Examining Sources and Results of Pollution in Christmas Brook: An Independent Research Project

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Environmental Studies 102
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From its origin near Stone Hill to its outflow at the Green River, Christmas Brook provides a fascinating and challenging micro-example of how a stream runs its course, and especially how can become polluted along the way. My independent research project attempts to study water quality in this brook in order to determine how, when, and why it gets polluted. As well, I would like to use this data to assess what effects this pollution might have on vegetation and wildlife, both along Christmas Brook and in the Green River. In doing all this, I hope to be able to paint an accurate picture of Christmas Brook's evolving water quality and related ecosystem--from its relatively pure beginning between Stone Hill and Cluett Hill, down along Gale Road, across the Taconic Golf Course, under Williams College buildings and parking lots, and ultimately into the Green River (see Map 2). I ultimately want to find out why the water entering the brook is not chemically the same as the water leaving the brook.

Background

Before I actually began doing field work and research for this project, I hypothesized that the Taconic Golf Course, which runs along a quarter of the brook's length (see Map 1), was the major contributor of pollutants to what otherwise might be considered a "clean" stream (e.g. similar to Birch Brook). Furthermore, I believed that before the golf course opened (on April 22) there would be fewer pollutants entering the brook than there would be afterward, when pesticide spraying became intense. And finally, I felt that pollution coming from residential homes located upstream, along Gale Road and Stone Hill, would be negligible. Basically, I wanted to lay responsibility for Christmas Brook's pollution on the golf course.

To be safe, though, I surmised that there were probably at least three main sources of pollution which enter the brook: septic tank and old sewer

effluents, road salts, and pesticides, especially. Other factors such as backyard gardens, automobile exhaust and fluids, residential construction, and fertilizers from Weston Field might also contribute pollution. Since the soil in Christmas Brook's drainage basin (see Map 3) is characterized as "well drained and moderately well drained, stony, limestone soils with hardpans on uplands with slopes less than 15 percent" (General Soil Map, Town of Williamstown), it is certainly possible that any of the above factors could contributed pollutants to the brook. In other words, this soil composition is conducive to carrying pollutants quickly and efficiently through the drainage basin and into the brook. With this information and theoretical framework in mind, I began in earnest to test my hypothesis and determine the sources (and effects) of pollution in Christmas Brook.

think not only about pollutants, but pathways - are they there?

look at the well map

not really -- let's talk somewhere about how these soils work

Methods and Materials

By sampling water and observing algal growth at intervals along the brook, I hoped to scientifically determine types and sources of pollution which enter the brook. Since this particular brook can be examined virtually from start to finish, I was afforded the opportunity to pinpoint specific factors which contribute to the contamination of Christmas Brook. This seems to be an unusual opportunity since most rivers and streams have a wealth of factors which contribute to their contamination by humans. In this study, I originally felt there were few factors.

you said this before

Sampling of the brook was undertaken at five different sites, as well as at a sixth site along the Green River (see Map 1). It is important to mention a few site characteristics so that I might explain the logic and reasoning behind the choice of each individual site. Sites are clearly denoted on Map 1. (Note: At the time of sight selection, I was still assuming that most of the pollution would be coming from sources on the golf course.

spell it right

Therefore, I wanted to pinpoint where on the course pollutants were coming from.)

Site #1 was supposed to measure the level of pollution generated along the upper third of the brook. This area can best be characterized as gradually sloping to the northeast, with residential homes sparsely dotting its length. The area between Gale Road and the brook is generally wooded, with a dense, thorny underbrush. On the opposite side of the brook, or the north slope of Stone Hill, there is more forestation which gives way to grassy fields. Perhaps this area was once used for farming. The homes furthest from Gale Road are not connected to town sewer lines; they use septic tanks. The specific site, which was used on two separate occasions for sampling, is characterized by a moderate level of water flowing through fallen trees, mulch, and grasses at a steady pace. Gray algae grows fairly abundantly along the brook's bottom. No visible pollutants were present. Samples were taken from the center of the stream, as water passed over a cement ledge (probably once part of a home foundation).

Site #2 is located about 50 yards beyond Gale Road, just after the fourth tee on the golf course. This site was selected for its proximity to the road and the wetland area located adjacent to the golf course. As well, this is the last site which is does not come into contact with pesticides used on the golf course. This sampling site is characterized by a rocky and fine pebbled streambed, swift water running through mulch and tree roots, as well as a rusty pipe running along this narrow section of the brook. Only a little gray algae was present. Water samples were taken from the swiftest moving section of the stream by partially submerging the bottle.

Site #3 is located about 150 yards further down stream, just beyond a small pond and just before a major tributary (which originates near the

comes downhill to that point!

intersection of South Street and Gale Road). This site was chosen for its proximity to both a green (the third) and a fairway (the fourth). Since different pesticides are used for different parts of the course, this seemed to be a logical place to detect various pollutants. Also, the brook contains little mulch, brush, or trees at this point. However, tall grass and deep green algae are abundant. This is true not only at the sampling point, but also along the entire area from pond to pond on the course (see Map 1).

how do you know?

Site #4 is the last location related to the golf course. The samples were taken from a human-made dam at the end of the pond on the 18th fairway. The pond itself allows ample opportunity for sedimentation of pollutants as well as absorption of pollutants by vegetation. The reason I chose to sample the outflow of this pond is that I want to know what pollutants flow downstream, rather than what is absorbed in the pond. The dam provides a small waterfall from which samples were taken. Traces of foam were observed downstream, as were fallen trees and dense shrubbery. Unlike the previous sampling area (and the area between the ponds) this sampling site had little algae present. It was gray, not green, in color.

thanks

] as it's English

Site #5 was the final sample site on Christmas Brook--since the location of the outflow into the Green River was unaccessable. This is due to the fact that the brook flows underground until it cascades out of a sheer concrete wall just of Water Street and into the Green River. Thus the location of this last site is just beyond the Weston athletic fields at the edge of Latham Street, immediately before the brook disappears into a storm drain. This site, much like site #3, is characterized by tall grasses and few trees or shrubs alongside the brook. Also, the algae is again abundant and deep green in color. Samples were again taken by partially submerging the bottles in the swiftest moving section of the brook.

no.... you could have!

Site #6 is located on the Green River, just upstream from the Christmas Brook outflow. The river was flowing moderately fast the first time samples were taken, and the water had a silty coloring. The second time samples were taken, the Green was green and water flow had dropped precipitously. The riverbank is lined by trees and sparse shrubbery. Little algae was present during either sampling. Sample bottles were filled by wading out a few feet into swifter water where they were partially submerged.

In terms of specific analysis which was performed once samples were collected--first on April 19 and then again on April 26--I conducted ion chromatograph, as well as fecal and total coliform tests. All of these experiments were undertaken the same day that the samples were collected. The IC test was used to isolate specific compounds present in the brook and in the river. All samples were filtered before being tested. The fecal and total coliform tests were used to detect pollutants. As their names imply, the fecal test detects feces in the samples and the total test detects overall pollution in the samples. Both the IC and coliform tests yielded intriguing results which led to a reassessment of my original hypothesis. However, before I revise my original theories the test results and their implications should be examined.

Data and Results

According to my original expectations, the level of pollution in Christmas Brook should have been minimal at site #1, similar at site #2, significantly higher at site #3, somewhat higher still at site #4, and somewhat lower at site #5. Also, levels of all pollutants should have been higher at site #5 that at site #6 on the Green River. That was my hypothesis, anyway.

This would imply considerable knowledge about the Green River

The results of the IC test yielded detectable concentrations of chloride (CL), nitrates (NO3), and sulfates (SO4). However, the changes in concentration of these compounds from sample site to sample site was not as I originally predicted. Nonetheless, the data collected from both sets of samples is certainly nontrivial. Much information can be culled from my IC data, which is displayed in the following table and in graphs 1, 2, and 3.

IC Test Results

Samples (4-19)	Cl	NO3	SO4	Samples (4-26)	Cl	NO3	SO4
			Christmas Brook				
Site #1	1.60	0.40	**8.12**	Site #1	1.63	0.51	**9.28**
Site #2	**5.77**	0.89	8.64	Site #2	**6.58**	1.13	9.60
Site #3	5.89	0.93	8.78	Site #3	7.85	0.98	10.14
Site #4	6.80	**2.76**	**11.63**	Site #4	**10.45**	**2.32**	**13.04**
Site #5	**8.34**	2.59	12.19	Site #5	9.58	2.36	12.92
			Green River				
Site #6	**4.36**	3.67	**6.56**	Site #6	**6.08**	3.73	**8.29**

Figures which appear in bold face indicate points where the concentration of a compound either increased or decreased dramatically. For a clearer indication of relative changes in the amount of a particular compound detected by the IC, again refer to graphs 1-3. At this point it is worth noting a few striking features of this data. First, and most obviously, this data shows that Christmas Brook contributes relatively high concentrations of chloride and sulfates into the Green River. (Remember that actual compound concentrations which enter the Green may be even higher due to additional road salts and pollutants which Christmas Brook may acquire while travelling underground.) Looking only at samples taken April

19th, it appears that the brook was contributing almost doubly concentrated levels of chloride and sulfates into the Green River.

A second interesting result of the IC test is that despite eminent danger of nitrate pollution in the brook by residential septic tanks and pesticides on the golf course, the Green River still maintained a higher concentration of nitrates. This is not to say that Christmas Brook is unpolluted, rather it indicates that the Green River must have significant sources of nitrate pollution along its banks. Good point (perhaps like many Christmas Brooks)

The final observation which seems interesting, though it creates more questions than it answers, is that the results varied from sample period to sample period--especially regarding chloride and sulfates. One reason for this discrepancy may have to do with the relative water flow levels on those two days. Using flow data collected on Birch Brook as an indicator of flow levels in Christmas Brook, it appears that the average water flow for April 19 was about twice as high as the flow on April 26. On the 19th, Birch Brook averaged 4.79 cubic feet per second (a moderate flow) as compared with 2.00 cfs (a low flow) on the 26th (see graph 4). At this point I will not speculate as to why the flow level may have changed chloride or sulfate levels in the brook and river; however I would like to highlight this fact. ← and coming off a period of high flow

The fecal and total coliform tests also yielded interesting results. However, much like the rest of the data, these results also may have generated more questions than they answer. The data provides more perspectives from which we can examine levels and types of pollution in the brook and river. The fecal test will most likely indicate pollution by septic tank effluent or manure, while the total coliform will indicate more general pollution by Cl, NO3, and SO4--as well as pollution by trace levels of other compounds. The coliform test results are as follows:

Fecal and Total Coliform Test Results

Sample (4-19)	Fecal	Total	Sample (4-26)	Fecal	Total
			Christmas Brook		
Site #1	2	**56**	Site #1	2	34
Site #2	1	35	Site #2	1	31
Site #3	0	26	Site #3	0	24
Site #4	**4**	11	Site #4	0	13
Site #5	1	12	Site #5	2	**48**
			Green River		
Site #6	**2**	48	Site #6	0	40

a nice, consistent set.

Clear results from the coliform tests are difficult to discern. Nonetheless, two possible patterns and two definite questions seem to emerge from the results. First, it appears as though there is a generally higher level of fecal pollution when the brook and river are at higher water flows. The notable exception to this pattern occurs at sample site #5, but the discrepancy is only 1. This deviation may be explained by the random sampling technique employed for this project.

The second pattern also relates to the high water flow. It appears that there is a consistently higher level of total coliform in samples taken on April 19 than in those taken on April 26 (see notable exception at site #5 again). In this pattern, though, it is more difficult to attribute the high level of total coliform at site #5 (on the 26th) to random error. Clearly, there is something unique about the coliform samples taken from this site on the second date. Again, I will leave speculation for the discussion section. My questions, then, are best left for later since they ask why a few total and fecal coliform test results vary so drastically over the course of a week.

coliforms generally quite low on your tests!

The final and perhaps most significant data I collected comes from Peter Lund, Head Greenskeeper at the Taconic Golf Course. He revealed that

the course had not been sprayed with pesticides or fertilized until May 2--almost one week after my final samples were taken. Thus, none of my samples were measuring pollutants which were added to the course since November, 1988. In essence, my original hypothesis was going to be incorrect insofar as I was not going to be measuring recent surface pollution of the golf course. Mr. Lund did indicate that residuals from last year's spraying and fertilization would probably still be entering the brook. Thus my discussion will focus less on short-term surface pollution by the golf course, and more on long-term "trickle-down" pollution.

To give an idea of the breadth and magnitude of sprays and fertilizers used on the course, I was able to obtain information on the pesticides which have been added to the course since May 2. They are Dursban 4e, Chipco 26019, and Mocap. Dursban is a liquid used to kill weevils, which is applied by spraying at the rate of 1 1/2 ounce per 1000 square feet. It is diluted to a 4% solution. Its chemical name is chlorpyrifos and its compound is C9H1003PSNCl3. Chipco is a flowable powder which is dissolved in an alcohol solution. It is used to retard leaf blight by being sprayed at the rate of 8 ounces per 1000 square feet (in a 5% solution). Its chemical name is Iprodione and its compound is C13H13Cl2N3O3. Mocap was also used to kill white grubs (Japanese beetle larvae). It is a granular insecticide used at a rate of 20 pounds per square acre. Its chemical name is ethyl dipropyl phosphorodithioate.

According to Mr. Lund, these three chemicals, along with all other compounds used on the course, have an absorption rate of at least 95% in the first 1 inch of turf. Of course, if these chemicals are exposed to bare soil or cart paths they will tend to leech off. However, if and when this happens, the runoff generally ends up filtering through turf before it percolates

through the soil, toward the brook. Unless there were to be a direct spill of chemicals into the brook, Mr. Lund claims that his chemicals will not adversely affect the brook. He professes to follow EPA procedures to the letter of the law; and the agency's warning on all his chemicals states: "Prevent from entering any streams, ditches, or bodies of water." He says that the Taconic Golf Course and its greenskeepers do just that.

what about fertilizers?

Discussion and Conclusions

your results look excellent!

Due to the non-specific nature of many of my results, I believe it will be more fruitful to incorporate my various conclusions into the broader discussion section. This will allow me greater freedom to present different conclusions, each of which may explain the pollution which permeates Christmas Brook. More likely, though, a combination of conclusions will together explain pollution in the brook. In order to come to these conclusions, I will systematically discuss pollution at each of the sample sites, hypothesize how it got its current level of pollution, and determine potential effects of the pollution on the ecosystem. By doing all this, the conclusions will be formed and I will understand much better, though never completely, how Christmas Brook's pollution and affected ecosystem got to its current state.

isn't this strong?

to current

Returning to site #1, which I originally hypothesized as relatively clean and pollution-free, it is now apparent that I was mistaken. Based on both the IC tests and on the cloriform tests, it looks as though the residential development along the upper fourth of Christmas Brook significantly contaminates the water. Three observations in particular lead me to this conclusion. First, the IC reading for sulfates was extremely high at 8.12 ppm. I am not at all convinced I know why there are so many sufates, since traditional sources of SO4 stem from factory byproducts, burning of fossil

no, no natural

fuels, and automobile exhaust. There are no factories, little automobile traffic, and little burning of fossil fuels by residential homes. Thus there must be another source of SO4. Perhaps some septic tank effluents contain sulfates (though generally just nitrates), maybe construction of the Gale-Ide sewer system generated sulfates which are slowly seeping into the water system, or possibly the ongoing construction of residential housing along Gale Road and Stone Hill generate the compound. Finally, I suppose the brook could receive runoff which comes into contact with sulfur deposits (though the soil composition in the area is generally limestone). I simply do not have a good answer.

However, by examining the fecal and total coliform, it appears that there is some seepage of septic tank effluent into the brook. Although nitrate levels are low, fecal matter was detected and there is an abundance of total coliform bacteria. This indicates that either some source of manure, perhaps from a backyard garden, or septic tank leakage is entering the stream. As well, the extremely high number of total coliform indicates that perhaps some undetected pollutants are also present in the water. Finally, the presence of only a little gray algae along this section of the brook indicates that there are few phosphates or nitrates upon which the algae flourish.

The second site is less than one quarter mile past the first, yet its characteristics have changed rather dramatically. Specifically, less fecal and total coliform was detected--perhaps as a result of filtration and sedimentation which takes place in the wetland adjacent to the golf course and Gale Road--and chloride levels increased dramatically. The net result of this change in chemical composition on vegetation in the brook seemed minimal. Perhaps there was even less gray algae than before. Otherwise

site #2 looked much like the first. The increased Cl be attributed mostly to road salt, as the brook passes directly beneath Gale Road. Another potential source of salt is from minimal contact with the golf course and its pollutants. This contact with the course might also explain the slight increases in NO3 and in SO4.

Site #3, which is located just below the first pond on the golf course, shows the first long term effects of the pesticides and fertilization used on the course. Even though the coliform tests shows a large drop off in bacteria detected, and the IC results show no dramatic increases in chemical concentrations, effects are still clearly visible. The fact that the pond filtered out many new pollutants did not dampen the visible bright green algae which begins just below its dam. This algae is a strong indicator that undetected pollutants, perhaps phosphates, carbons or other growth-inducing compounds, are continuing to seep into the brook. This is occurring despite the fact that no spraying or fertilization has been done since November. In this section, many small sized trout are visible as well.

The algae continues its green path along the brook until reaching a second pond. It is the outflow of this second pond that yields sample site #4. The results taken from this site show an increased fecal count on one of the two days, and increases in chloride, nitrates and sulfates. The incresed fecal count can be explained by noting that between sites three and four a tributary (which comes from around the intersection of Gale Road and South Street--see map 1) feeds into the brook. During higher water flows, it is likely that effluent from leaky septic tanks in this area are deposited downstream in Christmas Brook. This would explain the high fecal count at site #4. To explain the increased levels of the various compounds, it is worth topographically important to note that most runoff from the course occurs

before the fourth site. Thus, only by the time the brook runs across much of the golf course does it pick up perceptible increase of chloride, nitrates, and sulfates. All of these are commonly found in golf course fertilizers and pesticides. The one real mystery about site #4 is that is has only a little gray algae. One possible explanation for this decrease in healthy algal growth is that the organics which are causing its growth get filtered out by plants and sedimentation while moving slowly in the pond. This would be further evidence to support the idea that there are undetected pollutants in the brook.

Site #5 lies at the end of Weston field, just below Latham Street. This site is somewhat of an enigma since it defies the patterned results displayed by the previous four sites. This site had increase fecal and total coliform counts in periods of low water flow, decreasing concentrations of compounds detected by the IC, and--unlike the fourth site--deep green algal growth. The algal growth might be explained by runoff of fertilizers and pesticides from the Weston playing fields. This would be an effect similar to that displayed between the third and fourth sampling sight, where the algae was also bright green. In terms of the IC and coliform test results, I simply do not know why these results deviate from the rest of the study. However, I do have a hypothesis: If there happens to be a significant, purer runoff, which I was unable to detect in the form of a tributary, from the area across the brook from the playing fields, then it is possible that this other runoff could dilute the concentrations of compounds tested by the IC. As well, this unknown runoff could also be the source of the additional fecal and total coliform bacteria. Like I stated earlier, this is just one possibility. Perhaps absorption by vegetation and mulch helped purify the water. Or perhaps my

you're OK

sample was taken in too close a proximity to Latham Street to yield an untainted sample. This is another open ended area in my conclusion.

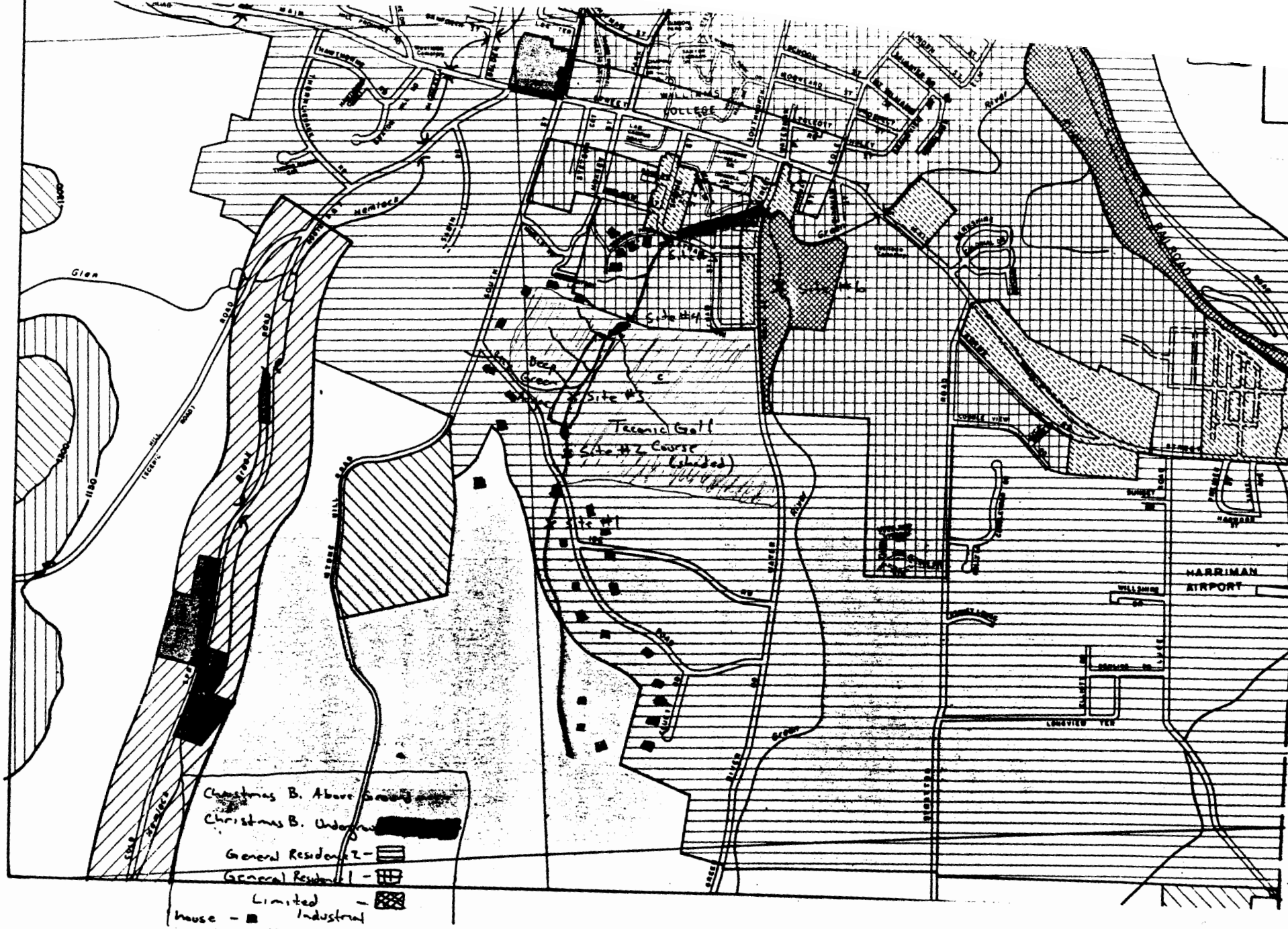
Finally, site #6 gave a basis for comparison so that I might be able to determine relative levels of pollution in the brook. Based on the IC results primarily, it appears that Christmas Brook is a minor aggravation to the already polluted Green River. By adding chloride and sulfate concentrated water to the Green, Christmas Brook is a net polluter. This does not even take into account additional pollution generated in the underground segment of the brook. If this data were available, it is very likely that the brook would be an even greater source of pollution to the Green River.

Steps should be taken upstream, especially on the Taconic Golf Course and in the residential area above site #1, to cut back on pollution generating practices--especially in the use of fertilizers and pesticides. These seem to be the major long term contributors, let alone potential short term contributors such as accidental pesticide spills, to the continued abusive pollution of the Green River and subsequently the Hoosic River. Once specific polluters can be further isolated, they can be curtailed. However, if the current trend of allowing small amounts of pollution continues, then we can never hope to clean our rivers and streams. We must start the clean up effort in our own backyards...and on our own college golf course.

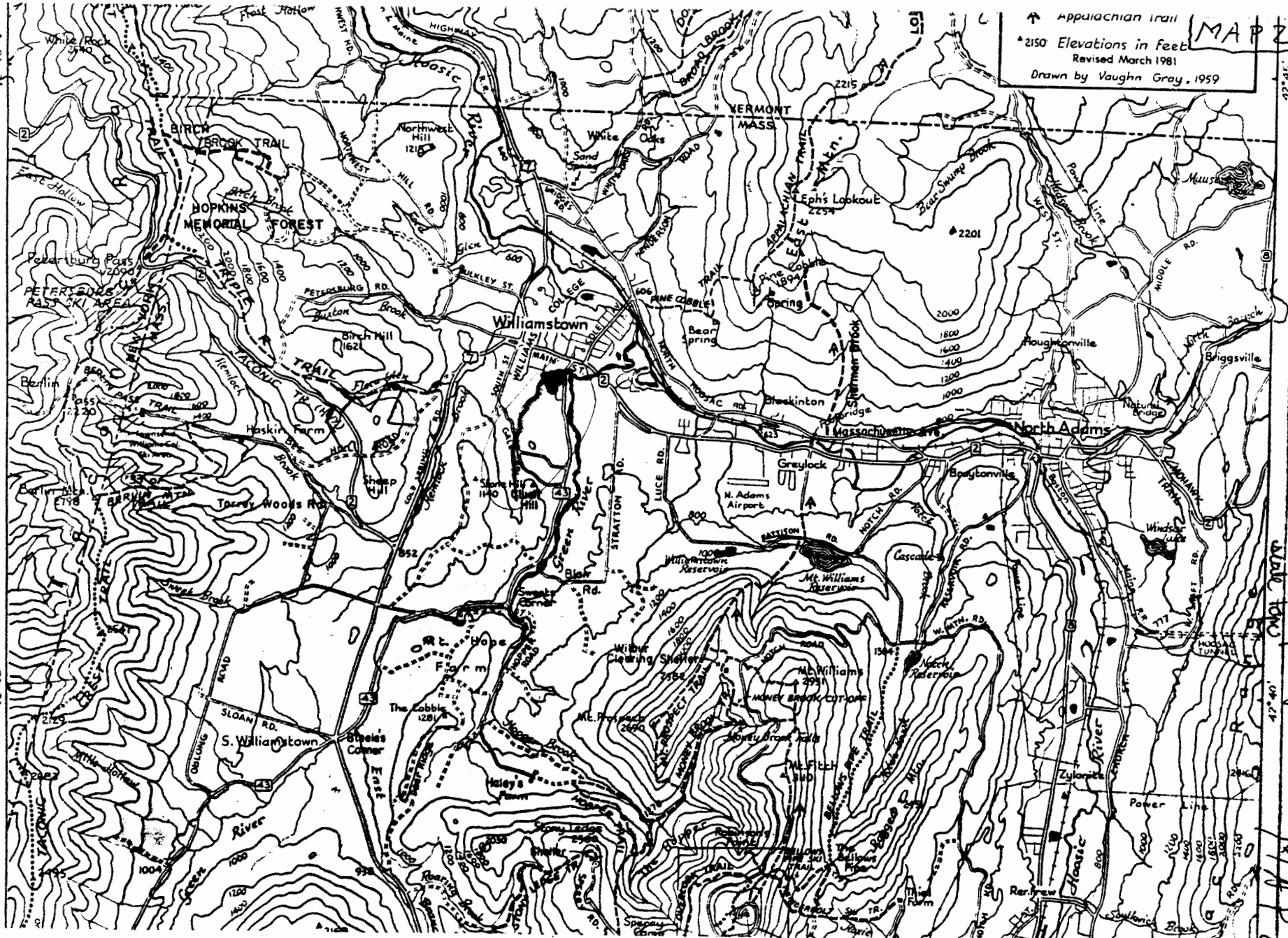
how much are we worried

Greg - Good paper and good analysis, except your discussion fails to highlight what your data show.... the importance of non-golf course sources! And you could have helped your case by using some general references on what you'd expect for water quality. The Cl, in fact, as your key, since it almost surely represents effluent!

David


Glen
Beep Green
Site #3
Tecnic Golf
Site #2 Course
(closed)
Site #1
HARRIMAN
AIRPORT
Christmas B. Above
Christmas B. Under
General Residential 2 -
General Residential 1 -
Limited Industrial -
House -

Outing Club
Williamstown
d March 1981)



General Soil Map

Town of Williamstown

LEGEND

1 - EXCESSIVELY DRAINED AND WELL DRAINED SANDY AND GRAVELLY SOILS ON TERRACES WITH SLOPES GREATER THAN 15 PERCENT.

2 - EXCESSIVELY DRAINED AND WELL DRAINED SANDY AND GRAVELLY SOILS ON TERRACES WITH SLOPES LESS THAN 15 PERCENT.

3 - WELL DRAINED AND MODERATELY WELL DRAINED SILTY SOILS ON FLOOD PLAINS.

4 - WELL DRAINED AND MODERATELY WELL DRAINED STONY, ACID SOILS WITH HARDPANS ON UPLANDS WITH SLOPES GREATER THAN 15 PERCENT.

5 - WELL DRAINED AND MODERATELY WELL DRAINED STONY, ACID SOILS WITH HARDPANS ON UPLANDS WITH SLOPES LESS THAN 15 PERCENT.

6 - POORLY DRAINED AND VERY POORLY DRAINED MINERAL SOILS.

7 - VERY POORLY DRAINED ORGANIC SOILS.

8 - WELL DRAINED AND MODERATELY WELL DRAINED, STONY, LIMESTONE SOILS WITH HARDPANS ON UPLANDS WITH SLOPES GREATER THAN 15 PERCENT.

9 - WELL DRAINED AND MODERATELY WELL DRAINED, STONY, LIMESTONE SOILS WITH HARDPANS ON UPLANDS WITH SLOPES LESS THAN 15 PERCENT.

10 - SHALLOW TO BEDROCK SOILS AND DEEP, WELL DRAINED AND MODERATELY WELL DRAINED STONY SOILS WITH HARDPANS ON UPLANDS WITH SLOPES GREATER THAN 15 PERCENT.

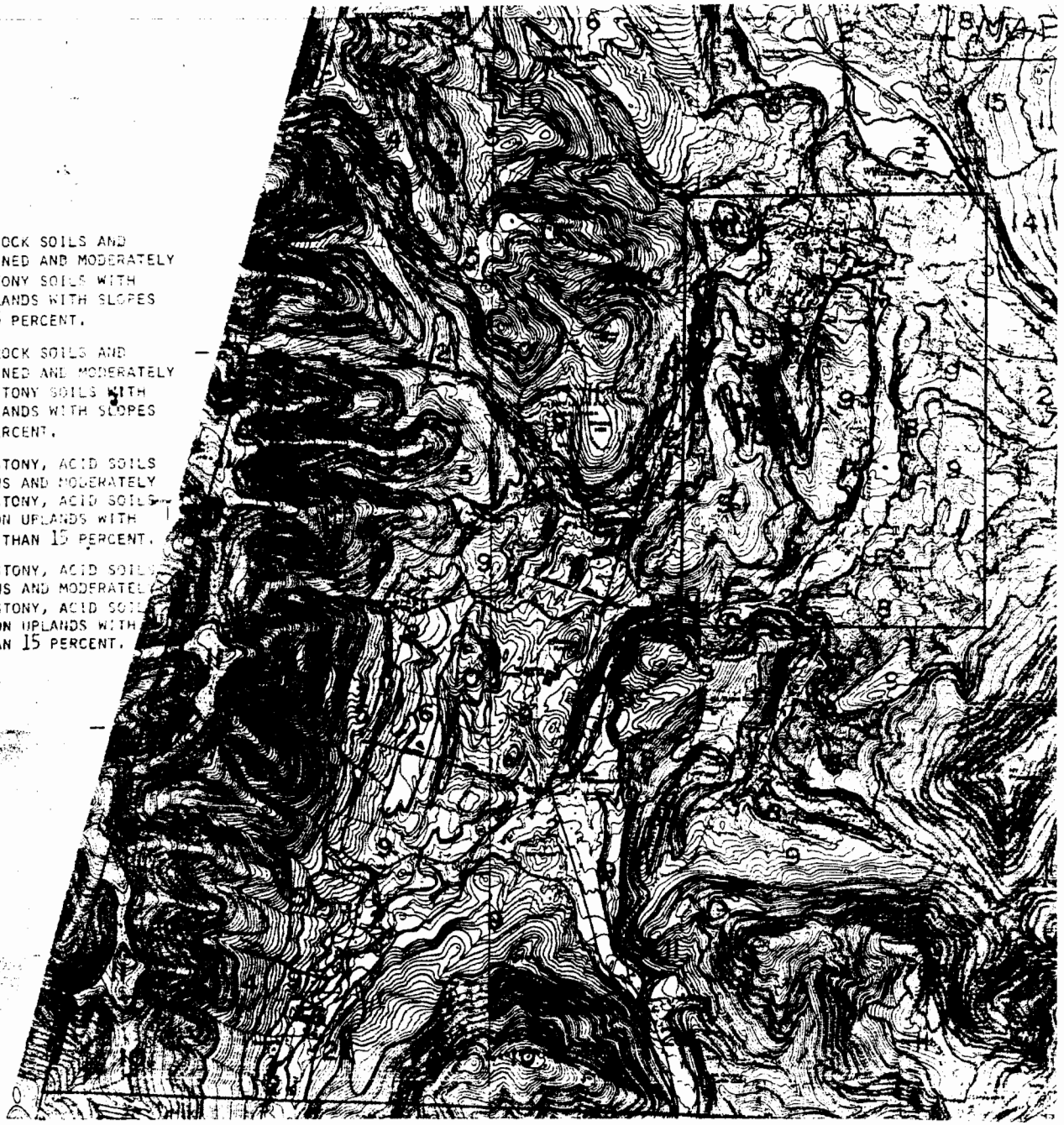
11 - SHALLOW TO BEDROCK SOILS AND DEEP, WELL DRAINED AND MODERATELY WELL DRAINED, STONY SOILS WITH HARDPANS ON UPLANDS WITH SLOPES LESS THAN 15 PERCENT.

14 - WELL DRAINED, STONY, ACID SOILS WITHOUT HARDPANS AND MODERATELY WELL DRAINED, STONY, ACID SOILS WITH HARDPANS ON UPLANDS WITH SLOPES GREATER THAN 15 PERCENT.

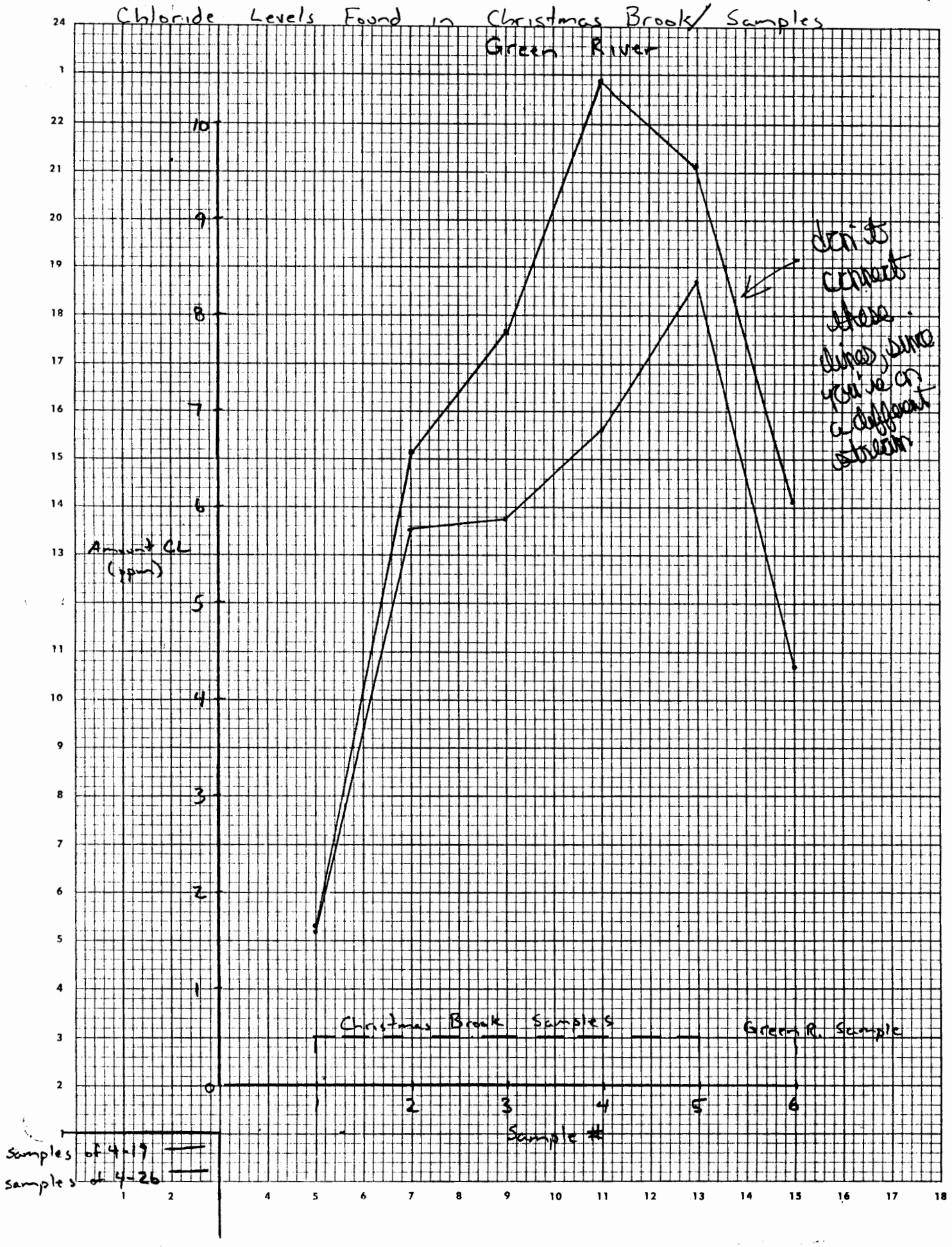
15 - WELL DRAINED, STONY, ACID SOILS WITHOUT HARDPANS AND MODERATELY WELL DRAINED, STONY, ACID SOILS WITH HARDPANS ON UPLANDS WITH SLOPES LESS THAN 15 PERCENT.

Approximate Drainage Area

INFORMATION SOURCE:
GENERAL SOILS REPORT X
BERKSHIRE COUNTY, MASSACHUSETTS
NORTHERN PART

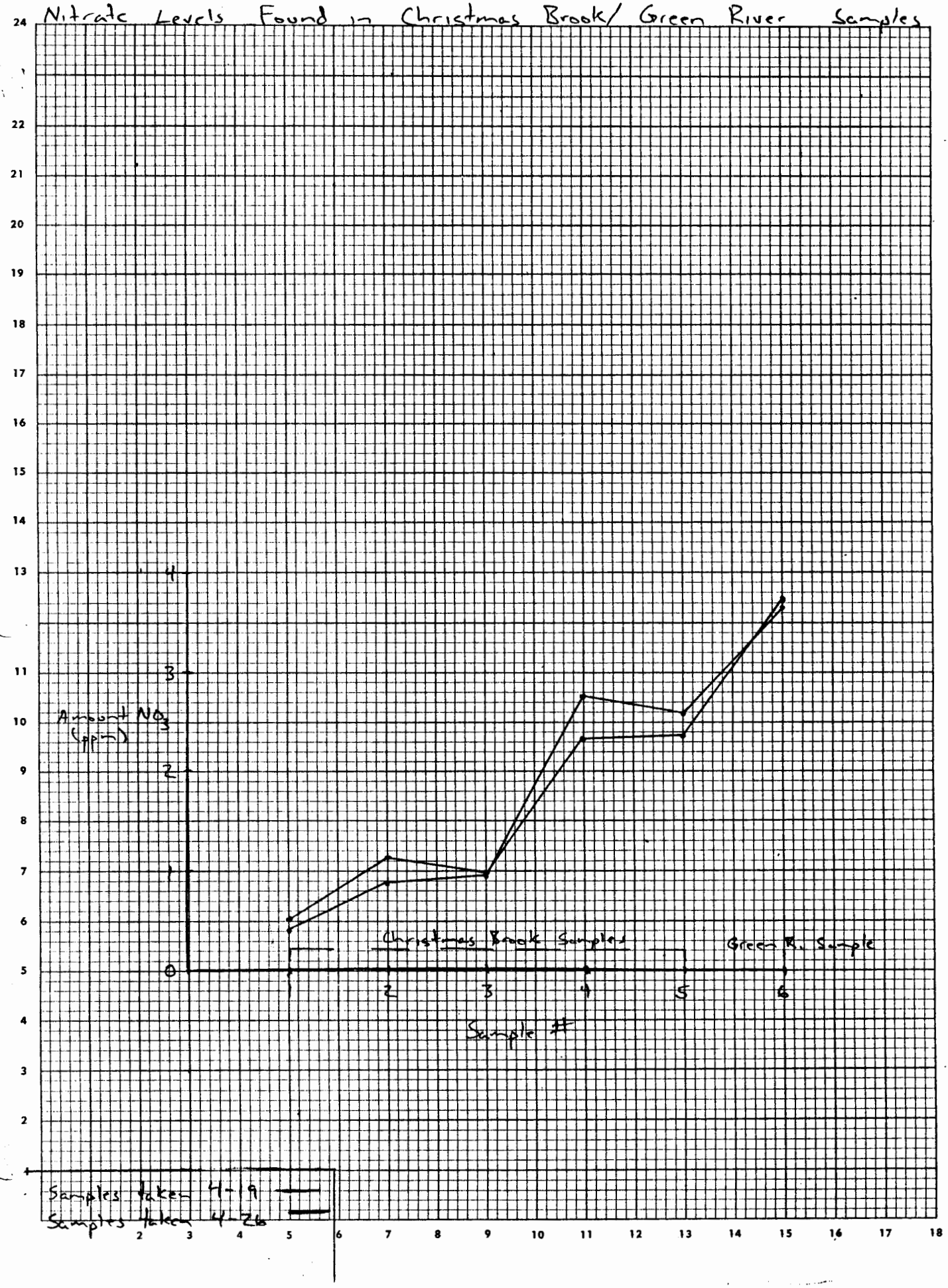


GRAPH #1


Chloride Levels Found in Christmas Brook/ Samples
Green River
Amount Cl (ppm)
Christmas Brook Samples
Green R. Sample
Sample #
samples of 4-19
samples of 4-26
don't connect these dots, since you're on a different stream

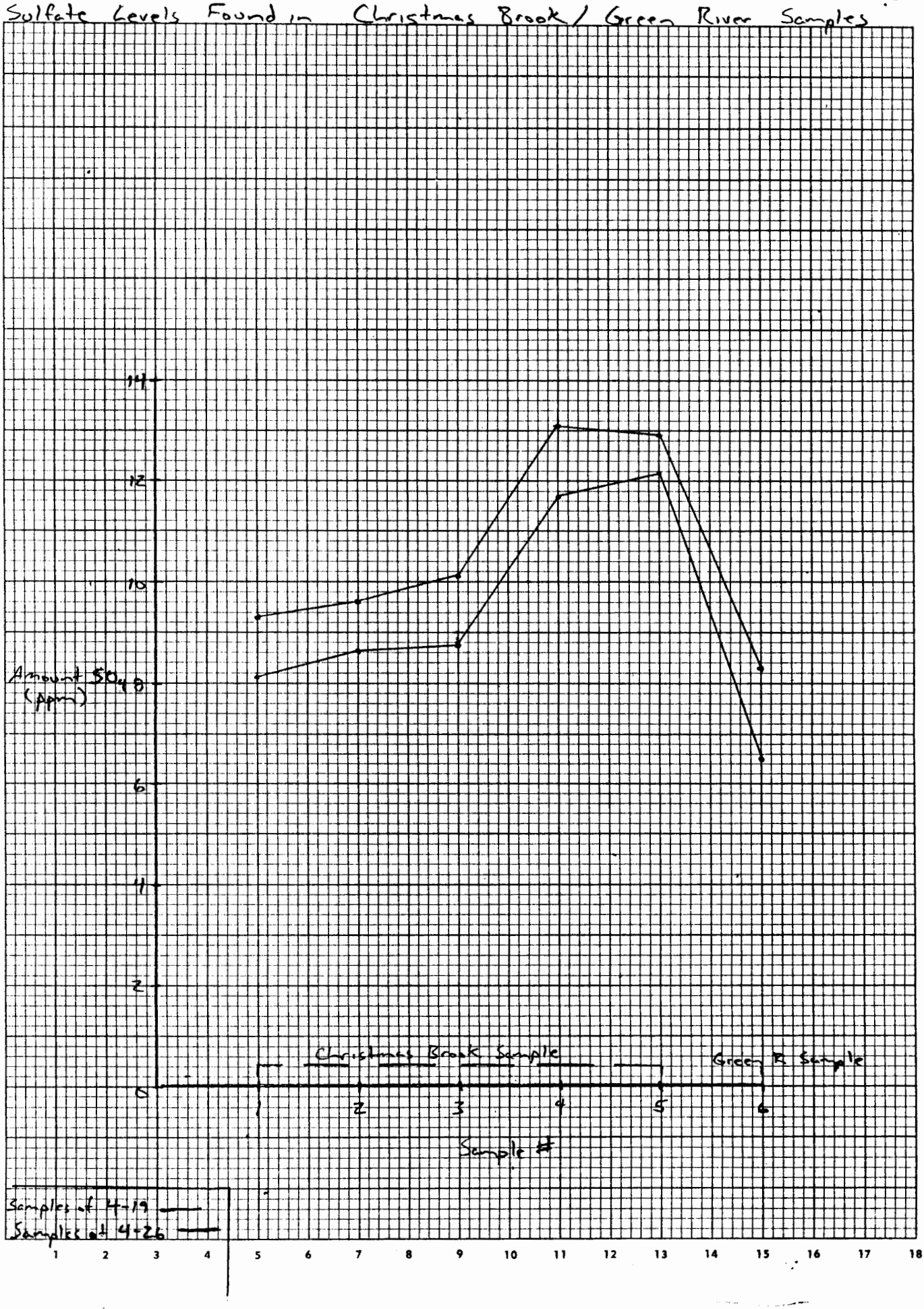
Graph 2

Nitrate Levels Found in Christmas Brook/ Green River Samples

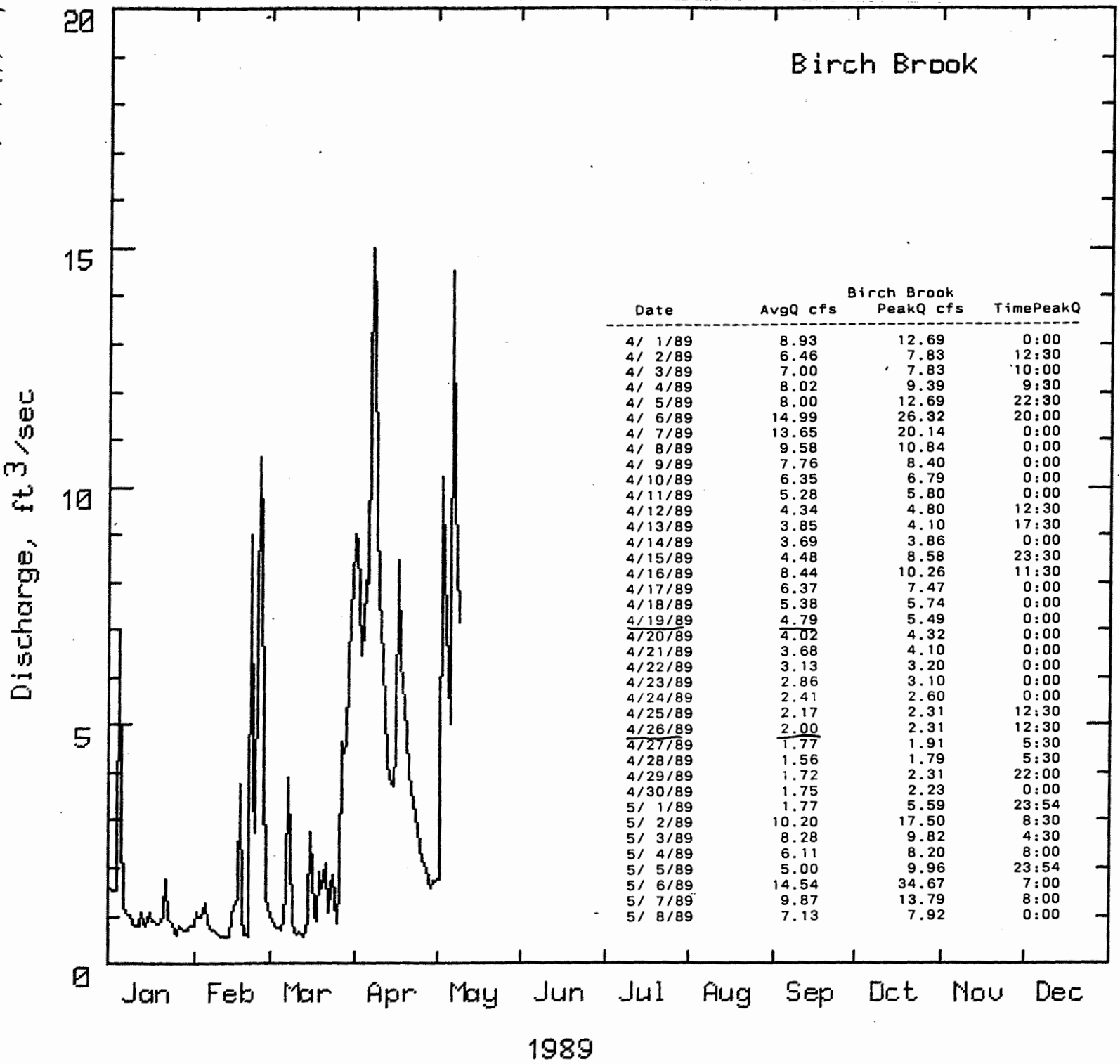


GRAPH #3

Sulfate Levels Found in Christmas Brook / Green River Samples



GRAPH 7



Birch Brook

Date	AvgQ cfs	PeakQ cfs	TimePeakQ
4/ 1/89	8.93	12.69	0:00
4/ 2/89	6.46	7.83	12:30
4/ 3/89	7.00	7.83	10:00
4/ 4/89	8.02	9.39	9:30
4/ 5/89	8.00	12.69	22:30
4/ 6/89	14.99	26.32	20:00
4/ 7/89	13.65	20.14	0:00
4/ 8/89	9.58	10.84	0:00
4/ 9/89	7.76	8.40	0:00
4/10/89	6.35	6.79	0:00
4/11/89	5.28	5.80	0:00
4/12/89	4.34	4.80	12:30
4/13/89	3.85	4.10	17:30
4/14/89	3.69	3.86	0:00
4/15/89	4.48	8.58	23:30
4/16/89	8.44	10.26	11:30
4/17/89	6.37	7.47	0:00
4/18/89	5.38	5.74	0:00
4/19/89	4.79	5.49	0:00
4/20/89	4.02	4.32	0:00
4/21/89	3.68	4.10	0:00
4/22/89	3.13	3.20	0:00
4/23/89	2.86	3.10	0:00
4/24/89	2.41	2.60	0:00
4/25/89	2.17	2.31	12:30
4/26/89	2.00	2.31	12:30
4/27/89	1.77	1.91	5:30
4/28/89	1.56	1.79	5:30
4/29/89	1.72	2.31	22:00
4/30/89	1.75	2.23	0:00
5/ 1/89	1.77	5.59	23:54
5/ 2/89	10.20	17.50	8:30
5/ 3/89	8.28	9.82	4:30
5/ 4/89	6.11	8.20	8:00
5/ 5/89	5.00	9.96	23:54
5/ 6/89	14.54	34.67	7:00
5/ 7/89	9.87	13.79	8:00
5/ 8/89	7.13	7.92	0:00

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