FINAL REPORT:

WATER QUALITY MONITORING AND EVALUATION OF POLLUTANT SOURCES WITHIN THE SOUTHWEST SUBWATERSHED OF ROCK LAKE

2010
Jefferson County
Land and Water Conservation Department

The work done by the Jefferson County Land and Water Conservation Department on this project was a contribution to a Wisconsin Department of Natural Resources Lake Planning Grant received by the Rock Lake Improvement Association.

FINAL REPORT:
WATER QUALITY MONITORING AND EVALUATION OF POLLUTANT SOURCES WITHIN THE SOUTHWEST SUBWATERSHED OF ROCK LAKE

Project Area

The Southwest Subwatershed drains 176.6 acres in the southwest corner of Rock Lake (Map 1). This landscape is a mix of agriculture, parkland, wetlands, forest, and residential development (Table 1). The low gradient glaciated landscape of the subwatershed was ditched for agricultural drainage probably in the 1930s or 1940s. This drainage ditch (referred to as ditch or stream in this report) enters Rock Lake via a channel adjacent to Cedar Lane and Shorewood Hills Road (identified as the "Miljala channel" in this report).

Table 1. Land Uses in the Southwest Subwatershed of Rock Lake

Land Use	Acreage	Percentage
Agriculture	59.2	33.5%
Grassland/Pasture (includes prairies)	36.34	20.6%
Forest	29.61	16.8%
Medium Density Urban (1/4 acre lots)	14.91	8.4%
Rural Residential (>1 acre lots)	13.59	7.7%
Wetland	10.81	6.1%
Roads	10.26	5.8%
Open water	1.89	1.1%

A portion of the subwatershed boundaries were field verified. As a result, there were some changes made to the watershed boundaries in the area of the Shorewood Meadows development. Please refer to Map 1 for the watershed boundaries.

Description of Problem

In 1995, the subwatershed of Rock Lake was modeled by R.A. Smith and Associates, Inc. using WINHUSLE and reported as delivering 41 tons/year of sediment and 262 lbs/year of phosphorus into Rock Lake (R.A. Smith and Associates 1995). As a comparison, the model estimated 339 tons of sediment and 2,066 lbs of phosphorus flow into Rock Lake annually from rural lands in the watershed. The R.A. Smith and Associates report ranked 28 subwatersheds of Rock Lake in terms of sediment load per acre per year. There are 12 subwatersheds that have higher sediment load per acre than the Miljala subwatershed.

In recent years, the amount of sediment entering the channel from the drainage ditch was thought to be more than what was modeled – based on observations and the necessity to dredge sediment from the Miljala channel. The extreme flooding events of the fall of 2007 and the spring of 2008 delivered a large amount of sediment to the channel, with the deepest deposits settling in the first 70 feet of the channel. The deepest sediment deposition was measured by landowners as 70 feet long by 50 feet wide by 6 feet deep. As a result, additional dredging of the channel occurred in 2009.

Testing by the Department of Natural Resources in June and July of 2008 found fluctuating levels of fecal coliform and e-coli counts. The e-coli ranged from 29 to 2,400 colonies per 100 ml. The fecal coliform ranged from 70 to 6,900 colonies per 100 ml.

Project Goals

Original Project Goals

Due to concerns over the amount of sediment, phosphorus, and bacteria in the stream/ditch, the Rock Lake Improvement Association applied for and received a Department of Natural Resources lake planning grant to perform sampling and analysis of the stream. Underwater Habitat Investigations, LLC (UHI) was hired to work on the project cooperatively with the Jefferson County Land and Water Conservation Department (LWCD) and the Rock Lake Improvement Association (RLIA).

The goal of the project was to monitor the stream and channel during both low flow and rainfall events to identify pollutant sources and loads. This includes assessing sources of fecal coliform and e-coli bacteria, phosphorus, and sediment. The health of the tributary was also assessed by performing fish and aquatic invertebrate sampling.

The project write-up for the original project goals, as well as comments on the Hey and Associates, Inc. report (see next section) is contained in this report written by the Land and Water Conservation Department.

Amended Project Goals

After approximately 3 months of sampling and assessment in 2009, it was determined that the source of the sediment and nutrients is the bottom and sides of the drainage ditch. Underground Habitat Investigations suggested that the remaining money in the grant should not be spent on additional base flow sampling or his time to perform the sampling. Instead, UHI recommended that the project move to the next level and include a preliminary engineering assessment to identify possible practices that would control the sediment and phosphorus delivery, and potentially the bacteria delivery also. With that advice, the RLIA requested and received a grant amendment to hire an engineering firm to do the following:

- Estimate watershed runoff volumes and peak flows for several storm events.
- Estimate stream hydraulic conditions (storm flow velocities) and sediment transport rates.
- Describe 2-3 management practices to improve sediment trapping. This description would include approximate sizes of the potential systems, ranges of possible costs, and discussion of feasibility. The feasibility discussion would include: potential upstream surface and ground water drainage impacts, long-term maintenance considerations, the most relevant storms to control for water quality and navigation objectives, and cost.
- Describe the conceptual engineering analysis, including concept drawings.
- Recommend next steps for developing preliminary and final engineering designs, including additional data needs and detailed engineering analyses needed.

The project write-up for the amended project goals are contained in a report prepared by Neal O'Reilly of Hey and Associates, Inc.: Evaluation of Management Alternatives for the Control of Sediment and Nutrient Inputs to the Miljala Channel and Rock Lake, January 15, 2010.

History of Channel Dredging

The Miljala channel was initially dredged for development most likely in 1957, based on aerial photos and newspaper ads for new "lake lots" available for development. The next known dredging of the channel took place in August 1998 with a hydraulic dredge on a barge. Approximately 6,000 cubic yards of sediment were removed from the channel. It is notable that half of what was removed was located in between the Cedar Lane road culvert and the bend of the channel (in the 1st 170 feet of the channel). The remaining 3,000 cubic yards was dredged from the bend of the Miljala channel to Rock Lake (approximately 700 feet). Therefore, the vast majority of sediment discharged in the Miljala channel from the stream is settling out within 170 feet of the road culvert. The dredged material removed in 1998 was placed upstream on farmland adjacent to the drainage ditch.

In March 2005, dredging of a portion of the Miljala channel was done with a back hoe from Cedar Lane. Approximately 500 cubic yards of sediment were removed from the culvert to the extent of the back hoe's reach. The dredged material was spread on conservation club land located outside of the subwatershed. In September 2007, landowners measured the depth of the sediment in the channel just downstream from the road culvert and found 2-3 feet of sediment. Therefore, 2-3 feet of sediment was deposited in 2.5 year. In the summer of 2009, the landowners reported that the area downstream from the road culvert had 6 feet of sediment. Therefore, 3-4 feet of sediment was deposited into the channel in 2 years. This increase of sediment deposition is more likely than not caused by the large and unprecedented precipitation events in the fall of 2007 and spring of 2008.

In August 2009, dredging was done again with a back hoe from Cedar Lane and from the land on both sides of the Miljala channel. Approximately 700 cubic yards of sediment were removed in the channel within 70 feet of the culvert. Sediment that was beyond 70 feet of the culvert was not dredged. It is the opinion of the author that the significant precipitation events of 2007 and 2008 delivered a large amount of sediment to the Miljala channel – more than what would have been delivered during normal precipitation years. The material taken out of the channel was spread on a farm field located outside of the subwatershed. A turbidity curtain was placed 30 feet from the culvert to prevent additional sediment from entering the rest of the channel. This curtain is anchored on the shoreline on both sides of the Miljala channel and extends to the bottom of the channel. A small portion of the top of the curtain is weighed down to allow water flow over the top of the curtain. The DNR permit for the turbidity curtain expires on August 17, 2012 and can be extended only once for an additional two years to August 17, 2014.

All of the dredging in the Miljala channel and material "disposal" was implemented under permits from the Department of Natural Resources (DNR). Any future dredging in the channel will require permits from the DNR.

Water Sampling

Methods

Underwater Habitat Investigations led the sampling effort with support from the Land and Water Conservation Department and several board members of the RLIA: Larry Clark, Milt Strauss, Ron Niedfeldt, and Tom Pezzi. Lee Gatzke also helped on one of the storm sampling events.

Several stream sampling points were chosen for the project (Map 2). Some of these points were pipes that never had any water flow out of them: I is a road culvert, and D is a large metal pipe coming out of the stream bank. Samples were taken from May 2009 through October 2009. Only one storm event was sampled. Other storm events were not sampled because there was not enough precipitation, or the timing did not fit into the schedules of the volunteers and consultants.

Parameters measured/sampled and the meter/method used are listed below:

Flow (cfs) – water flow was measured with a Swoffer Model 2100 meter. Water flow was also recorded by Hey & Associates on November 13, 2009 – a different type of meter may have been used.

Water Level (ft) – water level was read from a stream gauge graduated to hundredths and marked at every foot and every tenth. The gauge was attached to a steel beam which was driven into the stream bottom upstream from the culvert (site B)

Transparency (cm) – a 120 cm secchi transparency tube was used to measure the transparency or clarity of the water.

pH – the ExStik pH Meter was used to measure pH. The instrument was calibrated according to the manufacturer's directions. The YSI Model 63 was also used to measure pH.

Conductivity (uS/cm) – The ExStik II Conductivity Meter was used to measure conductivity. The instrument was calibrated according to the manufacturer's directions. The YSI Model 63 was also used to measure conductivity.

Dissolved Oxygen (mg/l) – The Hach Portable LDO meter (HQ10) was used to measures dissolved oxygen and temperature. The YSI Model 52 was also used to measure DO.

Temperature (°C) – Temperature was measured with the ExStik II Conductivity meter (°C) and the Hach Portable LDO meter (°F, then later converted to °C).

Total Phosphorus (mg/l), Ammonia as Nitrogen (mg/l), Nitrate plus Nitrite (mg/l) – Water sample collected in a 250 ml bottle, preserved with sulfuric acid, tested with pH paper to ensure pH <2, put on ice, and delivered to the State Laboratory of Hygiene within 24 hours of taking the sample.

Total Suspended Solids (mg/l), Total Dissolved Solids (mg/l) – Water sample collected in quart bottle, put on ice, and delivered to the State Laboratory of Hygiene within 24 hours of taking the sample.

Fecal Coliform, E. coli (colonies/100ml) – water sample collected in 125 ml bottle (sealed by lab), put on ice, and delivered to the State Laboratory of Hygiene within 24 hours of taking the sample.

Chloride (mg/l), Sulfate (mg/l) - water sample collected in quart bottle, put on ice, and delivered to the State Laboratory of Hygiene within 24 hours of taking sample.

Total Phosphorus in Sediment (mg/kg) – sediment sample collected in 250 ml bottle, put on ice, and delivered to the State Laboratory of Hygiene within 24 hours of taking sample.

Results

The majority of sampling parameters and associated results are contained in the Hey and Associates, Inc. report. Parameters not covered in the Hey and Associates report are covered below. (The Hey report, page 9, states that Total Dissolved Solids was not measured. However, there was one sample taken on July 28, 2009.)

There was one small storm event sampled on October 22-23, 2009. Hey and Associates presented these results in tables in their report. These tables include 2 columns at the end of the table that both are labeled for October 23. It is important to note that the 1st column contains results from the morning sampling, and the 2nd column has results from the afternoon sampling.

Water Level and Flow

The water level at Site B was recorded on every sampling date (Table 2). It ranged from 0.26 feet to 0.54 feet – a difference of only 0.28 feet, or 3.4 inches.

Table 2. Water Level (ft) Measurements at Site B (all readings taken in 2009)

5/19	**6/2**	**6/8**	**6/16**	**6/28**	**7/10**	**7/22**	**7/28**	**8/11**	**8/19**	**8/27**	**10/1**	**10/6**	**10/22**	**10/23 am**	**10/23 pm**
0.52	0.47	0.54	0.44	0.44	0.36	0.44	0.35	0.39	0.34	0.26	0.35	0.37	0.38	0.56	0.55

It should be noted that the 2.14 inch rain event in October did not produce a large rise in water level at Site B, upstream of the Cedar Lane road culvert. Given the size of the watershed, it would have been expected that a 2.14 inch rain event would have caused there to be more water at the discharge of the stream. This means that much of the rainwater infiltrated into the ground.

The water flow in cubic feet per second was also recorded (Table 3).

Table 3. Water Flow (cfs) Measurements at Site B (all readings taken in 2009)

5/5	**5/19**	**6/2**	**6/8**	**6/28**	**7/28**	**11/13**
0.21	0.34	0.42	0.5	0.25	0.14	0.46

Ammonia Nitrogen

In the Hey and Associates report (page 8), Table 7 containing the ammonia results did not include a comment from the State Laboratory of Hygiene:

- On June 26, 2009, the AE and AS lab test had the quality control compromised. Therefore, these results may not be definitive.

Chloride

Chloride can be an indication of pollution because it is not common in Wisconsin soils or rocks, except in areas with limestone deposits. Jefferson County is located in an area of the state that contains higher concentrations (>10 mg/l) of chloride than in other areas. Sources of chloride are animal waste, potash fertilizer, septic systems, water softening salt, and road salt. Roads in the watershed (Hwy S and Cedar Lane) receive road salt in the winter. Chloride can inhibit plant growth, impair reproduction, and negatively impact the diversity of the in-stream organisms.

On July 28, 2009, the chloride concentration of the water upstream of the Cedar Lane road culvert (site B) was 70.1 mg/l. This amount is well below the U.S. Environmental Protection Agency recommendation for aquatic life which is a 4-day average chloride concentration of 230 mg/l occurring once every 3 years; and the USEPA secondary maximum contaminant level fo 250 mg/l for chloride in drinking water (Mullaney 2009).

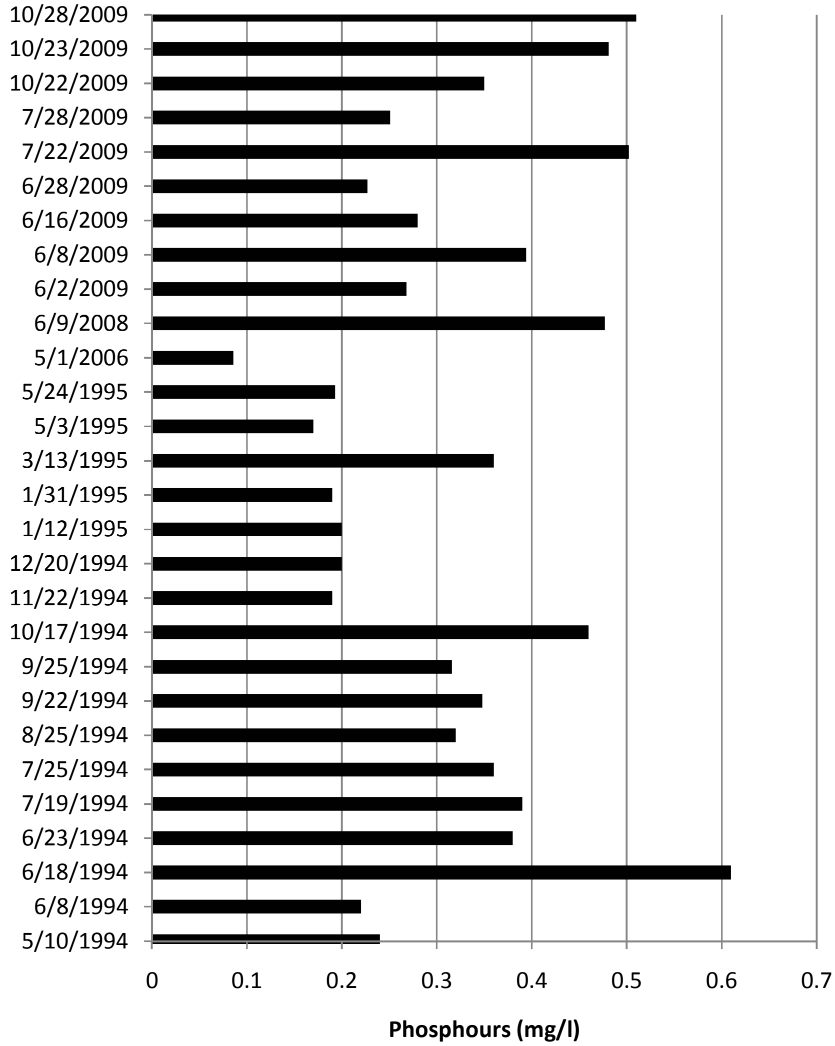
Phosphorus

It should be noted that Rock Lake has been shown to be phosphorus limited because the nitrogen to phosphorus ratio is approximately 55:1 (Marshall 1997). Lakes are phosphorus limited as long as the nitrogetn to phosphorus ratio exceeds 15:1.

The Hey and Associates report notes that three phosphorus samples (taken from site G and H) were above the statewide maximum levels of phosphorus in Wisconsin streams. On both occasions when water samples were taken from site G and H, the water was stagnant.

Phosphorus sampling in the stream upstream of the Cedar Lane culvert was performed in the past, mainly as part of the research for the Rock Lake Priority Lake project. Chart 1 shows the variation of total phosphorus measurements over time that ranges from 0.086 mg/l to 0.61 mg/l (within the range of statewide min/max values) and has an average value of 0.32 mg/l (greater than the statewide mean).

Chart 1. Total Phosphorus Data Available from Ditch Upstream of Cedar Lane Road Culvert



Sediment Phosphorus

On May 19, 2009, a sediment sample was taken upstream of the Cedar Lane road culvert (site B). The phosphorus concentration in the sediment was measured to be 1,410 mg/kg. This value is used below to estimate the annual phosphorus delivery from sediment delivered as bed load (see Table 10).

Sulfate

Sulfate is not an indication of pollution. Sulfate concentrations in water are associated with minerals found in the land and acid rain. Jefferson County is located in an area of the state that contains concentrations of sulfate >40 mg/l.

On July 28, 2009, the sulfate concentration of the water upstream of the Cedar Lane road culvert (site B) was 54.7 mg/l. However, the State Laboratory of Hygiene noted that the result is not definitive because a cooler in their facility lost power and the standard temperature was not maintained.

Total Dissolved Solids

On July 28, 2009, the total dissolved solids of the water upstream of the Cedar Lane road culvert (site B) was 566 mg/l.

Transparency

Transparency is a measure of water clarity. Materials suspended and dissolved in the water will impact the clarity of the water. The results from the sampling in the ditch are presented in Table 4.

Table 4. Transparency (cm) Measurements (all dates were in 2009)

Site	**5/5**	**5/19**	**6/2**	**6/8**	**6/16**	**6/28**	**7/22**	**7/28**	**8/11**	**10/22**	**10/23 am**	**10/23 pm**
B	110	120	77.6	66.4	87.6	115	ND*	77	42.8	67.8	45	35.4
AE		120	107		49.5	73	55.5			113.8	>120	
AS			>120		>120	>120	>120				>120	
G			>120		63							
H			>120		91.6							

*An accurate reading was not obtained.

Table 5. Median and Average Transparency (cm) for Wisconsin (Robertson 2006) and the Ditch

Month	**WI Median Transparency**	**Ditch Median Transparency***	**WI Average Transparency**	**Ditch Average Transparency***
May	105.0	120	89.8	116.7
June	88.5	107	79.6	96.7
July	90.0	77	82.9	84.2
August	>120	42.8	92.9	42.8
October	>120	90.8	107.9	83.7

*Transparencies that were >120 were assumed to be 120 for the median and mean calculations.

Table 5 shows the Wisconsin median and average transparency of streams and the data from the ditch (please note that in some months, the data from the ditch is limited). In May and June, the ditch transparency was greater than the average and median transparency of streams throughout WI. In July, the ditch transparency was close to WI stream norms. In August, the ditch transparency was much lower than the WI stream norms (based on one sample). For October, the median and average transparencies in the ditch were less than the WI stream norms. However, it should be noted that the October data was during a storm event, and transparencies decrease because more sediment is carried during storm events. The State minimum transparency for streams is 23.5 cm.

Storm Sampling

On October 22 and 23, 2009, a small storm event was sampled. The storm event produced 2.14 inches of rain (as measured from a volunteer's rain gauge). Total rain amounts were measured as follows:

10-22-09, 1:30 pm = 0.71 inches of total rain
10-23-09, 7:00 am = 1.82 inches of total rain
10-23-09, 4:00 pm = 2.14 inches of total rain

Measurements taken during the storm event at Site B are contained in Table 6 and 7.

Table 6. Water quality measurements at Site B during a storm event

Site B	Water Level (ft)	Temp (C)	Clarity (cm)	Conduc-tivity (uS/cm)	D.O. (mg/l)	Total P (mg/l)	Ammonia (mg/l)	Nitrate + Nitrite (mg/l)	TSS (mg/l)
10/22 10:50am	0.38	8.8	67.8	1052	8.2	0.35	0.032	2.83	34
10/23 9:50 am	0.56	9.2	45	1069	7.8	0.481	0.09	5.09	80
10/23 2:00 pm	0.55	10.3	35.4	1054	7.3	0.51	0.095	6.06	114

Table 7. Bacteria measurements at Site B during a storm event

Site B	E-coli (colonies/100 ml)	Fecal Coliform (colonies/100 ml)
10/22 10:50am	230	310
10/23 9:50 am	550	450
10/23 2 pm	350	320

The following can be said about the results:

- Conductivity levels suggest that the stream flow consists of mostly groundwater. Therefore, much of the rainfall during this event was mainly infiltrated through the ground and not delivered as runoff.
- The water level did not increase very much during the storm given the size of the watershed. Therefore, much of the rainfall is infiltrating into the ground instead of being delivered to the stream via surface runoff.
- Sediment delivery increases with increased flow. Because the flow is mostly groundwater, it is probably the case that the sediment in the stream originates in the channel of the stream.
- Bacteria levels increased with flow and then decreased again when the flow decreased.

Results Summary

A number of conclusions can be made from the results of the water quality sampling.

- Both temperature and conductivity results indicate that the water during the sampling days consisted primarily of ground water. This is not surprising since there was not much rain during the sampling period (May through October 2009).
- Ammonia results suggest that agricultural fertilizer runoff was not a major pollutant during the sampling period (May through October 2009).
- Total phosphorus concentrations in the stream are high compared to the statewide means.
- Nitrate plus nitrite concentrations are high compared to state statewide means. However, they are much less than the State maximum for streams (20.55 mg/l) and also less than the State and Federal public drinking water maximum of 10 mg/l.

Bacteria Sampling

One of the goals of the grant project was to discover the source of e-coli and fecal coliform bacteria. The sampling that was planned and implemented did not result in identifying the source. This is because the bacteria levels were very variable at all of the sampling points and therefore did not indicate a possible pollutant location. Possible bacteria sources could be one or more of the following: leakage from septic systems into the groundwater, leakage from a manure storage into the groundwater, contaminated sediment from previous runoff events from agricultural fields spread with animal waste, contributions of bacteria associated with organic wetland soils, and wildlife in the area.

The one manure storage structure in the watershed was properly closed in early December 2009. The storage had a concrete floor and clay side-walls. A Natural Resources Conservation Service engineer designed and inspected the closure which consisted of removing any remaining manure, breaking up the concrete floor, removing all contaminated soils, and filling the hole with clean fill. Therefore, if this storage was a source, then it will no longer be a source in the future.

During sampling events, there were several sightings and evidence of wildlife in the area. These include deer, waterfowl, and groundhogs.

A Jefferson County Health Department official cautioned about comparing bacteria levels from the stream to the levels set for beach advisories and closures. The reason for this caution is that the stream is only a couple inches deep, where as the beach samples are taken in a foot of water. Therefore, the sampling situations are different and the results should not be compared.

LWCD staff had a discussion with Sharon Kluender from the State Lab of Hygiene about bacteria and tests that could reveal a source of bacteria. She suggested a series of tests that could possibly help with source testing (human vs animal) that include: antibiotics, bacteriodes spp., bifidobacteria, hormones, pharmaceuticals/personal care products, rhodococcus coprophilus, sterols, and male specific RNA coliphage. She recommended that these tests should be done together (instead of picking a subset). Again, she was quick to point out that the testing could be implemented, and there could still be uncertainty in the results.

LWCD staff sent questions to Dr. Sandra McLellen about the bacteria data and future sampling on January 21, 2009. A response from her was not received prior to finalizing this report.

Habitat Sampling

On August 21, 2009, UHI and the LWCD surveyed the stream for fish and aquatic insects. Because of the shallow stream depth and very narrow channel, dip nets were used instead of electroshocking gear or seines. Six sites along the length of the stream were sampled (see Map 3).

No fish were found at any of the sites. In terms of the insects, amphipods were the dominant organism. Water striders were also present.

The amphipod's (also called scud – *Gammarus psuedolimneus*) body shape and side-swimming behavior enables it to not be washed downstream in currents. It eats decaying plants and animals. Amphipods are semi-tolerant of pollutants and their presence often indicate the presence of ground water.

Water striders live on the water surface and therefore breathe from the atmosphere instead of the water as do most fish, crustaceans and other aquatic insects. They can walk on water and they eat plants and insects. Water striders are not water quality indicators because they are air breathers and will not be effected by pollutants that lower dissolved oxygen in the water.

Stream Channel and Sediment Survey

On August 21, 2009, UHI and LWCD surveyed the stream bottom at six locations along the length of the stream (Map 3). Characteristics found at each sampling point are recorded in Table 8. Sediment depths along the channel profile were also measured at site 5 and 6 (Charts 2, 3). During the survey (and on other sampling days) the dark peat (or muck) sediment was observed flowing above the bottom of the stream (bed load). The dark peat/muck sediment is characteristic of wetland soils, such as Houghton muck which is the wetland soil surrounding the stream/ditch.

Given the sediment profiles (Charts 2, 3), an estimate of sediment that is located in the stream channel and has the potential to be delivered downstream during storm events can be determined. Based on field observations, an estimate was made as to the length of stream that contains sediment in the bottom of the channel. The estimated amount of sediment in the stream channel is 9,200 cubic yards.

Table 8. Stream Channel Characteristics

Site	Substrate	Channel Width (ft)	Average water Depth (ft)	Comments
1	Sand	3'	0.25	
2	Gravel, rubble	4'	0.25	
3	Mostly muck	4'	0.33	Bank erosion
4	~1" muck over sand	2.5'	0.25	Bank erosion
5	Muck	11'		Dredge spoils on west bank, eroding and poorly vegetated
6	Muck	15'	0.33	Heavily shaded with eroding banks

Field observations indicate that the section of the ditch that contains the most sediment in its channel is located upstream of Site 4, where the stream makes a 90 degree turn to run north-south (Map 3).

It is important to note that the observations on August 21, 2009 are different than the observations made by Hey and Associates on November 13, 2009 in terms of stream channel substrate. The differences are in Reach 1 and 2. In August, the channel substrate was characterized by sand and an area with gravel and rubble. In November, the channel substrate was characterized by peat (muck). This highlights the dynamic nature of this stream and again the sediment flow occurring in the stream.

Chart 2. Sediment Depths at Site 5 (see Map 3)

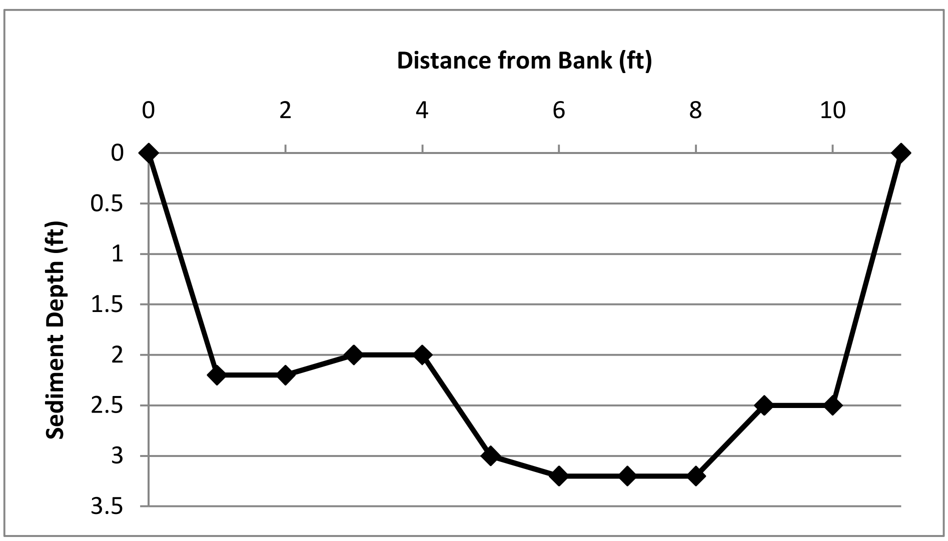
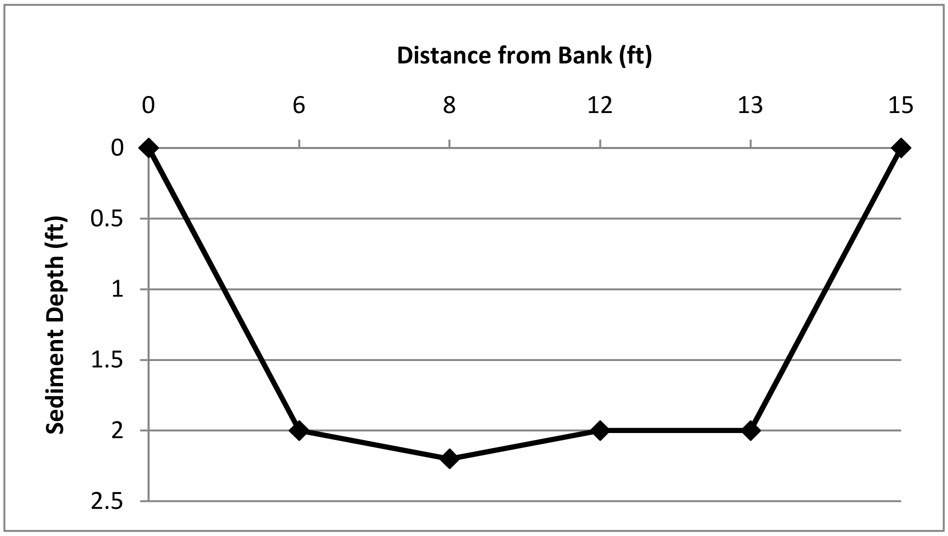


Chart 3. Sediment Depths at Site 6 (see Map 3)



Sediment and Phosphorus Loading

The Wisconsin Lake Modeling Suite (WiLMS) is a model that can estimate phosphorus loading rates from the stream. The results from the WiLMS model with current land uses are in Table 9. It is the case that the WiLMS model is conservative when it comes to estimating phosphorus loading from wetland areas. Because of the presence of a wetland soil (Houghton muck) along the ditch, it is possible that the area surrounding the ditch contain wetlands.

Table 9. Estimated Annual Phosphorus Loading from the Stream

	Low	**Most Likely**	**High**
Phosphorus Loading (lb/yr)	37.5	79.3	146.7

Table 10 reports the various estimates of sediment and phosphorus loading from the stream. What is important to note is that sediment and phosphorus delivery is occurring from the stream to the dredged channel, and the amount of loading to the channel has been identified as a problem impacting the channel and probably the lake area near the channel outlet.

Table 10. Estimates of Sediment and Phosphorus Loading

	WINHUSLE 1995	**WiLMS 2009**	**Bed Load 2009**
Estimated Sediment (tons/yr)	41		11.8
Estimated Phosphorus (lbs/yr)	262	37.5 - 146.7	33.3*

*The phosphorus loading was calculated given the sediment load delivery and the analysis of the amount of phosphorus contained in the sediment (1,410 mg/kg).

Potential Management Alternatives

The Hey and Associates, Inc. report includes an overview of several management alternatives. Below are a few comments and additional information about the practices.

Stream Bank Stabilization

A review of historic aerial photographs (1957, 1963, 1996, 2000, and 2004) indicates that the stream is not widening or meandering. Therefore, bendway weirs and stream barbs can be ruled out as possible management practices.

Rock riffles are another practice that can be ruled out because the stream does not have a steep grade and because of the nature of the soils in the stream. The wetland soils (peat/muck) in the stream are fine would probably just cover the rocks placed in the stream.

Though bank erosion is a concern for this system, it is the opinion of the LWCD that the bank erosion is not severe enough to warrant stone toe protection (also called "riprap").

Willow posts, vegetation, and stone toe protection could all address erosion happening on the bank of the stream/ditch. It is important to note that these practices will not address the sediment that is present on the bottom of the ditch channel.

Ditch Plugs

The Wisconsin Wetland Association's Wetland Restoration Handbook for Wisconsin Landowners states that the recommendation is to "plug at least 150 feet of ditch" (Thompson 2004). Hey and Associates, Inc. has interpreted this to mean a ditch plug every 150 feet of ditch for the entire 4,000 feet of ditch, amounting to 25-30 ditch plugs. The LWCD contacted a Natural Resources Conservation Service (NRCS) engineer who stated that ditch plugs are installed to fill in 150 feet of the ditch in order to ensure that the plugs are not eroded by the water flow and the water flow does not move around the side of the ditch plug. After given the information on the stream in question, the NRCS engineer stated that the system would most likely need 3-4 ditch plugs, each filling in 150 feet of ditch.

Field observations indicate that the majority of the stored sediment in the ditch is located upstream of Site 4 (Map 4). So, perhaps ditch plugs are not necessary downstream of Site 4 (amounting to roughly 1,500 feet of stream).

The NRCS engineer also noted that steps should be taken to make sure adjacent landowners are not impacted by the backed-up surface water and groundwater which can rise in elevation once the ditch plugs are installed.

Wetland Restoration

It should be noted that the information in Table 13 of the Hey and Associates, Inc. report (Typical Pollutant Removal Rates of Wetlands) should contain some caveats. The publication that is the source of the Table 13 information (Winer 2000) states that the figures are based on very limited data. In some instances, the percent removal of certain pollutants was based on fewer than 5 data points. The Winer publication also explains that the data in the table is based on ideal conditions and within the first 3 years of the practice installation. Long term pollutant removal rates are also not known. Therefore, the pollutant removal values in Table 13 of the Hey and Associates report should not be taken as definitive pollutant removal rates for constructed wetlands.

The Hey and Associates report indicates that the size of the Miljala channel watershed would require a constructed wetland to be 5.6 to 9.4 acres in size. To help in visualizing the size of such a wetland, please refer to Map 4.

Sedimentation Basin

The Hey and Associates report points out that forebays to capture coarse sediments are often added to wet detention ponds to reduce maintenance costs. Field observations do not indicate the presence of coarse sediments. Therefore, a forebay may not be applicable to the stream in question.

The Hey and Associates report comments that a detention pond for the size of the stream's watershed would be 2-3 acres in size. To help in visualizing the size of 2 and 3 acres, please refer to Map 4.

Conclusions and Recommendations

Underwater Habitat Investigations, Land and Water Conservation Department, Hey and Associates, Inc., and the Rock Lake Improvement Association are all in agreement that a solution should be identified and implemented to control the sediment, nutrients, and bacteria being delivered from the ditch to the Miljala channel.

Source of Sediment and Phosphorus

Underwater Habitat Investigations, Land and Water Conservation Department, and Hey and Associates all agree that the "source" of sediment is the sediment that is contained in the bottom and sides of the stream/ditch. Based on channel profiles of the sediment, the estimated amount of sediment sitting in and along the stream is 9,200 cubic yards. Based on a bed load sample, the estimated annual load of sediment is 23,652 pounds/year. Storm events will increase the sediment and nutrient delivery of the stream which is evidenced in the one storm event sampled and the sediment deposited in the Miljala channel during the record-setting precipitation events between Fall 2007 and Spring 2008.

Prior to starting this grant project, it was known that the sediment delivery to the channel was a problem because of the continued necessity to dredge the channel. This project has revealed the source of the sediment which will continue to be delivered to the channel as bed load and during storm events. Given the estimates of the sediment loading in the stream, it may not be necessary to perform additional sampling to estimate the amount of sediment loading.

Source of Bacteria

Bacteria levels in the stream have been variable. The source of the bacteria still remains a mystery. The LWCD recommends that the following questions be answered before choosing to initiate additional sampling:

- Given the mix of possible sources in the watershed, how definitive will RNA testing be? Would a series of bacteria testing (RNA, antibiotics, bacteriodes spp., bifidobacteria, hormones, pharmaceuticals/personal care products, rhodococcus coprophilus, and sterols) be more definitive?
- What is the sampling protocol, and the costs, for the recommended test(s)? For instance, how many samples and how many sampling points?
- Can the source of bacteria actually be contained in the sediments found in the stream channel?
- Can processes in adjacent wetlands and associated groundwater flow be a source of the bacteria?
- Will practices to control sediment in the stream work to control bacteria?

The LWCD sent these questions to Dr. Sandra McLellan, with the Great Lake WATER Institute in Milwaukee, and will forward the answers to the RLIA and DNR when they are received.

Work could be done to rule out one of the possible source of bacteria: septic systems. The majority of the septic systems in the watershed received permits from the Jefferson County Zoning and Planning Department when their systems were built. These permit holders also report to the Zoning Department when they complete the required pumping every 3 years. There are 2 septic systems in the watershed that pre-date the law that required a construction permit and maintenance. A request could be made to the Zoning Department to ask the owners of these systems if an inspection can be done to insure that the systems are functioning correctly. These inspections would not cost anything to the RLIA and could be performed prior to spending more money on bacteria sampling and analysis.

Possible Alternative

Currently, there is a temporary sediment curtain in the dredged channel of Rock Lake that lies between Shorewood Hills Road and Cedar Lane. Is there a possibility to install a permanent sediment curtain in the channel? Based on the fact that some landowners beside the ditch may not allow access to their land, it might be wise to investigate the feasibility of this practice. A meeting/conversation with the Water Regulations and Zoning Specialist with the Department of Natural Resources would reveal if a long-term sediment curtain could be used in the channel. If the DNR responds that this is an option, then it could be added to the list of possible solutions.

Costs

Based on construction costs alone, the most affordable practices include ditch plugs, streambank stabilization, and sedimentation basins. Estimated maintenance costs are only available for wetland restorations and sedimentation basins. Based on the high costs, the LWCD recommends that no further study be done on the feasibility of alum treatments or sand filters for this watershed.

It is the policy of Jefferson County to solicit written quotations for projects that will cost $5,000 - $25,000 and to obtain competitive bids for projects that will cost greater than $25,000. This policy ensures that the services purchased by the county are the most cost-effective and that tax-payer money is well spent. Perhaps the RLIA should consider adopting a similar policy.

Information Important to Permitting

Dan Hunt (Water Regulations and Zoning Specialist, Department of Natural Resources) was consulted about the designation of the stream. He determined that the stream does not have stream history and is not "navigable" under the Chapter 30 permit process.

Dan Hunt pointed out that there are designated wetlands adjacent to the stream which are regulated under state, federal and county regulations. Designated wetlands are wetlands that were identified by aerial photographs. The vast majority of the soil on either side of the stream is a hydric soil named Houghton Muck. When development or land disturbing activities are proposed near designated wetlands or in hydric soils, it is recommended that a wetland delineation be performed to ensure that the exact locations of wetlands are known.

Recommendations for Next Steps

The RLIA, Hey and Associates, LWCD, and UHI all agree that the sediment, nutrient, and bacteria pollution should be addressed by controlling the source of pollution. The LWCD recommends the following actions and process to achieve this goal.

Landowner and Public Input

During the course of the last few months, some landowners who live along the ditch have voiced their concerns about not being included in the process. In the public-centered and resource-centered work done every day by the Land and Water Conservation Department, the LWCD knows that including effected and interested citizens in the decision-making process is not only vital when making resource decisions, but it also results in a stronger product. Therefore, it is the recommendation of the LWCD that a meeting be held with the landowners to bring them up to date on the current data and possible solutions, and to include them in the decision-making process. This meeting could also accomplish the following:

- Landowners may have important information to add about their land, such as the location of tile drains.
- Landowners could potentially provide input as to the practice(s) that would be acceptable to them and the practice(s) that would not be acceptable to them. This in turn could reduce the costs of the next grant project because if a practice is not acceptable to the landowners, then that practice would not be considered by the next grant project. It is important to note that the practice should not be considered if there are valid reasons given for not wanting the practice on their land.

- If certain landowners decided that they don't want their land to be used for practice placement, then that land would not be included in the wetland delineation or the tile drain survey if they were down stream of the potential practice location. Therefore, there would be additional cost-savings for the next grant project.
- Landowners would be included in the process to identify solutions and therefore would be more willing to have the selected practice installed on their property.

Process for Achieving a Solution to Problems

⇒ Meeting with Affected Landowners, RLIA, LWCD, and Hey and Associates
  - to review information produced in the Hey and Associates report and in this report
  - to help possibly refine the practices that will be considered in the next grant
  - to determine which areas of the ditch will be available for practice installation

⇒ Possible Inspection of Septic Systems by the Jefferson County of Zoning and Planning

⇒ Obtain Additional Information and Make Decision on Bacteria Sampling

⇒ Write a Request for Proposal to Engineering Firms to complete the following:
  - Draft Lake Planning grant application
  - Determine 2-3 conceptual practice options (including conceptual drawings showing practices in potential locations in watershed) based on current data, watershed/ditch characteristics, and potential to receive permits through conversations with the DNR
  - Meeting with stakeholders (RLIA, LWCD, affected landowners, interested citizens) to present conceptual options and to help determine chosen practice(s)
  - Choose practice(s) with project leaders
  - Perform necessary surveys (tile drains, wetland delineation) at the potential sites where practice(s) could be installed
  - Produce engineering designs for chosen practice(s) (It might be possible that an engineer from NRCS or the State Department of Agriculture could provide this service free of charge.)
  - Produce a report that includes the engineering designs, review of public input & acceptance by affected landowners, and fiscal estimates for implementing the chosen practice
  - Present final design to all stakeholders
  - After approval of design and reports, obtain any necessary easements and permits
  - Draft Lake Protection grant application for implementation

⇒ Choose an Engineering Firm to Complete Project and Write Necessary Lake Planning Grant Application(s)

⇒ Review and Submit Lake Planning Grant Applications (August 1, 2010)

⇒ Hire Engineering Firm to Complete Project

⇒ Submit Project Results to DNR for Review, Obtain Easements, and Obtain Permits

⇒ Write a Request for Proposal for Construction and Inspection of the Project (If a State Department of Agriculture or NRCS engineer designs the project, they could inspect the installation free of charge)

⇒ Choose a Contractor to Construct Project

⇒ Review and Submit Lake Protection Grant Application (May 1, 2011) for Implementation

⇒ Implement Management Practice in 2011

References

R.A. Smith and Associates, Inc. 1995. Rock Lake Planning Grant Study. Rock Lake Improvement Association.

Robertson, D.M., Graczyk, D.J., Garrison, P.J., Wang, L., LaLiberte, G., and Bannerman, R. 2006. Nutrient Concentrations and their Relations to the Biotic Integrity of Wadeable Streams in Wisconsin. U.S. Geological Survey Professional Paper 1722. Madison, WI.

Marshall, Dave. 1997. Rock Lake Priority Lake Project Water Resources Appraisal. Wisconsin Department of Natural Resources.

Mullaney, J.R., Lorenz, D.L., and Arntson, A.D. 2009. Chloride in Groundwater and Surface Water in Areas Underlain by the Glacial Aquifer System, Northern United States. U.S. Geological Survey Scientific Investigations Report 2009-5086.

Thompson, A.L., and Luthin, C.S. 2004. Wisconsin Wetland Association's Wetland Restoration Handbook for Wisconsin Landowners, 2nd Edition. Wisconsin Wetland Association. Madison, WI.

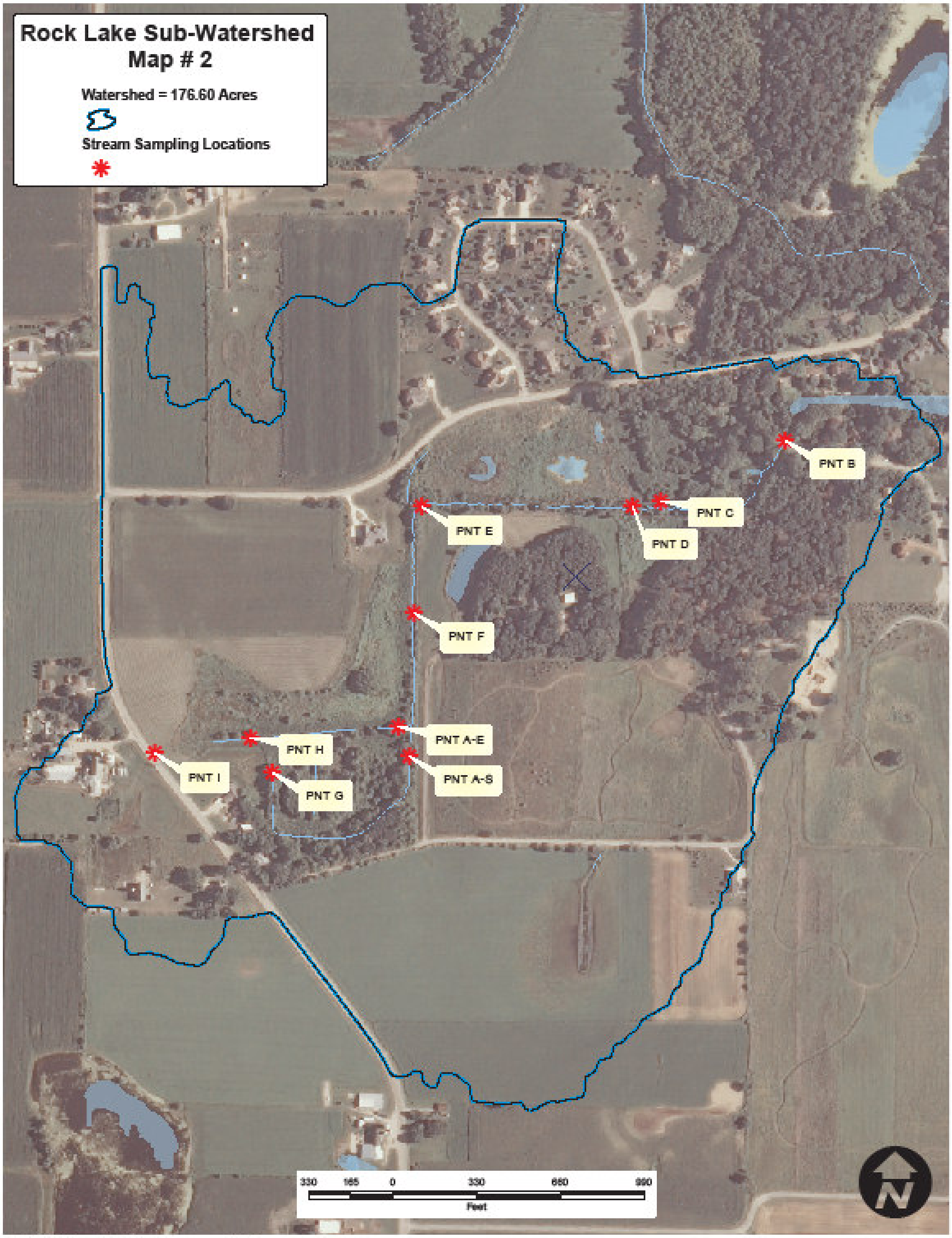
Winer, R. 2000. National Pollutant Removal Database for Stormwater Treatment Practices, 2nd Edition. Center for Watershed Protection. Ellicott City, MD.

Note

This report was written with comments on the draft from Underwater Habitat Investigations, the Department of Natural Resources, and a member of the Rock Lake Improvement Association Board.

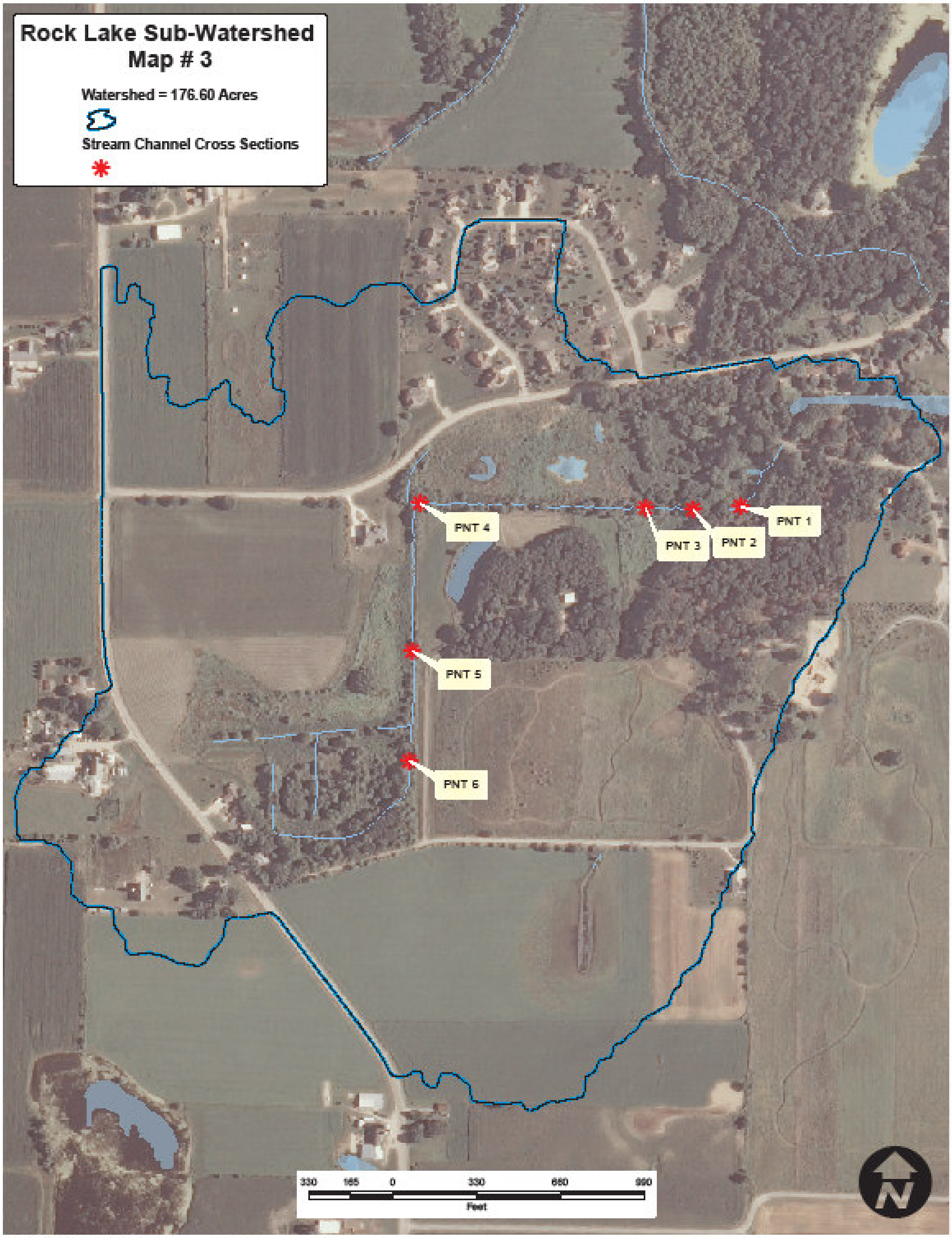
Aerial Photos Taken Summer 2008

Compiled by the Jefferson County Land & Water Conservation Department



Aerial Photos Taken Summer 2008

Compiled by the Jefferson County Land & Water Conservation Department



Aerial Photos Taken Summer 2008

Compiled by the Jefferson County Land & Water Conservation Department


Rock Lake Sub-Watershed
Map # 4
Watershed = 176.60 Acres
= 9 acres
= 5 acres
= 3 acres
= 2 acres
= 1 acres
330 165 0 330 660 990
Feet
Aerial Photos Taken Summer 2008
Compiled by the Jefferson County Land & Water Conservation Department