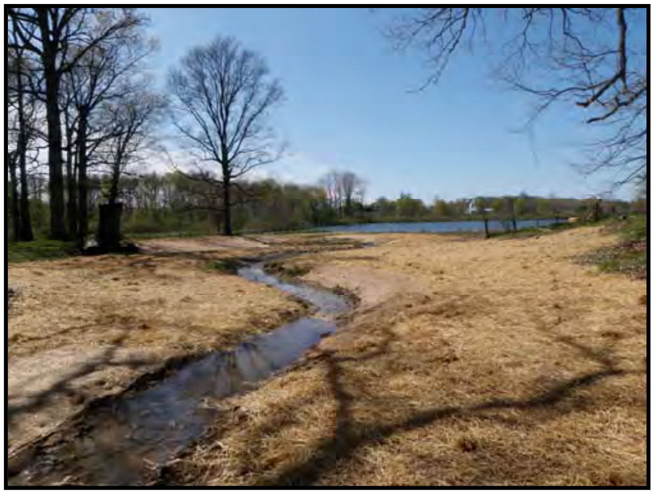
Village Lake Stream

Final Construction Report

May 2012



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FINAL REPORT
NOBLE COUNTY, INDIANA

1.0 PROJECT DESCRIPTION AND PURPOSE

The Village Lake stream project is located in Sections 29 and 32 of Sparta Township, Noble County, Indiana (Figure 1). The project area is on the northeast shore of Village Lake just east of State Road 5. Village Lake is an approximate 11.3 acre lake on Turkey Creek, which flows into the southeast side of Lake Wawasee. The Wawasee Area Conservancy Foundation (WACF) purchased 128.7 acres including the Village Lake tributary stream corridor in 2004 (Figure 2). The previous owner retained grazing rights on the property through 2014 within this parcel.

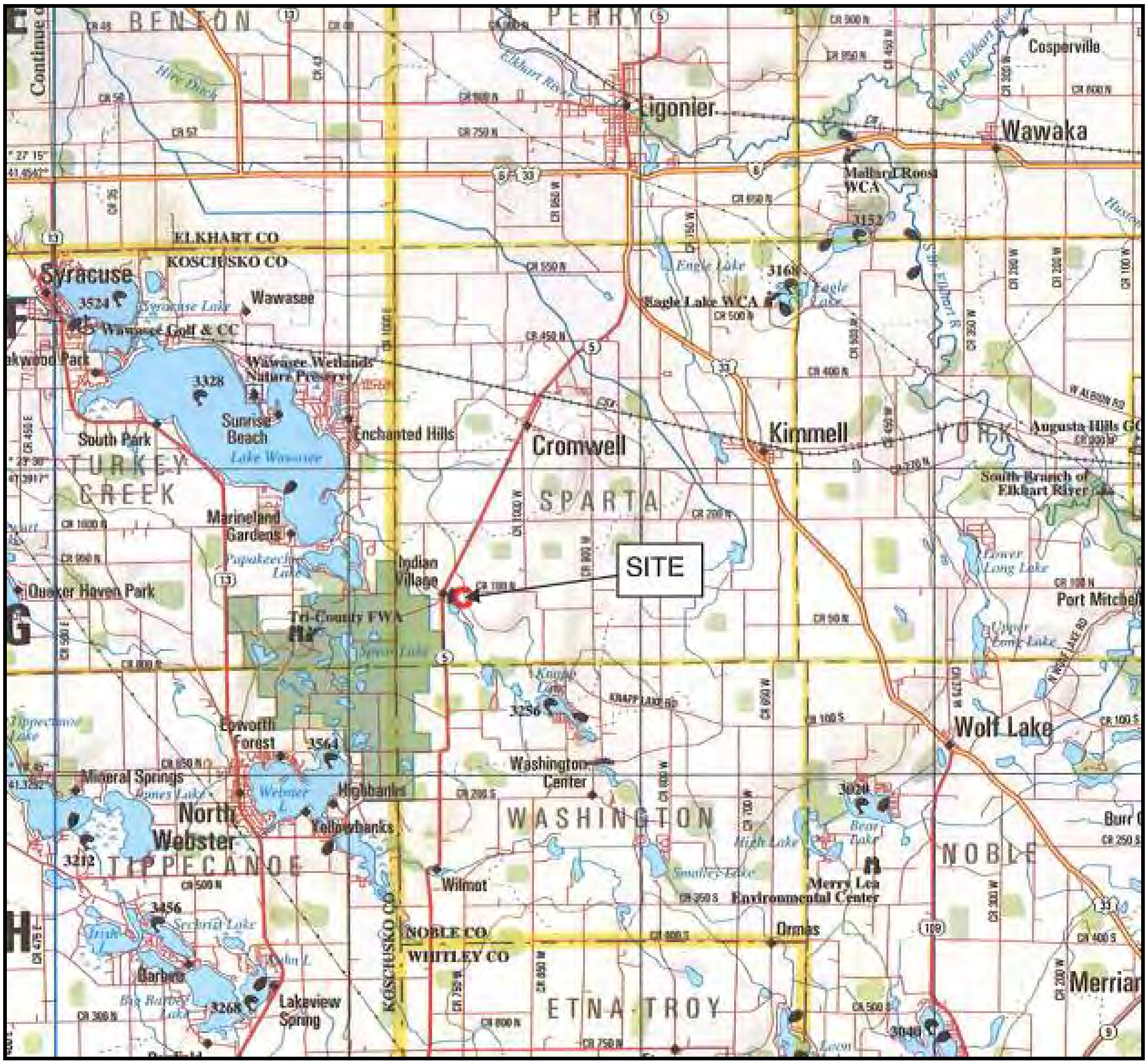

Figure 1. Project location map, Village Lake Stream Restoration Project, Noble County, Indiana.

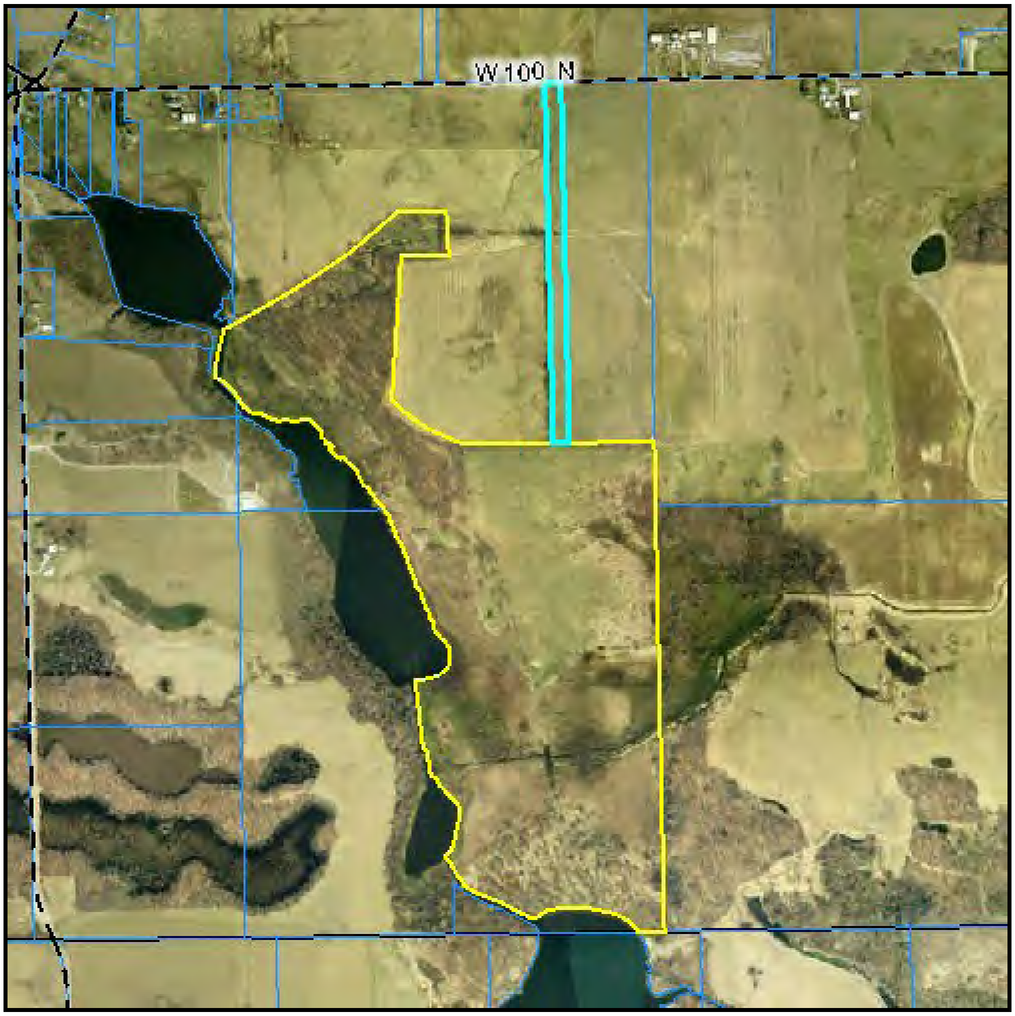

Figure 2: Parcel owned by WACF including the majority of the open Village Lake stream.

The Village Lake stream flows into the northeast side of Village Lake and drains approximately 270 acres (Figure 3). The drainage is more than 70 percent agricultural row crops and almost 25 percent pasture. V3 Companies Ltd. (2009) noted in the draft engineering report, a significant amount of erosion was historically occurring in the watershed of the Village Lake stream which resulted in a loss of at least an acre of Village Lake and adjacent wetland at the mouth of this tributary. It was noted in various field inspections of the site between 2004 and 2009 that the embankments of the stream were a significant source of sediment to the lake. The significance was documented (V3 Companies, Ltd., 2009) by the measured 531 feet of vertical stream banks from three to five feet in height. At a conservative erosion rate of just six inches per year, these banks alone contributed over two tri-axle dump truck loads (about 40 cubic yards) of eroded soil to Village Lake per year. In addition to the sediment loading, the 30 - 40 grazing cattle had open access to the stream and lake contributing an unknown amount of bacteria, nitrogen, and phosphorus to the Turkey Creek system. As a result, WACF pursued design and construction funding through the Lake and River

Enhancement (LARE) Program to reduce the erosion and nutrients entering Village Lake. This report documents the design and construction process.

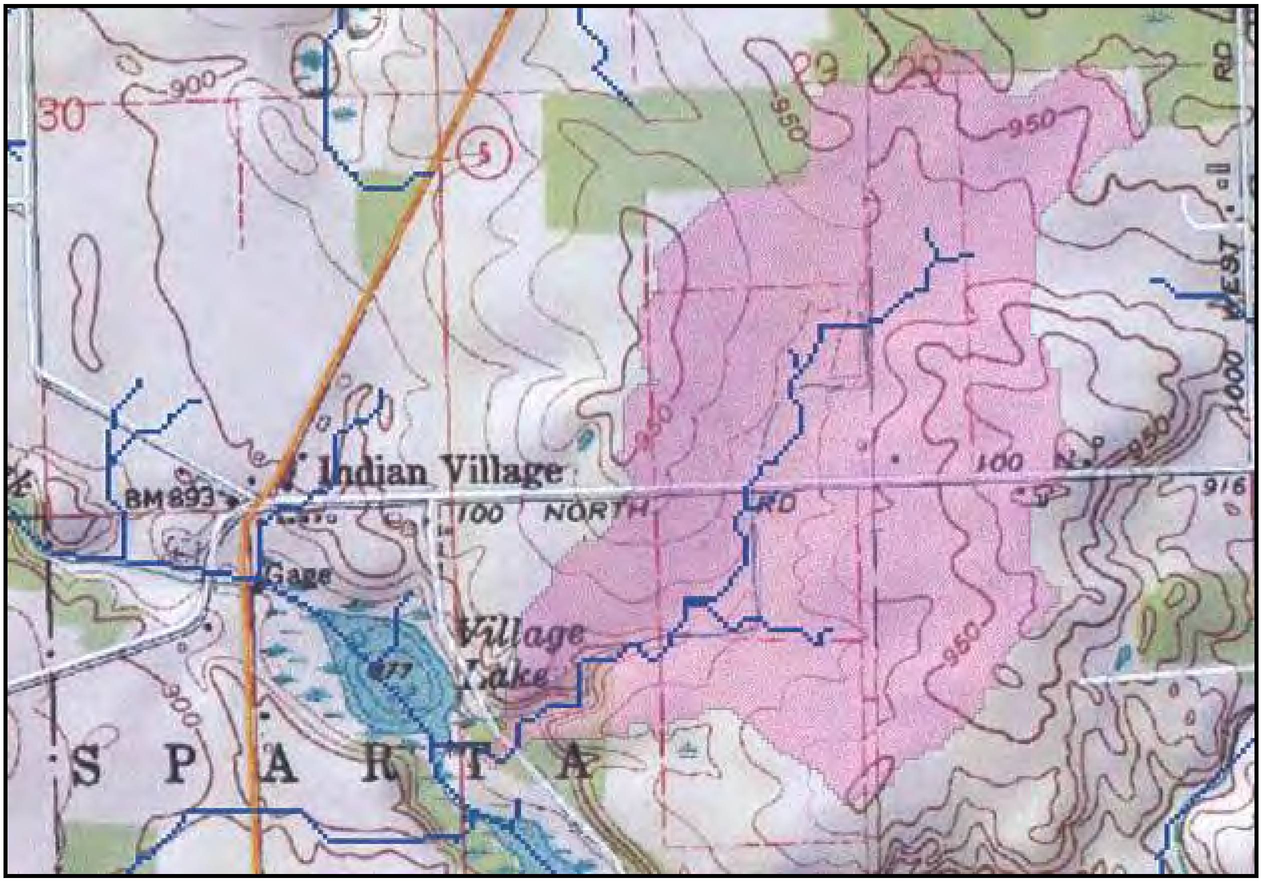

Figure 3. Project area drainage of approximately 270 acres.

2.0 BACKGROUND INFORMATION

The Village Lake tributary stream drains row crop agricultural fields using subsurface tile and a grassed waterway into an open ditch (Village Lake stream) just upstream from the WACF property line. The first 100 feet or more of this open ditch is an eroded gully beginning at the tile depth of approximately one foot below grade and ending at a constructed trapezoidal ditch section that is approximately five feet below grade. The next 300 feet lie in a wooded trapezoidal ditch that has little to no erosion occurring on the bed or embankments and remains stable at five to six feet below grade. The trapezoidal ditch ended at the WACF property line where years of ditch maintenance and erosion had created at least two visible floodplain benches above the current level of the base flow. From the property line to Village Lake the existing floodprone area of the ditch at its pre-construction elevation ranged from approximately 7 feet wide to 70 feet wide, with the low flow of the stream averaging approximately 4-5 feet wide, where water was present. The majority of the stream was dry at normal flows, the water flowing through or under the loose gravel and cobble substrate.

The stream channel was a series of scoured reaches (clay bottom), avulsed reaches (piled up gravel and cobble), and shifting sand and fine gravel bed (toward the lake).

The centerline of the channel meandered in its available floodprone area, bouncing from one high bank to another, creating vertical embankments. Cattle grazed freely on slopes ranging from 30 degree angles to near vertical embankments where grass was available. A great deal of cattle waste was present in and adjacent to the channel. Riparian vegetation ranged from the well-grazed pasture grasses to multiflora rose, mulberry, box elder, and a large willow at the upper end, to oaks, cottonwood, Kentucky coffee tree, and honeysuckle dominated system in the middle reach, to more open grazed pasture grasses and scattered oaks at Village Lake (V3 Companies, Ltd., 2009) complete report for additional soil descriptors and a wetland delineation of the parcel.

According to the TR-20 model (V3 Companies, Ltd., 2009) the streams average annual discharge is 32.5 cubic feet per second (cfs) and the 100 year discharge is 305.9 cfs. The velocity of the stream is 5.41 feet per second (fps) to 10.25 fps at the discharges according to the TR-20 model results. The USGS StreamStats program provides somewhat lower discharge estimates from 48.6 to 68.4 cfs (10-100 year discharge) using regression equations based on gauged watersheds (http://water.usgs.gov/osw/streamstats/indiana.html). On site measurements suggested a bankfull return flow of 10-12 cfs. Bankfull return flows normally occur every 1-1.5 years. These flows are important in determining stable channel and floodprone area dimensions.

3.0 DESIGN RATIONALE

The design process originally focused on trapping sediments at the base of the stream (V3 Companies, Ltd., 2009). Additional measures designed by V3 Companies, Ltd. (2009), included stabilizing the nearly vertical eroding banks using soil encapsulated lifts reinforced with live stakes and fascines. Fascines are bundles of cuttings taken from dormant shrubs (usually willows) bound together to form a log type structure. This approach was based on the belief that stabilizing the eroding banks was treating the source of the eroded sediment but neglected the cause of the erosion. Based on regulatory agency feedback during the permitting process, the design was modified to eliminate a proposed sediment basin at the bottom of the valley. While all parties originally felt that this basin was an important component of the project, it was realized at some point that if the erosion was significantly reduced upstream there would be no reason for a sediment trap.

Cardno JFNew took a slightly different approach to the erosion issue. The eroding banks were a result of a floodprone area too small for the high velocity flows coming down the valley. At an estimated 10 fps during high flows, the existing embankment vegetation is severely stressed. At 5 fps during annual flows, bare soil can easily be eroded. Most rain events likely produce flows with velocities lower than these estimates; however, the soils in this valley are highly erosive and are frequently damaged and disturbed by grazing cattle. Stabilizing the eroding embankments alone would transfer energy to other embankments causing erosion in another location. Our approach was to reduce velocities at all flows beyond base flow by increasing the width of the floodprone area and making it accessible at the slightest increase in stage height, similar to the two-stage channel concept (Ward et al, 2008). This was accomplished by excavating as wide as a floodprone area shelf as feasible through the upper half of the project area. In creating this shelf, the vertical eroded embankments were completely removed and the soil blended into the upper abandoned benches. The result of the excavation would become a hydraulically efficient floodprone valley with a greatly reduced flood velocity and lower shear stress on the embankments, and a reduction in nutrients to the lake (Bukaveckas, 2007). The low flow channel was left in place with resulting natural meanders. The topography and mature oak canopy in the middle to lower reach of the stream valley did not allow for as much floodprone area development. In this reach, the original concept of soil encapsulated lifts was utilized in combination with limited floodplain excavation. However, the soil encapsulated lifts were badly damaged by grazing cattle between 2010 and 2012 when additional grant money was received. A decision was made to armor the four of the 90 degree bends in the stream with large boulders in order to prevent the cattle from damaging these banks further.

4.0 DESIGN AND CONSTRUCTION SPECIFICS

4.1 Stream Reconstruction

Design guidelines for two-stage channels suggest that the floodprone width be at least 3 times the width of the bankfull channel (Jayakaran and Ward, 2007 and Natural Resource Conservation Service, 2007). For the Village Lake tributary that means the stream needs a floodprone area of 21 to 24 feet at a minimum. There is one reach of several hundred feet in length in the middle of the valley where that minimum is barely met due to constrictions caused by mature trees on a grade five feet higher than the stream. The remainder of the stream was constructed with an average floodprone width of 40-50 feet, which is at least twice the original average width. This width effectively reduces the velocity and shear stress on the outside embankments, thereby reducing erosion potential and allowing vegetation to grow. The excavated floodprone area was seeded with a native wetland seed mix (Table 1) and the slopes of the floodplain up to the next terrace were seeded with a prairie mix (Table 2). The entire floodplain and the slopes were blanketed with a biodegradable coconut-straw erosion control mat to resist surface erosion (Appendix A).

Where the floodprone area was minimal, a stone toe was placed at the eroding embankment toe of slope and one or two soil-encapsulated lifts (V3 Companies, Ltd., 2009) were placed on top of the stone toe to a height of at least 18 inches. Any remaining embankment above the soil lifts were sloped at a 3:1 (horizontal to vertical), seeded with native vegetation (Table 2) and covered with a biodegradable coconut-straw erosion control mat. There were over 400 dormant cuttings of red osier and silky dogwood stakes placed on 3-foot centers under and between soil-encapsulated lifts. These cuttings were intended to form a living shrub wall on the outside bends of the stream where the lifts were constructed. Two years after construction a site inspection revealed the lifts had been badly damaged by hoof shear, basically the cattle walking the banks had destroyed the integrity of the fabric which held the soil in place for vegetation to establish (Appendix A). Survival of the shrubs was 10-15 percent. This damage was limited to four bends in the stream or about 300 feet. During the 2012 construction these same outside banks were reinforced with additional stone extending higher than the opposite floodplain to permanently protect the banks.

To protect the expanded floodplain and lifts from future grazing damage, a solar-powered electric fence was installed along the top of embankment for the defined floodway throughout the entire project reach. Over 3,000 feet of double stranded electric wire was used for this purpose. The wire is held up by metal T-posts on 60 feet centers and step-in removable stakes on 10-feet centers between the T-posts. The charger is rated for up to 3 miles of fencing. The fencing was repaired six months after initial installation as branches and fallen trees likely shorted out the power. At least one-third of the wire had been broken or dragged off by cattle or deer. When we returned to the site in March 2012 the fencing was in complete disrepair with over 90 percent of the wire torn from the posts. A decision was made to remove the fencing in its entirety because, despite intentions, maintenance labor was not available to keep up with the repairs. The floodplain was 100 percent vegetated at this point and hoof damage was limited to the few outside bends of the stream and the embankments of the expanded floodplain (Appendix A). The nutrient rich waste remains an issue; however, the cattle should be restricted from the entire areas by 2014.

Table 1: Wetland seed mix utilized on the created floodplain

Scientific Name	*Common Name*
Asclepias incarnata	swamp milkweed
Aster novae-angliae	New England aster
Avena sativa	oats
Carex frankii	bristly cattail sedge
Carex vulpinoidea	brown fox sedge
Elymus riparius	riverbank wild rye
Elymus virginicus	Virginia wild rye

Table 2: Embankment stabilization mix used on slopes and other disturbed upland areas.

Scientific Name	*Common Name*
Andropogon gerardii	big bluestem grass
Aquilegia canadensis	wild columbine
Asclepias tuberosa	butterfly weed
Avena sativa	oats
Elymus canadensis	Canada wild rye
Elymus hystrix (Hystrix patula)	bottlebrush grass
Lolium multiflorum	annual rye grass
Monarda fistulosa	wild bergamot
Panicum virgatum	switch grass
Ratibida pinnata	yellow coneflower
Rudbeckia hirta	black-eyed susan
Schizachyrium scoparium (Andropogo	little bluestem
Sorghastrum nutans	Indian grass

To protect the stream from future incision, the grade of the entire stream was controlled with rock drop structures know as grade controls. There were 27 control structures built into the stream averaging one every 50 feet in the upper section where grades were as steep as 3 percent and 1 every 100 feet or more where grades were less than 1 percent toward the bottom. These grade controls are constructed by excavating a trench across the channel and into the floodplain at least three feet and then filling this trench with boulders from 12 to 36 inches. The more successful structures had a shallow "U" shape with the most upstream rock being the center rock. The greatest fall in these structures was two feet, requiring flat rocks at the point of fall on the downstream end to prevent scour. Since rocks are not consistent in size and shape, some structures worked better than others, and repairs had to be made to at least a third of the structures to prevent the channel from migrating around the structure. Figure 3 shows a typical structure that worked well.

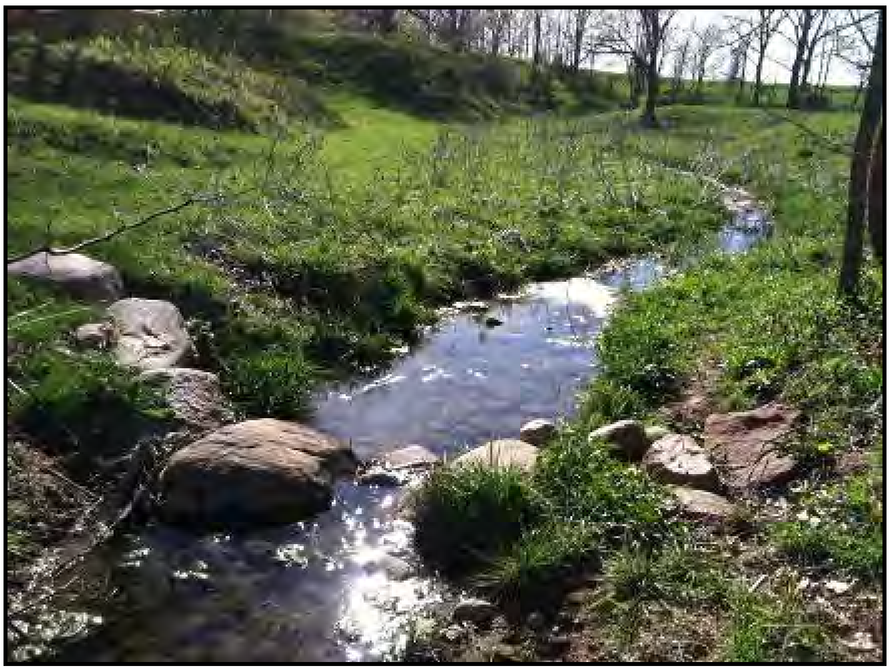

Figure 4. Typical grade control installed in Village Lake stream to prevent stream incision.

4.2 Landowner Agreement

The majority of the project was designed within property that is currently owned by the project sponsor (WACF) and thus no specific owner permission was required for the project to proceed. The final reach of stream which included the majority of the constructed floodplain wetland is on property currently owned and controlled by Kim Martin. Mr. Martin signed an agreement allowing the project to take place, and the floodplain is not jurisdictional wetland.

4.3 Permitting

According to documentation and correspondence received by V3 Companies, Ltd. (2009), no permits were required for this project.

4.4 Project Cost

V3 Companies, Ltd. (2009) estimated the cost of soil encapsulated lifts at $350.00 per lineal foot. The original design had 531 feet of lifts which equated to $185,850.00 for the project not including construction engineering, seeding and erosion control of disturbed areas, and the proposed sediment basin or any cattle exclusion fencing. Available funding for the initial construction work was $79,500.00. This initial funding was utilized in the following manner: $13,500.00 in erosion control materials, $2,500.00 in seed and cuttings, $1,300.00 in fencing materials, $41,000.00 for clearing and grubbing, earthmoving, and rock acquisition (which was gathered on site). The remainder was in labor costs for seeding, blanketing, lift construction, and fencing. Approximately 5 percent was used for project management. A $5,000.00 grant from USFWS was obtained in late 2010 to make repairs to the fencing and multiple grade controls, and construct one new grade control. An additional $28,000.00 LARE grant was received in 2011, and was utilized in the spring of 2012 to construct and finish the final 400 feet of the project including more than ¼ acre of floodplain wetland at the outlet. The USFWS contributed an additional $2,485.74 for the 2012 work by purchasing seed and wetland plant plugs for the project. The total cost of the project was $114,985.74.

5.0 CONSTRUCTION SCHEDULE

Construction took place during about 20 work days from November 13, 2009 to December 15, 2009. Repairs were made in the late summer of 2010 to multiple grade controls and the fencing. The final construction occurred over a three week period in April and May 2012.

6.0 MONITORING AND MAINTENANCE ACTIVITY

The project site was monitored several times during the first two years. The fencing was removed due to the extensive repair and maintenance requirements. Repairs were made to several grade controls and the soil encapsulated lift structures which did not hold up to the continued use of the area by cattle. Monitoring should continue by checking on the growth of vegetation throughout the site. After two or more growing seasons at least 80 percent of the ground surface should be obscured by vegetation in the recently planted wetlands and floodplains along the final 400 feet upstream of Village Lake. The areas planted in 2009 and 2010 met this criteria except where cattle were damaging the slopes of the floodplain to terrace transition. These slopes should continue to be monitored and perhaps replanted after the cattle have been removed from the site in 2015. Prairie and wetland development requires three to five years for full establishment. After five years, (one year after grazing is halted in 2015) the plants should be mature and bloom times of various forbs should be evident throughout the growing season.

The stream should have vegetated banks throughout its entire reach. The monitoring should include looking for erosion rills or gullies developing anywhere in the floodplain or on the stream banks as well as surface scour indicating that the stream channel is moving. If there are rills or gully erosion, find the source of the water and identify a solution to prevent the erosion. The installed boulder structures should be closely viewed for evidence that the stream is migrating around the structures. If the channel appears to be eroding around any structures, the structure should be modified or removed to allow the stream to stay in the designed flow path. Also check for sandbar development. Sandbars, if present, should only be on the inside corners of bends, and not mid-channel. If there are mid-channel bars developing then one or more rock structures need to be removed to increase the gradient or the channel narrowed to increase velocity so the sediment does not force the stream to erode a new channel.

7.0 PROJECT SUMMARY

Sediment flowing to the Village Lake from its 270-acre tributary drainage has filled in at least an acre of the 11-acre lake. The sediment originated from the crop fields and from the embankments of the open tributary stream. To reduce the sediment from the tributary, the floodplain has been more than doubled in size along 2,000 feet of the tributary, which in turn reduces the velocity of the stormwater and the related shear stress on the embankments. Rock grade controls were installed at 27 locations along the channel to stabilize the grade. A solar-powered electric fence was installed along the top of bank of the floodplain on both sides of the stream in order to exclude cattle; however, that effort failed because of the lack of continuous maintenance and the fencing was removed in 2012. Over 600 feet of soil encapsulated lifts were constructed in areas where the floodplain could not be significantly increased. When a majority of these lifts were damaged by cattle the lifts were reinforced with additional rock to a height above the opposite floodplain. All of the embankments, created floodplains, and slopes were seeded with native seed and protected with erosion control blankets. A total of 2,000 lineal feet of stream channel within a 1,300 feet long valley has been restored by stabilizing the tributary within a minimum 40 feet wide floodplain, including the removal of over 600 cubic yards of eroded sediment from the outlet at Village Lake to restore approximately 12,000 square feet of wetland.

8.0 REFERENCES

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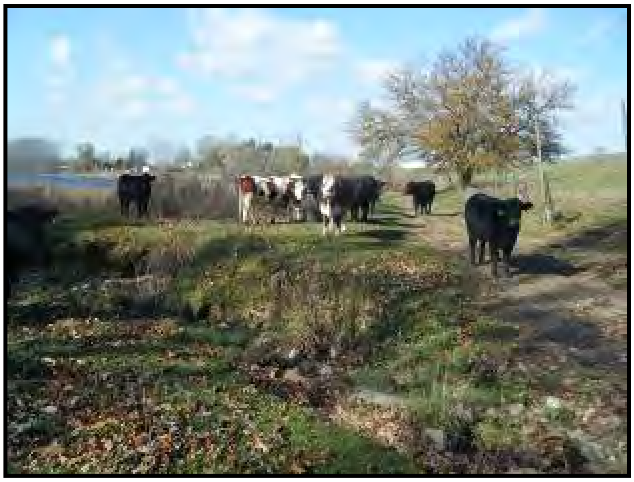
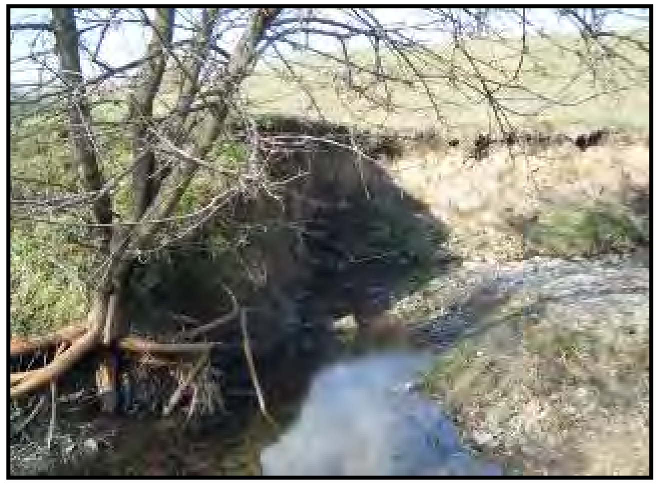
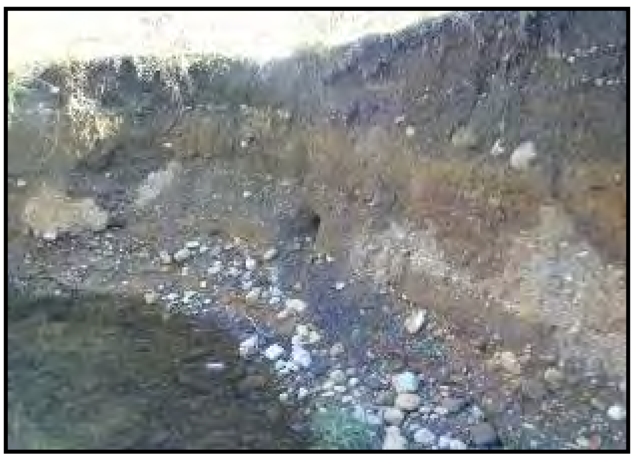
Appendix A
Pre-Construction and Post Construction Photographs

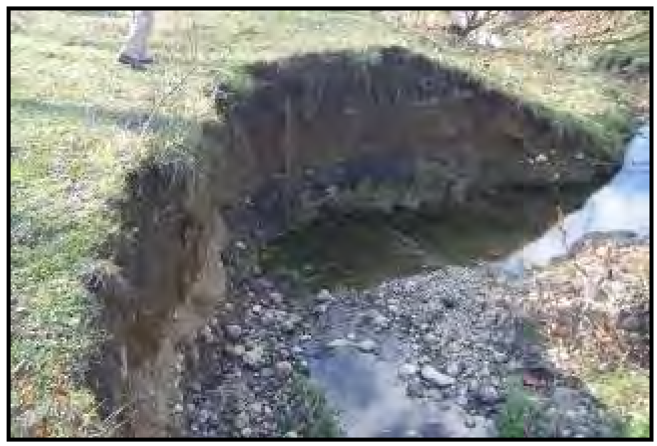
Cardno JFNew

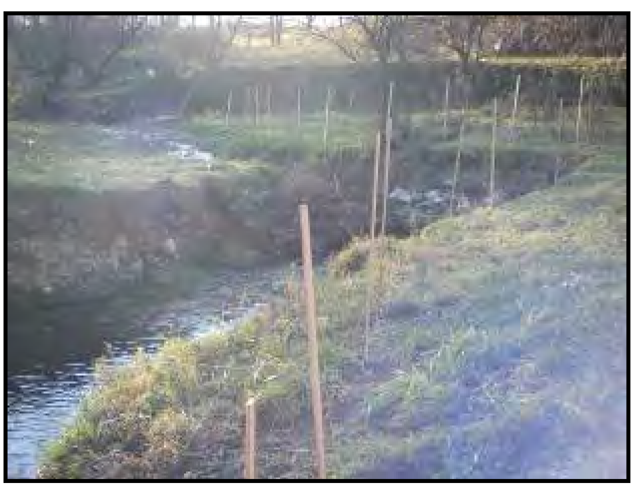
Pre-Construction Photographs

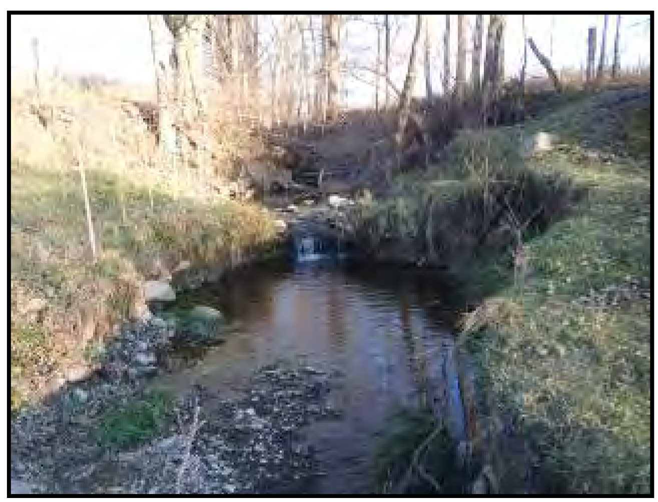












Post Construction Photographs