AN INVESTIGATION INTO THE DEGRADATION OF A WATERWAY

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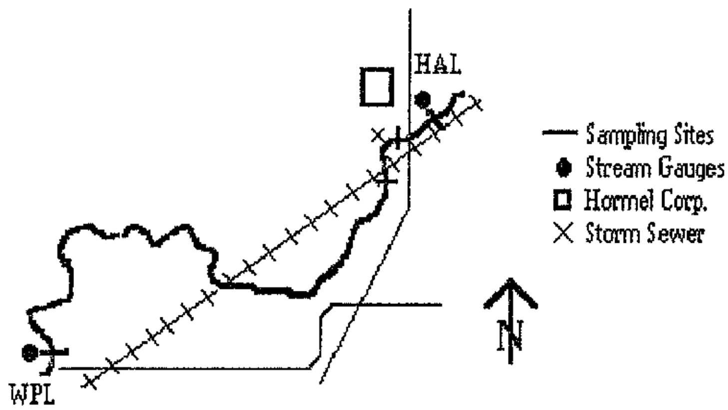
INTRODUCTION

Spring Brook is located east of the city of Beloit in south-central Wisconsin. The stream originates 12.5 kilometers east of the city in an agricultural region. On the outskirts of the town, the stream encounters the City of Beloit's industrial park. From this point, it travels approximately 5.6 kilometers into town, where it then converges with the Rock River.

Two stilling wells, equipped with hydrographs, were installed at two location on the stream, as shown in Fig. 1. These recorded the height of the stream continuously over the period of one week. The upstream hydrograph (HAL) differed greatly from the downstream hydrograph (WPL). It was observed that daily peaks were occurring at the downstream station that were not present at the upstream station even though no precipitation occurred. This confirmed that Spring Brook was receiving an impact through storm sewer influx and discharges from the industrial park. The one that was suspected of discharging into the stream is a storm sewer pipe located directly behind the Hormel Co. Plant and is the first encountered downstream from the HAL station. (Fig. 1).

The purpose of this study was to determine if there were any levels of substances that were above regulation being discharged from the storm sewer behind Hormel. The first step in this study was to take water samples and onsite measurements at HAL, Hormel, and WPL. Those measurements would then be analyzed and compared to World Health Organization, EEC, and state regulations. The discharge would also be compared to the composition of the stream.

Map Of Spring Brook



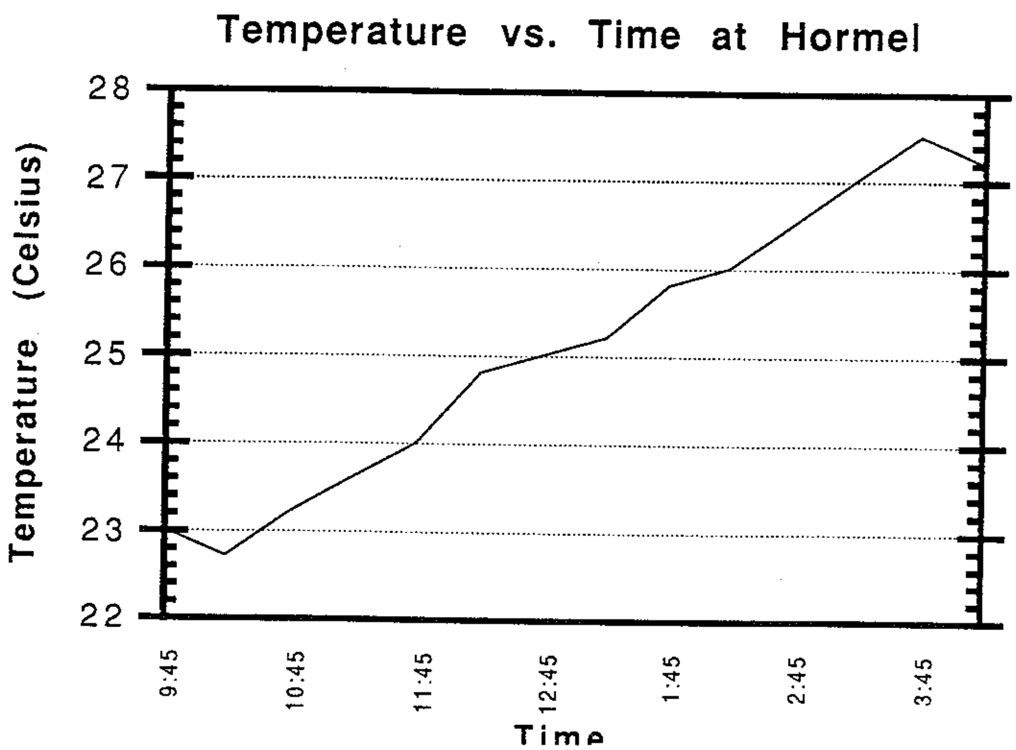
(Figure 1)

SAMPLING PROCEDURE

Water samples at HAL and WPL were taken equal-distant from one another across the width of the stream with a depth integrated sampler. Three samples taken at each location were then pooled to insure a sample that was representative of the entire portion of the sampling site. Samples were also taken upstream and downstream from the storm sewer behind Hormel in the same manner. At the storm sewer samples were taken directly from the mouth of the pipe to insure that the sample would be representative of the discharge. Figure 1 shows the location of the sampling sites with respect to one another. To determine if there was any variation in the discharge throughout time, samples were taken at thirty minute intervals over a period of six and a half hours.

build expensive cooling towers when they can simply discharge their cooling water into a ditch. As the common law stands, cooling ponds are the best available technology, but the outcome of this litigation may change that fact. Hormel is abiding by both the Clean Water Act's best available technology requirement and the restrictions set forth in the WPDES permit.

Hormel's discharge is clean, and while the thermal disturbances cause an increase in algae and weeds, it does not appear to be having a devastating effect on the stream. Hormel is a responsible industry that has a discharge permit and is abiding by it. The Beloit Industrial Park has a whole series of new roads that are awaiting industries to inhabit them. Part of the threat to Spring Brook comes from these new, unknown industries. The other two storm sewers from this study service Frito Lay and Enzyme Biosystems, but there are another two storm sewers that were being constructed over the summer on newly built roads We can only hope that these new industries are as conscientious and responsible as Hormel.



All samples were tested on-site for pH, temperature, color, turbidity, and dissolved oxygen. The samples were then run through an inductively coupled argon plasma atomic emission spectrometer (ICAP) to test for calcium, aluminum, magnesium, sodium, potassium, iron, manganese, barium, cobalt, chromium, copper, lead, zinc, cadmium, nickel, and silicon concentrations. Table 1 gives the detection limits for the various elements. An ion chromatograph tested for fluoride, chloride, nitrate, sulfate, and phosphate concentrations. Samples were also tested for biochemical oxygen demand levels and bacteria levels (total coliform, fecal coliform, and fecal streptococci).

ICAP DETECTION LIMITS
(Table 1)

Calcium	0.004 ppm	Cobalt	0.002 ppm
Aluminum	0.008 ppm	Chromium	0.002 ppm
Magnesium	0.022 ppm	Copper	0.002 ppm
Sodium	0.009 ppm	Lead	0.018 ppm
Potassium	0.218 ppm	Zinc	0.005 ppm
Iron	0.003 ppm	Cadnium	0.002 ppm
Manganese	0.001 ppm	Nickel	0.006 ppm
Barium	0.001 ppm	Silicon	0.014 ppm

ANALYSIS

The World Health Organization Recommendations of 1984 for drinking water quality are utilized for the physical and chemical analysis, EEC Recommendations of 1980 for recreational waters are used for the microbiological data, EEC Recommendations of 1980 for the quality of water for human consumption are also used for the chemical and physical analysis, and the State of Wisconsin Administrative Code of 1974 (Chapters NR102-Water Quality for Wisconsin Surface Waters and NR109-Safe Drinking Water) requirements are used. (See Table 2). Though Spring Brook would not be considered for either recreational or drinking purposes, correlating the results to drinking water and recreational water standards is beneficial in knowing the state of the stream.

The onsite data results, proceeding downstream from HAL, indicate conductivity levels higher than the EEC recommended value of 400 μS/cm. All sites range at least 200 μS/cm higher, except WPL which registers at 436.3 μS/cm. The discharge value of 680 μS/cm is lower than the upstream value and higher than the downstrean value. The pH values at all sites (8.0-8.4) are all within the recommended levels of 6-9. The color levels are higher than the EEC, WHO, and Wisconsin recommendations of 20, 15, and 15 tcu's respectively. The highest value, 152 tcu, was recorded at HAL. While the lowest value, 28 tcu, was recorded downstream from the storm sewer. Turbidity levels were also higher than the recommended of 5 to 10 ntu's. The highest values were located upstream from the storm sewer with the lowest being that of the discharge. This indicates that the discharge is clearer in terms of suspended solids. The State of Wisconsin Administrative Code Chapter NR 102 states that "the maximum temperature rise at the edge of a mixing zone shall not exceed 5 degrees Fahrenheit." The discharge temperature was 73.0 degrees Fahrenheit and the temperature downstream from the storm sewer, which could be considered the edge of the mixing zone, was 77.0 degrees Fahrenheit. The State of Wisconsin Administrative Code Chapter NR102 states that the level of dissolved oxygen "shall not be lowered to less than 5 mg/L (ppm)." This level is critical for life. All sites range from 7.5 to 15.8 mg/L, with the highest being that of the discharge. Figure 2 displays the onsite data at all of the sites .

ICAP data results indicated levels below detectable limits at all sites for aluminum, cobalt, chromium, lead, cadmium and nickel. The levels at all sites are lower than recommended limits for barium, sodium, copper, zinc, iron, and potassium. Recommended limits were not available for calcium, magnesium, or silicon. ICAP data results indicate a drop in the zinc concentration in the discharge relative to that of the stream. Copper, barium, and calcium concentrations increased down the course of the stream. While potassium, silicon, and magnesium concentrations remained relatively constant. The high calcium, magnesium, and silicon concentrations at the sites is due to the bedrook underlying the area. The stream begins in an area underlain by Platville dolomite and Decorah sandstone, changes to St. Peter's sandstone near the industrial park, and then to

Trempealeau sandstone near the WPL site. The ion chromatograph data results indicated levels at all sites below recommendations for sulfate and fluoride. Nitrate levels at all sites are above the State of Wisconsin 's recommended limit.

The ICAP six and a half hour study down at the storm sewer pipe behind Hormel indicated relatively constant levels of calcium, magnesium, sodium, potassium, and silicon. Variation was shown in concentration levels of barium, iron, copper, and zinc. The on-site data showed a steadily increasing temperature throughout time and discharge amounts varied due to the internal operation of Hormel.

Water Quality Standards
(Table 2)

Parameters	EEC norm.	EEC max.	WHO norm.	WHO max.	WIS norm.	WIS max.
Microbiological						
Total Coliform/100ml	500	(10,000)			200	
Fecal Coliform/100ml	100	(2,000)			200	
Fecal Strept./100ml	100					
Physical-chemical						
pH		(6-9)	(6.8-8.5)			(6-9)
color (tcu)	1	20	15			15
turbidity (ntu)	1	10	5			5
conductivity (us/cm)	400					
aluminum (ppm)	0.05	0.20	0.20			
barium (ppm)	0.10					
cadmium (ppm)		0.005	0.005		0.01	
chromium (ppm)		0.05	0.05		0.05	
copper (ppm)	0.10		1.0		1.0	
fluoride (ppm)		0.70	1.50		2.2	
iron (ppm)	0.05	0.20	0.30		0.30	
lead (ppm)		0.05	0.05		0.50	
manganese (ppm)	0.02	0.05	0.10		0.05	
nickel (ppm)		0.05				
nitrate (ppm)	25.0	50.0	45.0		10.0	
potassium (ppm)	10.0	12.0				
sodium (ppm)	20.0	175	200			
sulfate (ppm)	25.0	250	400		250	
zinc (ppm)		0.10	5.0		5.0	

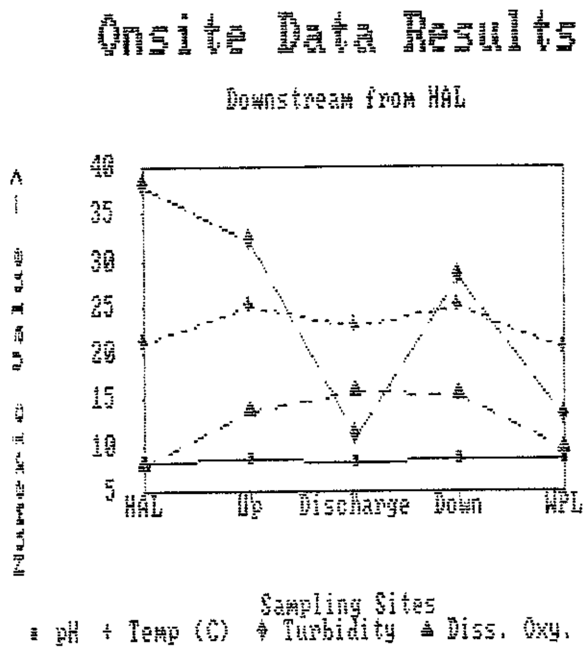


Figure 2

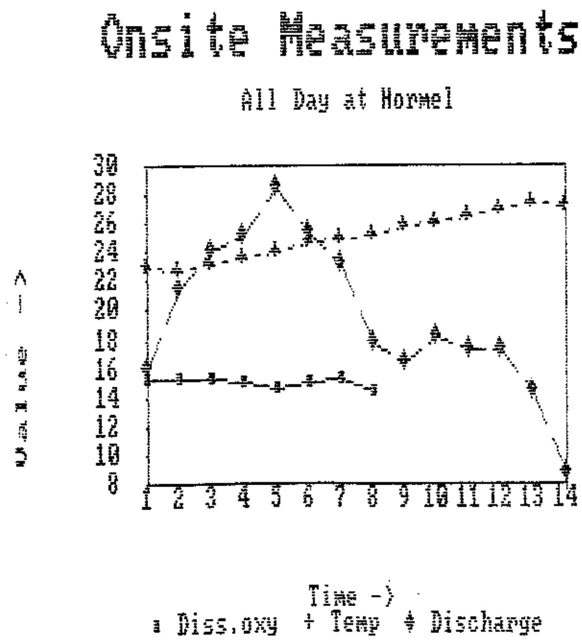


Figure 3

Bacteria results for HAL show levels of 3,400/100ml total coliform, 770/100ml fecal coliform, and 71,000/100ml fecal streptococcus. WPL results indicated a total coliform count of 2,700/100ml, a fecal coliform count of 440/100ml. and a fecal streptococcus count of 14,800. The discharge revealed a count of 210/100ml for total coliform, 43/100ml for fecal coliform, and 161,000/ 100 ml for fecal streptococcus. The total coliform counts at all sites were above the 200/100ml recommendation of the State of Wisconsin. The only site to be below the 200/100ml Wisconsin limit for fecal coliform was the discharge. All sampling are extremely high in comparison to the EEC limit for fecal streptococcus at 100/100ml.

The 5-day biochemical oxygen demand was .887 mg/L at HAL, 5.440 mg/L upstream from the storm sewer, 5.067 mg/L for the discharge, 4.680 mg/L downstream from the storm sewer, and 3.120 mg/L at WPL. The State of Wisconsin recommendations lists a BOD limit of not less than 3 mg/L. The only site that is below this limit is the HAL station. This could be due to the course of the stream through an agricultural region prior to HAL.

Onsite measurements for all day at Hormel indicate a steadily increasing temperature throughout time and a fluctuation in discharge, due to the internal working of the corporation. (See Figure 3)

SUMMARY

The high color and high turbidity measurements are based on drinking water standards; therefore, the stream can be considered in its natural state. The high nitrate levels can be contributed to the agricultural runoff from crops that have been fertilized. The agricultural nature of the region also impacts the stream through high bacteria counts and the low BOD at HAL. The conductivity of the discharge is higher than EEC regulations, but is within the stream's natural level. This is also true for the nitrate concentration. The calcium, magnesium, and silicon concentrations of the discharge is within the stream's natural limits. The temperature of the discharge from the Hormel Corporation is of some concern due to the fact that the temperature seems to increase throughout the day. If the discharge is constant in temperature throughout the year, problems could occur in the winter months when the natural stream temperature would be much lower than the discharge. The impacts on aquatic life during the winter months could be investigated further. Overall , the discharge does not seem to be causing any detrimental damage to the stream, with exception to the temperature which may cause problem during the winter months if it continues to be released at its present temperature.

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Chemical and Physical Effects of Springs on a Stream System

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Introduction

Raccoon Creek is located about four miles west of Beloit College in Beloit, Wisconsin. The section of the stream being studied was about one-quarter of a mile long and flowed east to west. The stream originates about two miles northwest of the area under study and runs through an area dominated by farm fields. It is a low-energy stream that is only an average of six to eight inches deep, and supports only minimal biotic life such as minnows and an occasional crayfish. However, the stream is highlighted by the fact that it contains many visible springs that are located along the northern bank.

The study area of Raccoon Creek has been historically known as Chamberlin Springs. In the late 1800's, geologist T.C. Chamberlin owned and resided on the land that contained the springs. The springs were said to have medicinal properties and attracted many visitors, both sick and healthy. The Chamberlin's even had the springs analyzed and were told that "health-giving minerals were present". The Chamberlin Springs property is now owned and preserved by Beloit College.

The purpose of this study was to analyze the water from the springs to determine its chemical content and to determine how this water affected the chemistry of the normal stream discharge. Time was also spent analyzing the physical effects, such as volume and temperature, of the springs on the stream system .

Field Methods

Chamberlin Springs is located in a heavily wooded area along Raccoon Creek. It is bounded in all four directions by farm fields, accessible only by a main road to the north of the woods. The path to the stream was heavily overgrown, taking two days to clear a trail to the site.

After the site was reached, it was necessary to determine the number and locations of the springs. Springs were identified mostly by sight and verified by temperature readings. The springs were located only within the north side of the stream bed and sometimes on the northern bank of the stream. A characteristic light colored ring of fine grained sediment often accompanied a spring located within the stream. If a spring originated in the bank of the stream, it was also accompanied by a trail of light colored sediment.

The temperature of the springs was about 10 - 11° C while the temperature of the stream was about 22° C on average. Ten springs were identified in the two-tenths of a mile stretch of the stream that was studied. Once the springs were identified, water samples were taken and pH and conductivity were measured.

In order to assure that accurate water samples were obtained, it was necessary to determine the rate at which spring water mixed with regular stream discharge. A powdered dye was added to the stream, at approximately six inches upstream from a spring. The dye turned a bright green color upon contact with the stream. It was observed, however, that when the spring water was introduced, it remained clear and colorless as it flowed from the mouth of the spring. The spring water eventually combined with the stream flow a few inches away and turned a similar green color as the stream had. Therefore, the spring water does not immediately mix with the regular stream discharge and can be sampled near the mouth of the spring without any contamination from the surrounding stream water. A turkey baster was used to sample the water next to the mouth of the spring before it was mixed in with the regular stream flow.

Water samples were taken at various points in the stream such as upstream from the springs, in between springs, and downstream from the springs. It was neccessary to assure that representative samples were being collected. Three samples were taken along the cross section of the stream at an equal distance apart to check that the spring and stream water were well-mixed. There was no observed variability in water samples across the stream (fig. 1). Therefore, all further stream samples could be taken from the center of the stream cross section and be representative of the entire cross section. Samples were also taken from the springs themselves as well as from an abandoned well that was located to the north of stream. Chemical tests including conductivity and pH were also performed at the same locations as water samples were taken from.