Background

In the summer of 2005 a heavy rain storm caused a 15 cubic yard section of an unstable ravine West of Cyrus Trail and 300 yards north of 130th Street to slough off an undercut bank and wash down the ravine. Figure 1 shows the size of the most recent erosion area, a small canyon formed by the collapse of the banks in one branch at the head of the ravine. The 8 foot long 2x4 in the picture illustrates the size of the area and the volume of material that has been washed into the lake.

Figure 1. - A lead forming at the head of the ravine.

The large slug of soil-water slurry plugged a 24" culvert which carried the ravine water under a driveway en route to the Cyrus Trail road ditch, which leads to the Wolf Creek inlet to the lake. The slurry buried the driveway culvert, overtopped the banks of the ravine and washed across the road. Figure 2 shows the inlet to the culvert after a backhoe was used to clear it of silt.

Figure 2. - The driveway culvert inlet, buried in silt.

It carved a 2 ft. deep trench through the gravel road and washed the gravel and mud across two homeowners' lawns and then into the creek. Subsequent investigation revealed that although the damage to the road and the plugged culvert were easily repaired within 24 hours, a much more serious problem was discovered. The silt-laden water from the ravine, which flowed heavily every time there was a significant rainstorm, was flowing directly into the lake via the creek inlet.

The lake association had just completed a lake property owners' survey in preparation for the writing a lake management plan for Circle Lake. The association was encouraged to prepare this plan by the Rice County water resource planning staff. They explained that with a lake management plan, it would be much easier for the association to obtain county and state funding for lake improvement projects.

The results of the survey showed the owners' primary concern was the lake's high fertility, causing severe algae blooms. Figure 3 shows an aerial view of the Wolf Creek Inlet during the summer. Note the color of the algae in the water, which is greener than the surrounding farm fields.

Figure 3. - Aerial view of Wolf Creek Inlet.

The association also learned from the county and other water resource conservation organizations (MPCA, CRWP, etc.) that the cause of the algae was high levels of phosphorus in the lake which was being introduced mostly by soil erosion in the lake's watershed. The phosphorus is attached to soil particles.

Project Initiation

So, in 2005 the CLAA directors chose this ravine erosion project as a "starter" lake cleanup project. They believed at the time that although there were probably more serious sources of phosphorus introduction, this one was judged to be more easily accomplished because there were only three or four landowners involved. Since Rice County is one of the few within 50 miles of the twin cities metro area that does not have an erosion control ordinance, any erosion controls must be accomplished with the full knowledge, cooperation and agreement of the affected landowners.

It was discovered that the National Resource Conservation Service, a division of the US Department of Agriculture, provides a free advice and design service to farm landowners where there is a "drainage" problem. As a result, the NRCS conservation officer was willing to advise us and provide a design for a drainage system for the farm fields above the ravine which would improve the drainage on the fields, but also to capture the water and route it around the ravine and down to the lake via a safe, non-erodible route. The conservationist's experienced opinion was that if the main water sources into the ravine were cut off, the rainfall into the ravine itself would not be enough to cause the banks to erode. He explained that more aggressive, but reliable and effective solutions would be much more expensive and esthetically unacceptable, e.g. cut down all the old-growth trees in the ravine, re-contour the banks to lower their slopes and plant grasses.

So the association's directors started the project by asking NRCS for a preliminary design and by attempting to get the affected landowners' permissions. Unfortunately, one of the landowners, an absentee owner who leased the fields to a local farmer, was initially un-approachable on the subject. The result was that NRCS stopped work on the design until it was shown the fields' owner was in agreement with the proposed changes to his land. The project remained in this state for one year, until finally the landowner agreed to give the tenant a three-year lease. This enabled the local tenant farmer to apply for the NRCS EQUIP cost-sharing grant, as the assistance is called.

Project Funding

The association started a serious fundraising effort in November of last year. At that time, preliminary cost estimates were $15,000, so when the Tri-Lakes Sportsman's Club was approached for their support, they agreed to contribute up to one-half the project's cost after the EQUIP grant, $3000, as a match to what the lake association could raise in member donations. But then, when NRCS completed what proved to be the second of four design iterations and the estimated cost rose to $20,000, CLAA support for the project began to falter. Three years had passed since the project was begun, and some of the new association directors, who were not involved in the initial decision to initiate the project, were skeptical of its benefits in light of its increased cost and a number of other risk factors. In fact, at a directors' meeting in June 08, when the projected cost had risen to $30,000, the question of whether CLAA should continue the project or cancel it was raised. It was decided that the matter would be put to a vote by the full membership at the July annual meeting and picnic. There were five choices listed on the ballot:

1) CLAA would contribute up to $8000, drawing from all its financial resources, current and future member pledges, membership dues and previous treasury balance.
2) CLAA would contribute $3000, to fully utilize the Tri-Lakes challenge grant.
3) CLAA would contribute only those funds collected from members designated as the one-time special donation to the ravine project.
4) CLAA would contribute the one-time special ravine project donations plus an amount which matches donations received from the residents of Cyrus Trail and from those residing on both sides of Wolf Creek inlet.
5) CLAA would cancel the project and return all donations made by the members to the project to date.

The voting tally showed an overwhelming choice for option 1.

We also approached Mr. Richard Carlander, a noted environmental conservation supporter, and asked him to assist in supporting this project. He agreed, with the understanding that he would be contributing in the neighborhood of $3,000 to $5,000. With his support, and with the results of the membership vote, we realized we had raised enough money to complete the project.

Project Design Changes

One reason for the directors' concern was the changing nature of the design. The first NRCS design had the water collected discharge directly into Wolf Creek via a drain pipe buried under the 130th Street road ditch. We were advised by other environmental organizations (Barr Engineering, MPCA, and CRWP) and the county that this is not best practice, because significant amounts of residual silt and also chemical fertilizers would be deposited in the lake. The environmentally-preferred practice is to discharge the water into a settling pond, or, even better, into a wetland. These allow any residual silt to settle out or be filtered out by the wetland plants and the chemicals to be absorbed by the plants also.

So the second design had the water passing south under 130th Street and discharging in a small wetland adjacent to the creek. At first the owner of this wetland property was in agreement with this plan, but in June he changed his mind, citing maintenance liability concerns. The design was changed again, this time to use the bottom of the ravine itself as a route for the buried drain pipe, this time passing under Cyrus Trail and outletting in a small wetland owned by the state and administered by the county. This plan was subject to county approval, which was finally obtained in November. In the meantime, the NRCS conservationist designer consulted with an NRCS civil engineer from the Rochester office, who counseled that the buried drain pipe was unnecessary and could cause other problems. Therefore the design was changed a third time to bring the water from the basins to the bottom of the upstream end of the ravine and allow it to flow on the surface through the bottom of the ravine and through a culvert under Cyrus Trail into the state-owned wetland. One fortunate outcome of this final design change was a cost reduction to $22,000. The cost would have been reduced even further, had NRCS not excluded the cost to install the culvert under Cyrus Trail from the EQUIP contract. Their policy is to still discharge their drainage systems directly into the nearest waterway, be it a ditch, stream or lake, in violation of MPCA best practice and possibly in violation of county ordinances. The lake association will investigate this in the coming months.

Project Details

The purpose of the project was to stop the erosion of topsoil from within a steep ravine a few hundred feet north of 130th Street and west of Cyrus Trail, a private road paralleling the Wolf Creek inlet on the south end of the lake. During the spring thaws and every heavy rain event for at least the last 15 years, water flowing east off the farm fields west of the ravine would run over the edges of numerous sharp, un-vegetated, unstable ravine banks, undercutting and tearing out the banks and washing the soil down through the ravine and into the inlet. As explained above, the soil contains phosphorus, which fosters the growth of algae and lake weeds. The solution to the problem was to construct a drainage system that would carry the water from the fields down to the lake via alternative routes and stop the water from washing over the ravine banks. The excavation contractor hired to install the system per the design, first constructed a series of four drainage basins at strategic locations in the fields, designed to collect and temporarily hold the water which used to flow toward the ravine. See figure 4.

Figure 4. – Drainage Project Map.

At the bottom of each of these basins, there is an orange perforated standpipe and drain installed, (shown as a yellow dot in the figure) which is connected to a polyethylene drainage tile. The tiles are buried underground and routed to outlets at the bottom of the ravine. The paths of the tiles are show as orange lines in the figure. There is a constrictor plate installed under each standpipe, at the inlet to each drain tile. The diameter of the constrictor plate hole is calculated to restrict the water flow in such a way that the water volume collected in a 10 year rain event (4.3 in./24 hours lasting for 36 hours) will not breach the top of the basin's ridge or berm, but will instead be held in the basin and will drain out over a 35 hour period. In NRCS design parlance, this is called the "dewatering time".. The drain tiles each terminate at the bottom of one of two ravines. Basins 2, 3 and 4 are outlet into the Cyrus Trail Ravine, carrying the water east to the lake. Basin 1 outlets into another, stable ravine which flows north into the lake. So now a portion of the water which used to drain from the fields into the Cyrus Trail ravine is diverted to the stable north ravine. In addition to the buried drain tiles, each basin also has a perforated drain tile buried under its high-side berm (shown as blue lines in Figure 4); to prevent water from infiltrating the compacted soil and to drain it away before it can saturate the soil and cause the berms to leak. The photos in figures 5 through 12 show each basin from various directions and distances.

Figure 5. - Basin 1, Looking North

Figure 6. - Basin 2, Looking Northeast

Figure 7. - Basin 3, Looking Northeast

Figure 8. - Basin 3, Looking Southeast

Figure 9. - Basin 3, Looking North

Figure 10. - Basin 4, Looking Northeast

Figure 11. - Basin 4, Looking East

Figure 12. - Basin 4, Looking East, Wide View

Figures 13 through 15 show the basins' outlets into their respective ravines as described above.

Figure 13. - Basin 1 Outlet, Looking North

Figure 14. - Basins 2 & 3 Outlet, Looking Southwest

Figure 15. - Basin 4 Outlet, Looking Northeast

The water that enters the Cyrus Trail Ravine then travels along the channel at the bottom of the ravine, east, toward Cyrus Trail. Originally, before the channel reached the road however, it turned right (south), passed under one driveway and then merged with the road drainage ditch, ran through the ditch for about 350 feet, then turned left and passed under the road and through another ditch traveling east, and emptied into Wolf Creek. If the drainage system used this path to the lake, the county and the MPCA would object, because this would constitute a "direct discharge" into a public waterway, which is no longer permitted. That is because the water will still contain a small amount of silt and a significant amount of nutrients – bad for the lakes and rivers. So a second feature was added to the drainage system. The ravine's channel was changed to flow under the road where it originally turned right instead of merging with the road ditch. A new culvert was installed under the road, which outlets into a small DNR-owned parcel between the road and the lake, at the mouth of the Wolf Creek Inlet. That parcel contains a small wetland. The MPCA considers a drainage discharge into a wetland to be an ideal solution, because wetlands filter the remaining silt out of the water and also absorb the nutrient chemicals before they reach the lake. The DNR allows the county to manage its lakeshore lands and the county gave their permission for this outlet location. Figures 16 through 19 show the road culvert's inlet and outlet and the redirected path of the ravine channel.

Figure 16. - Culvert Inlet, Looking West

Figure 17. - Culvert Outlet, Looking East, Showing Wetland and Creek Mouth

Figure 18. - Redirected Channel Path, Looking Northeast

The green material shown in the figures is a permanent erosion control fabric. In Figure 18, the original channel path passed to the right. It has been filled in to block the path through the driveway culvert (not shown) and into the road ditch.

The berms forming the high-side containment wall of each basin have been seeded with native grasses to protect them from erosion. The bottoms of the basins will contain the crops planted in the fields. They will not contain standing water long enough to cause damage to the crop plantings. The Basin 4 outlet tile's path from the basin down to the bottom of the ravine is steep and now contains loose, non-compacted soil due to the tile's burial, so in addition to its' being seeded, it was covered with a 3 inch layer of straw mulch to protect it from erosion until it vegetates. See Figure 15.

Tom Coffman, the NRCS district conservationist who designed the system, has advised us monitor the system during its first use next spring and summer. If any of the basin outlets' water flow causes erosion or scouring of the ravine soil, he asks us to place field stones under the mouth of the outlet to take the force of the fast-moving flow and slow it down, thus preventing the flow from scouring. There are adequate stones available nearby in the ravine bottom. Additionally, if we find that the water flow through the ravine is scouring soil, he advises that we install small (6" to 12" high) dams, made from field stones, straw logs or straw bales, about every 50 to 100 ft. in the ravine's bottom to

create a series of small pools, which will slow the flow and allow the sediment to settle. Both Tom and Tony Gillen, the tenant who farms the fields, are pleased with the installation and think it will be effective. If we find that there is still significant erosion taking place, Tom said we could initiate another EQUIP project to modify the system, possibly to bury a continuous length of 6" tile under the bottom of the ravine, from its upstream connections to the basin outlets to the culvert inlet and/or to add a layer of rip-rap to the entire length of the ravine, from the basin outlets to the culvert. Tom believes this step will probably be unnecessary though.

The project's final costs are as follows:

Field work, terracing and tiling	$17,080.00
Road culvert install & channel redirect	4,960.00
Total project cost	$22,040.00

The project's funding sources were:

USDA EQUIP Cost Sharing grant	$12,336.10
CLAA membership contributions	3,000.00
Tri-Lakes Sportsman's Club grant	3,000.00
Richard & Lorraine Carlander contribution	3,703.90
Total project funding	$22,040.00

The residents of Cyrus Trail will closely monitor the flow through the ravine and culvert over the next few years and notify the association if there are any problems discovered. They will be responsible for keeping the culvert clean and in good repair. NRCS will be consulted again if we discover any unanticipated problems.