Long Lake Shoreline Inventory

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1.0 Introduction

The Ramsey Conservation District (RCD) was approached by the Long Lake Homeowners Association in 2007 and asked for assistance in addressing the erosion issues and overall environmental quality of Long Lake. Partnering with Rice Creek Watershed District, the RCD collected and analyzed data in and out of the field. This data was compiled and the resulting information is presented within this report. Data shows that the lake faces several challenges such as nutrient loading and turbidity attributed to many factors, two of which are erosion and lack of vegetation within the shoreline. The overall findings within this report identify locations along the bank that are highly susceptible to erosion and identify areas along the shore that have little or no buffering potential. The information within this report can be used by natural resource managers to provide education and outreach for lakeshore homeowners and as a basis for making future shoreline restoration management decisions.

2.0 Background

2.1 Lake Characteristics

Long Lake is located in north central New Brighton, MN, within the Rice Creek Watershed District. Long Lake is approximately 191 acres with a shoreline of approximately 24,375 linear feet. There are 15,088 linear feet of privately owned shoreline, and 9,287 linear feet of public shoreline. The land is broken up into 134 parcels that surround the lake, with the majority of the publicly owned shoreline consisting of Ramsey County Park and Recreation land located on the east side of the lake (Figure 1). The Ordinary High Water (OHW) elevation is 864.93 feet and maximum depth is 30 feet (MN DNR, 2003 Survey).

Currently, Long Lake shoreline owners are reporting a perceived increase in the rate of shoreline erosion. It is believed, amongst residents, that one of the reasons for the accelerated shoreline erosion is the increase in motorized water sport activities. In recent years, lakeshore residents have reported an increase in motorboat traffic generating large wakes. While conducting the Long Lake survey several homeowners approached staff and stated their concerns with the fluctuation of water levels.

Figure 1. *Parcels and Park that surround Long Lake and Long Lake's location within Ramsey County.*

2.2 Causes of Erosion

Shoreline erosion is caused by both natural and human induced processes. Water level fluctuation, wave action caused by wind, ice jams, and the natural absence of vegetation are some of the factors that can lead to natural shoreline erosion. Human interactions such as waves generated from boating, development along the shoreline, and development within the shoreline buffer zone (50 feet landward from the ordinary high water level [MN DNR, 2007]) are factors that can greatly accelerate shoreline erosion (Asplund, 2000). Physical features that make up the shoreline such as highly erodible soils and steep slopes, in conjunction with a developed shoreline, can add to the rapid increase of shoreline degradation. Accelerated shoreline erosion can reduce water clarity and quality which negatively effects macrophyte growth, fish reproduction, and the aesthetic value of the lake for recreational use (MN DNR, 2007). All of these factors can also result in lower lakeshore property values (Krysel et al., 2003).

2.3 Lake Statistics

Existing survey information and lake assessment data has shown that Long Lake has increased nutrient loading and low water clarity. Between the years of 1997 and 2006 data collected by the MN PCA shows phosphorous levels in the lake average 103±4 parts per billion. When phosphorus concentrations go over 40 or 50 ppb, they can produce algae blooms and create turbid water conditions which reduce water clarity. Algae are abundant in the lake, making the water a gritty green color that increases turbidity which, in turn, limits aquatic macrophyte plant growth. A macrophyte plant survey was conducted in June of 2008 to inventory aquatic vegetation within Long Lake. Out of the 189 points surveyed within the littoral zone, 51 points contained aquatic plants (Ramsey Conservation District, 2008).

2.4 Study Rationale

It is believed that the alteration of the shoreline landscape has increased nutrient loading and erosion in and around the lake. The purpose of this study is to locate banks along Long Lake that are highly susceptible to erosion and to identify areas within the buffer zone that have little or no buffering potential. The study was conducted to provide an assessment of these areas so that management decisions can be made.

3.0 Methodology

3.1 Areas of Study and Ranking System

The assessment consisted of using a combination of data collected in the field and Geographic Information System (GIS) layers to determine a rank of erosion susceptibility and water quality buffering potential within two zones along the shoreline of each parcel. The two zones are the bank zone and shore zone (Figure 2). Within the bank zone erosion susceptibility was assessed and within the shore zone buffering potential was assessed. The spatial extent of the bank zone consisted of the area from the current water line to the top of the bank top. The shore zone, also referred to as the buffer zone, encompassed the area from the bank top 50 feet landward. Within the bank zone of each parcel were three factors: dominant land cover, soil erodibility (K factor), and slope. These were ranked and added to determine erosion susceptibility. The same three factors were also ranked and added to determine the buffering quality within the shore zone.

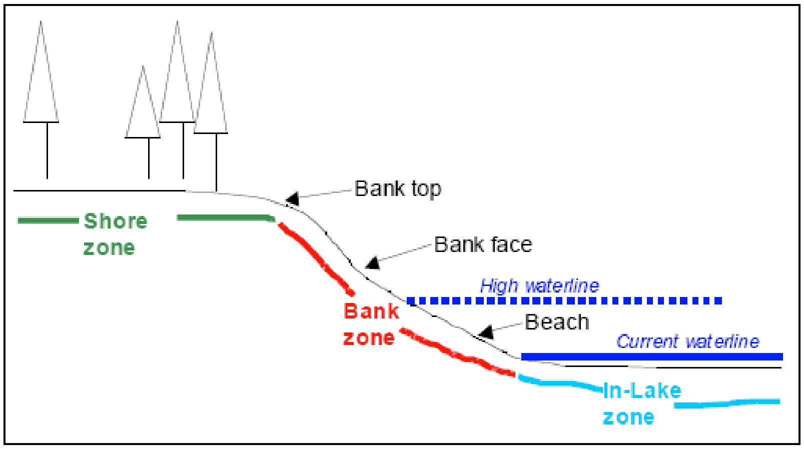

Figure 2. *Lakeshore zones (adapted from Rowan et al. 2006).*

3.2 Data Collection

The field data was collected in mid to late July, 2008. It was determined that the majority of shoreline vegetation would be well established during this time of year and that any warm season vegetation would be emerging for identification. To aid in data collection a geodatabase was created to provide surveyors with spatial reference when collecting data out in the field and a pull down menu to choose land cover type and slope within either the bank zone or shore zone of each parcel. The field data was collected using a combination of parcel lines loaded into a Garmin GPS 76 for spatial reference, and parcel lines, aerials, and field collection data loaded into a Panasonic Toughbook laptop. The data in the laptop was viewed and edited using ArcGIS 9.3 software. The combination of using the toughbook loaded with ArcGIS 9.3 and Garmin GPS provided advanced editing of data out in the field and an estimated average spatial accuracy of 3-5 meters.

Using the GPS unit to determine where the edge of the lot lines were, surveyors walked or canoed along the bank/shore and recorded land cover between the lot lines within each zone. If there was a variation of land cover types within each parcel, the dominant types were recorded at a minimum of every ten feet within each parcel.

To determine the slope, survey points were taken approximately every 20 feet along the zones and then averaged to determine overall slope within each parcel. If there was an extreme variation in slope within a parcel, measurements were recorded at these points at a minimum distance of every 10 feet. Due to land access issues along a large portion of the lake the bank zone slopes within many of the parcels, and most of the shore zone, were determined by educated deductions of the surveyors observing the topography while collecting field data.

Soil samples were taken around the lake within each of the soil signatures that surrounded the lake so that the findings could be compared to the digital soils layer. The soils were dug on site and assessed for texture and material type. The Urban Land and Udifluvents soils listed were missing cohesive factors (K-factor) within the table data. To determine the missing K-factors for the soils surrounding the lake listed as Urban Land and Udifluvents, surveyors compared soil texture to adjacent soils and took into consideration these soils parent materials. Therefore, the K-factor for the Urban Land and Udifluvents was found to be at a factor of 0.17. The additional soils K-factors did not change, since the soil samples compared favorably to the NRCS GIS soils layer.

In mid-July photos were also taken of the shoreline using a Garmin GPS 76 handheld unit, a boat, and a Canon Power Shot A590 IS stabilized by a tripod. Photos of each parcel were taken using a procedure adopted from Minnesota's Sensitive Lakeshore Area Identification Manual written by the Minnesota Department of Natural Resources (MN DNR) Division of Ecological Services (adapted from Rowan et al., 2006). Using a GPS to determine lot lines the boat driver centered the boat between parcel lines and approximately 50 feet from shore. From the observation location the photo was taken of the zones within each parcel.

3.3 GIS Data Analyses

Once the field data was collected, it was tabulated and analyzed using ArcGIS 9.3 software and Microsoft Excel. The land cover and slope data was added as one feature class to a File Geodatabase and the soils layer was imported into the File Geodatabase as another feature class. Rank fields were added to both feature classes and were populated depending on the land cover type, slope, and soil type within each parcel section. Once ranked, the feature classes were merged together to create a single feature class. Within this feature class the field ranks for the land cover, slope and soil were added and populated into an overall rank field. The bank zone and shore zone polygons within each parcel then had an overall rank value. Within a bank zone polygon a ranking of 6 or 7 was classified as low, a ranking of 8 or 9 was classified as medium, and a ranking of 10 or 11 was classified as high for susceptibility to erosion. Within the shore zone a ranking of 5 or 6 was classified as low, a ranking of 7 or 8 was classified as medium, and a ranking of 9 or 10 was classified as high for lack of buffering potential (Table 1). In addition to the

Table 1. *The ranking schema for the shore and bank zones.*

Shore Zone- Buffering	
Cover	**Ranking**
Native Vegetation	1
Weedy Vegetation	2
Turf Grass	3
Bare Soil	4
Impervious Surface	5
	Linear Feet
Soils/ Erodibility	**Ranking**
Clay (k≥0.28)	1
Loam (k: 0.2<0.28)	2
Sand (k≤0.2)	3
	Total
Slope	**Ranking**
> 10:1	1
5:1 to 10:1	2
verticle to 4:1	3
	Total

Bank Zone- Erosion Susceptability	
Cover	**Ranking**
Native Vegetation	1
Rip Rap/Retaining Wall	2
Weedy Vegetation	3
Turf Grass	4
Bare Soil	5
	Linear Feet
Soils/ Erodibility	**Ranking**
Clay (k≥0.28)	1
Loam (k: 0.2<0.28)	2
Sand (k≤0.2)	3
	Total
Slope	**Ranking**
> 10:1	1
5:1 to 10:1	2
verticle to 4:1	3
	Total

rankings, the shoreline photos were then linked to the bank zone spatial data within the geodatabase to provide additional information for resource management decision making.

4.0 Results and Discussion

4.1 Bank Zone Results

The overall findings within the bank zone show that out of the approximately 25,003 linear feet surveyed, 1,462 feet were classified as low, 18,087 feet were classified as medium, and 5,454 were classified as high for susceptibility to erosion (Table 2 and Figure 3). Out of the 5,454 linear feet that were classified as high, 1,526 linear feet lie within public parcels, and approximately 3,928 linear feet lie along private land. A detailed breakdown of the three variables that were added to create the overall ranking (land cover, soil type, and slope) within the bank and shore zone can be found in Table 2. The least abundant land cover type in the survey area is native vegetation, which makes up less than 1% of the overall land cover within the bank zone. Weedy

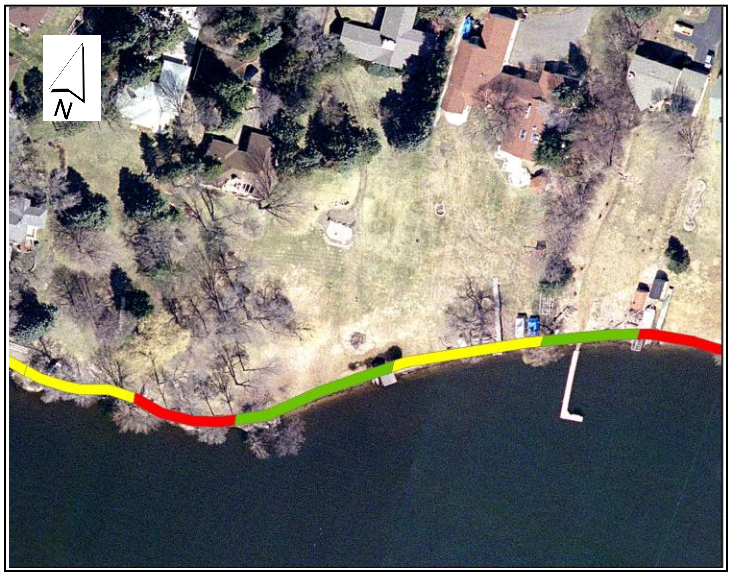

Figure 3. *An area along Long Lake depicting the different classifications of erosion susceptibility, red represents high (10/11), yellow represents medium (8/9), and green represents low (6/7).*

Table 2. *The three variables and overall ranking of the bank and shore zones.*

Bank Zone- Erosion Susceptability			
Cover	**Ranking**	**Linear Feet**	**Percent**
Native Vegetation	1	54	0.21
Rip Rap/Retaining Wall	2	8532	34.12
Weedy Vegetation	3	10244	40.97
Turf Grass	4	1221	4.88
Bare Soil	5	4952	19.80
	Linear Feet	**25003**	
Soils/ Erodibility	**Ranking**	**Linear Feet**	**Percent**
Clay (k≥0.28)	1	N/A	
Loam (k: 0.2<0.28)	2	1963	7.85
Sand (k≤0.2)	3	23040	92.15
	Total	**25003**	
Slope	**Ranking**	**Linear Feet**	**Percent**
> 10:1	1	1278	5.11
5:1 to 10:1	2	6211	24.84
verticle to 4:1	3	17514	70.05
	Total	**25003**	
	Overall Ranking	**Linear Feet**	**Percent**
	6/7	1462	5.90
	8/9	18087	72.00
	10/11	5454	22.00
		25003	

Shore Zone- Buffering			
Cover	**Ranking**	**Square Feet**	**Percent**
Native Vegetation	1	N/A	N/A
Weedy Vegetation	2	420962	43
Turf Grass	3	514689	52
Bare Soil	4	29993	3
Impervious Surface	5	15164	2
	Linear Feet	**980809**	
Soils/ Erodibility	**Ranking**	**Square Feet**	**Percent**
Clay (k≥0.28)	1	N/A	
Loam (k: 0.2<0.28)	2	75506	8
Sand (k≤0.2)	3	905303	92
	Total	**980809**	
Slope	**Ranking**	**Square Feet**	**Percent**
> 10:1	1	602504	5
5:1 to 10:1	2	264552	25
verticle to 4:1	3	113753	70
	Total	**980809**	
	Overall Ranking	**Square Feet**	**Percent**
	5/6	289656	30
	7/8	608490	62
	9/10	82752	8
		980898	

vegetation is the most abundant land cover type, making up 41% of the overall land cover type within the bank zone. The weedy vegetation consisted of such weeds as purple loosestrife, brome grasses, buckthorn, reed canary grass, etc.

4.2 Shore Zone Results

The shore zone consisted of approximately 980,808 square feet (22.52 acres) surveyed. Out of the 980,808 square feet classified, 289,656 square feet were classified as low, 608,490 square feet were classified as medium, and 82,752 square feet were classified as high (Table 2 and Figure 4). Of the shore zone classified as high, approximately 11,302 square feet is on public land, while 71,450 square feet lies on private land. There are seven different soil types that surround Long Lake. The majority of the soils have a K-factor of 0.17 which classified these areas with a rank of three. A small area of soils located in the northeast corner surrounding the lake are made up of Chaska silt loam, and therefore have a K-factor of 0.28. The soils that fell within the zones in these Chaska soil areas were ranked as a two.

Figure 4. *An area along Long Lake depicting the different classifications for lack of buffering potential, yellow represents high (9/10), purple represents medium (7/8), and the blue represents low (5,6).*

4.3 Additional Data Attributes

Prior to conducting the shoreline inventory the ranking system was created by the authors in an attempt to standardize protocol for determining where bank/shore erosion may occur. The model therefore was not to inventory where erosion was happening at the time of field inspections, but an analysis of where erosion may escalate in the future. When conducting the study surveyors not only collected slope and land cover data to analyze with the soils layer, but also entered note data if there was erosion occurring along the bank into a comments field within the bank zone attribute table. The current erosion that was observed may or may not necessarily coincide with the erosion potential model. For example, several eroding undercutting banks were noted in the comments field along the eastern shore of Long Lake along Ramsey County Parks' property. Although noted as having erosion issues, the makeup of the bank, i.e., land cover = weedy vegetation, slope = vertical to 4:1, and a K factor = 0.17, did not classify this particular area as highly susceptible to accelerated erosion and therefore was classified within the medium category. Another factor entered into the comments field, which could be incorporated into future models, was the ease of restoration on any particular parcel. At the discretion of the surveyors, comments were inserted stating the potential for restoration on any particular site. Factors considered by the surveyors included access to shore land, presence of manmade structures along the bank, and the overall cost/benefit of implementing restoration practices.

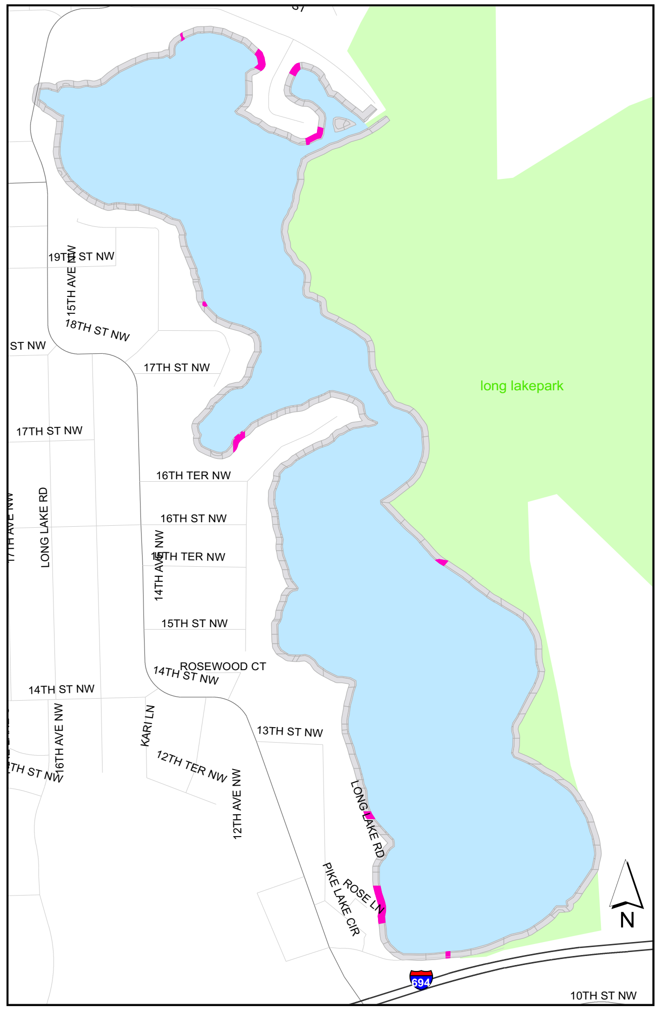

Figure 5. *Areas along Long Lake highlighted in pink were found to have high susceptibility to erosion and a low capacity for buffering runoff entering the lake.*

4.4 High Priority Areas for Restoration

Parcels with a classification of 10 or 11 within the bank zone were most susceptible to erosion and thus would be ideal locations to implement shoreline restoration initiatives given the parameters. Within the shore zone it was determined that areas classified as a 9 or 10 have little or no buffering potential to prevent runoff from entering the lake. Several areas adjacent to the lake, approximately 1,814 linear feet, had both high potential for erosion within the bank zone and a low potential for filtering runoff within the buffer zone. A combination of these two factors can lead to accelerated erosion and should be considered as priority areas to implement restoration practices (Figure 5). If high costs and limited access (consent from private owners) poses a problem for future shoreline restoration, several areas located within public lands (approximately 1,526 linear feet) may be the most ideal locations to target for restoration (Figure 6).

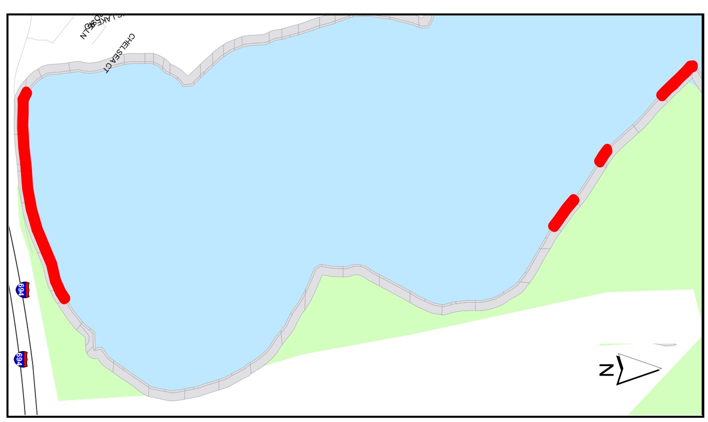

Figure 6. *Areas in red are highly susceptible to erosion and located along public property, making them ideal for implementing restoration practices.*

Surveyors noted that the cover on these high ranked public lands consisted of eroding paths to the water, sandy beaches, and impervious surfaces, which appeared to be adding to the erosion along the shoreline (Appendix 1.).

5.0 Conclusion

5.1 Shoreline Erosion Contributing Factors

Many factors appear to be playing a role in the existing conditions of Long Lake. Although no single contributing factor could be singled out as the major contributor to the increase of accelerated erosion, some theories were offered as to what may be aiding in the erosion process. One hypothesis is that the influx in boat traffic is increasing the erosion. Another factor may be the fluctuation in lake levels. Currently, no boat count data exists for Long Lake, so the volume of boat traffic on the lake is unknown, but lake level data, provided by the Minnesota Department of Natural Resources, does exist. Lake level information for Long Lake shows that there has been little deviation from the OHW mark (864.93 ft) so far in 2008, with 864.19 feet the lowest record taken in early September, and 865.95 feet recorded in early June. However, records for previous years have shown greater fluctuation (Figure 7). Although these two factors are thought to be contributing to shoreline erosion, the degree of erosion caused by recreational boating and lake level fluctuation will remain unknown until further research can be conducted.

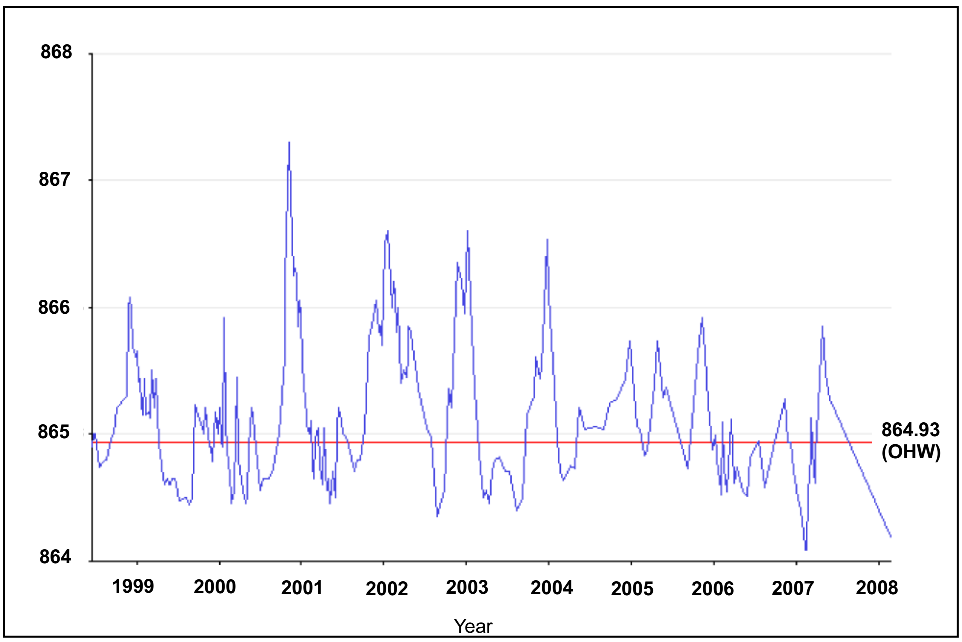

Figure 7. *Lake levels from 1999 - Present***.**

5.2 Restoration Practices and Costs

Despite what may be contributing to increased erosion on Long Lake, the data provided by this study can now be used to implement erosion control practices on land to slow erosion caused by unnatural factors. In the past, traditional methods such as concrete pilings and rip rap have been used to prevent erosion. Natural resource managers are moving away from these methods as they are expensive to implement, do not filter pollutants, and provide little habitat. Restoring the shoreline using native vegetation, natural materials, and bioengineering practices not only prevents further erosion but also provides habitat, filters pollutants, and can slow wakes. A cost estimate for a standard restoration project is estimated at $9.05 a square foot (Table 3). This breakdown was estimated to be $9.05 a square foot installed within an area classified as being highly erodible.

Table 3. *A cost breakdown of a 1200 square foot area at an estimated $9.05 a square foot, totaling $10, 854.00.*

Materials	$	2,143.00
Plants	$	975.00
Excavation/Grading	$	200.00
Misc	$	300.00
Material Estimate	$	3,618.00
Labor Estimate	$	7,236.00
Project Estimate	**$**	**10,854.00**
:-10%	$	9,768.60
:+10%	$	10,745.46

A further detailed breakdown of materials and labor costs can be found in Appendix 2. Some examples depicting how the installation of such materials would be implemented along the bank is shown in Appendix 3. The bank zone results were calculated in linear feet, but in actuality a restoration project along a bank is at minimum ten feet in width. With this in mind, the 5454 linear feet along the bank zone would be multiplied by 10 feet projecting the overall cost to restore the entire highly erodible bank zone along Long Lake at $493,580.00. The cost to implement buffers within the highly unfiltered shore zone was estimated at $748,905.00. Investing in restoration costs and implementing natural vegetation will result in the filtering of pollutants and the prevention of erosion within the banks and shores of Long Lake, ultimately creating a healthier shoreline and more sustainable lake ecosystem.

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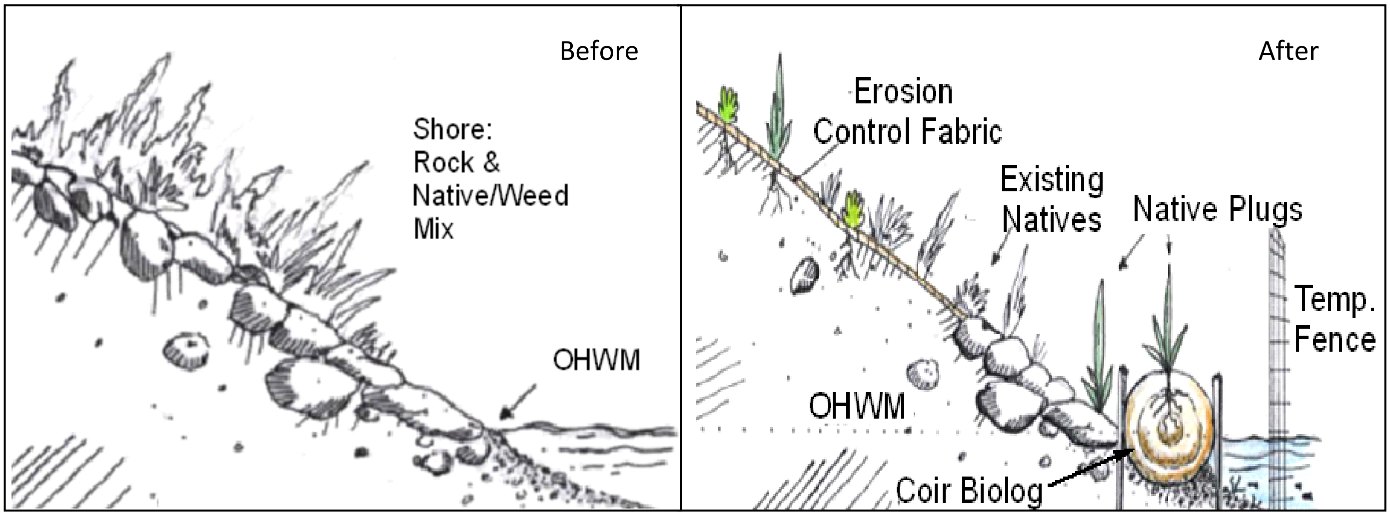
Appendices

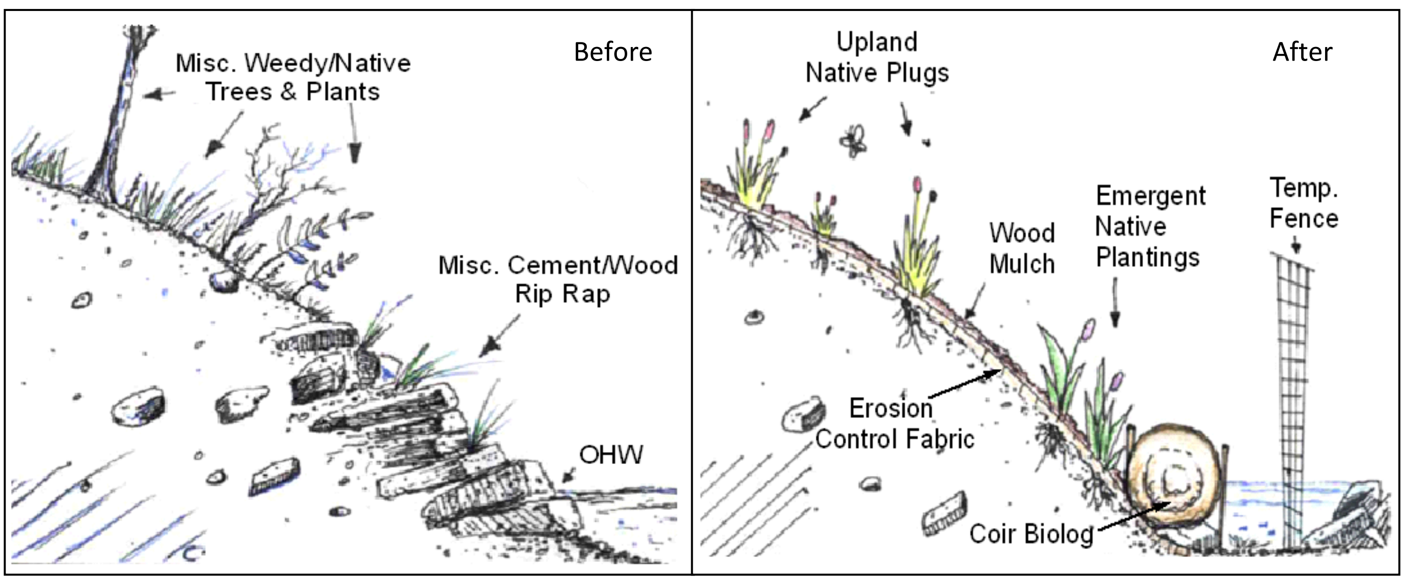
Appendix A. *Shoreline consisting of eroding paths and sandy beaches located on public property south and east along Long Lake.*

Appendix B. *A detailed breakdown of material and labor costs for a 1200 square foot shoreline restoration project.*

Long Lake					**total plants :**	550
Cost Estimate- High Erosion					**total lf :**	100
					total sf :	1200
					last revised:	17.nov.08
					$/sf (materials)	$3.02
					$/sf (materials and installed)	$9.05
		COST ESTIMATE				
Materials		**Qty**	**Unit**	**Unit Cost**	**Amount**	**Potential Source**
Site Prep (Chemical app. - eg. Rodeo/Roundup)		6	Ounces	$ 2.50	$ 15.00	Beisswnger's, Fair's, Dundee
Herbivore-Exclusion Fence (4' green vinyl-coated wire)		3	50' roll	$ 30.00	$ 90.00	Menards/Homedepot
T-Post (5.5' steel t-post)		17	each	$ 4.50	$ 76.50	Menards/Homedepot
Coconut Bio-Log (10' x 12" dia. (9lb/ft))		10	roll	$ 90.00	$ 900.00	Brock White, (651) 647-0950
Wood Stakes (2"x 2"x48" - hardwood)		66	each	$ 0.75	$ 49.50	Brock White, (651) 647-0950
Coconut E.C.B. (C125 - 6.6' x 108'/roll, or equivilant)		3	roll	$ 80.00	$ 240.00	Brock White, (651) 647-0950
6" Netting Pegs (bio-stakes)(1 stake /3 sq.ft. min) (1 box = 576 stakes)		1	box	$ 32.00	$ 32.00	Brock White, (651) 647-0950
Shredded Hardwood Mulch (2-3" depth) (entire planting area)		9	cu yd	$ 25.00	$ 225.00	Central Wood Prd, NRG, Local Landscaper
Landscape Edging (Black Poly, 3.5"x1/8"x50')		4	roll	$ 30.00	$ 120.00	Menards/Homedepot
Clean Fill (Grade to waters edge. No fill below OHW)		10	cu yd	$ 21.00	$ 210.00	NRG, Windscapes, Local Agg. Supplier
CCW-701 Sheet Membrane (Dock Access)		80	sq ft	$ 0.75	$ 60.00	Brock White, (651) 647-0950
Angular Rock (9-12")		5	cu yd	$ 25.00	$ 125.00	NRG, Windscapes, Local Agg. Supplier
				MATERIALS SUBTOTAL	**$ 2,143.00**	
Plants						
Native Aquatic Plants		50	4" pot	$ 4.50	$ 225.00	Native Plant Supplier
Native Plug - Transtional		250	each	$ 1.50	$ 375.00	Native Plant Supplier
Native Plug - Upland		250	each	$ 1.50	$ 375.00	Native Plant Supplier
				PLANT SUBTOTAL	**$ 975.00**	
Excavation and Grading						
Grading- (Backfill if needed)		2	hours	$ 100.00	$ 200.00	Landscape Contractor
				EXCAVATION/GRADING SUBTOTAL	**$ 200.00**	
Misc						
Soil Delivery		1	job	$ 70.00	$ 70.00	NRG, Windscapes, Local Agg. Supplier
Rock Delivery		1	job	$ 50.00	$ 50.00	NRG, Windscapes, Local Agg. Supplier
Mulch Delivery (14cy max/load)		1	job	$ 80.00	$ 80.00	Central Wood Prd, NRG, Local Landscaper
Plant Delivery		1	job	$ 100.00	$ 100.00	Native Plant Supplier
				MISC SUBTOTAL	**$ 300.00**	
				Materials	$ 2,143.00	
				Plants	$ 975.00	
				Excavation/Grading	$ 200.00	
				Misc	$ 300.00	
				Material Estimate	$ 3,618.00	
				Labor Estimate	$ 7,236.00	
				Project Estimate	**$ 10,854.00**	
				:-10%	$ 9,768.60	
				:+10%	$ 10,745.46	

Appendix C. *Diagrams showing before and after restoration practices implemented along the shoreline.*





Appendix C. *(Continued) Diagrams showing before and after restoration practices implemented along the shoreline.*