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AN ECOLOGICAL ASSESSMENT OF A BRIDGE DEMOLITION

by

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

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SUMMARY

Bridge demolition has long been known to mobilize large amounts of stream sediment in the immediate area of the structure. An ecological assessment in terms of stream macroinvertebrate samples and suspended solids measurements was made shortly before, shortly after and eight months after a demolition of a bridge deck. No environmental damage was indicated by the study even though suspended solids levels exceeded 200 parts per million shortly after demolition. The U. S. Environmental Protection Agency's proposed limits for suspended solids appear to be too low for short-term stream disturbing events.

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INTRODUCTION

As a result of a need for baseline information for the environmental impact process, an investigation was initiated by the Research Council to evaluate the effects of bridge demolition upon stream ecology. This study is of importance to those persons who write specifications regarding procedures associated with bridge demolition and to those who must apply to various state regulatory agencies for water quality permits.

Bridge demolition and replacement has long been known to disturb large amounts of sediment in the immediate area of construction. Typically a bridge deck is destroyed and allowed to fall directly into the stream. It is then removed, usually by crane and clam shell. The cleanup of the old bridge materials may take up to several days. If suspended sediment levels are significantly higher for this period of time, significant environmental damage may result. The disturbed sediment in the form of bedload and suspended load can drastically reduce bottom-dwelling or benthic organism populations downstream. These organisms are the principal food sources for fish and should their numbers be reduced there may be a corresponding reduction in the number of fish. This report summarizes the relationships of the generated suspended stream sediment to water quality index organisms for a typical bridge deck demolition.

LOCATION AND DEMOLITION PROCEDURE

The demolition of a two-lane highway bridge located on U. S. Route 29 south of Charlottesville, Virginia, was selected for this study (Figure 1). The bridge crosses the north fork of the Hardware River near Red Hill, Virginia. The Hardware River at the point of the crossing has a drainage area of 11 square miles (4.4 square kilometers) and has a ten-year discharge return frequency of 1,600 cubic feet per second (45,300 liters/sec). The overall length of the removed portion of the bridge was approximately 35 feet (10.7 meters). Demolition of the bridge allowed the main span and associated support pilings to fall directly into the stream. The demolition was accomplished with an explosive charge and the cleanup of the stream, which took several days, was accomplished by crane and clam shell (Figure 2).

Surber macroinvertebrate surveys and stream water suspended solids measurements were made upstream and downstream of the structure. These measurements were taken prior to demolition, shortly after demolition, and eight months after cleanup. In addition, suspended solids measurements were made during the demolition process.

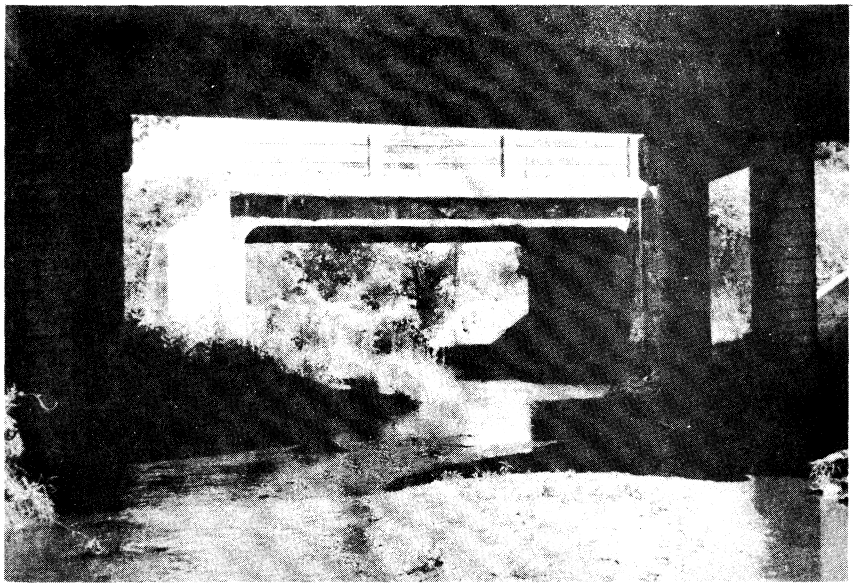

Figure 1. Bridge to be demolished during presurvey.

Figure 2. Demolished bridge during cleanup. Note rock berm.

RESULTS

The results of the suspended solids measurements are shown in Table 1. Shortly after demolition, the suspended solids levels rose approximately 230 parts per million (ppm) above ambient stream levels. Within three days and even though debris cleanup continued, the suspended solids level was well below the Environmental Protection Agency's (EPA) proposed safe level for aquatic life.[1] Before demolition two simple riprap berms were placed downstream of the work and were the only sediment control used in the stream.

Table 1

Suspended Solids Values

Date	Location	Remarks	Suspended Solids (ppm)
6/11/74	upstream	Pre survey	1.5
6/11/74	downstream	Pre survey	1.5
8/13/74	upstream	Bridge demolition	3.0
8/13/74	downstream	Bridge demolition	234.4
8/16/74	upstream	3 days after demolition	1.0
8/16/74	downstream	3 days after demolition	22.3
4/16/75	upstream	Post survey	8.3
4/16/75	downstream	Post survey	3.3

The macroinvertebrate surveys (Table 2) indicated that with the exception of seasonal changes in overall stream productivity, little or no downstream reduction in organisms occurred (Figures 3 and 4). The demolition had the same effect as a one-day storm on the downstream populations when considered from the standpoint of suspended solids.

Figure 3. Downstream sampling location. Note rock berm.

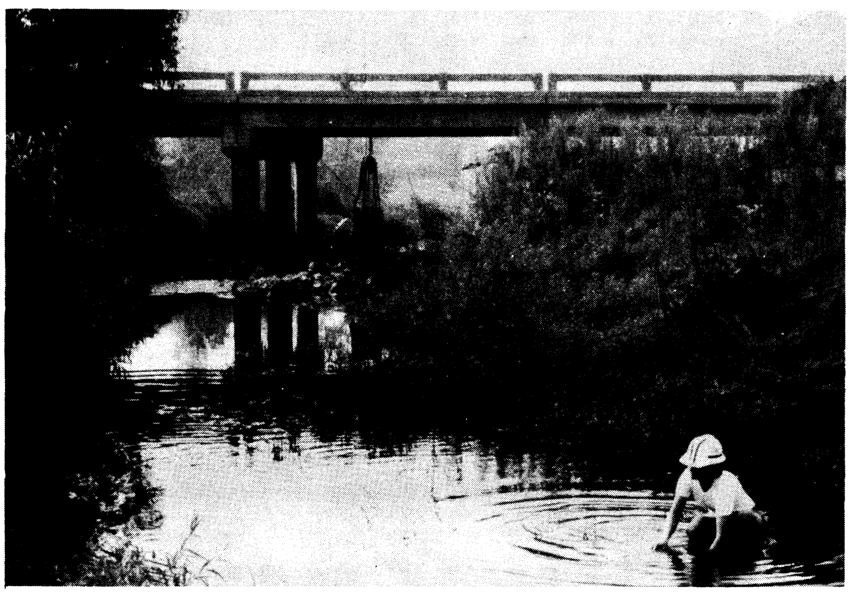

Figure 4. Upstream sampling location.

Table 2

Results of Macroinvertebrate Survey

Date	Location	No. Organism/Ft^2*
6/11/74	upstream	41
6/11/74	downstream	59
8/16/74	upstream	11**
8/16/74	downstream	59
4/16/75	upstream	5
4/16/75	downstream	3

*Only one Surber sample (one square foot or 929 cm^2) was taken at each location.

**Exact location of previous sampling unobtainable due to excessive pooling behind rock berm.

No downstream damage (i.e. no significant downstream differences in total numbers of organisms) was observed between the pre survey and those samples taken shortly after demolition. The post survey made eight months after the demolition indicated that a lower number of organisms were present in the stream when compared to the other surveys. This was the result of low winter productivity as well as high seasonal discharges on the Hardware River prior to the survey (Figures 5 and 6).

It should be pointed out at this point that while EPA procedures commonly require only a single Surber sample to be taken, a better statistical sampling of organisms would be realized during any one survey if more Surber samples were taken. In order to improve the reliability of the results of future investigations of this type it is recommended that Hester-Dendy substrates be used in sufficient numbers to allow even greater statistical validity. Use of such substrates would also overcome the problems associated with trying to sample the exact same locations during subsequent surveys.

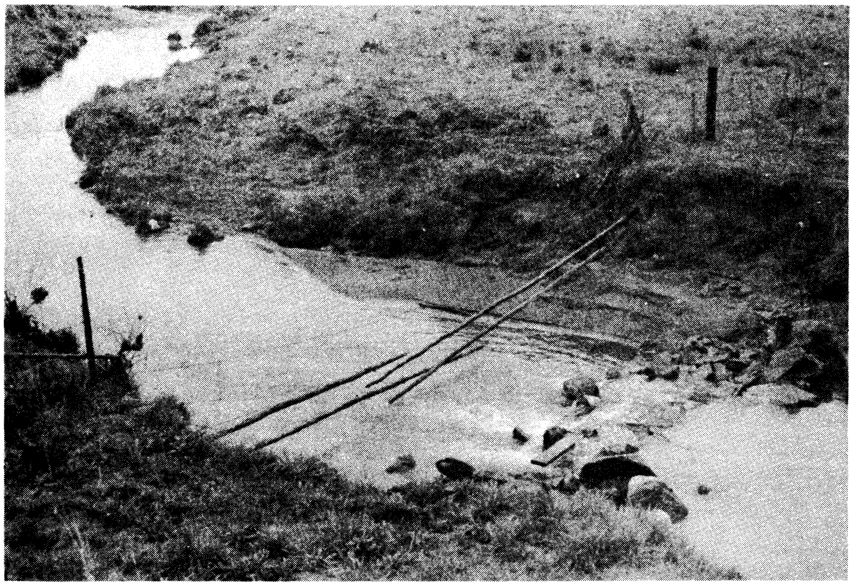

Figure 5. Downstream sampling area and rock berms 8 months after demolition.

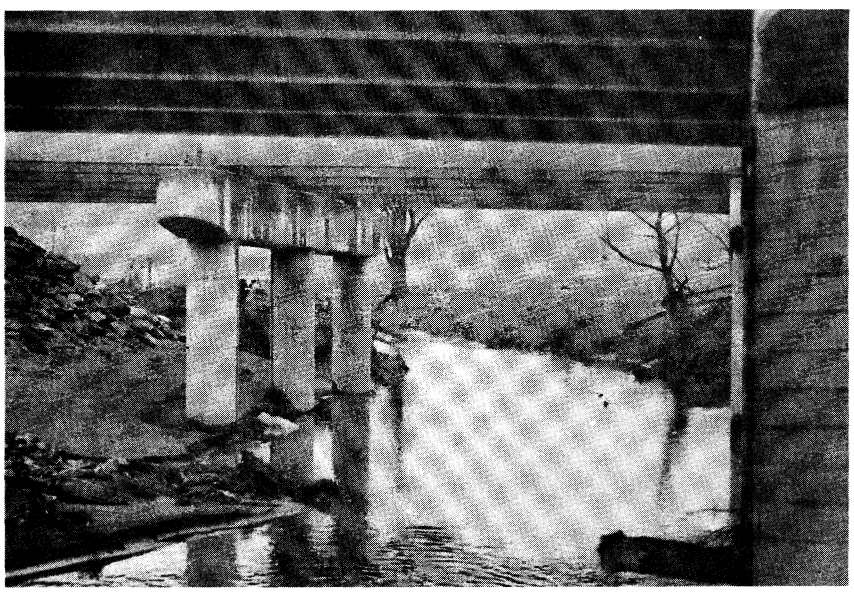

Figure 6. Constructed bridge eight months after demolition. Note sediment trapped on riprap after high spring flood.

Referring to Table 3, it should be observed that both the pre survey and the survey made three days after demolition showed an average of 59 organisms and the breakdown by orders of these surveys was identical. If one considers that the suspended solids levels in the stream exceeded 200 ppm during a significant portion of this latter survey period, then EPA's suggested suspended solids levels appear to be too low for short-term events.[1,2] Low values were observed in the post survey samples because of seasonal changes in productivity and because the stream profile was adjusting to recent spring floods (Figure 7). The stream will be rechecked approximately one year after demolition and is expected to show no evidence of environmental damage.

Examination of the organisms taken from the stream indicates that most of these are larval forms of flies of the family Chironomidae (true midges) which form an important food source for young and adult fish. Many fish biologists suggest that without this group many good fishing streams and lakes might be relatively barren.[3] Also present among the Diptera were the crane fly larvae, Antocha and Eriocera. Trichopteran genera were all of the caddis fly larvae, Hydropsyche. Ephemeropteran genera include the may fly larvae, Stenonema, Pseudocloeon and Ephemerella, which are all index organisms of excellent water quality as well as excellent food sources for fish. Other minor constituents of the macrobenthic survey included Stenelmis and Psephenus (Coleoptera), Ophiogomphus (Odonata) and assorted Gastropoda.

Figure 7. Detail of sediment trapped on riprap after high spring floods (8 months after demolition).

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Table 3

Number of Organisms per Biological Order

Order	6/11/74 Upstream	6/11/74 Downstream	8/16/74 Upstream	8/16/74 Downstream	4/16/75 Upstream	4/16/75 Downstream
Diptera	35	37	10	37		1
Trichoptera	5	10		10	2	
Ephemeroptera	2	2		2	3	
Coleoptera		1	1	1		
Other					1	2
TOTAL	41	59	11	59	6	3

CONCLUSIONS

1. Bridge demolition, while quite limited in extent, produces a significant level of suspended sediment which may persist for several days.

2. No effect on the downstream ecology of the stream was observed even though the EPA limits for suspended solids were exceeded during and for several days following demolition.

3. The EPA proposed limits for suspended solids appear to be too low for short-term stream disturbing events.

RECOMMENDATIONS

1. Rock berms should be used on similar projects where sediment is introduced into a stream for a short period of time (four to six weeks). Such berms should be introduced into the stream well before demolition takes place.

2. If future bridge demolitions are to be monitored, the following methodology should be used:

    a) A pre survey of suspended solids and a macroinvertebrate inventory should be taken prior to demolition.

    b) Shortly after demolition, a similar survey should be made.

    c) Three to five days after the demolition, a third set of surveys should be made.

For best statistical confidence, the macrobenthic survey should be made with a multiplate biologic substrate of at least five square feet (.465 m^2) of surface area or five samples should be taken with a Surber sampler.

Two sampling stations, one upstream of construction and one downstream, should be established in areas of approximately similar bottom characteristics. Beginning with the downstream location, a Surber sample and a suspended solids water sample should be taken.

If post surveys are made, then sampling should be made at least six to eight weeks after any rains which are considered by the investigator to be in excess of normal rainfall.

3. A study should be conducted similar to the present study but using the methodology of recommendation 2.

REFERENCES

1. U. S. Environmental Protection Agency, 1973, Proposed Criteria for Water Quality (EPA-335), Washington, D. C., 425 pages.

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3. Pennak, R. W., 1953, Fresh-water Invertebrates of the United States, Ronald Press, New York, 769 pages.

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