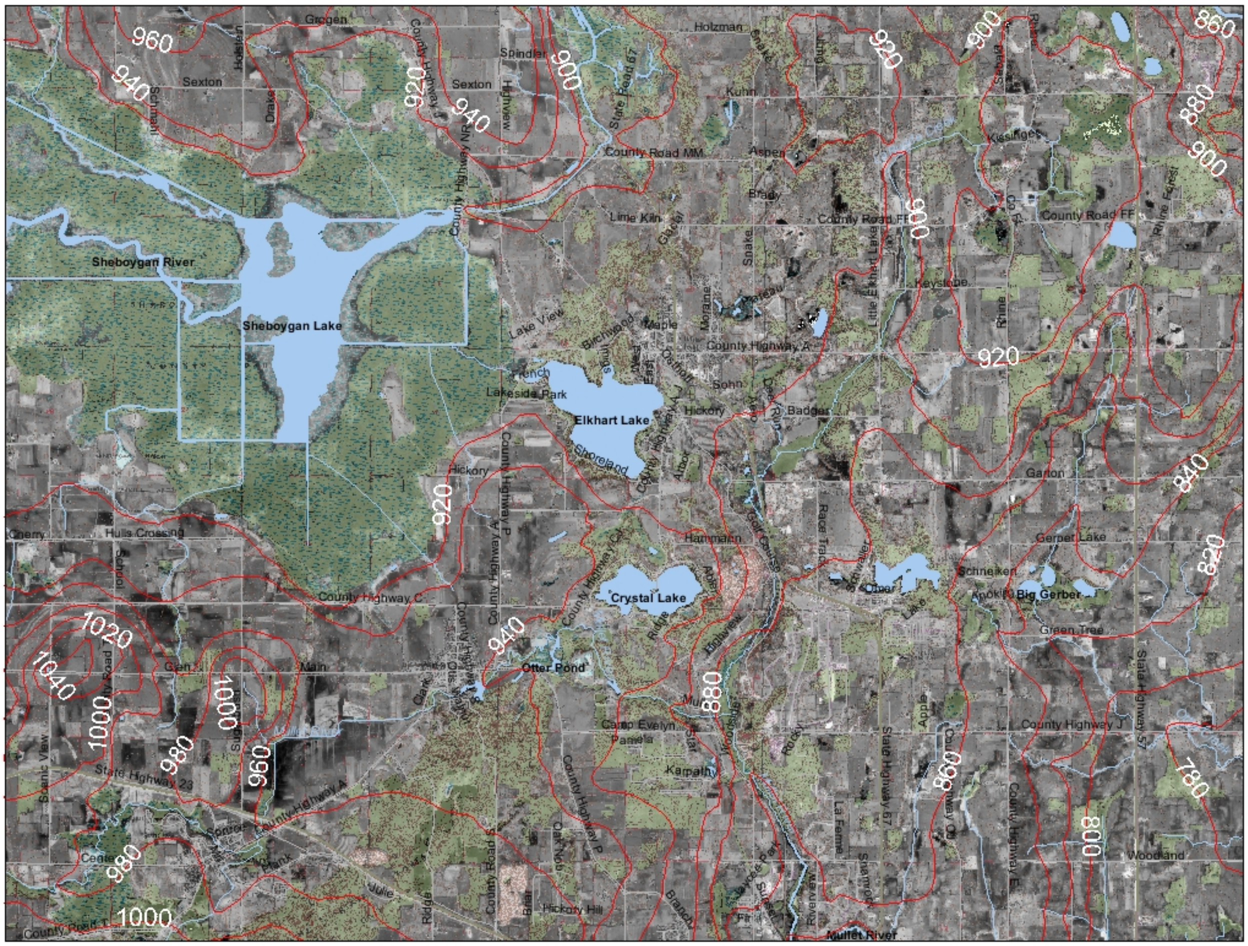
Hey and Associates, Inc.

GROUNDWATER MAPPING AND MONITORING REPORT
ELKHART LAKE
SHEBOYGAN COUNTY, WISCONSIN



Prepared for:

Elkhart Lake Improvement Association

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INTRODUCTION

Elkhart Lake is 286 acre glacial lake located in northwestern Sheboygan County. Table 1 outlines the general physical characteristics of the lake.

TABLE 1
Physical Characteristics of Elkhart Lake

Parameter	Value
Area of Lake	286 acres
Lake Volume	13,088 acre-feet
Maximum Depth	119 feet
Shoreline Length	3.74 miles
Watershed Size	1,536 acres
Residence Time	5.9 years

Source: WDNR and UWM

While Elkhart is relatively small lake as compared to many other lakes in Southeastern Wisconsin, it is the largest lake in Sheboygan County and one of the deepest in Wisconsin (Figure 1). Only two southern Wisconsin lakes, Geneva Lake in Walworth County and Big Green Lake in Green Lake County are deeper in depth.

The water quality of Elkhart Lake was the focus of two multi year study by the University of Wisconsin-Milwaukee Great Lakes Water Institute from 1993 through 2000. The results of the studies show Elkhart Lake to have some the clearest water clarity of lakes in Wisconsin. Figure 2 illustrates the water clarity of the lake as measured by a Secchi disc, a device used to measure the depth of light penetration. As we see Elkhart Lake is typically far clearer than the statewide mean of 2.3 meter, and ranges from 1.75 meters (5.75 feet) to 9.5 meters (31 feet).

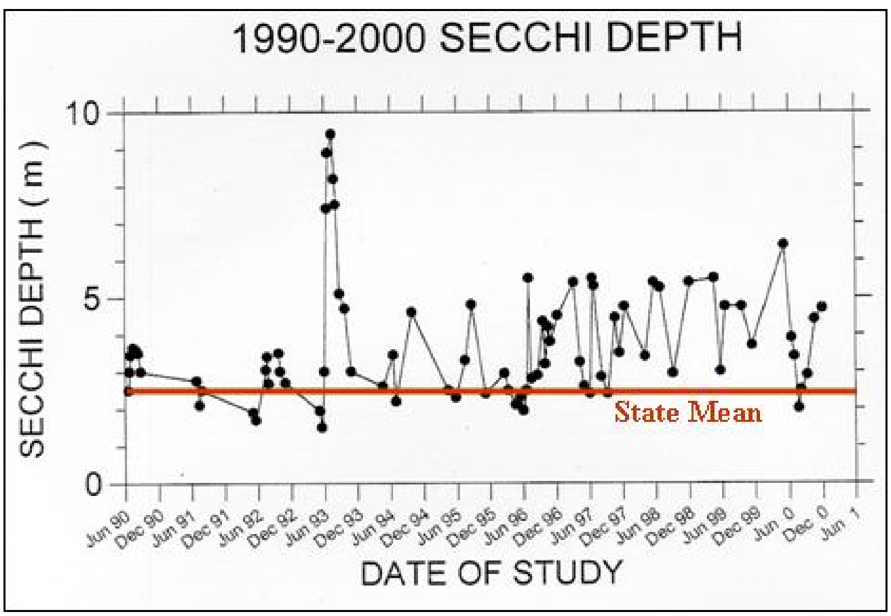


FIGURE 2
Water Clarity Elkhart Lake 1990 to 2000
(Source: Great Lakes Water Institute)

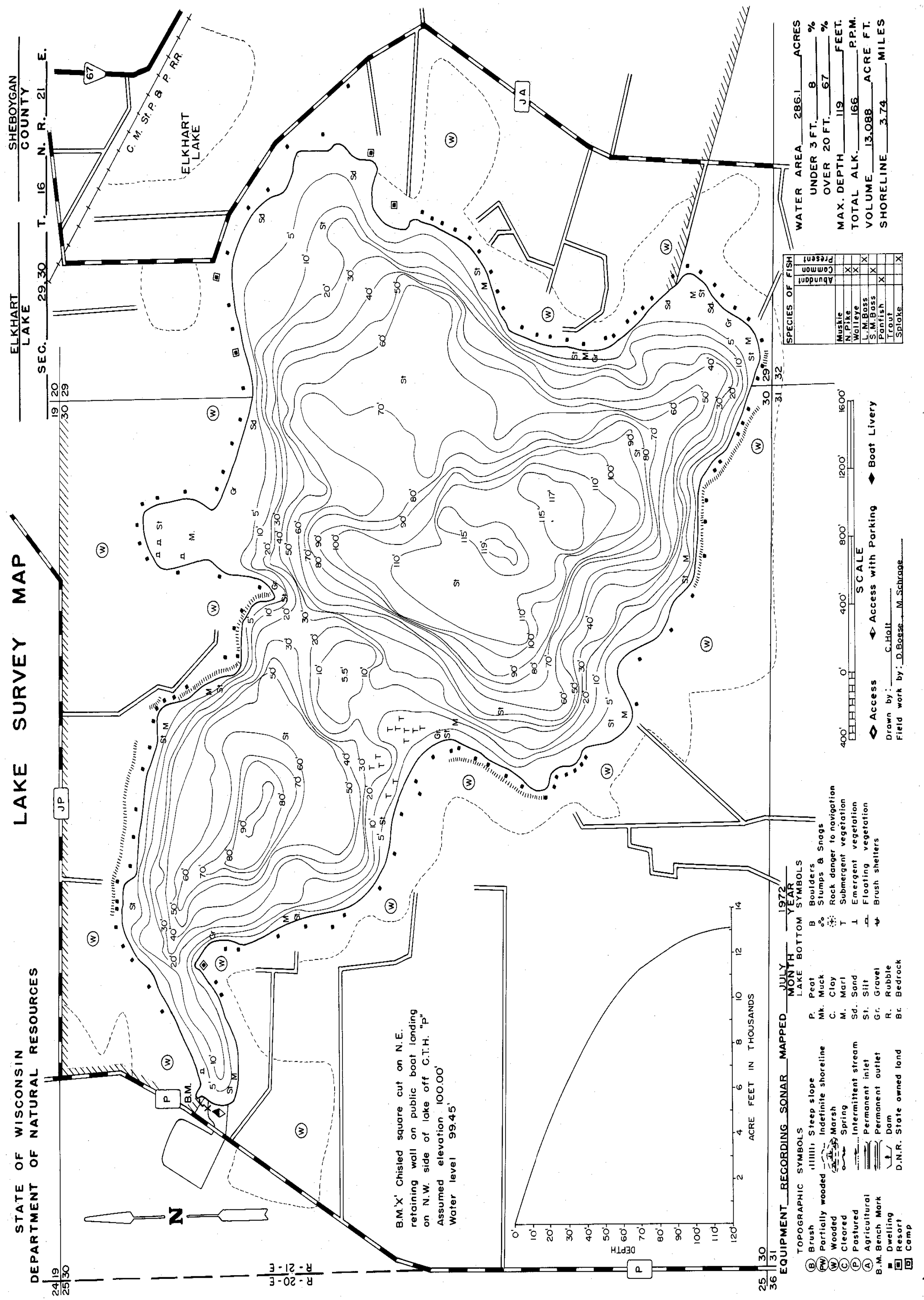


FIGURE 1

Elkhart Lake Bathometric Map

Elkhart Lake is a natural groundwater seepage lake. The lake was formed by glaciers approximately 10,000 to 15,000 years ago as a large ice block left in the glacial till melted leaving a deep depression in the earth. The soils around the lake are predominantly sand and gravel that easily transmit water movement. The Great Lakes Water Institute study estimated that 71 percent of the water that inflows to Elkhart Lake enters in the form of ground.

Elkhart Lake has a relatively long residence time of 5.9 years. Residence time is how often the complete volume of the lake is replaces with new incoming water. The following are some typical residence times for some familiar lakes in Southeastern Wisconsin:

▪ Elkhart Lake (Sheboygan Co.)	5.9 years
▪ Lake (Racine Co.)	0.5 years
▪ Nagawicka (Waukesha Co.)	1.7 years
▪ Delavan Lake (Walworth Co.)	1.8 years

Lakes with short residence times tend to recover rapidly after a pollution input as new fresh water can flush the pollutants out of the system. Lakes with long residence times tend to retain pollutants and recover slowly after the inputs of contaminants. Lakes with long residence times are more sensitive to pollutants that do not break down over time such as phosphorus, heavy metals, and salts such as chlorides.

Phosphorus and nitrogen are nutrients that stimulate plant growth and have been a concern at Elkhart Lake. Today Elkhart Lake receives relatively low total phosphorus loadings ranging from 10 to 26 $mmol/m^2$, and dissolved nitrate loadings that range from 0 to 1400 $mmol/m^2$ (UWM, 2001). However, monitoring shows that increases in nutrient levels can stimulate more rooted plant growth and algae blooms. Figure 3 illustrates the major sources of total phosphorus to Elkhart Lake. As we see sediments, which contain the build-up of material over many centuries, are the larges sources of phosphorus, the second largest sources are groundwater and septic systems.

Sources of groundwater contamination can include the following:

- Malfunctioning septic systems
- Leaking sanitary sewer
- Back-flush water from water softeners
- Runoff from feedlots
- Storage of animal waste (manure)
- Application of commercial fertilizers
- Chemical spills

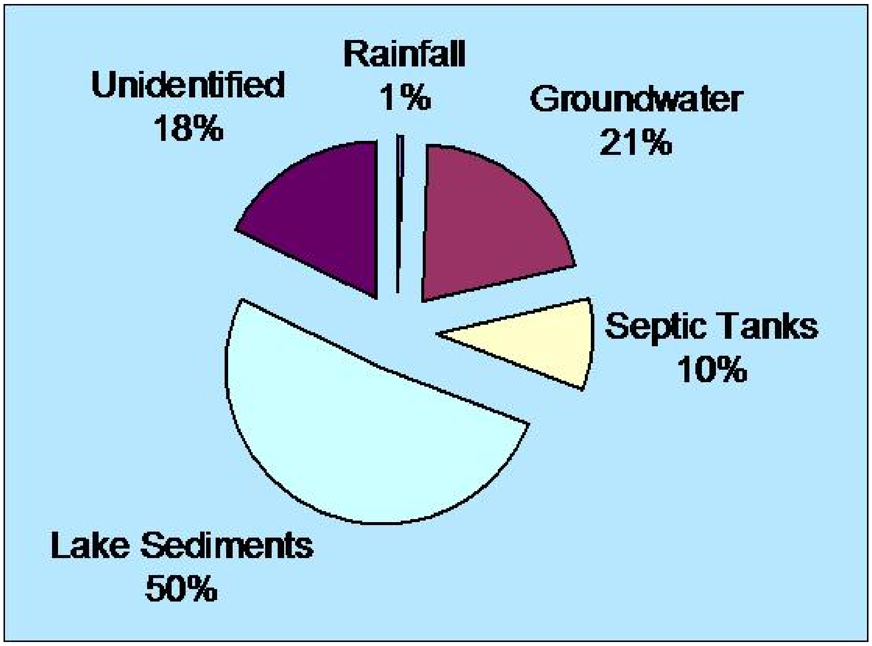


FIGURE 3
Total Phosphorus Sources to Elkhart Lake
(Source: Great Lakes Water Institute)

As outlined above Elkhart Lake has outstanding water quality and as a unique resources that needs to be protected. However, with the lakes long residence time the lake is very sensitive to any pollutant sources. Also, discussed above, groundwater is the major source of water input to the lake and one of the largest sources phosphorus to the system. The Elkhart Lake Improvement Association (ELIA) has always maintained a long-term goal of protecting Elkhart Lake. As a follow up to the University of Wisconsin- Milwaukee Great Lakes Water Institute studies ELIA decided to conduct additional groundwater monitoring to help identify sources of potential groundwater pollution.

PROJECT GOALS AND OBJECTIVES

The goal of this lake planning grant project is to lay the foundation for the preparation of a long-term groundwater protection plan. The objectives were to begin compiling information on groundwater flow patterns and water chemistry. The work was broken down into the following three components:

- Mapping of the groundwater recharge areas to Elkhart Lake
- Sampling to determine if groundwater contamination from local septic systems is a problem
- Conducting a series of public education program on how residents can participate in protecting groundwater around Elkhart Lake.

METHODS

Mapping of Groundwater Recharge Areas

Elkhart Lake is located in an area of complex glacial terrain made up of glacial moraines, knolls, and glacial outwash features. The groundwater systems of Crystal Lake, Elkhart Lake and the Sheboygan Marsh are inter-connected. Currently no mapping of the groundwatershed of Elkhart Lake exists. As part of this project, a groundwatershed map of the glacial till surface aquifer was produced.

The groundwatershed map was generated from a map of the water table in the areas of Crystal and Elkhart Lakes. Well log information from private wells was be used to map the surface water table. Well logs were obtained from the Wisconsin Geological and Natural History Survey. The well logs, submitted by local well drillers, show the depth of the well, soil material the well was drilled into, and depth from the surface to the water table. Topographic maps from the U. S. Geological Survey (USGS) were used to identify the surface elevations of the wells. Digital versions of the USGS maps of the study area were used as the base for the mapping effort. All mapping was done in a GIS software, ARCView®. Work for this element was conducted by work-study students under the guidance of Dr. Maureen Muldoon at the University of Wisconsin--Oshkosh, Geology Department. The work product from this effort is a map showing groundwater elevations, arrows showing the directions of groundwater flow, and areas of groundwater recharge that should be protected as part of the Smart Growth Planning.

Sampling to Determine Groundwater Contamination

The Elkhart Lake Improvement Association is concerned about protecting both the quality of Elkhart Lake and the drinking water of the lake area. Most residents on the lake receive their drinking water from shallow wells and treat their waste with septic systems. To determine existing groundwater contamination, the planning grant project will conduct two types of groundwater sampling. The first will be a volunteer sampling program of private wells; the second will be sampling of a series of shallow monitoring wells along the lake edge.

<u>PRIVATE WELL TESTING</u>

With the assistance of Dave Such, Community Resource Development Agent for UW-Extension for Sheboygan County, a private well testing program was conducted in the spring of 2004. Residents were encouraged to voluntarily sample their wells for contamination. The sampling was conducted at the property owner's expense. Parameters that were available for them for testing included: bacteria, nitrate, chloride, pH, alkalinity, hardness, conductivity, corrosivity, arsenic, copper, lead, iron, manganese, zinc, sodium, calcium, magnesium, sulfates, and triazine (pesticides) screen. ELIA facilitated the availability of sampling kits by advertising the sampling program through their newsletter and public news releases. On a Saturday in June 2204 sample kits were available at the public library for residents to pick up and return. The samples were transported to a laboratory at UW--Stevens Point for analysis.

MONITORING WELL TESTING

To determine groundwater recharge areas along the lakeshore and potential contamination by local septic systems, a series of mini piezometers were installed along the lakeshore. Local volunteers and student interns who were trained by groundwater hydrologist on proper construction and installation installed the mini pyrometers. The mini piezometers construction and installation was based on a design developed by the U. S. Geological Survey. An outline of the mini piezometers construction and installation procedure is located in Appendix A of this report. 25 mini piezometers were installed around the lake. At each location a shallow 4 to 5 foot well and deeper 8 foot well was attempted to be installed. The locations of the wells were similar to locations used by UW-Milwaukee in a previous study. At several locations wells could not be installed at the near shore location due to excessive natural rocks and boulders that prevented driving the mini piezometers more than a few feet. Several of the shallow wells were dry throughout the study period and were unable to be sampled for water depth or chemistry. 14 wells were sampled for water elevation and potential chemical contamination. Parameters that were sampled included E. Coli bacteria, nitrite and nitrate, chlorides, and total phosphorus.

Public Education Program on Groundwater and Septic System Maintenance

Following the mapping and sampling programs above, the Elkhart Lake Improvement Association in cooperation with UW-Extension conducted three public education programs on groundwater protection and septic system maintenance. Two of the programs were held as part of ELIA'a annual meetings in 2004 and 2005. UW-Extension helped a separate public education forum to present the results of the private well testing program.

GLACIAL GEOLOGY OF SHEBOYGAN COUNTY

(Excerpt from: The State of the Sheboygan River Basin October, 2001, PUBL WT 669 2001 prepared by WDNR)

The geology of the Sheboygan Basin reflects the region's glacial history. Glacial maps indicate that surface geology and soil types in the Basin generally align parallel to the lateral moraines of the Lake Michigan Lobe advance. Within the Basin, groundwater is generally drawn from one or more of three main formations:

- Unconsolidated Glacial Drift (sand and gravel aquifer)
- Silurian Dolomite (Niagaran aquifer)
- Cambrian Sandstone (sandstone aquifer)

Unconsolidated Glacial Drift (Sand and Gravel Aquifer)

The sand and gravel aquifer is composed of Pleistocene glacial drift, which varies substantially in thickness and continuity. The unconsolidated sand and gravel aquifer is generally the shallowest water bearing unit in the Sheboygan Basin and is therefore susceptible to climatic changes and to the vertical migration of organic contaminants. Predominant soils in the eastern half of the basin have a loamy surface layer and a loamy or clayey subsoil and substratum formed under forest vegetation. These soils consist of fine textured silts and clays with low infiltration rates; the soils are susceptible to runoff but less vulnerable to groundwater contamination. Water yields from sand and gravel wells completed in the eastern side of the Basin can be inconsistent. Higher yield rates are noted in the western side of the Basin, which has more sandy loam soils with more rapid percolation rates; these conditions also result in greater susceptibility to aquifer contamination. A survey of well logs identify sand and gravel well completion in the Basin that range from 28 feet (ft.) below land surface (BLS) to 220 ft. BLS.

Silurian Dolomite (Niagaran Aquifer)

The Silurian Dolomite sedimentary formation is the primary aquifer for residential, municipal and industrial use in the Sheboygan River Basin. In Sheboygan County, the Silurian Dolomite formation dips to the east-southeast away from the igneous and metamorphic core of the Canadian Shield, which is located to the west and north of Sheboygan County. Sheboygan County has the greatest recorded thickness of “Niagaran Formation” (719 ft.) in the State of Wisconsin (Weidman and Schultz, 1915). Pleistocene era glacial deposits truncate the Dolomite. In addition, the thickness of the formation decreases to the west due to truncation caused by pre-glacial erosion of the exposed dolomite on the flanks of the uplifted Canadian Shield. Where truncated, the glacial sands, gravels and tills that overlie weathered, fractured dolomite are often hydraulically connected; the units act as one aquifer. The degree of preglacial weathering, the vertical fractures and the primary porosity of the dolomite units establish the permeability and well yields in the Niagaran Aquifer. Ozaukee County residents experience lower well yield where this secondary porosity is absent; a conforming Devonian Rock formation overlies the Silurian Dolomite. In much of Sheboygan County, the Devonian 43 Formations were stripped away by erosion prior to deposition of the Pleistocene “sand and gravel aquifer”. Construction logs identify wells completed in the Niagaran aquifer range from 57 ft. BLS to 740 ft. BLS. Within the Basin; well logs identify the top of the dolomite formation ranging from 13 ft. BLS in the Town of Sheboygan (Sheboygan County), to 201 ft. BLS in Meeme Township (Manitowoc County).

Cambrian Sandstone (Sandstone Aquifer)

Cambrian rocks overly the Pre-Cambrian Crystalline rocks throughout Sheboygan and Manitowoc Counties. The sandstone aquifer has not commonly been used for domestic water supplies in the Sheboygan Basin due to the availability of sufficient water yields in more shallow formations. Increased demand, improved technology, contamination of upper aquifers, and localized factors have driven extensive access to the sandstone aquifer in neighboring Basins.

RESULTS OF GROUNDWATER TABLE MAPPLING

As outlined in the method section above a groundwater map of Elkhart Lake area, including the Village of Elkhart Lake, and Towns of Greenbush, Plymouth, Rhine, and Russell was prepared from available well logs collected when private wells were installed in the area. The logs include information on depth to groundwater and geological strata the well is drilled through. Few logs include the elevation of the ground surface or water table. To determine water level from the depth to water table information provided in the well logs, the elevation of each well was determined from USGS topographical maps, which have 10-foot contour intervals and an accuracy of ± 5 feet. To stay with in the degree of accuracy of the available data the water table contours were mapped at a 20-foot contour. Due to the steep topography on the study area 20-foot contours provides adequate data to determine regional groundwater flow directions. Figure 4 illustrates the groundwater table elevations in the study area and general directions of regional groundwater flow.

Figure 5 illustrates the approximate groundwatershed boundary for Elkhart Lake. It should be noted that the mapping included few wells located north and northwest of the lake where few homes are located or public drinking water is available. Due to the lack of available field data, accuracy of the map in the area of the Village of Elkhart Lake is less accurate than other areas mapped.

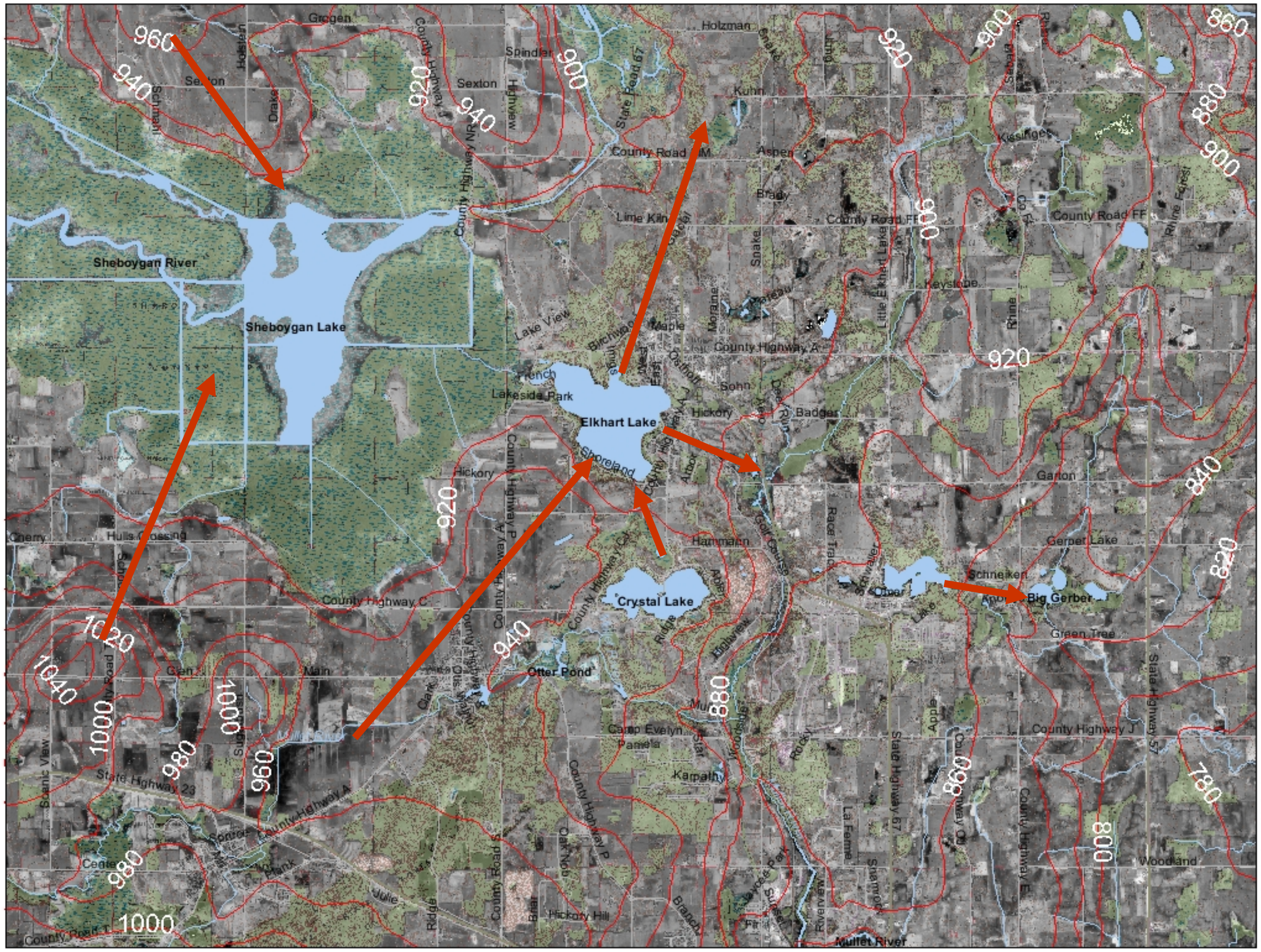


Figure 4
General Groundwater Flow Patterns in Northwestern Sheboygan County
(Contour Line indicate groundwater Depth Above Sea Level)

Elkhart Lake

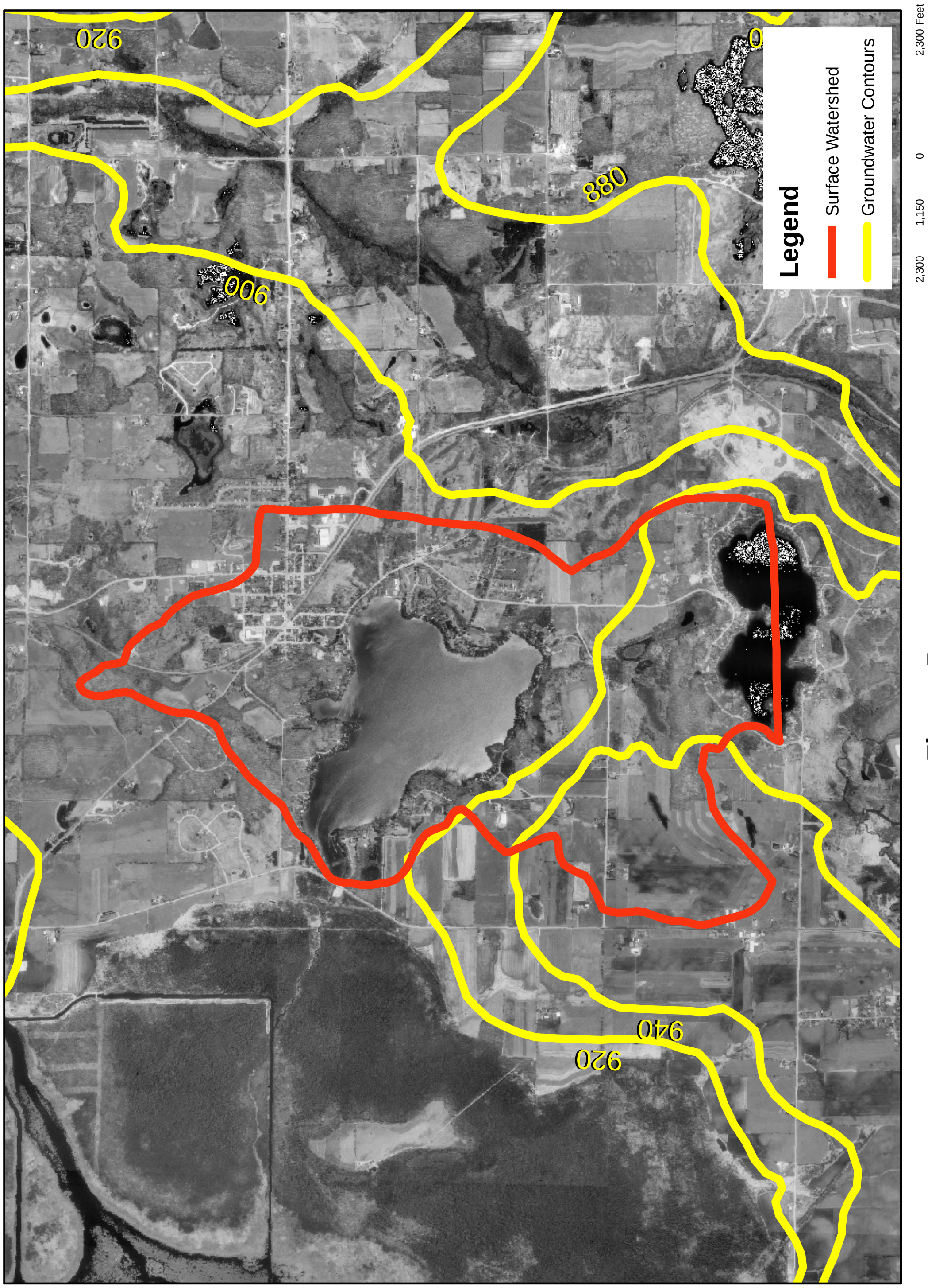


Figure 5
Groundwatershed Map for Elkhart Lake

RESULTS OF PRIVATE WELL TESTING

In June 2004, 114 residents in the Northwestern Sheboygan County participated in the private well testing program sponsored by the UW-Extension and ELIA. The results of the sampling are summarized in Appendix B of this report. Table 2 summarizes the mean, standard deviation, maximum value for the parameters measured. For comparisons, the Wisconsin Groundwater Quality Standards Prevention and Action Limits (Wisconsin Administrative Code NR 140 have been added to Table 2.

TABLE 2
Summary of Private Well Sampling in Northeastern Sheboygan County

Parameter*	Mean	Standard Deviation	Maximum Value	Number of Samples	Wisconsin Public Health and Welfare Groundwater Quality Standards	
					Preventive Action Limit	Enforcement Action Limit
pH (units)	8.03	0.19	8.49	117	NA	NA
Conductivity	699.31	234.8	1464	117	NA	NA
Alkalinity	305.16	45.58	364	117	NA	NA
Hardness	314.86	118.08	629	117	NA	NA
Chloride	41.30	53.91	211	117	125 mg/l	250 mg/l
Nitrate	2.16	4.04	25.90	117	2 mg/l	10 mg/l
Triazine	0.08	0.04	0.10	44	NA	NA
Calcium	54.76	32.12	113.4	44	NA	NA
Copper	0.23	0.34	1.46	44	130 mg/l	1300 mg/l
Iron	0.34	0.61	2.67	44	0.15 mg/l	0.30 mg/l
Potassium	4.97	22.11	148.1	44	NA	NA
Magnesium	33.36	19.55	83.8	44	NA	NA
Manganese	0.03	0.14	0.90	44	0.025 mg/l	0.05 mg.l
Sodium	54.26	66.85	218.2	44	NA	NA
Lead	0.01	0.01	0.05	44	1.5 mg/l	15 mg/l
Zinc	0.07	1.36	5.41	44	NA	NA
Arsenic	0.01	0.0	0.02	44	1.0 mg/l	10 mg/l
Sulfate	26.55	55.17	378.3	44	125 mg/l	250 mg/l

All units are in mg/l unless specified.
Source: UW-Extension

Of the above parameters only four were found to exceed the Wisconsin Public Health or Welfare Groundwater Quality Standards Preventive or enforcement limits. Chloride was found to exceed the preventive limit in 3 wells and did not exceed the enforcement level in any wells. The wells with elevated chloride levels are illustrated in Figure 4. Nitrates were found to exceed the preventive limit of 2 mg/l in 14 wells and the enforcement standard of 10 mg/l in 2 wells. Figure 5 illustrates the location of wells with elevated nitrate levels.

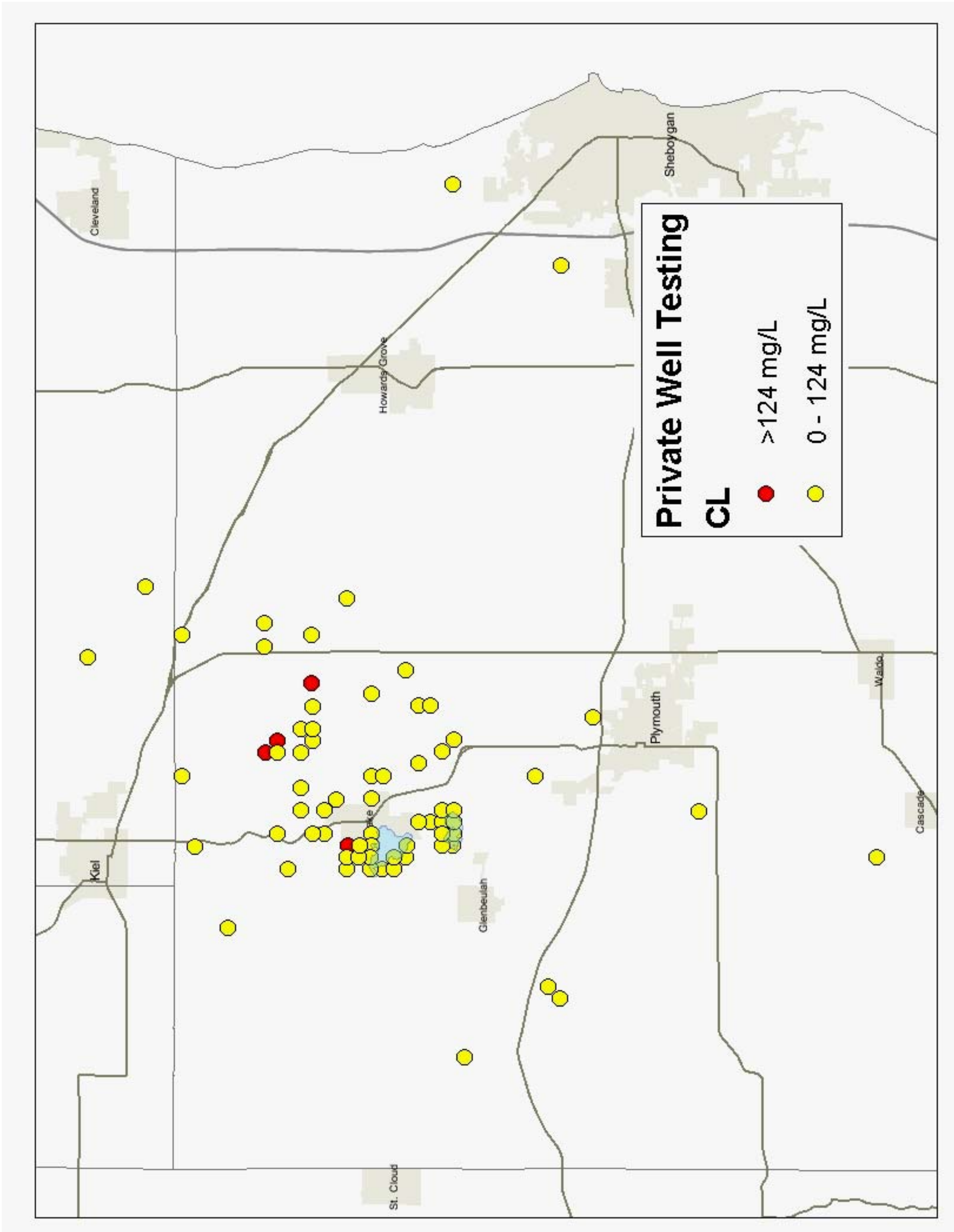


Figure 6
Elevated Chloride Levels in Private

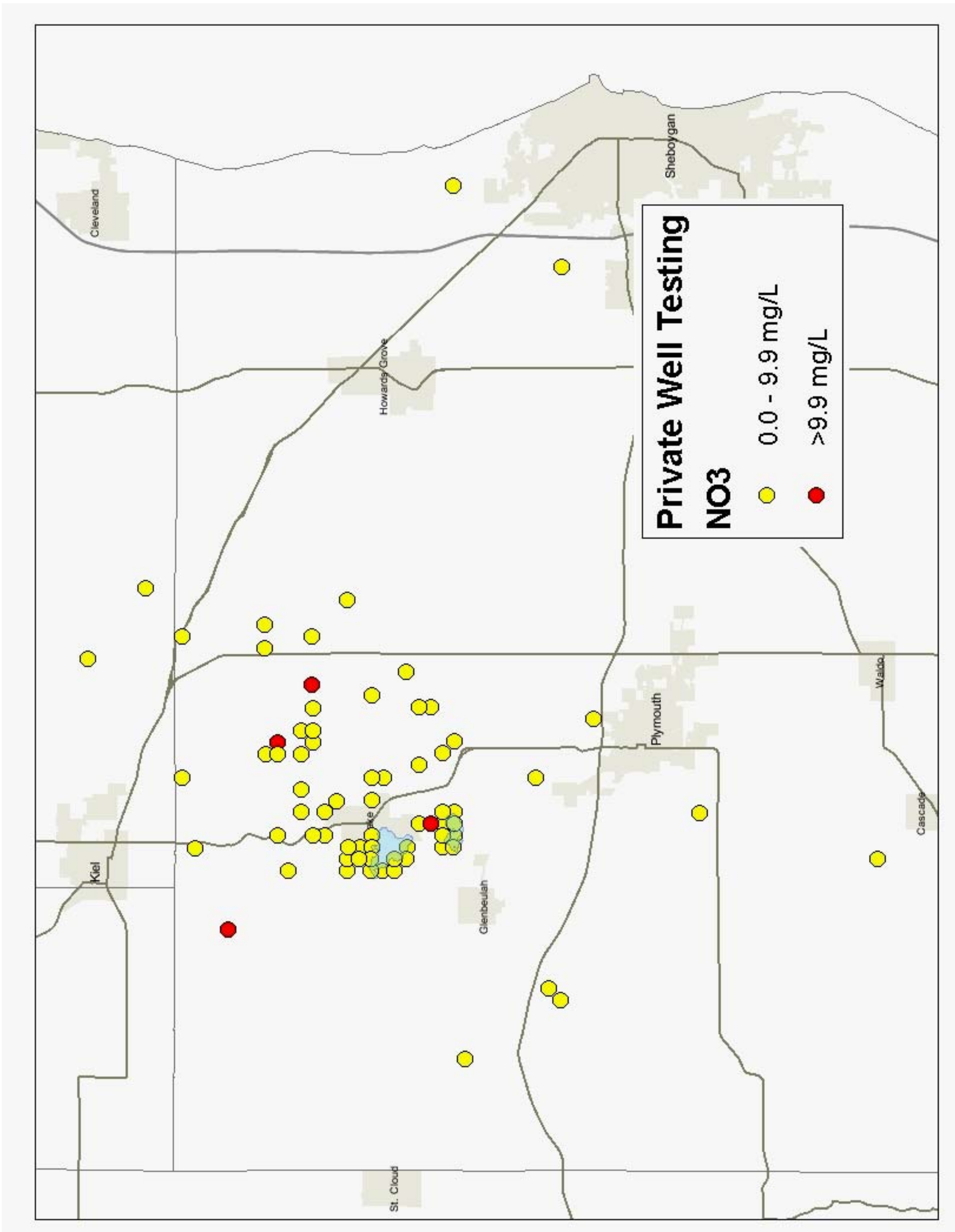


Figure 7
Elevated Nitrate Levels in Private

Iron levels were found to exceed the state preventive limit of 0.15 mg/l in 14 wells, and enforcement limit of 0.30 mg/l in 10 wells (Figure 8). Manganese exceeded the preventive limit of 0.025 mg/l in 8 wells and enforcement limit of 0.05 mg/l in 3 wells. Sulfate exceeded the state enforcement limit of 250 mg/l in one well. Many of the wells that exceeded state standards are planned to be re-sampled to assure the elevated results were not the result of sampling error on the part of the home owner.

Generally it can be concluded from the private well sampling program that groundwater contamination in Northwestern Sheboygan is not widespread and is limited where prevalent to single wells. No regional patterns of contamination were identified by this sampling program.

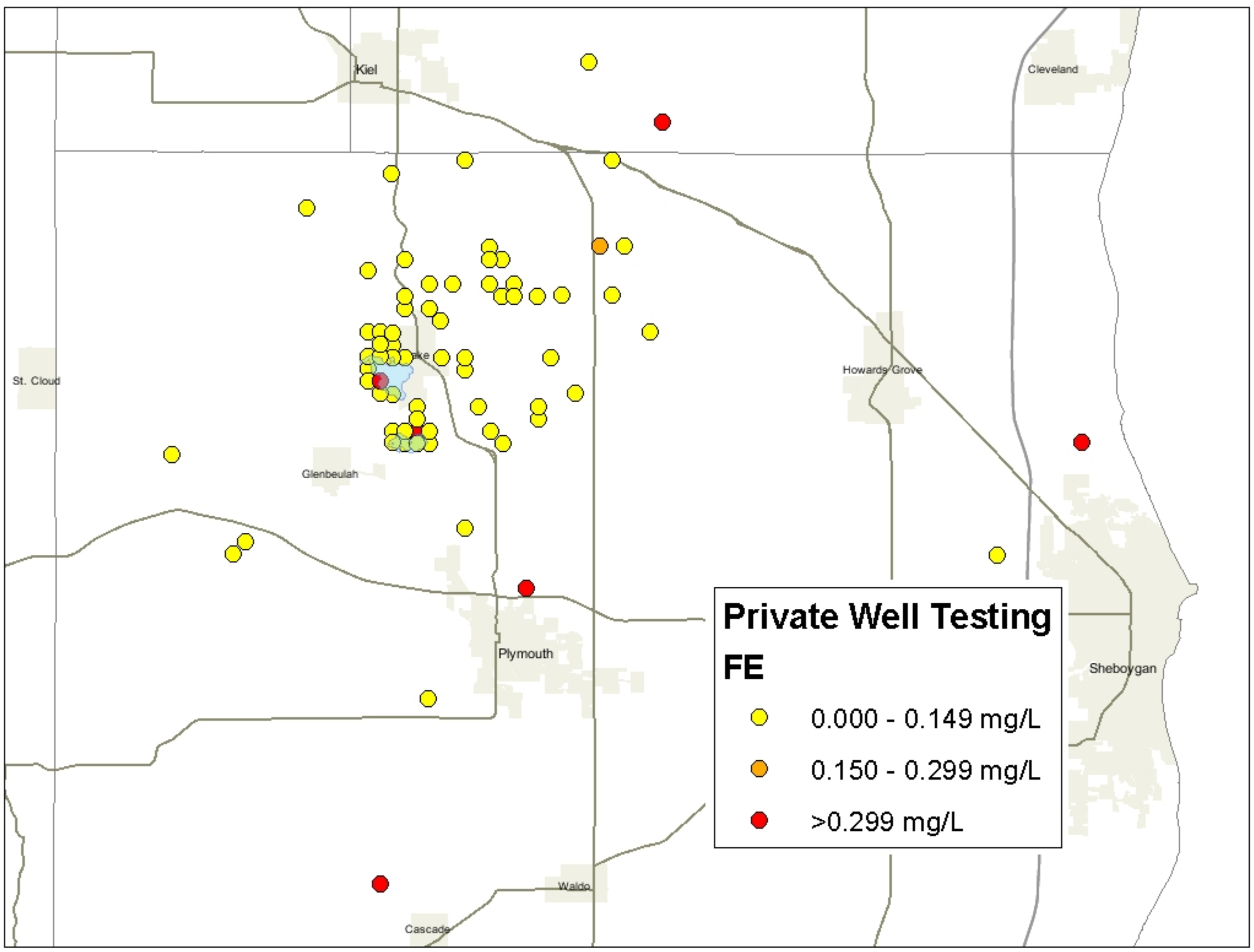


FIGURE 8
Elevated Iron Levels in Private Wells

RESULTS OF MINI PIEZOMETERS TESTING

To identify potential area of localized groundwater contamination a series 25 mini piezometers, which as small monitoring wells, were installed by interns and volunteers along the shoreline of Elkhart Lake. Fourteen of these wells were sampled for water quality on four dates for following parameters:

- Total Phosphorus
- Dissolved Nitrate and Nitrite
- Chloride
- Fecal Coliform Bacteria

On one sample date, a shipping problem resulted in samples not being run by the State Laboratory of Hygiene. The results of the sampling are summarized in a spreadsheet located in Appendix C of this report. The results are also illustrated graphically in Figures 8 through 20. The size of the dot at the sampling location illustrates the degree of contamination, with small dots illustrating low levels and large dots high or elevated levels of concern.

Based on the minipiezometer sampling the following conclusions can be reached:

1. Chloride levels are generally low at all sampling locations and sampling dates, indicating that salt from road deicing and water softeners is not causing elevated levels in the groundwater at this time.

2. Nitrite/Nitrate nitrogen levels were generally low at all sampling locations and sampling dates. These forms of nitrogen can be indicators of excess fertilization, malfunctioning septic systems, or human or animal waste. One elevated level was observed on the east side of the lake on October 24, 2004, this may be due to excess geese at the time.

3. Total phosphorus levels were elevated at most sites and on most dates. Like nitrogen, phosphorus can be an indicator of excess fertilization, malfunctioning septic systems, or human or animal waste. It is interesting to note that elevated levels of total phosphorus were observed in areas of the east side of the lake that are serviced with sanitary sewer, indicating that septic systems and agricultural runoff cannot be the only cause for these elevated levels.

4. Fecal Coliform, bacteria that are found in the waste of all warm blooded animals was found to be elevated predominantly on the east side of the lake. As discussed the east side of the lake is served with sanitary sewer. Potential causes of the elevated bacteria levels that should be explored include excess waterfowl, such as geese, or potential leaks in the sanitary sewer system in the area.

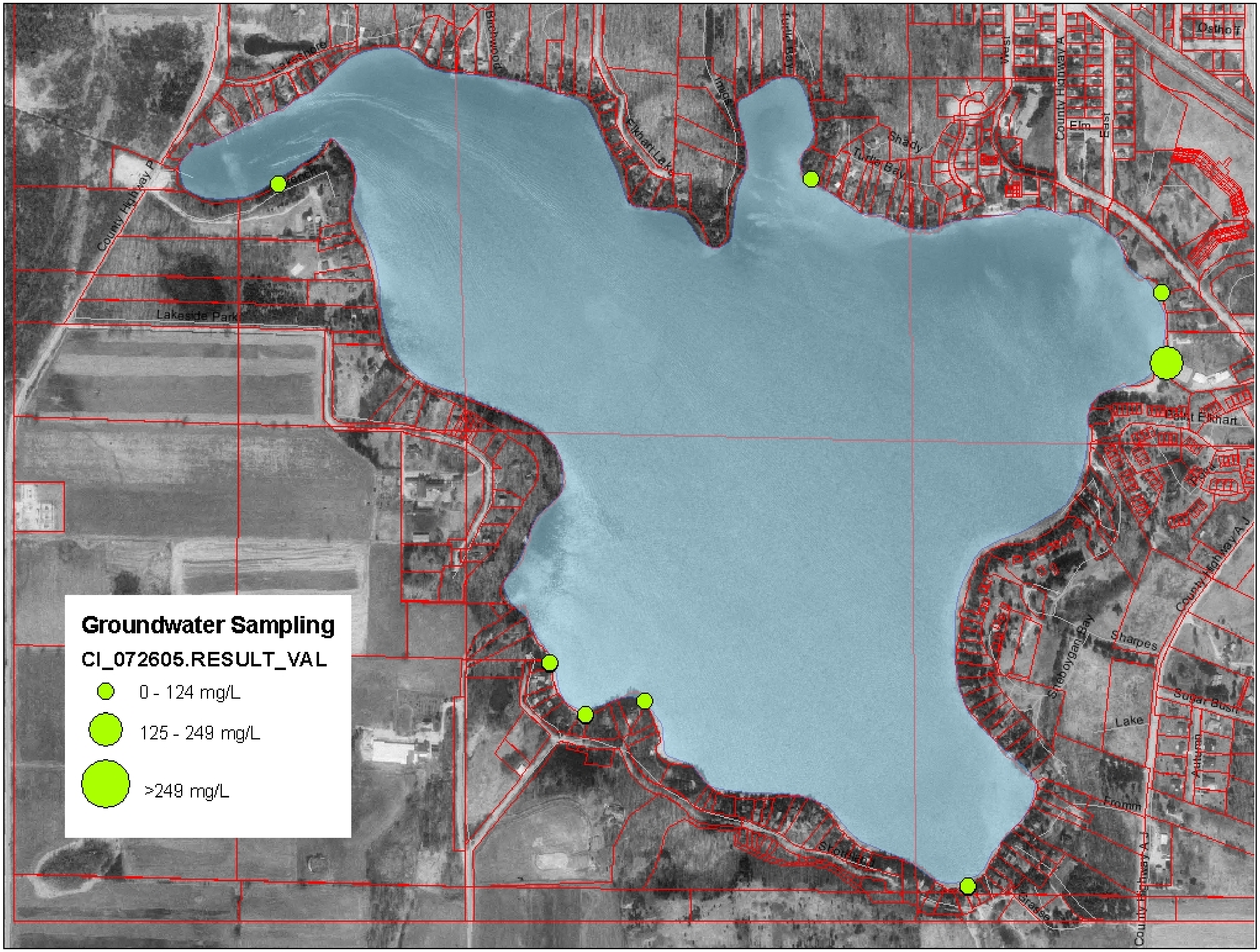


FIGURE 9
Chloride Levels July 26, 2004

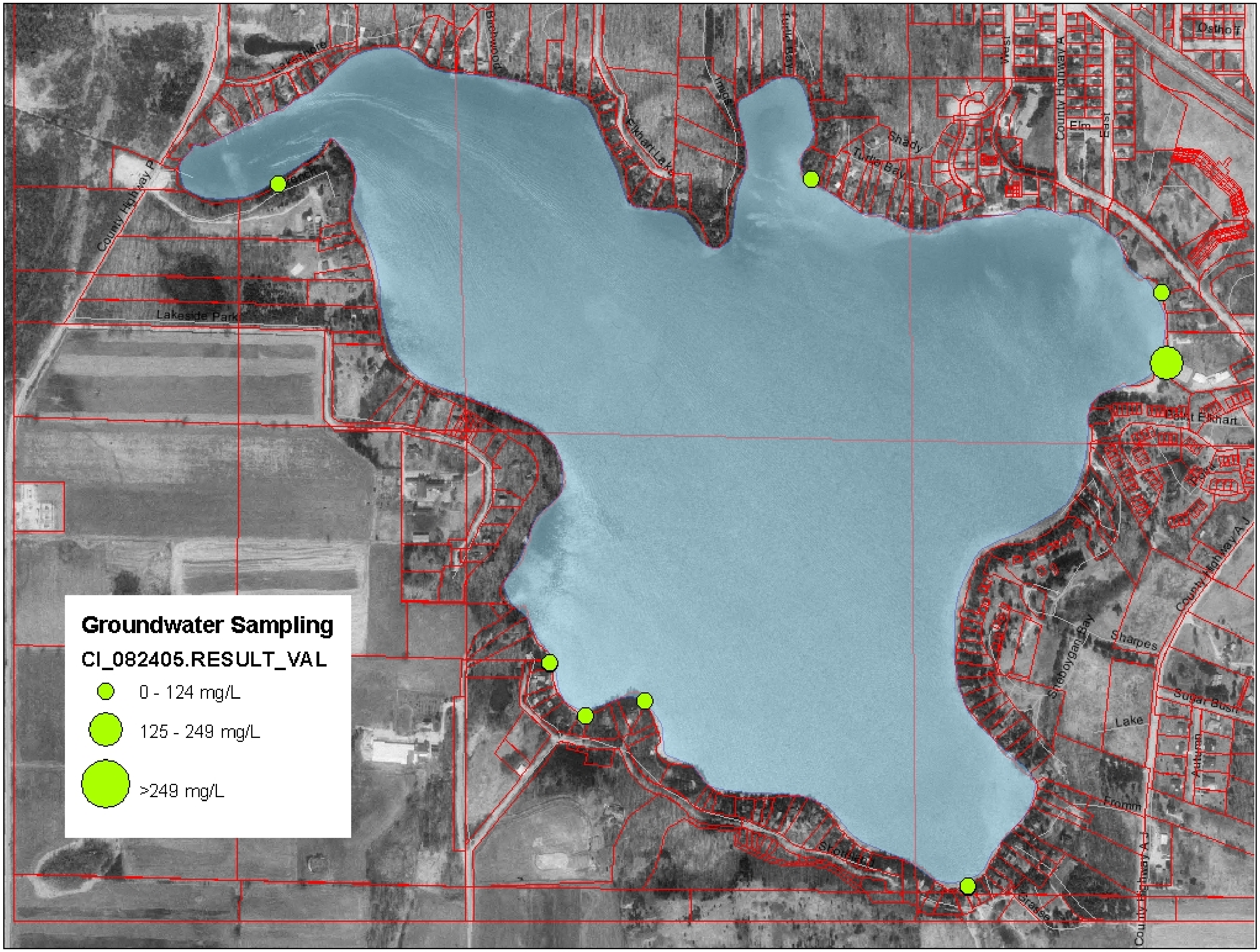


FIGURE 10
Chloride Levels August 24, 2004

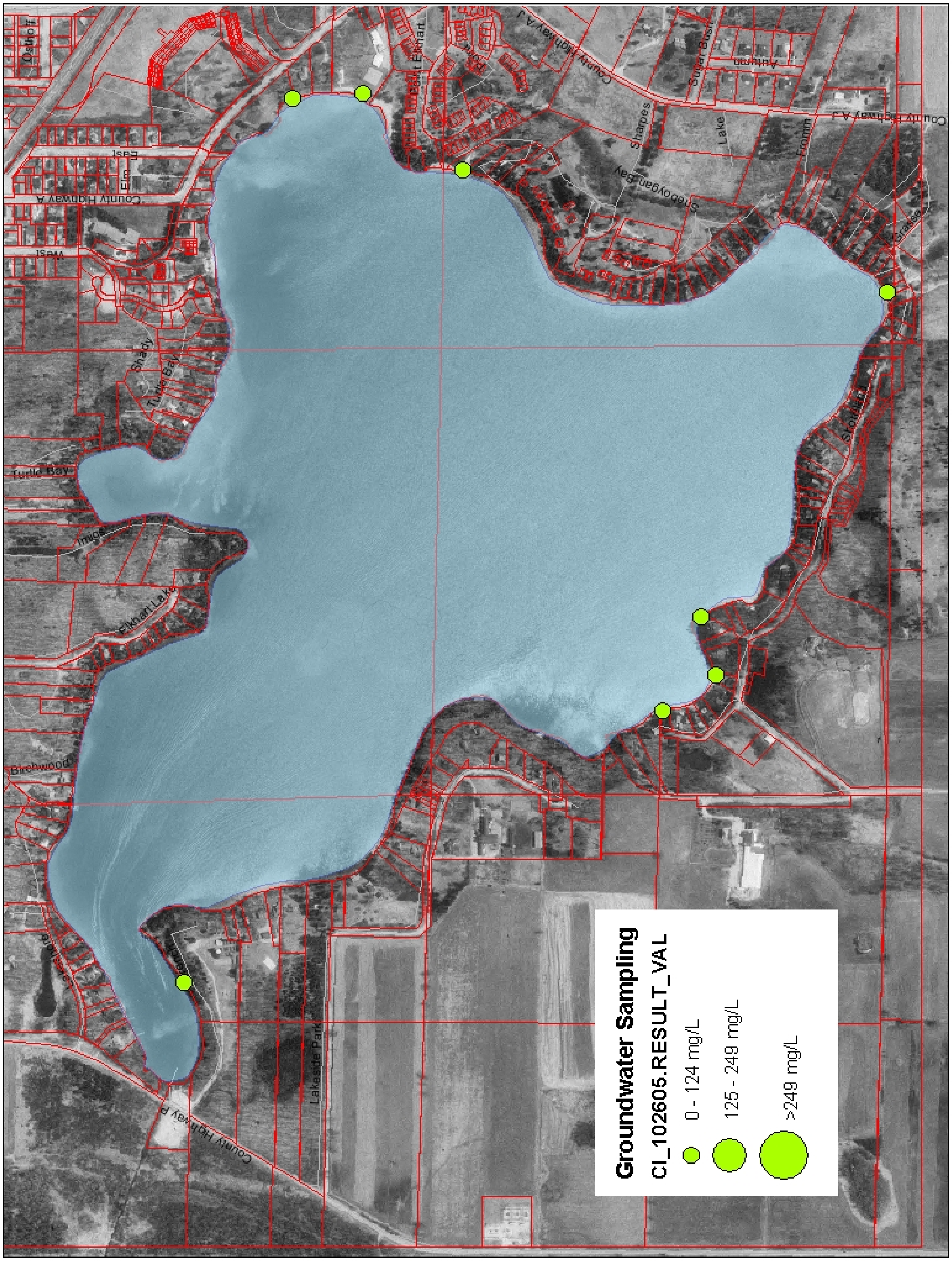


FIGURE 11
Chloride Levels October 26, 2004

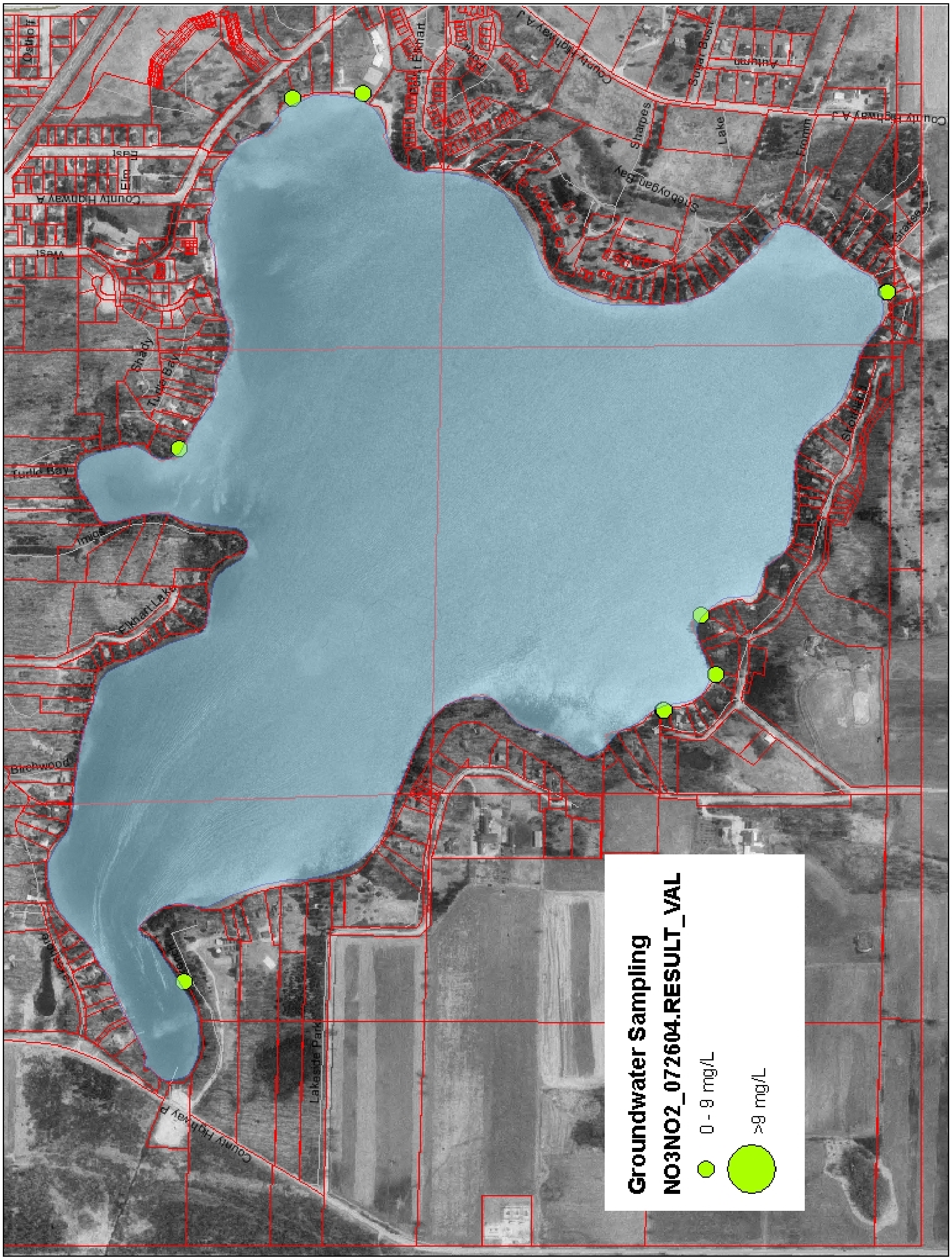


FIGURE 12
Nitrate/Nitrite Levels July 26, 2004

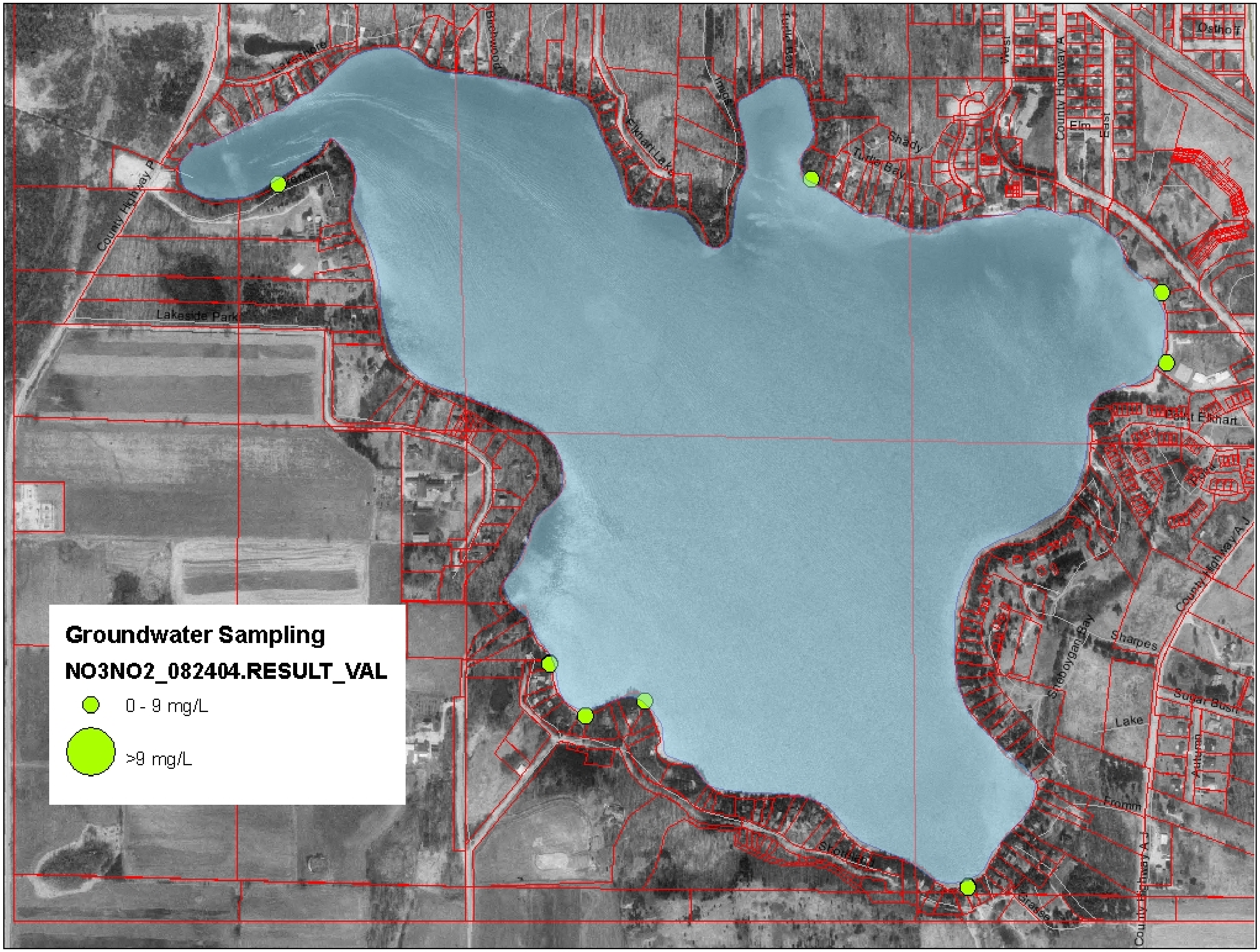


FIGURE 13
Nitrate/Nitrite Levels August 24, 2004

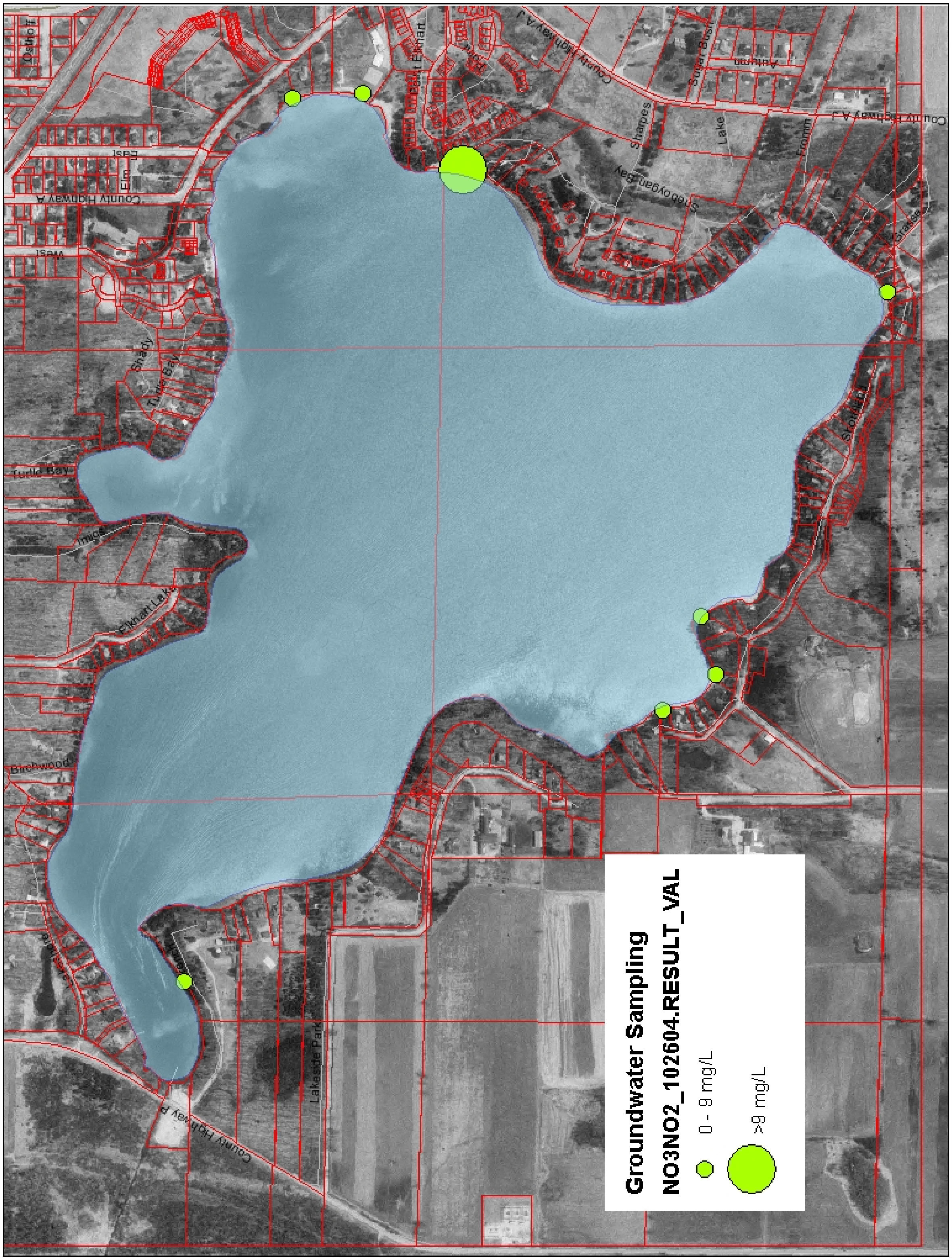


FIGURE 14
Nitrate/Nitrite Levels October 26, 2004

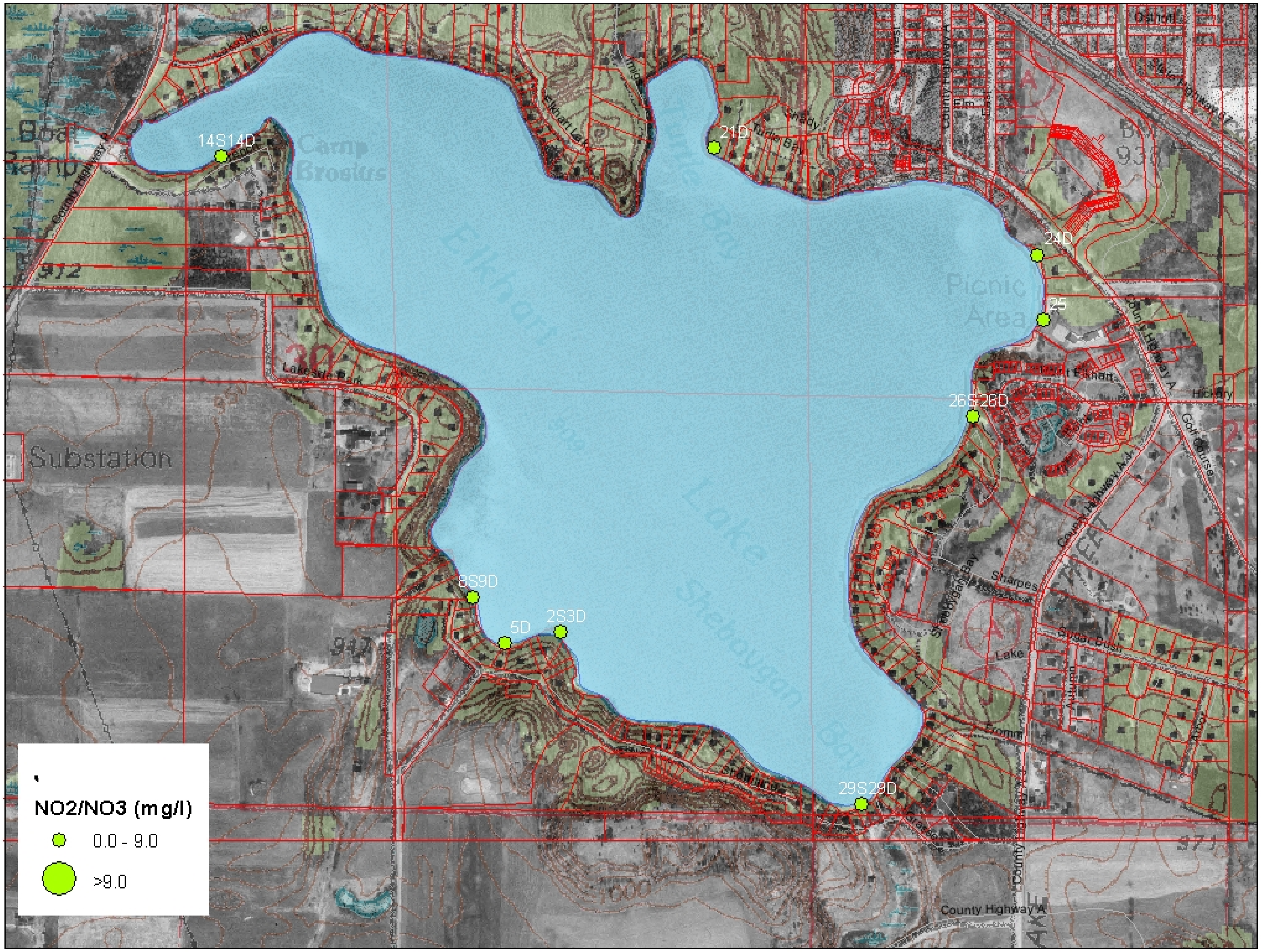


FIGURE 15
Nitrate/Nitrite Levels June 22, 2005

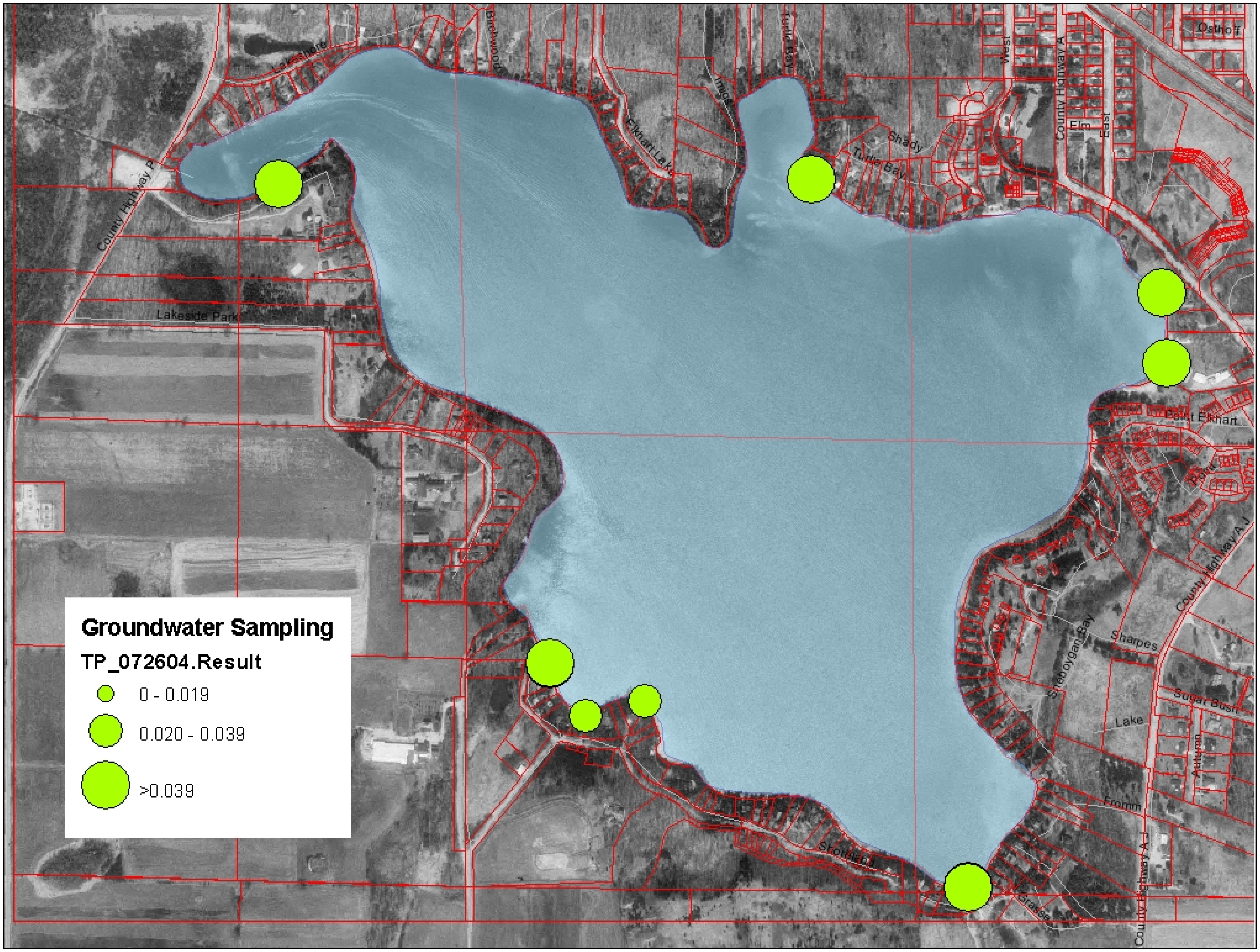


FIGURE 16
Total Phosphorus July 26, 2004

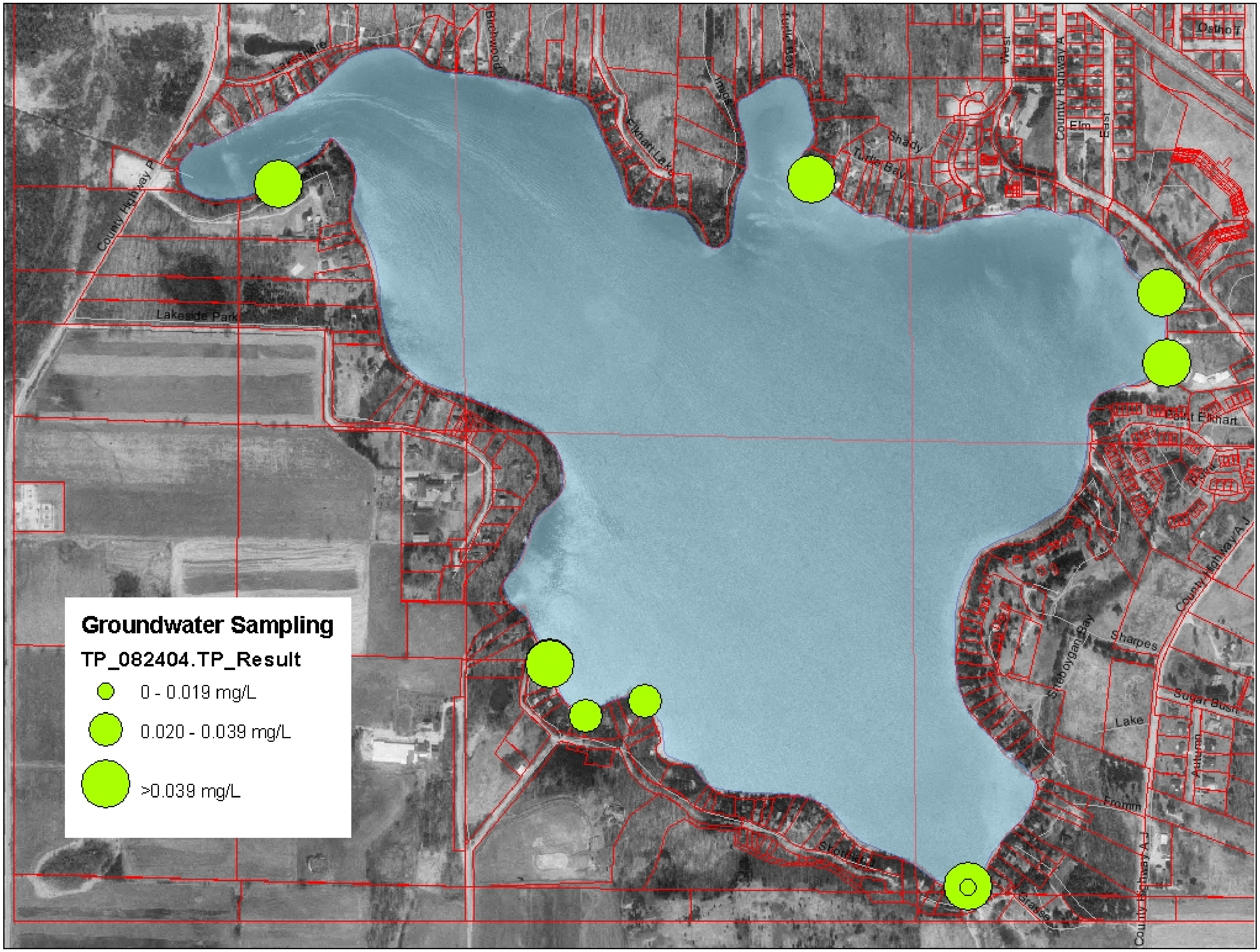


FIGURE 17
Total Phosphorus August 24, 2004

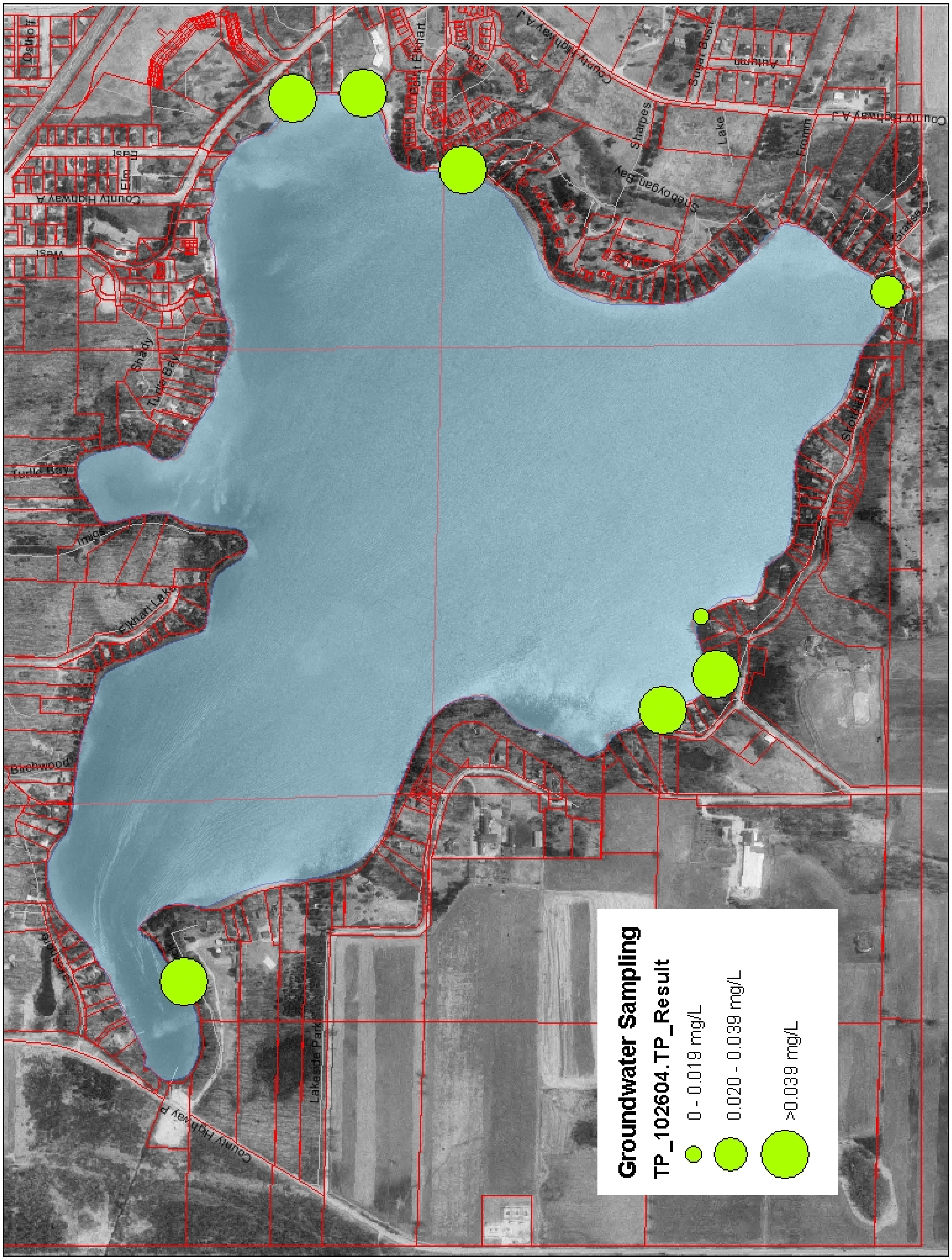


FIGURE 18
Total Phosphorus October 26, 2004

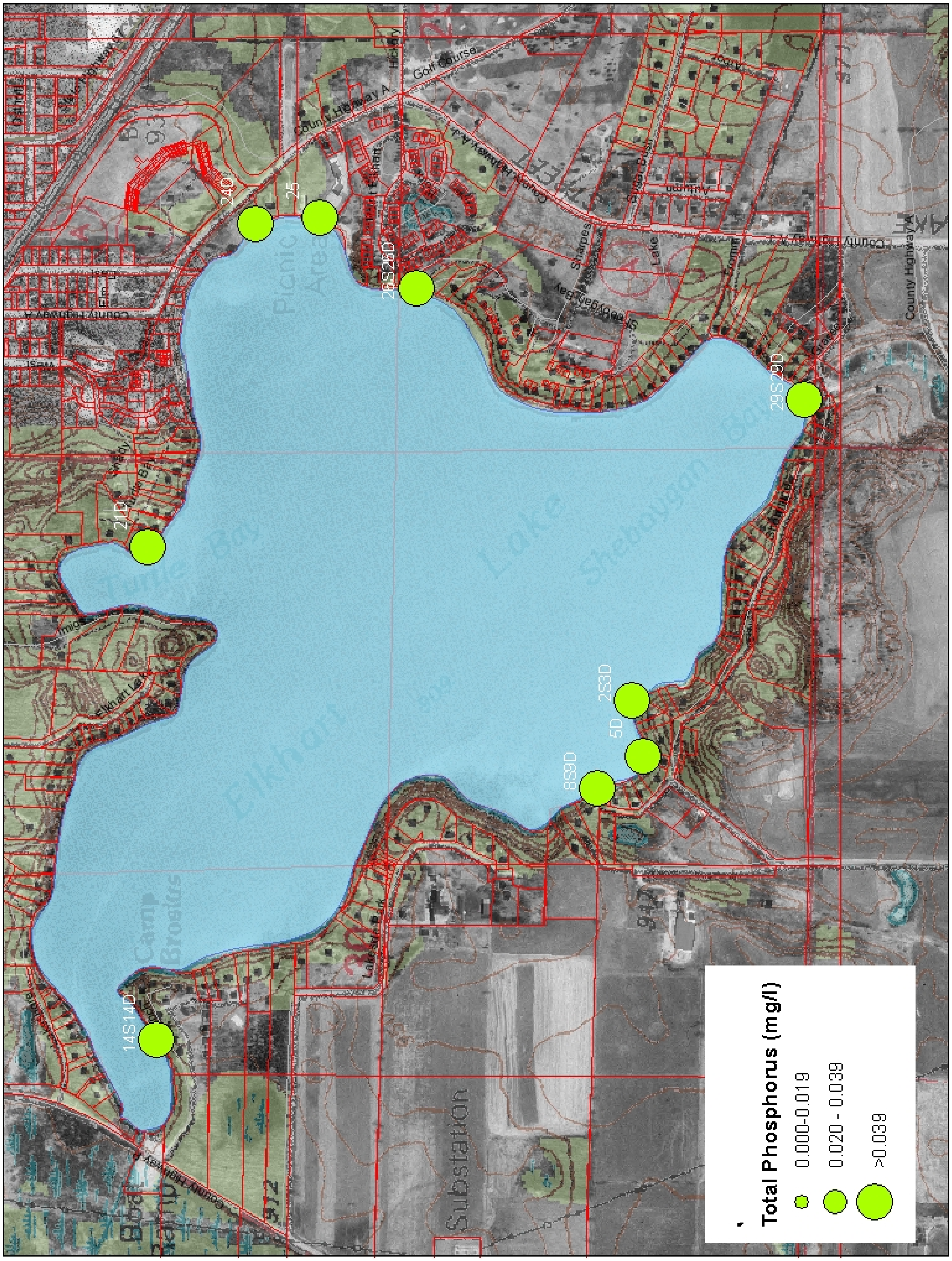


FIGURE 19
Total Phosphorus June 22, 2005

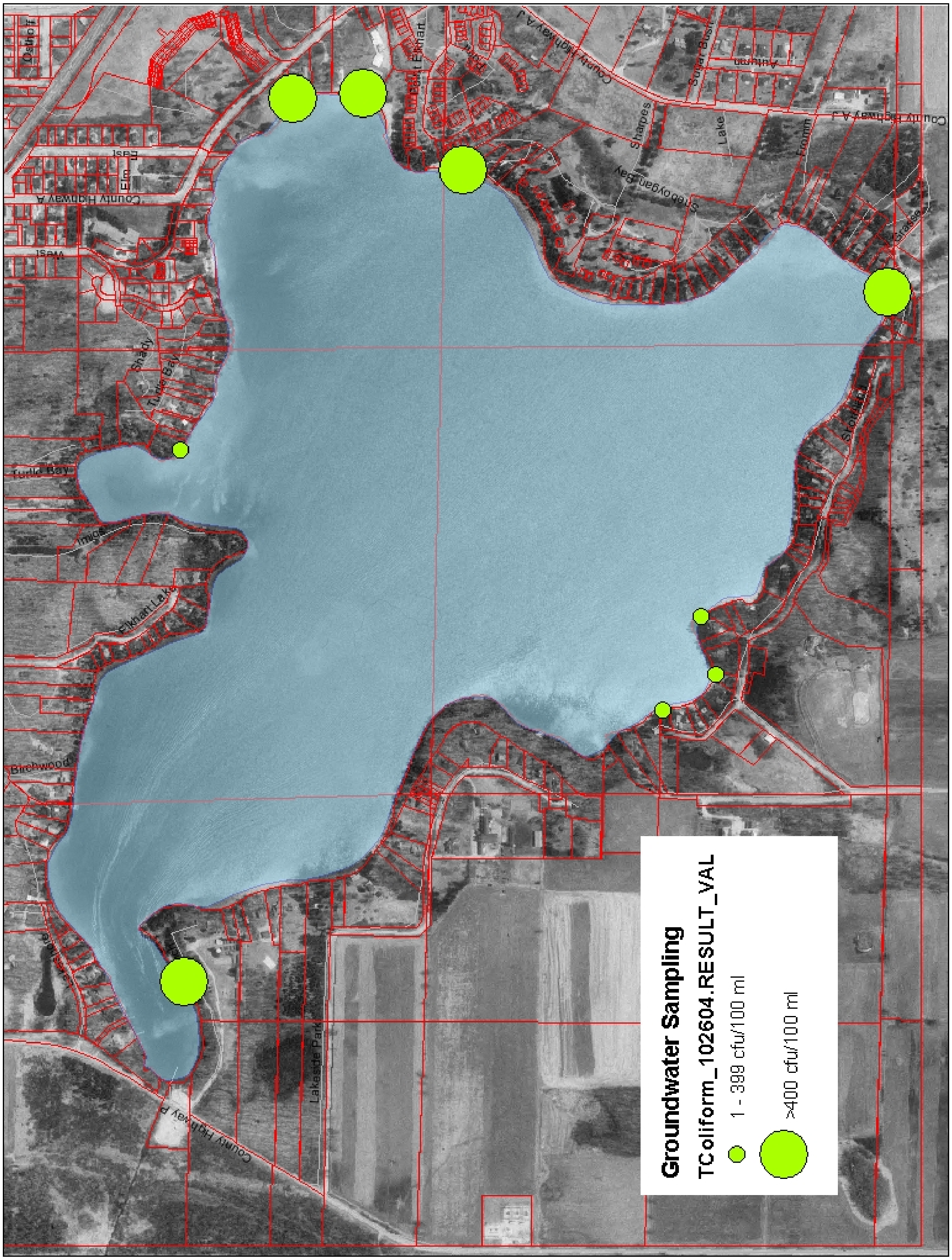


FIGURE 20
Fecal Coliform October 24, 2004

ACTIONS TO PREVENT LOCAL SEPTIC SYSTEMS FROM POLLUTING ELKHART LAKE

Evidence of a malfunctioning septic system:

- Sewage backing up in basement or drains
- Ponded water or wet area over drain field
- Bright green grass over drain field may indicate that the system is forcing effluent to the surface
- A dense stand of aquatic plants along the shoreline
- Slow draining of drains and toilets
- Sewage odors
- Bacteria or nitrates in nearby well water test
- Biodegradable dye flushes through your system in detectable in the lake

Things You Can Do To Promote the Life of Your Septic System:

- Locate drain fields as far as possible from the lake.
- Divert surface water away from the drainfield.
- Avoid driving or parking over the drain field to prevent compaction of the soil and premature failure.
- Keep roots of trees and shrubs away from drain field pipes to avoid obstructed drain lines.
- Pump the tank at least every three years Increase the frequency if you have a large family.
- Pump a holding tank when the alarm indicates a full tank.
- Avoid using a garbage disposal: compost your vegetable scraps with lawn refuse instead.
- Use water efficient appliances and flow restrictors to reduce volume of wastewater the system must absorb.
- Avoid chemicals which may harm the organisms that break down waste.
- Use Toilet paper that decomposes quickly (put some in a bottle and shake to confirm).
- Use detergents which contain no fillers. Filers may over time clog the drain field.
- Avoid material that may clog the drain field, such as:
    - Cooking grease
    - Oils
    - Coffee grounds
    - Facial tissue
    - Sanitary napkins
    - Tampons
    - Paper toweling
    - Disposal diapers

RECOMMENDATIONS FOR FUTURE ACTION

1. The groundwatershed for Elkhart Lake identified in the study should be zoned for only the following uses:

    a. Agriculture
    b. Low Density Residential

2. All agricultural fields should have a pesticide and nutrient management plan prepared under the guidelines Natural Resource Conservation Service (NRCS).

3. All manure should be stored in an engineered containment facility.

4. A public education program on septic tank management and lawn fertilization should be conducted in 2006. The Elkhart Lake Improvement Association will dedicate space in one of its newsletter to septic system management.

5. Sheboygan County has established a new septic system inspection program that will track properties with septic and holding tanks and require inspection and maintenance. The program is being funded through a new county sanitary assessment fee of $7.50 per property.

6. Continuation of groundwater monitoring:

    a. Additional wells to better define the inflow and outflow areas around the lake. During the last sampling program several areas of the lake were not sampled. The gaps in the monitoring well network should be filled in to provide a better representation of the entire shoreline of the lake.
    b. The mapping of the groundwatershed has shown that an under ground connection between Crystal Lake and Elkhart Lake likely exists. To document this connection a monitoring well should be installed between the two lakes at a site near CTH A and the Southeast corner of Elkhart Lake.

7. Identify why phosphorus and fecal coliform concentrations are high on the east shore of the lake where sanitary sewers exist. Discussion should take place with the Village of Elkhart Lake to determine if they have any inspection or flow records that would indicate a potential leak in the sanitary sewer system.

8. Install a water level recorder at the lake outlet to determine surface water outflow. This gauge will help determine how much water leaves the through surface outflow versus groundwater and evaporation.

REFERENCES

University of Wisconsin-Milwaukee, 1996. *Water, Nutrient Budgets, and Trophic Status of Elkhart Lake, Sheboygan County*, Center for Great Lakes Studies, Milwaukee, WI.

University of Wisconsin-Milwaukee, 2001. *Project Completion report: Wisconsin Department of Natural Resources Lake Planning Aids Grant LPL-455*, UW-Milwaukee Great Lakes WATER Institute, Milwaukee, WI.

APPENDIX A

MINIPIEZOMETER SCREEN CONSTRUCTION AND PIEZOMETER INSTALLATION

Supplies and Equipment for Construction of Screens:

- Polyethylene tubing (1/2 in. O.D., 3/8 in. I.D.)
- Silk screen fabric or something similar
- Hot-glue gun
- Wood dowel (about 15 in. in length and <3/8 in. diameter)
- Electric drill and small bit (about 1/8 in.)

Screen Construction Procedure:

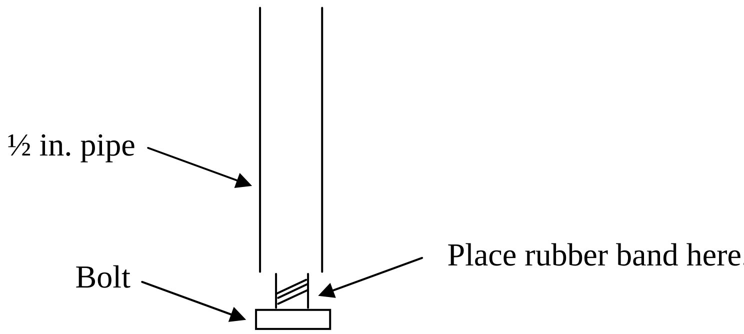
1. Perforate a piece of tubing with drill. The length will depend on how long the screen will be. Leave un-perforated about ¾ in. at each end.
2. Insert dowel into tubing to keep it straight.
3. Cut silkscreen fabric to cover perforations with 2 to 3 complete wrappings.
4. Put a small bead of hot glue the length of the tubing and quickly wrap the fabric. Tack all edges of the fabric with hot glue. Bulges of glue can be smoothed with the edge of the hot glue gun.
5. Plug one end of the tube with hot glue.

Supplies and Equipment for Installation of Minipiezometers:

- 1/2 in. steel pipe and steel couplings (Ends of pipe must be reamed and have no snagging edges, and oil contamination from threading process must be removed.)
- 1/2 in. diameter x 1 in. long hex-head bolts
- Rubber bands
- Post driver (10-20 lbs.)
- Small pipe wrenches (14-in. ok)
- Jack (Hi-lift)
- Small vice wrench
- Short lengths of 3/8 in. O.D. X ¼ in. I.D. polyethylene tubing. (About 1.5 in. long)
- Supply of ½ in. O.D. X 3/8 in. I.D. polyethylene tubing. (Sold in 100 ft. coils.)
- 1/4 in. wide steel measuring tape
- Chalk

Minipiezometer Installation Procedure:

1. Insert 1/2 in. hex-head bolt into end of steel pipe. Wrap a rubber band (or two) around the bolt to prevent the bolt from falling out of the pipe. The rubber band is needed only if installing the piezometer into a lake or stream bottom from the ice surface and it is not possible to manually hold the bolt in place.



2. Drive the pipe to desired depth with the post driver. Be sure to have a coupling on the top end of the pipe to prevent damage to the thread.

3. Connect piezometer screen to a length of polyethylene tubing using a short length of 3/8 in. O.D. tubing, and insert the screen and tubing (screen-end first) into the steel pipe.

4. Maintain a down force on the tubing and pull up on the steel pipe a distance sufficient to expose the screen to the aquifer. This is easier to do with two people than with one. Use of a mechanical (Hi-lift) jack for this is helpful. Using a vice wrench to grip the tubing to maintain down force on the tubing is helpful.

5. Cut the polyethylene tubing flush with top of the steel pipe. A cheap pruning shears works well for this.

Use chalked 1/4 in. measuring tape to measure water level in the piezometer. Measure and record the water level in the piezometer immediately after installation and again a minute or two later to get a feel for how fast the water level is equilibrating. A fast equilibration indicates a highly conductive aquifer. Whereas, a slow equilibration indicates a less conductive aquifer.

APPENDIX B

Results of UW-Extension Well Sampling

TOWN	RANGE	REW	SECTION	QS	QQS	UNIT	PH	COND	ALK	THARD	NO3	CL	SI	BACT	CA	CU	FE	K	MG	MN	NA	PB	ZN	AS	SO4
16	21	E	34	NE	SE	Rhine	7.90	602	308	328	<0.1	4.5	0.8	NEG											
16	21	E	30	NE	NE	Rhine	7.77	970	364	437	2.3	89.0	0.8	POS	88.8	0.230	0.091	1.5	52.1	0.002	39.0	0.009	0.139	<0.005	17.5
16	21	E	9	SE	SE	Rhine	7.92	1464	328	404	8.0	211.0	0.8	NEG	75.8	0.246	0.004	1.7	45.7	0.009	150.9	0.008	4.758	<0.005	21.3
15	20	E	10	SE	SE	Greenbush	7.79	801	380	420	<0.1	28.5	0.9	POS											
16	21	E	30	SE	SE	Rhine	7.80	1304	304	344	2.3	239.0	0.7	NEG											
16	21	E	30	NW	NE	Rhine	8.08	1223	340	458	2.3	195.0	1.1	NEG	97.9	0.177	0.262	1.5	51.7	0.007	84.8	<0.002	0.275	<0.005	20.5
16	21	E	32	SE	NW	Rhine	8.10	600	280	304	<0.1	29.5	1.0	NEG											
16	21	E	30	SE	SE	Rhine	8.06	662	308	402	1.8	22.0	1.0	NEG	82.1	0.118	0.029	1.5	47.8	0.001	37.3	0.002	0.246	<0.005	16.9
16	21	E	15	NW	NW	Rhine	7.93	1134	324	444	13.7	137.0	0.6	NEG	45.1	0.701	0.007	148.1	26.8	0.005	45.9	0.006	1.869	<0.005	30.7
16	21	E	17	NW	NW	Rhine	8.02	732	344	400	8.7	12.0	1.1	POS											
15	23	E	17	NW	NW	Sheboygan	7.60	1406	300	629	1.9	53.0	0.6	NEG	113.4	1.164	0.086	4.3	83.8	0.025	70.9	0.003	0.024	0.009	378.3
16	21	E	12	SE	SW	Rhine	8.00	674	344	4	1.2	12.5	-0.5	NEG	2.5	0.181	0.004	3.5	2.7	0.003	169.7	0.002	0.187	<0.005	9.1
16	21	E	32	SW	NW	Rhine	7.91	576	280	309	<0.1	22.0	0.7	NEG	66.1	0.018	0.761	1.7	34.8	0.042	8.2	0.019	0.043	<0.005	11.9
16	21	E	13	SW	SE	Rhine	8.03	725	292	332	3.4	39.0	0.9	NEG	0.8	0.182	<0.002	3.9	0.2	<0.001	181.6	0.005	0.015	<0.005	43.5
16	21	E	32	SW	NE	Rhine	8.17	702	272	280	<0.1	76.0	1.0	NEG											
16	21	E	29	NE	NE	Rhine	8.24	892	320	380	3.4	90.5	1.2	POS											
16	21	E	32	SW	NE	Rhine	7.98	665	248	288	<0.1	46.5	0.7	NEG	0.6	0.001	0.091	<0.3	0.1	0.002	171.5	0.004	0.121	<0.005	17.4
16	21	E	26	NW	NW	Rhine	7.69	932	356	408	4.6	81.5	0.7	NEG											
16	21	E	30	NW	NE	Rhine	8.16	466	232	4	<0.1	8.5	-0.9	NEG											
16	21	E	32	SW	SW	Rhine	8.09	815	320	4	<0.1	59.0	-0.9	POS											
16	21	E	19	SE	NW	Rhine	8.31	454	264	240	<0.1	1.5	0.9	NEG	40.0	0.068	1.032	1.1	37.7	0.022	7.2	<0.002	0.023	<0.005	0.6
16	21	E	16	SW	NW	Rhine	7.99	748	312	384	2.4	48.0	1.0	NEG											
16	21	E	30	NE	NE	Rhine	7.88	890	352	392	<0.1	74.5	0.9	POS											
16	21	E	32	SW	NW	Rhine	7.73	690	320	360	0.4	31.0	0.7	NEG	77.1	0.164	0.072	1.5	40.7	0.062	11.3	0.002	0.349	<0.005	19.4
16	21	E	32	SW	SE	Rhine	8.10	411	196	192	<0.1	20.5	0.6	NEG											
16	21	E	19	SE	NW	Rhine	7.93	507	284	260	<0.1	1.5	0.7	NEG											
16	21	E	19	SE	SW	Rhine	8.16	604	284	324	<0.1	36.0	1.0	POS											
16	21	E	19	SW	NE	Rhine	8.09	476	228	248	<0.1	2.5	0.8	POS											
16	21	E	19	SE	SE	Rhine	8.07	537	304	248	<0.1	1.0	0.9	NEG											
16	21	E	18	NW	SE	Rhine	7.72	602	276	316	1.0	3.5	0.6	NEG											
16	21	E	30	SW	NE	Rhine	8.03	588	288	316	1.2	13.5	0.9	NEG											
16	21	E	30	SE	NW	Rhine	8.29	546	272	316	<0.1	8.0	1.1	NEG	62.3	0.412	0.818	1.1	38.9	0.018	3.9	0.021	0.584	<0.005	20.8
16	21	E	30	SW	NE	Rhine	8.03	550	280	309	0.3	8.5	0.8	NEG	61.1	0.183	0.008	1.1	38.0	0.003	3.7	0.003	0.241	<0.005	24.7
17	21	E	26	NE	NE	Schleswig	7.95	673	348	386	0.8	16.5	1.0	NEG	85.0	0.057	0.108	1.4	42.0	0.076	4.0	0.020	0.523	<0.005	15.8
16	21	E	28	NW	SE	Rhine	8.19	592	300	324	<0.1	12.0	1.1	NEG											
16	21	E	15	SW	SE	Rhine	7.69	880	392	432	<0.1	56.0	0.8	NEG											
16	21	E	15	SW	NE	Rhine	7.79	846	360	380	3.1	57.0	0.8	NEG	0.7	0.161	<0.002	<0.3	<0.1	<0.001	218.2	0.003	0.018	<0.005	22.6
16	21	E	20	NE	SE	Rhine	8.06	676	308	352	5.8	18.5	1.0	POS											
16	21	E	4	NW	NE	Rhine	7.94	572	304	320	2.2	3.5	0.9	NEG											
16	21	E	32	NW	NE	Rhine	8.02	544	264	288	0.1	23.5	0.8	NEG											
16	21	E	32	NW	NE	Rhine	8.09	775	300	364	5.2	66.0	1.0	NEG											
16	21	E	30	NW	NE	Rhine	7.84	1281	400	504	2.1	197.0	1.0	NEG											
16	21	E	30	NW	NE	Rhine	8.19	446	228	240	<0.1	1.5	0.9	POS											
16	21	E	14	SW	SE	Rhine	7.89	1460	308	360	13.9	228.0	0.8	NEG											

TOWN	RANGE	REW	SECTION	QS	QQS	UNIT	PH	COND	ALK	THARD	NO3	CL	SI	BACT	CA	CU	FE	K	MG	MN	NA	PB	ZN	AS	SO4
15	21	E	9	SW	NE	Plymouth	7.57	915	376	460	3.4	65.5	0.7	NEG											
16	21	E	32	SE	SW	Rhine	8.19	373	188	192	<0.1	11.0	0.7	NEG											
16	21	E	15	SW	SW	Rhine	8.01	735	340	392	4.2	29.5	1.0	NEG											
16	21	E	30	SE	SW	Rhine	8.12	630	304	356	2.5	22.0	1.0	NEG	76.6	0.032	0.004	1.3	40.1	<0.001	7.0	0.002	0.619	<0.005	21.1
16	21	E	30	NE	NW	Rhine	8.18	386	220	120	<0.1	1.5	0.6	NEG											
16	21	E	19	SE	SE	Rhine	8.05	720	328	360	0.8	41.5	1.0	NEG											
16	21	E	33	SE	NE	Rhine	7.78	571	280	296	<0.1	24.0	0.6	NEG											
16	22	E	19	SW	NW	Herman	7.77	695	332	356	4.7	23.5	0.8	NEG	0.4	0.200	<0.002	0.3	0.2	<0.001	184.8	0.006	0.075	<0.005	23.9
16	21	E	28	NW	NE	Rhine	7.90	674	304	4	1.7	35.5	-1.1	NEG											
16	21	E	34	NE	NE	Rhine	8.03	762	312	320	0.9	67.0	0.9	POS											
16	21	E	32	SE	NW	Rhine	8.49	617	300	329	<0.1	16.0	1.4	NEG	71.5	0.008	1.079	1.4	36.5	0.900	6.7	<0.002	0.008	<0.005	21.6
16	21	E	32	SW	NE	Rhine	8.18	486	240	248	<0.1	28.0	0.9	NEG											
16	21	E	16	SE	NE	Rhine	7.90	634	296	340	5.3	19.0	0.8	POS											
16	21	E	30	NE	NE	Rhine	8.24	558	252	275	<0.1	8.0	0.8	NEG	42.3	0.445	0.019	1.3	41.0	0.005	4.0	0.006	0.087	<0.005	25.1
16	21	E	32	SW	NW	Rhine	7.88	530	256	276	0.2	23.0	0.7	NEG											
16	21	E	31	SE	NE	Rhine	7.86	651	312	336	0.6	28.0	0.8	NEG											
16	21	E	15	SW	SE	Rhine	7.98	668	332	376	3.7	14.5	1.0	NEG											
16	21	E	33	NE	NW	Rhine	8.34	433	224	228	<0.1	2.0	1.0	POS											
16	21	E	32	SW	NE	Rhine	8.00	574	264	295	<0.1	39.5	0.8	NEG	66.0	0.019	2.673	2.0	31.6	0.042	13.4	0.004	0.022	<0.005	10.6
16	21	E	31	SE	SE	Rhine	8.34	783	336	380	<0.1	70.0	1.3	NEG											
16	21	E	29	NW	NW	Rhine	8.18	563	300	312	<0.1	9.0	1.1	NEG											
16	20	E	12	NW	NW	Russell	7.68	918	352	488	26.9	38.0	0.8	NEG											
16	21	E	30	SE	NW	Rhine	8.19	545	300	332	<0.1	5.0	1.0	NEG	64.8	0.010	0.356	1.1	41.4	0.016	3.7	<0.002	0.175	<0.005	19.4
16	21	E	30	NW	SE	Rhine	8.03	875	376	4	4.1	30.5	-0.9	NEG											
16	21	E	20	NW	NW	Rhine	7.82	766	328	382	1.2	56.0	0.7	NEG	77.8	0.227	0.116	1.7	45.4	0.005	23.3	0.005	0.476	0.005	22.9
16	21	E	17	SW	SW	Rhine	8.01	707	312	344	1.0	45.5	0.9	NEG											
16	21	E	32	SW	NW	Rhine	8.23	622	308	336	<0.1	23.0	1.2	NEG											
16	21	E	30	SE	SW	Rhine	7.91	670	332	371	1.9	21.5	0.8	POS	69.6	0.067	0.015	3.0	47.9	0.110	10.3	<0.002	0.125	0.006	25.9
16	21	E	15	SE	SE	Rhine	8.23	708	328	380	3.7	32.5	1.2	NEG											
16	21	E	32	SE	SW	Rhine	8.25	385	192	188	<0.1	17.0	0.8	NEG											
16	21	E	30	SE	SE	Rhine	7.88	648	312	340	2.1	21.5	0.8	NEG											
16	21	E	30	SE	SW	Rhine	8.05	695	324	383	5.2	27.0	1.0	NEG	81.3	0.639	0.008	1.8	43.6	<0.001	7.9	0.022	0.405	<0.005	23.5
17	22	E	31	NW	SE	Meeme	8.22	380	216	191	<0.1	2.5	0.6	POS	31.0	0.029	1.971	1.0	27.6	0.019	16.1	0.014	0.088	<0.005	6.0
16	21	E	20	NE	NW	Rhine	8.09	518	284	308	1.1	5.0	0.9	POS	64.1	0.014	0.089	1.0	35.8	0.003	3.2	0.003	0.326	<0.005	15.4
16	21	E	19	SE	NW	Rhine	8.01	594	328	352	<0.1	3.0	1.0	NEG											
16	21	E	30	SE	SW	Rhine	8.05	665	296	304	4.3	33.5	0.9	POS											
16	21	E	30	NW	NE	Rhine	7.78	996	392	440	2.7	94.5	0.9	NEG											
16	21	E	19	SE	SW	Rhine	8.13	506	304	272	<0.1	1.5	1.0	NEG											
16	21	E	30	SE	SW	Rhine	8.12	821	380	432	6.3	41.0	1.2	NEG											
16	21	E	30	SE	SW	Rhine	7.95	687	300	352	5.9	30.5	0.9	POS											
16	21	E	30	SE	SW	Rhine	8.04	747	336	388	2.6	43.0	1.1	NEG											
16	21	E	30	NE	NW	Rhine	7.75	866	336	358	2.3	87.5	0.7	POS	76.6	0.413	0.024	1.2	40.4	0.004	7.2	<0.002	0.130	0.006	19.6
16	21	E	32	SW	NW	Rhine	8.36	704	328	4	<0.1	28.5	-0.8	NEG	0.7	1.185	0.090	5.2	0.8	0.010	186.8	0.003	0.071	<0.005	18.8
16	21	E	30	SE	SE	Rhine	7.84	643	316	348	1.7	22.5	0.8	POS											
16	21	E	30	SE	SW	Rhine	8.15	630	304	257	2.2	22.5	0.9	NEG	51.4	0.237	<0.002	3.1	31.2	0.005	52.7	0.004	2.160	<0.005	21.7
16	23	E	33	SE	SE	Mosel	8.01	603	232	218	<0.1	37.0	0.6	NEG	46.1	0.001	0.521	1.7	25.0	0.033	55.2	<0.002	0.036	<0.005	51.2
15	21	E	15	SE	SW	Plymouth	8.03	631	336	384	<0.1	16.0	0.8	POS	52.3	0.009	0.588	1.8	61.5	0.018	7.0	0.002	0.311	0.019	23.7
16	21	E	30	NE	NW	Rhine	7.93	751	312	378	1.0	66.0	0.8	NEG	73.7	0.062	0.038	1.4	47.1	<0.001	16.2	0.005	0.185	0.005	15.7
16	21	E	32	SW	SE	Rhine	8.27	454	220	220	<0.1	25.5	0.9	NEG											
16	21	E	30	SW	NE	Rhine	8.25	579	304	324	<0.1	12.0	1.2	NEG											
16	21	E	34	SW	SW	Rhine	7.71	849	340	382	0.8	81.0	0.7	POS	81.4	0.195	0.025	1.6	43.4	0.002	42.6	0.006	0.634	<0.005	25.3

TOWN	RANGE	REW	SECTION	QS	QQS	UNIT	PH	COND	ALK	THARD	NO3	CL	SI	BACT	CA	CU	FE	K	MG	MN	NA	PB	ZN	AS	SO4
16	21	E	30	SE	NW	Rhine	8.07	549	300	326	0.2	5.0	0.9	NEG	63.2	0.004	0.665	1.2	40.7	0.028	3.6	<0.002	0.448	<0.005	19.5
16	21	E	29	NW	NW	Rhine	7.90	719	328	340	2.4	40.0	0.9	NEG											
16	21	E	29	NW	NW	Rhine	8.23	563	296	316	<0.1	10.5	1.1	POS											
16	21	E	6	NE	SE	Rhine	8.20	632	304	344	1.9	27.0	1.1	NEG											
16	21	E	12	SW	SW	Rhine	8.11	452	260	252	<0.1	4.5	0.9	POS	0.4	<0.001	0.264	<0.3	0.1	0.002	124.9	0.002	0.494	<0.005	0.7
16	21	E	32	NW	SE	Rhine	7.88	880	328	468	25.9	37.5	0.9	NEG	99.3	1.459	0.007	0.9	53.3	0.002	11.1	0.046	5.411	<0.005	13.2
16	21	E	30	NE	NW	Rhine	7.92	889	340	414	2.7	100.0	0.9	NEG	79.0	0.190	0.007	1.4	52.5	0.009	26.4	0.002	4.723	<0.005	15.0
15	20	E	4	NW	NE	Greenbush	8.27	580	328	284	<0.1	4.0	1.2	NEG	0.4	0.005	0.013	0.5	<0.1	<0.001	165.6	0.003	0.014	<0.005	20.7
16	21	E	30	NE	NE	Rhine	7.70	811	364	372	2.0	60.0	0.3	POS	36.5	0.574	0.110	0.8	21.3	0.003	137.7	0.012	3.959	<0.005	19.6
16	21	E	30	NE	NE	Rhine	8.06	601	320	340	0.4	10.0	1.0	NEG											
16	21	E	17	SE	NW	Rhine	7.92	830	332	393	3.1	74.5	0.9	NEG	84.1	0.052	0.011	2.5	44.2	0.001	32.9	0.002	0.111	<0.005	16.1
16	21	E	30	NE	NW	Rhine	7.90	893	344	408	2.5	96.5	0.9	NEG											
14	21	E	18	SE	SW	Lyndon	8.33	533	296	291	<0.1	1.5	1.1	POS	58.2	0.002	0.708	2.0	35.3	0.008	13.7	0.002	0.032	0.010	0.3
14	21	E	18	SE	SW	Lyndon	8.24	539	296	292	0.1	1.5	1.0	NEG	59.0	0.006	2.146	2.0	35.1	0.008	14.1	0.002	0.007	0.006	0.2
15	20	E	15	NE	NW	Greenbush	8.14	627	336	360	0.2	7.0	1.1	NEG											
15	21	E	32	NE	NW	Plymouth	8.12	578	268	316	1.5	34.5	1.0	NEG											
16	21	E	32	SE	NW	Rhine	8.43	427	228	4	<0.1	13.0	-0.7	NEG											
16	21	E	19	SE	SW	Rhine	8.01	480	280	256	<0.1	2.0	0.8	NEG											
16	21	E	26	SE	SW	Rhine	8.27	552	288	14	<0.1	5.5	-0.3	POS	2.6	0.028	0.003	0.5	1.7	0.001	1.3	0.002	0.415	<0.005	0.4
16	21	E	1	NW	NE	Rhine	8.14	484	264	268	<0.1	5.0	0.9	POS											
16	21	E	19	SE	NE	Rhine	7.95	1723	464	632	3.5	341.0	1.2	POS											
16	21	E	16	NE	NE	Rhine	8.24	663	300	4	4.1	17.5	-0.8	NEG											

APPENDEX C

ELKHART LAKE ASSOCIATION MINIPIEZOMETER SAMPLING RESULTS

Sample/Labslip ID	Sample Collected (Start) Date	Field #	Sample Description	Sample Location	Sample Depth	DNR Parameter Description	Result value	Units	Lab Comment
BP005922	7/26/2004	24 SHALLOW	24S MINI PIEZO	OSTHOFF BOAT BEACH ELKHART LAKE	4'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005922	7/26/2004	24 SHALLOW	24S MINI PIEZO	OSTHOFF BOAT BEACH ELKHART LAKE	4'	E COLI COLILERT QUANTITRAY MPN	<1.0	PER 100 ML	
BP005923	7/26/2004	25 SHALLOW	25S MINI PIEZO	FIREMAN'S PARK/ELKHART LAKE	5'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005923	7/26/2004	25 SHALLOW	25S MINI PIEZO	FIREMAN'S PARK/ELKHART LAKE	5'	E COLI COLILERT QUANTITRAY MPN	<1.0	PER 100 ML	
BP005924	7/26/2004	28 DEEP	28D MINI PIEZO	YOUNGER/SHEBOYGAN BAY/ELKHART LAKE	8'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005924	7/26/2004	28 DEEP	28D MINI PIEZO	YOUNGER/SHEBOYGAN BAY/ELKHART LAKE	8'	E COLI COLILERT QUANTITRAY MPN	<1.0	PER 100 ML	
BP005925	7/26/2004	14SHALLOW	14 S MINI PIE20	CAMP BROSIUS ELKHART LAKE	4 FT	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005925	7/26/2004	14SHALLOW	14 S MINI PIE20	CAMP BROSIUS ELKHART LAKE	4 FT	E COLI COLILERT QUANTITRAY MPN	<10.0	PER 100 ML	
BP005926	7/26/2004	9 DEEP	9 DEEP MINI PIEZO	PFALLER/SHORELAND RD/ELKHART LAKET	9'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005926	7/26/2004	9 DEEP	9 DEEP MINI PIEZO	PFALLER/SHORELAND RD/ELKHART LAKET	9'	E COLI COLILERT QUANTITRAY MPN	1	PER 100 ML	
BP005927	7/26/2004	5DEEP	5D MINI PIE20	STRIGENZ/SHORELAND ROAD/ELKHART LAKE	8 FT	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005927	7/26/2004	5DEEP	5D MINI PIE20	STRIGENZ/SHORELAND ROAD/ELKHART LAKE	8 FT	E COLI COLILERT QUANTITRAY MPN	<10.0	PER 100 ML	
BP005928	7/26/2004	8 SHALLOW	8S MINI PIEZO	PFALLER/SHORELAND RD/ELKHART LAKE	5'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005928	7/26/2004	8 SHALLOW	8S MINI PIEZO	PFALLER/SHORELAND RD/ELKHART LAKE	5'	E COLI COLILERT QUANTITRAY MPN	<1.0	PER 100 ML	
BP005929	7/26/2004	3 DEEP	3D MINI PIEZO	SELLINGER/SHORELAND RD/ELKHART LAKE	8'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005929	7/26/2004	3 DEEP	3D MINI PIEZO	SELLINGER/SHORELAND RD/ELKHART LAKE	8'	E COLI COLILERT QUANTITRAY MPN	<1.0	PER 100 ML	
BP005930	7/26/2004	4 SHALLOW	4S MINI PIEZO	STRINGENZ/SHORELAND RD/ELKHART LAKE	4'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS

Sample/Labslip ID	Sample Collected (Start) Date	Field #	Sample Description	Sample Location	Sample Depth	DNR Parameter Description	Result value	Units	Lab Comment
BP005930	7/26/2004	4 SHALLOW	4S MINI PIEZO	STRINGENZ/SHORELAND RD/ELKHART LAKE	4'	E COLI COLILERT QUANTITRAY MPN	<1.0	PER 100 ML	
BP005962	7/26/2004	22 SHALLOW	22S MINI PIEZO	SEIFERT/TURTLE BAY POINT	4'	TEMPERATURE AT LAB	*ICED	C	SAMPLE EXCEEDS 6 HRS/TESTED WITHIN 24-48 HRS
BP005962	7/26/2004	22 SHALLOW	22S MINI PIEZO	SEIFERT/TURTLE BAY POINT	4'	E COLI COLILERT QUANTITRAY MPN	<1.0	PER 100 ML	
BP012792	8/24/2004	85	5 FT PREZOMETER	PFALLER SPRINGS		TEMPERATURE AT LAB	*ICED	C	
BP012792	8/24/2004	85	5 FT PREZOMETER	PFALLER SPRINGS		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012793	8/24/2004	5D	8 FT PREZOMETER - STRIZENG (NEURES BAY) LOW RECHARGE	STRIZENG LOT LINE	8	TEMPERATURE AT LAB	*ICED	C	
BP012793	8/24/2004	5D	8 FT PREZOMETER - STRIZENG (NEURES BAY) LOW RECHARGE	STRIZENG LOT LINE	8	E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012794	8/24/2004	9D	8 FT PIEZOMETER	PFALLER SPRINGS		TEMPERATURE AT LAB	*ICED	C	
BP012794	8/24/2004	9D	8 FT PIEZOMETER	PFALLER SPRINGS		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012795	8/24/2004	3D	PIEZOMETER	SELLINGER SPRING AREA		TEMPERATURE AT LAB	*ICED	C	
BP012795	8/24/2004	3D	PIEZOMETER	SELLINGER SPRING AREA		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012796	8/24/2004	14S	4 FT. PIEZOMETER	CAMP BROSIUS		TEMPERATURE AT LAB	*ICED	C	
BP012796	8/24/2004	14S	4 FT. PIEZOMETER	CAMP BROSIUS		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012797	8/24/2004	22	5 FT. PLEZOMETER	SEIFERT POINT (TURTLE BAY)		TEMPERATURE AT LAB	*ICED	C	
BP012797	8/24/2004	22	5 FT. PLEZOMETER	SEIFERT POINT (TURTLE BAY)		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012798	8/24/2004	24	4 FT PEZOMETER	OSTHOFF BEACH		TEMPERATURE AT LAB	*ICED	C	
BP012798	8/24/2004	24	4 FT PEZOMETER	OSTHOFF BEACH		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012799	8/24/2004	25	5 FT. PIEZOMETER	FIREMAN'S PARK NORTHEAST END		TEMPERATURE AT LAB	*ICED	C	
BP012799	8/24/2004	25	5 FT. PIEZOMETER	FIREMAN'S PARK NORTHEAST END		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012800	8/24/2004	28	8 FT PIEZOMETER	YOUNGER SHEBOYGAN BAY		TEMPERATURE AT LAB	*ICED	C	
BP012800	8/24/2004	28	8 FT PIEZOMETER	YOUNGER SHEBOYGAN BAY		E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	SHIPPING PROBLEM
BP012806	8/24/2004	29	4 FT PIEZOMETER	YOUNGER - SHEBOYGAN BAY	4	TEMPERATURE AT LAB	*ICED	C	
BP012806	8/24/2004	29	4 FT PIEZOMETER	YOUNGER - SHEBOYGAN BAY	4	E COLI COLILERT QUANTITRAY MPN	*SP	PER 100 ML	BOTTLE CONTAINED SULFURIC ACID
IP002670	7/26/2004	22 SHALLOW	MINI PIEZOMETER (22S)	SEIFERT, TURTLE BAY POINT - ELKHART LAKE	F4	TEMPERATURE AT LAB	ICED	C	
IP002670	7/26/2004	22 SHALLOW	MINI PIEZOMETER (22S)	SEIFERT, TURTLE BAY POINT - ELKHART LAKE	F4	NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	

Sample/Labslip ID	Sample Collected (Start) Date	Field #	Sample Description	Sample Location	Sample Depth	DNR Parameter Description	Result value	Units	Lab Comment
IP002670	7/26/2004	22 SHALLOW	MINI PIEZOMETER (22S)	SEIFERT, TURTLE BAY POINT - ELKHART LAKE	F4	PHOSPHORUS TOTAL	0.099	MG/L	
IP002670	7/26/2004	22 SHALLOW	MINI PIEZOMETER (22S)	SEIFERT, TURTLE BAY POINT - ELKHART LAKE	F4	CHLORIDE	9.7	MG/L	
IP002671	7/26/2004	24 SHALLOW	MINI PIEZOMETER (24S)	OSTHOFF RESORT, BOAT BEACH - ELKHART LAKE	F4	TEMPERATURE AT LAB	ICED	C	
IP002671	7/26/2004	24 SHALLOW	MINI PIEZOMETER (24S)	OSTHOFF RESORT, BOAT BEACH - ELKHART LAKE	F4	NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP002671	7/26/2004	24 SHALLOW	MINI PIEZOMETER (24S)	OSTHOFF RESORT, BOAT BEACH - ELKHART LAKE	F4	PHOSPHORUS TOTAL	0.191	MG/L	
IP002671	7/26/2004	24 SHALLOW	MINI PIEZOMETER (24S)	OSTHOFF RESORT, BOAT BEACH - ELKHART LAKE	F4	CHLORIDE	21.6	MG/L	
IP002672	7/26/2004	25 SHALLOW	MINI PIEZOMETER (25S)	FIREMAN'S PARK - ELKHART LAKE	F5	TEMPERATURE AT LAB	ICED	C	
IP002672	7/26/2004	25 SHALLOW	MINI PIEZOMETER (25S)	FIREMAN'S PARK - ELKHART LAKE	F5	NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP002672	7/26/2004	25 SHALLOW	MINI PIEZOMETER (25S)	FIREMAN'S PARK - ELKHART LAKE	F5	PHOSPHORUS TOTAL	0.151	MG/L	
IP002672	7/26/2004	25 SHALLOW	MINI PIEZOMETER (25S)	FIREMAN'S PARK - ELKHART LAKE	F5	CHLORIDE	142	MG/L	
IP002673	7/26/2004	28 DEEP	MINI PIEZOMETER (28D)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F8	TEMPERATURE AT LAB	ICED	C	
IP002673	7/26/2004	28 DEEP	MINI PIEZOMETER (28D)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F8	NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP002673	7/26/2004	28 DEEP	MINI PIEZOMETER (28D)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F8	PHOSPHORUS TOTAL	0.047	MG/L	
IP002673	7/26/2004	28 DEEP	MINI PIEZOMETER (28D)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F8	CHLORIDE	33.2	MG/L	
IP002674	7/26/2004	29 SHALLOW	MINI PIEZOMETER (29S)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F4	TEMPERATURE AT LAB	ICED	C	
IP002674	7/26/2004	29 SHALLOW	MINI PIEZOMETER (29S)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F4	NITROGEN NO3+NO2 DISS (AS N)	2.04	MG/L	
IP002674	7/26/2004	29 SHALLOW	MINI PIEZOMETER (29S)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F4	PHOSPHORUS TOTAL	0.097	MG/L	
IP002674	7/26/2004	29 SHALLOW	MINI PIEZOMETER (29S)	YOUNGER, SHEBOYGAN BAY - ELKHART LAKE	F4	CHLORIDE	16.1	MG/L	
IP002675	7/26/2004	3 D	MINI PIEZOMETER (3D)	SELLINGER, SHORELAND RD	F8	TEMPERATURE AT LAB	ICED	C	
IP002675	7/26/2004	3 D	MINI PIEZOMETER (3D)	SELLINGER, SHORELAND RD	F8	NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP002675	7/26/2004	3 D	MINI PIEZOMETER (3D)	SELLINGER, SHORELAND RD	F8	PHOSPHORUS TOTAL	0.033	MG/L	
IP002675	7/26/2004	3 D	MINI PIEZOMETER (3D)	SELLINGER, SHORELAND RD	F8	CHLORIDE	20.7	MG/L	
IP002676	7/26/2004	4 S	MINI PIEZOMETER (4S)	STRIGENZ, SHORELAND RD	F4	TEMPERATURE AT LAB	ICED	C	
IP002676	7/26/2004	4 S	MINI PIEZOMETER (4S)	STRIGENZ, SHORELAND RD	F4	NITROGEN NO3+NO2 DISS (AS N)	0.026	MG/L	
IP002676	7/26/2004	4 S	MINI PIEZOMETER (4S)	STRIGENZ, SHORELAND RD	F4	PHOSPHORUS TOTAL	0.022	MG/L	
IP002676	7/26/2004	4 S	MINI PIEZOMETER (4S)	STRIGENZ, SHORELAND RD	F4	CHLORIDE	53.6	MG/L	

Sample/Labslip ID	Sample Collected (Start) Date	Field #	Sample Description	Sample Location	Sample Depth	DNR Parameter Description	Result value	Units	Lab Comment
IP002677	7/26/2004	8 SHALLOW	MINI PIEZOMETER (8S)	PFALLER, SHORELAND RD - ELKHART LAKE	F4	TEMPERATURE AT LAB	ICED	C	
IP002677	7/26/2004	8 SHALLOW	MINI PIEZOMETER (8S)	PFALLER, SHORELAND RD - ELKHART LAKE	F4	NITROGEN NO3+NO2 DISS (AS N)	4.3	MG/L	
IP002677	7/26/2004	8 SHALLOW	MINI PIEZOMETER (8S)	PFALLER, SHORELAND RD - ELKHART LAKE	F4	PHOSPHORUS TOTAL	0.199	MG/L	
IP002677	7/26/2004	8 SHALLOW	MINI PIEZOMETER (8S)	PFALLER, SHORELAND RD - ELKHART LAKE	F4	CHLORIDE	87.4	MG/L	
IP002678	7/26/2004	9 DEEP	MINI PIEZOMETER (9D)	PFALLER, SHORELAND RD - ELKHART LAKE	F9	TEMPERATURE AT LAB	ICED	C	
IP002678	7/26/2004	9 DEEP	MINI PIEZOMETER (9D)	PFALLER, SHORELAND RD - ELKHART LAKE	F9	NITROGEN NO3+NO2 DISS (AS N)	2.66	MG/L	
IP002678	7/26/2004	9 DEEP	MINI PIEZOMETER (9D)	PFALLER, SHORELAND RD - ELKHART LAKE	F9	PHOSPHORUS TOTAL	0.368	MG/L	
IP002678	7/26/2004	9 DEEP	MINI PIEZOMETER (9D)	PFALLER, SHORELAND RD - ELKHART LAKE	F9	CHLORIDE	111	MG/L	
IP002679	7/26/2004	14 SHALLOW	MINI PIEZOMETER (14S)	CAMP BROSIUS - ELKHART LAKE	F4	TEMPERATURE AT LAB	ICED	C	
IP002679	7/26/2004	14 SHALLOW	MINI PIEZOMETER (14S)	CAMP BROSIUS - ELKHART LAKE	F4	NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP002679	7/26/2004	14 SHALLOW	MINI PIEZOMETER (14S)	CAMP BROSIUS - ELKHART LAKE	F4	PHOSPHORUS TOTAL	0.051	MG/L	
IP002679	7/26/2004	14 SHALLOW	MINI PIEZOMETER (14S)	CAMP BROSIUS - ELKHART LAKE	F4	CHLORIDE	22	MG/L	
IP002680	7/26/2004	5 D	MINI PIEZOMETER (5D)	STRIGENZ, SHORELAND ROAD	F8	TEMPERATURE AT LAB	ICED	C	
IP002680	7/26/2004	5 D	MINI PIEZOMETER (5D)	STRIGENZ, SHORELAND ROAD	F8	NITROGEN NO3+NO2 DISS (AS N)	**	MG/L	NO BOTTLE RECEIVED, NO TEST DONE
IP002680	7/26/2004	5 D	MINI PIEZOMETER (5D)	STRIGENZ, SHORELAND ROAD	F8	PHOSPHORUS TOTAL	**	MG/L	NO BOTTLE RECEIVED, NO TEST DONE
IP002680	7/26/2004	5 D	MINI PIEZOMETER (5D)	STRIGENZ, SHORELAND ROAD	F8	CHLORIDE	49	MG/L	
IP005617	8/24/2004	9D	PIEZOMETER #9D (DEEP) - TAN COLOR	PFALLER SPRING		TEMPERATURE AT LAB	ICED	C	
IP005617	8/24/2004	9D	PIEZOMETER #9D (DEEP) - TAN COLOR	PFALLER SPRING		NITROGEN NO3+NO2 DISS (AS N)	2.06	MG/L	
IP005617	8/24/2004	9D	PIEZOMETER #9D (DEEP) - TAN COLOR	PFALLER SPRING		PHOSPHORUS TOTAL	0.233	MG/L	
IP005617	8/24/2004	9D	PIEZOMETER #9D (DEEP) - TAN COLOR	PFALLER SPRING		CHLORIDE	114	MG/L	
IP005618	8/24/2004	14S	PIEZOMETER #14S (SHALLOW - 5 FT)	CAMP BROSIUS		TEMPERATURE AT LAB	ICED	C	
IP005618	8/24/2004	14S	PIEZOMETER #14S (SHALLOW - 5 FT)	CAMP BROSIUS		NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP005618	8/24/2004	14S	PIEZOMETER #14S (SHALLOW - 5 FT)	CAMP BROSIUS		PHOSPHORUS TOTAL	0.053	MG/L	
IP005618	8/24/2004	14S	PIEZOMETER #14S (SHALLOW - 5 FT)	CAMP BROSIUS		CHLORIDE	21.1	MG/L	
IP005619	8/24/2004	22S	PIEZOMETER #22S (SHALLOW - 5FT) - GRAY MILKY SEDIMENT	SEIFERT POINT		TEMPERATURE AT LAB	ICED	C	

Sample/Labslip ID	Sample Collected (Start) Date	Field #	Sample Description	Sample Location	Sample Depth	DNR Parameter Description	Result value	Units	Lab Comment
IP005619	8/24/2004	22S	PIEZOMETER #22S (SHALLOW - 5FT) - GRAY MILKY SEDIMENT	SEIFERT POINT		NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP005619	8/24/2004	22S	PIEZOMETER #22S (SHALLOW - 5FT) - GRAY MILKY SEDIMENT	SEIFERT POINT		PHOSPHORUS TOTAL	0.137	MG/L	
IP005619	8/24/2004	22S	PIEZOMETER #22S (SHALLOW - 5FT) - GRAY MILKY SEDIMENT	SEIFERT POINT		CHLORIDE	10.2	MG/L	
IP005620	8/24/2004	24S	PIEZOMETER #24S (SHALLOW - 4FT)	OSTHOFF BEACH		TEMPERATURE AT LAB	ICED	C	
IP005620	8/24/2004	24S	PIEZOMETER #24S (SHALLOW - 4FT)	OSTHOFF BEACH		NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP005620	8/24/2004	24S	PIEZOMETER #24S (SHALLOW - 4FT)	OSTHOFF BEACH		PHOSPHORUS TOTAL	0.118	MG/L	
IP005620	8/24/2004	24S	PIEZOMETER #24S (SHALLOW - 4FT)	OSTHOFF BEACH		CHLORIDE	21.9	MG/L	
IP005621	8/24/2004	25	PIEZOMETER #25 (SHALLOW - 5FT)	FIREMAN'S PARK		TEMPERATURE AT LAB	ICED	C	
IP005621	8/24/2004	25	PIEZOMETER #25 (SHALLOW - 5FT)	FIREMAN'S PARK		NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP005621	8/24/2004	25	PIEZOMETER #25 (SHALLOW - 5FT)	FIREMAN'S PARK		PHOSPHORUS TOTAL	0.062	MG/L	
IP005621	8/24/2004	25	PIEZOMETER #25 (SHALLOW - 5FT)	FIREMAN'S PARK		CHLORIDE	146	MG/L	
IP005622	8/24/2004	28	PIEZOMETER #28 (DEEP - 8FT)	FIREMAN'S PARK		TEMPERATURE AT LAB	ICED	C	
IP005622	8/24/2004	28	PIEZOMETER #28 (DEEP - 8FT)	FIREMAN'S PARK		NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP005622	8/24/2004	28	PIEZOMETER #28 (DEEP - 8FT)	FIREMAN'S PARK		PHOSPHORUS TOTAL	0.017	MG/L	
IP005622	8/24/2004	28	PIEZOMETER #28 (DEEP - 8FT)	FIREMAN'S PARK		CHLORIDE	33.9	MG/L	
IP005623	8/24/2004	4S	PIEZOMETER #4S (SHALLOW - 4FT)	STRIGENZ LOT LINE		TEMPERATURE AT LAB	ICED	C	
IP005623	8/24/2004	4S	PIEZOMETER #4S (SHALLOW - 4FT)	STRIGENZ LOT LINE		NITROGEN NO3+NO2 DISS (AS N)	ND	MG/L	
IP005623	8/24/2004	4S	PIEZOMETER #4S (SHALLOW - 4FT)	STRIGENZ LOT LINE		PHOSPHORUS TOTAL	0.024	MG/L	
IP005623	8/24/2004	4S	PIEZOMETER #4S (SHALLOW - 4FT)	STRIGENZ LOT LINE		CHLORIDE	65.1	MG/L	
IP005624	8/24/2004	8S	PIEZOMETER #8S (SHALLOW) - TAN COLOR	PFALLER SPRING		TEMPERATURE AT LAB	ICED	C	
IP005624	8/24/2004	8S	PIEZOMETER #8S (SHALLOW) - TAN COLOR	PFALLER SPRING		NITROGEN NO3+NO2 DISS (AS N)	2.21	MG/L	
IP005624	8/24/2004	8S	PIEZOMETER #8S (SHALLOW) - TAN COLOR	PFALLER SPRING		PHOSPHORUS TOTAL	0.308	MG/L	
IP005624	8/24/2004	8S	PIEZOMETER #8S (SHALLOW) - TAN COLOR	PFALLER SPRING		CHLORIDE	73.3	MG/L	
IP005625	8/24/2004	3D	PIEZOMETER #3D (DEEP - 8FT)	SELLINGER POINT		TEMPERATURE AT LAB	ICED	C	
IP005625	8/24/2004	3D	PIEZOMETER #3D (DEEP - 8FT)	SELLINGER POINT		NITROGEN NO3+NO2 DISS (AS N)	3.12	MG/L	
IP005625	8/24/2004	3D	PIEZOMETER #3D (DEEP - 8FT)	SELLINGER POINT		PHOSPHORUS TOTAL	0.022	MG/L	

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IP005625	8/24/2004	3D	PIEZOMETER #3D (DEEP - 8FT)	SELLINGER POINT		CHLORIDE	20.9	MG/L	
IP005626	8/24/2004	29	PIEZOMETER #29 (SHALLOW - 4FT) - CLOUDY W/SEDIMENT	YOUNGER - SHEBOYGAN BAY		TEMPERATURE AT LAB	ICED	C	
IP005626	8/24/2004	29	PIEZOMETER #29 (SHALLOW - 4FT) - CLOUDY W/SEDIMENT	YOUNGER - SHEBOYGAN BAY		NITROGEN NO3+NO2 DISS (AS N)	0.98	MG/L	
IP005626	8/24/2004	29	PIEZOMETER #29 (SHALLOW - 4FT) - CLOUDY W/SEDIMENT	YOUNGER - SHEBOYGAN BAY		PHOSPHORUS TOTAL	0.071	MG/L	
IP005626	8/24/2004	29	PIEZOMETER #29 (SHALLOW - 4FT) - CLOUDY W/SEDIMENT	YOUNGER - SHEBOYGAN BAY		CHLORIDE	23.6	MG/L	