Effects of the Hoosac Water Quality District Wastewater Treatment Facility on the Hoosic River

Final Project for ENVI 102

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5/12/89

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I. Introduction.

The development of sewage treatment plants in the Berkshires is a fairly recent occurrence. Primary treatment plants located along the Hoosic River were opened in North Adams in 1935 and in Williamstown in 1963. These plants preformed primary chlorification but did not employ the aeration techniques incorporated in the presently more acceptable process known as secondary treatment. The Hoosic Water Quality District Wastewater Treatment Facility opened in Williamstown in 1977 to replace the older primary plants and currently provides secondary treatment for sewage from both North Adams and Williamstown (see figure 1). The Treatment Facility has the capacity to treat sewage from a population of 37,200 as well as the small amount of industrial waste in the area.[1] Licensing is obtained by both the state and the E.P.A. Regulations on the quality of the water returned to the river as the final effluent leaves the plant are established by the E.P.A. and the plant is inspected approximately every other month. In addition to these inspections the plant is responsible for conducting various prescribed tests the results of which must be submitted "properly filled in and signed, on the fifteenth of every month . . . to the Regional Administrator and Director."

Although according to the above description it sounds as if the Williamstown sewage plant is well regulated with in the E.P.A. rulings, it is common knowledge that the E.P.A. regulations are not immune to change. The complete environmental impact caused by man is often hard to determine. Regulations, which are products of politics as well as concern for the environment, are established on a base of information that changes with new discoveries and political pressures. This project focuses on data collected from various independent testing of the water at different points on the Hoosic River and incorporates test results gathered from the lab at the sewage plant. Its conclusions are an attempt to investigate the effects of the Hoosac Water Quality District Wastewater Treatment Facility on the quality of water in the Hoosic River.

II. Methods.

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[1] Public information brochure available at the treatment plant.

Water samples for testing in the Williams College lab were collected in nine plastic sample bottles from five different sites. The general testing area revolved around the outlet from which the treatment plant discharges its final effluent into the Hoosic. The outlet itself is only a few hundred feet from the treatment building and can be reached by walking down a slight incline of manicured lawn. Three samples (U-1, U-2, U-3) were taken from a designated site 34 feet upstream from the effluent inflow. The higher sample numbers correspond to samples taken respectively further from shore. Sample U-3 was collected with the aid of a sampling can on a broom handle length pole. At this site the natural hardwood forest of sugar maple, Beech, American Elm, and White Ash had not been physically altered by construction of the plant. An increase in elevation created a steeper bank. Two samples of the final effluent (I(s)-1, I(s)-2) were collected from the chlorination tanks at the point right before the water is discharged to the river. A sample was also taken at the inflow into the river described above (I(r)) where the water was visibly being agitated from its underground downhill journey from the chlorination tanks.. The first downstream sample site was 30 feet from the inflow and still at a relatively grassy area. Two samples were taken here, (D-1) close to the bank and (D-2) a broom handle's length into the current. The furthest downstream site, approximately another 50 feet down, was in a very low and muddy although forested area. The Elms here were apparently dying from Dutch Elm disease. One sample (F-D) was taken at this site. (see figure 2)

Sets of samples collected and transported to the lab for testing were taken on two different days. The first day April 21 was sunny as had been the weather over the preceding few days. Total and Fecal Coliform tests were conducted on these samples immediately upon returning to the lab. Samples were refrigerated until the afternoon at which point the samples' pH, alkalinity (both Standard and EPA), and conductivity were tested. The samples taken on the 21st were again refrigerated and used on April 26 for an Atomic Absorption test for sodium. Residual chlorine data was gathered from a new set of samples taken on May 3. This day had been preceded by a few days of rain. Water temperature at the different sites was recorded on May 3, as well as May 5. On site testing for Dissolved Oxygen was conducted also conducted on May 5. The sky was overcast, but actual rain drops scarce.

There is some overlap between tests conducted in this project and those conducted regularly by the treatment facility. Specific test results required to be turned in monthly to the Regional administrator by the lab at the Hoosac Wastewater Treatment Facility are listed in their files as:

Flow	continuous recording
TSS (sludge)	2X weekly
Total Coliform	1X weekly
pH	1X daily
Settleable Solids	1X daily
Chlorine Residual	1X daily
DO	1X daily

The various places tested by the plant include the raw sewage, primary tank, primary and secondary mixed, the final effluent, and sites upstream and downstream. Our sampling site of the final effluent in the chlorination tank as well as our upstream and first downstream site were the same as the test sites for the treatment plant's lab. Although the treatment plant does not always test at all the sites, research into their data was able to provide at least some comparisons to our data. Many observations could also be made upon looking at the range of test data collected by the sewage plant over time. For organizational purposes further considerations of methods when necessary, as well as data and discussion is grouped according to the different types of testing.

III. Data and Discussion.

pH (Tables 1. and 2.)

The pH of our samples was tested on a standard pH meter located in the lab. The sewage plant only tests the pH of their final effluent, but their entry for the test on the day we sampled and tested, April 21, was a pH of 7.50. Our two readings from the same sample site were 7.55 and 7.50. It seems ~~safe to assume that~~ our pH measurements are fairly accurate. According to both sources the pH of the final effluent was very close to neutral. The small variance in plant data over the month also indicates that the effluent's pH is consistently at a level close to neutral. There seems to be no significant variation between the pH of the water upstream from the

and theirs!

plant and downstream. The pH of the water emitted from the Hoosac Water Quality District Wastewater Treatment Facility is well within the E.P.A. regulation that "pH of the effluent shall not be less than 6.0 nor greater than 9.0 at any time unless these values are exceeded due to natural causes or as a result of the approved treatment process."

ANC (Table 3.)

The ANC of samples for this project was tested on a standard pH meter in the lab using 1.6 N sulfuric acid in a batch titrator. From the digits on the titrator both Standard Alkalinity and EPA alkalinity were calculated. The treatment plant does not test for ANC so there is no basis for comparison. From our data it appears that the river water already has buffing qualities when it reaches the sewage plant, and that the noticeably higher ANC of the treated water is considerably, but not totally diluted as this water mixes with the river. The percent increase calculated using upstream and downstream averages was 44% for Standard ANC and 43% for the EPA ANC.

The Buffing capacities in water are generally regarded as advantageous and at least in the case of sewage treatment are not regulated. A probable source for the high buffing capacities of the river water is the calcium carbonate that exists in the Williamstown area. Waste and treatment water originating from the Williamstown wells would, therefore, also be expected to have a high buffing ability and contribute to the high level in the final effluent. The increase in buffing abilities of the treated water is considerable and probably also caused by other particles or ions not removed in the treatment process. More extensive chemical analysis would have to be conducted to specify what else in the water was causing the high ANC.

Conductivity. (Table 4.)

Conductivity, which was measured on a conductivity meter in our lab, is a general indication as to the amount of ions present in a sample of water. Although conductivity does not indicate specific ions present in the treated water, the data of 750 and 710 microsiemens for the final effluent indicates considerably high ion concentration in the effluent as compared to water upstream from the plant. The average of the downstream test results represents an increase of 91% from the upstream average. The effects of this drastic increase in ions on the river is very dependent on what types of ions are present since many ions occur naturally.

chlorination

Some increase in ions is expected due to the chlorine used in the ~~chlorification~~ process necessary for reducing the amount of bacteria present. The chlorine applied in its elemental or hypochlorite form readily, hydrolizes into various forms of free chlorine which can then react (with what?) to form chloramines[1]. The chlorine reduced to chlorides would contribute to the high conductivity of the water. Probably the many possible sources for increased conductivity is what creates an absence of its regulation on the part of the E.P.A. The environmental effects of the increase in concentration of these ions occurring at the treatment plant is, however, at least a concern worthy of further study.

Atomic Absorption. (Table 5.)

Samples were diluted and tested for absorption due to sodium cations on the atomic absorption spectrometer. From a standard curve of absorption vs. concentration the concentration of the samples was determined and converted, with corrections for the dilutions, into ppm. The high presence of sodium cations must have contributed, along with the chloride, to the increase in ionic content of the river measured by the conductivity test. The sodium data follows the basic trend of indicating that a test level particularly high in the final effluent causes an increase in the test level between the upstream and downstream sites, 278% in this case.

Many of the storm sewers in Williamstown feed into the sewer lines and contribute to the flow of wastewater entering the treatment plant. The presence of sodium cations could therefore, be a result of road salt still washing off the roads from this winter. The day on which the samples used in this test were taken was April 21, a date before and on which, as

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[1] Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Waterworks Association, Water Pollution Control Federation. Washington D.C.:American Public Health Association, 1985.

Table 6. DPD Standards

DPD conc.ppm	%trans	absorption
.5	81	.09
1	66	.18
2	43.5	.36
3	32	.49
4	23	.64

Nice

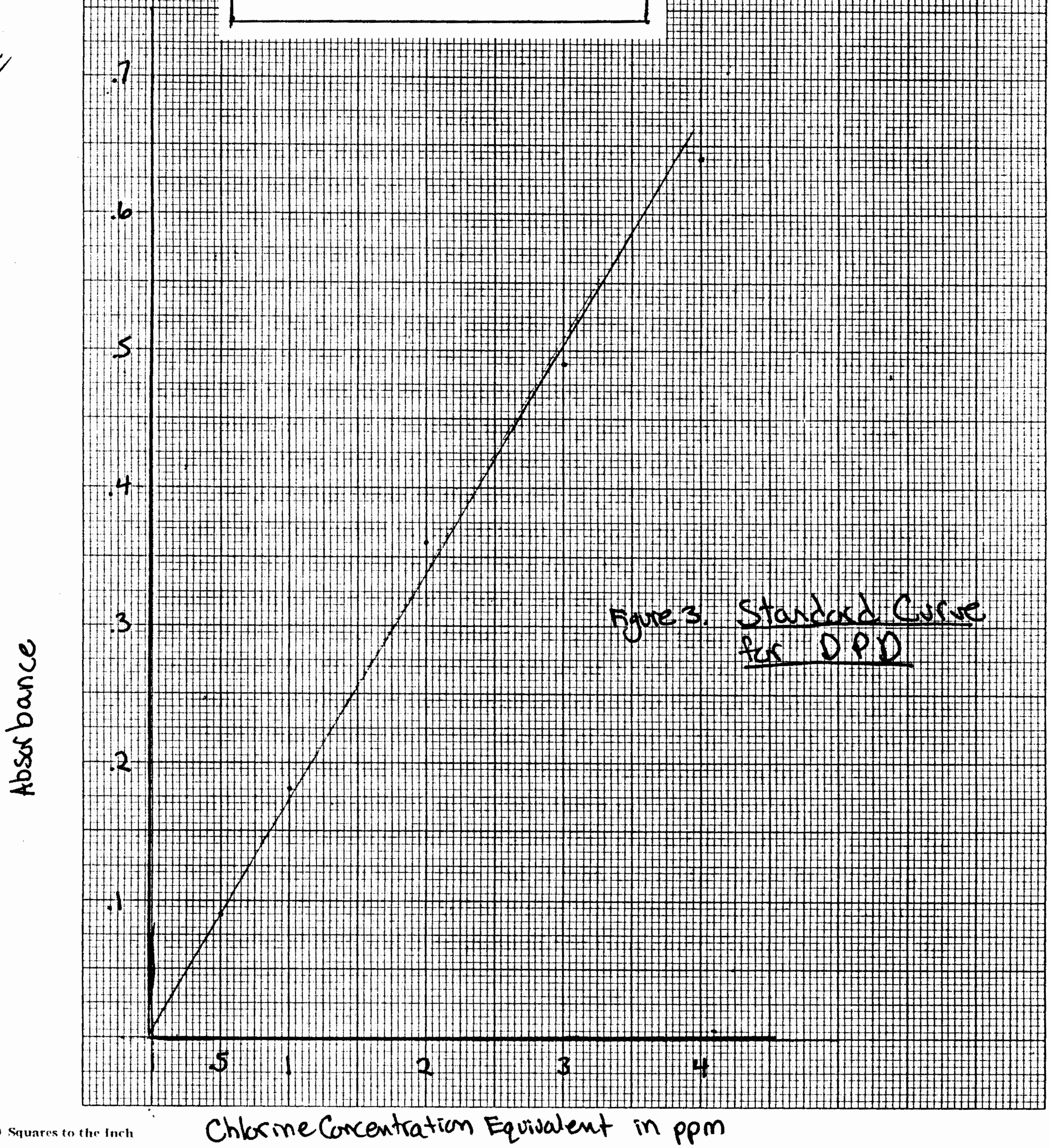

Figure 3. Standard Curve for DPD

Table 7. Residual Chlorine

sample	turbidity	%transmittance	absoption	cl conc. ppm
U-1	97	100	.000	.000
U-2	96	99	.004	.026
U-3	97	97.5	.011	.017
I(s)-1	97	95	.022	.141
I(s)-2	97	95	.022	.141
I(r)	98	95.5	.020	.128
D-1	97	96	.018	.115
D-2	96	95.5	.020	.128
F-D	96.5	96.5	.015	.096

Table 8. Plant Data Residual Chlorine

date	Cl ppm	time 1	Cl ppm	Time 2
4/3	.01	1:50		
4/4	.1	8:15	.31	12:40
4/5	.2	10:55		
4/6	.3	11:15		
4/7	.56	1:45		
4/8	.3	10:30		
4/9	.2	11:00		
4/10	.4	10:55		
4/11	.0	8:15	.11	2:45
4/12	.3	10:45		
4/13	.4	10:45		
4/14	1.75	1:30		
4/15	.7	7:40		
4/17	.0	8:05		
4/18	.2	11:10	.5	2:30
4/19	.5	11:00		
4/20	.2	10:00	.2	11:40
4/21	.5	9:40	.3	2:25
4/22	.3	10:30		
4/23	.0	9:00		
4/24	.0	2:45		
4/25	.3	9:55		
4/26	.3	9:30	.3	10:55
4/27	.3	11:05		
4/28	.2	9:45		
4/29	.3	7:35		
4/30	.2	7:40		

Coliform Testing. (Tables 9. and 10.)

Regulations on the maximum level of coliform counts are stated in the Hoosac Water Quality District Wastewater Treatment Facility as

	monthly avrg.	weekly avrg.	daily
fecal coliform	200/100ml	400/100ml	400/100ml
total coliform	1000/100ml	2000/100ml	2000/100ml

As a part of this project we conducted both fecal and total coliform analyses on 100 ml samples from the various sites. The widespread absence of colonies seems to bode well for the quality of water processing at the sewage treatment plant. The treatment facility is only required to test coliforms once a week. The closest test to ours was conducted on April 25 (our samples were collected and tested on the 21) and its results also include 0's for all the fecal coliforms and one of the total coliforms. All this data is well within the set limits.

The coliform data over time, however, is not so encouraging. Some data skyrockets above the limits hitting a high of 9000/100 ml total coliform at one point among other measurements labeled TNTC (too numerous to count). On two days in the past month fecal coliform in the final effluent were also measured as TNTC. In response to questioning as to why these values were not jeopardizing the plant's licence the lab technician replied that the because many of the storm sewers attach to the sewage main, on days with lots of rain the plant must process a much larger than normal flow of water. The plant can only handle a certain amount of water and as a consequence of the extra flow the water simply had to be processed more quickly on rainy days. The extraordinarily high coliform count was a result of wastewater spending less time in each of the purification tanks. Apparently this is an acceptable excuse to the Regional Administrator to whom the plant submits these test results every month.

The weather on and before April 21 had not involved rain and thus the coliform test results obtained both in the lab and at the sewage treatment plant were extremely low and produced no threat to the Hoosic River. On days of particularly high wastewater flow the Hoosac Water Quality District Wastewater Treatment Plant significantly increases the presence of both total and fecal coliform bacteria in the river.

Temperature. (Table 11.)

Temperature readings were taken at the different sample sites on May 3 and May 5. The temperature of the final effluent was greater than 2° C warmer than the water temperature upstream on both days. The increase in downstream temperature from upstream readings was between 0.4° and 0.7° C . Making a conclusion as to the sewage plants effect on the river temperature on the small temperature sources here would have a margin of error due to possible variation of temperature within the river itself. If the data is valid and even this early in the spring the warming of water in the treatment tanks has a small effect on the river, one could expect a greater increase in temperature will result as the days become hotter and sunnier. Although thermal pollution is acknowledged by the E.P.A. in sources such as the Massachusetts Wetland Protection Act there appears to be no specific regulations as to the amount by which the Hoosac Treatment Plant is allowed to change the water temperature. No monitoring is done by the plant.

Dissolved Oxygen (Tables 12. and 13.)

Measurements of dissolved oxygen taken on a portable DO meter indicate that there is a very small amount of oxygen in the chlorination tank (I(s)), but that the level has increased drastically by the time the water pours through the outflow tube to the river. An increase in DO seems plausible when observing the vigor with which the water is splashing from the opening. The data shows no conclusive evidence that the lack of oxygen in the final effluent effects the level in the water downstream from the plant. Data from the lab at the sewage treatment plant only also only evidences very small decreases as a result of the slightly lower DO in the final effluent. Our reading for the DO in the final effluent seems rather off. The movement of the water at this sampling site made testing difficult and is perhaps a cause of error.

IV. Conclusions.

The Hoosac Water Quality District Wastewater Treatment Plant states in its brochure that they remove about 90% of the major pollutants in the wastewater. This project, however, evidences the fact that what is determined pollution is a rather subjective decision based on the limited environmental knowledge that exists and the relatively small amount of testing that occurs. Many of the tests conducted at the sewage plant in Williamstown exhibit results that are acceptable by E.P.A. or state regulations. The sewage plant, however, does not monitor ANC, conductivity, or temperature of its effluent. Many of the tests that it does conduct regularly such as residual chlorine are only conducted on the effluent. The ability of the E.P.A. to make safe regulations depends on the test results that they have access too. It is worrisome that a plant will only conduct tests for conditions specifically regulated by the E.P.A. or other legislature.

Yes

Analysis of data gathered in this project provide evidence that the Hoosac Water Quality District Wastewater Treatment Plant does produce a calculable impact on various aspects of the water in the Hoosic River. ANC, conductivity, sodium concentration, and residual chlorine all show increases downstream from the plant. The downstream increase in both total and fecal coliform on days of high wastewater flow is a definite cause for concern. The pH and the amount of dissolved oxygen in the water downstream from the plant do not appear to be affected greatly by the plant, but thermal pollution is another possible concern.

The effects of the Hoosac Water Quality District Wastewater Treatment Facility on the water in the Hoosic River can be assessed by various chemical and laboratory procedures. The full environmental impact of the changes in water quality of the Hoosic described in this report will hopefully be discovered through two bio assays on the Hoosic River that are scheduled to be conducted by the treatment facility in the near future.[1]

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[1] interview with Chief Operator of the treatment plant, George Heisler, Jr.