Mission Creek: Flood Risk Reduction and Streambank Restoration

On June 19th, 2012, the residents of Duluth, Minnesota experienced a storm event for the record books. Over the course of 24 hours, approximately 9 inches of rain pummeled the landscape, causing massive floods and landslides throughout the city. As a result, Duluth's infrastructure and natural resources were severely damaged, notably miles of designated trout streams. In fact, the floods were so severe in parts, the polar bear at the Lake Superior Zoo was able to get out of its exhibit and according to staff, stalk the zookeepers. Even the seal was able to ride the currents out onto Grand Avenue and

Left: Initial field survey in August, 2013. This slope failure is representative of others within the project boundary. Above: Same slope 1 year later; toe is stabilized with rootwads, live stakes, wattles, and native grass.

make its way towards downtown. Large woody debris carried downstream by the high flows became bound up on culverts, which, coupled with the deposition of eroded bank material, exacerbated flooding in residential areas, leading Duluth to be declared a Presidential Disaster Area.

Mission Creek was among the hardest hit trout streams in the City. Mission

Creek flows through the Fond du Lac neighborhood located in West Duluth. A notable structure on the creek is a large debris catcher located roughly 1 river mile upstream of the Trunk Highway 23 (TH-23) bridge. This structure spans the width of the stream, and serves to keep large woody debris from traveling downstream. In fact, this structure did its job so well, the sheer amount of debris bound up on the structure completely blocked the existing channel and acted as a 10-foot high dam. With nowhere to flow, Mission Creek simply carved a new flow path – consuming a favorite hiking trail as it coursed violently downstream, exemplifying the absolute destructive power water can have.

Following the Presidential Disaster Declaration, the City quickly mobilized consultants to assess the damage to infrastructure and streams, which included Mission Creek. LimnoTech staff walked miles of trout stream taking pictures and measurements to understand the magnitude of the destruction. This information was brought back to the office where engineers pulled out their pencils, paper, and calculators to quickly develop construction cost estimates to repair streambanks and remove debris. The pictures, descriptions of the damage, and cost estimates were compiled into grant applications. The City then applied for grants from the state and federal government for the repair of streambanks and removal of debris in order to reduce the flood risk to local residents and reduce major erosion of sediment into the stream.

The following summer (2013), the Natural Resources Conservation Service (NRCS) awarded the City of Duluth a grant under the Emergency Watershed Protection (EWP) program. The EWP program helps communities address watershed impairments that pose imminent threats to lives and properties. The EWP program requires a 25% local match and funds engineering design and construction. The NRCS grant to the City for Mission Creek required completion of construction by the end of December, 2013.

In the case of Mission Creek, hundreds of fallen trees in the stream channel and severely eroded streambanks posed a serious threat to the local neighborhood in terms of debris flows, flooding, and landslides. In the Fond du Lac neighborhood, the TH-23 bridge was a point where debris flows bound up on the two culverts, blocking flow and forcing it up and over the road.

Above: This site is located at the upstream end of the project boundary. Note the concrete barriers embedded in the bank and channel bottom. Below: A bank that was stabilized by recreating a 3:1 slope and planting live stakes and native grass.

Once the City was notified of the award, they quickly hired LimnoTech to complete engineering plans, specifications, and bidding documents for the removal of fallen trees and stabilization of exposed streambanks. Engineers got to work immediately on the design and bidding documents and the City was able to hire a contractor by October, 2013.

As a result of the emergency nature of the work and strict timeline required by the NRCS, project permits were applied for during the design and bidding process. Permits were received by the end of October, 2013. The following permits and approvals were obtained prior to starting

physical work on the site:

- USACE – Section 401 Water Quality Certification
- USACE – Section 404 Permit
- USACE – Section 106 Review
- MNDNR – Public Waters Work Permit
- MNDNR – Natural Heritage Review
- MNDNR – No-rise Certification
- NPDES Construction Stormwater Permit
- St. Louis County – permission to work on Tax Forfeit land

In order for the project to progress at a pace that would allow construction to be nearly complete by the end of the year, the City and regulatory agencies had to work closely together to review, approve, and permit the project. The agencies all pitched in to make this project happen. Most notably, Jill Pohjonen of the MNDNR assisted in hydraulic modeling to ensure that the proposed work would not cause any increases in the floodplain elevations over the existing conditions.

The contractor began work immediately as the cold of northern Minnesota began to set in. The cold weather was both a burden and a blessing. On the one hand, cold temperatures make it difficult for workers and machinery to operate efficiently. On the other, cold temperatures and frost make soils more firm and easier to work on without causing rutting and further erosion issues. The risk of rainstorms and ensuing flows in the creek are also greatly reduced during the colder times of the year. Because Mission Creek is a trout stream, the MNDNR in-stream blackout dates apply, meaning no work can be done in the stream channel from Sept. 15 to June 30. The blackout, or no work dates are intended to be protective of trout spawning periods of the year. Fortunately, the City and its contractors got permission from the MNDNR to work in the channel during the blackout dates.

Overall, it took approximately five months to develop plans, bid the project, and substantially complete the physical debris removal and restoration work. The only work left to complete was installation of live stakes, which was completed in the Spring of 2014. NRCS allowed a time extension for the grant as they realized that the live staking would have a better chance of success if completed in the spring.

When coming up with a design for

bank stabilization, the approach was to address low hanging fruit, meaning stabilize the streambanks with the greatest erosion potential and remove the fallen trees with the highest potential for movement downstream. One of the major design constraints was the funding amount. An attempt to stabilize just one entire exposed slope would have required a level of engineering that would have turned a natural wild forest slope into a super engineered façade. Instead, simple but effective methods to reshape, stabilize, and protect streambanks were used at Mission Creek. Using on-site materials was a key component in simplifying the methods and minimizing costs. The design was intended to give Mission Creek a push in the right direction towards stability, without completely locking the stream into place.

Before work could be performed in the channel, preventative measures were taken to reduce the disturbance to the stream bed. Because Mission Creek is a designated trout stream, and work was occurring during the trout spawning dates, the skid loaders and backhoe couldn't travel up and down the stream corridor without restrictions. The majority of Mission Creek is located within a dense forest area and clearing trees in the overbank areas for access was not seen as a favorable option, especially for a restoration project. The contractors used both log mats and pre-constructed pipe mats as stream crossing points that spanned the channel in order to minimize disturbance in the stream channel. When work was completed in one section, the temporary crossings were moved downstream to the next work area.

Above: Spring 2014 installation of live stakes. Below: South side of the debris catcher. The water in the photo is the original Mission Creek flow path. Woody debris bound up on the other side and caused the creek to carve a new flow path around the debris catcher.

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In order to stabilize the toe of large exposed slopes, a combination of rootwads, wattles, and live stakes were used. Rootwads are large trees with their rootballs still intact. Typically, trunks are driven into the slope with the rootwad pointing upstream so that flow velocity vectors are broken up and scattered in all directions, thus decreasing the energy hitting the bank and greatly reducing erosion. Rootwads also provide resting and refuge areas for fish and other small critters. At Mission Creek, the contractors were unable to drive the rootwads into the bank due to the presence of random boulders and rocks. Therefore, rootwads had to be laid out at the toe of failed slopes and then covered with excess material on site. This created a floodplain bench, which helped strengthen the toe and dissipate energy during larger flows in the creek. Due to the abundant number of felled trees onsite, all of the rootwads for the project were obtained from the site.

In addition to the rootwads, two rows of wattles and a mix of willow and red osier dogwood live stakes were used to fill in the gaps and naturally reinforce the floodplain benches.

On smaller slopes with sufficient overbank space, the slopes were regraded by pulling back the slope to get as close to a 1V:3H slope as possible without moving the toe. This practice did produce quite a bit of excavated material, but contractors were able to reuse this material for fill over rootwads in other areas where the toe of the slope was being protected. A single row of willow and red osier dogwood live stakes placed at the toe of the bank provided further protection against future excessive erosion and streambank cutting.

All areas that were worked, meaning areas impacted by construction machinery, had to be permanently stabilized within 24 hours per the NPDES Construction permit. The contractor followed the grading work immediately with native seeding and erosion control blanket. MnDOT recommends different seed mixes for the various regions of Minnesota to ensure the best success for growth. A seed mix specific to northeast Minnesota was applied by hand and with great success – native grasses began to grow in the spring of 2014. A second motivation for following the grading work immediately was because the ground was freezing quickly and the stakes for the erosion control blanket had to be driven in before the ground froze. Natural netting and stitching was required for the erosion control blanket, as it biodegrades over time, which is better for the natural streambanks.

In the winter of 2013-2014, the Polar Vortex threw everyone in the nation for a spin, and Minnesota was no exception. Sub-zero temperatures and high snowfall events were cause for concern with such a freshly completed project. Were the live stakes and rootwads going to survive the winter ice in the stream and spring snowmelt runoff? Following the snowmelt and runoff in the spring of 2014, the project areas were inspected and found to be completely intact. The rootwads and stabilized streambanks had held up to the extreme conditions.

Mission Creek and the restoration work presented many challenges, including regulatory requirements, schedule, and construction access. All of the project challenges required a delicate balance between permitting requirements, minimization of further damage to the habitat, flood risk minimization, funding limitations, and an aggressive schedule. Project stakeholders were able to streamline the permitting process and design, while saving money by using on-site materials for bank stabilization and construction access. At the close of the project, the Fond du Lac neighborhood now has reduced flood risk and Mission Creek has reduced erosion that can affect water quality and trout populations. **L&W**

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