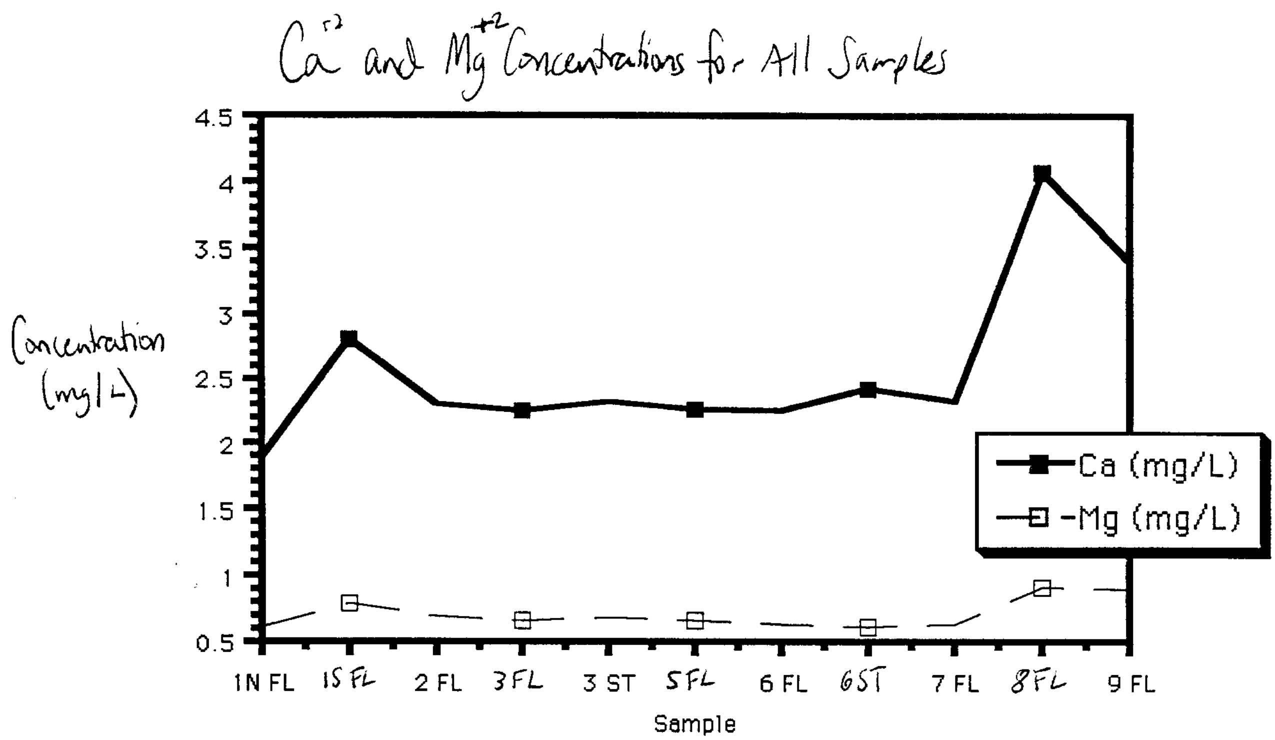


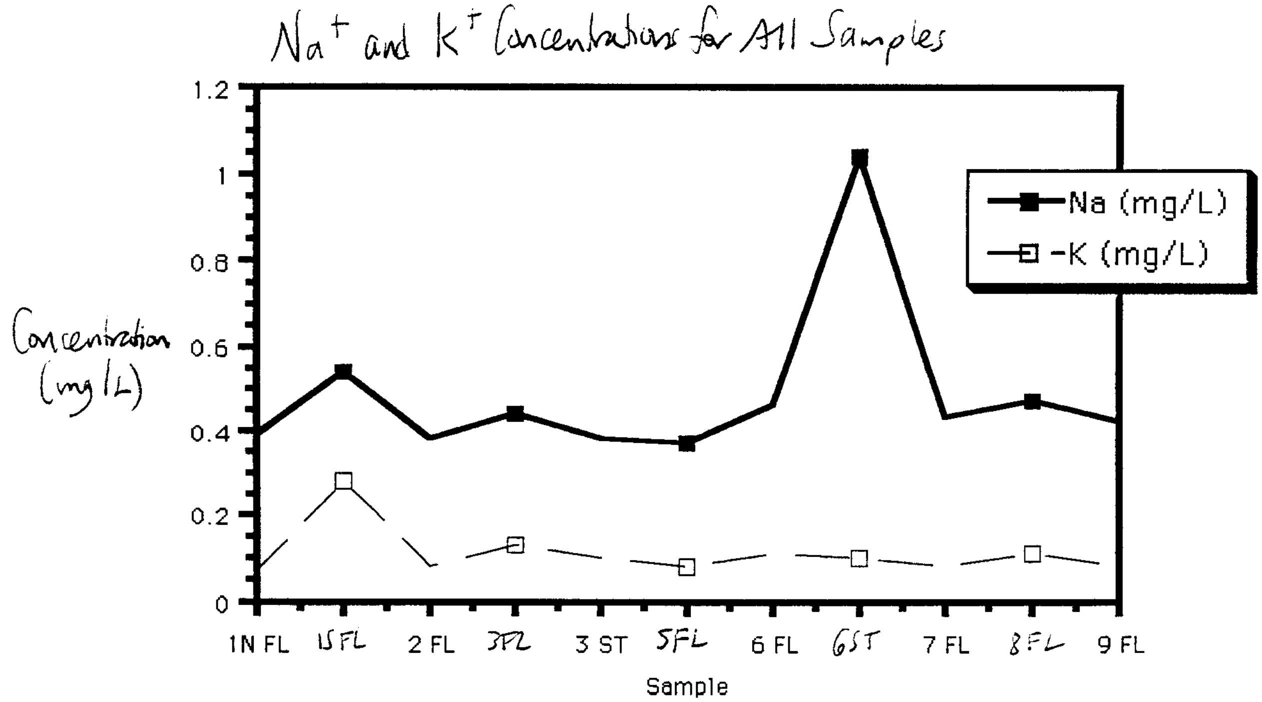
Acid Neutralizing Capacities for All Samples



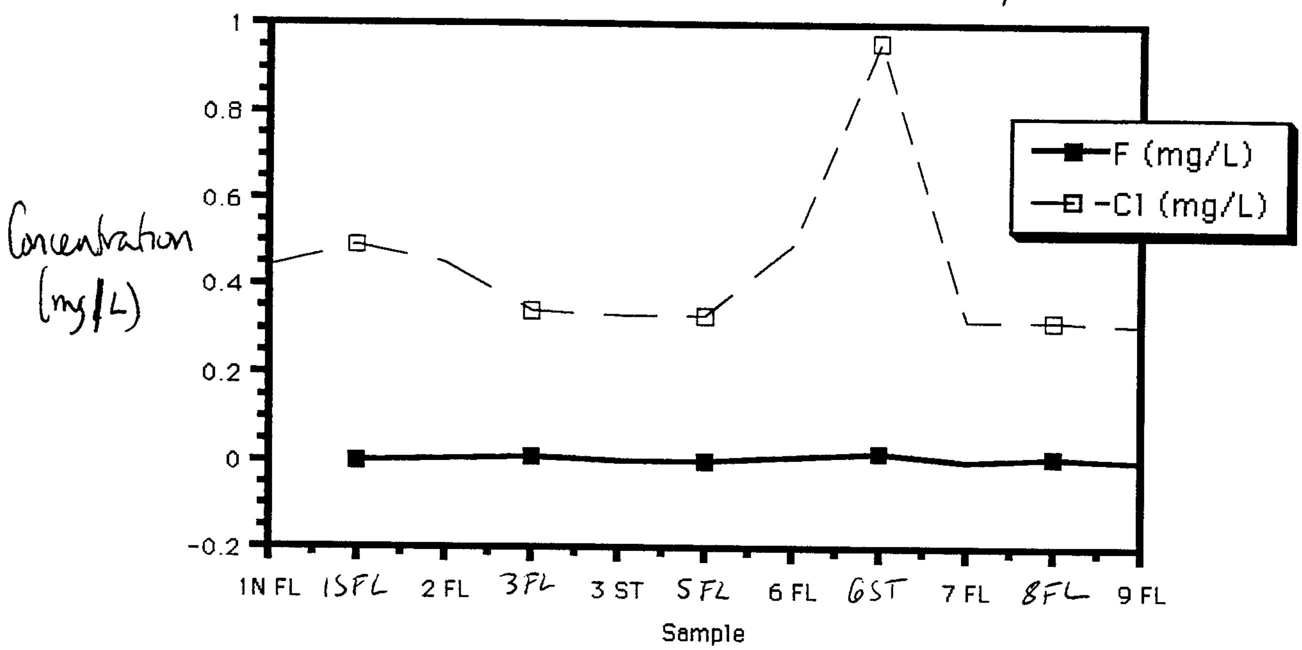
Total and Fecal Coliform Counts for All Samples



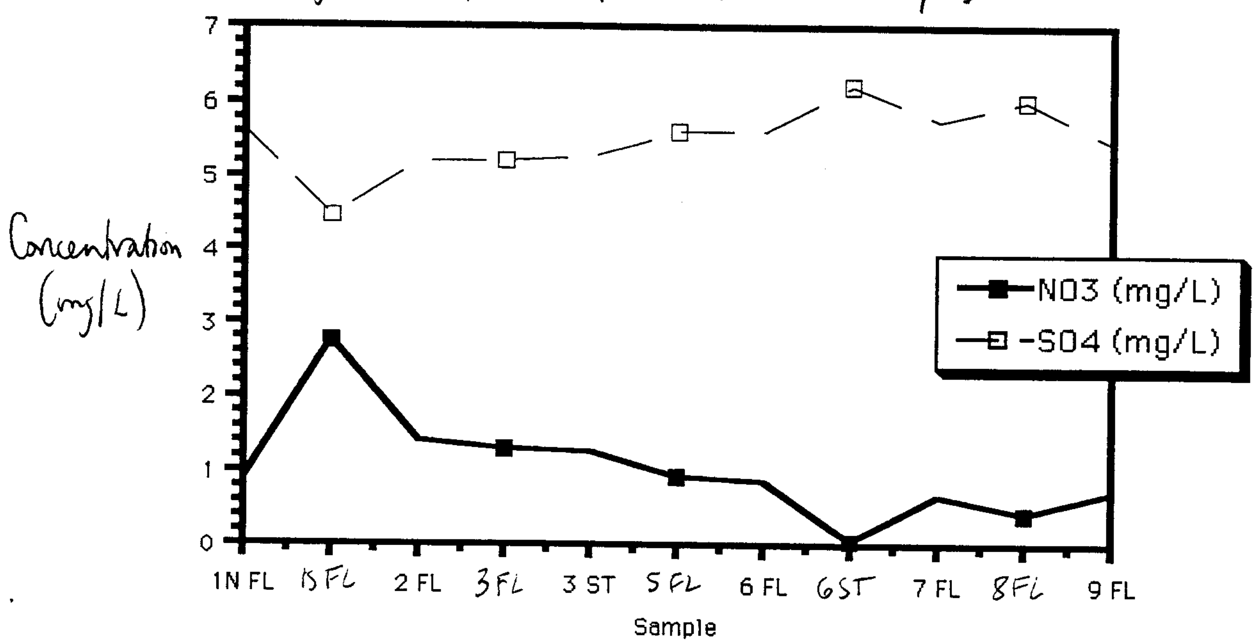

Ca+2 and Mg+2 Concentrations for All Samples
Concentration (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
Ca (mg/L)
Mg (mg/L)
1N FL
1S FL
2 FL
3 FL
3 ST
5 FL
6 FL
6 ST
7 FL
8 FL
9 FL
Sample


Na+ and K+ Concentrations for All Samples
Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
Na (mg/L)
K (mg/L)
1N FL
1S FL
2 FL
3 FL
3 ST
5 FL
6 FL
6 ST
7 FL
8 FL
9 FL
Sample

F^- and Cl^- Concentrations For All Samples

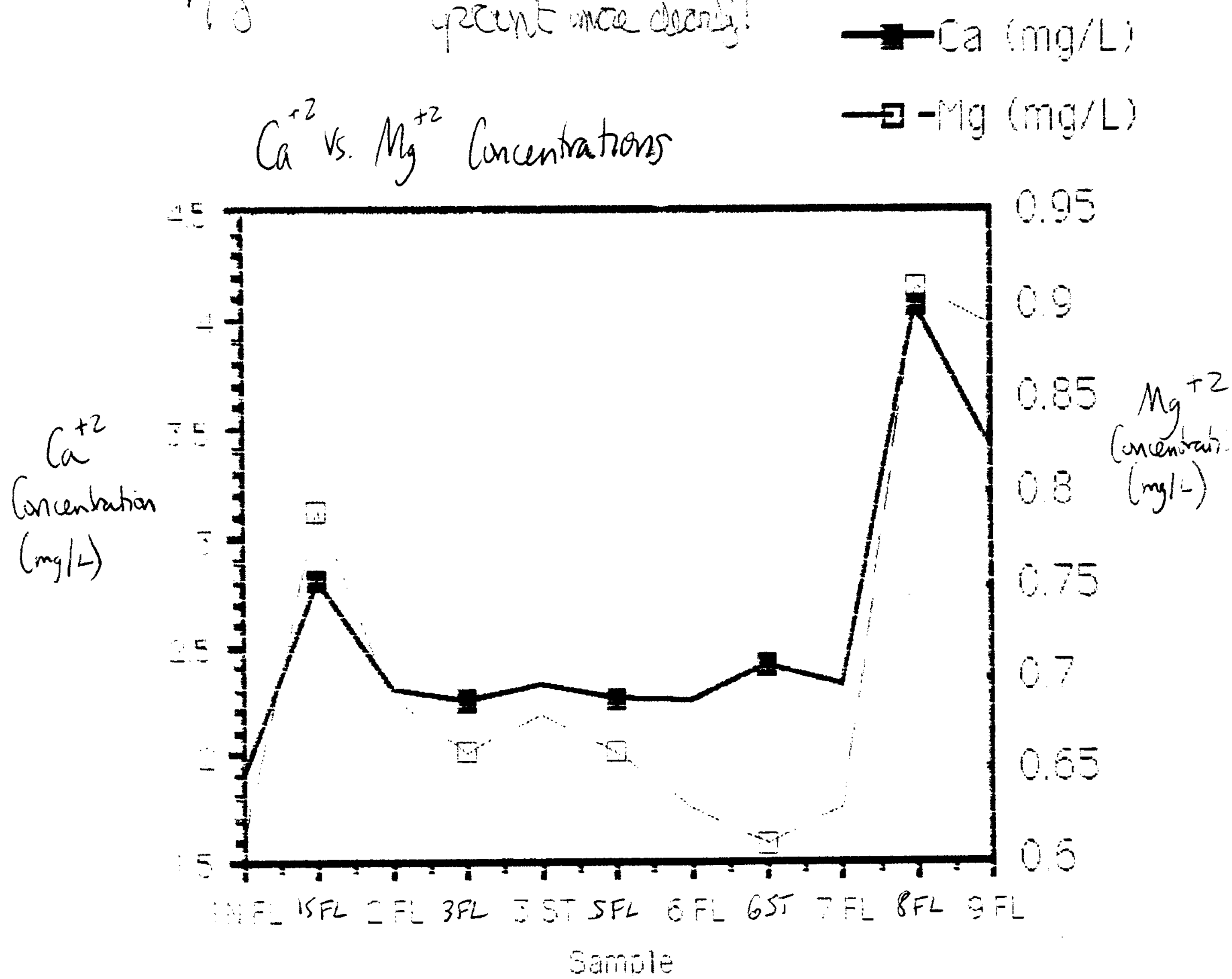


NO_3^- and SO_4^{-2} Concentrations for All Samples



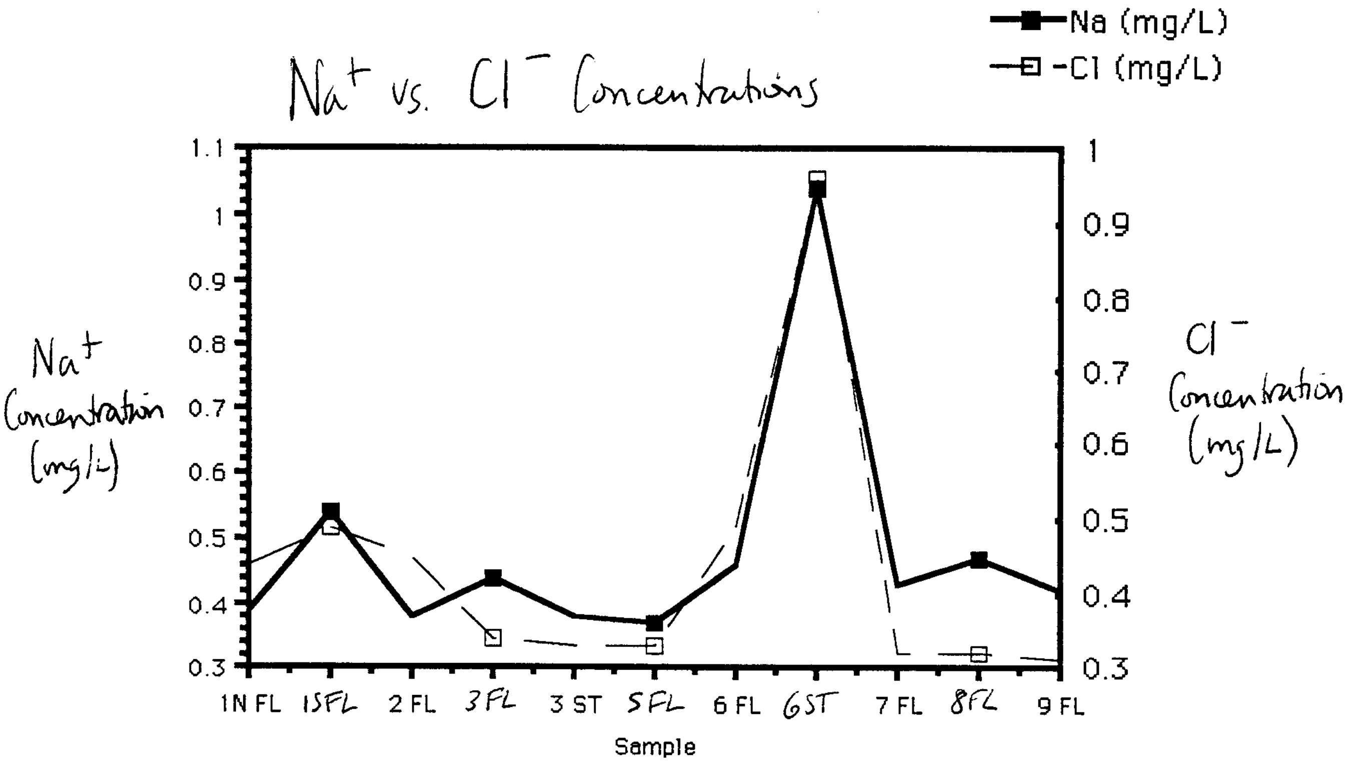
Appendix 3

x/y correlation would have made your point more clearly!



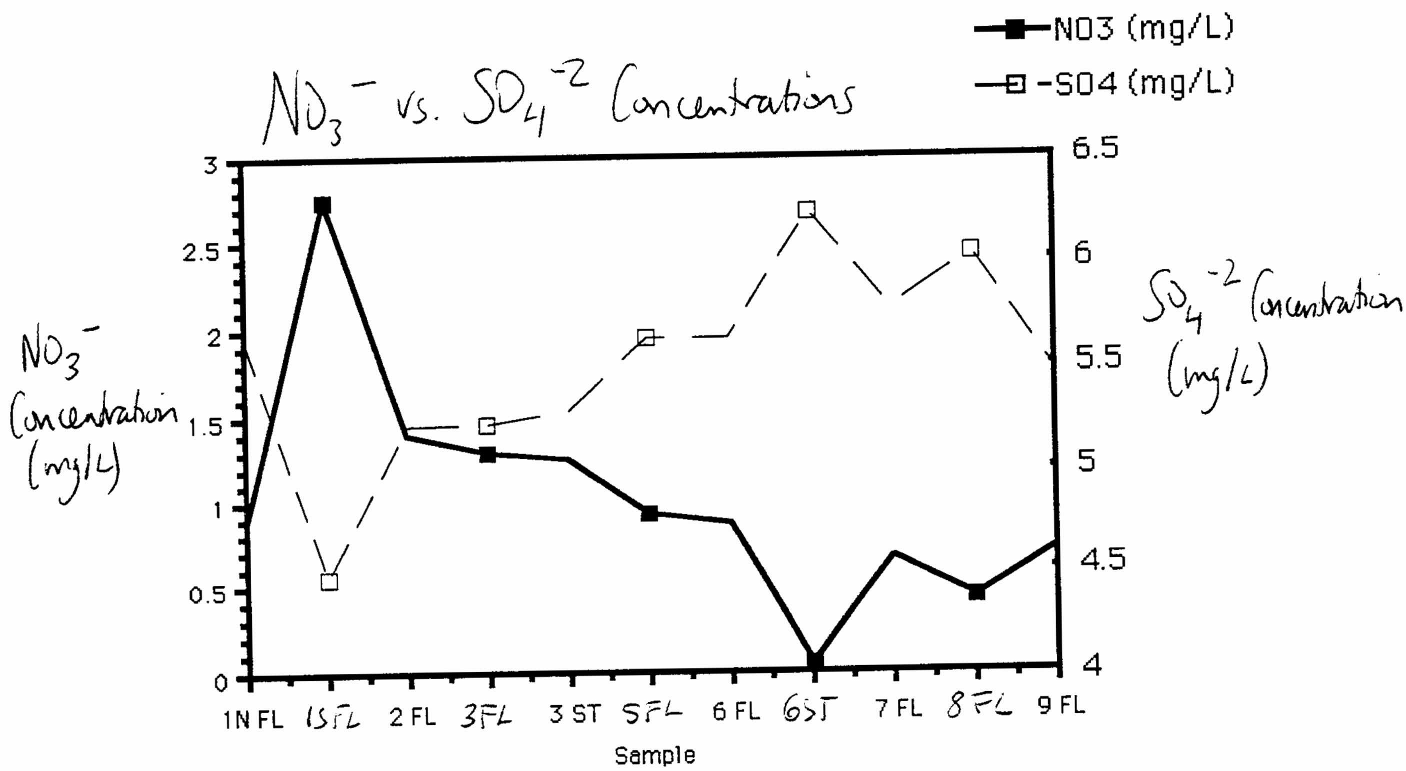
Ca^{+2} vs. Mg^{+2} Concentrations

Appendix 4



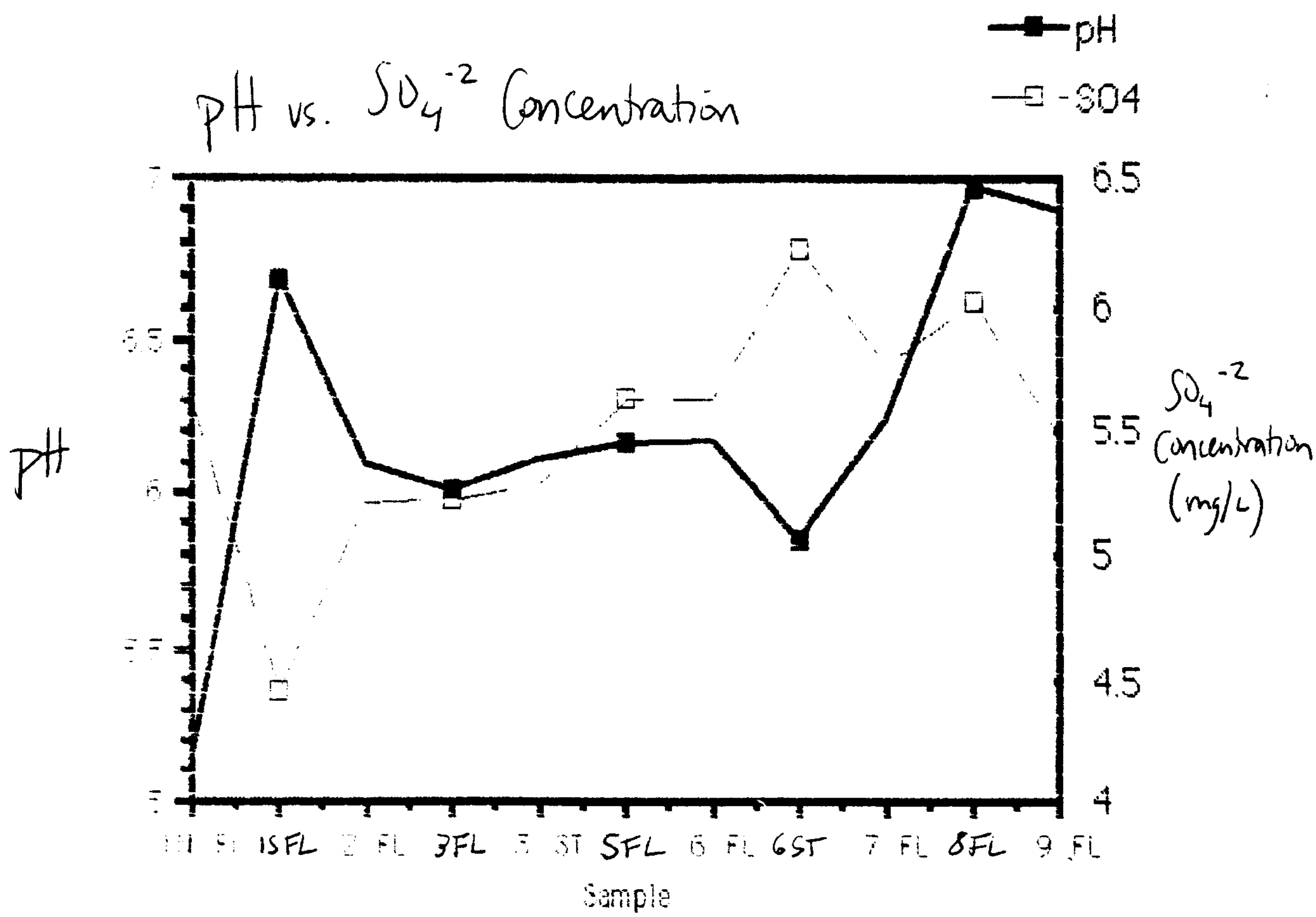
Na (mg/L)
Cl (mg/L)
Na+ vs. Cl− Concentrations
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Na+ Concentration (mg/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Cl− Concentration (mg/L)
1N FL
1SFL
2 FL
3FL
3 ST
5FL
6 FL
6ST
7 FL
8FL
9 FL
Sample

Appendix 5

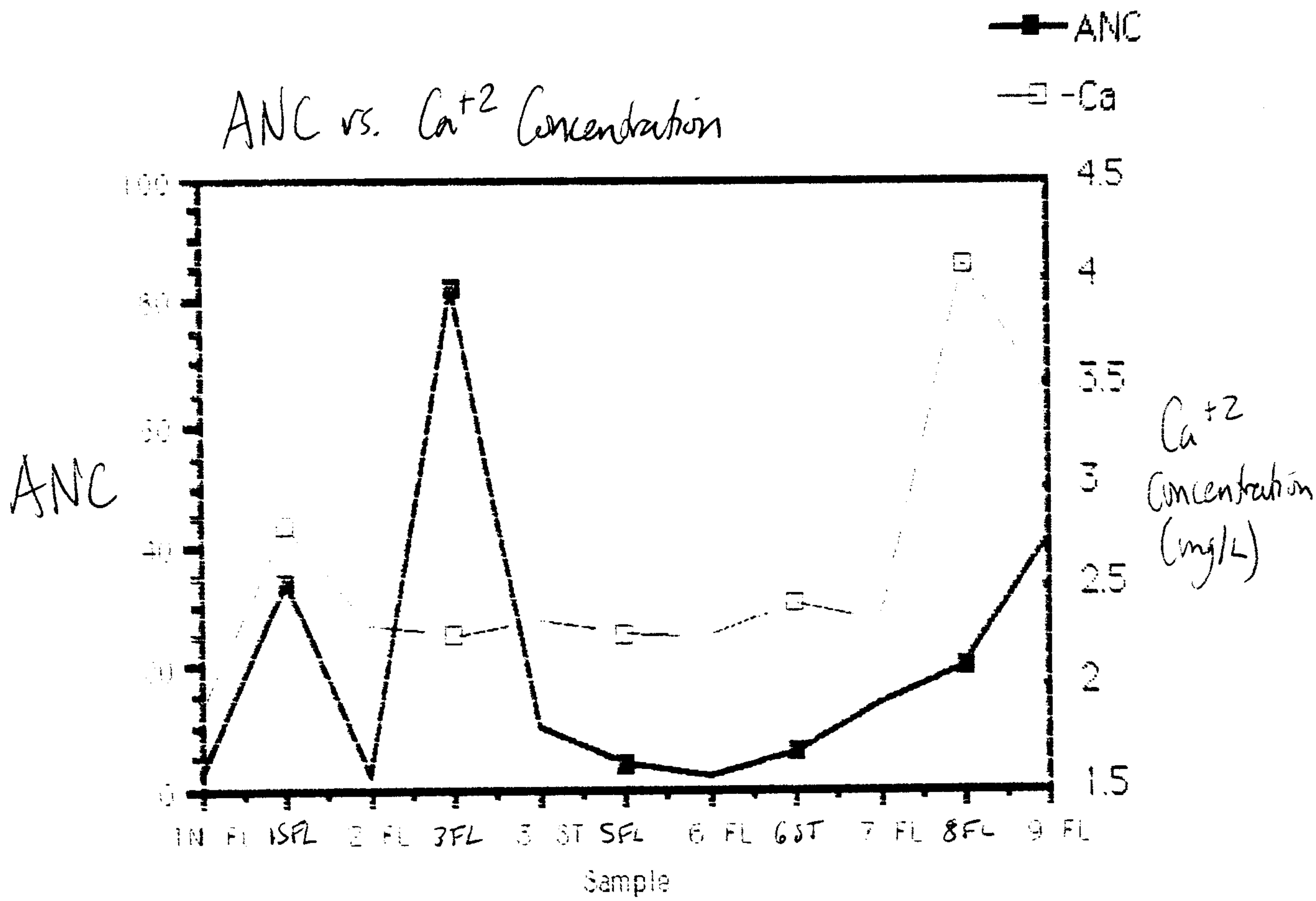


NO3 (mg/L)
-SO4 (mg/L)
NO_3^- vs. SO_4^{-2} Concentrations
NO_3^- Concentration (mg/L)
SO_4^{-2} Concentration (mg/L)
3
2.5
2
1.5
1
0.5
0
6.5
6
5.5
5
4.5
4
1N FL
1SFL
2 FL
3FL
3 ST
5FL
6 FL
6ST
7 FL
8FL
9 FL
Sample

Appendix 6


pH
SO4
pH vs. SO_4^{-2} Concentration
pH
SO_4^{-2} Concentration (mg/L)
6.5
6
5.5
5
4.5
4
1SFL
3FL
5FL
6ST
7 FL
8FL
9 FL
Sample

Appendix 7


ANC
-Ca
ANC vs. Ca+2 Concentration
ANC
Ca+2 Concentration (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1N FL
1SFL
2 FL
3FL
5 ST
5FL
6 FL
6ST
7 FL
8FL
9 FL
Sample

Appendix 8

Outflow rates on South Branch of Birch Brook

Provisional
1.18 km^2

Date	Birch Brook South AvgQ cfs	Birch Brook South PeakQ cfs	TimePeakQ
2/ 1/91	0.69	0.70	0:00
2/ 2/91	0.66	0.67	0:00
2/ 3/91	0.73	0.86	16:00
2/ 4/91	0.99	1.28	23:54
2/ 5/91	1.54	1.95	23:54
2/ 6/91	3.46	4.73	14:00
2/ 7/91	2.89	3.45	0:00
2/ 8/91	2.36	2.54	0:00
2/ 9/91	2.09	2.26	0:00
2/10/91	1.69	1.87	0:00
2/11/91	4.03	5.59	13:00
2/12/91	2.49	5.15	0:00
2/13/91	1.65	1.69	10:00
2/14/91	1.35	1.86	23:54
2/15/91	3.17	6.17	3:00
2/16/91	1.05	1.10	0:00
2/17/91	0.94	0.99	0:00
2/18/91	1.00	1.16	23:54
2/19/91	1.38	1.69	7:30
2/20/91	1.21	1.26	0:00
2/22/91	1.40	1.47	13:30
2/23/91	2.22	5.26	10:30
2/24/91	1.87	4.75	0:00
2/25/91	0.93	0.99	0:00
2/26/91	0.86	0.89	0:00
2/27/91	0.82	0.84	0:00
2/28/91	0.76	0.78	0:00
3/ 1/91	0.83	0.98	15:00
3/ 2/91	1.52	2.23	13:30
3/ 3/91	1.73	2.14	23:54
3/ 4/91	4.87	6.30	14:30
3/ 5/91	4.37	5.15	0:00
3/ 6/91	3.52	3.73	0:00
3/ 7/91	4.50	5.94	4:30
3/ 8/91	3.17	3.57	0:00
3/ 9/91	2.85	3.34	10:00
3/10/91	2.41	2.86	11:30
3/11/91	2.09	2.29	13:00
3/12/91	1.64	1.86	0:00
3/13/91	1.46	1.58	14:00
3/14/91	1.27	1.32	0:00
3/15/91	1.17	1.23	0:00
3/16/91	1.12	1.19	13:00
3/17/91	1.12	1.28	13:30
3/18/91	1.38	1.80	13:30
3/19/91	1.49	1.57	0:00
3/20/91	1.28	1.40	0:00
3/21/91	1.14	1.18	0:00
3/22/91	1.16	1.37	17:30
3/23/91	1.31	1.18	0:00
3/24/91	1.48	2.36	19:00
3/25/91	1.50	1.98	0:00
3/26/91	1.27	2.04	14:30
3/27/91	1.24	1.91	23:54
3/28/91	1.96	2.04	10:00
3/29/91	1.86	1.91	0:00
3/30/91	1.82	1.92	13:00
3/31/91	1.66	1.80	12:30
4/ 1/91	1.55	1.58	10:00

Date	Birch Brook South AvgQ cfs	Birch Brook South PeakQ cfs	TimePeakQ
4/ 2/91	1.39	1.47	10:30
4/ 3/91	1.35	1.41	0:00
4/ 4/91	1.32	1.42	14:30
4/ 5/91	1.29	1.31	0:00
4/ 6/91	1.29	1.31	23:54
4/ 7/91	1.30	1.33	10:30
4/ 8/91	1.33	2.04	23:00
4/ 9/91	2.21	3.68	14:00
4/10/91	2.46	3.02	3:30
4/11/91	2.33	2.36	0:00
4/12/91	2.18	2.24	0:00
4/13/91	1.97	2.07	0:00
4/14/91	1.88	2.04	15:30
4/15/91	1.84	2.43	17:30
4/16/91	1.78	1.91	0:00
4/17/91	1.69	2.86	22:30
4/18/91	2.00	2.50	0:00
4/19/91	1.73	1.85	0:00
4/20/91	1.56	1.62	0:00
* 4/21/91	2.36	3.09	12:30
4/22/91	2.62	2.69	0:00
4/23/91	2.52	2.64	15:30
4/24/91	2.32	2.36	10:30
4/25/91	2.18	2.26	0:00
4/26/91	1.93	2.05	0:00
4/27/91	1.82	1.98	16:00
4/28/91	1.60	1.63	0:00
4/29/91	1.46	1.53	0:00
4/30/91	2.36	3.86	11:30
5/ 1/91	2.87	3.15	0:00

* Day I took my samples with higher outflows.

ge 22

Appendix 9

<u>Data from Water Samples Collected Below Intersection of Birch and Buxton Brooks</u>

= highlights days with higher outflow/precipitation rates measured on Birch Brook, South Branch.

Rebecca E. (can get a diskette if you want

Date	Sample#	Ca, mg/L	Mg, mg/L	Na, mg/L	K, mg/L	NH3, mg/L	HCO3, mg/L	SO4, mg/L	Cl, mg/L	NO3, mg/L	pH	Conductivity
4/3/83	1.00	4.52	1.11	0.550	0.240	0.120	7.80	6.80	0.500	0.0800	6.80	38.0
5/15/83	2.00	4.45	0.800	0.650	0.200	0.150	11.3	7.40	0.300	0.110	6.60	37.0
6/19/83	3.00	7.65	1.50	0.730	0.340	0.260	23.4	7.90	0.0500	0.130	7.40	57.0
7/17/83	4.00	13.6	2.20	0.730	0.290	0.130	35.2	8.80	0.300	0.220	7.60	80.0
8/21/83	5.00	16.2	2.70	0.940	0.240	0.240	46.9	10.6	0.300	0.130	7.70	103
9/18/83	6.00	13.8	2.95	1.10	0.200	0.450	52.4	12.7	0.500	0.0700	7.70	108
10/16/83	7.00	13.7	2.90	0.940	0.580	0.130	46.0	11.0	0.500	0.120	7.60	96.0
11/20/83	8.00	9.70	1.96	0.770	0.260	0.0900	27.7	12.3	1.10	0.140	7.50	73.0
12/18/83	9.00	2.50	1.30	0.550	0.0800	0.130	8.40	7.90	0.600	0.0300	6.50	33.0
1/15/84	10.0	5.30	1.20	0.550	0.160	0.160	14.9	8.90	0.800	0.0600	7.20	47.0
2/19/84	11.0	3.60	0.930	0.730	0.200	0.210	8.10	7.40	0.700	0.0800	6.90	9.99
3/18/84	12.0	4.50	1.05	0.730	0.0800	0.340	12.7	7.90	1.00	0.130	7.10	9.99
4/15/84	13.0	3.24	0.700	0.450	0.0400	0.210	6.10	6.90	1.40	0.140	6.90	9.99
5/29/84	14.0	4.15	0.980	0.650	0.0600	0.190	7.40	7.70	1.50	0.0300	6.60	43.0
6/17/84	15.0	3.90	0.670	0.570	0.190	0.130	7.60	6.30	0.600	0.0400	6.30	9.99
7/31/84	16.0	13.9	2.18	1.65	0.460	0.150	47.5	8.60	1.30	0.0400	6.50	9.99
8/19/84	17.0	6.90	1.28	0.650	0.160	0.160	27.4	7.70	0.700	0.01000	6.80	9.99
9/16/84	18.0	8.30	1.49	0.620	0.200	0.240	18.0	7.70	0.700	0.0900	6.80	9.99
10/21/84	19.0	8.31	1.73	0.700	0.120	0.560	30.3	8.10	0.800	0.0300	7.00	9.99
11/18/84	20.0	11.1	2.33	0.970	0.330	0.430	31.0	10.7	1.10	0.0600	7.60	9.99
12/13/84	21.0	3.65	0.970	0.490	0.120	0.230	8.40	8.70	0.900	0.0200	6.80	9.99
1/20/85	22.0	4.10	0.860	0.300	0.170	0.340	9.80	8.30	0.930	0.0300	7.10	9.99
2/17/85	23.0	4.65	1.04	0.350	0.180	0.210	12.3	7.40	0.900	0.100	7.10	9.99
2/17/85	24.0	7.45	1.35	0.370	0.270	0.180	13.3	7.75	1.97	0.150	6.95	9.99
2/24/85	25.0	4.62	1.43	0.300	0.160	0.450	7.34	6.75	0.850	0.0900	6.81	9.99
3/17/85	26.0	4.60	1.05	0.850	0.180	0.210	5.88	6.90	4.56	0.110	6.40	9.99
4/21/85	27.0	9.60	1.22	0.400	0.120	0.180	15.8	7.40	0.930	0.0200	7.30	9.99
5/19/85	28.0	8.50	1.47	0.950	0.230	0.120	21.8	7.15	1.65	0.0300	7.10	9.99
6/17/85	29.0	8.00	1.57	0.370	0.170	0.130	19.9	6.80	0.450	0.01000	7.43	9.99
7/21/85	30.0	13.5	2.35	0.500	0.170	0.140	34.7	8.50	0.510	0.110	7.62	9.99
8/18/85	31.0	25.6	1.74	0.500	0.330	0.350	38.6	8.65	1.17	0.0800	7.62	9.99
9/23/85	32.0	13.6	2.01	0.850	0.170	0.230	45.8	10.0	1.40	0.0300	7.31	9.99
10/21/85	33.0	24.0	2.58	2.15	0.330	0.170	63.1	11.4	2.23	0.01000	7.86	9.99
11/26/85	34.0	9.48	1.05	1.45	0.170	0.140	23.5	9.65	2.27	0.0400	6.51	9.99
12/10/85	35.0	9.60	1.05	1.30	0.330	0.230	27.1	8.90	1.97	0.0300	6.88	9.99
1/20/86	36.0	10.5	1.08	2.13	0.500	0.320	28.3	8.85	2.72	0.0500	7.00	9.99
2/24/86	37.0	12.4	1.08	2.02	0.0300	0.160	25.2	8.60	2.53	0.0400	6.95	9.99
3/26/86	38.0	8.00	1.14	1.45	0.170	0.110	23.0	8.15	1.94	0.01000	6.15	9.99
4/22/86	39.0	8.84	0.900	1.92	0.170	0.0900	29.5	8.35	2.42	0.120	7.35	9.99
							51.0	8.40	2.35	0.0200	7.93	9.99
5/19/86	40.0	13.9	2.01	2.52	0.170	0.100	28.6	6.74	0.450	0.0500	7.39	9.99
6/16/86	41.0	9.96	0.750	0.470	0.330	0.180	22.8	7.20	0.840	0.0800	7.29	9.99
7/21/86	42.0	7.67	1.14	0.510	0.200	0.220	16.8	4.59	0.250	0.140	7.10	9.99
8/15/86	43.0	5.43	0.230	0.210	0.560	0.320	17.3	4.48	0.690	0.140	7.01	9.99
9/22/86	44.0	5.84	0.580	0.710	0.240	0.180	22.6	5.76	0.780	0.120	7.12	9.99
10/20/86	45.0	6.76	1.24	1.35	0.700	0.450	29.8	6.41	1.36	0.0800	7.25	9.99
11/17/86	46.0	10.7	0.820	0.970	0.170	0.120	21.8	2.72	0.490	0.0600	7.23	9.99
12/15/86	47.0	6.41	0.980	0.940	0.230	0.0900	14.6	2.36	0.760	0.230	7.60	9.99
1/12/87	48.0	3.99	1.02	0.430	0.370	0.250	13.7	7.12	1.01	0.210	7.12	9.99
2/9/87	49.0	4.72	1.51	0.530	0.120	0.450	17.0	7.88	0.630	0.130	6.98	9.99
3/9/87	50.0	5.13	2.01	0.610	0.540	0.390	19.0	8.89	0.670	0.150	7.54	9.99
4/6/87	51.0	6.98	1.52	0.720	0.190	0.220	16.8	8.72	1.23	0.220	7.39	9.99
5/4/87	52.0	7.59	1.38	0.490	0.150	0.180	27.4	7.74	0.890	0.190	7.24	9.99
6/1/87	53.0	8.24	1.76	1.21	0.270	0.270	37.4	9.12	0.960	0.240	7.19	9.99
7/2/87	54.0	10.9	2.30	1.62	0.350	0.130	24.5	8.93	0.420	0.160	7.38	9.99
8/10/87	55.0	7.56	1.79	1.32	0.490	0.250	36.5	10.7	0.690	0.110	7.68	9.99
9/8/87	56.0	13.1	0.860	2.13	0.320	0.310	37.7	6.76	0.890	0.0800	7.29	9.99
10/8/87	57.0	11.2	0.940	2.24	0.190	0.360	23.3	8.12	1.12	0.150	7.13	9.99
11/2/87	58.0	8.56	0.760	1.52	0.110	0.460	17.0	9.79	1.36	0.170	7.01	9.99
12/3/87	59.0	7.12	1.23	0.540	0.540	0.760	11.0	8.23	0.740	0.250	7.56	9.99
1/10/88	60.0	5.50	0.890	0.420	0.320	0.230	15.1	7.89	0.830	0.380	6.88	9.99
2/2/88	61.0	5.45	1.20	0.870	0.270	0.450	21.4	4.76	0.910	0.470	7.62	9.99
3/1/88	62.0	6.37	0.870	1.03	0.840	0.760	8.88	6.38	1.07	0.750	6.85	9.99
4/4/88	63.0	2.91	0.940	0.920	0.220	0.970	17.3	7.88	1.14	0.790	7.19	9.99
5/2/88	64.0	5.86	0.870	1.12	0.340	0.460	24.0	9.08	0.990	0.970	7.28	9.99
6/13/88	65.0	7.23	1.12	2.01	0.570	0.870	26.9	10.7	1.21	1.00	7.20	9.99
7/11/88	66.0	10.9	0.830	0.490	0.230	0.760	14.6	9.32	0.870	0.740	6.98	9.99
8/8/88	67.0	9.46	0.980	0.760	0.450	0.340	16.8	7.65	0.970	0.340	7.39	9.99
9/6/88	68.0	6.78	0.940	0.870	0.340	0.370	46.4	8.96	1.29	0.00	7.77	92.0
10/4/88	69.0	14.5	3.06	1.44	0.350	0.0600	20.7	8.89	1.62	0.930	7.37	64.0
11/15/88	70.0	7.47	1.49	1.04	0.200	0.0400	14.6	8.30	0.740	1.01	7.05	9.99
12/30/88	71.0	5.51	1.28	0.410	0.0800	0.100	21.0	8.83	0.540	0.890	7.24	55.0
2/6/89	72.0	6.79	1.55	0.440	0.0800	0.0800	19.0	8.82	0.860	1.27	7.20	59.0
3/7/89	73.0	7.50	1.63	0.500	0.170	0.0800	18.8	8.32	0.910	2.16	7.24	61.0
3/20/89	74.0	7.22	1.76	0.450	0.210	0.0600	14.6	8.47	0.790	3.95	7.17	48.0
5/1/89	75.0	7.92	1.60	0.630	0.170	0.0400	10.5	7.82	0.710	1.47	6.90	43.0
5/15/89	76.0	5.15	1.19	0.550	0.220	0.0300	11.7	7.32	0.650	1.54	7.21	39.0
6/12/89	77.0	4.94	1.17	0.490	0.170	0.0500	31.5	7.88	0.450	0.630	7.32	74.0
8/21/89	78.0	9.30	2.82	0.610	0.190	0.0400	36.6	8.04	0.400	0.940	7.37	83.0
9/4/89	79.0	10.5	2.72	0.720	0.230	0.0900	22.7	6.50	0.530	1.12	7.20	45.0
10/30/89	80.0	5.13	1.35	0.540	0.240	0.0700	15.4	6.90	0.850	1.38	7.43	44.0
							20.0	7.70	0.800	1.49	7.29	53.0
11/26/89	81.0	5.05	1.26	0.560	0.160	0.100	15.1	6.54	0.660	3.10	6.97	36.8
1/10/90	82.0	6.69	1.58	0.660	0.140	0.0200	17.6	6.92	0.560	1.54	7.27	43.5
3/19/90	83.0	3.88	0.960	0.560	0.130	0.0200	14.9	6.94	0.990	1.75	7.30	43.0
4/30/90	84.0	4.97	1.15	0.680	0.170	0.0200	19.0	7.29	0.430	1.43	7.42	48.0
5/29/90	85.0	5.09	1.14	0.650	0.170	0.0200	39.0	7.82	0.460	1.43	7.70	99.0
6/25/90	86.0	6.19	1.49	0.510	0.180	0.0700	16.8	5.64	0.470	2.31	7.11	48.0
8/1/90	87.0	9.19	2.06	0.600	0.270	0.0700	31.2	7.45	1.02	0.00	7.48	70.0
8/6/90	88.0	5.95	1.38	0.430	0.480	0.0700	16.1	7.25	1.00	0.480	7.33	46.0
10/15/90	89.0	8.88	2.12	0.600	0.500	9.99	11.0	6.84	0.450	1.13	7.06	34.0
11/25/90	90.0	5.45	1.29	0.530	0.190		14.1	7.84	0.560	0.990	7.18	
12/24/90	91.0						12.7	7.30	0.460	0.770	7.15	
1/22/91	92.0											
2/18/91	93.0											
4/29/91	94.0											