Clearbrook Stormwater Pond

Way back in 2003, the Red Lake Watershed District started looking at how stormwater runoff is affecting water quality in rivers and streams running through the towns of Clearbrook and Gonvick. Water quality data from the Lost River upstream and downstream of Gonvick didn't indicate negative impacts on water quality from stormwater in that town.In Clearbrook, water quality samples taken from flowing stormwater outlets during a rain storm showed that high concentrations of sediment and nutrients were being flushed into Clear Brook (a tributary of Silver Creek, which is impaired by E. coli bacteria).

The Clearwater County Soil and Water Conservation District received a BWSR Challenge Grant to use the water quality data collected by the RLWD to conduct P8 stormwater modeling and design stormwater treatment systems in the town of Clearbrook. Priority watersheds within the town were identified, delineated, modeled, and surveyed. Three stormwater pond sites were designed and stormwater retention alternatives (raingardens, inline sediment traps) were researched. Two of the three ponds encountered private land-ownership-related obstacles that haven't been solved yet. Construction plans proceeded for a pond that was designed on city property, but this pond had a couple of obstacles to overcome of its own. A sanitary sewer line had to be moved and construction was delayed until 2012 because of high water levels at the site.

Construction on the first Clearbrook Stormwater Retention Pond (RLWD Project No. 160) was completed in November of 2012. It will treat runoff from the "North Downtown" portion of Clearbrook, 82% of which is covered impervious surfaces. The total construction cost of the project was $43,674. The P8 model estimated that this pond will trap 65 pounds of sediment during a single 1 inch rain event and more than a ton of sediment on an annual basis.

Above: Sediment plumes in Clear Brook from stormwater runoff.

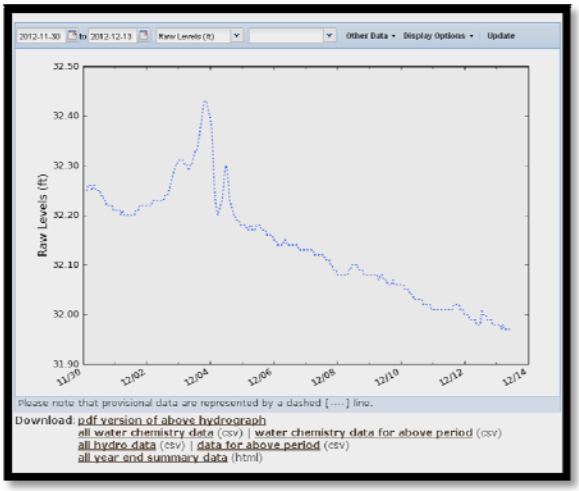
Right: Completed stormwater pond.

Red Lake River Watershed Assessment Project
(Watershed Restoration and Protection - WRAP)

- Task 3 – Continuous Water Quality Monitoring
  - Cleaned DO loggers, downloaded data, and conducted post-deployment DO calibrations (to calculate calibration drift).
- Task 5 – Stage and Flow Monitoring
  - HOBO water level loggers were retrieved for the year as rivers and streams began to freeze over for the winter.
  - Data was downloaded from HOBO water level loggers.
- Task 8 – Data Entry
  - 2012water quality monitoring data was entered and submitted to the MPCA for entry into the EQuIS database on November 1st.
- Task 10 – Civic Engagement
  - Michael Knudson (University of Minnesota, Crookston) has prepared a set of stormwater-related survey questions for a survey that he plans to conduct this winter. This survey will assess the knowledge and attitudes toward water quality, pollution sources, and managing stormwater in communities within the RLWD. The survey addresses the current local regulation of stormwater pollution sources and the enforcement/outreach associated with those regulations. There also is an opportunity for survey takers to provide their concerns and suggestions about stormwater management practices within their community.
  - Lori Clark, Jim Courneya, and Corey Hanson met in November to discuss civic engagement plans for final 6-7 months of the Phase I WRAP projects.
  - Lori Clark will be mapping social networks within the watershed.
  - Lori is also planning a “World Café” event in the watershed that will involve a meal for participants (covered by a separate grant) and small group discussions about specific topics.
  - Civic group presentations, public library presentations, a public update meeting for the Upper Red Lake River watershed, a public update meeting for the Lower Red Lake River watershed, an open house event at the RLWD, coordination with school field trips (if possible), coordination with Chamber of Commerce events, and website development are in the plans for the first six months of 2013.
- Task 11 – Identification of Sources and Solutions
  - A culvert inventory for the hydro-correction of LIDAR data continued in September. Alisha Mosloff, the RLWD Water Quality Assistant is continuing to work part-time and help with this project during the school year.
  - The RLWD ditch inspector reported that many tile outlets aren’t being properly armored, so they are causing erosion where they enter ditches.

Thief River Watershed Assessment Project
(Watershed Restoration and Protection - WRAP)

- Task 5 – Stage and Flow Monitoring
  - HOBO water level loggers were retrieved for the year as rivers and streams began to freeze over for the winter.
  - Data was downloaded from HOBO water level loggers.
  - The DNR has installed two new permanent gauges in the Thief River watershed.
    - A gauge is installed at the CR7 ("Agassiz Bridge") crossing of the Thief River. Telemetry has been installed at this gauge so real time stage data is accessible online. You can find it with a Google search for "MPCA DNR Cooperative Gauges," clicking on the top search result, and using the interactive map to find the gauge. Or, you can go directly to this address: http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=getsitereport&site=65017001.



    - A gauge has been installed on the Mud River at Highway 89. This site currently doesn't have telemetry, but it may be installed there in the future.

- Task 6 – Channel Stability Assessment
  - Stephanie Klamm and Jason Vinje completed the follow-up geomorphology work at a couple of sites on the Thief River and the Mud River.
- Task 9 – Data Entry
  - 2012 monitoring data was entered and submitted to the MPCA for entry into the EQuIS database.
  - Completed a data review for this project.
- Task 11 – Civic Engagement
  - Lori Clark, Jim Courneya, and Corey Hanson met in November to discuss civic engagement plans for final 6-7 months of the Phase I WRAP projects.
  - Lori Clark will be mapping social networks within the watershed.
  - Lori is also planning a "World Café" event in the watershed.
  - Civic group presentations, public library presentations, a public update meeting for the Upper Red Lake River watershed, a public update meeting for the Thief River watershed, an open house event at the RLWD, coordination with school field trips (if possible), coordination with Chamber of Commerce events, and website development are in the plans for the first six months of 2013.
- Task 12 – Identification of Sources and Solutions
  - The RLWD ditch inspector reported that many tile outlets aren't being properly armored, so they are causing erosion where they enter ditches.
  - Jim Blix has been working on a Stream Power Index for the Marshall County Ditch 20 and Judicial Ditch 30/18 watersheds. A large proportion of time spent with LiDAR technology at the Red Lake Watershed District has been devoted to building an inventory of conditioned DEM surfaces, starting with those needed for the Thief River Watershed Restoration and Protection porject. Steps include:
    - Assembling (downloading and mosaicing) raw digital surfaces from the 2-kilometer tiles distributed by the International Water Institute
    - Determining the location of digital dams on these surfaces, including the "ground-truthing" of key culvert placements
    - Generating a conditioned surface with the Spatial Analyst and Arc Hydro extensions of Arc Map.
    - This inventory of conditioned surfaces can then be directly applied to such tasks as:
    - Accurately delineating catchments and watersheds
    - Defining streams based on flow accumulation
    - Delineating non-contributing areas (usually wetlands)
    - Detecting surface runoff patterns
  - Used in combination with other surface data such as soil maps and land cover/land use categories, conditioned surfaces can also be used for higher-order analyses:
    - Calculation of a Stream Power Index for each cell in a given catchment or watershed. Each surface cell has a Stream Power Index (SPI) calculation associated with it. The SPI value is a function of slope, runoff volume, and CN value. It is a measure of flow energy and is a predictor of soil erosion at each cell location.

    - Drainage benefits determination
- One of the tasks in the Thief River WRAP that will considerably aid implementation efforts is the identification of areas with high erosion potential by calculating a Stream Power Index for each 3-meter cell in the sub-basins of the Thief River watershed. The raw surface for the Basin has been assembled from 1-meter tiles, converted to a floating-decimal data type, and re-sampled to a 3-meter surface. A delineated, conditioned surface exists for tributary drainage areas of Marshall County Ditch 20 and Judicial Ditch 30, and is pending for the remainder of the Basin. The current focus is on digitally representing the branched flow pattern through the Agassiz Wildlife Refuge area and correcting the water surfaces in that area. The next step will be to verify the corrections and culvert placement with Agassiz staff.
- The Stream Power Index analysis for the Thief River Basin will require only a small fraction of the time required to produce a conditioned surface as input to the analysis. District staff will consult with Houston Engineering GIS specialists to review our procedures to ensure consistency with other watershed districts and agencies throughout Minnesota and the Red River Valley.

What is LiDAR?

The term LiDAR is an acronym for Light Detection and Ranging and refers to a remote sensing technology that emits LASER (Light Amplification by Stimulated Emission of Radiation) light and detects the return reflection of that light from objects at or near the ground. A digital LiDAR-based model represents terrain features as a projection of points in space, each representing a unique location expressed in three-dimensional linear coordinates. When displayed, a set of point data visually resembles a cloud and is thus referred to as point cloud data.

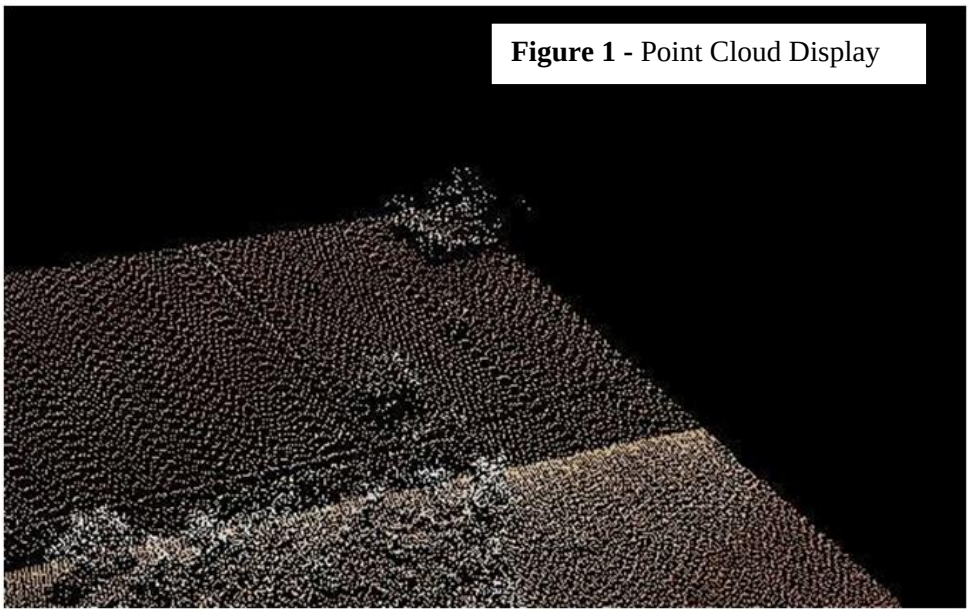


Figure 1 - Point Cloud Display

Each point in a data cloud is tagged with a unique integer representing the time difference between pulse emission and return detection. Shorter time periods indicate a shorter travel distance from aerial surfaces such as buildings and trees, while the longer time periods indicate the longer reflection time from bare earth.

Some GIS software is capable of selecting cloud points with a longer return distance, saving them to a separate data set as bare earth points. A special algorithm interpolates these bare earth points into a 1-meter orthogonal grid commonly called a Digital Elevation Map or a DEM grid. Each point in a DEM grid is spaced 1-meter from its neighbors, horizontally and vertically. Points are expressed in terms of x, y, and z integers in a UTM coordinate system.

Benefits of LiDAR Technology

A digital representation of the location and elevation of terrestrial features based on LiDAR data offers unprecedented accuracy and resolution. Before the advent of LiDAR, the best available elevation data came from an on-site survey or from the USGS quad-scale map set.

Site surveys, while extremely accurate, are costly and usually limited in scale. The USGS quad maps were derived from a massive 30-meter (98 ft.) survey grid arithmetically and visually averaged to form the contour lines shown on the maps. The earliest DEMs were produced by scanning and digitizing these contour lines and then applying an interpolation algorithm to generate 30-meter DEMs. These DEMs have been applied successfully in large scale analyses, but they lack sufficient resolution and accuracy to be reliable at smaller scales, particularly in flat terrain.

LiDAR technology addresses the problems of cost versus accuracy. Vertical accuracy is between 12.6 cm (5 inches) and 13 cm (5.1 inches) in the Red Lake Watershed District. Elevation points are distributed at a 1-meter (3.28 ft) grid interval. This does not yield the same accuracy as site surveying, but it is well suited for drainage area calculations, flow direction and accumulation and for various terrain and hydraulic analyses. A LiDAR-derived DEM surface used with modern GIS software is a vast improvement over a USGS map for similar applications.

Limitations of Raw LiDAR Data

LiDAR technology exhibits two inherent limitations that require additional processing: subsurface flow detection and the accurate rendering of open water surfaces.

1. ***A LiDAR scan cannot detect subsurface flow paths.*** In order to use a DEM surface for runoff analysis, digital flow must exhibit real world patterns. A raw (unaltered) DEM surface will contain digital "dams" at points where culverts and other subsurface flow paths are not seen by LiDAR.

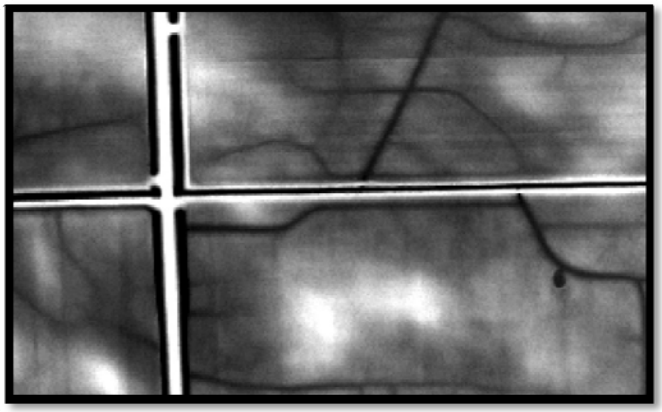


Figure 1 – This rendering of raw LiDAR surface shows higher elevations in lighter tones and lower elevations in darker tones. Culverts and bridges are invisible in an unconditioned surface.

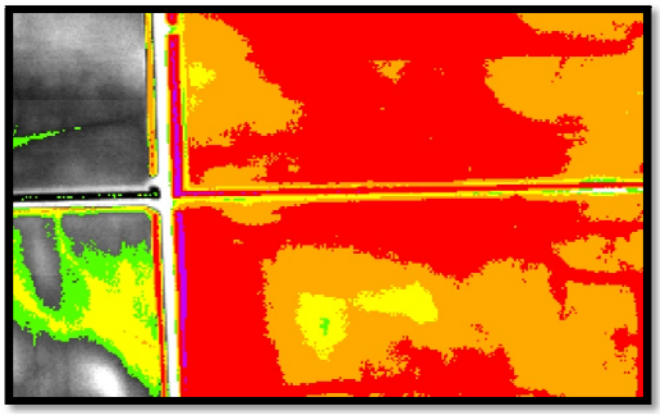


Figure 2 – Filling the pits and sinks on an unconditioned raw LiDAR surface shows the effects of digital damming. Fill depth increases from green to purple. Flow paths appear blocked because LiDAR cannot see beneath the bare earth surface.

Subsurface (culverts and bridges) flow paths are forced through a "digital dam" by creating and using a shapefile line feature that is consistent with the flow paths at those culvert and bridge locations. GIS software uses these line features to generate a new surface on which the elevation values of the grid cells coinciding with them are altered to allow natural flow. Basically, holes are cut through these virtual dams in order to represent real flow paths.

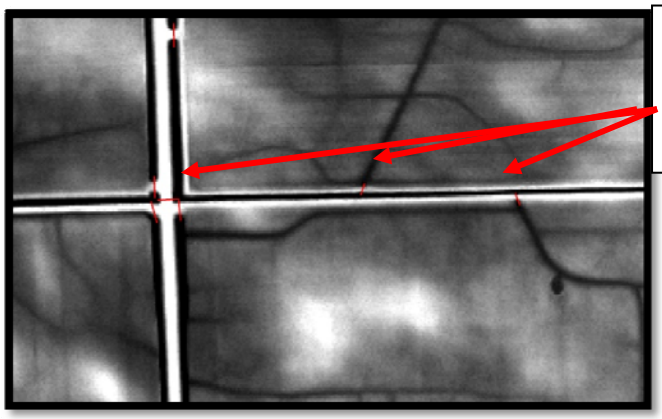


Figure 3 – Line features (red) are placed in alignment with subsurface flow paths.

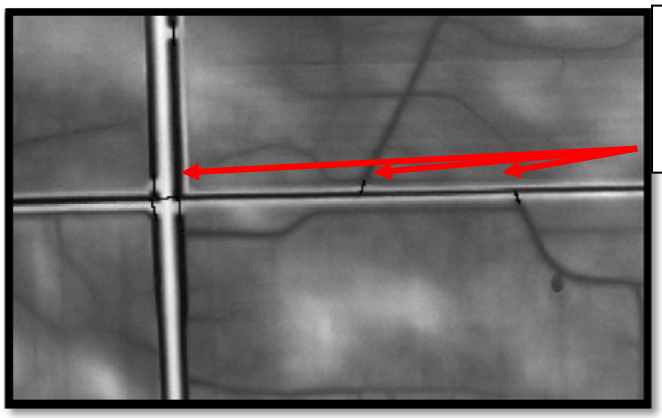


Figure 4 – The modified surface shows where elevations have been adjusted ("burned") to create real-world flow paths.

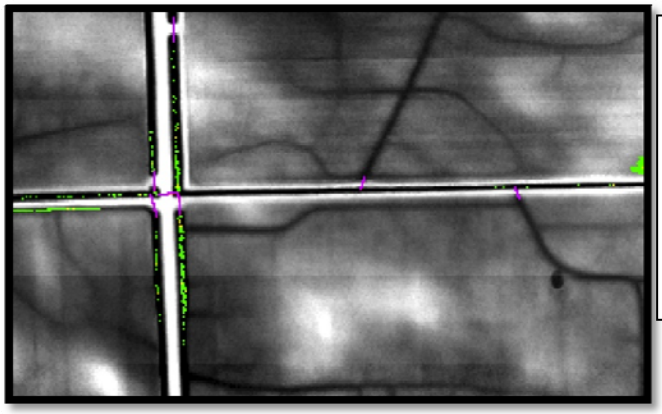


Figure 5 – Filling the pits and sinks on a conditioned surface shows the effects of culvert adjustments. The pits (purple) are mostly limited to the "burn" locations, and digital damming no longer occurs. Compare this image to Figure 3 to see the difference this makes.

2. ***A terrestrial LiDAR scan cannot accurately sense a water surface.*** A lake or river surface is seen on a raw DEM surface as a cluster of triangular features sometimes referred to as *tinning*.

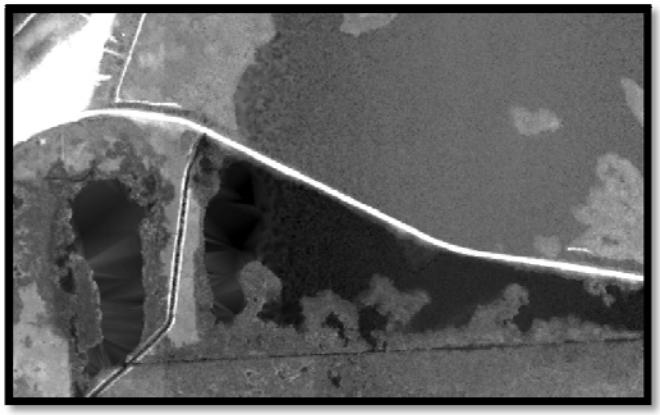


Figure 6 - The raw LiDAR surface shows the "tinning" of open water surfaces.

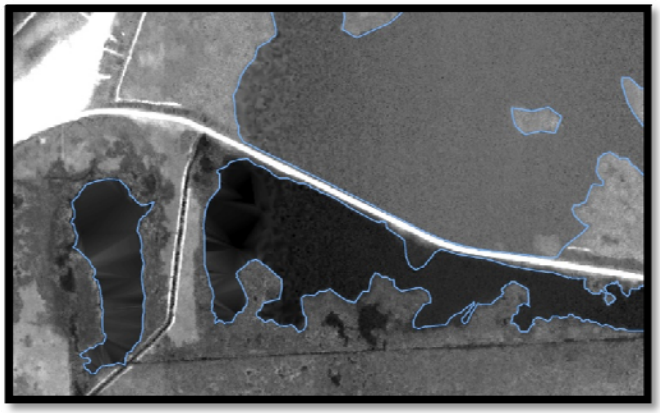


Figure 8 – In order to be useful for hydraulic and other analyses, the water surface is first delineated as a polygon shapefile and then assigned a uniform elevation value.

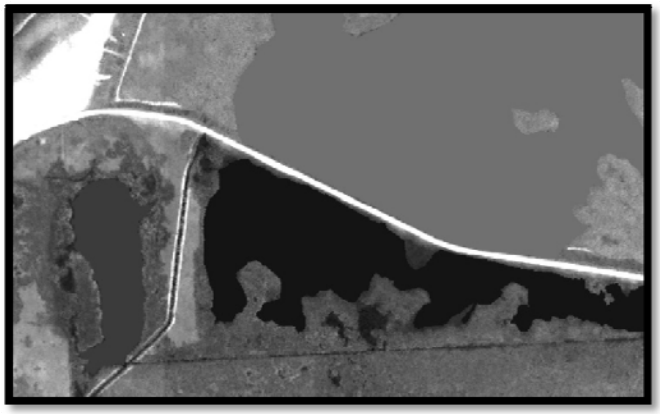


Figure 7 – GIS software will render an output DEM with a uniform elevation in the area inside the polygon. A new surface is generated that shows delineated lake areas at an assigned uniform elevation.

Flage Erosion Control Project

This fall, construction began on an erosion control in Red Lake County that will help keep sediment out of the Red Lake River. The outlet near the river was armored and stabilized. A drop structure and erosion control mats were used to stabilize the steep slope above the river. The ditch upstream of the outlet was also re-sloped and stabilized with bio-rolls.

Outlet at the Red Lake River, before construction

Outlet at the Red Lake River, after construction.

Stabilized ditch, looking north.

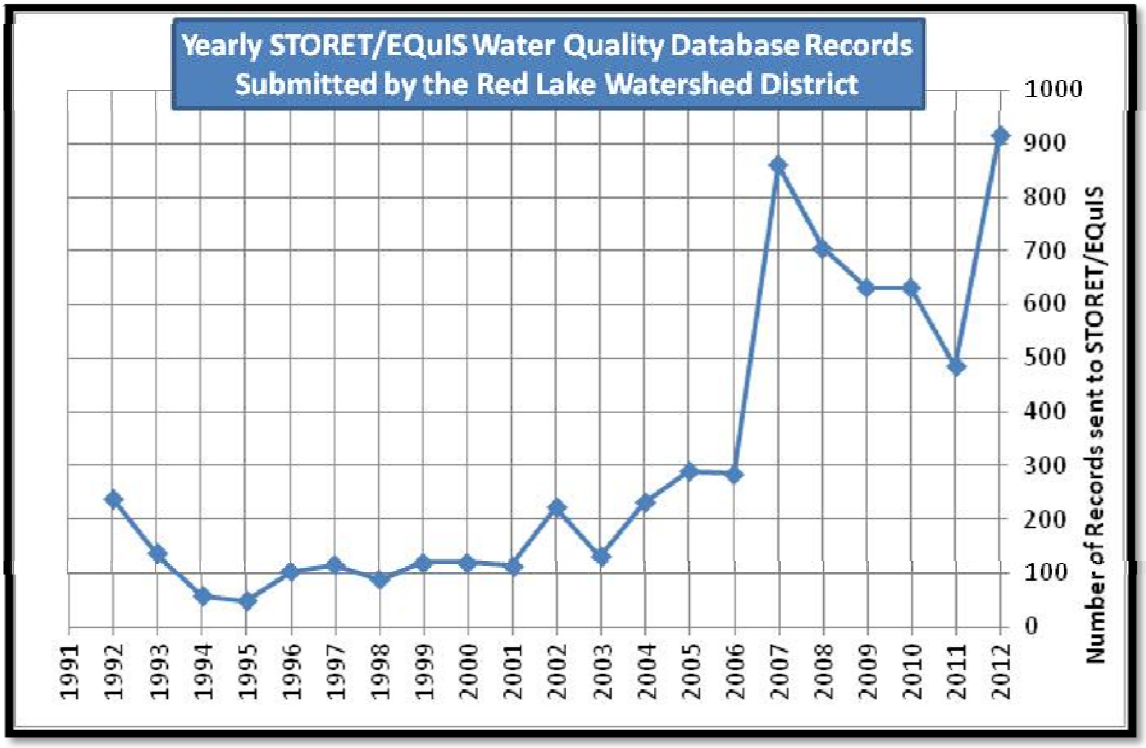
Close-up view of grade stabilization structures and erosion mats.

Erosion before construction of the drop structure.

Drop structure - after construction.

Other Notes

- The RLWD submitted data from five projects to the MPCA for entry into the EQuIS water quality database. Because of the number of projects and the amount of help from county staff, the International Water Institute (IWI), and our seasonal Water Quality Assistant, the RLWD submitted 916 records this year. This was the most ever and didn't even include River Watch data, which is submitted to the MPCA by IWI staff.



- Entered Red Lake River and Grand Marais Creek Surface Water Assessment Grant water quality monitoring data from 2012. The data was sent to the MPCA for entry into the EQuIS database. A data review was also completed for this project.
- Entered Red Lake Watershed District long-term water quality monitoring program data from 2012. The data was sent to the MPCA for entry into the EQuIS database.
- Photos taken while sampling for both the Thief River and Red Lake River/Grand Marais Creek Surface Water Assessment Grant projects were labeled, burned to a CD, and mailed to the MPCA project manager.
- The Grand Marais Creek Watershed Restoration and Protection project could be starting as soon as mid-December. $115,000 in Clean Water, Land, and Legacy funds will be going to EOR Engineering to cover most of the work and $8,400 will be going to the Red Lake Watershed District.
- The RLWD Board of Managers approved a change order for R.J. Zavoral & Sons to allow further construction on the Grand Marais Creek Cut Channel Stabilization project. Streambank stabilization similar to the work done to the east of Polk County Road 64.

- The RLWD Board of Managers approved the request of the Red Lake County SWCD for cost share in the amount of $6,934.25 for the Dave Schirrick Grassed Waterway with Drop Structure Project (see photos below).

- HOBO water level loggers were retrieved from Gentilly Creek, Hill River, Lower Badger Creek, and the Spring Gravel Dam blowout area.

November Meetings and Events

- **November 1, 2012 –** EQuIS data submittal deadline.
- **November 20, 2012 –** Civic Engagement planning meeting with the MPCA and RMB Environmental Laboratories.
- **November 21, 2012 –** Marshall County Water Resources Advisory Committee meeting
  - Lots of acres of CRP will be expiring in 2013.
  - The United State Fish and Wildlife Service (USFWS) is looking for producers who would graze cattle on parts of Agassiz National Wildlife Refuge. They have two pools in mind, to start with, for the grazing. They hope it will help with managing cattails.
  - The Agassiz Pool (Agassiz NWR) radial gates outlet repair project (new seals) is almost complete.
  - Sign-up for the Thief River Buffer Initiative has been slowed by high crop prices, drought (no obvious erosion problems when there's a lack of rain), and an unpopular land sale. Recently, the project has managed to get six new side water inlets and a buffer strip signed up.
  - There has been low water in Thief Lake this fall. All the flow coming into Thief Lake from the Moose River was lost to evaporation. Water discharged from the Moose River Impoundment resulted in no change in water levels in Thief Lake. The precipitation that occurred late in the fall was just enough to get the lake up to its winter drawdown level.
  - Jim Ziegler of the Detroit Lakes MPCA office is taking over as Regional Manager for the retiring Will Haapala.

  - The Middle-Snake-Tamarac Rivers Watershed District requires permits for tile drainage. A large percentage of the permit applications that they receive are for tile drainage installation.
  - There was some discussion about the need for a Marshall County culvert inventory.
- **November 29 through December 1, 2012 –** MAWD 2012 Annual Meeting and Trade Show

Plans for December 2012 and January 2013

- Thief River Watershed Restoration and Protection Project.
  - Complete a report on the existing data that is available for the watershed.
  - Stream power index analysis of sub-basins in the Thief River watershed.
  - Create a web page dedicated to the Thief River Watershed
  - Finish cleaning and calibrating continuous water quality monitoring equipment.
  - Compile and apply corrections to continuous water quality data.
  - Compile flow monitoring data.
- Red Lake River Watershed Assessment Project
  - Complete a report on the existing data that is available for the watershed.
  - Create a webpage dedicated to the Red Lake River
  - Finish cleaning and calibrating dissolved oxygen loggers.
  - Compile and apply corrections to continuous dissolved oxygen data.
  - Compile flow monitoring data.
- Data reviews for EQuIS submittals.

Future Meetings/Events

- **December 7, 2012 –** Red River Basin Monitoring Advisory Committee, Sand Hill Watershed District, 9:30 am.
- **December 10, 2012 –** Pennington County Water Resources Advisory Committee meeting.
- **January 9, 2013 –** Marshall County Water Resources Advisory Committee
- **January 31, 2013 –** The second progress report or final report for the Thief River SWAG monitoring is due.
- **February 1, 2013** - BWSR CWF Grant semi-annual progress reports are due.
- **February 1, 2013 -** MPCA Thief River Watershed Assessment Project semi-annual progress report is due.
- **March 20, 2013 -** Marshall County Water Resources Advisory Committee
- **June 30, 2013** – Expiration of the Thief River Watershed Assessment Project Contract.
- **June 30, 2013** – Expiration of the Red Lake River Watershed Assessment Project – Phase I Contract.
- **June 30, 2013 –** Final report for the Thief River SWAG grant is due
- **July 30, 2013** – Due date for the final progress report and final invoice for the Thief River Watershed Assessment Project

- **July 1, 2013** – Beginning of Phase II of the Thief River and Red Lake River Watershed Restoration and Protection Projects.
- **July 17, 2013** - Marshall County Water Resources Advisory Committee
- **July 31, 2013** – Final payment request for the Thief River SWAG is due.
- **October 16, 2013** - Marshall County Water Resources Advisory Committee

Red Lake Watershed District Monthly Water Quality Reports are available online at: http://www.redlakewatershed.org/monthwq.html.

"Like" the Red Lake Watershed District on Facebook to stay up-to-date on RLWD reports and activities.

Quotes of the Month:

"Good judgment comes from experience. Experience comes from bad judgment" – Jim Horning

"When you think you know everything, you know nothing" - Unknown

"He who dares nothing need hope for nothing." - Anonymous

"Your future depends on many things, but mostly you." – Frank Tyler

"Leadership is doing what is right, even when no one is watching." George Van Valkenburg

"Excuses are the tools of the incompetent." – Mike Tomlin