DATA COMPILATION AND MANAGEMENT OPTIONS FOR THE LAKE BENEDICT/TOMBEAU DAM

WALWORTH COUNTY, WISCONSIN

August 23, 2003

Northern Environmental[SM]
Hydrologists • Engineers • Geologists

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Prepared for:

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1.0 EXECUTIVE SUMMARY

The Lake Benedict/Lake Tombeau Lake Management District (the Lake District) owns a low head-water level control dam. The Wisconsin Department of Natural Resources (WDNR) has ordered that the dam be repaired or replaced. Northern Environmental was contracted to complete a study to help the Lake District identify feasible dam management options.

The practicality and cost of four dam management options were compared. These included repairing the existing dam and constructing new dams made of concrete, earth, or sheet piling. Dam repair and construction of an earthen dam were not found to be practical. A new sheet piling dam can be installed for between $50,000 and $70,000, having a minimum useful life of 20 to 25 years. A concrete dam will cost approximately twice this amount, but can be expected to last approximately twice as long. The final choice will depend on the desires of the Lake District and its constituents.

The normal water level of the lakes is a matter of controversy, and is a critical element to dam design. A consensus must be reached regarding what “normal” water levels are, and potential modification made to state and federal records and studies.

Over half of Lake Tombeau is filled with oxygen-deficient water during mid summer. This situation promotes the nuisance growth of algae and other aquatic plants, and limits the portion of the lake supporting desirable aquatic plants and animals. Options exist that should help improve water quality and aquatic habitat in Lake Tombeau. A bottom-draw draft tube incorporated into the design of the replacement dam should reduce the volume of anoxic water found in Lake Tombeau in summer. This in turn should help reduce nuisance aquatic plant and algal growth, and should increase the proportion of the lake providing habitat to desirable aquatic plants and animals. However, the cost of the draft tube could more than double the price of the dam. The long-term cost of a possible alternative (in-lake aeration) is essentially equal to the long-term cost of the bottom-draw draft tube. The Lake District and its constituents will need to consider if the benefits of this option justify its cost.

2.0 INTRODUCTION AND BACKGROUND INFORMATION

Lake Benedict (occasionally referred to as Benedict Lake) and Lake Tombeau (commonly referred to as Tombeau Lake, and formerly known as Nippersink Lake) are located astride the Walworth/Kenosha County line in extreme southeastern Wisconsin. The two lakes are connected by a narrow channel, share the same water level, and essentially behave as one lake with two distinct basins. The East Branch of Nippersink Creek acts as the outlet for Lakes Benedict and Tombeau. A low-head dam is located at the end of an artificially deepened and straightened channel on the west end of Lake Tombeau. This dam is used to stabilize/modify the water levels in both lakes. Wisconsin Department of Natural Resources (WDNR) inspectors judged that the dam was in a serious state of disrepair and issued repair orders on April 19, 2000.

The Lake Benedict/Tombeau Lake Management District (Lake District) assumed control of the water level control dam during June 2002. The ownership transfer permit required that the Lake District observe a number of conditions, including submission of a plan to address outstanding repair work no later than November 1, 2002. In response to this requirement, the Lake District contacted and subsequently met with Northern Environmental Technologies, Incorporated (Northern Environmental) during October 2002. A conceptual workplan was developed and discussed with the Lake District and WDNR staff, and was used as the basis of the dam repair workplan submitted to the WDNR on October 24, 2002. This report presents the results of feasibility study portion of the workplan. As such, this report compiles information relevant to dam repair and design, and uses these data to help develop management options. The Lake District can then use these data and options to develop an action plan desirable to most stakeholders.

3.0 STUDY GOALS, METHODS, AND LIMITATIONS

The overall goal of this study is to assemble relevant information, interpret this information as needed, and estimate cost and other management concerns when possible. This process is designed to allow the Lake District members to educate themselves, thereby allowing them to:

- ▲ Evaluate various construction methods and materials and their effect on aesthetics, cost, maintenance, and dam longevity
- ▲ Consider alternate dam management scenarios, including incorporation of novel design elements that may benefit the lake ecosystem and lake users
- ▲ Recognize the importance of stakeholder needs, desires, and concerns in the overall project

Northern Environmental endeavors to present all information and options in an unbiased fashion, fostering an atmosphere allowing stakeholders to make a decision that is not only technically valid, but more importantly, is right for *them*. As such, we make recommendations only when there is a technical reason to do so or when specifically requested. This document specifically avoids the temptation of providing a prescribed “cook book” solution based solely on technical merit, instead presenting the information needed by those who will choose options and those who will be affected by the final decision. In this way, non-technical aspects of the decision making process are given importance in scale with the community’s needs and desires.

Northern Environmental spent considerable time and effort to locate information that is needed to evaluate the situation at hand, to develop management alternatives, and to develop attendant information critical to the decision making process (e.g., cost, practicality). The references from which we gathered information are presented in the references section (Section 7.0). Source or reference documents and analyses, as well as other particularly noteworthy information sources are included in the appendices.

4.0 NATURAL RESOURCE CHARACTERISTICS

4.1 Physiography

Lake Benedict lies mostly in the town of Randall, Kenosha County, Wisconsin. The northwestern third of Lake Benedict and all of Lake Tombeau lie in the town of Bloomfield, Walworth County, Wisconsin (Figure 1). The local area is scattered with numerous lakes. The second deepest natural lake in Wisconsin (Lake Geneva) is located less than 7 miles to the west-northwest. Other notable local lakes include Elizabeth Lake, Marie Lake, Powers Lake, and the Fox Lake Chain over the border in Illinois. Most local lakes are heavily used for recreation since they are situated near many large urban areas, including the Chicago and Milwaukee metropolitan areas.

Approximately 160 feet of relief exist within 2 miles of Lakes Benedict and Tombeau. The highest elevations are found just over a mile east of Powers Lake in an area of irregular topography just north of County Highway F. The highest known elevation in this area is over 950 feet above mean sea level (msl). Other prominent highlands include ridges just south of Lake Tombeau and south of Pell Lake that have elevations above 900 feet msl. The lowest elevation occurs at Elizabeth Lake (water surface elevation of 793 feet msl). Lakes Benedict and Tombeau share a water elevation of 822 feet msl and drain to the south southwest via Nippersink Creek. The topography of lands immediately surrounding the study area is illustrated in Figure 2. Figure 2 also presents lake depth contours and identifies the approximate dam site.

4.2 Climate

Southeastern Wisconsin has a continental climate with wide variations of temperature possible day-to-day and season-to-season. Winters are cold and rather snowy, while summers are warm with short periods of hot and humid weather. Areas near Lake Michigan have a somewhat moderated temperature regimen.

The growing season at Lake Geneva is 161 days. "Growing season" is defined as the number of days between the last freezing temperature in spring and the first freezing temperature in fall. Growing season length is also influenced by topography and other local factors. The number of daylight hours ranges from a minimum of 9 hours and 3 minutes during late December to 15 hours and 20 minutes during late June (Haszel, 1971).

Temperature and precipitation information for Lake Geneva are presented in the table below (WOI, 2003). These data should approximate conditions at Lake Benedict/Tombeau.

Table 1 Temperature and Precipitation Information

Climate Normals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Ave Daily High (°F)	27.4	32.6	44.0	58.4	71.1	81.0	85.0	82.4	74.5	62.0	46.5	32.2
Ave Daily Low (°F)	10.9	14.9	25.6	36.6	46.9	56.6	61.9	60.1	52.4	41.6	30.3	17.2
Ave Precip (inches)	1.84	1.46	2.78	3.66	3.25	3.88	4.30	3.92	4.09	2.74	2.65	2.34
Ave Snowfall (inches)	12.8	9.3	8.9	2.4	0.1	0.0	0.0	0.0	0.0	0.2	3.0	11.4

Rainfall intensities are important data for determining runoff volumes. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) recently revised rainfall intensity data (SEWRPC, 2000). These data are reproduced below.

Table 2 Recommended Design Rainfall Depths for Southeastern Wisconsin

	Recurrence Interval and Depths (inches)					
Storm Duration	**2 Years [a]**	**5 Years [a]**	**10 Years [a]**	**25 Years**	**50 Years**	**100 Years**
5 Minutes	0.40	0.48	0.54	0.62	0.68	0.74
10 Minutes	0.64	0.76	0.85	0.98	1.08	1.19
15 Minutes	0.83	0.98	1.07	1.21	1.31	1.41
30 Minutes	1.07	1.29	1.45	1.68	1.85	2.02
60 Minutes	1.31	1.60	1.84	2.20	2.50	2.82
2 Hours	1.54	1.93	2.23	2.73	3.16	3.64
3 Hours	1.68	2.07	2.40	2.93	3.39	3.89
6 Hours	1.95	2.40	2.79	3.44	4.03	4.70
12 Hours	2.24	2.74	3.17	3.89	4.53	5.25
24 Hours	2.57	3.14	3.62	4.41	5.11	5.88
48 Hours	3.04	3.71	4.20	4.94	5.53	6.13
72 Hours	3.29	3.94	4.40	5.09	5.63	6.17
5 Days	3.77	4.42	4.84	5.43	5.86	6.26
10 Days	4.68	5.42	5.89	6.55	7.03	7.46

[a] Factors presented in U.S. Weather Bureau TP-40 were applied to the SEWRPC 2000 annual series depths with recurrence intervals of 2, 5, and 10 years, converting these depths to the partial duration series amounts set forth in this table. The annual series depths were adjusted as follows:

2-year: multiplied by 1.136; 5-year: multiplied by 1.042; and 10-year multiplied by 1.010

Average annual lake evaporation in southeastern Wisconsin is approximately 30 inches (Chow, 1964). Evapotranspiration includes water evaporated directly from the soil or water surface, plus that drawn from the soil by plants. As such, total evapotranspiration is generally higher than evaporation, and the rate is highly dependent upon the type and growth stage of plants present.

4.3 Geology and Soils

4.3.1 Regional Setting

Southeastern Wisconsin and adjacent portions of Illinois were repeatedly glaciated, with the ice retreating for the last time less than 14,000 years ago. Glaciation deranged pre-existing drainage patterns, creating many wetlands, lakes, and wandering streams. The ice repeatedly advanced and withdrew, leaving a series of ridges (moraines) with intervening lowlands. Certain areas were also covered with sand and gravel deposited by glacial meltwaters. Ice blocks commonly were buried in these sediments. When the ice blocks melted, the land surface collapsed, forming a “kettle hole.” This is the origin of the name of the nearby Kettle Moraine.

Lakes Benedict and Tombeau are located just beyond the furthest advance of the ice sheet depositing the brown and gray clays of the Oak Creek Formation. The farthest advance of the Oak Creek Formation is demarked with a prominent ridge named the Valparaiso Moraine (Hansel, 1983) (Schneider, 1983) (Clayton, 2001). Silver Lake and Camp Lake lie just west of the Valparaiso Moraine, while the community of Salem sets upon it. The ridges to the west and northwest of the Lakes Benedict and Tombeau are named the Genoa Moraine and are composed of sandier sediments of the New Berlin Member of the Holy Hill Formation.

Water emanating from melting glaciers stalled at the Valparaiso and Genoa Moraines deposited the sand and gravel outwash in western portions of Racine County and eastern and northern Walworth County. When the ice blocks buried in the sand and gravel melted, the complexly sloping topography seen today was formed. The deposits are aptly named "pitted outwash" with the more pronounced pits commonly referred to as "kettles." The basins of many lakes in the local areas are likely depressions left after very large ice blocks melted.

According to regional references, approximately 150 feet of unconsolidated sediments overlie bedrock in the local area (Borman, 1976). Nearly all these sediments were deposited by glaciers. A thin veneer of post-glacial sediments is found in some areas along major water bodies and within wetlands. Relatively large areas of wetland deposited high organic content soil are found along the East Branch of Nippersink Creek, as well as the creeks tributary to Powers Lake, Pell Lake, and Lake Ivanhoe.

Silurian-age dolomite underlies all of the local area (Borman, 1976). The surface of the bedrock is fairly regular in the local area, dipping to the east, and has an elevation of approximately 700 feet msl. The dolomite bedrock has several colloquial names such as the "Niagara bedrock" and as a building material is often labeled "Lannon stone".

4.3.2 Local Conditions

According to well constructor logs, a thick interlayered sequence of sand and clay is underlies Lakes Benedict and Tombeau. Copies of the well construction logs are included in Appendix A. None of the local well logs encountered bedrock, and the deepest available well logs describes over 165 feet of sediment. In general, these logs suggest that up to six distinct layers of granular outwash and clayey glacial till are found. In most areas, the uppermost mineral soils are reportedly composed of sandy clay, which is likely glacial till. The thickness of this surficial till varies greatly, and is altogether absent is some areas. The till may be buried by sands and gravel deposited during and after glaciation. In low lying areas, marsh deposited silt and high organic content soils overly glacial deposits.

Figure 3 illustrates the distribution of soil types around Lake Tombeau and portions of Lake Benedict (Link and Demo, 1970) (Haszel, 1971). As can be seen from this figure, granular sediments are exposed at the surface in most areas. Granular sediments typically exhibit geotechnical properties favorable to construction. Soil in many low lying areas, and areas at the foot of some slopes, consists of water-laid silt, clay, and muck. These soils do not have good foundation characteristics, and typically either need to be removed or special construction options must be chosen. Based upon what is known about local geology, most of the water-deposited silt, clay, and muck are underlain by granular soils. The thickest accumulations of silt, clay, and muck are anticipated in wetlands, where over 5 feet of these soils can be anticipated to overlie granular soil.

Typically, regional information is the only data available to predict subsurface soil and geotechnical conditions at a proposed construction site. However, the proposed dam construction site is less than 1000 feet upstream of the U.S. Highway 12 Bridge over Nippersink Creek. A foundation study was completed before the bridge was built in the mid-1960s (WisDOT, 1961). Two boreholes were drilled and the soils were logged. The resultant data is presented in Figure 4. The Highway 12 Bridge study suggests that an extremely thick sequence of soft sediment is found in the lowlands bordering Nippersink Creek. The depth of soft sediment is probably much less at the dam site, since an area or high ground composed of granular sediment is directly adjacent to the dam site. Extrapolating the surface topography of the slope located west of the dam site into the wetlands, the dam site may be underlain by a few feet to 15 feet of soft sediment. Essentially no soft sediment likely exists near the west shoreline, with progressively thicker accumulations of soft sediment as one moves east away from the west shoreline.

4.4 Overview of Local Water Resources

4.4.1 Surface-Water Drainage Patterns

Lake Benedict and Lake Tombeau are essentially one lake connected by a low gradient channel. As such, they share essentially the same water level. Lake Benedict has small contributing surface watershed (377 acres) and no significant tributary streams, and is largely fed by ground water (SEWRPC, 2001). Lake Benedict also has 714 acres of internally drained lands in its watershed, area where all runoff accumulates in low areas and percolates into the ground. Water actively drains from Lake Benedict to Lake Tombeau through the connecting channel. This defines Lake Benedict as a spring lake, that is, a lake primarily fed by ground water having no visible inlet, yet having an actively flowing outlet. Much of the ground water entering Lake Benedict is believed to flow through the subsurface from nearby Powers Lake.

Lake Tombeau has a large contributing watershed (5595 acres) with 1037 acres draining directly to the lake. The headwater section of the East Branch of Nippersink enters Lake Tombeau from the north. A low head dam was constructed downstream of Lake Tombeau at the end of a channelized section of the East Branch of Nippersink Creek. The elevated water and artificially deepened and widened channel of the outlet stream now appear as a long narrow arm of Lake Tombeau. More information regarding the history and design of the existing dam can be found in Subsection 4.6.1. The combined flow of the headwater section of the East Branch of Nippersink Creek, the Lake Benedict (the outlet channel), and direct runoff from the lands tributary to Lake Tombeau exit the lake at the dam site. Most of the water entering Lake Tombeau is believed to be surface runoff. Since Lake Tombeau has both a surface water inlet and outlet, it is considered a drainage lake.

The East Branch of Nippersink Creek has two primary contributing branches upstream of Lake Tombeau. These two branches join about 1 mile upstream of Lake Tombeau. The eastern branch acts as the outlet for Powers Lake, drains wetlands north and northeast of Powers Lake, and derives almost all its waters from areas within Kenosha County. The other branch extends north, receiving water from a series of wetlands and agricultural areas.

After leaving Lake Tombeau, the East Branch of Nippersink Creek flows southwest and then south to its confluence with the North Branch of Nippersink Creek. The combined flow is still called the North Branch of Nippersink Creek as it crosses the state line just south of Genoa City, or about 3.4 stream miles south of the Lake Tombeau dam. Nippersink Creek downstream of Lake Tombeau is a low gradient stream, dropping less than 10 feet in 3.4 miles. The section just below the U.S. Highway 12 Bridge is particularly flat. After leaving Wisconsin, the North Branch of Nippersink Creek flows south and joins the main branch of Nippersink Creek. Just west of Solon Mills and enters Nippersink Lake, a lake in the Fox River chain of lakes. In Illinois, the North Branch of Nippersink Creek is considered a "biologically significant stream" (IDNR, 1996) with "some of the best water quality in the region" (Openlands Project, 2002). It has been nominated as an "outstanding resource waterway", and is considered to be one of Illinois' finest streams by the Illinois Natural History Survey (Prairie Rivers Network, 2001). The Fox River in turn drains to the Illinois River, a tributary of the Mississippi River.

4.4.2 Surface-Water/Ground-Water Interaction

Three primary aquifers underlie the local area. The deepest aquifer is composed of Ordovician and Cambrian-aged sandstone, is hydraulically isolated from other aquifers, and is usually referred to as the "Sandstone Aquifer". The sandstone aquifer is not likely an important component of the ground-water flow system feeding Lakes Benedict and Tombeau.

The uppermost bedrock in most eastern Wisconsin is composed of Silurian-age dolomite. This bedrock formation is a very important supplier of potable water, and is often referred to as the "Niagara Aquifer" or formation. The Niagara Aquifer is usually in good hydraulic communication with the overlying glacially deposited Sand and Gravel Aquifer. The Niagara and the Sand and Gravel Aquifers interact with surface water throughout the local area. Recharge typically occurs in highland areas, while discharge occurs in low lying areas along major water bodies. Much of the ground-water recharge in the Lake Benedict/Tombeau area likely occurs a few miles to the northwest.

Ground water is the primary source of water to Lake Benedict. Most of this water is suspected to flow through the narrow intervening gravelly ridge from Powers Lake. Powers Lake has a water elevation approximately 10 feet higher than Lake Benedict. Most ground water entering Lake Benedict leaves the basin via the channel opening to Lake Tombeau. Some water may also exfiltrate into the lake bottom, mostly in the southwest corner.

Ground water is likely a comparatively minor contributor to the water balance of Lake Tombeau. Ground water is most likely discharges to Lake Tombeau in its eastern half. Lake water likely exfiltrates through the lake bottom in the western half of the lake, especially near the water level control dam.

The U.S. Geological Society (USGS) qualified the amount of "low-flow runoff" in various watersheds through Walworth County (Borman, 1976). Low-flow runoff is basically ground-water contribution to surface water flow during periods of drought. The USGS determined that the watershed contributing to the East Branch of Nippersink Creek produces 1.20 cubic feet per second (cfs) of baseflow per square mile of watershed. Since 8.7 square miles contribute water to the Lake Tombeau outlet dam, the anticipated baseflow is 10.5 cfs (approximately 4700 gallons per minute). The actual apparent baseflow at the Tombeau dam is a fraction of this (estimated to be 1 cfs during fall 2002). Consequently, substantial volumes of water may be exiting Lake Tombeau through permeable sediments adjacent and below the dam site, or the USGS baseflow estimate cannot be accurately applied to the entire watershed, contributing to the flow at the outlet dam.

4.5 Limnology of Lakes Benedict and Tombeau

A short, low-gradient stream connects Lake Benedict and Lake Tombeau. Even though they are considered separate and independent lakes, they share an essentially equivalent water level. However, the two lakes are dramatically different in terms of water source and quality. This section will compare and contrast the attributes of each lake.

4.5.1 Basin Morphology

According to topographic maps (USGS, 1971), Lake Benedict has a normal water elevation of 822 feet msl, a water elevation that should be equivalent to Lake Tombeau. A water elevation of 822 feet msl is approximately 4 feet lower than the state specified "normal" water elevation of 826 feet msl (Puruckert, 1965). More recent topographic information reveals that the water elevation of the lakes was between 820 and 825 feet msl (Figure 2). Finally, the Federal Emergency Management Agency (FEMA) Flood Insurance Study flood profile shows the top of the dam at 829.5 feet msl, and the streambed at the base of the dam at 825 feet msl (FEMA, 1983). The FEMA Flood Boundary Maps (1983) provide the location of elevation benchmarks referenced to the National Geodetic Vertical Datum of 1929, including chiseled squares on the County Highway U and the Powers Lake Road Bridges over the East Branch of Nippersink Creek (FEMA, 1983). These benchmarks, if they can be found, as well as the existing dam top of sheet piling and normal overflow elevation (notch in sheet piling) will need to be confirmed against a USGS third-order elevation benchmark. The actual water level of Lakes Tombeau and Benedict is not known at this time, and must be confirmed to assure what the actual "normal" water level is. Once determined, water elevation will have a profound influence on dam design, and may require extensive negotiation to revise state-mandated normal water surface elevation of both upstream lakes or computation of new flood profiles.

Lake Benedict covers 78 acres, has a maximum depth of 37 feet, and has a relatively low watershed to lake ratio of 4.8. Approximately 13 percent of Lake Benedict has water depths of less than 3 feet, while 47 percent has a water depth of greater than 20 feet. The mean lake depth is 15.4 feet (SEWRPC, 2001) (WDNR 1969). The total volume of Lake Benedict is 1207 acre-feet. A volume versus depth graph for Lake Benedict is presented in Figure 5 (WDNR, 1969). Given that little surface water enters the lake, average water residence time in Benedict Lake is 5.5 years. Most of Lake Benedict's bottom is covered with a mixture of silt and sand. Substantial portions of the lake bottom in near-shore areas are covered with sand and gravel. A very limited area near the lake's outlet is covered with silt (SEWRPC, 2001).

Lake Tombeau is smaller than Lake Benedict, but has similar basin morphology. The deepest area is found in approximately the middle of the lake, where a maximum depth of 26 feet is reached (Figure 2) (SEWRPC 2001) (WDNR 1995). The total volume of Lake Tombeau is a matter of controversy. The SEWRPC states that Lake Tombeau's volume is 670 acre feet. However, analysis of the depth contours and lake area presented in its report yield a volume of 453 acre feet. A newly computed depth versus volume graph for Lake Tombeau is presented in Figure 5. According to recent studies, Lake Tombeau receives direct surface-water runoff from 1037 acres, plus an additional 3844 acres of drainage area contributing water to Powers Lake and Lake Benedict. The large amount of surface water draining to Lake Tombeau means that water residence time is very short, averaging 2½ months. However, this should not be construed to mean that all of Lake Tombeau's water is replaced every 2½ months. Droughts, floods, and lake morphology/temperature induced flow conditions may cause water to be replaced or remain in the lake for considerably longer or shorter periods.

The size of Lake Tombeau is a matter of controversy. The WDNR states that Lake Tombeau covers 35 acres, while SEWRPC claims the lake covers 51 acres. Northern Environmental reviewed aerial photographs, and determined that open water areas of Lake Tombeau, including connected access channels, covers just over 33 acres. We can only speculate regarding the reason why SEWRPC states that Lake Tombeau covers 51 acres. One potential reason could be that SEWRPC considers a portion of the wetland extending to the northwest from the lake to be a part of the lake. Assuming Lake Tombeau presently covers 33 acres, a watershed to lake ratio of 148 results.

Lake bottom sediments are considerably coarser in Lake Benedict when compared to Lake Tombeau (SEWRPC, 2001). Most of Lake Benedict's bottom is covered with silt and sand, with substantial portions of the near-shore areas underlain by sand and gravel. Most of Lake Tombeau's bottom is covered with silt. This silt is believed to have been deposited fairly recently, especially in the northern portion of the lake. This finding suggests that much of the silt deposited in Lake Tombeau may be related to agriculture and other activities that have intensified in the East Branch Nippersink Creek watershed since European settlement. Shoreline and near-shore areas in Lake Tombeau are underlain by coarser grained sediments. In the eastern part of Lake Tombeau, sand and gravel composes the lake bottom near the shore. Sand and silt underlie most of the southern shoreline and near-shore areas.

4.5.2 Water Quality

Lakes Tombeau and Benedict and their watersheds are complex systems that are vulnerable to a wide range of contaminants, ranging from excessive loading of plant nutrients (e.g., phosphorus, nitrogen) and sediment to toxins inadvertently or purposely released into the environment. These substances may be innocuous or even beneficial in one setting, but when found in the wrong place or in excessive quantity, hinder the quality and use potential of the resource. While some contaminants can be controlled with minimal effort, others are nearly impossible to control once introduced.

Water quality samples help limnologists evaluate the trophic state of a lake, changes over time, and factors limiting desired uses. Water Quality data have been sporadically collected at Lake Benedict, Lake Tombeau, and connected lakes and streams since at least the 1960s (SEWRPC, 1978, 2001) (WDNR 1969, 1982, 1995). The available data are nicely compiled and tabulated in the 2001 lake study (SEWRPC, 2001). Relevant pages from the report are reproduced and included in Appendix B. The following sections discuss the meaning and importance of these data.

4.5.2.1 Temperature

Water temperature profoundly affects lake characteristics. Temperature influences water circulation patterns, solubility of various compounds, chemical reaction rates, and species and distribution of aquatic plants and animals. The temperature regimens of a lake are controlled by climatic and wind conditions, lake basin morphology, surrounding topography and vegetation, water inflows and outflows, and water chemistry.

Most deeper lakes in Wisconsin thermally stratify. In such lakes, temperature-induced density changes cause a lake to develop three distinct temperature zones. During summer, these zones include the epilimnion (warm surface layer), metalimnion (transitional layer), and the hypolimnion (cold bottom layer). Little mixing occurs between these layers while the lake is stratified. Since the hypolimnion is not exposed at the lake surface, it does not exchange gases with the atmosphere. In eutrophic lakes, decomposing organic debris in the hypolimnion can deplete oxygen, leading to an anoxic hypolimnion. Anoxic water is not habitable to most aquatic life, and encourages dissolution of phosphorus from bottom sediment (Shaw, et al., 1994). Excessive concentrations of dissolved phosphorus can cause problematic booms of algae and rooted aquatic plants.

In most lakes, thermal stratification breaks down each fall as the atmosphere cools, allowing deeper water formerly trapped in the hypolimnion to mix with surface layers. During winter, many lakes again stratify. Since water reaches its maximum density at 4° C (a temperature slightly above the freezing point of water), warmer water is found at depth, while cooler, near-freezing water is found directly below the ice. This inverse temperature stratification is easily disrupted, and lakes usually mix during spring. Mixing can bring large amounts of nutrients to the surface of a lake, enhancing productivity and commonly creating good conditions for algal blooms. Lakes that stratify and undergo two periods of mixing are termed “dimitic.”

Both Lakes Benedict and Tombeau stratify in the summer. Because of basin morphology, relatively more of Lake Tombeau’s water volume is composed of deeper, colder hypolimnetic water. Because of this, Lake Tombeau is more likely to remain stratified, all other conditions being equal. However, since Lake Tombeau has significant surface water inputs, stratification can be disrupted by large storm flows.

4.5.2.2 Oxygen

Oxygen solubility varies with temperature, water purity, and atmospheric pressure. More oxygen can dissolve into pure cold water at low elevations. Increasing water temperature, salinity, and elevation decreases oxygen saturation potential. Biological productivity also affects dissolved oxygen concentrations. Aquatic plants produce oxygen, but plant and animal decomposition and respiration use oxygen. When respiration and decomposition use more oxygen than can be replenished by exchange with the atmosphere and plant oxygen production, oxygen levels decrease. Oxygen can be exhausted in some cases, especially when water cannot freely mix and exchange gases with the atmosphere. Fish kills can occur during winter because ice does not allow air to water oxygen transfer, while ice and snow limit light penetration hindering photosynthetic oxygen production. Waters in a lake's hypolimnion cannot freely mix with the surface and receive oxygen-consuming debris from the surface. Consequently, oxygen can be depleted in the hypolimnion in many lakes. In some lakes, abundant aquatic plant growth can cause dissolved oxygen concentrations to rise above saturation values. Supersaturated oxygen concentrations are also detrimental to many aquatic organisms.

Water should contain at least 5 milligrams per liter (mg/l) oxygen to support a healthy warm-water fishery. To support trout, at least 7 mg/l oxygen should be present. Concentrations of 2 mg/l or less are lethal to many desirable fish species. Even though fish can tolerate lower oxygen concentrations for variable periods, low oxygen levels stress the fish and often promote the success of less desirable species, such as carp and bullheads.

Oxygen is depleted in the deeper portions of both lakes during the summer (Figure 5). However, over 88 percent of Lake Benedict's water volume contains more than 2 mg/l oxygen. In contrast, only about half of Lake Tombeau's water volume is habitable for aquatic life during mid-summer. In simple terms, this means that half of Lake Tombeau's water volume is not contributing to a desirable aquatic life during summer. Furthermore, anoxic waters promote release of plant nutrients from bottom sediments, promoting algal blooms and problematic amounts of aquatic plants (see Subsection 4.5.2.3.1). Approximately two-thirds of Lake Tombeau's bottom is covered with anoxic water during mid-summer, conditions favoring phosphorus release to the water column.

4.5.2.3 Nutrients

Nitrogen and phosphorus are macronutrients essential to plant growth. While plants require many compounds to live, most are readily available in sufficient quantities to allow growth. Nitrogen and phosphorus are typically not as available, and the concentrations of one or the other usually limit aquatic plant growth. Consequently, knowing the concentration of these compounds in lake water can help us understand current and potential plant growth limitation factors.

4.5.2.3.1 Phosphorus

In 80 percent of Wisconsin lakes, phosphorus is the key nutrient controlling aquatic plant growth (Shaw, et al., 1994). Lake water phosphorus concentrations are usually measured as soluble reactive phosphorus and total phosphorus. Soluble reactive phosphorus is readily available to plants. Consequently, its concentration can vary widely over short periods. A potentially better measure of lake water phosphorus concentration is total phosphorus, which measures dissolved phosphorus as well as phosphorus in plant and animal fragments suspended in lake water.

Phosphorus is very reactive in the environment, being absorbed by plants and attaching itself tightly to sediments. Consequently, sediments carried by surface water are typically the largest external source of phosphorus to lakes. Phosphorus does not readily dissolve in lake water, forming insoluble precipitates with iron, calcium, and aluminum. Consequently, most fully oxygenated lakes have a net flux of phosphorus to the lake bottom. However, if oxygen is lacking, iron precipitates become unstable and release phosphorus to the overlying water. The hypolimnia in eutrophic and most mesotrophic lakes are often devoid of oxygen during summer, allowing phosphorus releases from bottom sediment, increasing the concentration of phosphorus available to plant growth.

In contrast, only about one-quarter of Lake Benedict's bottom is exposed to anoxic water. Recent studies have shown that much of Lake Tombeau's bottom is covered with recently deposited silt, sediments that likely contain high concentrations of phosphorus. The large area of phosphorus-rich sediment exposed to anoxic water makes internal cycling of phosphorus an important and, possibly predominant, contributor to the total phosphorus loading of Lake Tombeau. Water quality sampling results from throughout Wisconsin were collected and presented for comparison (Lillie and Mason, 1983). Data from 61 southeastern Wisconsin lakes reveal that the mean total phosphorus concentration is 0.030 mg/l, a concentration noted as typically denoting "good" water quality (Shaw, 1994). Lake Benedict's surficial water generally has low concentrations of phosphorus (e.g., less than 20 mg/l). Deeper water drawn from the hypolimnion during summer typically has higher phosphorus concentrations (up to 77 mg/l), concentrations typically related to eutrophic (nutrient enriched) waters.

Phosphorus concentrations in Lake Tombeau's surface water are similar to Lake Benedict. However, water drawn from Lake Tombeau's hypolimnion contains extremely high concentrations of phosphorus during summer (up to 597 mg/l total phosphorus). This finding strongly suggests that anoxic water-induced phosphorus release from bottom sediments is a primary source of plant nutrients to Lake Tombeau.

4.5.2.3.2 Nitrogen

Nitrogen is the other nutrient commonly limiting the growth of aquatic plants, usually second in importance to phosphorus. Nitrogen limits the growth of plants in a few Wisconsin lakes. Nitrogen can be found in lakes in many forms including nitrate, nitrite, and ammonia. Nitrite is usually present in only trace quantities and is readily transformed to nitrate in oxygenated water. Ammonia is also typically scarce in oxygenated water. Ammonia is the most plant-available source of nitrogen, but is toxic in high concentrations. Ammonia concentrations may increase in anoxic waters as nitrate levels decrease.

Sources from which nitrogen can enter a lake include precipitation (which can have concentrations of nitrogen as high as 0.5 mg/l), breakdown of organic compounds, and human-induced sources of nitrogen such as fertilizers, sewage effluent, and animal waste. Even though nitrogen demand in vegetated terrestrial soil is high during active growing periods, nitrogen can move through soil and reach ground water if:

- Vegetation is not actively growing
- Nitrogen supply exceeds vegetative demand
- Nitrogen is injected directly to subsurface sediment (e.g., septic system drainfields)

Nitrate migrates freely with ground water.

Kjeldahl nitrogen includes nitrogen contained in suspended organic matter and ammonium. Total nitrogen is calculated by adding nitrate and nitrite to Kjeldahl nitrogen. If spring inorganic nitrogen levels are below 0.3 mg/l, summer algae blooms are less likely (Shaw, et al., 1994). The median organic nitrogen concentration in a study of 61 southeastern Wisconsin lakes was 0.77 mg/l, while the average total nitrogen concentration for these lakes was 1.18 mg/l (Lillie and Mason, 1983).

Total nitrogen concentrations in Lake Benedict ranged from 0.024 mg/l to 1.34 mg/l. Low spring nitrogen concentrations denote a low likelihood for problematic algal blooms. Lake Tombeau water quality samples contained between 0.66 and 0.86 mg/l nitrogen. The higher spring total nitrogen concentrations reveal Lake Tombeau is likely to experience nuisance algal blooms. Much of the nitrogen found in Lake Tombeau may find its way to the lake in tributary streams.

Ammonia is found in the hypolimnia of both lakes during summer, suggesting release from bottom sediments and/or decomposition of detritus under oxygen-deficient conditions. Since ammonia is readily absorbed by plants, it can also indirectly contribute to total nitrogen concentrations. Therefore, ammonia released from bottom sediments and decaying detritus may be a significant contributor of nitrogen to both lakes during summer.

4.5.2.3.3 Nitrogen/Phosphorus Ratio

When the ratio of total nitrogen to total phosphorus concentrations are greater than 15 to 1, plant and algae growth in a lake is controlled by the amount of phosphorus available and is considered “phosphorus-limited.” When the ratio is below 10 to 1, nitrogen is the limiting nutrient for plant and algae growth, values between 10 to 1 and 15 to 1 are considered transitional (Shaw, et al., 1994). Most Wisconsin lakes are phosphorus limited.

The following table summarizes nitrogen/phosphorus ratios for both lakes.

Table 3 Nitrogen/Phosphorus Ratios of Lakes Benedict and Tombeau

	Nitrogen/Phosphorus Ratio		Typical Limiting Nutrient
	Range	Average	
Lake Benedict			
Shallow[1]	18-92	58	Phosphorus
Middle[2]	18	18	Phosphorus
Deep[2,3]	34	34	Phosphorus
	(8.4-76)	(36)	(Phosphorus)
Lake Tombeau			
Shallow[1]	17-35	28	Phosphorus
Middle[2]	26.3	26.3	Phosphorus
Deep[2,3]	9.2	9.2	Nitrogen
	(1.4 – 60)	(12)	(Nitrogen)

Notes:
1 Does not include May 7, 1998 sample because total nitrogen value seems erroneously low
2 Nitrogen data for middle and deep samples were only available for one date during 1977 or 1978. Phosphorus concentrations from the single date are much lower than those measured by SEWRPC during 1998-1999.
3 Includes maximum probable nitrogen/phosphorus ratio extrapolated from SEWRPC data (in parentheses).

As can be seen from these data, essentially all of Lake Benedict's waters are phosphorus-limited, as are the waters of most Wisconsin Lakes. The hypolimnion of Lake Benedict is apparently nitrogen-limited on some occasions, a normal occurrence in mesotrphic lakes.

Chemical reactions occur in oxygen-deficient bottom waters. As was explained in an earlier section, anoxic water causes phosphorus to be released from bottom sediments. Similarly, nitrates are converted to nitrogen gas by certain organisms under anoxic conditions, lowering organic nitrogen concentrations. Ammonia concentrations increase by enhanced release from bottom sediments and by the shut-down of typical oxidation processes. In Lake Benedict, phosphorus and ammonia concentrations are commonly elevated in oxygen-deficient waters, suggesting phosphorus is released from bottom sediments under certain conditions.

The hypolimnion of Lake Tombeau occupies a much greater proportion of the total lake volume, covers more of the lake bottom, and likely is present for longer periods. As such, phosphorus and ammonia enrichment and nitrate depletion are likely to be more pronounced. The available data shows this is indeed the case. The deeper portions of Lake Tombeau are commonly phosphorus enriched and nitrogen limited.

4.5.2.4 Chlorophyll a

Chlorophyll *a* concentrations correspond to the abundance of planktonic algae in lake water. Chlorophyll *a* concentrations respond to seasonal light changes, lake-water nutrient content and transparency, aquatic macrophyte growth, temperature, and zooplankton abundance. High chlorophyll *a* concentrations relate to algal blooms. Algal blooms most often occur after spring and fall turnovers in lakes with anoxic hypolimnia. Algal blooms can also occur when other events liberate nutrients into the lake system or otherwise upset nutrient equilibrium. Examples of events that could cause algal blooms are:

- ▲ Severe thunderstorms washing nutrient-laden water or sediment into a lake
- ▲ Mid-season circulation of the hypolimnion caused by storms, flood flows, etc.
- ▲ Decrease in zooplankton abundance
- ▲ Anoxic water conditions destabilizing phosphorus bound in bottom sediments
- ▲ Significant manipulation of the macrophyte community

If macrophytes are destroyed, the demand for limiting nutrients is decreased and nutrients are returned to the water from decomposing aquatic plants. This chain of events can also cause algal blooms.

Southeastern Wisconsin lakes' mean chlorophyll *a* concentration is 9.9 micrograms per liter (µg/l). Values of 10 µg/l or higher are associated with algae blooms. Chlorophyll *a* readings less than 5 µg/l indicate very good water quality, while values less than 1 µg/l are indicative of excellent water quality (Lillie and Mason, 1983).

Water samples from Lake Benedict contained between 1.64 and 8.53 mg/l chlorophyll *a*. The highest concentrations were found during the spring, after winter turnover brings nutrient-rich water from the lake bottom. Summer water samples consistently contain less than 3 mg/l chlorophyll *a*, suggesting that Lake Benedict's water quality is good to excellent.

Lake Tombeau has higher concentrations of chlorophyll a, with concentrations ranging from 4.94 to 15 mg/l. The data show that Lake Tombeau can experience algal blooms during spring and summer. These algal blooms are likely fueled by storm runoff or nutrient-rich bottom water making its way to the surface. When compared with Lake Benedict, Lake Tombeau's waters have a considerably higher potential for nutrient enrichment. Lake Tombeau has a large watershed and strong anoxic hypolimnion, both of which contribute phosphorus. Excessive phosphorus is usually the cause of algal blooms and high chlorophyll a concentrations.

4.5.2.5 Alkalinity and pH

Lake water alkalinity is largely attributable to bicarbonate and carbonate that are typically released from dissolution of calcite and dolomite. Dissolution of calcite and dolomite also releases calcium and magnesium, producing hard water. Median alkalinity concentration in 61 southeastern Wisconsin lakes is 160 mg/l (Lillie and Mason, 1983). Alkalinity buffers the effects of acidic rainfall by neutralizing low pH rainfall.

Lakes with abundant plant growth and high alkalinity water often have marl deposits. Marl is composed primarily of calcium carbonate, but also includes phosphorus. Plant growth fosters marl formation by removing carbon dioxide from the water, increasing pH. Marl is often visible on the leaves of certain aquatic macrophytes as an encrustation.

The alkalinity of both lakes range from 168 to 262 mg/l, values higher than average. This may be related to the significant inflow of ground water into the lakes. Both lakes are well protected against negative affects from acid rain. Water from deeper portions of the lakes contained higher alkalinity concentrations, perhaps because of less influence by precipitation and aquatic plants.

pH is an exponential index of hydrogen ion concentration used to measure acidity. pH is represented on a logarithmic scale from 1 to 14, with 7 being neutral. Readings above 7 have less hydrogen ions and are basic (alkaline), readings below 7 have more hydrogen ions and are considered acidic. The median pH of 61 southeastern Wisconsin lakes is 8.0 (Lillie and Mason, 1983). Lower pH measured may result from abundant rainfall. Rainfall in southeastern Wisconsin is acidic, having a pH of about 4.4. The pH of the water in both lakes ranged between 7.1 and 8.4. Near-surface waters exhibited higher pH values, a fact probably attributable to plant respiration. Plant respiration raises pH, promoting marl precipitation.

4.5.2.6 Transparency

Transparency is a function of water color and turbidity and is usually measured with a secchi disk. A secchi disk is an 8-inch circular plate with alternating black and white quadrants fixed to a length of graduated cord. During the middle of the day, the disk is lowered on the shaded side of the boat until an observer can no longer see the secchi disk. The depth is noted, the disk is then raised until it just again is visible, and the depth again is noted. The two measurements are averaged to give a reading. The deeper the secchi disk reading, the clearer the water. High concentrations of algae or suspended sediment usually account for shallow secchi disk readings. In some instances, colored water can also account for lower secchi readings. Weekly secchi depth readings collected over a number of years during open water periods provide an excellent, low-cost method to evaluate changes in lake clarity, which may relate to other changes in lake water conditions.

Secchi depths have been characterized as follows (Shaw, 1994):

Water Clarity	Secchi Depth (feet)
Very Poor	<3
Poor	5
Fair	7
Good	10
Very Good	20
Excellent	32

Lake Benedict's water transparency does not appear to vary significantly, ranging from 5.6 to 8.9 feet. Given the low chlorophyll a concentrations in Lake Benedict, the lower skimmer transparency is not likely solely related to algae. Instead, particulates such as marl or sediment stirred up by motor boats are likely causes for decreased summer transparency.

Lake Tombeau has variable water clarity with secchi depths ranging from 4.3 to 10.5 feet. Water transparency appears to decrease as the summer progresses. Nevertheless, Lake Tombeau's transparency is better than average for southeastern Wisconsin lakes (slightly more than 3 feet). Lake Tombeau's decreased summer transparency is likely related to algal blooms as suggested by higher chlorophyll a concentrations.

4.5.2.7 Chloride and Specific Conductance

Under natural conditions, chloride concentrations in natural surface water in Wisconsin should be quite low. For example, in sparsely populated northern Wisconsin, median lake-water chloride concentrations are between 1 and 2 mg/l. The presence of high chloride levels usually is accountable to human pollutants like road salt, fertilizers (potash), septic system effluent, and animal wastes. Septic effluent commonly contains 50 to 100 mg/l chloride (Shaw, et al., 1994).

Southeastern Wisconsin is home to extensive agriculture and large numbers of people. Additionally, bedrock aquifers in some portions of southeastern Wisconsin have brackish water. Therefore, lakes in southeastern Wisconsin typically contain more chlorides than other parts of the state. Median chloride concentration of 61 southeastern Wisconsin lakes is 16 mg/l (Lillie and Mason, 1983).

Chloride concentrations are similar in both lakes (between 40 and 60 mg/l). Lake Benedict exhibits somewhat higher chloride levels, potentially due to its longer water residence time. Lake Benedict's chloride concentrations have risen more than six-fold since the 1960s, and are now higher than average for southeastern Wisconsin. Lake Tombeau's chloride concentrations have more than doubled since the 1960s, and are again appreciably higher than the regional average. High chloride values are likely a result of the large number of residences and intense agriculture in the watershed.

Specific conductance is related to the amount of dissolved solids in lake water. Lakes with high conductivity readings are often eutrophic. Septic effluent, agricultural waste, and fertilizers are common human-related pollutants that can cause high conductivity readings. Chlorides are common components of both septic effluent and fertilizer contributing to higher specific conductance. Conductivity readings are commonly twice the alkalinity levels (Shaw, et al., 1994).

4.5.2.8 Trophic Status

Total phosphorus, chlorophyll a, and secchi disk depths are used to classify the trophic state of a lake. A trophic state is an indicator of water quality. The SEWRPC took all available data and charted trophic status for both lakes (SEWRPC, 2001). A copy of this chart can be found in Appendix B. Both lakes are primarily mesotrophic lakes. Mesotrophic lakes commonly have anoxic hypolimnia, good fisheries, and after can experience algal blooms. Lake Tombeau's water quality typically characterizes it as a eutrophic lake during mid-summer. Eutrophic lakes typically have poor water clarity, are nutrient laden, and typically experience vexing management issues. Wide swings in oxygen concentrations are common, and oxygen concentrations can decrease to below levels needed to support desirable fish communities. Excessive planktonic algal populations impede growth of desirable rooted aquatic macrophyte communities.

4.6 Tombeau Outlet Channel and Water Level Control Dam Information

4.6.1 History and Design of Existing Dam

The channel of the East Branch of Nippersink Creek downstream of Lake Tombeau was deepened and straightened as part of the filling and construction work completed when the Nippersink Lodge was built. To maintain "normal" water levels in the lake, a low dam was built (Railroad Commission of Wisconsin, 1931). This outlet dam regulating water levels on both Lakes Benedict and Tombeau was constructed during 1921 or 1922 by the original owner of the Nippersink Lodge (Koehn, 1950). This dam will be referred to as the "Tombeau Dam." Before the Tombeau Dam was built during the early 1920s, a dam existed in the channel connecting Lake Tombeau and Lake Benedict, regulating the water level of Lake Benedict alone (Steinmetz, 1950). Unusually, the water level that the Tombeau Dam was supposed to maintain was not specified for over 40 years, other than maintaining "normal" water level. During 1965, the Public Service Commission of Wisconsin specified that the dam should maintain a water level of 87.20 feet relative to a benchmark on an abutment to a timber bridge 300 feet upstream of the dam (Purucker, 1965). According to available records, this water level equates to approximately 826 feet above msl. Later records suggest that the water level could be lowered to approximately 823 feet above mean sea level by removing stoplogs. However, the state re-emphasized the importance of maintaining the 826 feet msl water level (Brick, 1972).

The Wisconsin Bureau of Water and Shoreland Management expressed concern regarding the integrity of the Tombeau dam during 1973. Available documents state that the dam was "out" later the same year, and that water levels were being maintained by a sheet of plywood in front of a culvert 300 feet upstream of the dam site. Water was described as flowing around and other the dam abutments (Bureau of Water and Shoreland Management, 1973). These findings resulted in issuance of a dam replacement order during late August, 1973 (Brick, 1973). A flurry of correspondence to and from residents of both Lake Tombeau and Lake Benedict reveal they were quite upset with the low lake levels and lack of progress on water level restoration. A memo states that the low water levels noted by residents were about 1 foot lower than the state-mandated water level of 826 feet msl, and that the channel conditions could allow water level to decrease another foot (Roden, 1973).

During early 1974, a plan for a sheet-piling dam was submitted to the WDNR (Lipschultz, 1974). The sketch and plans call for a dam approximately 40 feet wide located a short distance upstream of the then existing dam. The dam was to be constructed of 10 foot lengths of steel sheet piling, driven 7 feet into the channel bottom. The sections of sheet piling were to be tied together on the upper end, with two 4-foot operable gates. The Bureau of Water and Shoreland Management stated that the general design sounded feasible, but suggested that geotechnical information be collected to determine the dam's resistance to overturning. This letter also suggested that plans be prepared by a professional engineer (Brick, 1974a).

Mr. Lipschultz wrote a letter to the WDNR during February 1974 explaining the small amount of funds available to repair the Tombeau Dam, and assuring that the method outlined in his January letter were acceptable to engineers and contractors with whom he had spoken (Lipschultz, 1974b). In this letter he also stated that dam overturning would not be an issue since they were driving the sheet piling into "solid soil", and stone would be placed on both sides of the dam. Lastly, Mr. Lipschultz provided information regarding the material properties of the sheet piling and asked for approval for construction. The WDNR re-emphasized the importance of appropriate design, but offered an option for a 10-year performance bond as opposed to having a professional engineer design the structure (Brick, 1974). Mr. Lipschultz immediately retorted to this letter with two more letters, letters demanding an immediate approval without further ado, since a contract to repair the dam had already been signed. A series of letters was subsequently exchanged between the WDNR and Mr. Lipschultz regarding maintenance bonding. Apparently, the dam was built without state authorization and without bonding (Morrissey, 1977). Subsequent inspections note that the dam was constructed during 1974 using 12- or 14-foot long piles. Water levels were noted to be lower than "normal", but this fact was potentially attributed to drought. The dam itself is described as "rebuilt recently and is structurally adequate" (Nestingen, 1977).

The January 1974 Lipschultz letter design sounds remarkably similar to the dam now at the site and, in the absence of additional information, should be considered the design actually installed during 1974 with the possible exception of the vertical length of the pilings used. A copy of this letter and sketch are included in Appendix C.

Since the dam was reconstructed during 1974, the left (east) abutment had failed and has been adequately repaired on at least one occasion (Sturtevant, 1995). Mr. Sturtevant mentioned that because of the (poor) nature of the soils in the embankment, the dam should be monitored, and all brush removed. The east side of the dam is described as "washed out" during 1999, with upstream lake levels 1 foot lower than normal (Austin, 1999). The WDNR subsequently issued a repair order to the owners of the dam (Pilarski, 2000), leading to the current study. The Lake District contracted a surveyor to define the dam site and other information (Bolender, 2001). This survey determined the following:

- ▲ The sheet piling dam is approximately 44 feet wide.
- ▲ The length of the dam within the creek banks is approximately 20 feet, with the remainder extending into floodplain areas.
- ▲ The dam is positioned near the center of a rectangular parcel measuring 56 feet (approximately perpendicular to the creek) by 20 feet.

A copy of the survey is included in Appendix D.

The WDNR staff currently managing the dam repair/replacement order expressed the following opinions regarding why the dam is failing (Hereng, 2003).

- ▲ Sheet piling is bending and/or tipping when the dam is overtopped.
- ▲ Original energy dissipating/stabilization zone placed downstream of the dam has been largely washed out.
- ▲ Replacement stone was larger (24 inches to 36 inches), but was placed with smaller stoned. Smaller stone washed out causing larger stones to move.
- ▲ Overbank areas erode when the dam is overtopped.

The available information is assembled to produce a probable construction schematic for the existing sheet piling dam (Figure 6). Figure 6 also includes some of the non-design notations from sketches and correspondence.

4.6.2 Hydrology and Hydraulics

The best source of hydrology and hydraulics information for the Tombeau dam is contained in the federal flood insurance study covering Walworth County (FEMA, 1983). Relevant portions of the study are included in Appendix E, while the floodway and flood fringe are delineated on a local topographic map (Figure 7). The "floodway" is basically the portion of a stream where floodwaters actively flow. The "flood fringe" are backwater areas, where floodwaters are stored, but do not flow. These areas were mapped by surveying channel cross sections, completing hydraulic modeling, and interpolating the resultant water level data over topographic maps between cross sections.

Twenty-one channel cross sections were completed on the East Branch of Nippersink Creek. Twelve cross sections are upstream of Lake Tombeau, while nine are downstream. To the good fortune of this study, three cross sections were completed at the study area. Cross-Section J covers the mouth of the creek as it enters Lake Tombeau. Cross-Section I is completed at the roadway approximately 300 feet upstream from the dam. Cross-Section H represents the dam and adjacent flood lands. When the Lake Tombeau dam is repaired or replaced, the final cross section through the dam should not be altered compared to Cross-Section H (FEMA, 1983) to avoid affecting the 100-year flood elevation. Therefore, surveying work before dam replacement would have to include obtaining cross-section H (from WDNR or FEMA) and comparing it to the surveyed current cross section at the dam. If cross-section H is altered, a Chapter NR 116, Wisconsin Administrative Code (NR 116, Wis. Adm. Code) flood study would be required to determine the change in the flood elevation. Obtaining backwater easements from property owners would be required if a greater than 0.01-foot increase in the 100-year flood elevation occurred upstream (or downstream) of the property on which the dam sits.

Several sources of information were located that include hydrologic and hydraulic data for the East Branch of Nippersink Creek near and at the Tombeau Dam (Table 4). Hydrologic and hydraulic conditions were studied at the U.S. Highway 12 Bridge just downstream of the Tombeau Dam (SEWRPC, 1970) (DeLeuw, Cather, & Company, 1960). The WDNR also provided a flood flow estimate (Nereng, 2003).

FEMA (1983) reports 50-, 100-, and 500-year flood flows of 800, 950, and 1400 cfs, respectively. These values are much higher than the 196 cfs 100-year flood flow determined by the WDNR floodplain analysis database hydrology tool. The WDNR's lower flow estimate may be due to inclusion of storage in wetlands and lakes (Krug et. al., 1992). Older calculations show a 50-year flow of 1925 cfs at the U.S. Highway 12 Bridge. These values may be ignored since the WDNR's 100-year flow indicates that the 1983 FEMA flood insurance study hydrology provides conservatively high flow values suitable for design of the dam.

In addition to flood flow information, the FEMA study includes information regarding floodplain width, dam height, velocity, and other information. Some of this data is included in Table 4. Cross Section "H", which is the Tombeau Dam site, shows that the floodway width is 880 feet. This demonstrates that much of the high water flow of the Lake Tombeau outlet flows in floodway areas, predominantly to the southeast of the dam site. The cross section shows the dam to be approximately 3.4 feet high, and is completely submerged by the 50 and 100-year floods (Figure 8). The channel of the East Branch of Nippersink Creek is quite steep downstream to the U.S. Highway 12 Bridge, descending approximately 5 feet in 650 feet, or at a gradient equivalent to over 40 feet per mile. The creek descends only 2 feet in the next 1.5 miles.

5.0 REPLACEMENT DAM DESIGN CONSIDERATIONS

5.1 Dam Replacement or Reconstruction

The new or reconstructed dam at the site of the existing dam will need to be 50 feet long (perpendicular to flow in Nippersink Creek) with a structural height of approximately 3.5 feet. The spillway crest elevation will be set to maintain the "normal" water level of Lake Tombeau, which needs to be determined as discussed in Subsection 4.51, Basin Morphology. The parcel the dam sits on is 65 feet long by 20 wide. The 10-, 50-, and 100-year floods overtop the existing dam by 1, 2, and 3 feet, respectively. The regulatory floodway is 880 feet wide at the dam (FEMA, 1983). Due to the width of the floodway compared to the dam and its submergence, the dam has little effect on the water surface profile of the 100-year flood, and so the dam has only a minor influence on the hydraulic capacity of the floodway. The dam must be designed for overtopping and care must be taken to avoid erosion on either side of the dam.

The following design, inspection, and planning tasks will be required:

- Topographic survey of the dam property, a cross section of the floodplain at the dam, and cross sections of the stream bed and banks at 100, 200, and 300 feet below the dam. Tie elevation measurements to a third-order USGS elevation benchmark. Attempt to locate and confirm FEMA reference marks RM-50 and RM-52, shown on map Panels 0135 and 0145, respectively (FEMA, 1983).

- When the Lake Tombeau dam is repaired or replaced, the final cross section through the dam should not be altered compared to Cross-Section H (FEMA, 1983) to avoid affecting the 100-year flood elevation. Therefore, surveying work before dam replacement would have to include obtaining cross-section H (from WDNR or FEMA) and comparing it to the surveyed current cross section at the dam. If Cross-Section H is altered, a Chapter NR 116, Wisconsin Administrative Code (NR 116, Wis. Adm. Code) flood study would be required to determine the change in the flood elevation. Obtaining backwater easements from property owners would be required if a greater than 0.01-foot increase in the 100-year flood elevation occurred upstream (or downstream) of the property on which the dam sits.

- Perform scour analysis for design of rip-rap at dam and in the East Branch of Nippersink Creek for 300 feet downstream of the dam.

- Prepare plans and specifications for the dam reconstruction meeting the requirements of the April 19, 2000 WDNR Order (Pilarski, 2000) and obtain approval of the design from the WDNR. Mr. Nereng of the WDNR confirmed that the dam is on the list of "small dams," less than 6-foot structural height, so that NR 333, Wis. Adm. Code does not apply. A dam failure analysis and emergency action plan are typically not required for small dams, and the April 19, 2000 WDNR Order does not call for these.

- Prepare a project manual, obtain bids from contractors, and prepare the construction contract.

- Inspect construction and prepare as-built report for submission to the WDNR.

- Prepare an Inspection, Operations, and Maintenance Plan for the dam.

Table 5 provides conceptual descriptions, costs, advantages, and disadvantages of various dam construction options. Maintenance and aesthetic issues are also discussed in Table 5. All options are presented because the decision on how to proceed involves trade-offs between cost, dam life, and aesthetics that need to be evaluated by the dam owner in consultation with other stake holders.

5.2 Stabilization of Nippersink Creek downstream of Dam.

The WDNR has indicated that the steeper portion of the East Branch Nippersink Creek, for up to 150 to 200 feet downstream of the dam, may need stabilization to prevent erosion. The scope of this potential problem needs to be further investigated. Table 5 provides a conceptual description and preliminary cost estimate for this work.

5.3 Water Quality Enhancement

As was discussed in Subsection 4.5.2, ample data exist demonstrating that much of Lake Tombeau's water volume does not contain sufficient concentrations of oxygen to support desirable aquatic life through much of the summer. Low oxygen concentrations promote release of critical plant nutrients from bottom sediments, a situation exacerbating the nuisance growth of algae and rooted aquatic vegetation. The outlet dam can incorporate design features to lessen the severity and extent of the anoxic bottom waters. A simple weir outlet, such as now exists at the terminus of the outlet channel, allows excess lake water to be drawn from the lake's surface. Surface water is well oxygenated, and is the water most conducive to desirable to aquatic life in Lake Tombeau. Water does not need to be released from the lake's surface, and instead can be drawn from depth. A draft tube can extend to a critical depth, allowing excess lake water to be drawn from colder, deeper, less oxygenated areas of Lake Tombeau. This would reduce the volume of anoxic bottom hypolimnetic water, especially during seasons of high precipitation and baseflow. The water would be re-aerated as it cascades over the outlet dam. Reducing the volume and extent of oxygen-deficient waters in Lake Tombeau should reduce internal phosphorus cycling, and in overall terms should reduce phosphorus loading to water bodies downstream of Lake Tombeau.

The approximately 1050-foot bottom draft tube would run from the 25-foot bathymetric contour, near the bottom of Lake Tombeau, to the dam following the outlet channel. In warmer weather, it would draw the water with low dissolved oxygen concentrations and lower temperatures from the bottom of Lake Tombeau, allowing water with higher dissolved oxygen concentrations to reach the lake bottom. The water from near the lake bottom would flow through the bottom draft tube to a control structure at the dam, where the rate of flow could be controlled via a hand wheel and gate valve. The dissolved oxygen concentration in the lake-bottom water would have to be increased before discharging it to the East Branch Nippersink Creek. To accomplish this, the water would flow over a weir that would distribute it in a thin sheet onto a steep slope of concrete-stabilized stones on the downstream side of the dam. The water would be aerated as it trickles over the stones due to the water turbulence and high air-to-water surface area. The WDNR will likely require that the effectiveness of this aeration structure be field confirmed. During wintertime or as needed, the flow through the bottom draw pipe can be discontinued. In this case, water in the outlet channel would overflow at the dam, as currently occurs.

The deeper portions of Lake Tombeau could also be oxygenated by direct aeration/induced circulation. Direct aeration of Lake Tombeau would involve installing air diffusers on the lake bottom, connected via tubing to compressors on shore. The diffusers would release fine air bubbles that make the lake water less dense, causing it to rise, creating whole-lake circulation. If the aeration system is adequately sized, the lake will turnover, bringing water with high dissolved oxygen concentrations from near the lake surface to the lake bottom. Some oxygen would also directly dissolve into the lake water from the air bubbles released by the diffusers. The overall effect is a lake that is well mixed with adequate dissolved oxygen present from top to bottom. The aeration system would only have to be operated when the lake is stratified from late spring to fall.

Northern Environmental has briefly discussed the regulatory feasibility of both these options with WDNR staff (Bunk, 2003). The WDNR has concerns regarding implementing either option, but will consider both. The primary concern regarding the bottom-draw dam is its effect on flora and fauna in areas downstream of the dam site. The WDNR is also rightfully concerned about the true effectiveness of in-late aeration. Aeration does not effectively improve water quality in all lakes. Indeed, in some lakes, it can lead to transfer of nutrients from the lake bottom, which in turn can worsen nuisance aquatic plant and algae problems.

Both the bottom-draw draft tube and in-lake aeration systems require that piping and other structures be placed in the lake. State law (Wisconsin Statutes Chapter 30.12 [Wis. Stats 30.12]) closely regulates the installation of structures on the beds of lakes and rivers. A permit may be granted for installation of such structures if the structure does not:

- Materially obstruct navigation
- Reduce the effective flow capacity of a stream
- Produce a detriment to public interest

5.4 Funding Options

Additional water quality information for Lake Tombeau is required to determine the applicability and success of a bottom-draw pipe or lake aeration system. The Lake District should consider applying for a Lake Management Planning Grant to help fund the collection of such data. Collection of additional information specific to Lake Tombeau, such as detailed oxygen and nutrient profiles, sediment composition, and aquatic plant species abundance and distribution, could enhance management of Lake Tombeau and could be funded by the same grant.

At least three potential funding sources are available to the Lake District for the construction of a new dam and water quality enhancement. Installation of a bottom-draw pipe or lake aeration will help improve water quality of both Tombeau Lake and Nippersink Creek; therefore, the Lake District should be eligible for funding through a lake improvement category of the Lake Protection and Classification Grant Program administered by the WDNR. Construction of the dam could be financed by a low interest loan through the State Trust Fund Loan Program that is available to all municipalities, including lake districts, metropolitan sewerage districts, and town sanitary districts. The U.S. Army Corp of Engineers (USACE) offers a grant for aquatic ecosystem restoration for which the Lake District may be eligible. The USACE grant provides a 65 percent federal cost share for projects that improve aquatic habitat. More information about these funding sources can be found in Table 6. No funding is currently available though the Dam Maintenance, Repair, Modification, and Removal Grant administered by the WDNR, but this grant should be watched for future funding.

The wetlands surrounding Lakes Benedict and Tombeau provide habitat for waterfowl and spawning fish, and also act to protect the water quality of the lakes. As a result, the Lake District may also be eligible to apply for funding from the wetland restoration category of the Lake Protection and Classification Grant Program administered by the WDNR. Without the outlet dam, the wetlands upstream of Lake Tombeau on the East Branch of Nippersink Creek would be dewatered.

Nippersink Creek has been identified as an outstanding resource in Illinois and is identified as biologically significant. Because Nippersink Creek is a watershed of the Mississippi River, the reduction in phosphorus loading to the Nippersink Creek will ultimately reduce phosphorus loading to the Mississippi River and to the Gulf of Mexico. As a result, federal funding may be available for the installation of the bottom draw pipe.

Several local and national environmental organizations with local chapters work to protect wetlands, streams, and wildlife habitat. Some organizations may be interested in working with the Lake District, and they may be a possible source of funding that could benefit the surrounding habitat directly and the lakes indirectly. A partial list of non-profit organizations and contact information is found below. The McHenry County Defenders listed below is an Illinois-based group sponsoring work to protect and enhance the Nippersink Creek watershed.

Wisconsin Wetland Association
D. Strohl, Program Director
222 South Hamilton Street, #1
Madison, Wisconsin 53703
(608) 250-9971

Wisconsin Wildlife Federation
720 St. Croix Street, Suite 101
Prescott, Wisconsin 54021
(715) 262-9279
(800) 897-4161

Izaak Walton League of America
Robert Elliker, Wisconsin Division President
5316 Forest Circle North
Stevens Point, Wisconsin 54481
(715) 344-1803

Wisconsin Waterfowl Association
South Shore Chapter (Racine County)
Chris Eisenman
(262) 639-6216

The Nature Conservancy
Post Office Box 1642
Madison, Wisconsin 53701
(608) 251-8140

River Alliance
306 East Wilson Street, #2W
Madison, Wisconsin 53703
(608) 257-2424

McHenry County Defenders
124 Cass Street, Suite 3
Woodstock, Illinois 60098
(815) 338-0393

Other important resources for the Lake District include volunteers, and donations of services, equipment, and materials from local citizens and businesses.

6.0 SUMMARY AND RECOMMENDATIONS

The Lake District owns the Tombeau outlet dam, and has been ordered by the WDNR to repair or replace this structure. To assure long-term satisfaction with their decision, the Lake District must consider the needs and desires of those affected by dam replacement. This includes residents of the Lake Benedict/Tombeau area and those downstream of the dam. Important factors to consider when considering a proposition include life cycle cost (not just the initial capital expenditure), tangential benefits and potential problems, and the long-term willingness for cooperation and volunteerism.

Several viable options are available to the Lake District to conform with state law. Northern Environmental believes that the most prudent course of action is to replace the existing dam with a new sheet piling dam. The new dam should be covered with quarry stone. The quarry stone will:

- Stabilize and reinforce the downstream side of the dam
- Armor the upstream face of the dam from ice and debris
- Provide a more natural finish

The dam will need to be fitted with an operable gate to allow water levels to be manipulated in the upstream lakes. The gate can be a simple flashboard arrangement, or could consist of a more expensive, but easier to operate, handwheel connected to sliding gates. Cost and the need for convenience will control this selection. In either case, an access catwalk must be constructed to allow safe and easy access to the controls of the gate structure. The Lake District should poll its constituency to determine what type of dam and outlet structure is desired by most stakeholders.

Given the available data, we believe that the quality of the aquatic habitat of Lake Tombeau can be significantly improved if the size of the anoxic hypolimnion can be reduced. With the limited available information, we believe that a bottom-draw draft tube could achieve help achieve this goal. Unfortunately, the bottom-draw draft tube will likely cost more than the replacement sheet piling dam itself. On the other hand, the money saved by installing a sheet piling dam as opposed to a concrete dam would pay for much of the bottom-draw draft tube. In-lake aeration is another potential option to decrease the size of the anoxic hypolimnion, but when electricity and maintenance costs are considered, costs are nearly the same as the bottom-draw draft tube. Since the life-cycle cost of the in lake aeration is essentially equal to the bottom-draw draft tube, and since in-lake aeration projects have commonly not been successful, we suggest that the Lake Association seriously consider the bottom-draw draft pipe option. The Lake District must decide if the additional expense is worth the benefits achieved, and can only do so by polling stakeholders.

Another issue that came to light during the course of this investigation is the uncertainty regarding just what "normal" water levels are in Lakes Benedict and Tombeau. The FEMA study identifies the crest elevation of the dam to be 829.5. This is approximately 3.5 feet higher than the state-mandated normal water elevation. A consensus must be reached regarding what normal water level is, and any revision to mandated water levels must then be made. If the normal water level requires a weir height differing from the FEMA cross sections, hydraulic analysis will likely need to be done to determine the revised dam's height on upstream and downstream flood elevations.

After the issues listed above have been resolved, focused field studies and dam design may begin. The component issues of much of this work were described in earlier sections of this report.

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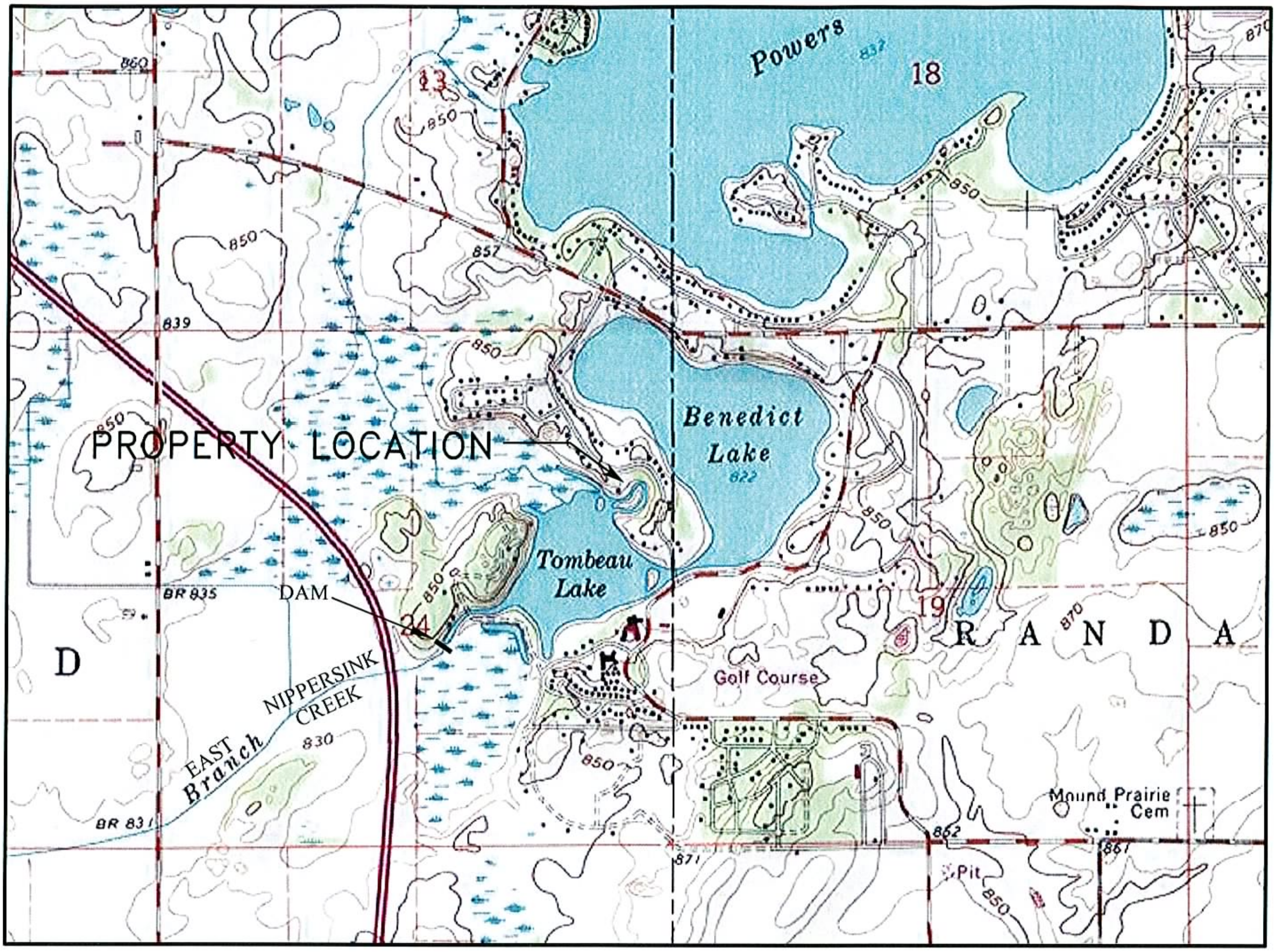

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SCALE IN FEET

1" = 2000'

0 1000 2000 3000 4000 5000 6000 7000 8000

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

BASE MAP SOURCE: USGS 7.5 MINUTE QUADRANGLE, GENOA CITY, WISCONSIN, 1971 (NATIONAL GEOGRAPHIC HOLDINGS, INC.)

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STUDY AREA LOCATION & LOCAL PHYSIOGRAPHY

LAKE BENDICT/TOMBEAU LAKE MANAGEMENT DISTRICT

WALWORTH/KENOSHA COUNTIES

CREATION DATE: 07/31/03	
DRAWN BY:	KAA
REVISION DATE: 08/23/03	

PROJECT NUMBER: BTL01-3100-2507 FIGURE 1

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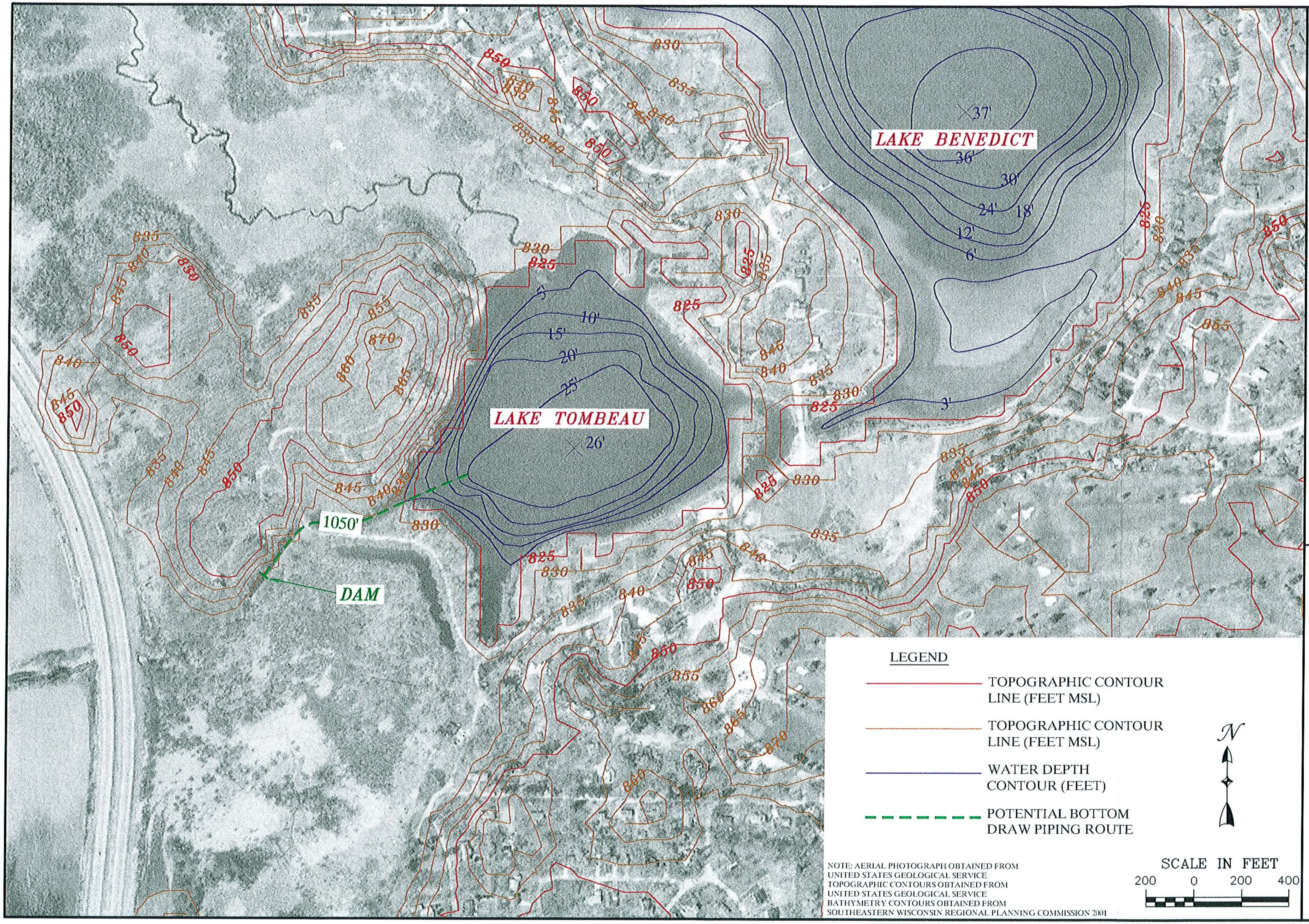

LAKE TOMBEAU BATHYMETRY & SURROUNDING UPLAND TOPOGRAPHY

LAKE BENEDICT/TOMBEAU LAKE MANAGEMENT DISTRICT
WALWORTH/KENOSHA COUNTIES

FIGURE 2

PROJECT NUMBER: BTL01-3100-2507

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CREATION DATE: 04/25/03
DRAWN BY: KAA
REVISION DATE: 08/23/03

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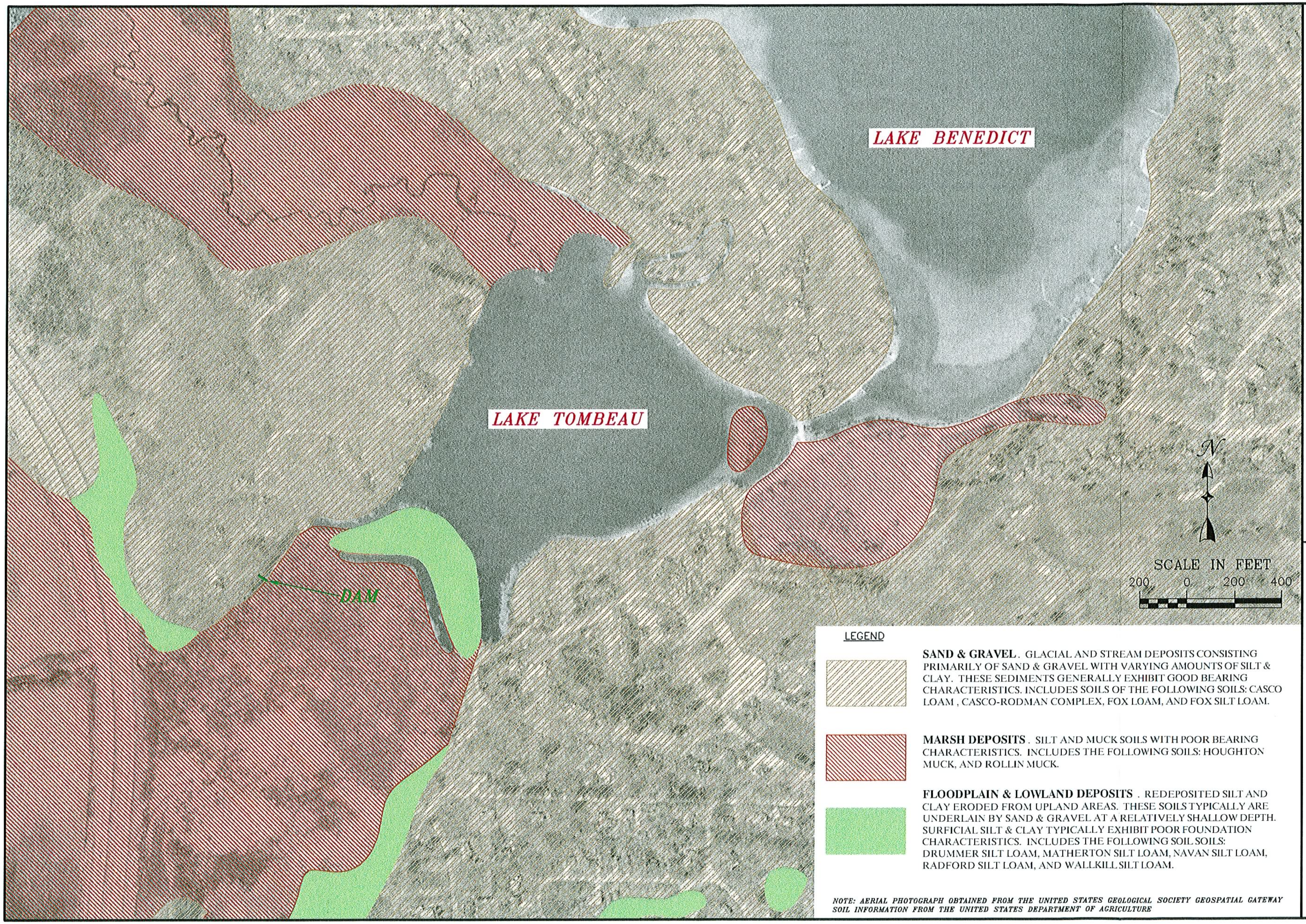

SOIL TYPES NEAR LAKE TOMBEAU

LAKE BENEDICT/TOMBEAU LAKE MANAGEMENT DISTRICT
WALWORTH/KENOSHA COUNTIES

PROJECT NUMBER: BTL01-3100-2507

FIGURE 3

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REVISION DATE: 08/23/03

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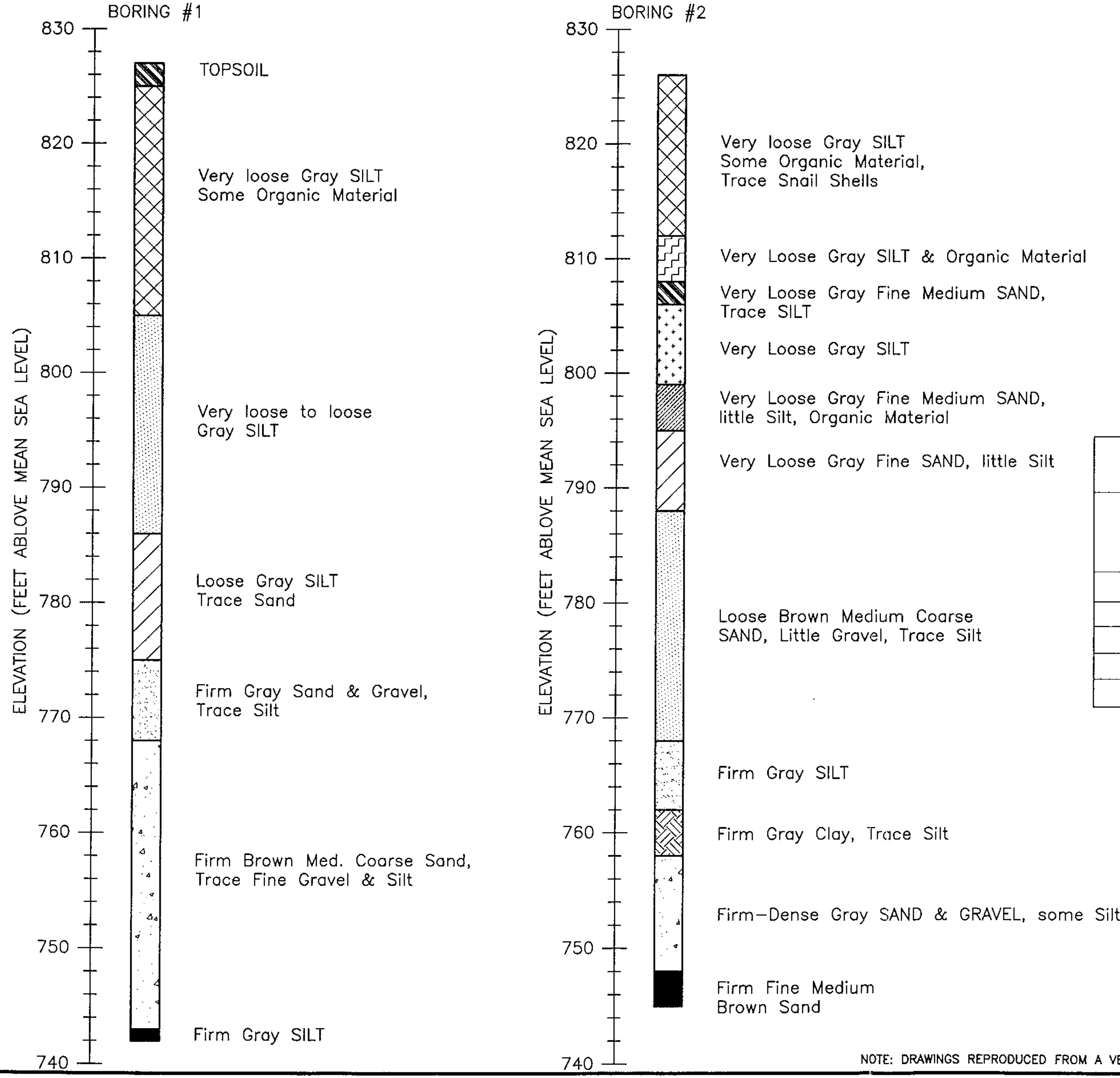

RELATIVE DENSITY DEFINITION GRANULAR MATERIAL	
RELATIVE DENSITY	BLOWS PER FOOT 140 lb. WEIGHT, 30" FALL 1-¼" SAMPLE SPOON
VERY LOOSE	0-4
LOOSE	5-10
FIRM	11-30
DENSE	31-50
VERY DENSE	OVER 50

NOTE: DRAWINGS REPRODUCED FROM A VERY POOR COPY OF THE ORIGINAL HAND-WRITTEN LOGS. SOURCE: WisDOT 1961

US HIGHWAY 12 NIPPERSINK BRIDGE
TEST BORING LOGS

LAKE BENEDICT/TOMBEAU LAKE MANAGEMENT DISTRICT
WALWORTH/KENOSHA COUNTIES

FIGURE 4

PROJECT NUMBER: BTL01-3100-2507

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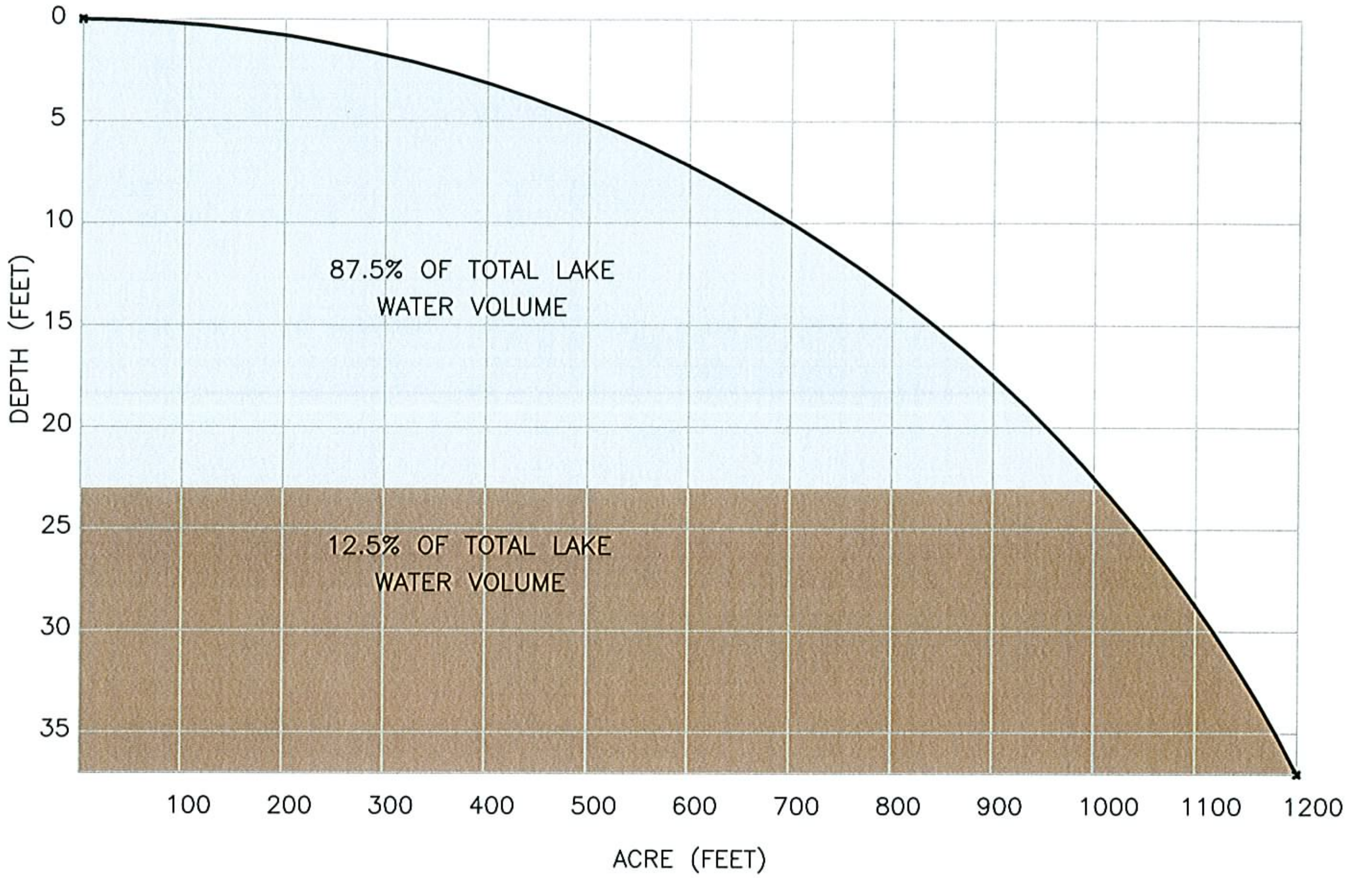
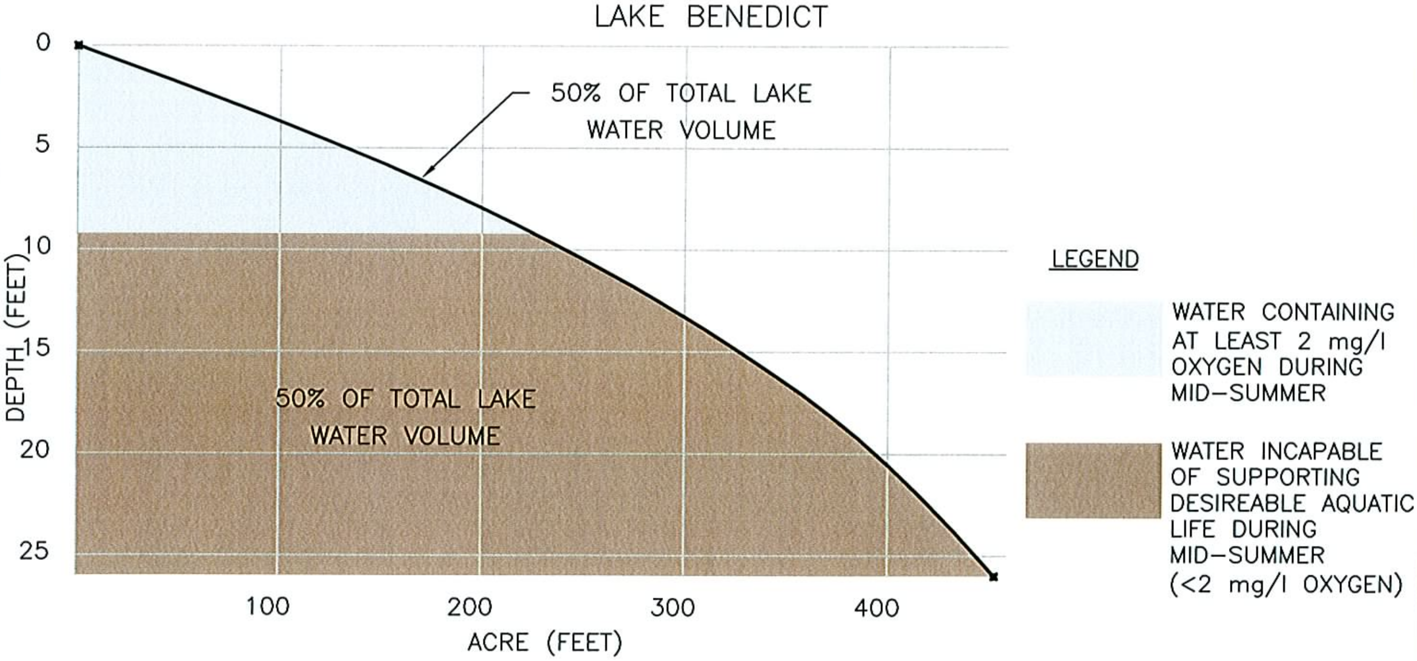
CREATION DATE: 08/01/03
DRAWN BY: KAA
REVISION DATE: 08/23/03



LAKE BENEDICT



LAKE TOMBEAU

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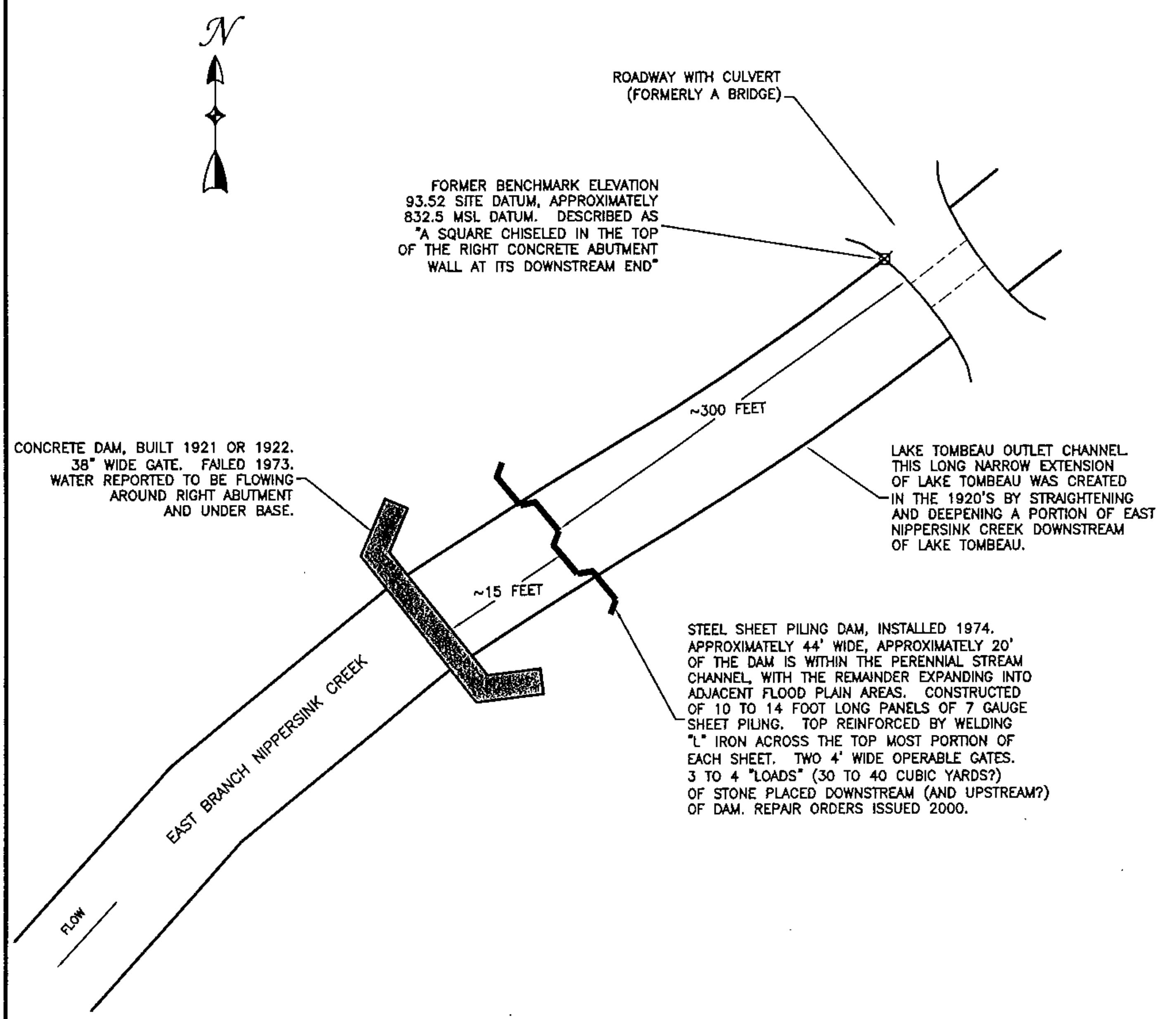
LAKE VOLUME vs. DEPTH LAKES BENEDICT & TOMBEAU

LAKE BENEDICT/TOMBEAU LAKE MANAGEMENT DISTRICT
WALWORTH/KENOSHA COUNTIES

CREATION DATE: 08/06/03	PROJECT NUMBER: BTL01-3100-2507
DRAWN BY: KAA	FIGURE 5
REVISION DATE: 08/23/03	



NOTE: THE INFORMATION COMPILED IN THIS ILLUSTRATION IS LARGELY DRAWN FROM SKETCHES AND CORRESPONDENCE IN WISCONSIN DEPARTMENT OF NATURAL RESOURCES DAM FILES.

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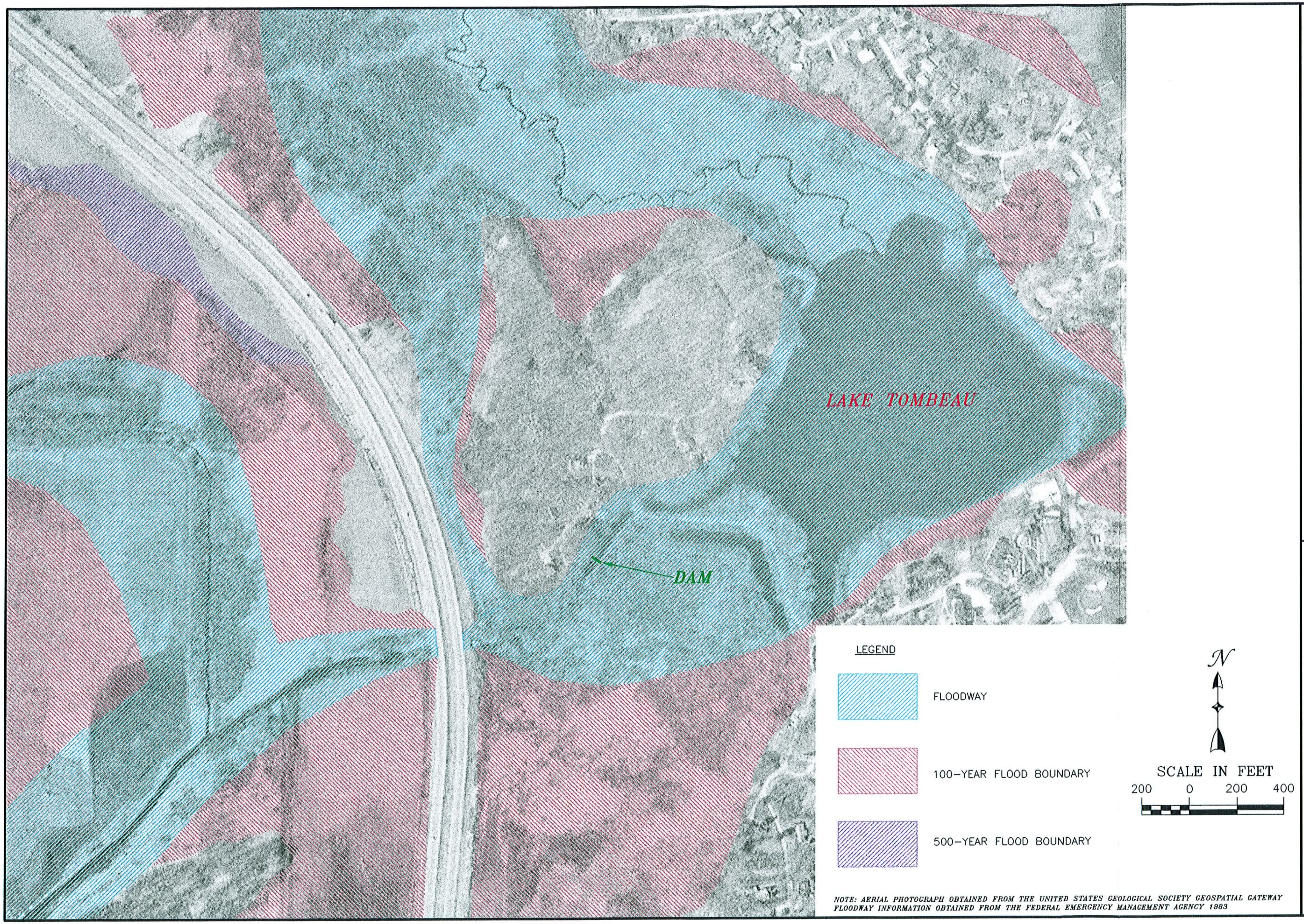
SCHEMATIC OF 1921/1922 & 1974 TOMBEAU OUTLET DAMS

LAKE BENEDICT/TOMBEAU LAKE MANAGEMENT DISTRICT
WALWORTH/RACINE COUNTIES

CREATION DATE: 08/05/03	PROJECT NUMBER: BTL01-3100-2507
DRAWN BY: KAA	FIGURE 6
REVISION DATE: 08/23/03	



FLOOD BOUNDARIES

LAKE BENEDICT/TOMBEAU LAKE MANAGEMENT DISTRICT
WALWORTH/KENOSHA COUNTIES

PROJECT NUMBER: BTL01-3100-2507

FIGURE 7

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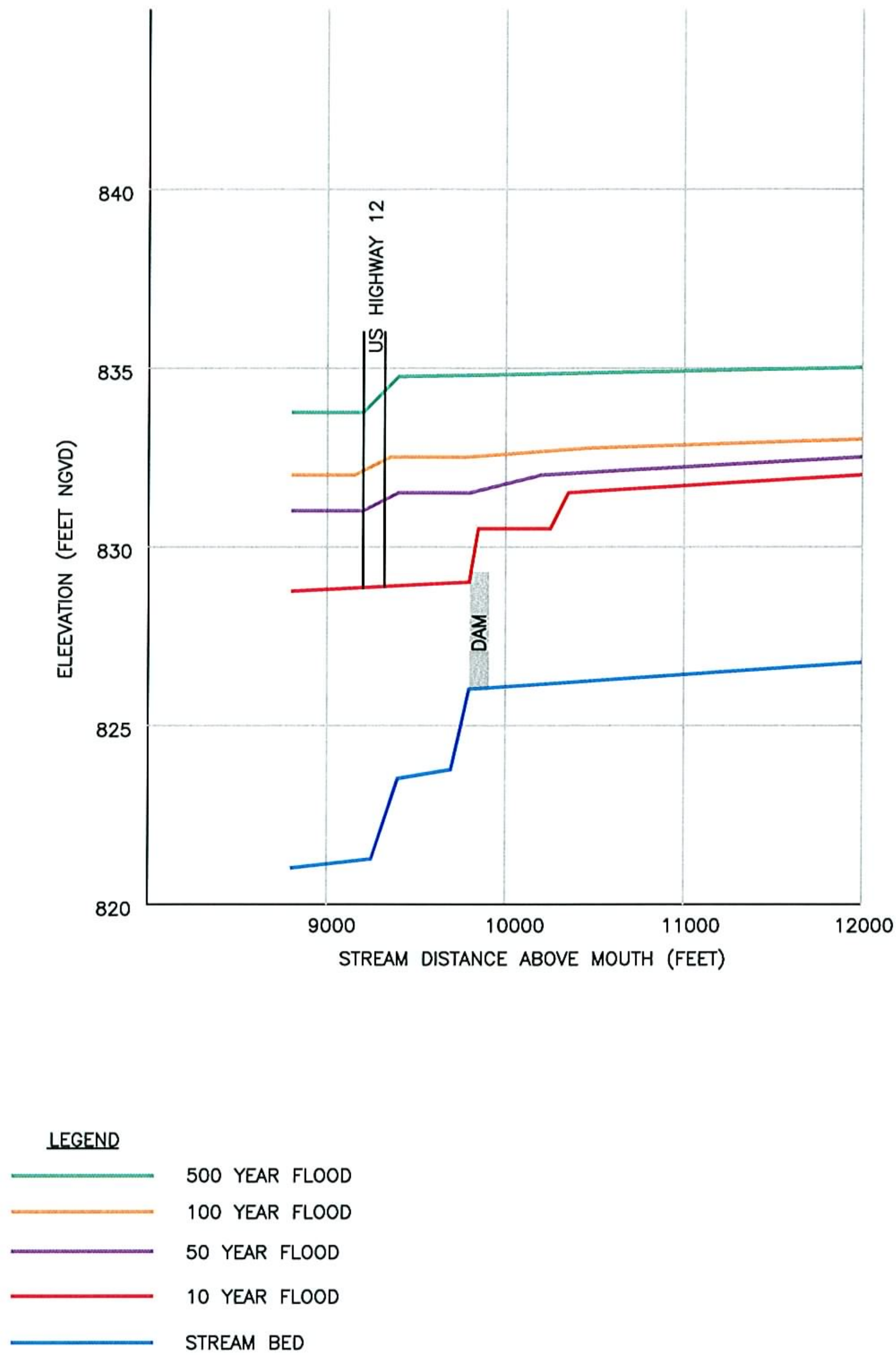

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CHANNEL & FLOOD PROFILES EAST BRANCH NIPPERSINK CREEK

LAKE BENEDICT/TOMBEAU LAKE MANAGEMENT DISTRICT
WALWORTH/RAINE COUNTIES

CREATION DATE: 08/07/03
DRAWN BY: KAA
REVISION DATE: 08/23/03

PROJECT NUMBER: BTL01-3100-2507

FIGURE 8

Table 5 Options for Dam and Related Work

1.	**Replacement Dam.** The new or reconstructed dam at the site of the existing dam will need to be 50 feet long (perpendicular to flow in Nippersink Creek) with a structural height of approximately 3.5 feet. The spillway crest elevation will be set to maintain the normal water level of Lake Tombeau, which needs to be determined. The parcel the dam sits on is 65 feet long by 20 wide. The 10-, 50-, and 100-year floods overtop the existing dam by 1, 2, and 3 feet, respectively. The regulatory floodway is 880 feet wide at the dam (FEMA, 1983). Due to the width of the floodway compared to the dam and its submergence, the dam has little effect on the water surface profile of the 100-year flood, and so the dam has only a minor influence on the hydraulic capacity of the floodway. The dam must be designed for overtopping and care must be taken to avoid erosion on either side of the dam. All costs below include design, permitting, bidding, construction inspection, and preparation of the as-built report and the dam Inspection, Operations, and Maintenance Plan. They also include restoring vegetation on the access route. The vegetation restoration includes 80 square yards of heavy-duty turf reinforcement mats for preventing erosion of grass/plants adjacent to the dam. These permanent plastic-mesh mats are laid on the ground and filled with soil. The roots of grass and plants grow through the plastic mesh. This would provide stability from flowing floodwaters of Nippersink Creek. The costs below are estimated; they are not based on actual bids from contractors. They are typical of current costs based on available information on the dam site.	
	Description of Alternative	**Advantages, Disadvantages, and Cost**
1.1	Repair Existing Dam. This would require shoring up or replacing damaged portions of the sheet piling with new sheet piling.	This is not recommended due to the age of the existing sheet piling. Due to mobilization costs, the repair would cost almost as much as a new sheet-piling dam.
1.2	Earthen Dam, protected with concrete paving or articulated concrete blocks (ex. Armorflex®)	An earthen dam will not fit within the existing property boundaries. A 3.5-foot high dam in a 20 foot wide (base of dam, parallel to flow) lot would require 3-foot run to 1-foot rise (3:1) slopes, which is too steep for a safe and stable earthen dam..
1.3	Sheet-Piling Dam, covered with 3-foot angular quarry stone. Sheet piling would be driven immediately upstream of the existing dam at least 12 feet into the ground and would extend approximately 4 feet above the streambed. The 3-foot quarry stone would stabilize the sheet piling and surrounding soils. Includes installation of mechanical level control gate in corrugated steel structure and steel catwalk to gate. After installing the new dam, the old sheet piling would be cutoff 1 foot below the level of the existing streambed. Purchasing additional property upstream of the existing dam, approximately a 10-foot by 65-foot wide strip, would make sheet-piling installation easier. The new sheet piling cannot easily be installed downstream of the existing dam because the quarry stones there would have to be cleared first, which could cause the existing dam to fail. Further field investigation is required to assess existing obstructions and available locations for installing new sheet piling.	Cost: $60,000 to $80,000. Minimum expected life: 20 to 25 years Similar to existing dam, but stabilized with quarry stone. This rock cover is often considered aesthetically more attractive. Sheet piling can be driven into water without any temporary dam or water diversions. Little or no maintenance is required, except possibly restoring rock to original position every 10 to 20 years. (Mechanical gate in steel structure and catwalk adds $10,000 to $15,000 to cost)

Table 5 Options for Dam and Related Work

1.4	Concrete Dam. The concrete dam would be shaped like a broad weir with 2:1 side slopes. It would rest on steel H-pilings driven into the ground, and would include a sheet piling cutoff wall. Includes installation of mechanical level control gate in concrete structure and steel catwalk to gate.	Cost: \$120,000 to \$160,000. Minimum expected life: 50 years Some may consider this option more aesthetically attractive than option 1.3 – stone covered sheet piling. Temporary cofferdams and a diversion channel are required during concrete installation and initial curing. These temporary structures account for approximately 25% of the cost; they could be avoided by temporarily reducing the lake water level by 4 to 5 feet. Little or no maintenance required, inspect for cracks and repair if needed. (Mechanical gate in concrete structure and catwalk adds \$15,000 to \$20,000 to cost)
2.	**Stabilization of East Branch Nippersink Creek downstream of Dam.** The WDNR has stated that there is a slight chance that high gradient portions of the East Branch of Nippersink Creek (an area extending 150 to 200 feet downstream of the dam) may need stabilization to prevent erosion. The scope of this potential problem needs to be further investigated. Installation of 24-inch rip-rap on each bank of Nippersink Creek for 200-feet downstream of the dam, 10 to 15 feet wide on each bank, would cost \$17,000 o \$23,000. The actual amount of erosion control work needed could be considerably less, so these costs should be the maximum potential cost.	
3.	**Improving Summertime Water Quality in Lake Tombeau.** The options below would reduce the volume of anoxic water in Tombeau Lake during summer months. This would in turn lessen internal phosphorus loading and improve and enlarge habitat required to promote desirable aquatic plants and animals.	
	Description of Alternative	**Advantages, Disadvantages, and Cost**
3.1	Bottom-Draw Pipe. The colder bottom waters of Lake Tombeau do not circulate in summer, do not contact the atmosphere, and consequently become oxygen deficient. In this option, water would be drawn from a deep portion of the lake, releasing some of this non-circulating water volume downstream. This water would then be replaced by oxygenated surface water moving downward. In contrast, the existing dam skims the warmer, oxygenated water from the lake's surface, leaving colder oxygen deficient water in place To construct the bottom draw draft tube, a weighted pipe could be set on the lake bottom, extending from a deep portion of Lake Tombeau, along the outlet channel, to the dam (approximately 1,050 feet). An 18-inch diameter pipe would be required to carry the anticipated base flow (up to 2 cubic feet per second) with only 6-inch of friction head loss. This would leave 3-feet of water head to aerate the water by cascading it in a thin layer over rocks downstream of the dam, preventing low dissolved oxygen downstream in Nippersink Creek. A flow control structure would also be installed on this pipe at the dam. The concrete weights would be 1100 pounds on 15-foot centers.	Cost: \$110,000 - \$130,000 for a system with piping placed directly on the lake/channel bottom. If extensive permit negotiation and/or piping burial is required, costs would be substantially higher. The WDNR will also require evaluation of lake and stream conditions. The cost presented above does not include testing and studies. At a minimum, the WDNR will require that downstream portions of the East Branch of Nippersink Creek be evaluated to help assure that biota are not adversely affected. Minimum Expected Life: 50 years Very few mechanical parts. No energy input required. Flow though bottom draw pipe would have to be turned on and off in the spring and fall. If the pipe is not buried, it may pose a hazard to navigation in shallow areas.

Table 5 Options for Dam and Related Work

	State law inhibits laying pipe directly on the lake and/or channel bottom. At best, exemptions and permits will need to be procured to allow installation. These permits could be difficult to acquire, and could require partial burial in the lake and/or channel bottom. Piping burial would complicate installation and substantially raise construction cost.	
3.2	<u>Aerate Lake During Summer</u>. Lakes can be aerated to disrupt stratification, and help assure that most of the lake contains oxygenated water. Aeration commonly involves emitting compressed air at the lake bottom. The compressed air induces lake circulation, allowing most of the lake's volume to come in contact with the atmosphere, where the lake water becomes oxygenated. Compressors would be installed on shore; 1.1-inch outer diameter tubing would run from shore to diffuser locations on the lake bottom. The preliminary estimate indicates that three, less than 1-horsepower compressors installed at three locations on shore and 12 air stations (with four diffuser heads each) distributed over the lake bottom would provide one "lake turnover" per day, de-stratifying the lake. Lake aeration was recently installed at Little Green Lake, Green Lake County. Lake Emily, Dodge County, also has lake aeration installed. As with a bottom draw pipe, state law inhibits laying piping or aerators on the lake bed. At best, exemptions and permits will need to be procured to allow installation. These permits could be difficult to acquire, and could require partial burial of structures in the lake bottom. Burial would complicate installation and substantially raise construction cost. Lake aeration is not suitable in all lakes. In some instances, it can induce undesirable transfer or nutrients to the surface, causing algal blooms. Factors that would influence the potential for success of aeration at Lake Tombeau should be examined before a system is installed. The WDNR will likely require such a study before approving installation of an aeration system.	Present worth of cost to maintain and replace for 60-years operation: $70,000 to $150,000 (depending on actual capital costs, maintenance costs, interest rate, and equipment life.) This assumes that all submersed equipment can be lie on the surface of the lakebed. Initial Cost $30,000 to $50,000. If portions of the submersed equipment require difficult permit negotiation and/or burial, costs would be substantially higher. Electrical cost would be $75 to $125 per month when operating (late spring to fall). Compressors must be located on shorefront property, within about 100 to 200 feet of shore. They are reportedly quiet – about 45 decibels outside the cabinet supplied with them. Compressors will require periodic maintenance (1 – 2 times per year). Wind and waves may displace the tubing and diffusers; they commonly also clog. The diffusers have perforated flexible membranes that are reportedly self-cleaning. However, they may need to be periodically replaced (every 10 to 20 years at a cost of $5,000 to $10,000).

Table 6 Potential Funding Sources

Program	Founding Source	Eligible Projects	Funds Available	Funding Term	Application Deadline	Contact
Lake Protection Grant	WDNR	▲ Lake improvement and restoration projects, such as pollution prevention, aeration, and wetland restoration	▲ 75% reimbursement of project costs, up to $200,000 ▲ 25% cost share amounts acceptable in form of cash, funds from third party, donated labor, services, materials, or equipment		May 1st of each year	Heidi Bunk Lake Coordinator (414) 229-0819 Mary Ellen Franson Environmental Grants Specialist (414) 263-8569
Lake Management Planning Grant	WDNR	▲ Small-scale projects: - Studies and assessments needed to update existing management plans - for expanding monitoring. ▲ Large-scale projects - Collecting physical, chemical, and biological data - Developing management and implementation plans for lake protection and rehabilitation	▲ Up to $3,000 for small-scale projects ▲ Up to $10,000 for large-scale projects ▲ State will provide up to 75% of project costs ▲ 25% cost-share amounts acceptable in forms of cash, funds from third-party, donated services, materials, or equipment		February 1st and August 1st of each year	Heidi Bunk Lake Coordinator (414) 229-0819 Mary Ellen Franson Environmental Grants Specialist (414) 263-8569
State Trust Fund Loan Program	Board of Commissioners of Public Lands	▲ Dam removal, construction	▲ Up to $5,000,000 per calendar year ▲ No cumulative limit on amount of loans that may be obtained	▲ Loan terms up to 20 years ▲ Interest rate may change due to market conditions and availability of funds, but loan rate is guaranteed for life of loan	None	Coletta DeMuth or Bruce Vande Zande (608) 267-2787
Aquatic Ecosystem Restoration – Sec 206	U.S. Army Corp of Engineers	▲ Restoration, improvement, or protection of aquatic habitat for plants, fish, and wildlife	▲ 65% of costs covered by federal government ▲ 35% of costs covered by non-federal sponsor (public agency) ▲ $5 million maximum per project		None	Tom Crump, USAEC (651) 290-5284 thomas.l.crump@usac.army.mil

APPENDIX A

WELL CONSTRUCTOR REPORTS

OCT 22 1975

OCT 15 1975

WELL CONSTRUCTOR'S REPORT
FORM 3300-15

NOTE

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin

1. COUNTY Walworth — X Town — Village — City — NAME Bloomfield

2. LOCATION — ¼ Section N E — Section 24 — Township 1 N — Range 18 E

3. OWNER AT TIME OF DRILLING: Hugo Eckerle
Address: Rt. #1, Box 103
Genoa City, Wisc.

4. Distance in feet from well to nearest:

OTHER POLLUTION SOURCES

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia.	From	To
10"	Surface	10'
5"	10'	84'

7. CASING, LINER, CURBING, AND SCREEN

Dia.	Kind and Weight	From	To
5"	T & C New Steel Galv. 15lb. Per Ft. ASTM A53	Surface	84'

9. FORMATIONS

Kind	From	To
Sandy Clay Gravel	Surface	10
Sand & Gravel	10'	42
Sand & Clay	42'	69
Sand & Gravel	69'	84

8. GROUT OR OTHER SEALING MATERIAL

Kind	From	To
Drilling mud	Surface	10'

10. TYPE OF DRILLING MACHINE USED: X

Well construction completed on 10/7 1975

Well is terminated — inches X above / below final grade

Well disinfected upon completion X Yes

Well sealed watertight upon completion X Yes

11. MISCELLANEOUS DATA

Yield test: 2 Hrs. at 15 GPM

Depth from surface to normal water level 21' ft.

Depth to water level when pumping — ft.

Water sample sent to State Lab. of Hygiene, Madison, Wisc. laboratory on 10-15 19

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE Joseph H. Huemann & Sons, Inc.

William F. Huemann — Registered Well Driller

COMPLETE MAIL ADDRESS: 2370 N. Johnsburg Rd. McHenry, Ill. 60050

Please do not write in space below

COLIFORM TEST RESULT — GAS — HRS — GAS — HRS — CONFIRMED — REMARKS

REV. 3-71

WELL CONSTRUCTOR'S REPORT
FORM 3300-15

OCT 15 1975 OCT 22 1975

NOTE

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

1. COUNTY Walworth — X Town — Village — City — NAME Bloom Field

2. LOCATION — ¼ Section N E — Section 24 — Township 1 N — Range 18 E

OR — Street

AND

3. OWNER AT TIME OF DRILLING Hrylorij Wasylin
ADDRESS 272 N. Edgebrook
POST OFFICE Wooddale, Ill. 60191

4. Distance in feet from well to nearest

20'

CLEAR WATER DRAIN — SEPTIC TANK — PRIVY — SEEPAGE PIT — ABSORPTION FIELD — BARN — SILO — ABANDONED WELL — SINK HOLE

OTHER POLLUTION SOURCES

5. Well is intended to supply water for: House

6. DRILLHOLE

Dia.	From	To
10"	Surface	12'
6"	12'	167'

7. CASING, LINER, CURBING, AND SCREEN

Dia.	Kind and Weight	From	To
5"	T & C New Steel Galv. 15lb. Per ft. ASTM A53	Surface	167'

8. GROUT OR OTHER SEALING MATERIAL

Kind	From	To
Drilling Mud	Surface	12'

9. FORMATIONS

Kind		From	To
Sandy Clay Caving		Surface	10
Sand & Gravel		10'	
Clay & Sand		41'	84
Sand		84'	1
Sand & Clay		115'	13
Sand		135'	16
Course Sand		160'	16

10. TYPE OF DRILLING MACHINE USED

X Cable Tool — Direct Rotary — Reverse Rotary — Rotary-hammer — Jetting with

11. MISCELLANEOUS DATA

Yield test: 2 Hrs. at 15 GPM

Depth from surface to normal water level 23' ft.

Depth to water level when pumping 0' ft.

Well construction completed on 10/6 19

Well is terminated inches X above below final grade

Well disinfected upon completion X Yes

Well sealed watertight upon completion X Yes

Water sample sent to State Lab. of Hygiene, Madison, Wisc. laboratory on: 10/13 19

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE Joseph H. Huemann & Sons, Inc.

William J. Huemann — Registered Well Driller

COMPLETE MAIL ADDRESS 2020 W. Johnsburg Rd. McHenry, Ill. 60050

Please do not write in space below

COLIFORM TEST RESULT — GAS 24 HRS — GAS 48 HRS — CONFIRMED — REMARKS

REV. 3-71

WELL CONSTRUCTOR'S REPORT
FORM 3300-15

OCT 15 1975

NOTE

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

1. COUNTY: Walworth — X Town — NAME: Bloomfield

2. LOCATION — ¼ Section: N E — Section: 24 — Township: 1 N — Range: 18E

3. OWNER AT TIME OF DRILLING: Paul Wurtz & Associates
ADDRESS: 100 E. Main St.
Lake Geneva, Wisc.

4. Distance in feet from well to nearest

Building	20'	–	–	–	–	---	--	–	–

Clear Water Drain C.I.	Tile	Septic Tank	Privy	Seepage Pit	Absorption Field	Barn	Silo	Abandoned Well	Sink Hole
–	–	56'	–	--		–	–	---	---

OTHER POLLUTION SOURCES

5. Well is intended to supply water for: House

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)
10"	Surface	12'
5"	12'	143'

7. CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
5"	T & C New Steel Galv. 15lb. Per Ft.	Surface	143'

8. GROUT OR OTHER SEALING MATERIAL

Kind	From	To
Drilling Mud	Surface	12'

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Sandy Clay	Surface	12'
Course Sand	12'	54'
Sand & Gravel	54'	64'
Fine Sand Brown	64'	70'
Fine Sand Gray	70'	122'
Sand & Clay	122'	142'
Gravel	142'	143'

10. TYPE OF DRILLING MACHINE USED
X Cable Tool — Direct Rotary — Reverse Rotary — Rotary - Hammer — Jetting with

Well construction completed on 10/4 19 75

Well is terminated ... inches X above / below final grade

Well disinfected upon completion X Yes

Well sealed watertight upon completion X Yes

11. MISCELLANEOUS DATA
Yield test: 2 Hrs. at 15 GPM
Depth from surface to normal water level 35' ft.
Depth to water level when pumping 45' ft.

Water sample sent to State Lab. of Hygiene, Madison, Wisc. laboratory on: 10 - 13 19 75

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE: Joseph H. Huemann & Sons, Inc. — Registered Well Driller
COMPLETE MAIL ADDRESS: 3007 W. Johnsburg Rd.
McHenry, Ill. 60050

Please do not write in space below

COLIFORM TEST RESULT — GAS 24 HRS — GAS 48 HRS — CONFIRMED — REMARKS

REV 3-71

SEP 22 1978

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

NOTE:
White Copy - Division's Copy
Green Copy - Driller's Copy
Yellow Copy - Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300-15
Rev. 10-75

1. COUNTY Walworth — CHECK (✓) ONE: [✓] Town [ ] Village [ ] City — Name Bloomfield

2. LOCATION ¼ Section NE Section 24 Township 1 Range R18E
OR — Grid or Street No. Street Name
AND — If available subdivision name, lot & block No. Lot B Blk 5 Rose Garden Manor(?)

3. NAME [ ] OWNER [✓] AGENT AT TIME OF DRILLING CHECK (✓) ONE
Stampf(?) Builders Inc.
ADDRESS 2808 Lake Shore Court(?)
POST OFFICE Twin Lakes Wisc

4. Distance in feet from well to nearest: (Record answer in appropriate block)
Building 8; Sanitary Bldg. Drain C.I. Other; Sanitary Bldg. Sewer C.I. Other; Floor Drain Connected To C.I. Sewer Other Sewer; Storm Bldg. Drain C.I. Other; Storm Bldg. Sewer C.I. Other
Street Sewer San. Storm; Other Sewers C.I. Other; Foundation Drain Connected To Sewer Clearwater Dr.; Sewage Sump Clearwater Sump; Septic Tank 30; Holding Tank; Sewage Absorption Unit Seepage Pit Seepage Bed 60 Seepage Trench
Privy; Pet Waste Pit; Pit: Nonconforming Existing Well Pump Tank: none; Subsurface Pumproom Nonconforming Existing; Barn Gutter; Animal Barn Pen; Animal Yard; Silo With Pit; Glass Lined Storage Facility; Silo w/o Pit; Earthen Silage Storage Trench Or Pit
Temporary Manure Stack; Watertight Liquid Manure Tank; Solid Manure Storage Structure; Subsurface Gasoline or Oil Tank; Waste Pond or Land Disposal Unit (Specify Type); Other (Give Description): none

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	Surface	40			
4	40	82			

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
4	casing 11 lb/ft T & C ASTM A53 Wheatland Pipe	Surface	82

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Puddle Clay	Surface	40

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Topsoil	Surface	2
Clay	2	15
Sand & Clay	15	40
Clay	40	76
Water bearing sand & Gravel	78	82

10. TYPE OF DRILLING MACHINE USED
[✓] Cable Tool [ ] Rotary-hammer w/drilling mud & air [ ] Jetting with [ ] Air [ ] Water
[ ] Rotary-air w/drilling mud [ ] Rotary-hammer & air
[ ] Rotary-w/drilling mud [ ] Reverse Rotary

Well construction completed on June 1978
Well is terminated 12 inches [✓] above [ ] below final grade
Well disinfected upon completion [✓] Yes [ ] No
Well sealed watertight upon completion [✓] Yes [ ] No

11. MISCELLANEOUS DATA
Yield Test: 8 Hrs. at 15 GPM
Depth from surface to normal water level 20 Ft.
Depth of water level when pumping 30 Ft. Stabilized [✓] Yes [ ] No

Water sample sent to Madison laboratory on Sept 1978

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature Kenneth Lehovy(?) Registered Well Driller — Complete Mail Address Box 664 Twin Lakes, Wisc

SEP 22 1978

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

NOTE:
White Copy - Division's Copy
Green Copy - Driller's Copy
Yellow Copy - Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300-15
Rev. 10-75

1. COUNTY Walworth — CHECK (√) ONE ☑ Town ☐ Village ☐ City — Name Bloomfield

2. LOCATION — ¼ Section NE — Section 34 — Township 1 — Range 18E
OR Grid or Street No. Street Name Pippensink
AND If available subdivision name, lot & block No. Lot Blk ... Pippensink

3. NAME ☐ OWNER ☑ AGENT AT TIME OF DRILLING CHECK (√) ONE
ADDRESS Stampf Builders Inc
...
POST OFFICE Twin Lakes Wis

4. Distance in feet from well to nearest: (Record answer in appropriate block) — Building 8
Seepage Bed 60

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	Surface	40			
4	40	86			

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
4	new 11# per ft	Surface	86
	T & C ASTM A53		
	Wheatland pipe		

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Puddled Clay	Surface	40

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Topsoil	Surface	3
Sandy Clay	3	35
Clay	35	80
water bearing sand	80	86
Gravel		

10. TYPE OF DRILLING MACHINE USED
☑ Cable Tool ☐ Rotary-air w/drilling mud ☐ Rotary-w/drilling mud ☐ Rotary-hammer w/drilling mud & air ☐ Rotary-hammer & air ☐ Reverse Rotary ☐ Jetting with ☐ Air ☐ Water

11. MISCELLANEOUS DATA
Yield Test: 8 Hrs. at 12 GPM
Depth from surface to normal water level 20 Ft.
Depth of water level when pumping 30 Ft. Stabilized ☑ Yes ☐ No

Well construction completed on June 19 78
Well is terminated 12 inches ☑ above ☐ below final grade
Well disinfected upon completion ☑ Yes ☐ No
Well sealed watertight upon completion ☑ Yes ☐ No

Water sample sent to Madison laboratory on Oct 1978

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature ... Registered Well Driller — Complete Mail Address Box 669 Twin Lakes Wis

SEP 24 1980

WELL CONSTRUCTOR'S REPORT
FORM 3300--15

NOTE
WHITE COPY - DIVISION'S COPY
GREEN COPY - DRILLER'S COPY
YELLOW COPY - OWNER'S COPY

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

COUNTY [illegible]

CHECK ONE: Town / Village / City   NAME

LOCATION – ¼ Section / Section / Township / Range: [illegible] / 24 / [illegible] / [illegible]

R – Grid or street no. / Street name [illegible]

NO – If available subdivision name, lot & block no.

3. OWNER AT TIME OF DRILLING

ADDRESS

POST OFFICE

Distance in feet from well to nearest: (Record answer in appropriate block)

BUILDING	SANITARY SEWER C.I.	SANITARY SEWER TILE	FLOOR DRAIN C.I.	FLOOR DRAIN TILE	FOUNDATION DRAIN SEWER CONNECTED	FOUNDATION DRAIN INDEPENDENT	WASTE WATER DRAIN C.I.	WASTE WATER DRAIN TILE
52								

CLEAR WATER DRAIN C.I.	CLEAR WATER DRAIN TILE	SEPTIC TANK	PRIVY	SEEPAGE PIT	ABSORPTION FIELD	BARN	SILO	ABANDONED WELL	SINK HOLE
		50		50					

OTHER POLLUTION SOURCES (Give description such as dump, quarry, drainage well, stream, pond, lake, etc.)

Well is intended to supply water for: Home

DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	Surface	[illegible]	6	[illegible]	90

CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6	[illegible]	Surface	23
[illegible]	[illegible] Steel	38	70

9. FORMATIONS

Kind	From (ft.)	To (ft.)
[illegible]	Surface	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	25	72

See 11-11-81 letter in WD FILE

GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
[illegible]	Surface	[illegible]

10. TYPE OF DRILLING MACHINE USED

Cable Tool / Direct Rotary / Reverse Rotary / Rotary – air with drilling mud / Rotary – hammer with drilling mud & air / Jetting with Air / Water

11. MISCELLANEOUS DATA

Yield test: [illegible] Hrs. at [illegible] GPM

Depth from surface to normal water level [illegible] ft.

Depth to water level when pumping [illegible] ft.

Water sample sent to [illegible] laboratory on: [illegible] 19[illegible]

Well construction completed on [illegible] 19

Well is terminated [illegible] inches above / below final grade

Well disinfected upon completion ☒ Yes ☐ No

Well sealed watertight upon completion ☐ Yes ☐ No

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE – Registered Well Driller

COMPLETE MAIL ADDRESS

Please do not write in space below

COLIFORM TEST RESULT	GAS – 24 HRS.	GAS – 48 HRS.	CONFIRMED	REMARKS

REV. 3-71

State of Wisconsin
Department of Natural Resources
Private Water Supply
Box 7921
Madison, Wisconsin 53707

SPOT CHECK

NOTE:
White Copy - Division's Copy
Green Copy - Driller's Copy
Yellow Copy - Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300-15 Rev. 2-79

1981

1. COUNTY Walworth CHECK (✓) ONE: ☑ Town ☐ Village ☐ City Name Bloomfield

2. LOCATION ¼ Section or Gov't Lot NE Section 4 Township T1N Range
OR Grid or Street No. Street or Road Name Fontblau Road
AND If available subdivision name, lot & block No. 242 Nippersink Highlands

3. NAME ☐ OWNER ☐ AGENT AT TIME OF DRILLING CHECK (✓) ONE
Leland Stekr
ADDRESS 351 Main Street
POST OFFICE Twin Lakes ZIP CODE

4. Distance in feet from well to nearest: (Record answer in appropriate block)
Building 15
Sewage Absorption Unit: Seepage Pit / Seepage Bed / Seepage Trench 95
Septic Tank 65
Other: Drilling (?) ... [illegible]

5. Well is intended to supply water for: Single Family

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	Surface	20			
5"	20	126			

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification, Mfg. & Method of Assembly	From (ft.)	To (ft.)
5"	ASTM A53	Surface	126
	TEC Same		
	15/L6/per ft		
	2.50 wall		
5"	Johnson Screen 4 ft long	126	129

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Puddle Clay	Surface	20

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Gravel	Surface	40
Sandy Clay	41	110
water gravel	111	129

10. TYPE OF DRILLING MACHINE USED
☑ Cable Tool ☐ Rotary-hammer w/drilling mud & air ☐ Jetting with ☐ Air ☐ Water
☐ Rotary-hammer & air ☐ Reverse Rotary

11. MISCELLANEOUS DATA
Yield Test: 5 Hrs. at 15 GPM
Depth from surface to normal water level 25 Ft.
Depth of water level when pumping 30 Ft. Stabilized ☑ Yes ☐ No
Water sample sent to Mad laboratory on Nov 1979

Well construction completed on Nov 1979
Well is terminated 12 inches ☑ above ☐ below final grade
Well disinfected upon completion ☑ Yes ☐ No
Well sealed watertight upon completion ☑ Yes ☐ No

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature [signature] Registered Well Driller
Business Name and Complete Mailing Address RT 5 Box 794B Burl 53105

FEB 2 1 1980

State of Wisconsin
Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

NOTE:
White Copy – Division's Copy
Green Copy – Driller's Copy
Yellow Copy – Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300-15 Rev. 12-76

1. COUNTY: Walworth
CHECK (✓) ONE: [X] Town [ ] Village [ ] City
Name: Bloomfield

2. LOCATION: ¼ Section NE; Section 24; Township 1 N; Range 18 E
OR Grid or Street No. / Street Name: Circle Drive
AND If available subdivision name, lot & block No.: Powers Lake

3. NAME [X] OWNER [ ] AGENT AT TIME OF DRILLING CHECK (✓) ONE
Powers Lake Realty
ADDRESS: P.O. Box 200
POST OFFICE: Powers Lake, WI 53159

STATE 2/18/80
OWNER 2/18/80
DRILLER

4. Distance in feet from well to nearest: (Record answer in appropriate block)

[illegible]										
12	11	–	28	–	30	–	11	–	28	–

[illegible]											
–	–	–	–	–	20	–	–	20	85	–	Seepage Pit 90

[illegible]													
–	–		–	–	–	–	–	–	–	–	–	–	–

Temporary Manure Stack	Watertight Liquid Manure Tank	Solid Manure Storage Structure	Subsurface Gasoline or Oil Tank	Waste Pond or Land Disposal Unit (Specify Type)	Other (Give Description)	
–	–	–	–	–	–	–

5. Well is intended to supply water for: Residential

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
9	Surface	20			
5	20	70			

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
5"	New Black Steel	Surface	67
	T&C 15 PPF-ASTM		
	A-53 youngstown		
5"	Johnson SS Screen		
	Slot # 10	67	70

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Clay Slurry	Surface	20

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Clay	Surface	6
Sand & Gravel	6	30
Sandy Clay	30	50
Sand & Little Gravel	50	70

10. TYPE OF DRILLING MACHINE USED
[X] Cable Tool
[ ] Rotary-hammer w/drilling mud & air
[ ] Jetting with [ ] Air [ ] Water
[ ] Rotary-air w/drilling mud
[ ] Rotary-hammer & air
[ ] Rotary w/drilling mud
[ ] Reverse Rotary

Well construction completed on October 19, 1979

Well is terminated 13 inches [X] above [ ] below final grade

Well disinfected upon completion [X] Yes [ ] No

Well sealed watertight upon completion [X] Yes [ ] No

11. MISCELLANEOUS DATA
Yield Test: 2½ Hrs. at 12 GPM
Depth from surface to normal water level 27 Ft.
Depth of water level when pumping 35 Ft. Stabilized [X] Yes [ ] No

Water sample sent to Inter-City Milk Control laboratory on February 12, 19

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side. Safe 2/14/80

Signature: [signature] Registered Well Driller

Complete Mail Address:
HOOVER WATER WELL SERVICE, INC.
~~3700 West 33rd Street~~
Zion, Illinois 60099

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

NOTE:
White Copy - Division's Copy
Green Copy - Driller's Copy
Yellow Copy - Owner's Copy

DEC 23 1977

WELL CONSTRUCTOR'S REPORT
Form 3300-15
Rev. 10-75

1. COUNTY: Walworth — CHECK (✓) ONE: Town / Village / City — Name

2. LOCATION: ¼ Section NE; Section 24; Township 1N; Range 18E
OR - Grid or Street No. Street Name: Tombeau Rd
AND - If available subdivision name, lot & block No.: Nippersink

3. NAME: OWNER X AGENT AT TIME OF DRILLING
Paul Wurtz & Assoc.
ADDRESS: 100 E. Main, Hy 50
POST OFFICE: Lake Geneva, Wisc. 53148

4. Distance in feet from well to nearest: (Record answer in appropriate block)
Building: 15
Other: sump pump
Septic tank: 50
Seepage Bed: 60

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)
10	Surface	20
5	20	142

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
5	USS Seamless 15# AP5L Made in USA J 95-11 7K3X28 CG 05840-1 7K523 5 9/16 OD 258THK	Surface	142

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
drilling mud	Surface	20

9. FORMATIONS

Kind	From (ft.)	To (ft.)
clay	Surface	15
sand	15	130
gravel	130	142

10. TYPE OF DRILLING MACHINE USED
[X] Cable Tool

11. MISCELLANEOUS DATA
Yield Test: 8 Hrs. at 15 GPM
Depth from surface to normal water level: 30 Ft.
Depth of water level when pumping: 55 Ft. Stabilized [X] Yes [ ] No

Well construction completed on Nov. 12 1977
Well is terminated 12 inches [X] above [ ] below final grade
Well disinfected upon completion [X] Yes [ ] No
Well sealed watertight upon completion [X] Yes [ ] No

Water sample sent to Madison, Wisc. laboratory on Dec. 14th 1977

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature: Hubert R. Johnson — Registered Well Driller #026
Complete Mail Address: R. 2 Box 110, Genoa City, Wisc. 53128

SEP 22 1978

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

NOTE:
White Copy - Division's Copy
Green Copy - Driller's Copy
Yellow Copy - Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300-15
Rev. 10-75

1. COUNTY Walworth — CHECK (✓) ONE: ☑ Town ☐ Village ☐ City — Name Bloomfield

2. LOCATION — ¼ Section NE, Section 24, Township 1, Range 18E
OR Grid or Street No. Street Name Nippersink
AND If available subdivision name, lot & block No. Lot 15 Blk 4 Rose Looking Lake

3. NAME — OWNER / AGENT AT TIME OF DRILLING (CHECK A...) Stumpf Builders Inc
ADDRESS 2808 Lake Shore Dr..
POST OFFICE Twin Lakes, Wisc.

4. Distance in feet from well to nearest: (Record answer in appropriate block) Building 8; Septic Tank 30; Seepage Bed 60
Privy / Pet Waste Pit / ... none
Temporary Manure Stack / ... none

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	Surface	40			
4	40	94			

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
4	casing 11# per ft T & C ASTM A53 Wheatland pipe	Surface	94

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Puddle Clay	Surface	40

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Topsoil	Surface	2
Sand & Gravel	2	15
Sand & Clay	15	45
Clay	45	88
water bearing sand & Gravel	88	94

10. TYPE OF DRILLING MACHINE USED
☑ Cable Tool ☐ Rotary-hammer w/drilling mud & air ☐ Jetting with ☐ Air ☐ Water
☐ Rotary-air w/drilling mud ☐ Rotary-hammer w/air ☐ Rotary w/drilling mud ☐ Reverse Rotary

11. MISCELLANEOUS DATA
Yield Test: 8 Hrs. at 15 GPM
Depth from surface to normal water level 20 Ft.
Depth of water level when pumping 30 Ft. Stabilized ☑ Yes ☐ No
Water sample sent to Madison laboratory on Oct 1978

Well construction completed on July 1978
Well is terminated 12 inches ☑ above ☐ below final grade
Well disinfected upon completion ☑ Yes ☐ No
Well sealed watertight upon completion ☑ Yes ☐ No

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature Kenneth Gehring — Registered Well Driller
Complete Mail Address Box 664 Twin Lakes Wisc.

SEP 22 1978

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

NOTE:
White Copy – Division's Copy
Green Copy – Driller's Copy
Yellow Copy – Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300-15
Rev. 10-75

1. COUNTY Walworth — CHECK (✓) ONE: ✓ Town / Village / City — Name Bloomfield

2. LOCATION ¼ Section NE, Section 24, Township 1, Range 18E
OR Grid or Street No. / Street Name: Pepperside
AND – If available subdivision name, lot & block No.: Lot 15 Blk 5 Pow Harbor Sub

3. NAME — OWNER / AGENT AT TIME OF DRILLING CHECK (✓) ONE
Stampf Builders Inc
ADDRESS 2508 Lake Shore Way
POST OFFICE Twin Lakes, Wisc.

4. Distance in feet from well to nearest: (Record answer in appropriate block)
Building: 8
Septic Tank: 25
Seepage Bed: 50
Privy / Pet Waste Pit / Pit: Nonconforming Existing: None
Temporary Manure Stack / Manure storage: None

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)
8	Surface	40
4	40	92

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
4	casing 11# per ft T&C ASTM A53 Wheatland pipe	Surface	92

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Puddle Clay	Surface	40

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Topsoil	Surface	3
Sand & Gravel	3	10
Sand & Clay	10	40
Clay	40	86
water bearing sand & Gravel	86	92

10. TYPE OF DRILLING MACHINE USED
✓ Cable Tool

Well construction completed on July 1977
Well is terminated 12 inches ✓ above / below final grade
Well disinfected upon completion ✓ Yes / No
Well sealed watertight upon completion ✓ Yes / No

11. MISCELLANEOUS DATA
Yield Test: 8 Hrs. at 15 GPM
Depth from surface to normal water level 20 Ft.
Depth of water level when pumping 30 Ft. Stabilized ✓ Yes / No

Water sample sent to Madison laboratory on Oct 1978

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature: Kenneth Hehrung — Registered Well Driller
Complete Mail Address: Box 664 Twin Lakes, Wisc.

NE1/4 Sec 24 T1N R18E

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

RECEIVED
AUG 12 1948
BUREAU SAN. ENG.

1. County [illegible] Town ☐ Village ☐ City ☐ [illegible]
Check one and give name

2. Location [illegible]
Name of street and number of premise or Sec. Tn. and R. numbers

3. Owner ☐ or Agent ☐ [illegible]
Name of individual, partnership or firm

4. Mail Address [illegible]
Complete address required

5. From well to nearest: Building ______ ft; sewer ______ ft; drain ______ ft; septic tank ______ ft; dry well or filter bed ______ ft; abandoned well ______ ft.

6. Well is intended to supply water for: ______

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind	From (ft.)	To (ft.)
4	[illegible]		

9. GROUT:

Kind	From (ft.)	To (ft.)
[illegible]		

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

11. MISCELLANEOUS DATA:

Yield test: ______ Hrs. at ______ GPM.

Depth from surface to water: ______ ft.

Water-level when pumping: ______ ft.

Water sample sent to laboratory at ______ on ______ 19____

Construction of the well was completed on ______ 19____

The well is terminated ______ inches ☐ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes ______ No ______

Was the well sealed watertight upon completion? Yes ______ No ______

Signature [illegible signature]
Registered Well Driller

______
Complete Mail Address

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH
See Instructions on Reverse Side

1. County ______ Town ☐ Village ☐ City ☐ ______ Check one and give name

2. Location NE1/4 Sec 24 T1N R18E
Name of street and number of premise or Sec. Tn. and R. numbers

3. Owner ☐ or Agent ☐ ______
Name of individual, partnership or firm

4. Mail Address ______
Complete address required

5. From well to nearest: Building ______ ft; sewer ______ ft; drain ______ ft; septic tank ______ ft;
dry well or filter bed ______ ft; abandoned well ______ ft

6. Well is intended to supply water for: ______

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind	From (ft.)	To (ft.)

9. GROUT:

Kind	From (ft.)	To (ft.)

10. FORMATIONS:

Kind	From (ft.)	To (ft.)

11. MISCELLANEOUS DATA:

Yield test: ______ Hrs. at ______ GPM.

Depth from surface to water: ______ ft.

Water-level when pumping: ______ ft.

Water sample sent to laboratory at ______ on ______ 19____

Signature ______
Registered Well Driller

Construction of the well was completed on ______ 19____

The well is terminated ______ inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion?
Yes ______ No ______

Was the well sealed watertight upon completion?
Yes ______ No ______

______
Complete Mail Address

NE 1/4 SEC 24 T1N R18E

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

RECEIVED OCT 11 1949 BUREAU SAN. ENG.

1. County Walworth — Town ☒ Village ☐ City ☐ Bloomfield (Check one and give name)
2. Location Nippersink Lodge (Name of street and number of premise or Section, Town and Range numbers)
3. Owner ☐ or Agent ☐ [illegible] (Name of individual, partnership or firm)
4. Mail Address Nippersink Lodge + Country Club, Genoa City, Wis. (Complete address required)
5. From well to nearest: Building 15 ft.; sewer ___ ft.; drain ___ ft.; septic tank ___ ft.; dry well or filter bed 150 ft.; abandoned well ___ ft.
6. Well is intended to supply water for: Hotel
7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	0	40	8	40	97½

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind	From (ft.)	To (ft.)
8	Steel	0	77
7½	Screen	77	97½

9. GROUT:

Kind	From ft.	To ft.
Puddle Clay	0	40 ft.

10. FORMATIONS:

Kind	From ft.	To ft.
Top soil	0	3 ft.
Hard sand	3	40
Clay	40	65
Water bearing sand + gravel	65	97½

11. MISCELLANEOUS DATA:

Yield test: 5 Hrs. at 70 GPM.

Depth from surface to water-level: 35 ft.

Water-level when pumping: 45 ft.

Water sample was sent to the state laboratory at: Kenosha (City) on ______ 1948

Construction of the well was completed on: February 1948

The well is terminated 96 inches ☐ above, below ☒ the permanent ground surface.

Was the well disinfected upon completion? Yes X No ___

Was the well sealed watertight upon completion? Yes X No ___

Signature Leo Ekman (Registered Well Driller) — Box [illegible] Richmond, Ill. (Complete Mail Address)

Please do not write in space below

Rec'd ______ No. ______ — 10 ml 10 ml 10 ml 10 ml 10 ml

Ans'd ______ Gas—24 hrs.

Interpretation ______ 48 hrs.

Confirm.

B. Coli

Examiner ______

County Walworth Twp. Bloomfield Sec. ....

(Office Record—Do not fill in)

NE1/4 SEC 24 T1N R18E

TO THE WISCONSIN STATE BOARD OF HEALTH, WELL DRILLING DIVISION, MADISON, WIS.

WELL LOG PREMISES DIAGRAM, and REPORT

For Official Record of the Board

(TO BE USED FOR THAT PURPOSE ONLY)

Owner Leslie Carahar Driller M. Elfson

(If a joint ownership give name of responsible official. Also name of each individual holding an interest. Use a separate sheet and attach hereto.)

Address Richmond, Ill.

Address Nippersink Country Club (City, village, township, county)

Date of Report April 26 1939

Bloomfield township, Walworth county Registration No. 365

Give below the location of the property on which well is drilled.

If incorporated village or city: .... Name .... Lot .... B1 .... Street and No.

If unincorporated hamlet .... Name .... County .... Tp. .... Section

If Lake Shore Plat .... Name of Plat .... Lake .... Lot .... B1 .... Street

If Farm .... County .... Twp. .... Sec. .... Highway

If School .... County .... Twp. .... Sec. .... District

If other public building .... Kind .... County .... Twp. .... Sec.

Miscellaneous .... Kind .... County .... Twp. .... Sec.

WELL LOG and REPORT

Kind of casing and liner in feet. Kind of shoe. Indicate grout, screen, seal, etc.	WELL DIAGRAM Vertical Lines = in. Dia. Horizontal Lines = ft. Depth	Give depth of formations in feet. State if dry or water bearing	Record of FINAL Pumping Test
Black well drillers pipe	0 2 3 4 5 6 8 10 12 14 16 18 24; 0, 25, 50, 75	Top soil Sand and gravel Water bearing Blue clay Sand	Duration of test: Hours 5 hr. Pumping Rate. G. P. M. 5 Depth of pump in well Ft. .... Standing water-level (from surface.) Ft. 21 Water level when pumping Ft. 25

Miscellaneous .... Kind .... County .... Twp. .... Sec.

WELL LOG and REPORT

Kind of casing and liner in feet. Kind of shoe. Indicate grout, screen, seal, etc.	WELL DIAGRAM Vertical Lines = in. Dia. Horizontal Lines = ft. Depth	Give depth of formations in feet. State if dry or water bearing.	Record of FINAL Pumping Test
Black well drillers pipe	0	Top soil	Duration of test. Hours 5 hr.
		Sand and gravel	
		Water bearing	Pumping Rate. G. P. M. 5
	25	Blue clay	Depth of pump in well Ft.
	50		Standing water-level (from surface.) Ft. 21
		Sand	Water level when pumping Ft. 25
	75	Gravel	
Steel shoe			Water. End of test. Check: Clear ✓ Cloudy .... Turbid ....
	100		Was well sterilized before test? Yes ✓ No .... Date ....
	150		To which Laboratory was sample sent? Kenosha
	200		Date June 30
			Was the well sealed on completion? Yes ✓ No ....
	400		How high did you leave casing above grade? 6 in.
	800		Well was completed June 9 ...... 19[illegible]
			Well Driller: M. E[illegible] Signature.
	1200		(Be sure to complete the report on the reverse side)

NE 1/4 SEC 24 T1N R18E

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

Wel 6

See Instructions on Reverse Side

1. County Walworth — Town / Village / City: [illegible] Bloomfield (Check one and give name)

2. Location [illegible] (Name of street and number of premise or Section, Town and Range numbers)

3. Owner ☒ or Agent ☐ [illegible] (Name of individual, partnership or firm)

4. Mail Address [illegible] (Complete address required)

5. From well to nearest: Building [illegible] ft; sewer ___ ft; drain ___ ft; septic tank [illegible] ft; dry well or filter bed [illegible] ft; abandoned well ___ ft.

6. Well is intended to supply water for: [illegible]

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	[illegible]			0	40
8	[illegible]			40	6[illegible]

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
4	[illegible]	0	68

9. GROUT:

Kind	From (ft.)	To (ft.)
Puddle Clay	20	40
Drill Cuttings	0	20

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
[illegible]	0	[illegible]
Clay	[illegible]	60
Gravel	60	63
[illegible]	63	68

SAFE / ENGINEER

Construction of the well was completed on: July 21 1961

The well is terminated 12 inches ☒ above, below ☐ the permanent ground surface.

11. MISCELLANEOUS DATA:

Yield test: 6.0 Hrs. at 10 GPM.

Depth from surface to water-level: 25 ft.

Water-level when pumping: 35 ft.

Water sample was sent to the state laboratory at: Madison (City) on [illegible] 1961

Was the well disinfected upon completion? Yes X No ___

Was the well sealed watertight upon completion? Yes X No ___

Signature [illegible] (Registered Well Driller) — [illegible] (Complete Mail Address)

Please do not write in space below

Rec'd ___ No. ___

Ans'd ___

Interpretation ___

SAFE—BACTERIOLOGICALLY

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli					

Examiner ___

NE1/4 Sec 24 T1N R18E

Wel 6

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County [illegible] Town ☒ Village ☐ City ☐ [illegible] Bloomfield
   Check one and give name
2. Location [illegible]
   Name of street and number of premise or Section, Town and Range numbers

RECEIVED
DEC 17 1957
ENVIRONMENTAL SANITATION

3. Owner ☐ or Agent ☐ [illegible]
   Name of individual, partnership or firm
4. Mail Address [illegible]
   Complete address required
5. From well to nearest: Building [illegible] ft; sewer ____ ft; drain ____ ft; septic tank ____ ft; dry well or filter bed ____ ft; abandoned well ____ ft.
6. Well is intended to supply water for: [illegible]

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
5		[illegible]			

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
4	[illegible]		[illegible]
	Black		
	[illegible]		

9. GROUT:

Kind	From (ft.)	To (ft.)
puddled clay	[illegible]	[illegible]
drill cuttings		[illegible]

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
[illegible]		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	15
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		

11. MISCELLANEOUS DATA:

Yield test: [illegible] Hrs. at [illegible] GPM.

Depth from surface to water-level: [illegible] ft.

Water-level when pumping: [illegible] ft.

Water sample was sent to the state laboratory at: [illegible] (City) on [illegible] 19__

Construction of the well was completed on: [illegible] 19[illegible]

The well is terminated [illegible] inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes [illegible] No ____

Was the well sealed watertight upon completion? Yes [illegible] No ____

Signature [illegible] (Registered Well Driller) [illegible] (Complete Mail Address)

Please do not write in space below

			10 ml	10 ml	10 ml	10 ml	10 ml
Rec'd DEC 10 1957	No. [illegible]						
Ans'd		Gas—24 hrs.					
Interpretation		48 hrs.					
		Confirm					
		B. Coli					

Examiner____

E1/2 SEC 24 T1N R18E

Wel. 6-30M(16-50)

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County [illegible] — Town ☒ Village ☐ City ☐ [illegible] (Check one and give name)

2. Location [illegible] (Name of street and number of premise or Section, Town and Range numbers)

3. Owner ☐ or Agent ☐ [illegible] (Name of individual, partnership or firm)

4. Mail Address [illegible] (Complete address required)

5. From well to nearest: Building ___ ft; sewer ___ ft; drain ___ ft; septic tank 25 ft; dry well or filter bed 2[illegible] ft; abandoned well ___ ft.

6. Well is intended to supply water for: [illegible]

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
6	0	2[illegible]			

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
4	Black Iron [illegible]	[illegible]	[illegible]

9. GROUT:

Kind	From (ft.)	To (ft.)
Cement	1	2
Putty Clay	[illegible]	[illegible]

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
[illegible]	[illegible]	7
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

11. MISCELLANEOUS DATA:

Yield test: 5 Hrs. at [illegible] GPM.

Depth from surface to water-level: 35 ft.

Water-level when pumping: 52 ft.

Water sample was sent to the state laboratory at: [illegible] (City) on [illegible] 27 1952

Construction of the well was completed on: [illegible] 27 1952

The well is terminated 18 inches ☐ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes X No ___

Was the well sealed watertight upon completion? Yes X No ___

Signature [illegible] (Registered Well Driller) [illegible] (Complete Mail Address)

Please do not write in space below

Rec'd ___ No. ___ 10 ml 10 ml 10 ml 10 ml 10 ml

Ans'd ___ Gas—24 hrs. ___

Interpretation ___ 48 hrs. ___

Confirm ___

B. Coli ___

Examiner ___

NE 1/4 SEC 24 T1N R16E

W. 6-50M(6-50)

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County Walworth (Town / Village / City) Bloomfield (Check one and give name)

2. Location Blk 6- Lot 6 Nippersink subdivision, Lake Tombeue (Name of street and number of premise or Section, Town and Range numbers)

3. Owner ☐ or Agent ☐ Mr Joseph Revers (Name of individual, partnership or firm)

4. Mail Address 2476 Lincoln Ave, Chicago, Ill (Complete address required)

5. From well to nearest: Building ft; sewer ft; drain ft; septic tank 25 ft; dry well or filter bed ft; abandoned well ft.

6. Well is intended to supply water for: private home use

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	0	20			

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
5	black lapweld drillers casing	0	85

9. GROUT:

Kind	From (ft.)	To (ft.)
cement	18	20
drillings puddled clay	0	18

10. FORMATIONS:

Kind	From ft.	To ft.
top soil	0	3
sand	3	30
blue clay	30	60
hard pan	60	80
sand	80	85
water bearing formation	85	95

Construction of the well was completed on: Oct 24, 1953 19

The well is terminated 24 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes - No

Was the well sealed watertight upon completion? Yes - No

11. MISCELLANEOUS DATA:

Yield test: 8 Hrs. at 10 GPM.

Depth from surface to water-level: 25 ft.

Water-level when pumping: 30 ft.

Water sample was sent to the state laboratory at: Madison (City) on Oct 26 1953

Signature Anton M Jensen (Registered Well Driller) Rt 5 Bx 122 Burlington, Wisc (Complete Mail Address)

Please do not write in space below

Rec'd No. 10 ml 10 ml 10 ml 10 ml 10 ml

Ans'd Gas—24 hrs.

Interpretation 48 hrs.

Confirm

B. Coli

Examiner

WELL CONSTRUCTOR'S REPORT
FORM 3300-15

NOTE
WHITE COPY – DIVISION'S COPY
GREEN COPY – DRILLER'S COPY
YELLOW COPY – OWNER'S COPY

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

1. COUNTY [illegible] — X Town — Village — City — NAME [illegible]

2. LOCATION — ¼ Section, Section, Township, Range: [illegible] 54 [illegible] 57
AND [illegible]: [illegible]

3. OWNER AT TIME OF DRILLING [illegible]
ADDRESS [illegible]

4. Distance in feet from well to nearest [illegible]
CLEAR WATER DRAIN / SEPTIC TANK / PRIVY / SEEPAGE PIT / ABSORPTION FIELD / BARN / SILO / ABANDONED WELL / SINK HOLE / SEWER / WATER DRAIN TILE
5[illegible] 5[illegible]

OTHER POLLUTION SOURCES [illegible]

5. Well is intended to supply water for: [illegible]

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	Surface	15	6	15	5[illegible]

7. CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6	PIEASTMA 53418	Surface	52
6"	NEW 1877B3-1288 STAINLESS STEEL	88	90

See [illegible]

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
CLAY SLURRY	Surface	15

9. FORMATIONS

Kind	From (ft.)	To (ft.)
CLAY	Surface	15
[illegible]	15	55
SAND	75	90

10. TYPE OF DRILLING MACHINE USED
X Cable Tool — Direct Rotary — Reverse Rotary — Rotary – air — Rotary – hammer with drilling mud & air — Jetting with Air / Water

11. MISCELLANEOUS DATA
Yield test: 12 Hrs. at 15 GPM
Depth from surface to normal water level 35 ft.
Depth to water level when pumping 3[illegible] ft.
Water sample sent to ELKHORN

Well construction completed on 12-13 19[illegible]
Well is terminated [illegible] inches X above / below final grade
Well disinfected upon completion X Yes No
Well sealed watertight upon completion X Yes No
laboratory on 12-15-19[illegible]

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE — COMPLETE MAIL ADDRESS
Registered Well Driller [illegible]

Please do not write in space below
COLIFORM TEST RESULT — GAS – 24 HRS — GAS – 48 HRS — CONFIRMED — REMARKS

REV. 3-71

APR 30 1976

WELL CONSTRUCTOR'S REPORT

FORM 3300-15

NOTE

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

1. COUNTY: Walworth

Village / City: Bloomfield

2. LOCATION: SE 24 1N R19E

Lot 15 Blk 5 Rose Gardens Sub

3. OWNER AT TIME OF DRILLING: Stumpf Buildersoc

Twin Lakes

4. Distance in feet from well to nearest: 8 — 30 — 60

OTHER POLLUTION SOURCES

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)
8	Surface	40
4	40	91

7. CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
4	Steel casing 11# per ft T&C new steel ASTM 53 Youngstown	Surface	91

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Puddle Clay	Surface	40

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Topsoil	Surface	3
Clay	3	80
Sand	80	85
[illegible] Gravel	85	91

10. TYPE OF DRILLING MACHINE USED

Cable Tool ☑ Direct Rotary ☐ Reverse Rotary

Well construction completed on 11 / 3 1975

Well is terminated 12 inches ☑ above / below final grade

Well disinfected upon completion ☑ Yes No

Well sealed watertight upon completion ☑ Yes

11. MISCELLANEOUS DATA

Yield test 8 Hrs. at 15 GPM

Depth from surface to normal water level 25 ft.

Depth to water level when pumping 30 ft.

Water sample sent to Madison laboratory on Jan 12 1976

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE: Kenneth Lekinz

Registered Well Driller

COMPLETE MAIL ADDRESS: Box 664 Twin Lakes, Wis.

Please do not write in space below.

COLIFORM TEST RESULT — GAS 24 HRS — GAS 48 HRS — CONFIRMED — REMARKS

REV. 3-73

WELL CONSTRUCTOR'S REPORT
FORM 3300–15

AUG 12 1974

NOTE
WHITE COPY – DIVISION'S COPY
GREEN COPY – DRILLER'S COPY
YELLOW COPY – OWNER'S COPY

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

1. COUNTY Walworth
CHECK ONE: [x] Town [ ] Village [ ] City
NAME Bloomfield

2. LOCATION – ¼ Section SE | Section 31 | Township 1N | Range 18E
OR Grid or street no. | Street name
AND If available subdivision name, lot & block no.: Lot 2 Blk 5 ... Fitzpatrick ...

3. OWNER AT TIME OF DRILLING: [illegible]
ADDRESS: R 1
POST OFFICE: [illegible]

4. Distance in feet from well to nearest: (Record answer in appropriate block)

BUILDING	SANITARY C.I.	SANITARY TILE	SEWER FLOOR DRAIN C.I.	FLOOR DRAIN TILE	FOUNDATION DRAIN SEWER CONNECTED	FOUNDATION DRAIN INDEPENDENT	WASTE WATER DRAIN C.I.	WASTE WATER DRAIN TILE

CLEAR WATER DRAIN C.I.	CLEAR WATER DRAIN TILE	SEPTIC TANK	PRIVY	SEEPAGE PIT	ABSORPTION FIELD	BARN	SILO	ABANDONED WELL	SINK HOLE
		25			50				

OTHER POLLUTION SOURCES (Give description such as dump, quarry, drainage well, stream, pond, lake, etc.)
none

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	Surface	40			
5	40	86			

7. CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
5	Steel ... 16# per ft T & C	Surface	56

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Topsoil	Surface	4
Clay	4	40
Gravel	40	60
Sand	60	80
Red ... Limestone	80	86

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Puddle Clay	Surface	40

10. TYPE OF DRILLING MACHINE USED
[x] Cable Tool [ ] Direct Rotary [ ] Reverse Rotary
[ ] Rotary – air w. drilling mud [ ] Rotary – hammer with drilling mud & air [ ] Jetting with [ ] Air [ ] Water

11. MISCELLANEOUS DATA
Yield test: 8 hrs Hrs. at 15 GPM
Depth from surface to normal water level 35 ft.
Depth to water level when pumping 50 ft.
Water sample sent to Madison laboratory on: Aug 7 19 74

Well construction completed on July 31 19 74
Well is terminated 12 inches [x] above [ ] below final grade
Well disinfected upon completion [x] Yes [ ] No
Well sealed watertight upon completion [x] Yes [ ] No

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub surface pumprooms, access pits, etc., should be given on reverse side.

SIGNATURE: [illegible] Registered Well Driller
COMPLETE MAIL ADDRESS: [illegible]

Please do not write in space below

COLIFORM TEST RESULT	GAS 24 HRS	GAS 48 HRS	CONFIRMED	REMARKS

REV. 3–71

JAN 9 1979

State of Wisconsin
Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

NOTE:
White Copy – Division's Copy
Green Copy – Driller's Copy
Yellow Copy – Owner's Copy

WELL CONSTRUCTOR'S REPORT
Form 3300-15 Rev. 12-76

1. COUNTY Walworth — CHECK (✓) ONE: ☑ Town ☐ Village ☐ City — Name Bloomfield

2. LOCATION: ¼ Section SE, Section 24, Township 1N, Range 17E
OR – Grid or Street No. / Street Name: N1147
AND – If available subdivision name, lot & block No.

3. NAME ☑ OWNER ☐ AGENT AT TIME OF DRILLING CHECK (✓) ONE: Gregory Kozinski
ADDRESS
POST OFFICE Pell Lake

4. Distance in feet from well to nearest: (Record answer in appropriate block)
Building: 60
Seepage Bed: 60

5. Well is intended to supply water for: Home

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	Surface	30			
4	30	70			

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
4	casing 11# per ft ASTM 53 T&C Wheatland	Surface	66
3	X 4 screen	66	70

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
puddle Clay	Surface	30

9. FORMATIONS

Kind	From (ft.)	To (ft.)
Topsoil	Surface	2
[illegible]	2	35
Clay	35	60
water bearing sand & gravel	60	70

10. TYPE OF DRILLING MACHINE USED
☑ Cable Tool ☐ Rotary-hammer w/drilling mud & air ☐ Jetting with ☐ Air ☐ Water
☐ Rotary-air & drilling mud ☐ Rotary-hammer & air
☐ Rotary w/ drilling mud ☐ Reverse Rotary

Well construction completed on August 19 78
Well is terminated inches ☑ above ☐ below final grade
Well disinfected upon completion ☑ Yes ☐ No
Well sealed watertight upon completion ☑ Yes ☐ No

11. MISCELLANEOUS DATA
Yield Test: 8 Hrs. at 12 GPM
Depth from surface to normal water level 20 Ft.
Depth of water level when pumping 30 Ft. Stabilized ☑ Yes ☐ No

Water sample sent to Madison laboratory on [illegible] 19 78

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature [signature] Registered Well Driller

Complete Mail Address [illegible]

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

NOTE: OCT 28 1976

White Copy - Division's Copy
Green Copy - Driller's Copy
Yellow Copy - Owner's Copy

WELL CONSTRUCTOR'S REPORT

Form 3300-15
Rev. 10-75

1. COUNTY Walworth — CHECK (X) ONE: X Town / Village / City — Name Bloomfield

2. LOCATION ¼ Section SE, Section [illegible], Township [illegible], Range [illegible]
OR Grid or Street No. Street Name
AND If available subdivision name, lot & block No.

3. NAME ☒ OWNER ☐ AGENT AT TIME OF DRILLING
Robert H. Sorkin
ADDRESS
1[illegible] [illegible]. Randolph Street
POST OFFICE
Chicago, Illinois

4. Distance in feet from well to nearest: (Record answer in appropriate block) Building 150

5. Well is intended to supply water for: [illegible]

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	Surface	[illegible]	[illegible]	[illegible]	[illegible]

7. CASING, LINER, CURBING AND SCREEN

Dia. (in.)	Material, Weight, Specification & Method of Assembly	From (ft.)	To (ft.)
6ID	New Black Steel	Surface	84
	Sumito T&C A53		
	19.45		
5ID	Stainless Steel	[illegible]	[illegible]
	Sand Screen		

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
Drilling Mud Puddle Clay	Surface	[illegible]

9. FORMATIONS

Kind	From (ft.)	To (ft.)
[illegible]	Surface	[illegible]
Clay	[illegible]	[illegible]
Gravel	80	88

10. TYPE OF DRILLING MACHINE USED
Cable Tool / Rotary-hammer w/drilling mud & air / Jetting with Air / Water / Rotary-air / Rotary-hammer & air / Rotary w/drilling mud / Reverse Rotary

11. MISCELLANEOUS DATA
Yield Test: [illegible] Hrs. at [illegible] GPM
Depth from surface to normal water level [illegible] Ft.
Depth of water level when pumping [illegible] Ft. Stabilized ☒ Yes ☐ No

Well construction completed on Oct. [illegible] 197[illegible]
Well is terminated [illegible] inches ☒ above ☐ below final grade
Well disinfected upon completion ☒ Yes ☐ No
Well sealed watertight upon completion ☒ Yes ☐ No

Water sample sent to State Lab - Madison laboratory on Oct. [illegible], 19[illegible]

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature [signature] Registered Well Driller

Complete Mail Address
[illegible] WELL DRILLING
Rt. [illegible] - Box 140 - Delavan, Wisconsin

SE1/4 Sec 24 T1N R18E

Wel 6

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County ______ Town ☐ Village ☐ City ☐ ______ Check one and give name

2. Location ______
Name of street and number of premise or Section, Town and Range numbers

3. Owner ☐ or Agent ☐ ______ MAY 12 1958
Name of individual, partnership or firm

4. Mail Address ______
Complete address required

5. From well to nearest: Building ______ ft; sewer ______ ft; drain ______ ft; septic tank ______ ft; ______ dry well or filter bed ______ ft; abandoned well ______ ft.

6. Well is intended to supply water for: ______

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)

9. GROUT:

Kind	From (ft.)	To (ft.)

10. FORMATIONS:

Kind	From (ft.)	To (ft.)

Construction of the well was completed on:

______ 19__

The well is terminated ______ inches ☐ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion?

Yes______ No______

Was the well sealed watertight upon completion?

Yes______ No______

11. MISCELLANEOUS DATA:

Yield test: ______ Hrs. at ______ GPM.

Depth from surface to water-level: ______ ft.

Water-level when pumping: ______ ft.

Water sample was sent to the state laboratory at:

______ on ______ 19__
City

Signature Douglas [illegible] ______
Registered Well Driller

______
Complete Mail Address

Please do not write in space below

Rec'd ___ 8 1958 ___ No. 11784

Ans'd ______

Interpretation SAFE

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli	0				

Examiner______

WELL CONSTRUCTION REPORT
WISCONSIN STATE BOARD OF HEALTH
WELL DRILLING DIVISION

AUG -2 1939

Note: Section 32 of the Wisconsin Well Drilling Sanitary Code, having the force and effect of law, provides that within thirty days after completion of every well the driller shall submit a report covering all essential details of construction to the State Board of Health on a form provided by the Board.

Owner E.G.Shinner

Driller Oscar Krueger & Son

Street or RFD 733 W.64th St..

Post Office Burlington, Wis

Post Office Chicago

Date June 8 Permit No. 78

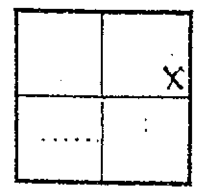
LOCATION OF PREMISES

Walworth (County) BLOOMFIELD (Town)

Nippersink Lodge
Describe further by subdivision, plat, district, lake, lot,

County trunk U
block, nearest principal highway, etc., whichever apply.

The square below represents a section of land divided into 40 acre tracts. Mark the position of the premises in the section.



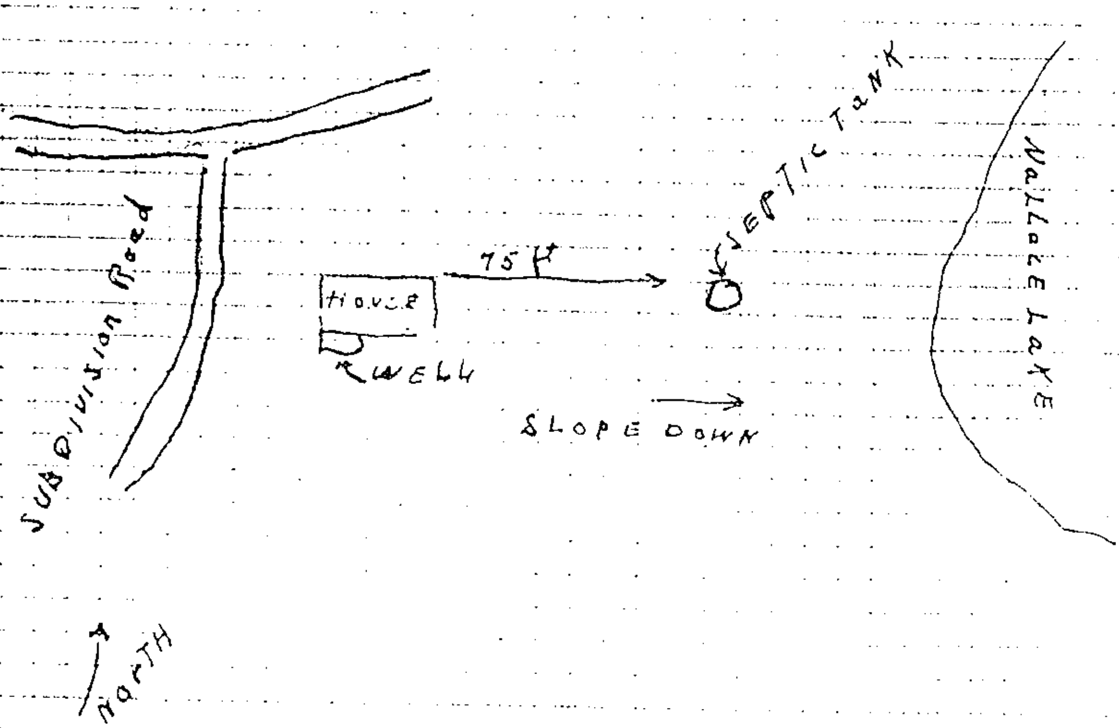
Sec. 24

Twp 1

Range 18 E W

DIAGRAM OF PREMISES

See discussion and illustration in Part III Well Drilling Code. In making the diagram in the space below consider 10 ft. as the distance between lines. Be sure to indicate NORTH.



Additional copies of this form may be obtained in lots of 12 for 25¢. Send remittance with order to State Board of Health, Well Drilling Division, Madison, Wis.

WELL LOG *and* REPORT

In this column indicate the kind of casing, liner, shoe and other accessories used.

5" Black Pipe
Std. wt. wrot steel
5" Postel steel Drive Shoe

WELL DIAGRAM
Use a red line to show casing or liner pipe. Use black for drill or borehole.

Inches Diameter 2 3 4 5 6 8 10 12 14 16 18 — Depth

20'
25
50
58'
60'
75
100
150
200
400
500
1200

Draw the diagram to show the right half only

In this column state the kind of formations penetrated, their thickness in feet and if water bearing.

20' Red sand
38' Hard pan
2' Sand & Gravel
60' Total Depth

Record of FINAL Pumping test

Duration of test
Hours 1

Pumping rate
G.P.M. 15

Depth of pump in well. Ft. Bailed

Standing water-level (from surface)
Ft. 12

Water-level when pumping Ft. 16

Water. End of test.
Clear YES
Cloudy
Turbid

Was the well sterilized?
Yes x No

To which laboratory w... sample sent?
Kenosha
Date 3/27/39

Was the well sealed ... completion?
Yes x No

How high did you leave the casing-pipe above grade?
5"

Well was completed
Date 3/28/39

Well Driller
Oscar Krueger & Son
Signature

WELL CONSTRUCTION REPORT
WISCONSIN STATE BOARD OF HEALTH
WELL DRILLING DIVISION

AUG -2 1939

Note: Section 32 of the Wisconsin Well Drilling Sanitary Code, having the force and effect of law, provides that within thirty days after completion of every well the driller shall submit a report covering all essential details of construction to the State Board of Health on a form provided by the Board.

Owner F.G.Shinner
Street or RFD 733 W. 64th St.,
Post Office Chicago, Ill

Driller Oscar Krueger & Son
Post Office Burlington, Wis
Date June 8, 1939 Permit No. 76

LOCATION OF PREMISES

Walworth
County

Bloomfield
Town

Nippersink Lodge
Describe further by subdivision, plat, district, lake, lot,
County Trunk U
block, nearest principal highway, etc., whichever apply.

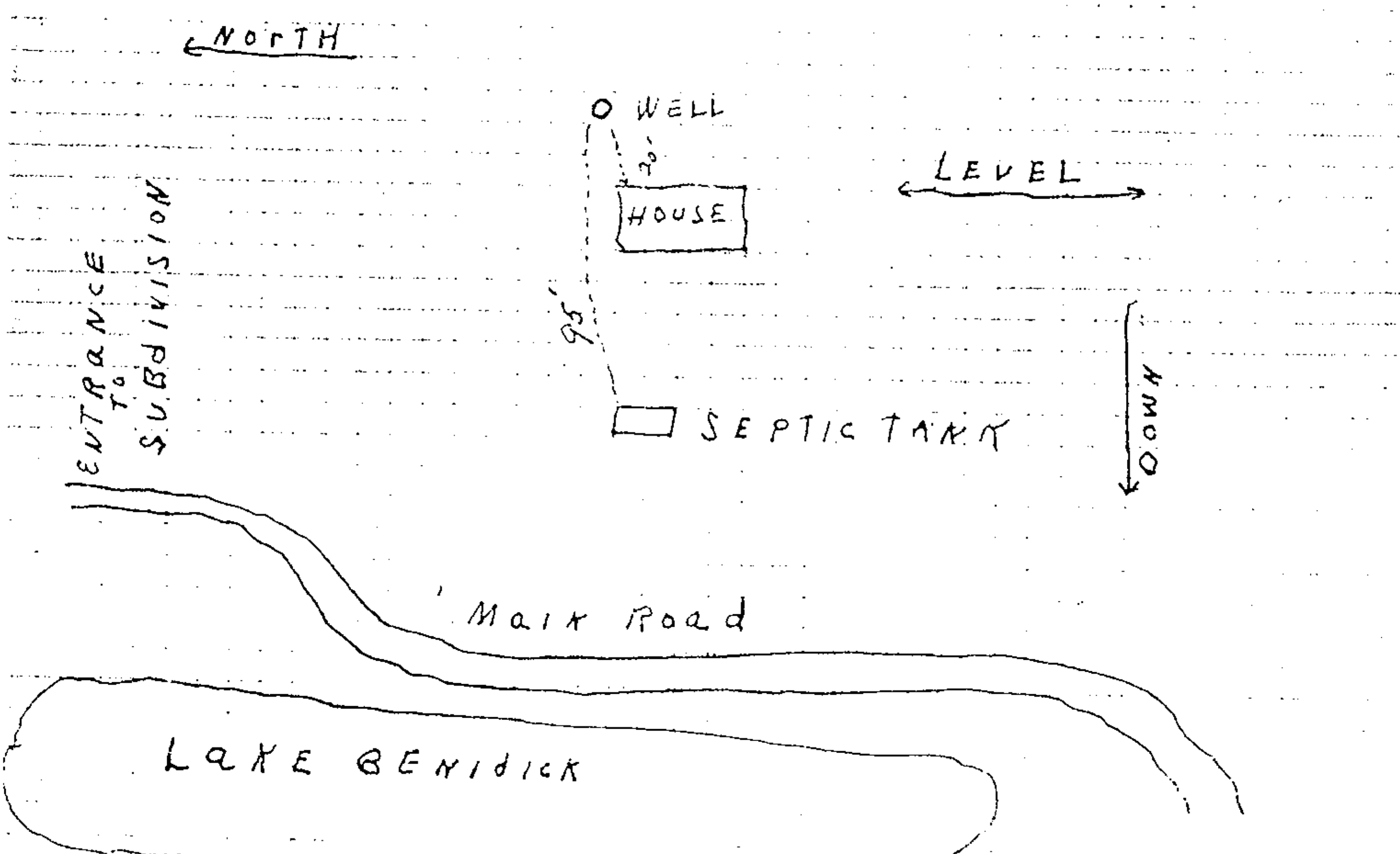
The square below represents a section of land divided into 40 acre tracts. Mark the position of the premises in the section.

x

Sec. 24
Twp. 1
Range 18 E ~~W~~

DIAGRAM OF PREMISES

See discussion and illustration in Part III Well Drilling Code. In making the diagram in the space below consider 10 ft. as the distance between lines. Be sure to indicate NORTH.



Additional copies of this form may be obtained in lots of 12 for 25¢. Send remittance with order to State Board of Health, Well Drilling Division, Madison, Wis.

WELL LOG *and* REPORT

In this column indicate the kind of casing, liner, shoe and other accessories used.	WELL DIAGRAM Use a red line to show casing or liner pipe. Use black for drill or borehole. (Inches Diameter 2 3 4 5 6 8 10 12 14 16 18) Depth	In this column state the kind of formations penetrated, their thickness in feet and if water bearing.
6" STD. Wt. Wrot Steel Pipe	18	18' Sand & Gravel
Drillers Special	25	
6" Postel Steel Drive Shoe	50	
	61'	43' Blue Hard Pan
	75	
	89	28' Muddy Sand
	97	8' Water bearing Sand & Gravel
	100	
	150	
	200	
	400	
	800	
	1200	

Draw the diagram to show the right half only

Record of FINAL Pumping test

Duration of test Hours 2

Pumping rate G.P.M. 35

Depth of pump in well. Ft. No pump Bailed

Standing water-level (from surface) Ft. 37

Water-level when pumping Ft. 42

Water. End of test.
Clear Yes
Cloudy
Turbid

Was the well sterilized? Yes X No

To which laboratory was sample sent? Kenosha
Date 3/7/39

Was the well sealed on completion? Yes X No

How high did you leave the casing-pipe above grade? 14"

Well was completed Date 3/7/39

Well Driller

Signature

WELL CONSTRUCTOR'S REPORT
FORM 3300-15

APR 11 1977

NOTE
WHITE COPY – DIVISION'S COPY
GREEN COPY – DRILLER'S COPY
YELLOW COPY – OWNER'S COPY

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
Box 450
Madison, Wisconsin 53701

1. COUNTY: Walworth
CHECK ONE: [X] Town [ ] Village [ ] City
NAME: Bloomfield

2. LOCATION – ¼ Section: SW Section: 24 Township: 1N Range: 18E
OR – Grid or street no. Street name
AND – If available subdivision name, lot & block no.: Nippersink Manor Lot 13 2nd Sub.

3. OWNER AT TIME OF DRILLING: L. Taylor c/o P. Wurtz & Assoc.
ADDRESS: 100 E. Main
POST OFFICE: Lake Geneva, Wisc. 53117

4. Distance in feet from well to nearest: (Record answer in appropriate block)

BUILDING	SANITARY SEWER C.I.	SANITARY SEWER TILE	FLOOR DRAIN C.I.	FLOOR DRAIN TILE	FOUNDATION DRAIN SEWER CONNECTED	FOUNDATION DRAIN INDEPENDENT	WASTE WATER DRAIN C.I.	WASTE WATER DRAIN TILE
8	25						25	

CLEAR WATER DRAIN C.I.	CLEAR WATER DRAIN TILE	SEPTIC TANK	PRIVY	SEEPAGE PIT	ABSORPTION FIELD	BARN	SILO	ABANDONED WELL	SINK HOLE
		50 plus		50 plus					

OTHER POLLUTION SOURCES (Give description such as dump, quarry, drainage well, stream, pond, lake, etc.)

5. Well is intended to supply water for: Household

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	Surface	15			
6	6	141			

7. CASING, LINER, CURBING, AND SCREEN

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
6	galv. T/C R & D 19.45	Surface	141
	Youngstown ASTM A-589		

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
drill cutting	Surface	15

9. FORMATIONS

Kind	From (ft.)	To (ft.)
top soil	Surface	3
caving sand & gravel	3	28
sandy clay	28	130
gravel	130	141

10. TYPE OF DRILLING MACHINE USED
[X] Cable Tool [ ] Direct Rotary [ ] Reverse Rotary
[ ] Rotary – air w/drilling mud [ ] Rotary – hammer with drilling mud & air [ ] Jetting with [ ] Air [ ] Wat

Well construction completed on 2-28 1977
Well is terminated 12 inches [X] above below final grac
Well disinfected upon completion [X] Yes [ ]
Well sealed watertight upon completion [X] Yes [ ]

11. MISCELLANEOUS DATA
Yield test: 4 Hrs. at 40 GPM
Depth from surface to normal water level 45 ft.
Depth to water level when pumping 47 ft.

Water sample sent to Wisc. State Laboratory of Hygiene laboratory on: March 23 1977

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, se type of casing joints, method of finishing the well, amount of cement used in grouting, blasting, sub-surface pumprooms, access pits, etc., shoul be given on reverse side.

SIGNATURE: [signature] #475 Registered Well Driller
COMPLETE MAIL ADDRESS: Rt. 7 Box 326 Burlington, Wisc. 53105

Please do not write in space below

COLIFORM TEST RESULT | GAS – 24 HRS. | GAS – 48 HRS. | CONFIRMED | REMARKS

REV. 3-71

Wel 6

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County WALWORTH — Town ☒ Village ☐ City ☐ BLOOM FIELD (Check one and give name)
2. Location SEC 24 R-15-E T-1-N (Name of street and number of premise or Section, Town and Range numbers)

RECEIVED MAY 10 1957 ENVIRONMENTAL SANITATION

3. Owner ☒ or Agent ☐ M.S. SCHLECHTER (Name of individual, partnership or firm)
4. Mail Address GENOA CITY, WIS (Complete address required)
5. From well to nearest: Building 4 ft; sewer ___ ft; drain ___ ft; septic tank 40 ft; dry well or filter bed 74 ft; abandoned well ___ ft.
6. Well is intended to supply water for: ______

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
8	0	20	4	20	144'6"

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
4	11-LB STEEL	0	144'-6

9. GROUT:

Kind	From (ft.)	To (ft.)
CLAY SLURRY	0	20

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
CLAY	0	30
WATER SAND	30	40
CLAY	40	80
WATER HARD PAN	80	90
CLAY	90	140
WATER GRAVEL	140	144-6

Construction of the well was completed on: APRIL 29, 1957

The well is terminated 24 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes ✓ No ___

Was the well sealed watertight upon completion? Yes ✓ No ___

11. MISCELLANEOUS DATA:

Yield test: 6 Hrs. at 10 GPM.

Depth from surface to water-level: 35 ft.

Water-level when pumping: 85 ft.

Water sample was sent to the state laboratory at: NOT SENT YET (City) on ______ 19___

Signature [signature] Registered Well Driller — RICHMOND, ILLINOIS Complete Mail Address

Please do not write in space below

Rec'd ______ No. ______

Ans'd ______

Interpretation ______

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli					

Examiner ______

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

1. County Walworth — Town ☒ Village ☐ City ☐ Bloomfield (Check one and give name)
2. Location Sec. 24 R. 18 E. T. 1 N. (Name of street and number of premise or Section, Town and Range numbers)
3. Owner ☒ or Agent ☐ [illegible] (Name of individual, partnership or firm)
4. Mail Address [illegible] (Complete address required)
5. From well to nearest: Building ___ ft; sewer ___ ft; drain ___ ft; septic tank ___ ft; dry well or filter bed ___ ft; abandoned well ___ ft.
6. Well is intended to supply water for: ___

7. DRILLHOLE:

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)
10	0	25	5"	25	92

8. CASING AND LINER PIPE OR CURBING:

Dia. (in.)	Kind and Weight	From (ft.)	To (ft.)
5	Standard steel	0	92

9. GROUT:

Kind	From (ft.)	To (ft.)
Clay [illegible]	0	25

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
Clay	0	25
[illegible]	25	85
[illegible]	85	92

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ENVIRONMENTAL SANITATION

Construction of the well was completed on: 8/4 1957

The well is terminated 10 inches ☒ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes X No ___

Was the well sealed watertight upon completion? Yes X No ___

11. MISCELLANEOUS DATA:

Yield test: 2 Hrs. at 10 GPM.

Depth from surface to water-level: 25 ft.

Water-level when pumping: 30 ft.

Water sample was sent to the state laboratory at: ___ (City) on ___ 19___

Signature [illegible] (Registered Well Driller) [illegible] (Complete Mail Address)

Please do not write in space below

Rec'd ___ No. ___

Ans'd ___

Interpretation ___

	10 ml	10 ml	10 ml	10 ml	10 ml
Gas—24 hrs.					
48 hrs.					
Confirm					
B. Coli					

Examiner ___

RECEIVED

WELL CONSTRUCTOR'S REPORT TO WISCONSIN STATE BOARD OF HEALTH

See Instructions on Reverse Side

APR 1 9 1963

SANITARY ENGINEERING

1. County WALWORTH — Town ☒ Village ☐ City ☐ BLOOMFIELD (Check one and give name)
2. Location SEC. 34-T1N. R18E. LOT 57 2ND SUB. NIPP. PARK. (Name of street and number of premise or Sec. Tn. and R. numbers)
3. Owner ☒ or Agent ☐ WILLIAM C. MC LENNAN & CO. (Name of individual, partnership or firm)
4. Mail Address 6 EAST N.W. HIGHWAY CHICAGO 31, ILL. (Complete address required)
5. From well to nearest: Building 15 ft; sewer ____ ft; drain ____ ft; septic tank 50 ft; dry well or filter bed 60 ft; abandoned well ____ ft.
6. Well is intended to supply water for: HOME

7. DRILLHOLE:

Dia. (In.)	From (ft.)	To (ft.)
8	0	9
4	9	65

8. CASING AND LINER PIPE OR CURBING:

Dia. (In.)	Kind	From (ft.)	To (ft.)
4	WROUGHT STEEL	0	65

9. GROUT:

Kind	From (ft.)	To (ft.)
CLAY	0	9

10. FORMATIONS:

Kind	From (ft.)	To (ft.)
SAND AND GRAVEL	0	20
CLAY	20	45
WATER BEARING SAND AND GRAVEL	45	65

11. MISCELLANEOUS DATA:

Yield test: 5 Hrs. at 15 GPM.

Depth from surface to water: 18 ft.

Water-level when pumping: 20 ft.

Water sample sent to laboratory at April on 17 1963

Construction of the well was completed on APRIL 15 1963

The well is terminated 18 inches ☐ above, below ☐ the permanent ground surface.

Was the well disinfected upon completion? Yes X No ____

Was the well sealed watertight upon completion? Yes X No ____

Signature [signature] Registered Well Driller

550 WALNUT
Complete Mail Address
RICHMOND ILLINOIS

APPENDIX B

WATER QUALITY DATA

Table 3

BENEDICT LAKE WATER QUALITY DATA: 1966-1999

Parameter[a]	03/31/66		08/25/66		08/26/75	07/27/77			05/07/98		06/26/98		07/28/98	
	Shallow	Deep	Shallow	Deep	Shallow	Shallow	Middle	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (feet)	10	17	10	30	1.0	1.0	28	38	0.5	10.0	0.5	11.0	0.5	11.0
Specific Conductance (µS/cm)	426	423	413	423	407	439	493	515	622	631	601	659	601	716
pH (standard units)	--	--	8.4	8.2	8.3	8.3	7.9	7.6	8.2	7.6	7.9	7.4	8.0	7.2
Water Temperature(°F)	--	--	71.4	56.8	--	78.8	57.2	51.8	60.8	47.5	82.6	48.2	78.6	48.7
Turbidity (NTU)	--	--	--	--	2.5	3.0	3.4	3.9	3.6	--	--	--	--	--
Secchi Depth (feet)	--	--	--	--	--	--	6.9	--	5.6	--	6.2	--	6.2	--
Dissolved Oxygen	--	--	8.5	1.0	--	6.3	2.1	0.1	10.6	0.8	8.1	0.2	9.3	0.2
Hardness, as CaCO3	--	--	--	--	--	--	--	--	260	--	--	--	--	--
Calcium, Dissolved	33.2	20	19.7	22.3	27	30	40	46	46	--	--	--	--	--
Magnesium, Dissolved	26.2	29.5	28.8	28	36	43	41	41	36	--	--	--	--	--
Sodium, Dissolved	4.0	4.0	4.4	4.3	7.0	14	12	12	25	--	--	--	--	--
Potassium, Dissolved	1.7	1.7	1.7	1.8	1.7	3.3	1.9	2.3	2.3	--	--	--	--	--
Alkalinity, as CaCO3	200	200	180	187	168	170	208	238	--	--	--	--	--	--
Sulfate, Dissolved SO4	36.5	36.3	39.5	39	34	35	34	32	33	--	--	--	--	--
Chloride, Dissolved	7.6	7.6	8.1	8.6	19	23	24	24	56	--	--	--	--	--
Fluoride, Dissolved	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silica, Dissolved	--	--	--	--	--	--	--	--	3.3	--	--	--	--	--
Solids, Dissolved at 180°C	--	--	--	--	--	--	--	--	374	--	--	--	--	--
Nitrogen, NO2+NO3, Dissolved	--	--	--	--	0.26	0.095	0.117	0.074	0.625	--	--	--	0.337	--
Nitrogen, Ammonia Dissolved	--	--	--	--	0.03	0.13	0.29	0.69	0.117	--	--	--	0.098	--
Nitrogen, Organic Total	--	--	--	--	0.52	0.70	0.73	1.34	0.08	--	--	--	0.58	--
Total Phosphorus	0.14	--	0.10	0.06	0.01	0.03	0.04	0.04	0.014	0.024	--	--	0.010	0.069
Ortho-Phosphorus, Dissolved	0.40	0.08	0.05	0.10	0.005	0.005	0.006	<0.004	<0.002	--	--	--	0.002	--
Iron, Dissolved (µg/l)	0.02	0.04	0.12	0.12	0.08	<0.06	<0.06	0.41	<10	--	--	--	--	--
Manganese, Dissolved (µg/l)	--	--	--	--	0.03	<0.03	<0.03	0.07	<0.040	--	--	--	--	--
Chlorophyll-a (µg/l)	--	--	--	--	--	--	--	--	8.53	--	1.79	--	2.96	--

Table 3 (continued)

Parameter[a]	08/25/98			02/19/99		04/15/99		06/10/99		07/07/99		08/04/99		
	Shallow	Middle	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Middle	Deep
Depth of Sample (feet)	0.5	9.0	11.0	0.5	11.0	0.5	11.0	0.5	11.0	0.5	11.0	0.5	8.0	11.0
Specific Conductance (µS/cm)	582	631	774	541	679	654	660	612	691	569	695	561	610	733
pH (standard units)	8.2	7.7	7.2	7.9	7.7	8.2	8.1	8.2	7.6	8.2	7.5	8.1	8.0	7.2
Water Temperature(°F)	78.4	53.2	49.1	40.1	38.1	52.9	48.6	80.2	49.1	81.5	49.1	81.3	57.2	48.4
Turbidity (NTU)	- -	- -	- -	- -	- -	1.5	- -	- -	- -	- -	- -	- -	- -	- -
Secchi Depth (feet)	8.9	- -	- -	- -	- -	6.2	- -	7.5	- -	6.2	- -	6.2	- -	- -
Dissolved Oxygen	8.8	0.5	0.4	17.9	11.5	12.0	9.3	9.0	0.7	8.6	0.4	9.5	9.0	0.0
Hardness, as CaCO3	- -	- -	- -	- -	- -	260	- -	- -	- -	- -	- -	- -	- -	- -
Calcium, Dissolved	- -	- -	- -	- -	- -	46	- -	- -	- -	- -	- -	- -	- -	- -
Magnesium, Dissolved	- -	- -	- -	- -	- -	36	- -	- -	- -	- -	- -	- -	- -	- -
Sodium, Dissolved	- -	- -	- -	- -	- -	26	- -	- -	- -	- -	- -	- -	- -	- -
Potassium, Dissolved	- -	- -	- -	- -	- -	2.2	- -	- -	- -	- -	- -	- -	- -	- -
Alkalinity, as CaCO3	- -	- -	- -	- -	- -	222	- -	- -	- -	- -	- -	- -	- -	- -
Sulfate, Dissolved SO4	- -	- -	- -	- -	- -	34	- -	- -	- -	- -	- -	- -	- -	- -
Chloride, Dissolved	- -	- -	- -	- -	- -	59	- -	- -	- -	- -	- -	- -	- -	- -
Fluoride, Dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -		- -	- -	- -	- -
Silica, Dissolved	- -	- -	- -	- -	- -	5.8	- -	- -	- -		- -	- -	- -	- -
Solids, Dissolved at 180°C	- -	- -	- -	- -	- -	356	- -	- -	- -		- -	- -	- -	- -
Nitrogen, NO2+NO3, Dissolved	- -	- -	- -	- -	- -	0.557	- -	- -	- -	0.512	- -	- -	- -	- -
Nitrogen, Ammonia Dissolved	- -	- -	- -	- -	- -	0.353	- -	- -	- -	0.128	- -	- -	- -	- -
Nitrogen, Organic Total	- -	- -	- -	- -	- -	1.2	- -	- -	- -	0.92	- -	- -	- -	- -
Total Phosphorus	- -	- -	- -	0.014	0.023	0.018	0.021	0.007	0.075	0.010	0.012	0.020	0.030	0.077
Ortho-Phosphorus, Dissolved	- -	- -	- -	- -	- -	<0.002	- -	- -	- -	0.004	- -	- -	- -	- -
Iron, Dissolved (µg/l)	- -	- -	- -	- -	- -	<10	- -	- -	- -	- -	- -	- -	- -	- -
Manganese, Dissolved (µg/l)	- -	- -	- -	- -	- -	0.7	- -	- -	- -	- -	- -	- -	- -	- -
Chlorophyll-a (µg/l)	1.93	- -	- -	- -	- -	7.00	- -	1.70	- -	1.64	- -	3.00	- -	- -

[a]*Unless otherwise indicated, units are mg/l.*

Source: SEWRPC.

Table 4

TOMBEAU LAKE WATER QUALITY DATA: 1975-1999

Parameter[a]	08/26/75	07/27/78			05/07/98		06/26/98		07/28/98	
	Shallow	Shallow	Middle	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample (feet)	1.0	0.0	12	29	0.5	8.0	0.5	8.0	0.5	8.0
Specific Conductance (μS/cm)	428	347	385	428	605	630	586	646	547	648
pH (standard units)	8.0	7.8	7.7	7.5	8.1	7.5	8.1	7.4	8.5	7.3
Water Temperature(°F)	- -	75.2	68	44.6	60	44.6	82.0	46.0	77.5	47.3
Turbidity (NTU)	3.2	1.3	1.7	2.6	1.7	- -	- -	- -	- -	- -
Secchi Depth (feet)	- -	- -	4.8	- -	10.5	- -	10.2	- -	4.3	- -
Dissolved Oxygen	- -	7.3	0.6	0	9.8	0.0	8.2	0.1	12.0	0.1
Hardness, as CaCO3	- -	- -	- -	- -	280	- -	- -	- -	- -	- -
Calcium, Dissolved	37	48	52	66	57	- -	- -	- -	- -	- -
Magnesium, Dissolved	34	36	37	42	33	- -	- -	- -	- -	- -
Sodium, Dissolved	7.0	7.0	5.0	8.0	16	- -	- -	- -	- -	- -
Potassium, Dissolved	1.7	1.8	1.3	2.3	2.2	- -	- -	- -	- -	- -
Alkalinity, as CaCO3	180	196	230	262	- -	- -	- -	- -	- -	- -
Sulfate, Dissolved SO4	42	39	45	51	40	- -	- -	- -	- -	- -
Chloride, Dissolved	17	15	16	19	37	- -	- -	- -	- -	- -
Fluoride, Dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Silica, Dissolved	- -	- -	- -	- -	6	- -	- -	- -	- -	- -
Solids, Dissolved at 180°C	- -	- -	- -	- -	396	- -	- -	- -	- -	- -
Nitrogen, NO2+NO3, Dissolved	0.31	0.57	0.77	0.16	1.11	- -	- -	- -	0.096	- -
Nitrogen, Ammonia Dissolved	0.03	<0.03	0.18	2.93	0.072	- -	- -	- -	<0.013	- -
Nitrogen, Organic Total	0.66	0.70	0.79	.83	0.84	- -	- -	- -	0.86	- -
Total Phosphorus	0.04	0.03	0.03	0.09	0.024	0.214	0.015	0.597	0.026	0.131
Ortho-Phosphorus, Dissolved	0.006	0.01	<0.005	0.053	0.003	- -	- -	- -	0.002	- -
Iron, Dissolved (μg/l)	0.28	0.09	0.09	0.09	<10	- -	- -	- -	- -	- -
Manganese, Dissolved (μg/l)	0.04	<0.03	<0.03	0.53	7.9	- -	- -	- -	- -	- -
Chlorophyll-a (μg/l)	- -	15	- -	- -	10.5	- -	- -	- -	- -	- -

Table 4 (continued)

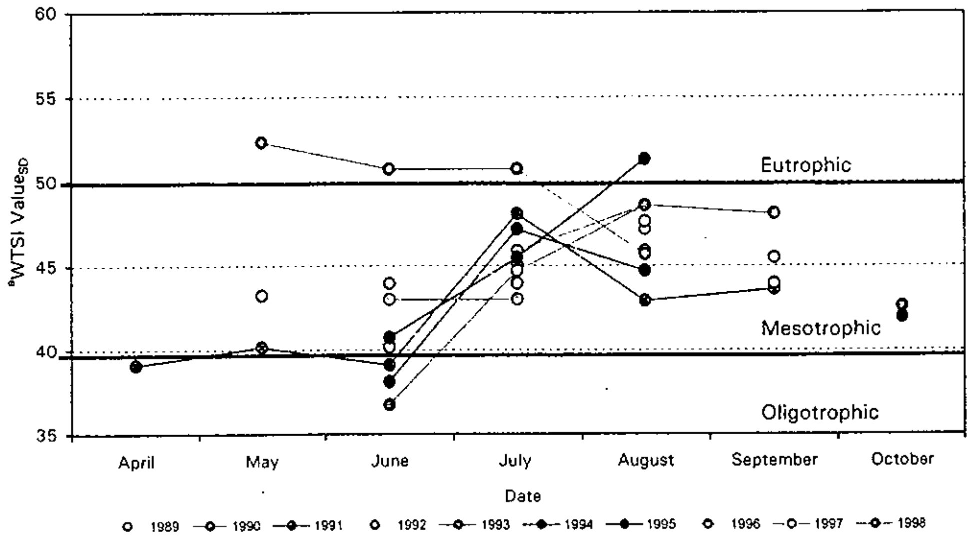
Parameter[a]	08/25/98			04/15/99		06/10/99		07/07/99		08/04/99		
	Shallow	Middle	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Middle	Deep
Depth of Sample (feet)	0.5	5.0	8.0	0.5	8.0	0.5	8.0	0.5	8.0	0.5	6.0	8.0
Specific Conductance (μS/cm)	568	585	684	637	647	563	668	529	672	542	590	655
pH (standard units)	8.4	7.4	7.1	8.2	7.6	8.2	7.8	8.3	7.3	8.3	7.4	7.1
Water Temperature(°F)	78.1	59.0	46.9	52.9	44.8	82.0	46.6	82.0	46.4	80.9	49.8	46.7
Turbidity (NTU)	--	--	--	1.2	--	--	--	--	--	--	--	--
Secchi Depth (feet)	8.2	--	--	7.9	--	7.5	--	5.6	--	7.5	--	--
Dissolved Oxygen	8.8	1.3	0.4	12.1	4.6	9.5	0.7	9.8	0.4	10.8	0.1	0.0
Hardness, as CaCO3	--	--	--	280	--	--	--	--	--	--	--	--
Calcium, Dissolved	--	--	--	56	--	--	--	--	--	--	--	--
Magnesium, Dissolved	--	--	--	34	--	--	--	--	--	--	--	--
Sodium, Dissolved	--	--	--	16	--	--	--	--	--	--	--	--
Potassium, Dissolved	--	--	--	2.5	--	--	--	--	--	--	--	--
Alkalinity, as CaCO3	--	--	--	230	--	--	--	--	--	--	--	--
Sulfate, Dissolved SO4	--	--	--	42	--	--	--	--	--	--	--	--
Chloride, Dissolved	--	--	--	41	--	--	--	--	--	--	--	--
Fluoride, Dissolved	--	--	--	--								
Silica, Dissolved	--	--	--	6.8	--	--	--	--	--	--	--	--
Solids, Dissolved at 180°C	--	--	--	358	--	--	--	--	--	--	--	--
Nitrogen, NO2 + NO3, Dissolved	--	--	--	1.22	--	--	--	0.283	--	--	--	--
Nitrogen, Ammonia Dissolved	--	--	--	0.053	--	--	--	0.019	--	--	--	--
Nitrogen, Organic Total	--	--		0.84	--	--	--	0.82	--	--	--	--
Total Phosphorus	0.020	0.071	0.113	0.028	0.101	0.021	0.014	0.025	0.024	0.024	0.029	0.147
Ortho-Phosphorus, Dissolved	--	--	--	0.002	--	--	--	0.003	--	--	--	--
Iron, Dissolved (μg/l)	--	--	--	<10	--	--	--	--	--	--	--	--
Manganese, Dissolved (μg/l)	--	--	--	3.6	--	--	--	--	--	--	--	--
Chlorophyll-*a* (μg/l)	--	--	--	6.46		4.94	--	6.72	--	6.00	--	--

[a]*Unless otherwise indicated, units are mg/l.*

Source: SEWRPC.

Figure 1

TROPHIC STATE INDEX FOR BENEDICT LAKE: 1989-1998

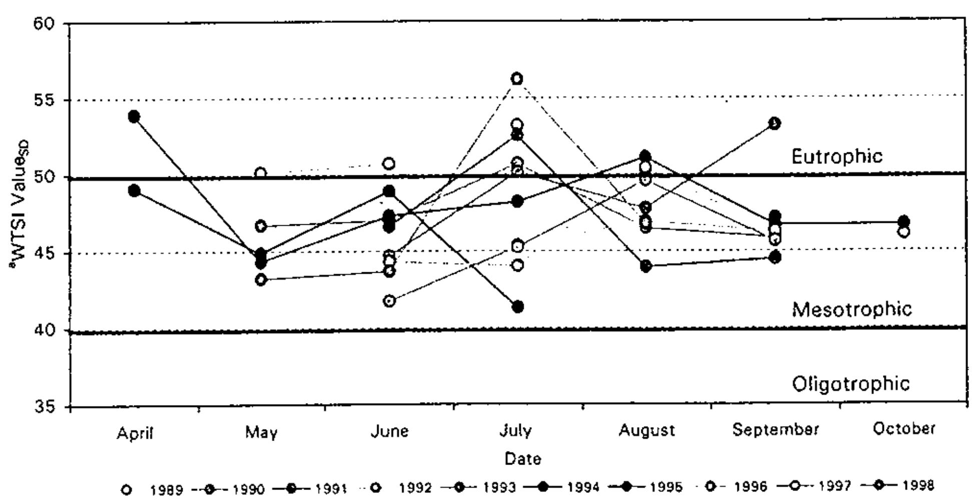


aSD = Secchi-disk depth, see R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes," Research and Management Findings, *Wisconsin Department of Natural Resources Publication No. PUBL-RS-735 93, May 1993.*

Source: Wisconsin Department of Natural Resources, U.S. Geological Survey, and SEWRPC.

Figure 2

TROPHIC STATE INDEX FOR TOMBEAU LAKE: 1989-1998

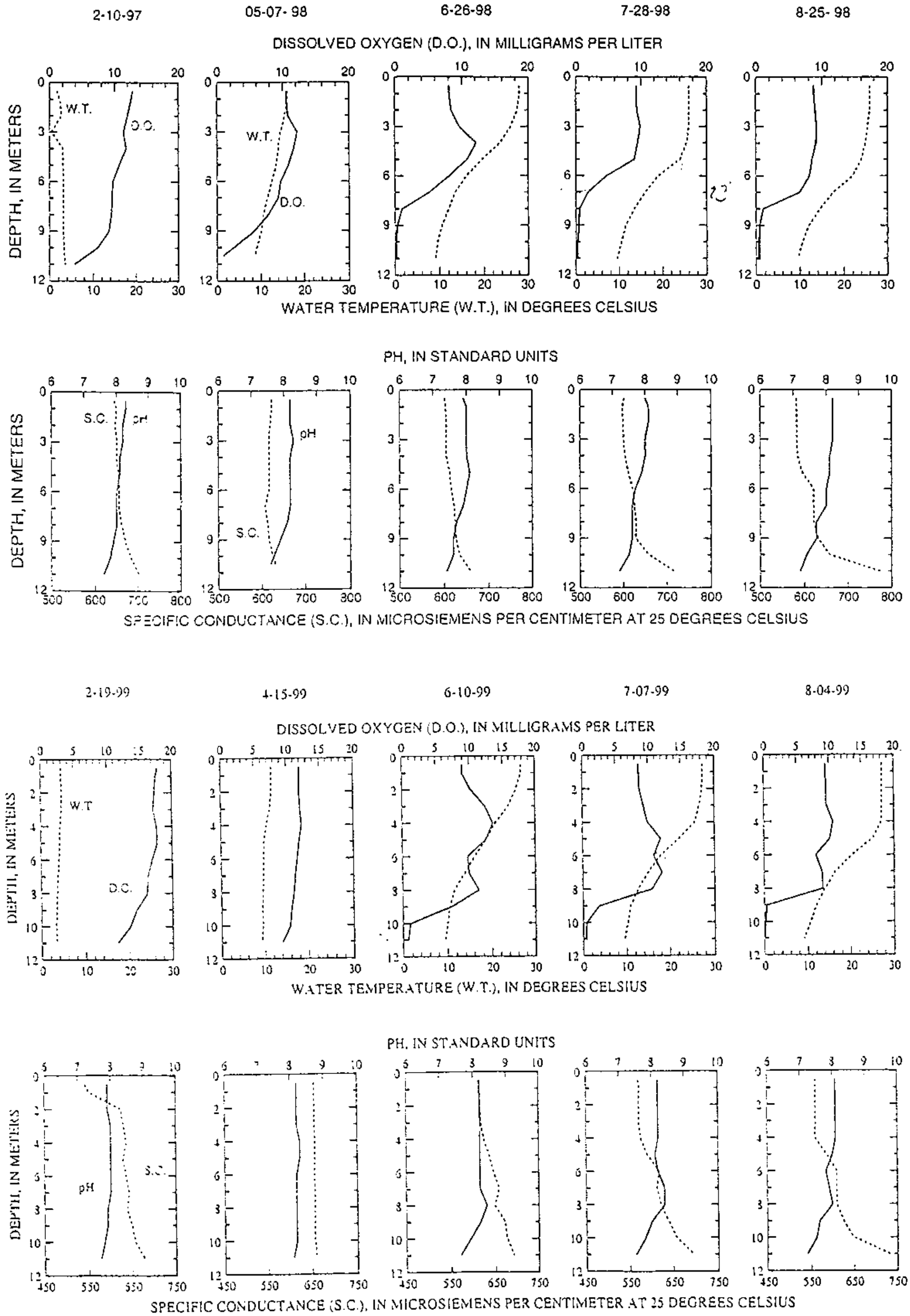


aSD = Secchi-disk depth, see R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes," Research and Management Findings, *Wisconsin Department of Natural Resources Publication No. PUBL-RS-735 93, May 1993.*

Source: Wisconsin Department of Natural Resources, U.S. Geological Survey, and SEWRPC.

Figure 3

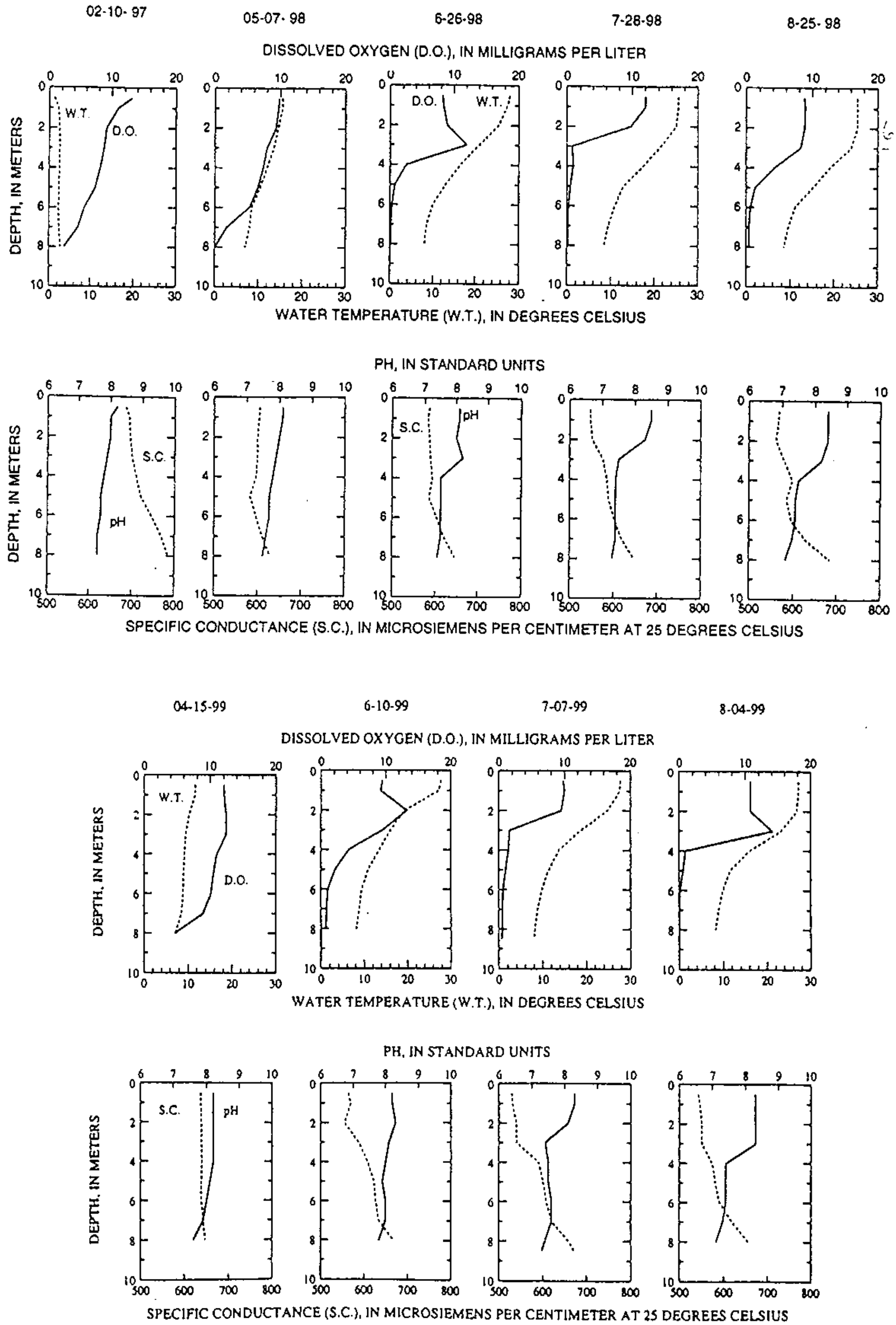
DISSOLVED OXYGEN, TEMPERATURE, pH, AND SPECIFIC CONDUCTANCE PROFILES FOR BENEDICT LAKE: 1997-1999



Source: U.S. Geological Survey.

Figure 4

DISSOLVED OXYGEN, TEMPERATURE, pH, AND SPECIFIC CONDUCTANCE PROFILES FOR TOMBEAU LAKE: 1997-1999



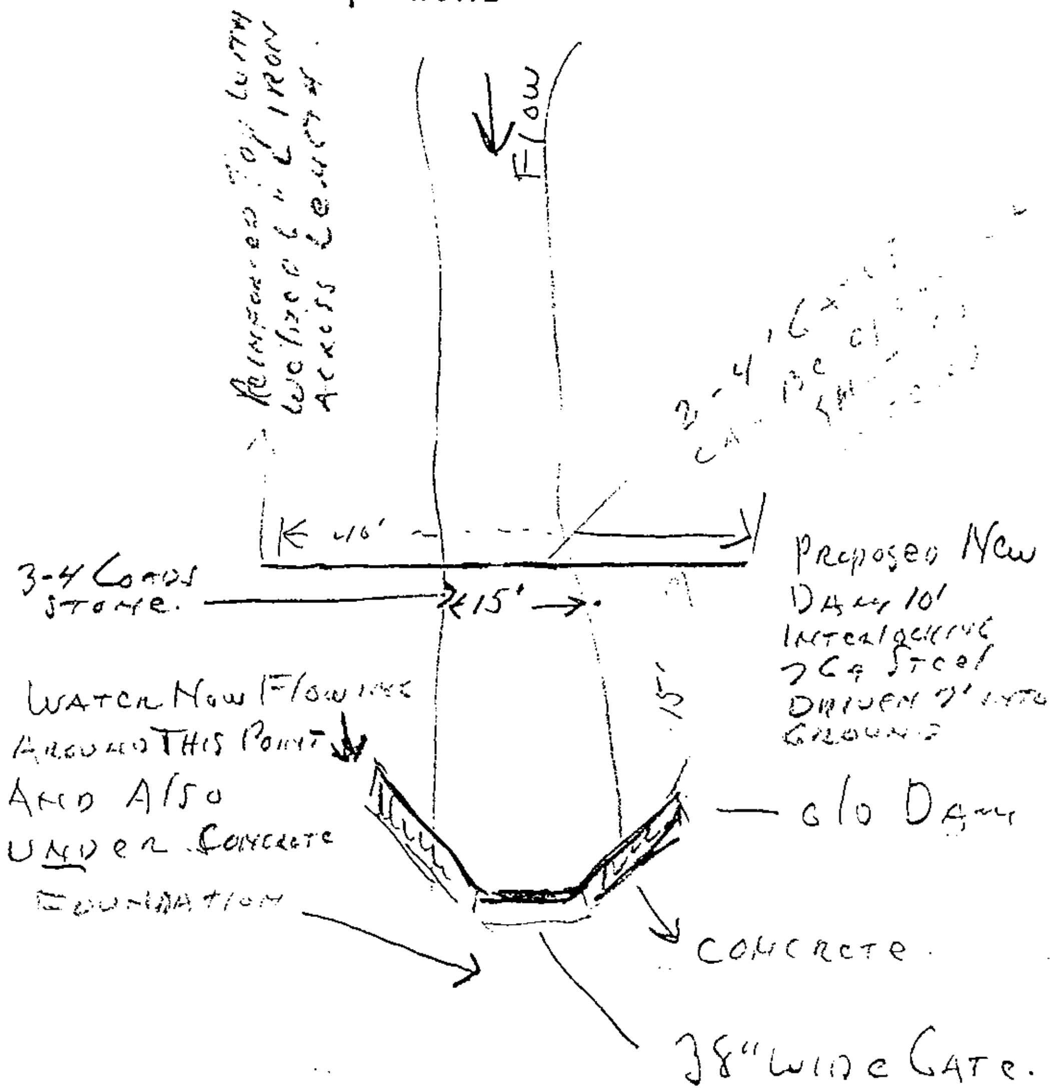
Source: U.S. Geological Survey.

APPENDIX C

1974 DAM DESIGN INFORMATION

from the desk of

M. A. Lipschultz



E-5067
SN

M. A. LIPSCHULTZ 214 S. CLINTON ST. CHICAGO, 60606 RANDOLPH 6-7484

January 18, 1974

JAN 21 1974

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

Attention: Mr. Edmund M. Brick, P.E., Chief
Water Regulation Section

Dear Mr. Brick:

I have a copy of your letter of August 28, 1973, addressed to Mr. Clarence Koehn, and I am enclosing a copy. I am the chairman of the Water Safety Committee for the Nippersink Community Club and have become involved in trying to find the funding for a proper method of repairing or rebuilding the dam in question.

Is there any reason why we could not build a new dam out of steel? We have available to us corrugated seven gauge steel of the interlocking type, which is designed specifically for seawalls. We have a man available who could build a dam 40' wide at the point approximately 15' from the existing dam. At that point the water is less than 15' wide. The intent is to drive 10' steel approximately 7' into the ground, tie it together with heavy steel construction at the top, leaving two 4' gates which can be raised or lowered, as required, and also locked if necessary. It is intended to unload approximately 3 - 4 loads of heavy stone on both sides of the steel construction.

We do not have a print of this intended construction but everyone seems to agree that it will work. If this seems satisfactory to you, we will proceed further with the negotiations and will be glad to give you any further information you want.

Very truly yours,

M. A. Lipschultz

M. A. Lipschultz
MAL:gt

E-5067

M. A. LIPSCHULTZ 214 S. CLINTON ST. CHICAGO, 60606 RANDOLPH 6-7484

726

February 20, 1974

Your Ref. 3560-4
E-5067

State of Wisconsin
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

Attention: Mr. Edmund M. Brick, P.E., Chief
Water Regulation Section

FEB 21 1974

Dear Mr. Brick:

In accordance with your request of February 6th, we would like to remind you of the fact that we are having extreme difficulty in funding this project since we have been unable to get aid from any of the state or local governmental agencies. Therefore, every effort is presently being made to do this reconstruction at the very lowest possible cost, since all funding will be on a private basis. Accordingly, we have a minimum of funds and simply cannot pay for engineering costs, soil borings, etc., etc.

In private conversations with several engineers and contractors, we have been assured that the scheme which I had outlined to you in previous correspondence is practical and workable and the most efficient means of accomplishing our purpose. Accordingly, we urgently request that you waive the requirement of submitting plans. This request is particularly made in accordance with previous telephone conversations which I have had with your department, wherein I was advised that the State does not require specific plans.

We are assured by our contractor that there will be no problem in the dam overturning, since it is intended to drive the steel down into solid soil. Further, the additional stone on both sides of the steel will provide the extra stability. The steel specifications are as follows:

Tensile strength 57,600 pounds per square inch
Yield strength 36,500 " " " "
Yield strength in pounds 3,100
Maximum load pounds 4,900
Elongation in 2" is 68
Section modulus 2.60 per cubic foot of wall
Weight 9.22 per square foot
Weight 13.61 per lineal foot
Material includes phosphorous .026%
sulphur .024% copper .044%

RECEIVED
FEB 21 1974
FILING

State of Wisconsin
Dept. of Natural Resources
Mr. Edmund M. Brick February 20, 1974

We would appreciate it if you would indicate your approval so that we can proceed immediately.

Very truly yours,

M. A. Lipschultz

M. A. Lipschultz
MAL:gt

APPENDIX D

DAM SITE SURVEY

STATE BAR OF WISCONSIN FORM 3 - 1982
QUIT CLAIM DEED

DOCUMENT NO.

Nippersink Country Club LLC

quit-claims to Lake Benedict - Lake Tombeau Lake Management District

the following described real estate in Walworth County County, State of Wisconsin:

Dam #64.23 is located on the East Branch of Nippersink Creek, down stream of Lake Tombeau. The dam is adjacent to the park which is located between Lots 5 and 6 in Lake Tombeau Woods Section 24 TINR18E, Town of Bloomfield, Walworth County, WI.
Dam #64.23 is a steel structure controlling the water level of Lake Tombeau and Lake Benedict.

THIS SPACE RESERVED FOR RECORDING DATA

NAME AND RETURN ADDRESS
Lake Benedict/Lake Tombeau Management District
P.O. Box 668
Genoa City, Wi 53128
Attn: Mel Gregory

PARCEL IDENTIFICATION NUMBER

This is not homestead property
(is) (is not)

Dated this 5th day of December 2001

Mel Gregory, Lake District Secretary (SEAL)
[signature]

Richard Anderson, Lake District Chairman (SEAL)
[signature]

Jerome M. Zwolak (SEAL)
[signature]

Operating Member and Authorized Representative, Nippersink Country Club, LLC (SEAL)

AUTHENTICATION

Signature(s) ______

authenticated this ____ day of ______ 20 ____

TITLE: MEMBER STATE BAR OF WISCONSIN
(If not, ______
authorized by §706.06, Wis. Stats.)

THIS INSTRUMENT WAS DRAFTED BY

(Signatures may be authenticated or acknowledged. Both are not necessary.)

ACKNOWLEDGMENT

State of Wisconsin, } ss.
Walworth County

Personally came before me this ______ day of ______ 20____, the above named

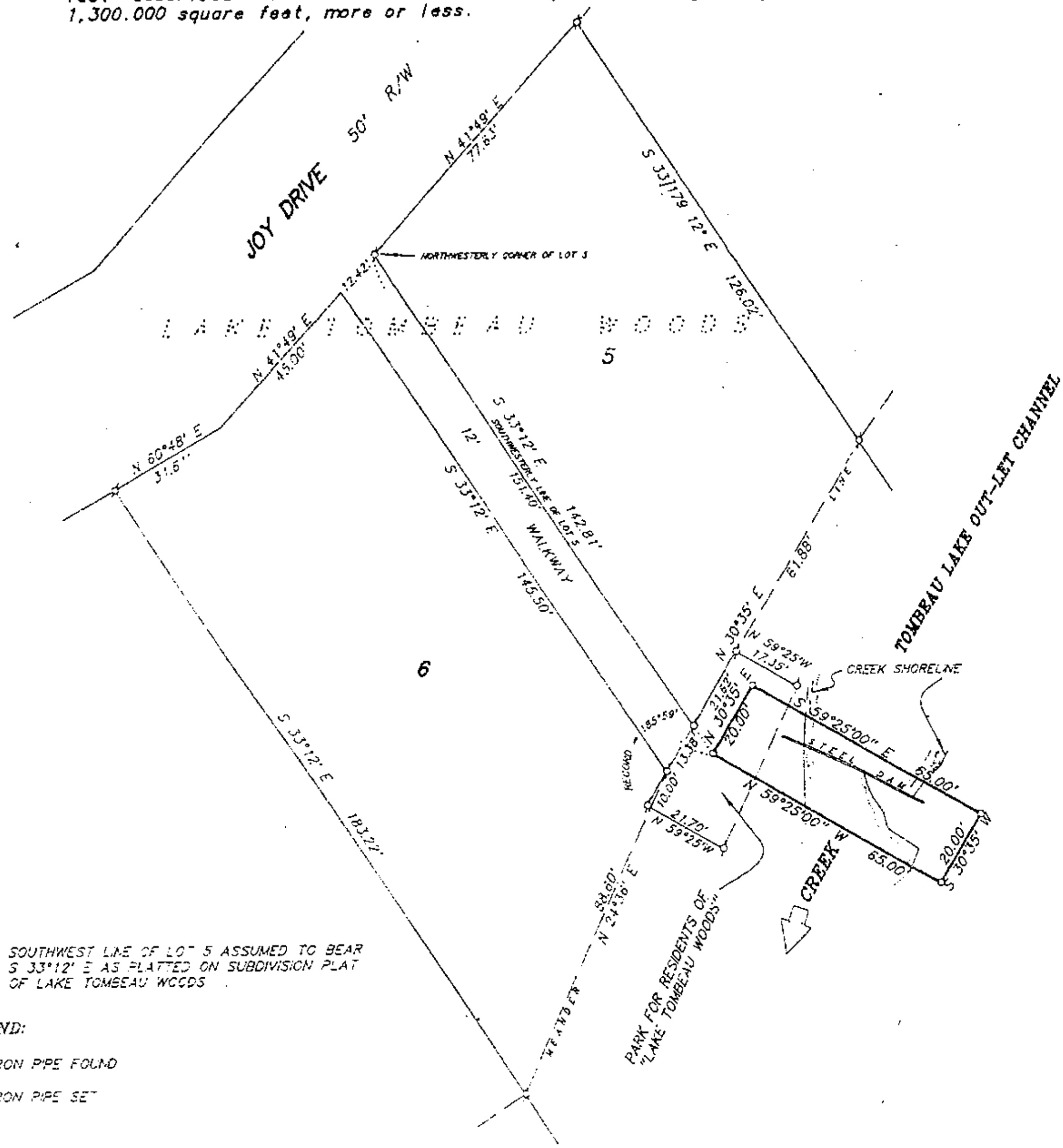
to me known to be the person ______ who executed the foregoing instrument and acknowledge the same.

Notary Public, ______ County, Wis.
My commission is permanent. (if not, state expiration date: 20 ______.)

* Names of persons signing in any capacity should be typed or printed below their signatures.

OF

that part of Lake Tombe[illegible] Woods, according to the recorded plat [illegible] eof and part of the Southeast Quarter of Section 24, Township 1 North, Range 1d East of the 4th Principal Meridian, Town of Bloomfield, Walworth County, Wisconsin, described as follows: Commencing at the northwesterly corner of Lot 5 of LAKE TOMBEAU WOODS, a subdivision located in the Southeast Quarter of Section 24, Township 1 North, Range 18 East of the 4th Principal Meridian, Town of Bloomfield, Walworth County, Wisconsin: thence South 33 degrees 12 minutes East along the southwesterly line of said Lot 5 and said lines southeasterly extension a distance of 151.40 feet to the point of beginning of the land to be described; thence North 30 degrees 35 minutes East parallel with the meander line of said Lot 5 a distance of 20.00 feet; thence South 59 degrees 25 minutes 00 seconds East at a right angle to the last described line 65.00 feet; thence South 30 degrees 35 minutes West at a right angle to the last described line 20.00 feet; thence North 59 degrees 25 minutes 00 seconds West at a right angle to the last described line 65.00 feet to the point of beginning. The parcel contains 1,300.000 square feet, more or less.



NOTE: SOUTHWEST LINE OF LOT 5 ASSUMED TO BEAR S 33°12' E AS PLATTED ON SUBDIVISION PLAT OF LAKE TOMBEAU WOODS.

LEGEND:

- ⌀ IRON PIPE FOUND
- ○ IRON PIPE SET

SCALE 1 inch = 30 feet

ORDERED BY M. Gregory / Lake Benedict-Lake Tombeau Lake Management

JOB NO. 0 1 1 7 9

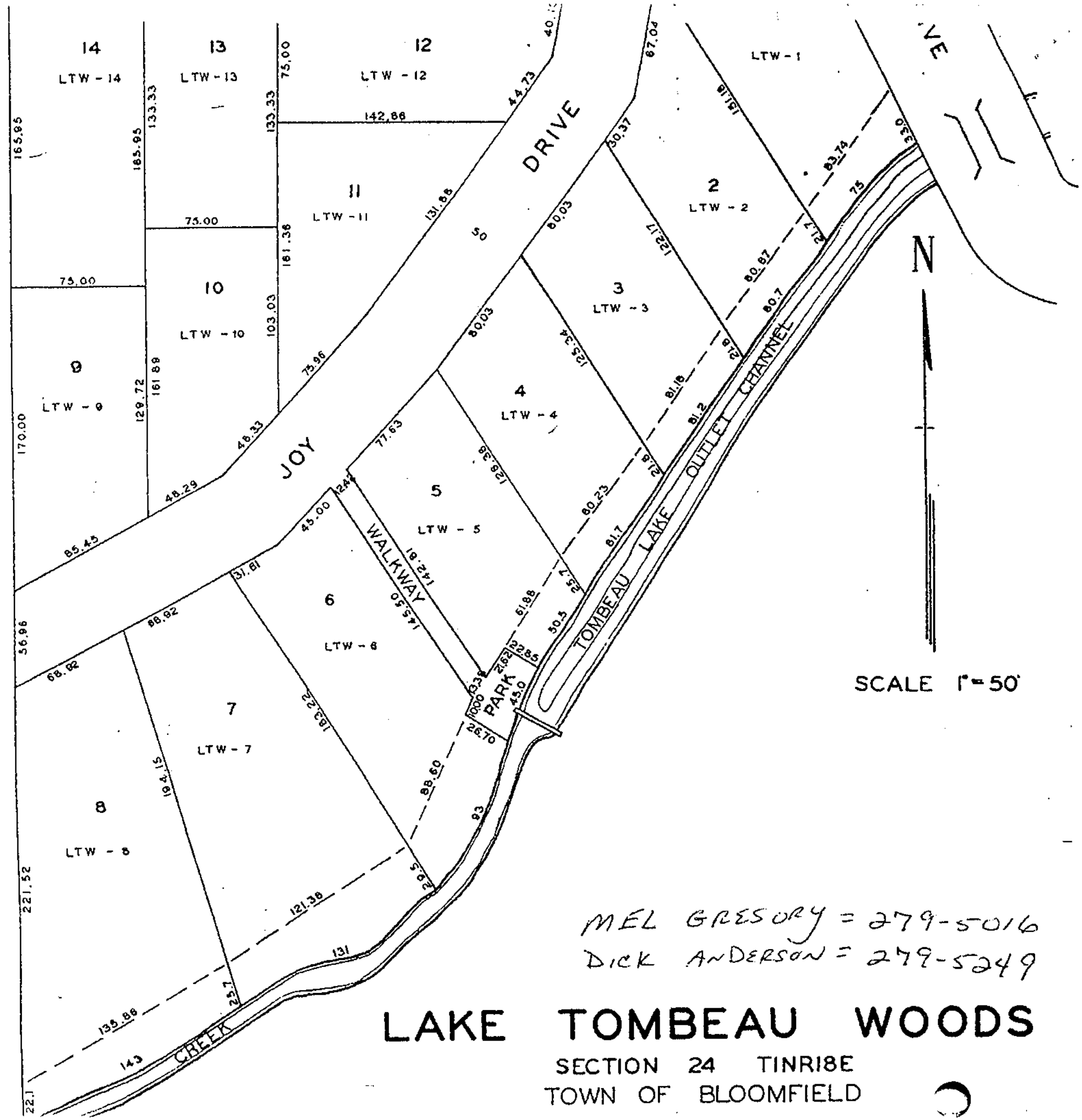
I hereby certify that I have surveyed the above described property and the above plat is a true representation thereof and shows the size and location of the property, its exterior boundaries, the location and dimensions of all visible structures thereon, boundary fences, apparent easements and roadways and visible encroachments, if any.

This survey is made for the exclusive use of the present owners of the property, and also those who purchase, mortgage, or guarantee the title thereto within one year from the date hereof.

Dated at Bassett, Wisconsin this 25th day of SEPTEMBER 2001.

Mark A. Bolender
Wisconsin Registered Land Surveyor S - 1784

WISCONSIN
MARK A. BOLENDER
S-1784
BASSET
WI
LAND SURVEYOR

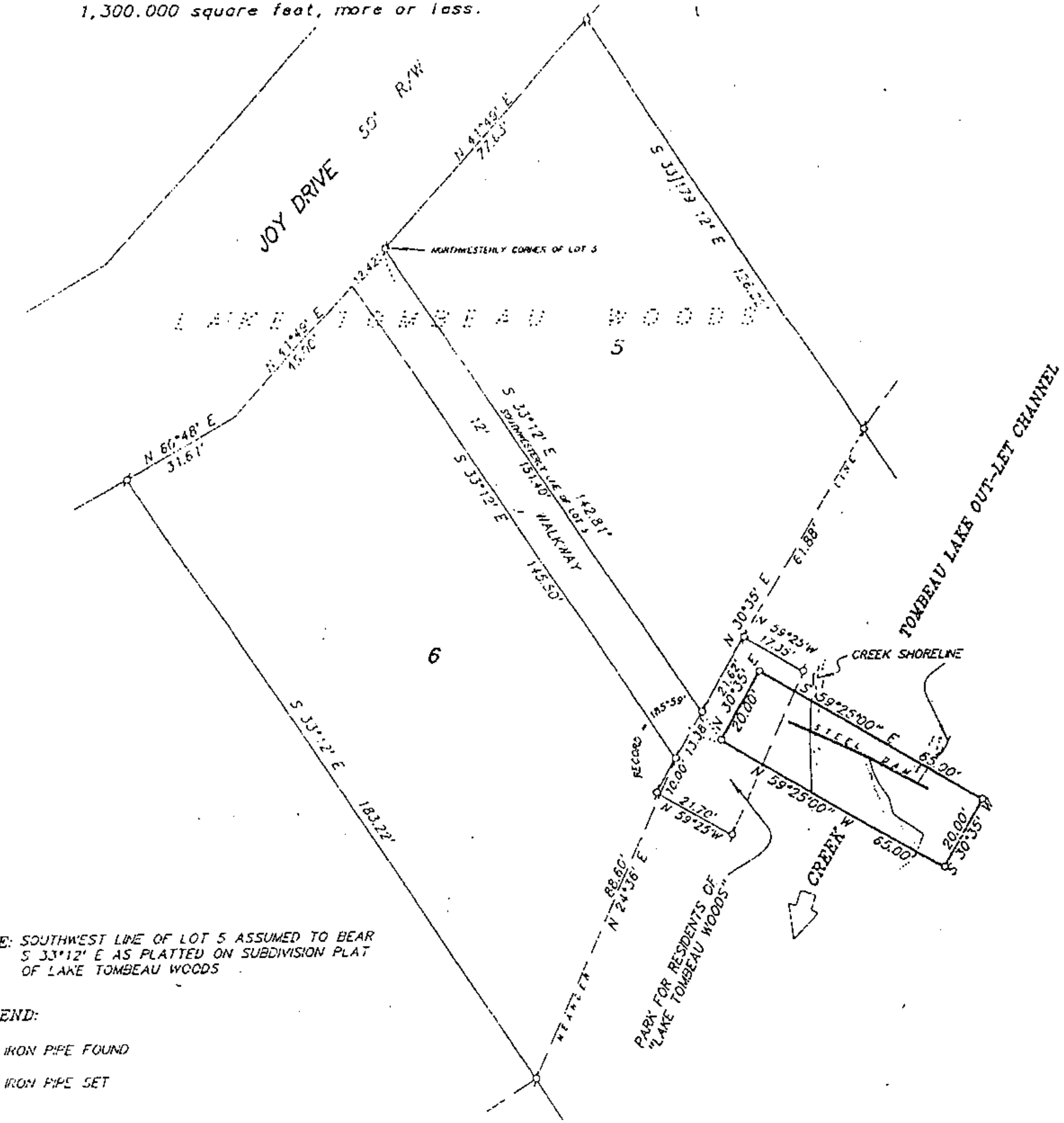


MEL GREGORY = 279-5016
DICK ANDERSON = 279-5249

LAKE TOMBEAU WOODS

SECTION 24 T1NR18E
TOWN OF BLOOMFIELD

that part of Lake Tombeau Woods, according to the recorded plat thereof and part of the Southeast Quarter of Section 24, Township 1 North, Range 18 East of the 4th Principal Meridian, Town of Bloomfield, Walworth County, Wisconsin, described as follows: Commencing at the northwesterly corner of Lot 5 of LAKE TOMBEAU WOODS, a subdivision located in the Southeast Quarter of Section 24, Township 1 North, Range 18 East of the 4th Principal Meridian, Town of Bloomfield, Walworth County, Wisconsin: thence South 33 degrees 12 minutes East along the southwesterly line of said Lot 5 and said lines southeasterly extension a distance of 151.40 feet to the point of beginning of the land to be described; thence North 30 degrees 35 minutes East parallel with the meander line of said Lot 5 a distance of 20.00 feet; thence South 59 degrees 25 minutes 00 seconds East at a right angle to the last described line 65.00 feet; thence South 30 degrees 35 minutes West at a right angle to the last described line 20.00 feet; thence North 59 degrees 25 minutes 00 seconds West at a right angle to the last described line 65.00 feet to the point of beginning. The parcel contains 1,300.000 square feet, more or less.



NOTE: SOUTHWEST LINE OF LOT 5 ASSUMED TO BEAR S 33°12' E AS PLATTED ON SUBDIVISION PLAT OF LAKE TOMBEAU WOODS

LEGEND:

IRON PIPE FOUND

IRON PIPE SET

Dick Anderson
279-5249
Mel Gregory
279-5016

APPENDIX E

FLOOD INSURANCE STUDY

FLOOD INSURANCE STUDY

COUNTY OF WALWORTH
WISCONSIN
UNINCORPORATED AREAS

FEBRUARY 15, 1983

Federal Emergency Management Agency

COMMUNITY NUMBER - 550462

TABLE 1: FLOODING SOURCES

FLOODING SOURCE	DESCRIPTION OF STUDY LIMITS FROM	TO	Distance (Miles)
DETAILED FLOODING SOURCES			
COMO CREEK	Mouth at White River	Como Lake	3.7
EAST BRANCH NIPPERSINK CREEK	Mouth at North Branch Nippersink Creek	County Highway V	4.5
HONEY CREEK	Honey Lake	Mill Lake	23.8
JACKSON CREEK	Mouth at Delavan Lake	Southwest corner of Section 9, at U.S. Highway 12	4.4
NORTH BRANCH NIPPERSINK CREEK	Genoa City corporate limits	Southwest corner of Section 27	2.6
PELL LAKE TRIBUTARY	Mouth at East Branch Nippersink Creek	Pell Lake	2.5
SPRING BROOK	Whitewater corporate limits	Southwest corner of Section 19	4.4
SUGAR CREEK	Mouth at Honey Lake	Northwest corner of Section 23	23.7
SWAN CREEK	Delavan Corporate limits	Delavan Lake	2.5
TURTLE CREEK	Rock County and Walworth County line	Turtle Lake (excluding City of Delavan)	17.3
WHITE RIVER	Kenosha County and Walworth County line	Lake Geneva Corporate Limits	15.4
WHITEWATER CREEK	City of Whitewater Corporate Limits	Rice Lake	4.2

TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ. Miles)	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
COMO CREEK					
Upstream of White River	16.7	350	570	670	970
Upstream of Section E	16.0	340	550	660	960
Upstream of State Highway 12	13.4	320	530	640	920
EAST BRANCH NIPPERSINK CREEK					
Upstream of North Branch Nippersink Creek	16.1	600	1,150	1,400	2,100
Upstream of Confluence of Pell Lake Tributary	11.1	400	800	950	1,400
Upstream of Section J	9.2	350	700	850	1,250
Upstream of Section P	5.2	250	500	600	900
HONEY CREEK					
Walworth-Racine County Boundary	151.2	2,070	3,430	4,100	5,900
Upstream of Sugar Creek	92.5	850	750	750	950
Upstream of Honey Lake	92.0	1,180	1,985	2,400	3,300
Upstream of Section 1	85.0	1,040	1,750	2,100	3,000
Upstream of County Highway D	79.0	1,060	1,770	2,110	3,100
Upstream of Section AA	73.0	910	1,600	1,965	2,900
Upstream of Helbach Road	67.0	1,180	1,900	2,240	3,100
Upstream of State Highway A1	58.0	1,065	1,740	2,080	2,900
Upstream of State Highway 20	55.0	875	1,420	1,700	2,400
Upstream of State Highway 15	51.8	950	1,570	1,900	3,250
Upstream of County Highway G	50.0	1,000	1,630	1,945	2,800
East Troy West Corporate Limits	45.0	950	1,590	1,900	2,700
Upstream of County Highway ES	36.3	500	810	960	1,350
Upstream of Marsh Line Road	30.1	230	375	445	640
Upstream of Section CE	27.0	70	120	180	250
Upstream of Pleasant Lake Road	24.1	40	60	70	90

TABLE 2 - SUMMARY OF DISCHARGES
(Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ. MILES)	PEAK DISCHARGES (CFS)			
		10-YEAR	50-YEAR	100-YEAR	500-YEAR
JACKSON CREEK					
Upstream of Delavan Lake	16.1	1,380	2,510	3,055	4,750
Upstream of Section C	9.6	1,010	1,840	2,240	3,485
Upstream of Section H	7.6	880	1,600	1,945	3,025
Upstream of County Highway H	6.8	815	1,480	1,800	2,800
NORTH BRANCH NIPPERSINK CREEK					
Genoa City North Corporate Limits	45.2	1,670	2,740	3,280	4,700
Upstream of Darling Road	17.0	850	1,600	1,900	2,900
Upstream of Section I	13.8	500	850	1,100	1,600
PELL LAKE TRIBUTARY					
Upstream East Branch Nippersink Creek	4.0	330	600	700	1,050
Upstream of Section C	3.5	300	550	650	975
Upstream of Daisy Road	2.2	60	120	150	225
Upstream of Section G	2.0	35	80	100	135
Upstream of Section I	1.6	20	40	50	70
Upstream of Pell Lake Road	1.5	7	9	10	50
SPRING BROOK					
Whitewater Corporate Limits	15.4	395	730	910	1,500
Upstream of Island Road	10.6	315	580	725	1,195
Upstream of Section O	3.7	165	310	385	640
SUGAR CREEK					
Mouth at Honey Lake	58.7	1,000	1,535	1,785	2,400
Upstream of Potter Road	56.0	970	1,500	1,750	2,370
Upstream of Hargraves Road	54.0	840	1,390	1,655	2,300
Upstream of County Highway G	51.2	850	1,440	1,720	2,380
Upstream of Bowers Road	49.0	840	1,460	1,775	2,450

TABLE 3 - MANNING'S "N" VALUES

STREAM	CHANNEL	OVERBANKS
Como Creek	0.03 to 0.04	0.08 to 0.10
East Branch Nippersink Creek	0.025 to 0.045	0.09 to 0.11
Honey Creek	0.03 to 0.05	0.055 to 0.12
Jackson Creek	0.015 to 0.045	0.07 to 0.085
North Branch Nippersink Creek	0.035 to 0.04	0.09 to 0.11
Pell Lake Tributary	0.04 to 0.09	0.10
Spring Brook	0.04 to 0.045	0.075 to 0.09
Sugar Creek	0.035 to 0.04	0.07 to 0.12
Swan Creek	0.045	0.08
Turtle Creek	0.015 to 0.045	0.06 to 0.095
White River	0.035 to 0.04	0.06 to 0.12
Whitewater Creek	0.04 to 0.05	0.065 to 0.075

Water-surface elevations were computed using the COE HEC-2 step-backwater computer program (Reference 13). Flood Profiles were drawn showing computed water-surface elevation. (Exhibit 1).

The Summary of Elevations for Lakes studied in detail are shown in Table 4.

STARTING WATER SURFACE ELEVATIONS

STREAM	STARTING WATER SURFACE ELEVATION OBTAINED FROM:
Como Creek	White River flood elevation at confluence*
East Branch Nippersink Creek	A Comprehensive Plan for the Fox River Watershed (Reference 4)
Honey Creek	Racine County Flood Insurance Study (Reference 11)
Jackson Creek	Delavan Lake Flood Stages
North Branch Nippersink Creek	East Branch Nippersink Creek 100-year flood elevation at confluence
Pell Lake Tributary	East Branch Nippersink Creek 100-year flood elevation at confluence
Spring Brook	City of Whitewater Flood Insurance Study (Reference 7)
Sugar Creek	Honey Lake Rating Curve
Swan Creek	City of Delavan Flood Insurance Study (Reference 16)
Turtle Creek	Rock County Flood Insurance Study (Reference 12)
White River	Racine County Flood Insurance Study (Reference 11)
Whitewater Creek	City of Whitewater Flood Insurance Study (Reference 7)

*The use of the 10-YEAR Flood Elevation of the White River to start the backwater calculations for Como Creek is justified due to the absence of a good downstream control section for a normal depth analysis, and to the differences in timing of peak discharges.

Numerous small dams were encountered along rivering systems within the county. The analysis for each of these dams varied based on the control head of the structure. High head structures were analyzed based on a hand computation of the backwater effects of the control outlets. Low head structures were assumed to be just restrictive sections.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
EAST BRANCH NIPPERSINK CREEK								
A	870	235	1221	1.1	828.6	828.6	828.6	0.0
B	2120	85	456	3.1	829.2	829.2	829.2	0.0
C	4240	90	544	2.6	830.8	830.8	830.8	0.0
D	5280	104	679	2.1	831.4	831.4	831.4	0.0
E	6516	670	4555	0.3	831.7	831.7	831.7	0.0
F	7366	665	3869	0.4	831.8	831.8	831.8	0.0
G	9406	380	1619	0.6	832.4	832.4	832.4	0.0
H	9806	880[2]	3322	0.3	832.5	832.5	832.5	0.0
I	10206	1200[2]	1233	0.8	832.7	832.7	832.7	0.0
J	11966	920[2]	2532	0.3	832.9	832.9	832.9	0.0
K	13806	1170[2]	2783	0.3	833.0	833.0	833.0	0.0
L	14766	1325	5007	0.2	833.1	833.1	833.1	0.0
M	16126	552	1487	0.6	833.2	833.2	833.2	0.0
N	17697	552	1206	0.7	835.6	835.6	835.6	0.0
O	18257	311	739	1.2	836.1	836.1	836.1	0.0
P	19777	509	1167	1.9	836.9	836.9	836.9	0.0
Q	20677	171	307	2.0	838.6	838.6	838.6	0.0
R	21247	407	271	2.2	841.3	841.3	841.3	0.0
S	22757	503	763	0.8	844.1	844.1	844.1	0.0
T	23457	328	759	0.8	844.6	844.6	844.6	0.0
U	23957	230	246	2.4	847.6	847.6	847.6	0.0

[1]FEET ABOVE MOUTH
[2]COMBINED DIVIDED FLOW FLOODWAY WIDTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

WALWORTH COUNTY, WI

(UNINCORPORATED AREAS)

FLOODWAY DATA

EAST BRANCH NIPPERSINK CREEK

TABLE 5

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
North Branch Nippersink Creek								
A	53330	524	2545	0.7	828.0	828.0	828.0	0.0
B	53930	540	2888	0.7	828.3	828.3	828.3	0.0
C	55726	374	431	4.4	828.4	828.4	828.4	0.0
D	56617	83	524	3.6	829.2	829.2	829.2	0.0
E	56835	300	1489	1.3	829.7	829.7	829.7	0.0
F	58875	982	1805	1.1	830.5	830.5	830.5	0.0
G	60115	921	1623	1.2	831.8	831.8	831.8	0.0
H	62395	618	1299	1.5	834.4	834.4	834.4	0.0
I	63995	619	1070	1.0	835.9	835.9	835.9	0.0
J	64915	334	704	1.6	836.7	836.7	836.7	0.0
K	66395	395	829	1.3	838.4	838.4	838.4	0.0

[1] FEET ABOVE MOUTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

WALWORTH COUNTY, WI
(UNINCORPORATED AREAS)

FLOODWAY DATA

NORTH BRANCH NIPPERSINK CREEK

TABLE 5

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
JACKSON CREEK Reach 1	0070, 0090	-1.6	-0.5	1.2	015	A3	Varies - See Map
NORTH BRANCH NIPPERSINK CREEK Reach 1	0145	-1.4	-0.4	1.0	015	A3	Varies - See Map
PELL LAKE TRIBUTARY Reach 1	0145, 0135	-0.9	-0.2	0.3	010	A2	Varies - See Map

[1] FLOOD INSURANCE RATE MAP PANEL [2] WEIGHTED AVERAGE [3] ROUNDED TO NEAREST FOOT

FEDERAL EMERGENCY MANAGEMENT AGENCY

WALWORTH COUNTY, WI
(UNINCORPORATED AREAS)

FLOOD INSURANCE ZONE DATA

JACKSON CREEK - NORTH BRANCH NIPPERSINK CREEK - PELL LAKE TRIBUTARY

TABLE 6

to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 6, "Flooding Insurance Zone Data", summarizes the flood evaluation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the unincorporated areas of Walworth County is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FEMA.

6.0 OTHER STUDIES

Except for two minor exceptions, the Flood Insurance Studies for the communities of Delevan, East Troy, Whitewater, Lake Geneva, Racine County, Rock County, Jefferson County, Kenosha County, and Waukesha County, Wisconsin, and Boone and McHenry Counties, Illinois, are in complete agreement with this study. These exceptions are as follows: Honey Creek, on the Racine-Walworth County line, and Tombeau Lake, at the Kenosha-Walworth County line. In these situations, the Walworth County study was generated using detailed methods, therefore, of greater accuracy. Other studies may have been completed within the county, but were not in areas of direct comparison.

Southeastern Wisconsin Regional Planning Commission (SEWRPC) has also published a report "Comprehensive Plan for the Fox River Watershed" (Reference 4). This Flood Insurance Study either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purpose of the National Flood Insurance Program.

A Flood Hazard Boundary Map has been published by the Federal Insurance Administration (Reference 15). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 300 South Wacker Drive, Chicago, Illinois 60606.

8.0 BIBLIOGRAPHY AND REFERENCES

1. The State of Wisconsin 1980 Blue Book compiled by the Wisconsin Legislative Reference Bureau, 1980.

2. Technical Paper 40, Rainfall Frequency Atlas of the United States, U.S. Department of Commerce, January 1963.

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5. Computer Program for Project Formulation, Technical Release No. 20, U.S. Department of Agriculture Soil Conservation Service, Control Technical Unit, May 1965.

6. National Engineering Handbook, Section 4, Hydrology, Soil Conservation Service, U.S. Department of Agriculture, August 1972.

7. Federal Emergency Management Agency, Flood Insurance Study, City of Whitewater, Wisconsin, 1980.

8. Estimating Magnitude and Frequency of Floods in Wisconsin, Duane H. Conger, 1971.

9. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L2010 HEC-1 Flood Hydrologic Package, Davis, California.

10. Walworth County, 2-foot contour maps, scale 1:2400, Aero-Metric Engineering, Inc., 1980.

11. Federal Emergency Management Agency, Federal Insurancy Administration, Flood Insurance Study, Racine County, Wisconsin.

12. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Rock County, Wisconsin, May 1978.

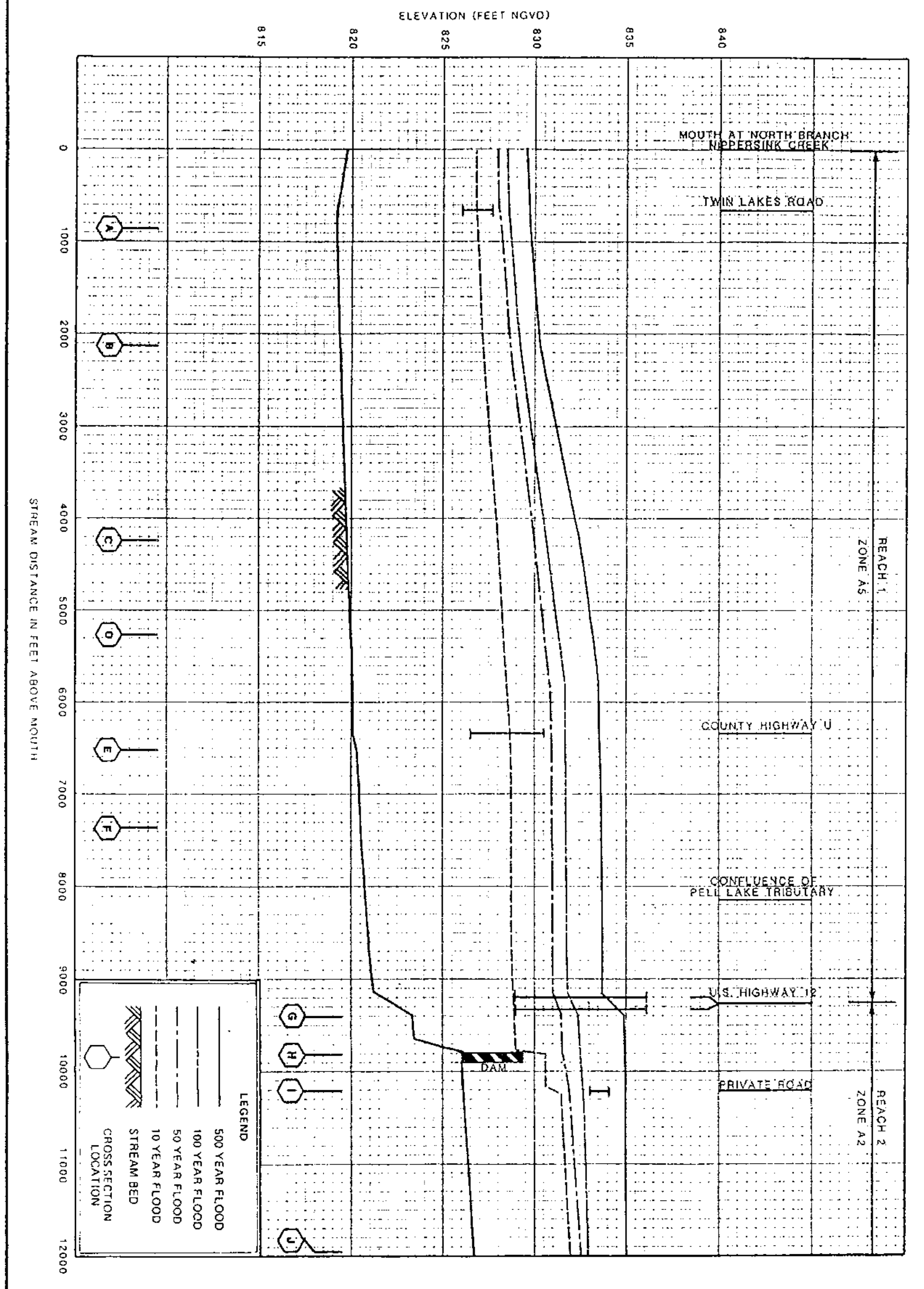
13. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A HEC-2 Water Surface Profiles, Davis, California, November 1976 with updates.

14. Wisconsin Department of Natural Resources, Wisconsin Flood Plain Management Program, Chapter NR 116, Register No. 259, 1977.

15. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Walworth County, Wisconsin (Unincorporated Areas), May 27, 1981.

16. Federal Emergency Management Agency, Flood Insurance Study, City of Delavan, Wisconsin (in progress).

17. -----, Flood Insurance Study, County of Kenosha, Unincorporated Areas, Wisconsin, February 1982.



FEDERAL EMERGENCY MANAGEMENT AGENCY

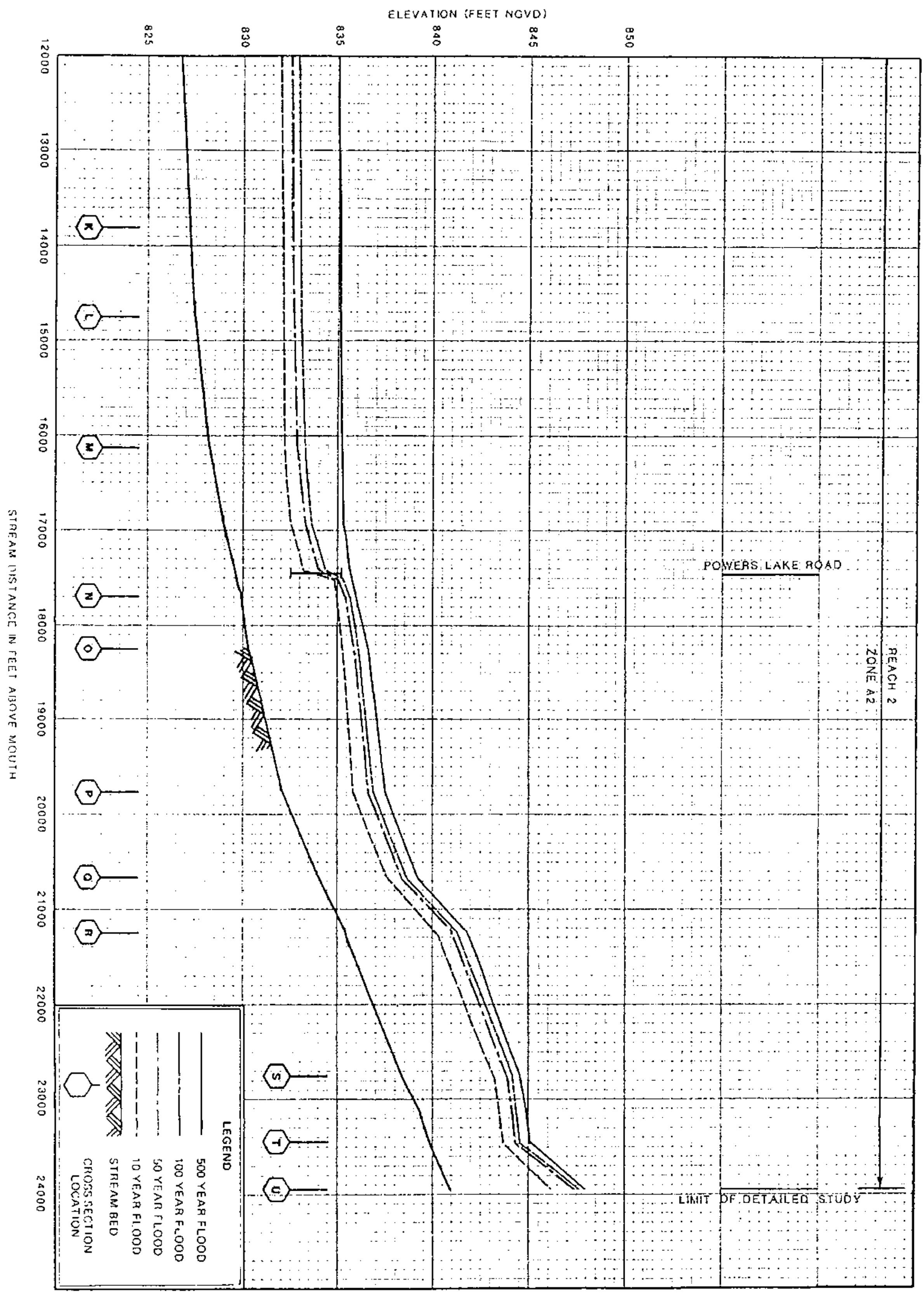
WALWORTH COUNTY, WI

(UNINCORPORATED AREAS)

FLOOD PROFILES

EAST BRANCH NIPPERSINK CREEK

03P



FEDERAL EMERGENCY MANAGEMENT AGENCY

WALWORTH COUNTY, WI

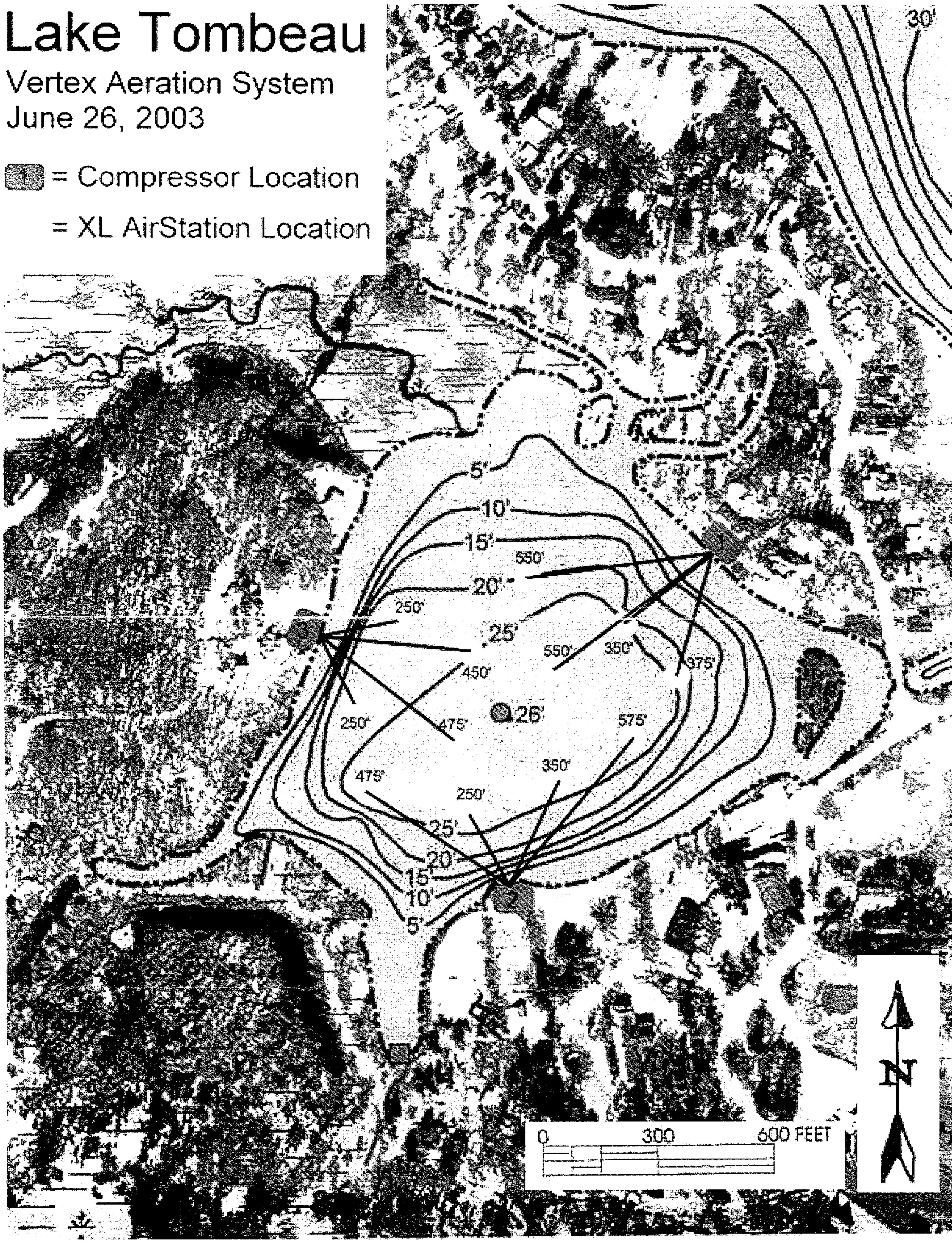
(UNINCORPORATED AREAS)

FLOOD PROFILES

EAST BRANCH NIPPERSINK CREEK

APPENDIX F

POTENTIAL AERATOR LAYOUT



Lake Tombeau
Vertex Aeration System
June 26, 2003
= Compressor Location
= XL AirStation Location
30'
5'
10'
15'
20'
25'
26'
550'
250'
550'
350'
375'
450'
475'
575'
350'
475'
250'
250'
1
2
3
0
300
600 FEET
N