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Engineered Riffles on Portage Creek, MI

Design, Post Construction Monitoring, and Lessons Learned

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Alcott Street Dam

- Built on Portage Creek in 1895 and reconstructed in 1946 for purpose of diverting water to provide hydromechanical power and process water to a former paper mill.
- 21 feet high, 40 feet long with 21 foot wide concrete spillway structure.
- Impoundment extended approximately 3,000 feet upstream and inundated 29 acres.

Sediment Contamination

- Kalamazoo River and Portage Creek listed as an Area of Concern (AOC) by EPA in 1990s due to historic releases of polychlorinated biphenyls (PCBs).
- 1998 and 1999 EPA dredged approx. 146,000 CYDs of PCB-containing sediment, residuals, and soils from the former Bryant Mill Pond then backfilled with clean fill.

Project Goals of Dam Removal

- Improve water quality
- Improve aquatic habitat and re-establish fish passage
- Re-establish native vegetation and fish/wildlife habitat
- Eliminate public safety hazard
- Provide stabilized channel minimizing erosion and channel migration

Design and Construction

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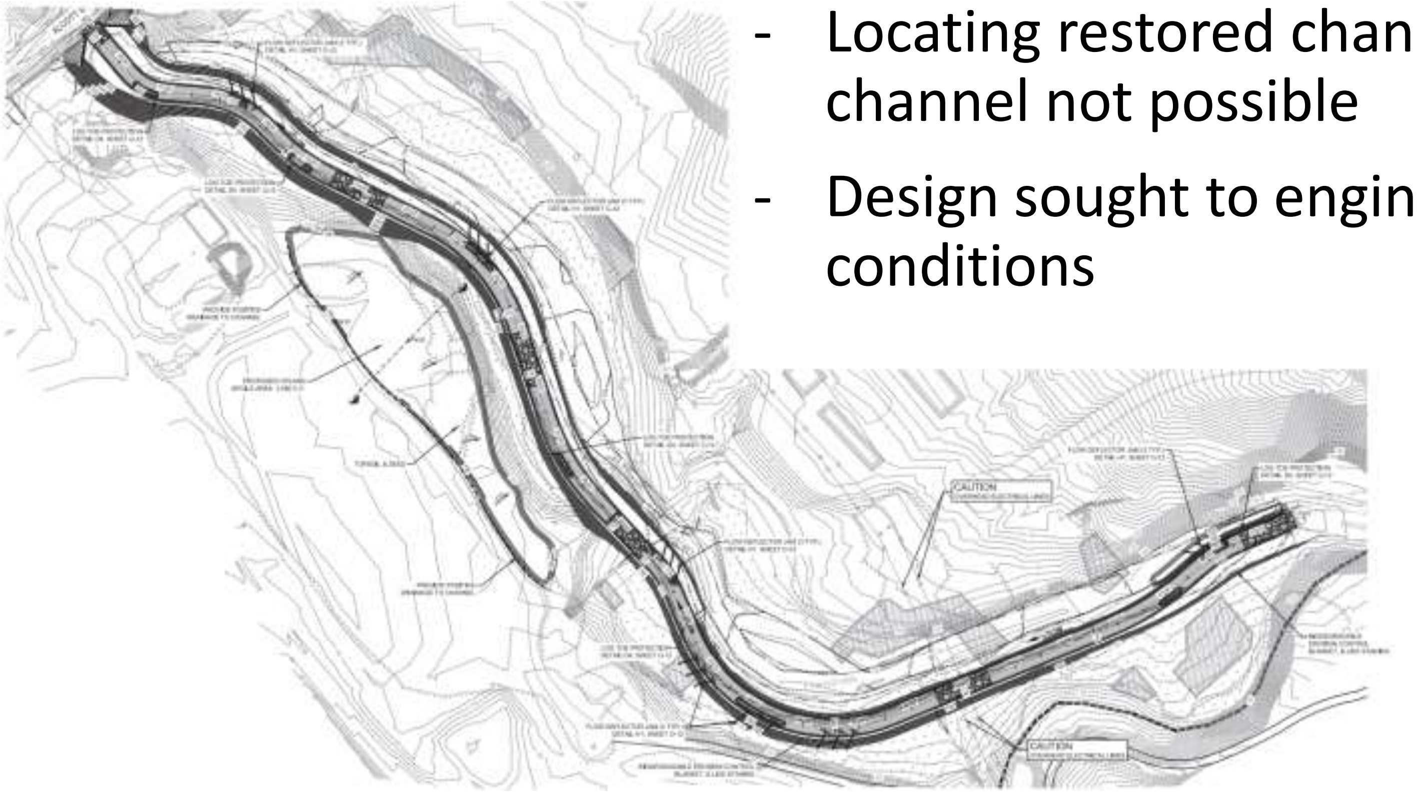
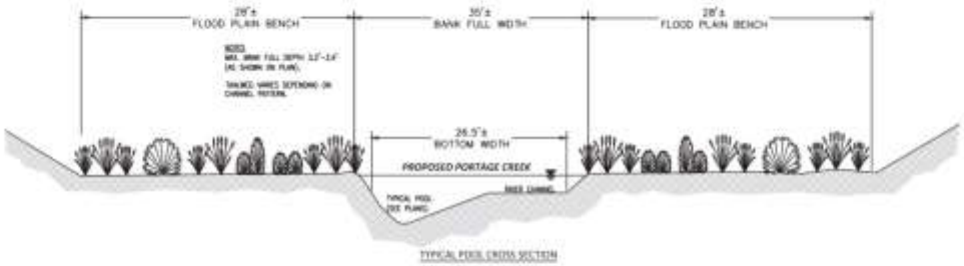
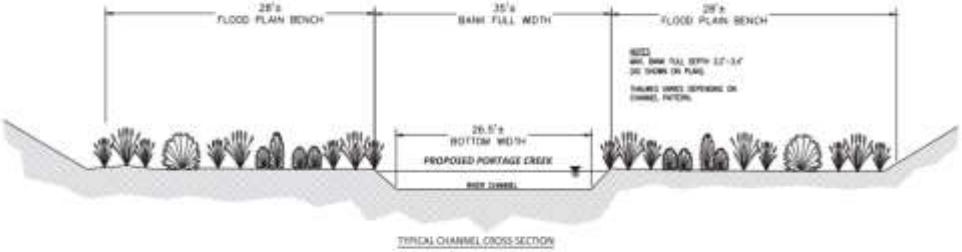
Design

- Due to extensive disturbance of sediments, native soils, and fill materials and the adjacent PCB-contaminated sediments it was important that the restored channel was stabilized to prevent head cutting and lateral migration through the former impoundment
- Locating restored channel in the natural (or pre-dam) channel not possible
- Design sought to engineer a channel that mimicked natural conditions

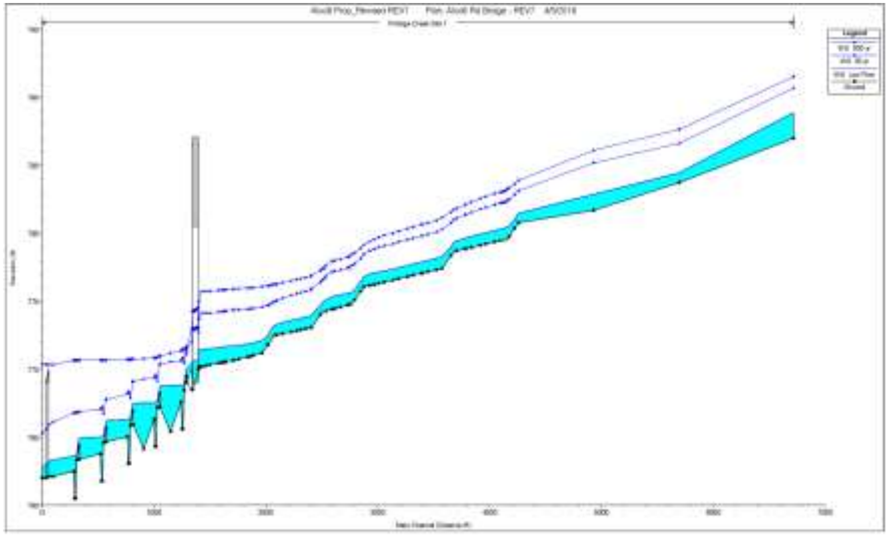


Channel Design



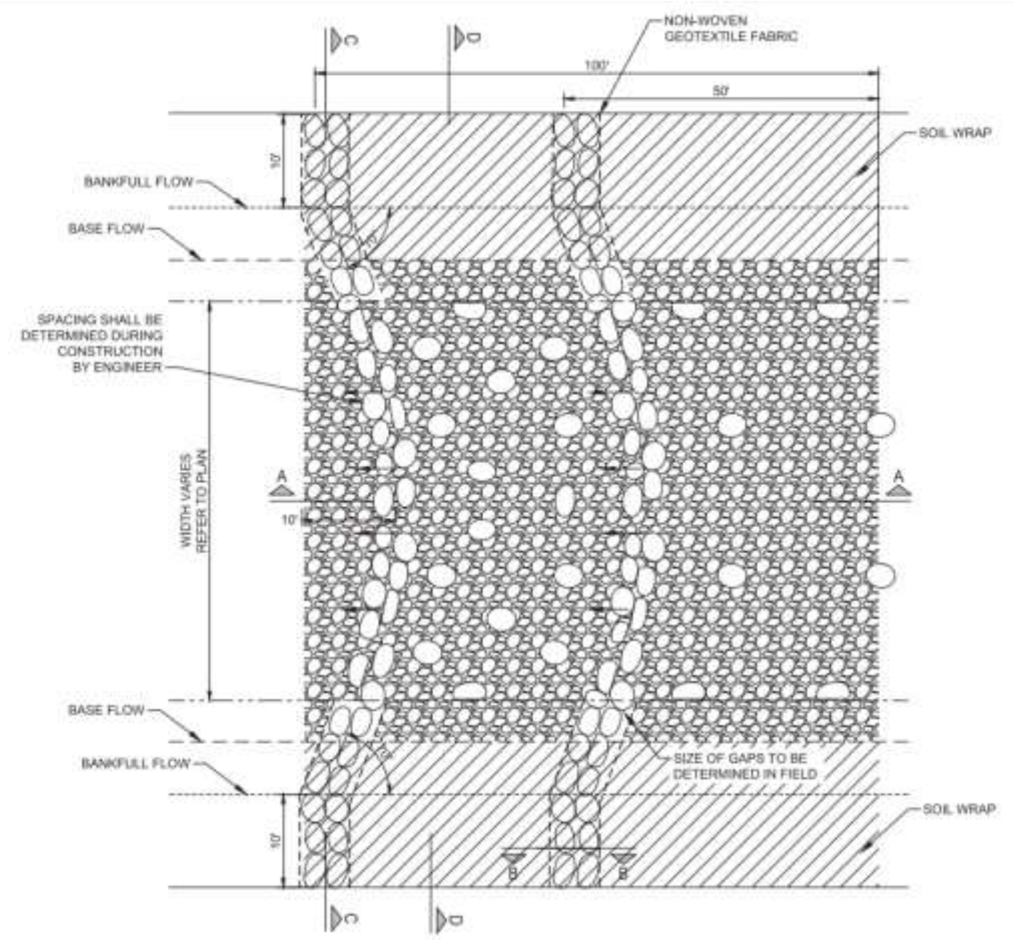


- Step pool system for 3,000 feet of restored channel with 5 engineered riffles for grade control
- Used regional bankfull curves for design
  - Bankfull discharge = 41cfs; width of 35 feet and depth of 1.25 feet
- Riffles with 1.2% slope, average channel slope between riffles of 0.2%
- Goal to achieve bankfull discharge < 3ft/s for fish passage criteria

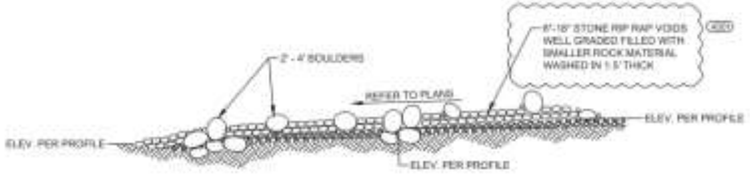


Engineered Riffles

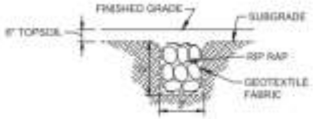
- Engineered riffles used to stabilize river profile
- Mixed gradation of materials
- Rock vane embedded into floodplain
- Soil wrapped banks with plantings
- HEC-RAS used to size material to be immobile



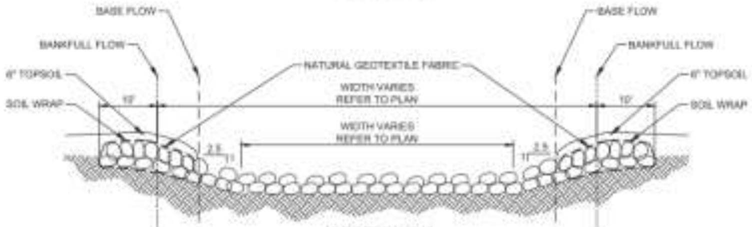
PLAN VIEW



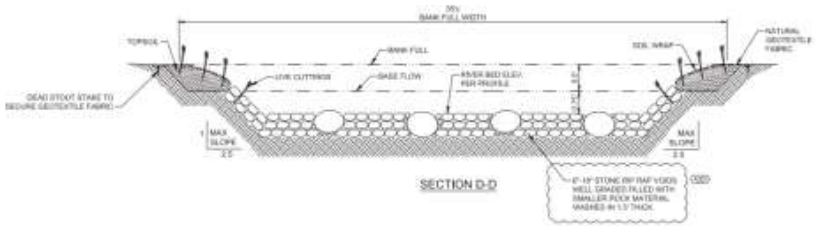
SECTION A-A



SECTION B-B



SECTION C-C



SECTION D-D

Construction (2018)

- Engineer on-site for riffle construction
- Constructed in non-flowing conditions

Engineered Riffle Construction

Riffles Prior to Bank Stabilization

Post Construction Monitoring

Monitoring 2019 - current

- Required by the State permit
- 5 years of post-construction monitoring
- Field visit 2-3 times each year primarily looking at vegetation establishment, bank erosion, and channel stability
- Through this program, targeted bank erosion was observed at multiple riffle locations

Riffle #1

August 2018

March 2019

June 2020

April 2021

October 2021

June 2022

Riffle #2


August 2018


March 2019


June 2019


June 2020


April 2021


June 2022

Riffle #3

August 2018

October 2018

March 2019

June 2020

April 2021

June 2022

Riffle #4


October 2018


March 2019


June 2019


June 2020


June 2021


June 2022

Fish Surveys

- Michigan Department of Natural Resources completed fish surveys in 2014 (pre-dam removal) and 2019 (post dam removal).
- Two sites, 1 upstream and 1 downstream were surveyed.
- The downstream site remained relatively the same:
- The upstream site saw improvement:
  - Smallmouth Bass and Brown Trout were captured upstream of the former dam for the first time

Table 2. Index of Biotic Integrity scores for the fish communities at the upstream and downstream electrofishing stations in Portage Creek in 2014 and 2019.

Metric	Upstream		Downstream	
	2014	2019	2014	2019
Fish Species	14	21	24	24
Darter Species	3	2	4	4
Sunfish Species	1	4	3	4
Sucker Species	1	3	3	3
Intolerant species	3	7	9	8
% omnivores	89.6	46.1	45.8	23.1
% insectivores	10.4	45.5	49.7	66.2
% piscivores	0.0	7.4	3.3	10.1
% tolerant	90.6	46.7	46.5	24.3
% SL spawners	72.3	54.5	53.4	27.9
Scores				
Fish Species	1	1	1	1
Darter Species	0	0	1	1
Sunfish Species	-1	1	0	1
Sucker Species	-1	1	1	1
Intolerant species	0	1	1	1
% Omnivores	-1	0	0	0
% insectivores	-1	0	0	1
% piscivores	-1	0	0	0
% tolerant	-1	0	0	0
% SL Spawners	1	1	1	0
TOTAL	**-4**	**5**	**5**	**6**
Scores	**Acceptable**	**Excellent**	**Excellent**	**Excellent**

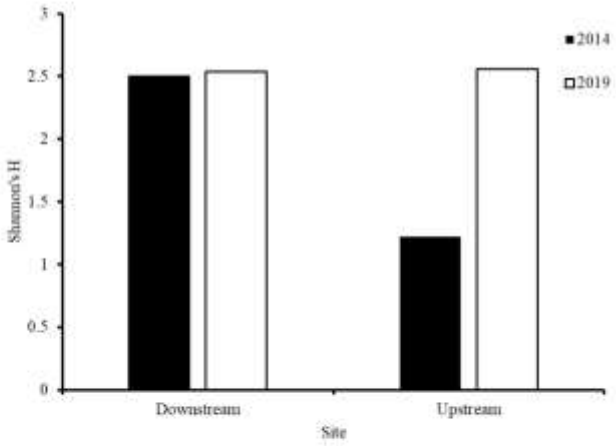


Figure 2. Shannon's Diversity Indices for the fish communities at the upstream and downstream electrofishing sites on Portage Creek in 2014 (pre dam removal) and 2019 (post dam removal).

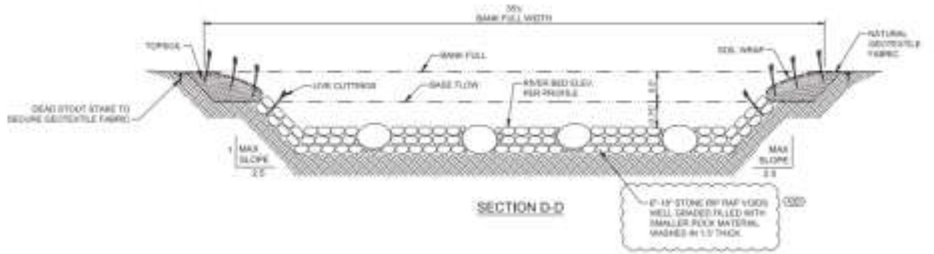
Observations and Lessons Learned

Observations

- Riffles 1, 2, and 3 have noted the most pronounced bank erosion between the embedded rock vanes.
- Riffle 4 has largely remained the same throughout the monitoring period.
- Bank erosion has been a slow process with small increases from year to year.
- Embedded rock vanes appear to be working t direct flow back toward the main channel.
- Aquatic habitat diversity with pool riffle system, undercut banks, and large wood structures has improved water quality and habitat as shown by fish survey data.

Lessons Learned

- When flow was introduced to channel some erosion of channel banks occurred – where not repaired those initial bank erosions have progressed in successive years.
  - Stabilize stream banks at riffles prior to introducing flow and/or be sure to re-establish designed banks at time of final restoration
- Details matter!



Lesson Learned (Cont.)

- Be aware of large boulders placed along stream banks that could incidentally direct flow toward bank or contribute to bank scour.
- Incorporate a third rock vane at upstream portion of riffle to further stabilize riffle.
- Restoration practices have shown success with habitat improvement and should be continued.

Questions?

Thank you.

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