Abstract

In 2016, the city of Silver Bay, MN put out a request for proposals (RFP) to restore an area on the East Branch of the Beaver River adjacent to the Silver Bay Municipal Golf Course that sustained damage from a 500-year flood event in June 2017. The goals of the RFP were to a) protect golf course infrastructure, b) restore river to a "stable state", and c) use "natural channel design" methods to accomplish the above objectives. A stream restoration design class of advanced interdisciplinary STEM students at the University of Minnesota-Duluth surveyed this site and evaluated two different design approaches with regards to the RFP.

The first plan involved a re-meander of the lower half of the existing reach and the second plan involved creating a deeper, lower sinuosity step-pool channel through the current floodplain. Each plan was based on existing proposals from the consulting firm undertaking the restoration project. Site surveys performed by the class in fall 2016 determined grain size distributions, vegetation composition, macroinvertebrate presence, and long profile and channel planform topography.

The following semester, two different restoration design plans were created and evaluated. The class analyzed hydraulics using HEC-RAS and CFD, executed a sediment analysis using RAS and Marine Carls simulations, created a re-vegetation plan, and proposed a post-construction monitoring plan. After both stream design plans were analyzed for suitability, the class concluded that the lower reach in meander met the RFP goals in the least invasive manner and more effectively transported sediment within and just below the stream reach of interest.

The class also concluded that the step-pool design was not ideal as it could create a net depositional environment below the study reach, inside the existing golf course channel.

The project stakeholders approved the step-pool plan, and it is scheduled to be constructed in summer 2018.

Conclusion

Both plans meet the RFP Goals. The re-meander minimizes impact to the riparian area, allowing for preservation of much of the area's native vegetation. The step-pool platform (Plan B) may have issues with sediment transport capacity upon reaching the golf course, while the remeander (Plan A) allows for deposition to continue in the reach.

The new step-pool channel will shorten the channel but provides additional wetland habitat.

The stakeholders opted for a step-pool channel design from Stanescu Consulting, similar to Plan B, which is slated for construction in 2018.

Many Thanks to: University of Minnesota, Duluth; Stanescu Consulting; Silver Bay Golf Course; Lake County SWCD.

Site Investigation

In Fall 2016, students collected data appropriate to develop a proposal for an active RFP including:
1. Watershed-scale site assessment
2. Vegetation and macroinvertebrate community
3. Sediment and Kandphotographs
4. Stream long profile and cross-section surveys
5. Gravel size distributions
6. Macroinvertebrate and vegetation sampling

Invasive species were identified and monitored. A focused on creation of pools, minimizing impact to riparian area, maximizing success of new vegetation.

Sinuosity and slope similar to upstream reaches (1.8% through project reach; low for step-pool designs). Increase in sediment transport capacity with new channel yet reach will still remain net depositional.

New channel remains in same classification as existing channel.

Create a wetland habitat that doubles as an overflow area.

Grain size distributions

Higher shear stresses than existing reach during high flows.

Restoration Design Evaluation of the East Branch of the Beaver River, Silver Bay, Minnesota: A Student-led Investigation Comparing Two Designs

Capstone Course for Stream Restoration Science & Engineering Graduate Program

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Plan A: Rememder

To preserve infrastructure and prevent further migration of the channel towards the golf course, this design will least impact the current pool habitat, riparian vegetation, and will result in minimal changes in channel length and slope.

Key Features:
- New channel remains in same classification as existing channel
- Model results indicate new geometry to remain stable
- Increase in sediment transport capacity with new channel set much will still remain net depositional
- Focused on creation of pools, minimizing impact to riparian area, maximizing success of new vegetation
- Shifts the channel alignment away from eroding bluffs
- Minimizes the reduction in length of the reach as much as possible
- Paleochannels were used to remove the lower portion of the reach away from an eroding bluff

Channel geometry modifications:
- Low-flow channel to increase to decrease during periods of critical low flow in the summer and winter months.

Channel materials:
- Woody debris, rock, poor stones, riffle boulder gardens, and other features were incorporated into the design to increase channel roughness and provide shelter for aquatic organisms.

Plan B: Step-pool

A complete re-route of the current channel as a low-sinuosity step-pool (type B) channel. This design introduces a stream channel of greater slope and roughness than the current channel with pool spacing every 3 bankfull widths.

Key features:
- Create a new step-pool channel using a palisade
- Create a wetland habitat that doubles as an overflow area
- Extra protection of golf course infrastructure long-term and in case of large flooding events
- Sinuosity and slope similar to upstream reaches (1.8% through project reach; low for step-pool platforms)
- Higher shear stresses than existing reach during high flows.
- Models indicate there will be sediment deposited downstream of the design

Channel materials:
- Materia will be boulders and cobble placed as a series of “steps” and pools ranging from irregular spacing to 3–5 bankfull widths. The bed and bank material of 8 channels are considered stable and contribute only small quantities of sediment during bankfull or storm events. Large woody debris is incorporated into the channel as it is an important component for fisheries habitat. Sinuosity should be around 3–4 but in this case is 5.