FINAL REPORT

EFFECTS OF IN-STREAM CONCRETE STRUCTURES ON THE pH LEVEL OF WATER

by

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Research Engineer

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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SUMMARY

The pH values above and below concrete structures in streams on nine active construction projects throughout the state were determined. It was concluded that for streams with flow rates of 0.3 to 112.5 cfs (0.01 to 3.2 cubic meter/sec) the variations in the pH levels of the water above and below the concrete structures were within the acceptable EPA limit of 0.5 pH unit. It was concluded that cured concrete structures in live streams do not significantly affect the pH level of the water.

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INTRODUCTION

The degree of acidity or alkalinity of a solution is termed it's pH. The term expresses hydrogen ion concentrations, or more precisely, the hydrogen ion activity. It is definied as the logarithm of the reciprocal of the hydrogen ion activity in moles per liter, or

$$(pH = -\log (H^+) \text{ or } pH = \log 1/(H^+)).$$

When a pH measuring device is used to measure the hydrogen ion concentration of pure water, a concentration equal to 10^{-7} mole/liter is determined. Since it takes one hydrogen ion for every hydroxyl ion to provide one molecule of water, a value of 7 was set as the neutral point of the pH scale at 25°C. The scale extends from 0, very acidic, to 14, very alkaline.

The pH values of most natural waters or live streams fall between 4 and 9, with the acceptable range for aquatic life being between 6 and 9. In addition, fluctuations not exceeding 0.5 pH unit from the natural seasonal minimum and maximum values are acceptable in most cases*. Extreme variations in pH can create stress conditions and kill aquatic life. In some cases moderate changes of pH will have deleterious effects on certain aquatic life. The nonlethal pH limits of 6 to 9 for most fish is wider than the limits for certain fish food organisms.

As a result of a growing concern in the Environmental Quality Division about the possibility of losing aquatic life from pH changes due to concrete structures such as piers and box culverts in live streams, this study was initiated.

PROCEDURE AND SCOPE

Nine active construction projects throughout the state having some type of concrete structure in a stream were selected for the study. Projects were selected in various geological areas in order to determine the effects, if any, from different aggregates. In addition, streams having different flow rates and exposed to cured concrete structures with different finishes and periods of curing were included.

*"Proposed Criteria for Water Quality", Volume I, U. S. Environmental Protection Agency, Washington, D. C., October 1973.

The following parameters were determined at each structure: (1) pH, (2) temperature, and (3) flow rate. The pH and temperature were determined at 50 feet (15.2 m) and 2 feet (0.6 m) above and below the structures.

The pH values were determined on the site with a portable pH meter having a precision of 0.1 pH unit. Since a 25°C water temperature is specified in the definition of pH, any difference in the water temperature from 25°C is compensated for within the meter. The temperature of the stream was measured with an ASTM approved thermometer accurate within 0.1°C. The flow was determined from the velocity of water through a section of the stream and from the cross sectional area of the section. A water soluble dye was used to measure the velocity.

RESULTS

Table 1 lists the average pH values, the temperatures and the flow rates at the four locations on each project.

As shown in Table 1, the flow rates varied from 0.3 to 112.5 cfs (0.01 to 3.2 cubic meters/sec). Even though the flow values covered a large range, the pH values were very close to neutral water (pH = 7.0) and well within the limits of aquatic life(pH = 6 to 9) on all projects. On projects 1, 2, 5, and 8, the pH varied the most below the concrete structure (+0.3, -0.2, +0.2, and +0.2 pH unit, respectively). On the average the pH varied less than 0.1 pH unit below the structure. Considering the average change, the individual variations, and the acceptable limit of 0.5 pH unit, the effect of finished concrete structures in streams does not constitute a problem for the Department.

CONCLUSION

Cured concrete structures in live streams do not significantly affect the pH level of the water. In addition, the small variations in the pH above and below the structures are within acceptable limits for aquatic life.

Table 1

Flow, Temperature, and pH Results

Project No.	Type Structure	Flow, cfs*	Above Structure				Below Structure			
			50 Feet **		2 Feet		2 Feet		50 Feet	
			Temp., deg. C	pH	Temp., deg. C	pH	Temp., deg. C	pH	Temp., deg. C	pH
1	Box culvert and paved channel	0.3	9.1	6.9	9.1	6.7	10.5	7.0	11.0	6.9
2	Pipe	0.4	5.8	7.2	5.8	7.2	5.8	7.0	5.8	7.1
3	Box culvert	0.5	5.8	7.0	5.8	7.1	5.8	7.1	5.8	7.0
4	Box culvert	0.8	7.8	7.1	7.8	7.1	8.2	7.2	8.2	7.4
5	Box culvert	5.8	6.0	7.6	6.0	7.3	6.0	7.5	6.0	7.7
6	Box culvert	19.9	2.8	7.0	2.8	6.9	2.8	7.0	2.8	6.9
7	Box culvert	54.8	9.5	6.8	9.5	6.8	9.5	6.7	9.5	6.8
8	Piers	103.6	5.8	7.0	5.8	6.9	5.5	7.1	5.5	7.2
9	Piers	112.5	5.1	7.0	5.1	7.2	5.9	7.2	5.9	7.2

*To convert cfs to cubic meters/sec. multiply by 0.02832.
**To convert feet to meters multiply by 0.3048.