CONTRIBUTION OF STORM SEWER RUNOFF TO THE TRACE METAL CONTENT OF THE ROCK RIVER, BELOIT, WISCONSIN

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INTRODUCTION

The City of Beloit, situated on the southern boundary of state of Wisconsin, rests on the flood plain of the Rock River. All the storm water runoff from the city enters the Rock River directly through storm sewers or via one of the near-by tributaries which join the river just below the Illinois-Wisconsin state line.

The Rock River is used primarily for recreational activities and hydro-electric power generation. The small reservoir above the Wisconsin Power and Light Blackhawk Generating plant is used heavily by boating enthusiasts and fishermen. The greater portion of residential storm sewer lines empty into the river above the dam. The downtown and industrial zones discharge primarily into the swifter waters below the dam.

Runoff from streets, parking lots, and industrial sights is known to be a contributor of hazardous pollution to river systems. Nearly all the major factories in Beloit have been built on the Rock River or one of its tributaries. These industries are primarily foundries and smelting facilities which discharge their waste water directly into the Rock River. In addition, overland and interflow contributions to the river often pass through the contaminated soils of the industrial sector.

The primary purpose of this study was to assess the potential contribution of trace metals by the City of Beloit during precipitation events. Two sets of water samples were taken during the study. The first set was taken to determin background concentrations of trace elements in the river. High background concentrations might indicate that industrial discharge plays a greater role in contaminating the river. The second set of samples was taken directly from sewer discharge during and shortly after a precipitation event to determine contribution of storm sewer runoff.

PROCEDURES

The sample bottles used for this study were standard 1 qt. "milk" bottles. The bottles were thoroughly washed and rinsed with distilled water. They were then rinsed with concentrated nitric acid to reduce the chances of contamination by the lab water supply.

The first group of samples was taken at two sites. The upstream sight was located just above the Beloit College Limnology Lab. This sight was chosen because it is above all city storm sewer outflows, and should represent water flowing into Beloit. The standard EWI (Equal Width Increment) sampling method was used. Samples were taken using a depth integrating sampler suspended from the bow of a Jon boat. The river at this location was approximately 325 meters wide. 10 samples were taken at 30 meter intervals, starting at 12.5 meters from shore. At each interval, the boat was anchored and the sampler was lowered and raised by a hand-cranked winch. In addition, three pH measurements were taken to determine the potential of the water to mobilize trace elements.

The downstream sight was located on the north side of the Shirland Avenue bridge. This sight was chosen because it is below all of the cities sewer outflows. EWI sampling method was again used. The depth integrating sampler was suspended from the bridge using a tripod crane and winch. The river was much narrower at this location, only 75 meters wide, so only 5 samples were taken. Samples were taken every 15 meters, starting 7.5 meters from the shore. PH readings were taken here as well.

The second group of samples was taken directly from five storm sewer outflows that were above river level. Due to variable outflow conditions at different sampling sights, samples were taken by dipping sample bottles under the outflow until bottles were approximately three quarters full.

All water samples attained were then prepped for ICaP analysis. The Inductively Coupled Argon-Plasma Atomic Emission Spectrometer analysed the water samples for 16 different elements, Ca, Al, Mg, Na, K, Fe, Mn, Ba, Co, Cr, Cu, Pb, Zn, Cd, Ni, and Si.

DISCUSSION

The water analysed from the upstream cross-section showed concentrations below detection limits for most of the heavy metals. Fig. 1, calcium, sodium and magnesium were relatively much higher, but well within expected parameters for natural waters. Results for each interval were within one part per million, indicating that the samples

CONCLUSIONS

1. The mean or average grain size of the sediment forming these ripples is 3.0 phi to 1.0 phi (0.125mm to 0.50mm), fine to medium sand.
2. Wavelength and height of the ripples are not so much affected by the velocity of the water, as by the grain size of the sediment.
3. These ripples are the result of a unidirectional current flow.

ACKNOWLEDGEMENTS

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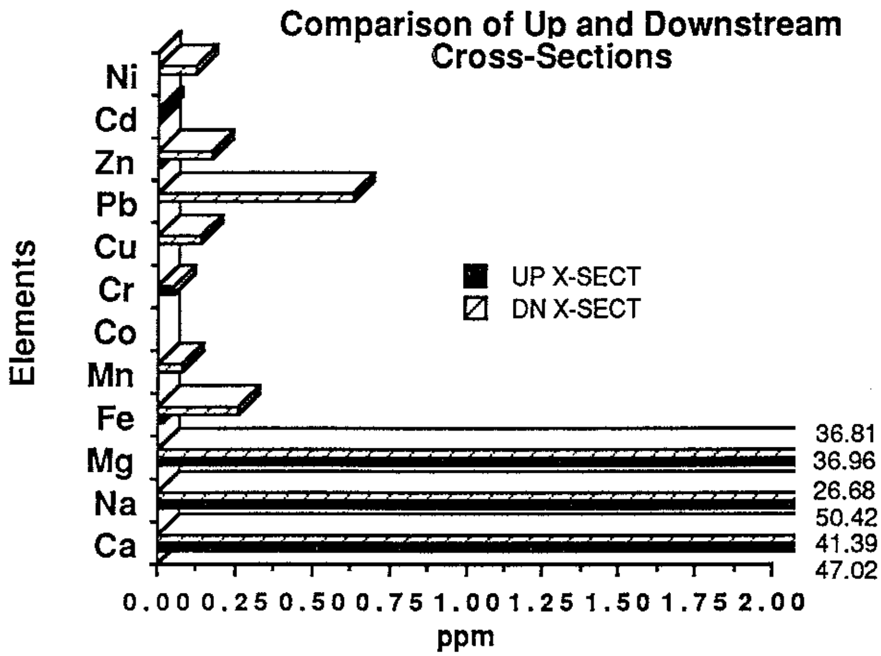


Comparison of Up and Downstream
Cross-Sections
Elements
Ni
Cd
Zn
Pb
Cu
Cr
Co
Mn
Fe
Mg
Na
Ca
UP X-SECT
DN X-SECT
36.81
36.96
26.68
50.42
41.39
47.02
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
ppm

Fig. 1

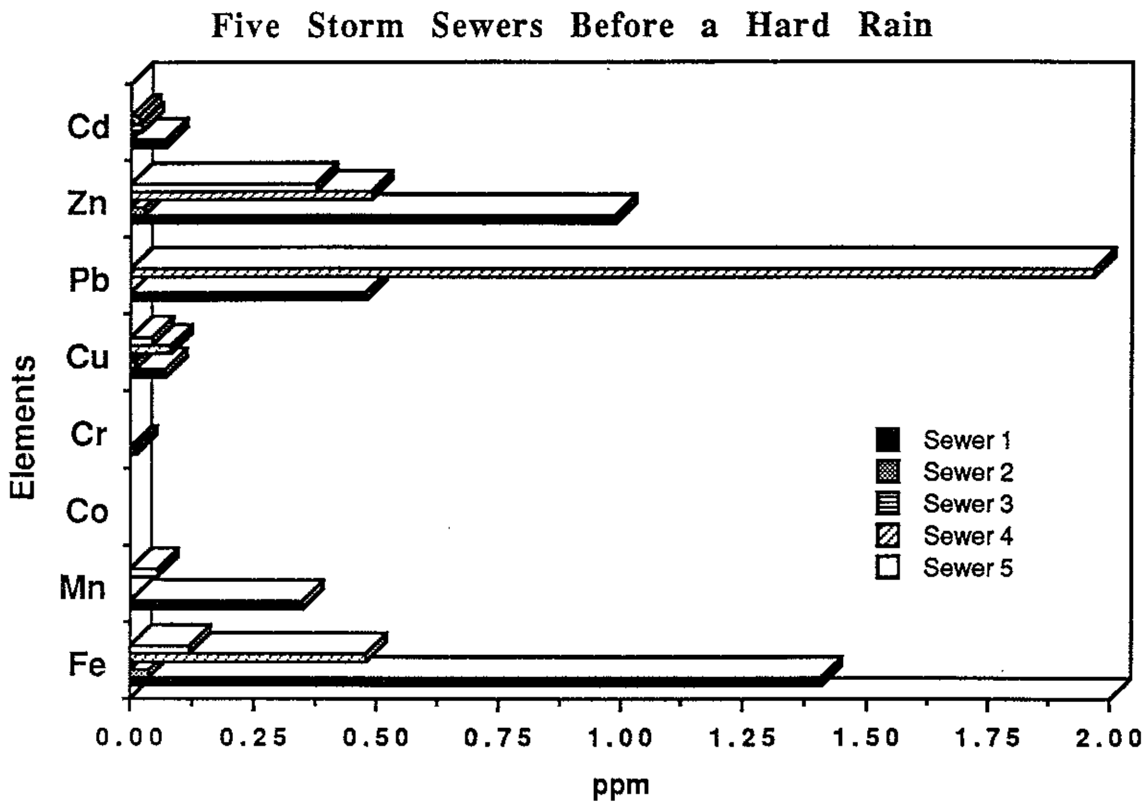
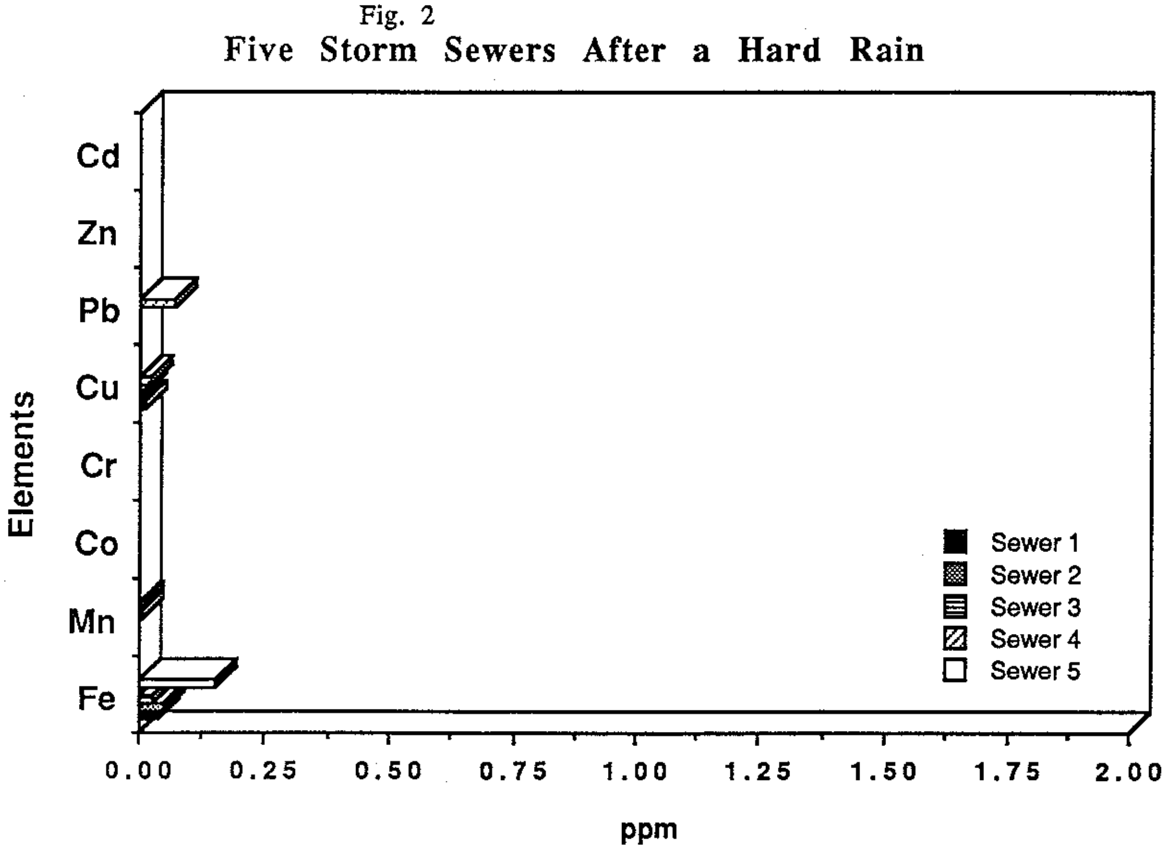

Five Storm Sewers Before a Hard Rain
Elements
Cd
Zn
Pb
Cu
Cr
Co
Mn
Fe
Sewer 1
Sewer 2
Sewer 3
Sewer 4
Sewer 5
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
ppm

Fig. 2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0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
ppm

Fig. 3

were sufficiently well mixed, and therefore were representative of the inflow into the City of Beloit. The average pH at this sight was 9.27, indicating a poor environment for heavy metal mobility.

The downstream cross-section showed elevated concentration levels across the board. The average Ca reading was 6 ppm higher, and the average for the sodium concentration was nearly 25 ppm higher. These jumps in concentration were due to the City of Beloit's waste water treatment facility. The outflow for the facility was located approximately 50 meters upstream from the Shirland Avenue bridge sampling sight. The water they were discharging was much higher in sodium and calcium than the river water.

The downstream cross-section also showed higher concentrations of the heavy metals. With the exception of cobalt and chromium, all the heavy metals showed up in concentrations of at least 1/100th of a part per million with some as high as1/2 a part per million. Lead showed up in the highest concentration, 1.258 parts per million at a single interval. Lead concentrations were also recorded at two of the other four remaining intervals. Initially such a high lead reading was attributed to an error in analysis or perhaps contaminated equipment. An additional cross-section was done the next day. Again the lead concentration was found to be quite high in a single interval, 1.753 ppm. This time however the interval wasn't the same. The lead plume appeared to have shifted to an adjacent interval. A third set of samples was taken the following day. This time, samples were taken every 5 meters. However, the lead was now below detectable limits and did not show up in the third analysis. pH taken at this sight was very similar to the upstream pH. The average pH reading taken here was 8.74, slightly more acidic but still an alkaline solution.

The analysis of the two suites of storm water outflow samples were informative. The analysis of the samples taken after a light sporadic rain on the 7th of August, showed very high concentrations of the heavy metals. Potassium, iron, cadmium, and lead were all seen in much higher concentrations than in the river. A lead concentration at one sight was 1.970 ppm. Iron was seen in concentrations as high as 1.406 ppm. A fairly high concentration of cadmium was seen, .0690. The analysis of samples taken on August 8th, after a heavy early morning rainfall, showed drastically reduced concentrations across the board. Nearly all the elements tested for were found to be below detection limits, or very in minute quantities. This trend in the data seems to indicate that most trace elements are washed out with the initial runoff or are more highly diluted by the greater amount of rainfall.

CONCLUSIONS

The data support the conclusion that, at least in the initial stages of a storm event, high concentrations of trace elements, especially lead, are washed into the Rock River by means of storm sewer runoff. Storm sewer runoff is a possible explanation for the high lead anomaly seen in the downstream cross-section. It is difficult to speculate on the exact amount of contribution by storm sewers. Concentrations could be contributed from any number of non-point sources. An in-depth study of the problem could prove enlightening. If several storm sewer outfalls could be monitored throughout an entire precipitation event, and then if several such events could be compared, a much more precise study could be developed. In addition, analysing the upper and lower cross-section after a storm event would determine whether or not the storm events produce a definite spike in the concentrations. Storm sewer runoff in highly industrialized areas makes a definite contribution to surface water pollution. The next step is to determine the exact extent of the problem.

WATER QUALITY OF TURTLE CREEK NEAR BELOIT, WISCONSIN

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INTRODUCTION

Two of water's unique qualities are that it is an exceptionally good solvent because of its strong dipolar nature and it has a strong dielectric constant or ability to keep ions in solution. In other words solutes are not only easily dissolved but their resulting ions' electric attraction is reduced drastically, making it difficult for ions to precipitate (Berner and Berner, 1987). Unfortunately these unique properties make it easier for water to carry pollution.

Pollution of surface water can take place in several different ways with pollutants being found in solution, suspension, or in bedload sediments. From the high number of water quality parameters, seven tests were chosen to characterize the water quality along the fifteen mile stretch of Turtle Creek from State Highway 140 to the confluence with the Rock River, south of Beloit. Parameters measured include: temperature, dissolved oxygen, pH, conductivity, turbidity, Total Coliform, Fecal Coliform, Fecal Streptococci, and dissolved trace heavy metals (Cu, Zn, Pb, Cd, and Ni).

This preliminary study includes only part of the information necessary to obtain a complete picture of the water quality at Turtle Creek, WI. However, these results are indicators of the overall water quality and provide an initial base for further study.

METHODS

Sampling techniques for on site measurements, bacteria, and heavy metals, followed those outlined by *Standard Methods For the Examination of Water and Wastewater*, 1985. To determine variation in measurements across the Creek, I took ten samples at equal increments at site C, six at site P, and three at site L (see Map). I found three samples per site was adequate. At sites B, H, and K, only one sample could be taken because the water was too deep across the remainder of the Creek.

Measurements of temperature, dissolved oxygen, pH, conductivity, and turbidity were performed using portable meters at sixteen different sites using the Equal Width Increment (EWI) method. Heavy metal samples were also obtained at these sites, as well as one extra site, site N, using depth integrated sampling and the EWI method. The high number of sites was intended to determine whether contamination was of the point source or diffuse source type. Also, more sites were established near the industrial area along the last mile of the Creek to pinpoint any potential polluters. At sites C, F, N, and P, I took one sample at the centroid of flow intending to use the samples for another test. Instead of disregarding them, these samples were also analyzed for heavy metals and are denoted by C', F', N', and P'. Dissolved heavy metal concentrations were then measured using the Inductively Coupled Argon Plasma Spectrometer (ICAP). At sites A and B, bacteriological testing was performed using the membrane filtration method. Site A was upstream of suspected septic system contamination and site B was downstream.

RESULTS

Given the limited scope of this report, I have chosen to give only dissolved oxygen, bacteriological, and dissolved heavy metals results.

Dissolved oxygen results can be seen in Figure 1, along with corresponding temperature and dissolved oxygen saturation levels. Levels of dissolved oxygen were not measured at sites A and B due to equipment malfunction.

Total Coliform counts were approximately 190 count/100 ml at sites A and B. Fecal Coliform results show 24 count/100ml at site A and approximately 112 count/100ml at site B. Fecal strep at each site was approximately > 2000 count/100 ml. Fecal coliform/fecal strep ratios were .012 upstream and .041 downstream.