Community Assistantship Program

. . .a program of the Center for Urban and Regional Affairs (CURA)

A Preliminary Assesment of Impairments to Melrose Lake, MN 2013

Prepared in partnership with
The City of Melrose
The Melrose Lake Improvement Association
St. Cloud State University

Prepared by
Ruby Irving-Hewey
Research Assistant
University of Minnesota

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Center for Urban and Regional Affairs (CURA)
University of Minnesota 330 HHH Center
301—19th Avenue South
Minneapolis, Minnesota 55455
Phone: (612) 625-1551
E-mail: cura@umn.edu
Web site: http://www.cura.umn.edu

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EXECUTIVE SUMMARY

Melrose Lake is a small section of the Sauk River which flows from its headwaters in Osakis to the Mississippi River. In the past the lake has been a source of recreation and has developed into a local scenic point for the City who maintains the park downstream of the dam. Over the course of time Melrose Lake has developed water quality issues dealing with sedimentation, excessive algae and aquatic plant growth, and the decrease of desirable fish species spurning the residents of Melrose to form a lake association. The Melrose Lake Improvement Association petitioned the Center for Urban and Regional Affairs for grant money and was awarded funding through the Community Assistantship Program to prepare a lake restoration study with the help of St. Cloud State University. The study was to prepare and provide a current assessment of the lakes' condition, address point and nonpoint sources of contamination and set forth a possible framework for mitigating the water quality issues that affect the lake.

Water quality data directly and indirectly related to Melrose Lake was obtained through previously published government reports and data sets. Samples were gathered during late June through mid-August 2013 to quantify impairment and to begin the process of data collection needed to apply for impaired status (which potentially brings in additional government resources). The results indicate elevated levels of total phosphorus in the water and sediment of Melrose Lake. The average phosphorus concentration exceeded the quality standards currently being reviewed in the Minnesota State Legislature.

INTRODUCTION

BACKGROUND

Melrose Lake is a 72 acre reservoir located in Stearns County on the Sauk River within the Sauk River watershed (Figure 1) which is part of the Upper Mississippi River Basin (MDNR, 2013). In 1862 William Clark built a log dam alongside his mill; in 1867 a formal dam was built to grind feed and to generate electricity. In 1933 the mill was replaced by the Schatzbrau Brewery and was later purchased by the National Egg Dryers company and then by Kraft. Originally named Mill Pond, Melrose Lake has been a focal point of the towns' commerce and recreation since the mid 1800's.

Once a beautiful lake for boating and fishing Melrose Lake has become impaired due to aquatic plant (both rooted and free-floating) and algae growth and is a major concern to Melrose residents and city officials. In response to the recent changes, several residents formed the Melrose Lake Improvement Association (MLIA). MLIA reached out for assistance from the Center for Urban and Regional Affairs (CURA) through the University of Minnesota and St. Cloud State University to start a process to mitigate these problems. This resulting report includes a review of the problem, diagnostic tests, and suggestions for future action.

Figure 1: Photo of Melrose Lake courtesy of the City of Melrose.

PROJECT OBJECTIVES

The MLIA set forth specific objectives when applying for funding for the Community Assistantship Program (CAP) through the Center for Urban and Regional Affairs (CURA). As the first step in the process of a restoration and protection plan this report was aimed at creating the baseline necessary to address sources of potential nutrient inputs and the implementation of possible management strategies. This report will be used to form the basis for new informed actions by the City of Melrose, MLIA and potentially other affected regulatory agencies and to ultimately improve the water quality of Melrose Lake and its surrounding area. The principal objectives of this project were:

- to obtain data directly and indirectly affecting Melrose Lake
- to summarize deficiencies in that research and data
- to determine the current status of water quality
- to identify the possible causes of observed conditions
- to summarize best practices for mitigating known deficiencies
- to determine locations best suitable for implementing restoration and protection projects

Literature research was also conducted to determine and substantiate the possible causes of the observed conditions of Melrose Lake, summarize best practices for mitigating those conditions, and to determine locations best suitable for implementing restoration/ protection projects.

PHYSICAL PROCESSES RELATED TO MELROSE LAKE IMPAIRMENT

Increasing concentrations of nutrients (mainly nitrogen and phosphorus) in the water and sediment of water bodies can lead to overgrowth of aquatic plants and algae. In most natural freshwater systems, phosphorus is the nutrient in shortest supply and generally limits plant and algae growth (Schindler, 1974). Phosphorus has affected much of the Sauk River and therefore has been highlighted in this report. Melrose Lake is surrounded by feedlots and agricultural lands which likely has been the main source of increased phosphorus entering into the Sauk River since the land was settled in the 1800's.

Untreated stormwater from urbanized areas also contributes to this external phosphorus loading. Phosphorus also accumulates internally in aquatic systems since it easily binds to fine sediments such as clay and silt (Vaze & Chiew, 2004). Both internally and externally supplied nutrients can result in excessive plant growth.

While damming rivers can store water, supply power, and prevent many downstream floods, dams also impede the movement of sediment which has had direct and indirect effects on the biology of rivers (Lin, 2011). Reducing flood potential has decreased downstream biodiversity which historically depended on the influx of nutrients from sediment and water to feed and renew stream bank ecosystems (Lin, 2011). The turbidity caused by suspended sediment has been found to decrease primary productivity and alter the composition of fish communities (Ryan, 1991). As the velocity of flow decreases, the deposition of suspended sediment increases causing a buildup of sediment behind dams (Ryan, 1991). Physical pieces of soil and organic debris from outside a lake can accumulate in its bottom, decreasing depth while nutrients allow aquatic plant and algae growth which results in a buildup of debris internal to the lake. Human land use changes may greatly accelerate sedimentation processes. Loading external (mainly from erosion) and internal can make water bodies increasingly shallow and may eventually (over geologic time) result in a terrestrial environment (Mackereth, 1966; Hakanson, 2004). This combination of fertile water and fertile sediment coming from the fertile landscape (accelerated by certain human activities) has led to the abundant aquatic plant and algae growth that concerns MLIA. By examing previous reports and collecting new data, a better picture of the current state of Melrose Lake can be obtained.

STUDY AREA

HYDROLOGY & WATERSHED TOPOGRAPHY

Hydrology involves the properties, occurrence, distribution and movement of water in its various forms and involves a number of physical, chemical and biological processes as it travels above, upon and below the Earth's surface (USGS, 2013). A watershed is an area of land that water drains into and can be classified along a scale from major to minor. The two factors that affect a watershed are gravity and topography which influence how the water travels (MDNR, 2013). In the state of Minnesota 81 major and approximately 5,600 minor watersheds have been delineated (MDNR, 2013). Melrose Lake lies on the Sauk River above the Sauk Horseshoe Chain of Lakes within the Sauk River Watershed. Flowing from northwest to southeast the Sauk River begins at Lake Osakis and travels through parts of Douglas, Meeker and Todd County but stretching mainly through Stearns County dropping in elevation approximately 340 feet over its length (MDNR, Watersheds, 2013)and (Waters, 1977). The Sauk River is approximately 120 miles long flowing from its source to its confluence with the Mississippi River near St. Cloud. The watershed covers a total of 1,043 square miles and approximately 90 miles in length (MPCA 2013). The Sauk River Watershed lies within the North Central Hardwood Forest Ecoregion (NCHF) and is dominated by glacial till and drift that contain high fractions of clay and silt (Figure 2).

Figure 2: The Sauk River Watershed (MPCA 2013).

CATCHMENT AREA

A catchment area is an area which, due to topography, catches runoff from rain events. This includes not only the water but the sediment and dissolved solids that the water carries as it travels downward towards a common area. The upstream catchment area of Melrose Lake is approximately 280,672 acres and the sub-water shed area on the south side of Melrose Lake is approximately 6,869 acres (Figure 3).

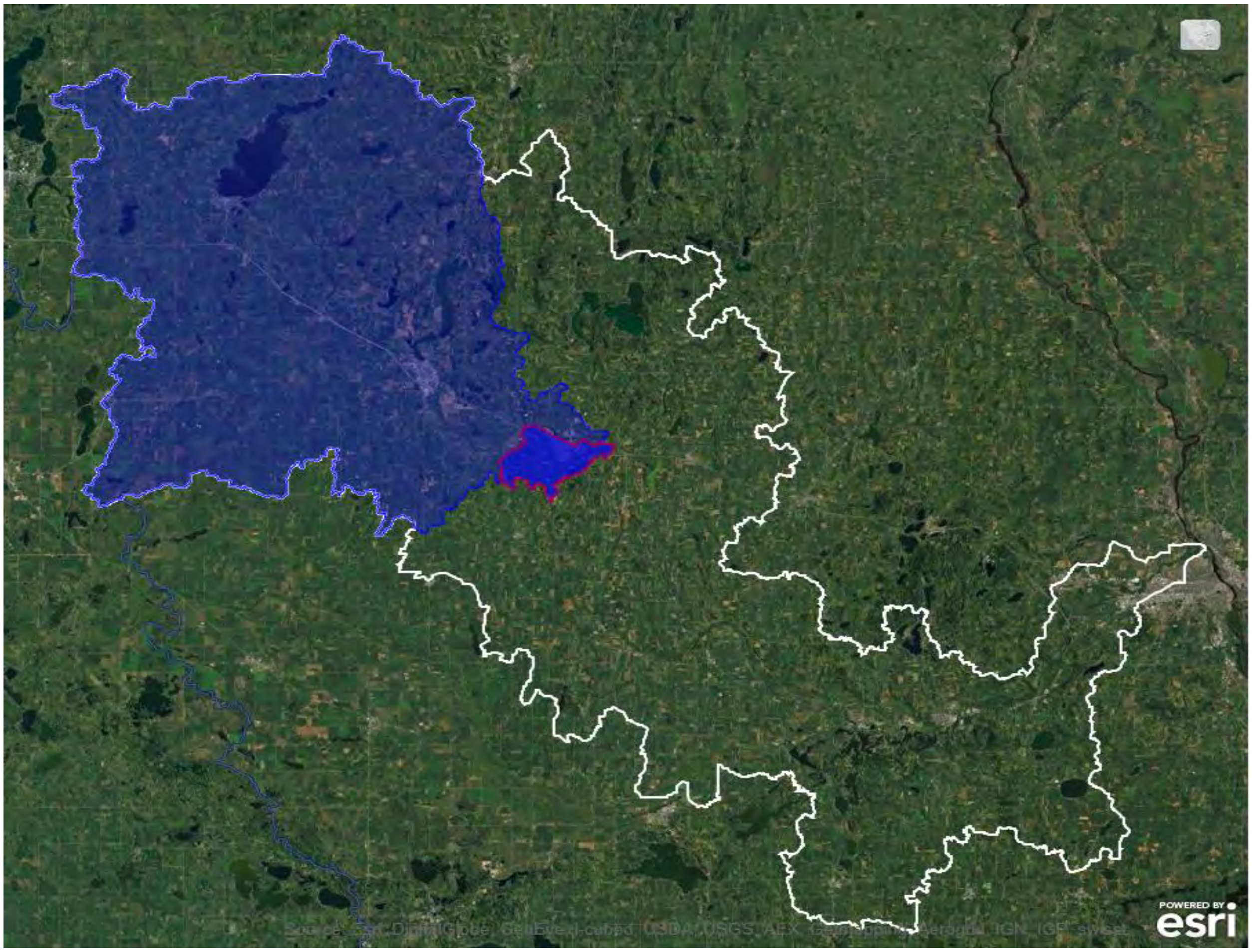


Figure 3: The upstream catchment area (outlined in blue) and the headwater catchment area (outlined in red) for Melrose Lake (MDNR, 2013).

The last depth mapping of Melrose Lake was in 1989 (Figure 4). The upper Northwest corner of Melrose Lake is narrow in width and ranged from 3ft deep to 1.5ft deep. As the waterway widened toward the main area of the lake in a southeasterly direction the depth deepened through a narrow band to approximately 4.5ft reaching 5ft and higher at the foot bridge. From the foot bridge to the dam Melrose lake depth varied from 2ft to 9ft with 4ft to 5.5ft being the main depth of the channel. The littoral zone of lakes and rivers are the areas near the shore and is defined by the MDNR as the area within a lake that is less than 15ft in depth (2012). Melrose Lake was mapped at its deepest to be 9ft in depth in 1989 and in 2013 and therefore can be classified as all littoral zones. Littoral zones support aquatic emergent and submerged vegetation, algae, and benthic organisms such as aquatic macroinvertebrates (Paterson, 1993). This ecosystem plays an important role in the lakes food- web which affects fish populations.

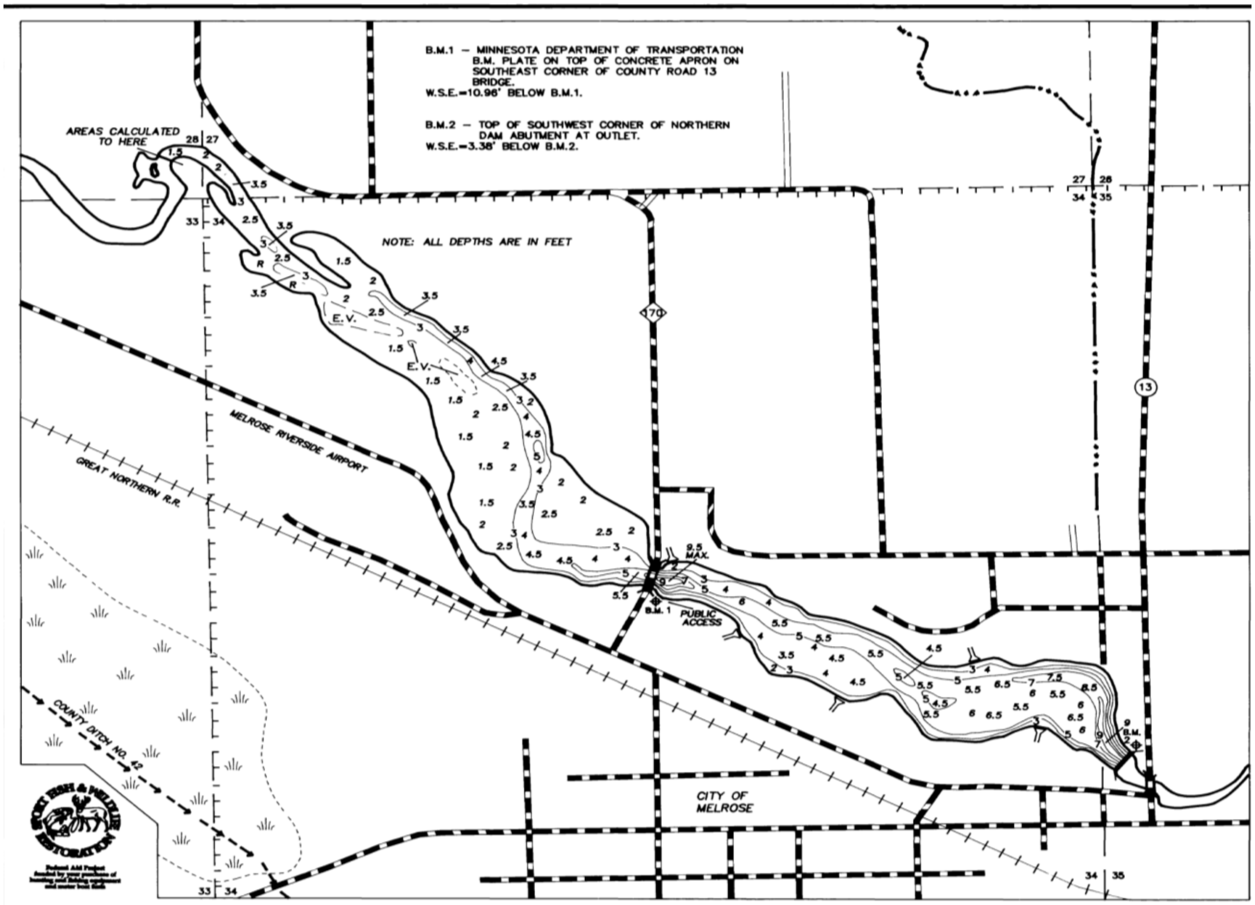


Figure 4: Lake depth map and storm sewer outfalls of Melrose Lake (DNR 1989).

LAND USE

Land use within a catchment area is pinnacle to the quality of water which it holds. Natural vegetation stabilizes soil from erosion and intercepts and assists in the infiltration of precipitation. In populated areas the cover of vegetation is decreased and impervious surfaces increased which creates amplified sources for point and non- point pollution such as storm water or fertilizer (Ferrell, 2001). Land-use for the entire water shed above the catchment area of Melrose Lake was calculated from 2006 NLCD (Figure 3). The total cultivated land in the Sauk River watershed above Melrose Lake is approximately 51.4%, perennial cover 37.7%, water 5.3% and other 5.7%. Within the 280,672 acre upper Sauk River watershed are feedlots which hold approximately 78,342 animal units and within the 6,869 acres of the lower Sauk River there are approximately 15,050 animal units (MPCA). Upstream about 3 miles west northwest from Melrose Lake the drainage area (419 mi^2) entering the Sauk River is comprised of 52% agricultural/cultivated land, 25% range land, 10% water, 7% forest and 5% urban area. To the northwest about 2 miles the drainage area (9 mi^2)of a tributary that drains into the Sauk River is comprised of 37% agricultural/cultivated land, 38% range land, 9% water, 12% forest and 4% urban area. Both of these areas converge a little over a mile west of Melrose Lake and contribute as a pour fall (Figure 5).

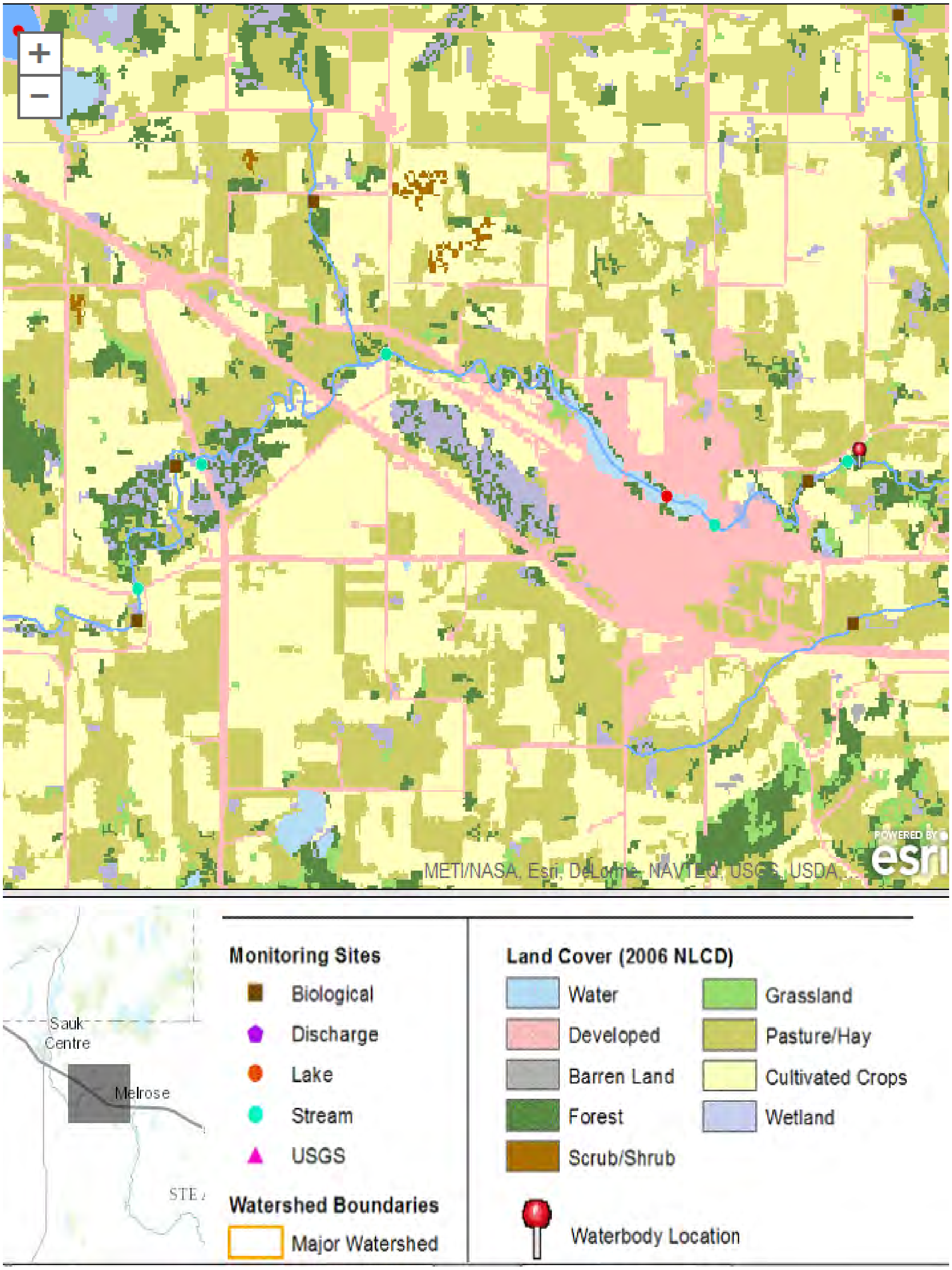


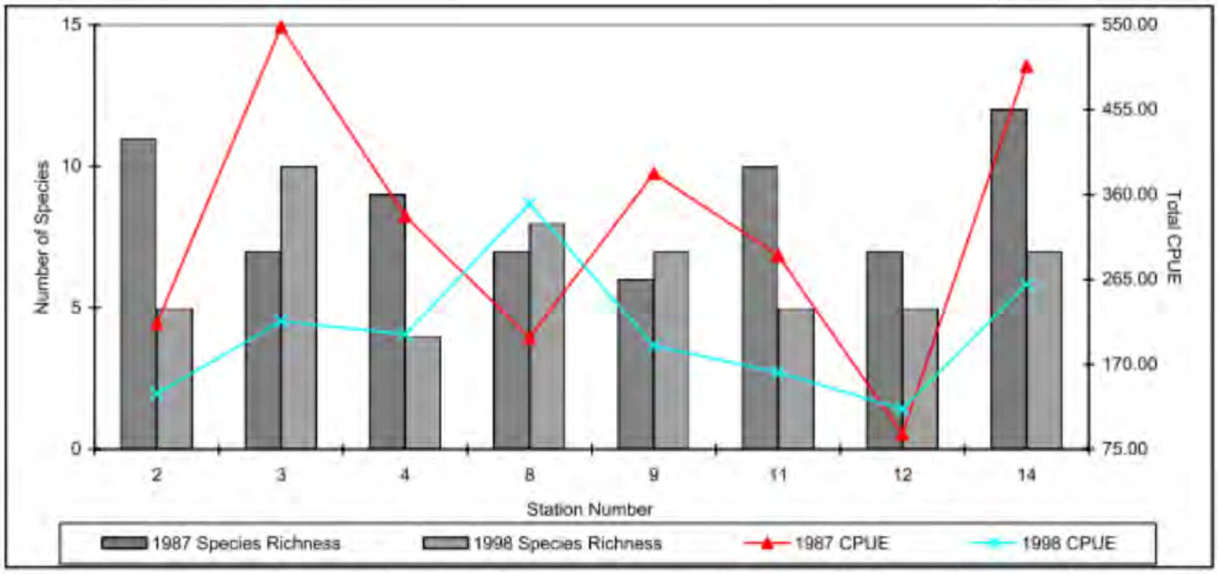
Figure 5: Land use map and stations map on the Sauk River and a tributary WNW and NW of Melrose Lake (MPCA 2013).

PROJECT METHODS

REVIEW OF EXISTING REPORTS

The data directly and indirectly related to Melrose Lake was determined as that data which has been collected over time by different entities regarding the hydrological, physiochemical, biological, and physical characteristics in and around the lake. To obtain this data and determine deficiencies in the data record, research was done of the various government websites that have jurisdiction over water related topics such as the Minnesota Pollution control Agency (MPCA), Department of Natural Resource (DNR), Stearns County Soil and Water Conservation District (SWCD), and the City of Melrose.

The DNR studied physical and chemical characteristics and the composition and abundance of aquatic organisms of the Sauk River in 1987 and 1998 (Altena, 1998). From five miles below Cold Springs Dam up to Sauk Centre Dam 12 sampling stations were used but only those stations above and below Melrose Dam are highlighted in this report (see Figure 6). Station 8 is approximately 21 miles south of Melrose Dam and station 9 is located just shy of a mile south of Melrose Dam. Station 10 is north of Melrose Dam two miles, station 11 is approximately 4 miles north of Melrose Dam and station 12 is approximately 14 miles north of Melrose Dam. Species richness between sites for the samples taken at Station 8 and Station 9 were similar for both 1987 and 1998. Station 11 and Station 12 however had a considerable drop in species richness from 1987 to 1998 (Figure 6).



Station	2	3	4	8	9	11	12	14
1987 Species Richness	11	7	9	7	6	10	7	12
1998 Species Richness	5	10	4	8	7	5	5	7
1987 CPUE	216.00	548.00	336.00	200.00	384.00	292.00	92.00	504.00
1998 CPUE	137.04	218.52	203.85	350.00	190.91	161.11	120.00	260.00

Figure 6: Sauk River species richness and catch per unit effort (CPUE) from electrofishing similar stations 1987 and 1998 (Altena, 1998).

In 2008 in response to the Minnesota's Clean Water Legacy Act (CWLA) that passed in 2006 the Minnesota Pollution Control Agency (MPCA) developed a watershed monitoring strategy that integrated a more holistic approach in assessing the states' surface waters. With the cooperation of stakeholders and local government this monitoring effort was implemented over a 10-year cycle to improve the coordination and implementation of projects so as to improve and/or restore water quality to surface waters. This watershed approach was initiated and a major monitoring of the Sauk River Watershed was implemented with the help of the Sauk River Watershed District (SRWD). Fifty four sites were sampled for biology and stream water chemistry.

The SRWD also entered into an agreement to provide assessment data to the MPCA which included the assessment of aquatic macroinvertebrates (including aquatic insects) to determine water quality. There were six areas sampled began at River's Edge in Sauk Centre and ended at St. Martins Canoe Access

Point off County Road 12 which is downstream of Melrose Dam. The first and second areas sampled were River's Edge and Sauk River Park in Melrose and are highlighted in this report. According to Schmude (2011) the Biotic Index for River's edge was poor and the Biotic Index for Sauk River Park was fair; a poor rating is consistent with waters that have very significant organic pollution and a fair rating is consistent with waters that have fairly significant organic pollution.

A 2011 report by the MPCA in conjunction with other agencies provides a summary of the results pertaining to all water quality assessments and available data within the Sauk River Watershed (Andrews, et al., 2011). Many of the lakes and streams assessed showed impairments of biota and/or nutrients throughout the entire watershed. The 2011 Fish Survey done by the DNR showed that the most abundant fish was the black bullhead, yellow bullhead and black crappie. Northern pike, yellow perch white suckers, sunfish and catfish were also caught but in extremely low abundance and had showed a decline from the previous survey done in 1988. Black bullhead are abundant in Minnesota lakes and are well acclimated to living in polluted and/or warm muddy water which is low in oxygen. Yellow bullheads are also common and are expected to increase in abundance as lakes become less oxygenated from heat and sediment pollution (MDNR, 2013). Water quality at the time of the 2011 survey was documented to be moderate. The most common aquatic vegetation listed was curly-leaf pondweed, Canada waterweed, filamentous algae and coontail. The other less common aquatic vegetation was jewelweed, narrow-leaf pondweed, river pondweed, and white water buttercup.

In 2005, Wenck Associates Inc., an engineering and consulting firm, assessed a 1990 report of alternatives that the United States Army Corp of Engineers developed to address the management of aquatic vegetation and the removal of silt from the Sauk River. After meeting with the SRWD, Wenck focused on six of the alternatives and provided a compare and contrast report of those alternatives and the estimated costs to implement them (WENCK, 2005). In 2011 Wenck was again commissioned by the

SRWD to write a report concerning the stormwater management plan of Melrose. Four areas were identified by both the City and the SRWD where stormwater management strategies could be implemented which WENCK elaborated on and discussed in their report. These areas were the 2015 Downtown Redevelopment project, the 2017 street reconstruction project, the proposed Commercial Development west of town and the proposed road expansion along 9th St. North. Wenck also included designs and estimated costs for the plan should the City of Melrose wish to move forward with integrating improved stormwater management into their future plans (WENCK, 2011) .

Conspicuously absent from these previous assessments was water and sediment tests, especially for phosphorus. As noted earlier, phosphorus and a few other water quality measurements can be used to establish that Melrose Lake is impaired, which can grant additional government resources to become available to improve the lake's health. Once this became clearer, the decision was made to put resources into this type of sampling.

FIELD AND LABORATORY METHODS

To investigate the current status of water quality in Melrose Lake water samples were collected at various sample points between June and August of 2013 and analyzed through the Waste Water Treatment Plant in Melrose for Total Phosphorus (TP) and for chlorophyll-a using certified methods. The TP was analyzed using the Ascorbic Acid Method from HACH and the chlorophyll-a was analyzed by a certified DHIA lab in Sauk Centre using the SM10200H Method (APHA 2013). Dissolved Oxygen (DO), conductivity, Total Dissolved Solids (TDS) measured during water collection using a Hach multi-parameter meter. Secchi disk data was also taken at some spots and dates. A preliminary data set of depth measurements were taken with a depth finder in cross sections at and near the dam to compare to the DNR Depth Map created in 1989. The sediment phosphorus was analyzed by the USDA lab in Albany MN using the Olsen test (Table 1).

Table 1. Water Quality and Sediment Analysis methods, detection limits and source of standard operating procedures.

PARAMETER	METHOD	DET. LIMIT	SOURCE
Total Phosphorus (H_2O)	Ascorbic Acid Method (Hach)	0.0159 mg/L	Standard Methods for the examination of Water & Wastewater (APHA 2013)
Total Phosphorus (Sediment)	Olsen		(Olsen, Cole, Watanabe, & Dean, 1954) (NRCS, 2013)
Dissolved O_2	Luminescent	0.2 mg/L	Hach, 2010
Conductivity/TDS	Electronic	5 µS/cm	Hach, 2010
Turbidity	Secchi Disk		
Chlorophyll a		0.5 mg/L	Stearns County DHIA Lab Method SM 10200H

RESULTS AND DISCUSSION OF FIELD AND LAB DATA

DEPTH

Preliminary depth mapping near the bottom of the lake in 2013 may indicate a loss of depth since 1989 (Figure 7). Lake bottom topography is continuously changing due to external loading of sediment, internal loading of aquatic biota and the water current. However, decreasing depth is a process that takes time. According to a couple of lifetime residence of Melrose, the lake depth has decreased significantly over the last 50 years and certainly plays a role in its current state. As the sediment builds up on the bottom of the lake it becomes easier to become resuspended by wind and currents potentially causing increased turbidity and the cycling of nutrients (Bloesch, 1995). This also may increase aquatic vegetation growth and decreases DO available for aquatic organisms including fish. In the future, to quantify changes in depth over the entire lake, it would be beneficial for the City of Melrose to enlist the DNR to create a new depth map.

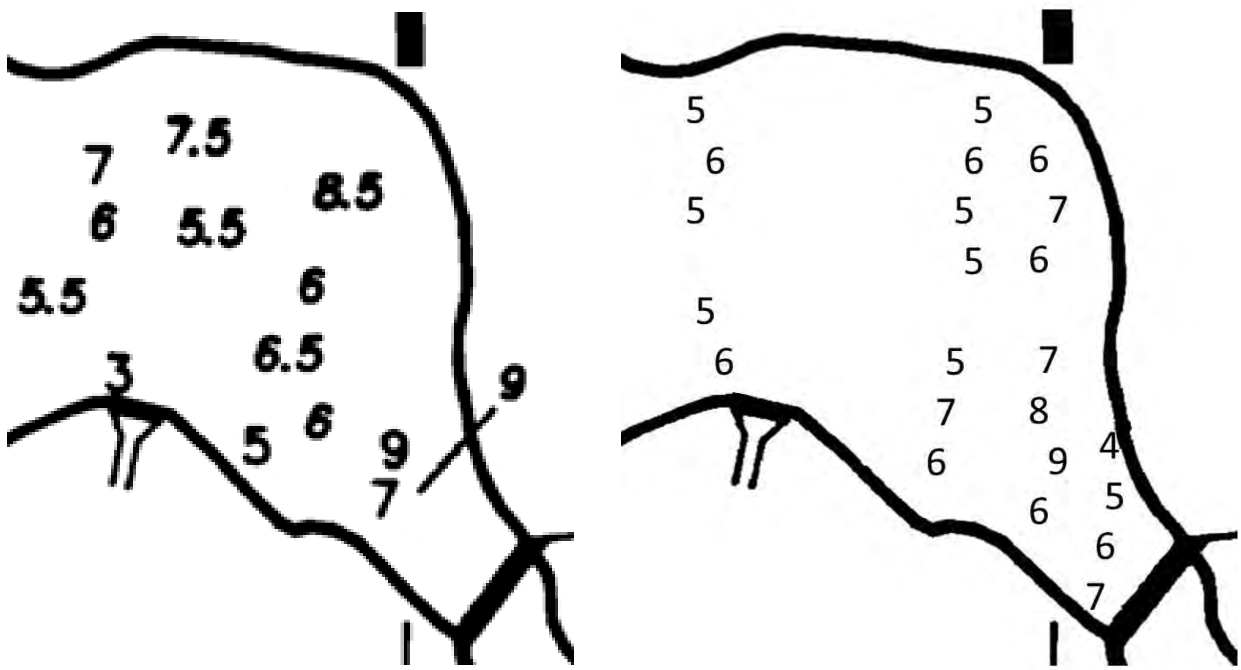


Figure 7: Left - area next to dam from MDNR 1989 depth mapping; right– area next to dam from July 2013 depth mapping.

Table 2: Sampling stations including coordinates with corresponding measurements taken of DO, TDS, CND, and TP.

DATE	SOURCE	LAT	LONG	DO (MG/L)	TDS(MG/L)	CND (µS/CM)	TP (MG/L)

6/25/2013	1	45.67746	-94.81212	4.91	212	433	0.334
	2	45.68014	-94.82032	4.73	215	430	0.178
	3	45.67999	-94.82076	5	218	436	0.191
	4	45.67856	-94.81742	5.31	218	436	0.172
	5	45.68265	-94.82269	4.29	218	436	N/A
7/16/2013	1	45.40677	-94.48721	N/A	246	492	0.181
	2	45.40694	-94.48821	N/A	N/A	N/A	0.329
	3	45.4079	-94.49138	N/A	250	501	0.186
	4	45.40713	-94.49042	N/A	217	434	0.145
7/25/2013	1	45.67667	-94.80933	N/A	N/A	N/A	0.143
	2	45.67856	-94.81742	3.94	237.5	475	0.142
	3	45.68265	-94.82269	3.82	237	474	0.138
	4	45.67659	-94.8102	3.64	238.5	477	0.189
	5	45.67634	-94.80902	N/A	N/A	N/A	0.138
	6	45.67773	-94.80875	4.5	239	478	0.139
	7	45.67662	-94.81021	2.53	240.5	481	0.135
8/13/2013	1	45.40672	-94.48726	N/A	N/A	N/A	0.265
	2	45.67962	-94.81912	N/A	N/A	N/A	0.092
	3	45.67754	-94.8128	N/A	N/A	N/A	0.11

WATER SAMPLING

The DO, Conductivity and TDS were measured at various sampling stations during the sampling season (Table 2). The lowest DO level was 2.53mg/L between the dam and the foot bridge at a stormwater outlet on the west bank of Melrose Lake during the month of August. The highest DO was 5.0mg/L and 5.31mg/L and located in the middle of Melrose Lake near the dam and on the east bank just north of the dam during the month of June. TDS/conductivity showed an incremental increase from the end of June until the middle of August except for a spike of 250mg/L that was measured in mid-July. Most of the samples had TP concentrations between 0.135mg/L and 0.191mg/L but in a few instances there were concentrations above 0.329mg/L (Table 2). The TP exceeded the proposed total maximum daily load (TMDL) of 0.1 mg/L in each of the water samples analyzed. These spikes of TP levels were found near the stormwater outfall in the residential area near River Heights Dr NE between the Dam and the footbridge (Figure 8). All but one water samples had TP amounts that exceeded the proposed limit making it a candidate to be listed as nutrient impaired, these data will be passed along to the SRWD and MPCA which should allow Melrose Lake to be officially listed as impaired and therefore be able to receive additional resources for its rehabilitation.

Figure 8: Sampling stations with the highest levels of TP during the sampling time frame. Photo courtesy of the City of Melrose.

A Secchi disk measures turbidity by measuring how far down a painted metal plate can go before it is no longer visible. Because of the lack of depth in Melrose Lake, many of the measurements went to the bottom of the lake, in only two places were measurement made (Figure 9). Near the foot bridge of Melrose Lake Secchi decreased approximately 3.3ft and in a deep section near the dam Secchi depth decreased by 1.9ft between June and August (Figure 9). Secchi values for waters in the NCHF Ecoregion of Minnesota that are less than 3.7 feet indicate impairment (MPCA, 2013).

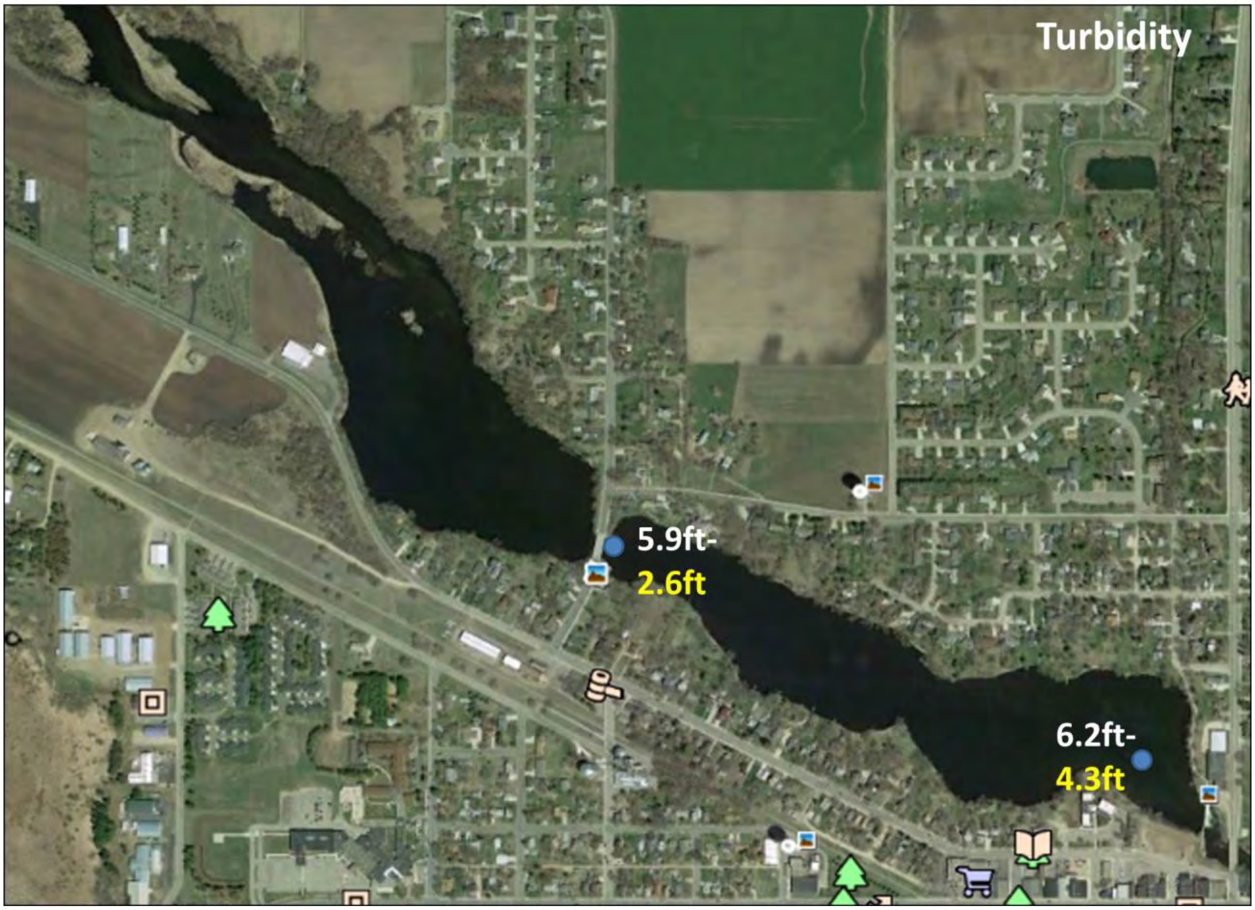


Figure 9: Sampling stations of Secchi Disk readings and corresponding turbidity data. Photo courtesy of Google Earth Maps (2013).

Chlorophyll a was measured at three points along the lake and ranged between 0.0921mg/L and 0.2392mg/L. The highest level of chlorophyll a was found upstream of the foot bridge and the lowest level of chlorophyll a was found near the dam (Figure 10). Chlorophyll a is a measurement of algal biomass and shows a decreasing trend from north of the foot bridge in a shallow area of excessive aquatic vegetative growth to the dam where the water is deeper and the current is stronger.

Chlorophyll-a concentrations for waters in the NCHF Ecoregion of Minnesota that are greater than 0.018 mg/L indicate impairment (MPCA, 2013).

Figure 10: Sampling stations and corresponding chlorophyll a levels. Photo courtesy of Google Earth Maps (2013).

SEDIMENT

The phosphorus detected in the sediment was found to be between 15mg/kg and 19mg/kg with the highest amount being found closest to the dam (Figure 11). The highest levels of TP in the water samples were also taken from this area and should continue to be monitored. According to the USDA lab, the 15mg/kg of phosphorus is considered high and both levels of 19mg/kg and 16mg/k are considered very high in terms of what is available for vegetative uptake. The amount of phosphorus found in both water and sediment samples were consistently high and contribute to both the excessive vegetation and algae growth on Melrose Lake. These amounts are indicative of impaired waters and with continued monitoring can lead to nutrient impaired status.

Figure 11: Sediment sample stations and corresponding phosphorus levels (mg/kg). Photo courtesy of Google Maps (2013).

MANAGEMENT STRATEGIES

Some of the biggest hurdles facing the City of Melrose to improve the quality of their lake are costs and restraining regulations. One approach to mitigating the negative impacts of eutrophication would be to dredge out the sediment that has built up over the last 50 years creating a constant supply of nutrients to the aquatic ecosystem. In order to address the issues facing Melrose Lake this report suggests the following as possible courses of action and elaborates on many of the solutions that would be cost effective for the City of Melrose.

BIOREMEDIATION

Bioremediation is the use of microorganisms such as bacteria, yeast or fungi, to reduce lake impairments like algal blooms by reducing nutrient availability (Kamath, 2007). It is one option that would need to be thoroughly researched and employed by an expert(s) in the field of bioremediation. Combined with other alternatives, such as manual harvest of aquatic vegetation and storm water control as outlined by Wenck (2005, 2011), bioremediation is a tangible method of reducing the impairment to Melrose Lake.

STORMWATER MANAGEMENT

Stormwater runoff is a major concern and proven impairment to water quality of nearby water ways. Impervious surfaces impede infiltration which prevents groundwater recharge (Abi Aad, Suidan, & Shuster, 2010) and directs an enormous amount of rainwater runoff with contaminated sediment into lakes, rivers and streams. Urbanized areas increase impervious surfaces which alter the infiltration capacity of land effecting groundwater recharge while creating greater pollutant loads on nearby lakes, rivers and streams. Impervious surfaces include everything through which nothing can penetrate such as roads, sidewalks, parking lots, driveways, and rooftops. The vegetation in these urbanized areas is reduced to a minimal variety of shrubs and grasses which are groomed and fertilized. Vegetation acts as a natural filter for rain runoff and often a natural barrier against erosion. The SRWD contracted Wenck to prepare a stormwater management plan for the city of Melrose in June of 2011 to address the lack of stormwater management which is having a negative impact on water quality in Melrose Lake and the Sauk River. There were five management strategies suggested in the report; rain gardens, storm sewer pipes fitted with sumps, pervious surfaces added to the infrastructure, forebays/ponds and infiltration/filtration basins (WENCK, 2011).

Rain gardens are small created areas of native vegetation such as shrubs and flowers that are used to catch water runoff from rain events and allow it to infiltrate into the ground. They are planted in various strategic areas near impervious surfaces such as streets and parking lots to help collect contaminated sediment. Rain gardens are easily implemented and are easy to maintain. Community involvement can be utilized as a resource to help defray the cost of storm water maintenance by volunteering to build, plant, and maintain residential rain gardens and is an effective way to beautify city streets with minimal effort.

Buffer zones are areas of vegetation which are located next to water bodies such as rivers, streams and lakes. These areas of vegetation are used to protect water quality by allowing stormwater runoff to infiltrate the soil and by preventing stream bank erosion (USEPA, 2012). Width and vegetation utilized in buffer zones is a function of slope, soil and other components such as annual rainfall and associated contaminants of runoff. Buffer zones can easily be implemented in residential areas along the shoreline of a river or a lake and can vary in width and composition depending on topography and soil. In agricultural areas buffer zones have been integrated into the landscape to reduce the nutrient load to nearby streams and rivers.

Many of the issues with stormwater arise due to the impervious nature of roads, parking lots, driveways and sidewalks. Because water is unable to infiltrate the ground the majority of water lands on the pavement of these structures and is guided to storm sewer drains. The water is then guided to either secondary treatment such as ponds or directly into nearby lakes and rivers. Pervious concrete has a multi-faceted utility by increasing infiltration, reducing stormwater runoff and providing storage and treatment of the discharge before entering surface waters. Pervious concrete has been shown to be a durable, easy to maintain and a cost effective way of mitigating runoff volume and pollutant loads to surface waters and would be beneficial as an augmentation to other BMPs being considered (USEPA, 2012).

Sumps are areas in a catch basin that filter out sediment and debris from storm water and can be inserted into already existing storm drains. The design of the catch basin and size of the sump is key to the amount of sediment and debris that can be collected and to how often it will require maintenance. However, it is important to note that this BMP for storm water runoff is not effective in filtering out soluble pollutants or fine sediment and should be used with other BMPs to reduce pollution entering Melrose lake (USEPA, 2012).

Stormwater ponds are constructed areas that catch runoff from impervious surfaces and acts as a treatment for reducing sediment and pollutants. Stormwater ponds are common BMPs for residential, industrial and agricultural areas and provide an effective, long term and low maintenance approach to stormwater treatment. Forebays are a pretreatment, small depressional area that is often placed at the entrance of a stormwater pond and reduces pollutant and sedimentation loads to the pond (McNett & Hunt, 2011). Infiltration and filtration basins, though not unlike ponds, are areas that catch stormwater and allow it to filter down into the soil. Often used alongside roadways, infiltration basins help to decrease flooding and increase sediment and pollutant capture.

NUTRIENTS

Ways to decrease internal loading has included dredging or the addition of Iron or Alum in which the sorptive ability of the sediment is increased. Due to the ability of phosphorus to accumulate and slowly re- suspend in aquatic environments, which can take years, reducing the external load is not sufficient in creating immediate results when trying to improve lake water quality (Sondergaard, Jensen, & Jeppesen, 2001; Sondergaard, Jensen, & Jeppesen, 2003). It has been noted that concentrations of phosphorus often increase during the summer due to internal processes such as the release of phosphorus that had been retained during the winter (Sondergaard, Jensen, & Jeppesen, 2003).

CONCLUSION

The results obtained through collection of water samples indicate that there are elevated levels of TP and chlorophyll a and decreased depth of Secchi disk readings which require continued monitoring to qualify for a 303d listing of impaired lakes. Each water sample but one that was gathered between June and August of 2013 had TP amounts that exceeded the proposed 0.100mg/L limit making it a candidate to be listed as nutrient impaired. The excessive growth of submerged vegetation, duckweed and algae and the sediment runoff from agricultural lands and stormwater has created a perpetuating cycle of nutrients that feed future vegetation communities. Though dredging would be an option in decreasing this continuous source of nutrients, it is cost prohibitive and difficult to initiate. Continuing to work with the SRWD, MDNR and MPCA will be key in determining the current state of Melrose Lake and future possibilities in returning Melrose Lake to a valuable recreational resource. The MPCA also has a Citizens Lake Monitoring Program which is an imperative step in the process of collecting necessary data to determine the impairments of Melrose Lake and eligibility of funding opportunities.

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