

PRELIMINARY RESULTS OF A DAM-REMOVAL ANALYSIS ON BREWSTER CREEK NEAR ST. CHARLES, ILLINOIS, 2002-2004

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ABSTRACT

The benefits of gradually removing a dam (through multiple notches) are to reduce the total project cost and reduce possible environmental effects by allowing the impounded sediment to slowly move downstream, and a stable stream and revegetated floodplain to form upstream. Notching, in this study of a dam on Brewster Creek, near St. Charles, Illinois, involves cutting a given height (in five 12–18 inch notches over approximately a 9 month period) across the length (or some portion of the length) of the dam. Brewster Creek is a tributary of the Fox River in northeastern, Illinois. Sediment, dissolved oxygen, and geomorphic response are being monitored before, during, and after a gradual (notching) removal of the dam. The study area includes the creek reach immediately below the dam and above the lake. Preliminary data analysis indicate that during and after the removal, the relation between the sediment transported to the study area from upstream and the sediment transported out of the study area remained relatively stable. This preliminary result indicates that the notching system created a fairly slow and predictable sediment transport response to storms, when compared to known upstream sediment loads. This result corresponds to the slow geomorphic response at the site since inception of the notching sequence in 2003. The creek responded to the five notches removed over the course of 9 months by gradually cutting through the former lakebed sediment to establish a meandering channel. Notchings did not appreciably affect dissolved oxygen concentrations in Brewster Creek.

KEYWORDS: sediment, transport, automated sampling, dam, removal, calculation, costs, analysis

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INTRODUCTION

The Illinois Department of Natural Resources (IDNR) declared the dam on Brewster Creek near St. Charles, Illinois a Class I structure, having a high probability of causing loss of life and/or substantial economic loss in the event of a catastrophic failure. The dam was in disrepair and, therefore, needed to be repaired or removed. Costs were prohibitive to repair the dam; therefore, the owners decided to remove the dam.

Costs and possible environmental effects of removing dams, and managing or removing the sediment impounded behind them also can be substantial. In Illinois, State regulations require complete sediment containment during any construction project. Project engineers developed a first design for the total removal of Brewster Creek dam that complied with these regulations. The projected construction, oversight and restoration costs of the dam removal under this first design were \$1.17 million, which exceeded available funds.

The Illinois Environmental Protection Agency (IEPA) granted permission for a pilot dam removal project, consisting of cutting five 12–18 inch notches, over approximately a 9-month period, across the length (or some portion of the length) of the dam. The projected construction, oversight, and restoration cost for the gradual removal was \$330,000.

The benefits of gradually removing a dam at this site using multiple notches included reducing the projected removal project cost and reducing possible environmental effects by allowing the impounded sediment to slowly move downstream and a stable stream and revegetated floodplain to form upstream.

PURPOSE AND SCOPE

The purpose of this paper is to present preliminary analysis of the sediment data collection (pre-notching, during notchings, and post-notching) and to document some geomorphic changes with selected project photos. Dissolved oxygen data, collected during notchings, also will be summarized. A final report is planned describing the entire study after the channel and floodplain have stabilized. Note that all data presented are provisional and subject to revision.

METHODS

Sediment concentrations and load are being monitored at two gaging stations (one upstream and one downstream of the dam) (Figure 1), by the U.S. Geological Survey (USGS), in cooperation with Kane County Department of Environmental Management (KCDEM), and the IEPA. From June 2002 through March 2004, more than 600 sediment samples were collected at the two gaging stations. Samples are obtained at various stream stages throughout the year, including all five dam notchings from June 2003 through February 2004. The USGS also monitored dissolved oxygen concentrations during each notching event.

Biologists from the IDNR and the Shedd Aquarium in Chicago are monitoring stream biota. Engineers and surveyors from the IDNR, Office of Water Resources and USGS are surveying geomorphic changes. Lastly, KCDEM is maintaining a Web site showing the progression of geomorphic changes by way of photographs taken during the course of the study.

Notching criteria will be developed based on watershed flow and sediment released in relation to the amount of stored sediment behind the dam. The notching criteria developed through this pilot project may be expanded to other watersheds so that the IEPA can develop criteria for other possible dam removals in Illinois.



Figure 1. Location of two USGS gaging stations near the dam on Brewster Creek near St. Charles, Illinois.

RESULTS

The following discussion summarizes preliminary results based on data collected from June 2002 through March 2004. Note that all data presented are provisional and subject to revision. A summary of sediment loads from storm events and notchings are given in Table 1 and Figure 2, along with peak flow and rainfall totals (Table 1).

The percent difference in sediment loads (downstream minus upstream) before any notchings was near zero or negative for storm events (Table 1 and Figure 3). This result means that the impounded water behind the dam trapped sediment. Also, as expected, after the notchings started, there was a shift in the percent difference in sediment load from negative to positive (Table 1 and Figure 3). At this point in time, the positive percent difference in sediment load has remained relatively stable, with a median value of 65 percent.

Data from the first storm after notch 5 yielded the highest sediment load (163 tons), but the difference as compared to the upstream gaging station is 66 percent. This result means that the sediment load only increased by 66 percent between the upstream and downstream gaging station, similar to the results of the other notchings and storms between notchings. Storms occurred between all notchings (except between notch 1 and 2) allowing for transport of

sediment (given the new base elevation near the dam), although the peak flows during some storms are relatively small (Table 1). A series of photos through time illustrate the gradual formation of a stream channel in response to the five notchings (Figure 4). Dissolved oxygen concentration during the notchings never dropped below 7 milligrams/liter (mg/L) at the downstream gaging station.

Table 1. Sediment loads at gaging stations upstream and downstream of a dam on Brewster Creek near St. Charles, Illinois, along with peak flow and total rain. [ft³/s, cubic feet per second]

Time Period	Total Sediment Load		Percent Difference (Downstream minus Upstream)	Peak Flow (ft ³ /s)	Total Rain (inches)	Event Type
	Downstream (tons)	Upstream (tons)				
07/08-07/15/2002	6.5	6.8	-4	20	1.41	Storm
08/03-08/10/2002	19.0	21.6	-12	27	1.08	Storm
08/12-08/16/2002	19.2	20.4	-6	58	3.33	Storm
08/21-08/29/2002	33.7	36.3	-7	81	3.34	Storm
04/29-05/03/2003	36.6	76.4	-52	100	3.67	Storm
05/04-05/12/2003	51.5	49.1	5	87	3.59	Storm
05/13-05/22/2003	14.4	13.7	5	42	0.58	Storm
06/19-06/22/2003	1.8	1.1	63	23	0.01	Notch 1
07/14-07/19/2003	12.5	9.1	37	19	0.00	Notch 2
07/30-08/07/2003	2.5	1.5	65	9	1.45	Storm
08/19-08/24/2003	2.9	1.1	165	4	0.00	Notch 3
11/01-11/08/2003	23.4	10.3	127	21	3.09	Storm
11/17-11/28/2003	30.6	19.09	60	35	1.92	Notch 4 and Storm
12/08-12/19/2003*	135.0	73.6	83	41	2.16	Storm
02/18-02/28/2004	8.9	7.0	27	16	0.52	Notch 5
03/03-03/09/2004	162.9	97.9	66	90	1.83	Storm

*estimated downstream sediment load due to sampler malfunction

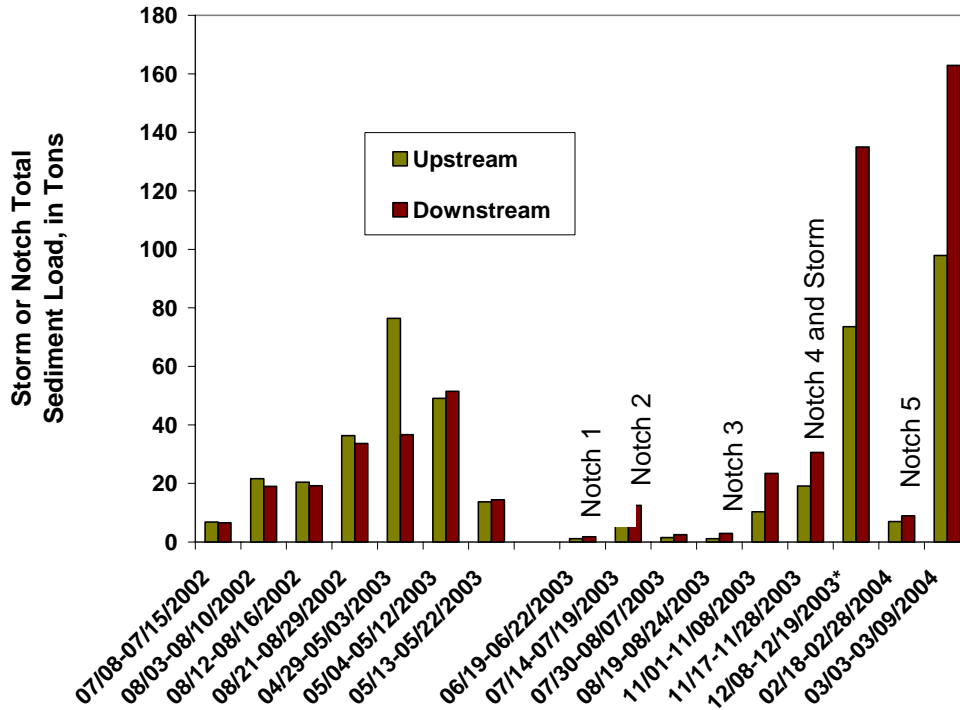


Figure 2. Total sediment load at the downstream and upstream gaging stations for storms and notches of a dam on Brewster Creek near St. Charles, Illinois.

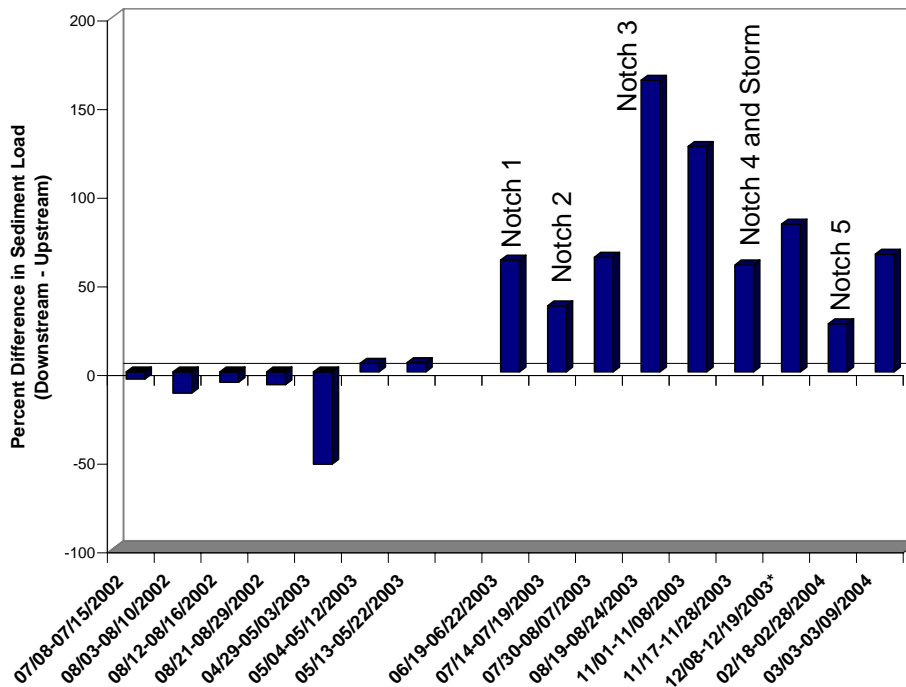


Figure 3. Percent difference in sediment load (downstream minus upstream) for storms and notches of a dam on Brewster Creek near St. Charles, Illinois.



Brewster Creek/ Willow Lake, pre-dam removal



June 2003



August 2003



March 2004



June 2004 (8 weeks after spring burn)

Figure 4. Geomorphic and vegetative response of Brewster Creek to gradual dam removal (photos taken looking upstream from bridge that is located 15 feet downstream of dam)

CONCLUSIONS

The benefits of gradually removing a dam on Brewster Creek, near St. Charles, Illinois, are to reduce the total project costs and reduce possible environmental effects by allowing the impounded sediment to slowly move downstream, and a stable stream and revegetated floodplain

to form upstream. Through the monitoring of sediment movement, dissolved oxygen concentrations, and geomorphic changes, notching criteria can be developed based on flow and sediment released in relation to the amount of sediment stored behind the dam.

The costs to remove the dam by using a gradual (notching) removal method were approximately one-quarter (\$330,000) the costs projected to remove the dam using traditional sediment-containment techniques (\$1.17 million).

As expected, the dam trapped sediment before removal. During and after removal, the impounded sediments are transported downstream. Also, during and after removal, the relation between the sediment transported to the study area from upstream and the sediment transported out of the study area remained relatively stable. This preliminary result indicates that the notching system created fairly slow and predictable sediment transport response to storms when compared to the expected upstream sediment load. This result corresponds to the slow geomorphic response at the site since inception of the notching sequence in June 2003. Based upon regional estimates of annual sediment yield (0.3 tons per acre per year), the current sediment loads of all events analyzed is less than would be expected for a watershed of this size.

Brewster Creek gradually cut through the former lakebed sediment to establish a meandering channel. As expected, the channel formation was most active during and after major storm events. The channel emerged after the first notching and gradually developed with the slow rate of notchings. After the fifth notch, the channel widened to the point that small meanders emerged within the channel banks, with gravel and cobble point bars on the inside bends.

Results indicate that the notchings did not appreciably affect dissolved oxygen concentrations in Brewster Creek. Before removal of the dam, the upstream lake was almost full of sediment, with maximum water depths of approximately 2 ft. The lack of any appreciable effects because of notchings could indicate a well-mixed lake with no areas of low dissolved oxygen concentrations given the low water depths in the lake.

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