-2-
LAKE AND WATERSHED OVERVIEW

"A lake is a landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature."

-- Henry David Thoreau, American philosopher and naturalist

2-1 LOCATION

Lake Ripley taken on a calm, summer morning.

Lake Ripley is located in Township 6 North, Range 13 East, Sections 7-8, Town of Oakland, in western Jefferson County, Wisconsin (see Figure 3). It is situated on the eastern edge of the Village of Cambridge (Dane County), and about 25 miles east of Madison. The Lake Ripley watershed, or the land area that drains surface water to the lake, covers just over seven square miles of the surrounding landscape within Sections 3 to 10 and 15 to 18. The mostly rural watershed includes the immediate lake area and extends 2.7 miles east of the lake. At its widest points, the watershed stretches four miles along its east-west axis, and three miles along its north-south axis.

2-2 HISTORICAL MILESTONES

According to Burris (1971), Native American burial mounds found along Lake Ripley's north and east shore mark the remains of an ancient civilization, and offer evidence of some of the first humans that frequented the lake (see Figure 4). [1] Long after these ancient Indians vanished, the modern indigenous tribes of the Pottawatomie and Winnebago came to fish and hunt around its shores.

It was not until the mid-19th century before European settlement began in earnest, bringing with it large-scale watershed changes that helped shape the lake into what it is today. A U.S. government survey conducted from 1834-1836 under the direction of Robert Lytle, Survey General, mapped and named the lake (see Figure 5). There were already 15 lots established around the lake at the time of the survey. The landscape around the lake at this time was characteristic of oak savanna, and consisted of a mix of wetlands, upland prairie, and central-hardwood woodlands.

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[1] Burris, John E. 1971. A Study of Man's Effects on Lake Ripley. University of Wisconsin-Madison. Zoology 518 Report.

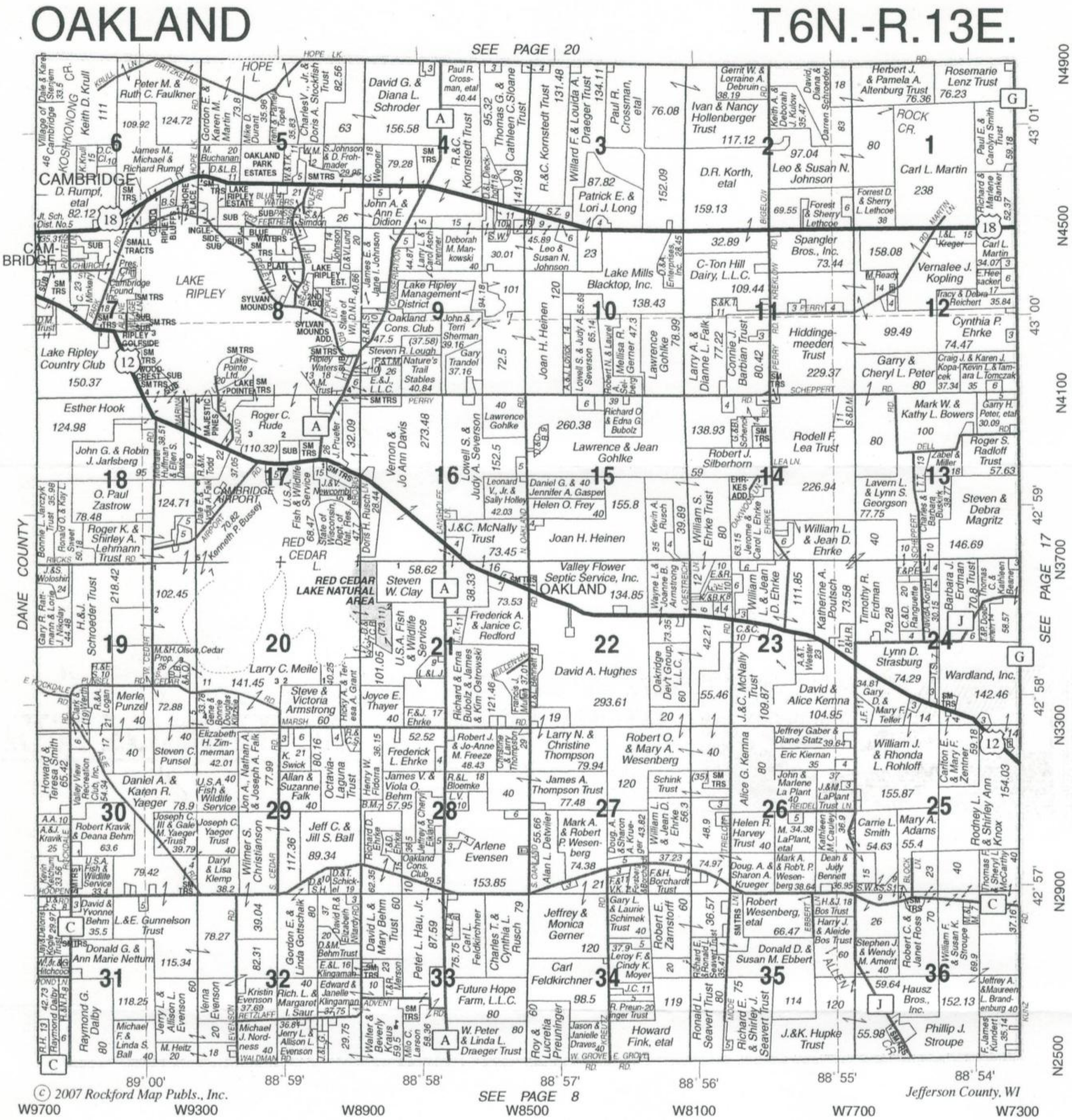

Figure 1: Town of Oakland Plat Map (2007)[2]

[2] 2007 Rockford Map Publishing, Inc.

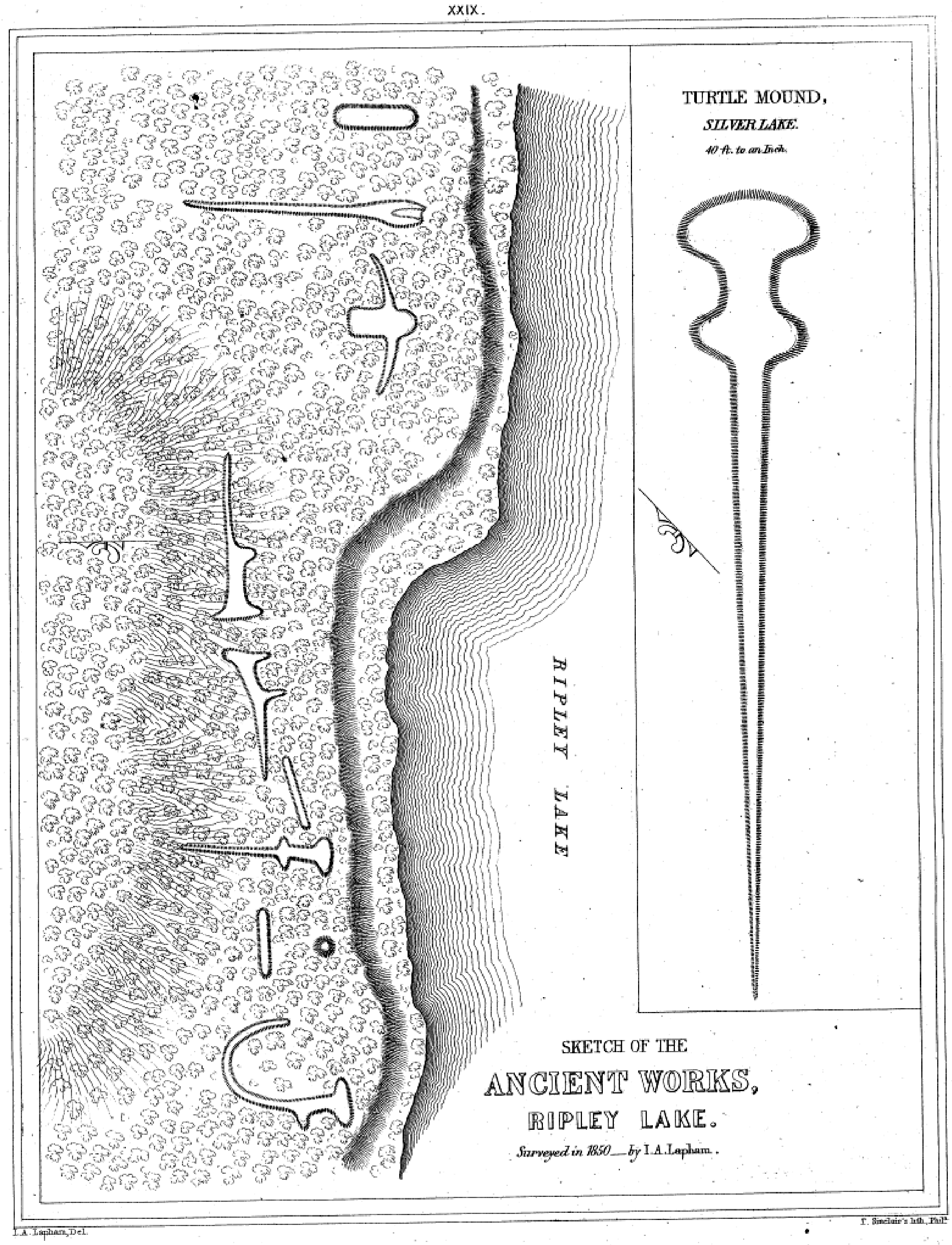

Figure 2: Map of Native American Effigy Mounds on Lake Ripley[3]

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[3] Lapham, Increase Allen. 1811-1875. The Antiquities of Wisconsin. Washington: Smithsonian Institution, 1855. plate 29.

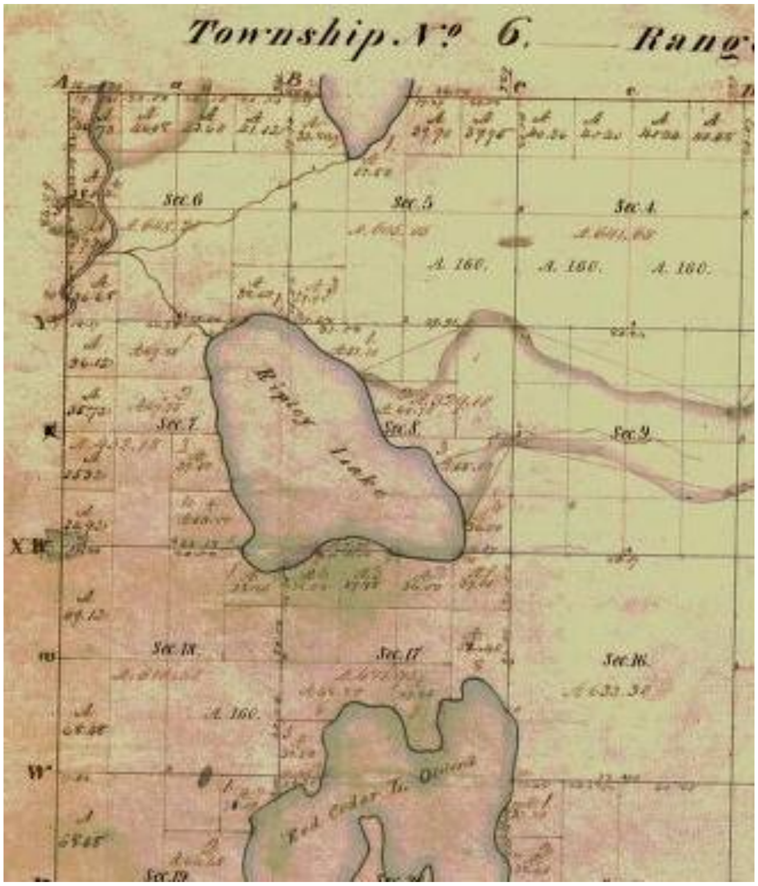

Figure 3: 1835 Oakland Township Plat Map Showing Lake Ripley Area[4]

During the late 1830s and early 1840s, European settlers started arriving. The first recorded settler, George Dow, was a Scottish immigrant from New York. Dow purchased a 242-acre government tract on Lake Ripley as an agricultural holding in 1840. The lake at that time was known as Lake Dow.[5] For the next 30 years, the Lake Ripley area was primarily devoted to farming, with about 400 people living in the vicinity by 1872. This time period marked the start of large-scale watershed alterations as early agricultural development led to extensive land clearing and wetland drainage.

The lake became a popular recreational destination for tourists and vacationing families following the completion of a railroad line from Milwaukee to Madison in 1881. Captain Cowles built the first summer home (named Inglesides) on the lake in 1882, prompting the building of a few additional summer houses over the next 13 years.[6] Summer home construction intensified when a railroad spur from the Town

[4] Garrison, Paul J. and Robert Pillsbury. 2009. Paleoecological Study of Lake Ripley, Jefferson County. Wisconsin Department of Natural Resources, Bureau of Science Services; and University of Wisconsin-Oshkosh, Department of Biology. PUB-SS-1062 2009.
[5] Dow, G. and A.B. Carpenter. 1877. Cambridge. In Dane County and Surrounding Towns; being a History and Guide. Wm. J. Park and Co. Madison, WI. Pp.366-370.
[6] Cambridge News, July 13, 1961, p.3.

of London to the Village of Cambridge was established, making the area easily accessible to summer visitors from Chicago and Milwaukee. Willerup Park, which is currently known as the Willerup Bible Camp, was purchased on Lake Ripley's west shore in 1886.

Lake Ripley became a small but popular summer resort area during the early part of the 20th century. This was also the time when Ole Evinrude, founder of Evinrude Outboard Motors, tested some of his first engine prototypes on the lake. Cedar Lodge was the first hotel built to accommodate visitors, followed shortly by The Hayden and Edgewood Villa. By 1914, Cedar Lodge had 14 cottages and could accommodate 130 people.[7] Cedar Lodge even produced a tourist pamphlet extolling the beauty of Lake Ripley and the vast number of bass and pickerel waiting to be caught.

While the railroad spur to Cambridge was discontinued in 1916, the lake remained a popular vacation spot. In 1924, there were two large hotels, three smaller ones, and a number of privately owned cottages.[8] Foundation Park (now called Lake Ripley Park and owned by the Cambridge Foundation) was purchased in 1932 as a place for the community to gather and enjoy the lake. Sometime shortly prior to this date, a rubble dam was first built at the outlet in an attempt to maintain water levels during drought conditions. The dam was raised and reinforced in 1932 by the Lake Ripley Betterment Club.[9]

Although the hotels eventually disappeared from Lake Ripley, cottages continued to be built along its shores, especially after World War II, and the lake remained popular with summer vacationers and tourists. Lake Ripley received additional notoriety in 1940 when the state record largemouth bass was caught, weighing a hefty 11 pounds, 3 ounces. Aerial photographs at this time show evidence of early hydrologic modifications, particularly the dredging and channelization of Lake Ripley's inlet.

Following World War II, agricultural mechanization greatly increased and the use of synthetic fertilizers became common practice. This resulted in a larger proportion of land within the watershed under cultivation, as well as increased rates of nutrient application onto the landscape, greater soil erosion, and increased nutrient runoff. Residential construction also affected the lake by increasing soil erosion rates, and by contributing sewage effluent as a result of failing septic systems.

By 1949, a small stream inlet on the north side of the lake was closed off and a pumping station was built in what is still called the Shore Place Subdivision. Originally a tamarack marsh, the growing subdivision was permitted to pump septic-contaminated water and divert it outside the watershed to the north. This practice was evident in a 1970 sanitary survey that discovered a fecal coliform count of 4,000/100 ml in a Highway 18 drainage ditch close to where the pump was discharging. Pumping continues to this day to keep nearby homes from flooding, but the

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[7] Chase, Wayland and Lowell Noland. The History and Hydrography of Lake Ripley. Trans. Wisconsin Academy of Sciences, Arts and Letters, vol. 23, 1927.
[8] Scott, B.M. 1924. History of Cambridge, Wisconsin. Unpublished manuscript. 35 pp.
[9] Public Service Commission report on permit to raise dam on outlet creek of Lake Ripley, January 8, 1960.

discharge water is no longer contaminated. This is most likely due to the replacement of private septic systems by a municipal wastewater treatment facility in the early 1980s.

In 1963, excavation of the 900-foot “Vasby’s Ditch” was initiated by a private landowner, eventually forming a horseshoe-shaped channel and three-acre island at the southern extent of South Bay. Aerial photographs taken between 1940 and 1963 are shown below as Figures 6-9.[10] These can be compared to a more updated 2005 aerial photograph shown as Figure 10.[11] Ten years following the completion of Vasby’s Ditch, an accident at a Lakehead Pipeline facility caused the release of an estimated 250,000 gallons of crude oil. The oil spill entered the inlet creek upstream of Highway A, but was contained and cleaned up before it could reach Lake Ripley.

A municipal sewer system was installed around the lake by 1984. The sewer system replaced private septic fields and permitted wastewater to be treated and discharged outside the lake’s natural drainage basin. In 1986, Lake Ripley became one of 50 lakes in the State to be selected by the Wisconsin Department of Natural Resources for long-term trends monitoring. Just three years later, the growth of Eurasian watermilfoil—a non-native, invasive lake weed—exploded and blanketed 40% of the lake surface with thick mats of vegetation. This prompted property owners to organize for the purpose of purchasing and operating mechanical weed-harvesting equipment to help manage the prolific weed growth.

By late 1990, property owners responded to the Eurasian watermilfoil crisis and continued water quality concerns by petitioning Jefferson County to organize as an Inland Lake Protection and Rehabilitation District under Chapter 33 of the Wisconsin Statutes. The Lake Ripley Management District formed and began operations the following year. An abbreviated summary of major Lake District activities and achievements is presented in Table 1.

[10] Aerial photographs copied from the Arthur H. Robinson Map Library, University of Wisconsin-Madison
[11] Digital aerial photograph from the Jefferson County Land Information Office

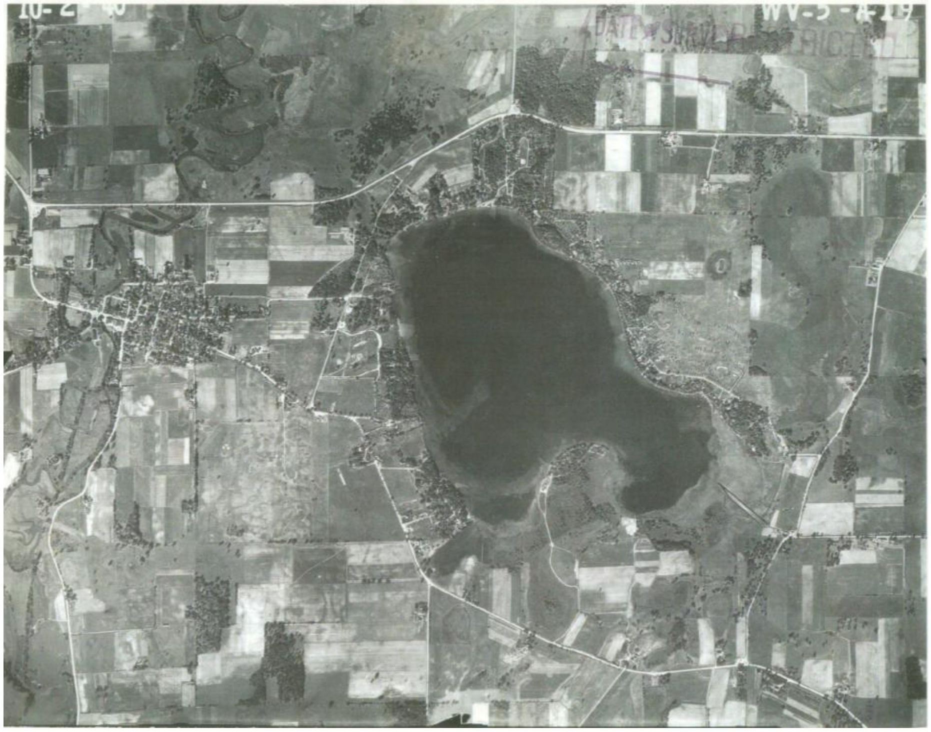


Figure 4: 1940 Aerial Photograph of Lake Ripley

Figure 5: 1950 Aerial Photograph of Lake Ripley

Figure 6: 1957 Aerial Photograph of Lake Ripley

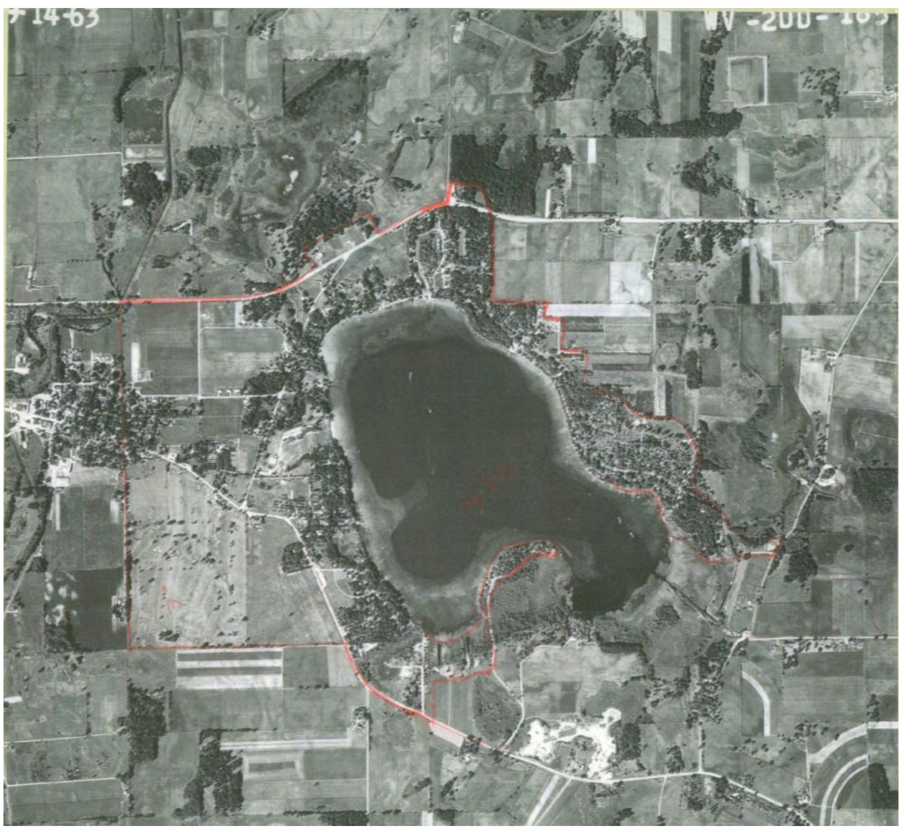


Figure 7: 1963 Aerial Photograph of Lake Ripley

Figure 8: 2005 Aerial Photograph of Lake Ripley

Table 1: Lake Ripley Management District retrospective (1991-2009).

Date	Major Events
1991	The Lake District takes over weed-harvesting operations. Town ordinance establishes slow-no-wake zones in both bays, and a 7:30 p.m. to 11:00 a.m. daily no-wake period. A $10,000 grant pays for the extraction and analysis of a sediment core to assess past water quality conditions in the lake. The study documents dramatic declines in water quality following periods of large-scale wetland drainage and watershed development.
1992	The lake's first aquatic plant management plan is prepared to guide weed-harvesting efforts. The Lake District conducts its first landowner opinion survey to assess local demographics and perceptions relating to a variety of lake-related topics. The first "carp-a-thon" event is hosted in an effort to reduce the carp population.
1993	Lake Ripley is granted "Priority Lake" status by the Wisconsin DNR, and is declared an outstanding natural resource needing protection and long-term management. As a result,

	nearly $1 million in Priority Watershed Project grants are earmarked through 2006. The money is used to hire a project manager, develop a nonpoint source pollution control plan, pay for community outreach, and provide landowner cost-share incentives to control soil erosion and sources of polluted runoff. The *Ripples* newsletter gets its debut, and a service-learning partnership is initiated with Cambridge High School.
1994	The use of "bioengineering" to control shoreline erosion is pioneered on Lake Ripley. A $90,000 grant is used to help renovate the public boat landing. Another $31,000 grant is used to purchase a new weed harvester. A Water Resources Appraisal is completed to characterize water quality conditions and offer management guidance. 426 feet of eroding shoreline is repaired.
1995	A Nonpoint Source Pollution Abatement Plan is completed. The Lake District receives an Outstanding Lake Stewardship Award from the Wisconsin DNR, UW Extension, and Wisconsin Association of Lakes. Town ordinance establishes controls on the placement of new piers in designated "sensitive areas." Another Town ordinance prohibits the use of motors in Vasby's Channel to protect fish-spawning habitat. Wetland and natural shoreline areas on the lake's south shore are put into conservancy as a result of a Lake District lawsuit brought against the developer. 120 feet of eroding shoreline is repaired.
1996	A boater opinion survey gauges public attitudes toward existing boating rules. A $2,000 grant pays for water testing supplies. 399 feet of eroding shoreline is repaired.
1997	A Town ordinance is adopted that regulates the burning of yard waste near the lake, primarily to keep phosphorus-rich ash from washing into the water. A $120,000 grant and $47,000 in donations are used to purchase the original 99-acre Lake District Preserve. 505 feet of eroding shoreline is repaired.
1998	Wetland-restoration projects and public-access improvements begin at the Lake District Preserve. An all-volunteer "Lake Watch" program is launched to monitor lake use and report observed boating violations. 335 feet of eroding shoreline and 2,950 feet of eroding ditch banks are repaired.
1999	A $1,800 grant is used to plug a drainage ditch at the Lake District Preserve. An $8,560 grant goes toward developing Lake Ripley's first comprehensive lake-management plan. Public opinion surveys and hearings are used to gather input on the lake's condition, use, and management priorities. The first annual community litter cleanup is co-hosted with Cambridge High School. 110 feet of eroding shoreline and 5,800 feet of eroding ditch banks are repaired.
2000	The Lake District establishes an online presence with a new Website. A two-year partnership with Jefferson County seeks to evaluate the present condition and management needs of the county's lakes. 100 feet of eroding shoreline and 3,500 feet of eroding ditch banks are repaired.
2001	A $10,000 grant helps fund an updated aquatic plant inventory and management plan. Town ordinance prohibits the feeding of geese to help control nuisance populations. 379 feet of eroding shoreline and 2,550 feet of eroding ditch banks are repaired.

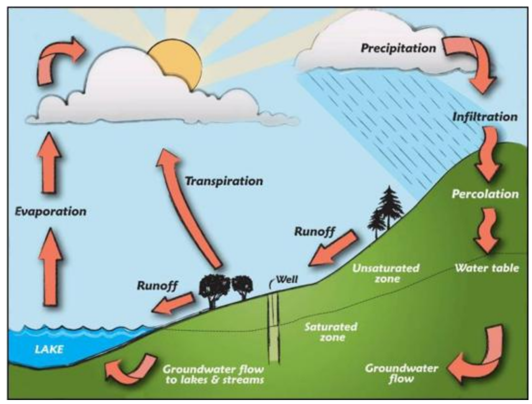
2002	A $2,200 grant is used to plug a 7,400-ft. drainage ditch and restore 20 acres of wetlands at the Lake District Preserve. In order to perform the ditch closure, an additional two acres were added to the Lake District Preserve through condemnation procedures. 561 feet of eroding shoreline is repaired.
2003	Special deed restrictions are negotiated with a lakefront developer to protect threatened wetlands and natural shoreline areas in South Bay. A watercraft census and recreational carrying capacity analysis shows that boat traffic regularly exceeds safe and responsible levels during times of peak use. An annual inventory of piers, boatlifts, watercraft, and shoreline conditions is initiated. 436 feet of eroding shoreline is repaired.
2004	A $3,500 grant is used to research the impacts of piers on near-shore aquatic life. The study shows that oversized piers negatively alter aquatic plant communities and fish habitat on Lake Ripley due to excessive shading. A $1,500 grant is obtained to install a 3,200-square-foot rain garden at the Oakland Town Hall. The Lake District partners with Jefferson County to strengthen shoreland zoning rules governing the clearing of trees and other shoreline vegetation. 295 feet of eroding shoreline and 2,800 feet of eroding ditch banks are repaired.
2005	Town ordinance increases public boat-launching fees, expands no-wake zones to within 200 feet of shore, and prohibits future keyhole developments to address lake-crowding concerns. Zebra mussels are first discovered in the lake. A $1,000 grant is awarded to increase public awareness about aquatic invasive species. A property owner opinion survey helps gauge attitudes about the condition, use and management of the lake. $15,300 in additional landowner cost-share funding is obtained from the state. 902 feet of eroding shoreline is repaired.
2006	The Lake Ripley E-Bulletin is initiated for the purpose of disseminating time-sensitive news and announcements. Virtual tours of the Lake Ripley shoreline and Lake District Preserve are produced for local cable television. The Lake District partners with UW-Madison to design and implement a community-based social marketing program to promote the building of rain gardens. John Molinaro, District Chair, receives the Wisconsin Lake Stewardship Award from the Wisconsin DNR, UW Extension and Wisconsin Association of Lakes. 927 feet of eroding shoreline is repaired.
2007	The grant-funded Priority Lake Project ends after 13 years. From 1993-2006, over $1 million dollars in grants were received, and an estimated sediment-load reduction of 2,100 tons/year is achieved. $20,000 in grants are obtained to perform a second sediment-core analysis, and to update existing lake and watershed management plans. Another property owner opinion survey is conducted. Town ordinance establishes an emergency no-wake policy during high-water conditions. 130 feet of eroding shoreline and 3.2 acres of wetland are restored.
2008	A $200,000 grant and over $43,000 in donations are obtained to help enlarge the Lake District Preserve by 66 acres, to a total of 167 acres. Another $6,500 is raised to successfully challenge an increase in the floodplain elevation around Lake Ripley. 158 feet of eroding shoreline is repaired.

2009	$78,000 in additional grants help pay for the 66-acre Lake District Preserve acquisition and related restoration work. An updated, comprehensive management plan is finalized and published. A sediment-core analysis shows significant improvements in water quality, watershed erosion, and lake-sedimentation rates since 1990. Prior Lake District advocacy efforts lead to statewide restrictions on the sale and use of phosphorus lawn fertilizers. 492 feet of eroding shoreline is repaired, and another 1,430 feet is currently progressing toward completion.

2-3 OVERVIEW OF RESOURCE CHARACTERISTICS

Lake Ripley is a natural, glacial kettle lake that formed approximately 12,000 years ago during the retreat of the last ice age. About a seven-square-mile watershed, as delineated from the lake's outlet, delivers surface water to the lake, predominantly as stream drainage. The lake, in turn, outflows to Koshkonong Creek and is part of the Lower Rock River and Upper Mississippi River Drainage Basins. Lake Ripley is classified as a drainage lake since it is fed by stream flow, groundwater, precipitation and runoff and is drained by a stream. Drainage lakes tend to be high in nutrients compared to other lake types, and their water quality is largely determined by watershed conditions.

The condition of Lake Ripley is ultimately determined by a combination of anthropogenic, climatic, hydrologic, geomorphic, and in-lake (physical, biological, chemical) factors. All of these forces act in concert to influence lake health. An abbreviated summary of these defining factors is provided in Table 2 below, and then described in greater detail in the sections that follow.



All lakes are products of the hydrologic cycle (or the means by which water enters and leaves the system) as represented in the above illustration. Source: UW-Extension

Table 2: Summary of lake and watershed characteristics

PHYSICAL AND HYDROLOGIC DESCRIPTORS	
Lake type (origin)	Natural, glacial kettle lake
Lake type (hydrologic)	Drainage lake with one perennial inlet and outlet
Main water source	Stream flow
Landscape position and hydrologic-connectivity classification	Class I headwater lake that is not connected to upstream water bodies
Regional drainage basins	Part of the Lower Rock River and Upper Mississippi Drainage Basins
Lake surface area	423.3 acres (main body); 1.7 acres (Vasby's ditch); 2.5 acres (dredged inlet channel)[12]
Watershed area	4,688 acres (7.3 square miles)[13]
Watershed-to-lake area ratio	11:1
Shoreline length	4.1 miles (main body)[14]; 0.57 mile (Vasby's ditch); 0.95 (dredged inlet)
Time of concentration	11.14 hours (maximum travel time for water particle to reach the lake from furthest reaches of watershed)[15]
100-yr. floodplain elevation	837.99 ft. above mean sea level[16]
Ordinary High Water Mark (OHWM)	836.5 ft. above mean sea level[17]
Average lake-surface elevation	835 ft. above mean sea level[18] (variable)
Max. lake depth	44 ft.
Mean depth	18 ft.
Surface area < 3 ft. deep	11%
Surface area < 5 ft. deep	36%
Surface area < 10 ft. deep	48%
Surface area > 20 ft. deep	40%
Lake volume	7,561 acre-feet[19]
Water residence time	2.85 years (amount of time water resides in the lake before it is flushed out and replaced with new water)[20]

[12] Delineation by Jefferson County Land & Water Conservation Department using 2005 aerial photograph
[13] Jefferson County LIDAR Project using 2005-derived Digital Elevation Model (ESRI Spatial Analyst Watershed Tools: http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=GP_Service_step-by-step%3A_Watershed)
[14] Ibid
[15] Montgomery Associates Resource Solutions, LLC. 2008. Floodplain Delineation Report for Lake Ripley, Jefferson County, Wisconsin. Computed using WinTR-55.
[16] Ibid
[17] 2002 OHWM determination by Wisconsin Department of Natural Resources relating to platting of Majestic Pines Subdivision
[18] U.S. Geological Survey. 1971 (photorevised), 1976 (photoinspected). Lake Mills, WI SW/4 Waterloo 15' Quadrangle.
[19] Wisconsin Department of Natural Resources. 1970. Lake Survey Map.

Inlet flow	5 cubic ft/sec (1993 annual mean); 1.6-8.8 cubic ft/sec (1993 annual range)[21]
Outlet flow	9 cubic ft/sec (1993 annual mean); 4.5-23.2 cubic ft/sec (1993 annual range)[22]
Groundwater component of hydrologic budget	30%[23]
Surface/groundwater flow direction	Generally east to west
Shore development factor	1.7 (circularity of lake shape, with 1 being a perfect circle)
Inlet stream length	4.25 miles (2.5 miles in 1907, prior to drainage ditching)
Lake fetch	1.3 miles
Lake-bottom substrates	45% organic silt, 35% sand, 20% gravel[24]
Thermal properties of water column	Dimictic (summer stratification with spring and fall lake-wide mixing)
Summer stratification period	June to September
Anoxic zone	> 20 ft. during summer stratification
Ice-cover period	97 days (1989-2009 average)
Watershed topography	Mostly flat to gently rolling
Watershed geology and soils	Lake is part of an extensive glacial outwash plain and terrace system; watershed soil types are primarily silt loam; common soil associations are Houghton-Adrian and Fox-Casco-Matherton[25]
Watershed land uses	48.4% (2,270 acres) cropland; 12.6% (592 acres) residential; 11.6% (543 acres) wetlands; 9.5% (444 acres) surface water; 6.3% (296 acres) upland woods; 4.2% (197 acres) streets; 4.2% (197 acres) rural uncultivated; and 3.2% (148 acres) gravel pits[26]
Watershed impervious cover	11%[27]
Wetland acreage	543 acres (originally 1,500 acres according to a 1908 USGS inventory); about 25% of shoreline still supports wetlands[28]

[20] Estimated using Wisconsin Lake Modeling Suite (WiLMS), Version 3.3.18.1

[21] Wisconsin Department of Natural Resources, and Lake Ripley Management District. 1994. Lake Ripley Water Resources Appraisal.

[22] Ibid

[23] Wisconsin Department of Natural Resources, Wisconsin Department of Agriculture, Trade and Consumer Protection, Lake Ripley Management District, and Jefferson County Land Conservation Department. 1998. Nonpoint Source Control Plan for the Lake Ripley Priority Lake Project. Wisconsin Nonpoint Source Water Pollution Abatement Program. Publication WT-512-98.

[24] Burris, John E. 1971. A Study of Man's Effects on Lake Ripley. University of Wisconsin-Madison. Zoology 518 Report.

[25] U.S. Department of Agriculture. 1979. Soil Survey of Jefferson County.

[26] Jefferson County Land and Water Conservation Department. 2008 Land Use Cover Maps.

[27] Information generated by Jefferson County Land & Water Conservation Department using 2008 land-use data and the Monroe County of Indiana methodology for Impervious Cover Coefficient distinction

[28] Wisconsin Department of Natural Resources. 1986. Wisconsin Wetlands Inventory.

BIOLOGICAL AND CHEMICAL DESCRIPTORS	
Watershed ecoregion	Southeastern Wisconsin Savannah and Till Plain[29]
Lake type (chemical)	Marl (high in calcium carbonate)
Lake trophic status	Meso-eutrophic
Average summer water quality indices	Total phosphorus ("good"); chlorophyll-*a* ("good"); water clarity ("fair")
Mean summer total phosphorus (surface)	20.3 µg/L
Mean summer total phosphorus (bottom)	70.0 µg/L
Mean summer chlorophyll-*a*	8.6 µg/L
Mean Secchi clarity	6.0 ft.
Limiting nutrient for algal growth	Phosphorus
Nitrogen-to-phosphorus ratio	>27:1[30]
Phosphorus-loading sources	Row crops (70.3%), urban/residential (17.4%), pasture/ mixed agriculture (5.5%), atmospheric deposition (4.1%), wetland (1.8%), forest (0.8%)[31]
Sensitivity of lake to changes in nutrient load	Low
Sediment loading sources (Pre-1998 estimate)	Eroding ditches (75%), shorelines (7%), construction sites (13%), cropland (4%), existing urban (1%)[32]
Mean sedimentation rate	0.7 g cm^{-2} yr^{-1} (based on sediment-core findings)[33]
Alkalinity	High (160-260 mg/L $CaCO_3$)
Average pH	High (8.5)
Acidification sensitivity	Low
Max. plant-rooting depth	~12-15 ft.
Total fish species	39 species documented since mid-1970s
Winterkill sensitivity	Low (due to water depth and volume)
Aquatic plant species documented	31 species[34]
Aquatic invasive species	Common carp (*Cyprinus carpio*); Eurasian watermilfoil (*Myriophyllum spicatum*); curly-leaf pondweed (*Potamogeton crispus*); zebra mussel (*Dreissena polymorpha*)

[29] Omernik, J.M. 1987. Ecoregions of the Conterminous United States.
[30] Wisconsin Department of Natural Resources, and Lake Ripley Management District. 1994. Lake Ripley Water Resources Appraisal.
[31] Analysis using Wisconsin Lake Modeling Suite (WiLMS), Version 3.3.18.1
[32] Wisconsin Department of Natural Resources, Wisconsin Department of Agriculture, Trade and Consumer Protection, Lake Ripley Management District, and Jefferson County Land Conservation Department. 1998. Nonpoint Source Control Plan for the Lake Ripley Priority Lake Project. Wisconsin Nonpoint Source Water Pollution Abatement Program. Publication WT-512-98.
[33] Garrison, Paul J. and Robert Pillsbury. 2009. Paleoecological Study of Lake Ripley, Jefferson County. Wisconsin Department of Natural Resources, Bureau of Science Services; and University of Wisconsin-Oshkosh, Department of Biology. PUB-SS-1062 2009.
[34] 2006 aquatic plant inventory conducted by the Wisconsin Department of Natural Resources

Endangered and threatened resources	WI and Federal Endangered Species: giant carrion beetle (*Nicrophorus americanus*); WI Special Concern Species: least darter (*Etheostoma microperca*), lake chubsucker (*Erimyzon sucetta*), and cuckoo flower (*Cardamine pratensis*); WI Threatened Species: pugnose shiner (*Notropis anogenus*) and blanding's turtle (*Emydoidea blandingi*)[35]
LAKE-USE AND DEMOGRAPHIC DESCRIPTORS	
Lake access	1 public boat landing with 16 parking spaces; 1 private marina with boat landing; 1 public fishing/swimming pier; 1 community park and swim beach
Septic treatment	Municipal sewage system that discharges treated waste water to Koshkonong Creek
Potable water source	Groundwater (private wells)
Number of piers	167 piers[36]
Number of parked boats	482 boats[37]
Shoreland development	90% of residences located within ¼-mile of the lake
Property owners who are <u>not</u> full-time residents of the Lake District	~49%[38]
Lakefront property owners who are <u>not</u> full-time residents	~65%[39]
Equalized valuation of Lake Ripley Management District (2009)	$237,284,218[40]
Lake-use zoning policies	7:30 p.m.-11:00 a.m. daily no-wake period; no-wake within 200 ft. from shore; no-wake within 100' of piers, rafts and buoyed restricted areas; no-wake within buoyed areas of both bays; no motor use within Vasby's Channel
Slow-no-wake and boat-restricted areas	125 acres

[35] Wisconsin Department of Natural Resources, and Lake Ripley Management District. 1994. <u>Lake Ripley Water Resources Appraisal</u>.
[36] 2009 visual inventory performed by Lake District staff
[37] Ibid
[38] Estimated using mailing address information taken from 2008 Jefferson County tax-parcel data
[39] Ibid
[40] Wisconsin Department of Revenue, Certification of Equalized Value for 2009

2-4 DEMOGRAPHICS

Pontoon boats docked on the north shore of Lake Ripley.

Lake Ripley is both a popular recreational destination and a regional driver of economic activity. People have historically been drawn to its shores to engage in a variety of leisure activities, including fishing, swimming and boating. The high density and value of development around the lake is a testament to the lake's value and significance as one of the area's primary attractions (see Figure 11). Small, summer cottages are continuing to be converted to year-round residences around the lake as an increasingly greater share of the population shifts to full-time residency. Development and lake-use pressure is high on Lake Ripley due to its proximity to major urban centers, such as Madison (WI), Milwaukee (WI), Chicago (IL) and Rockford (IL). Population densities vary on both a weekly and seasonal basis, especially near the lake, with summer weekends attracting the greatest number of visitors.

The Lake Ripley Management District is located next to the Village of Cambridge in the northwest corner of the Town of Oakland. In 2005, the Town of Oakland (Jefferson County) supported a mostly rural population of 3,368 people and roughly 1,300 households within its 36-square-mile boundary. The Village of Cambridge (Dane County) supported a population of 1,187 people. These populations are projected to grow by about 40% over the next 25 years.[41]

Although the Lake District includes only about 7% of the total land area in the Town of Oakland, it represents 68% of the Town's total tax base.[42] This fact alone speaks to the lake's tremendous regional economic value. It also helps support the case for active stewardship, especially in light of continued development pressures and related environmental stressors that threaten the quality of this important resource. Both "improved" and "unimproved" parcels with actual lake frontage are shown in Figure 12. The number of buildings and parcels by demographic segment around the lake are presented in Table 3.[43]

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[41] MSA Professional Services, Inc. 2008. Comprehensive Growth Plan for Town of Oakland, Jefferson County, Wisconsin.
[42] Wisconsin Department of Revenue. 2007 property assessment records.
[43] Jefferson County Land Information Office. 2005 land-use records.

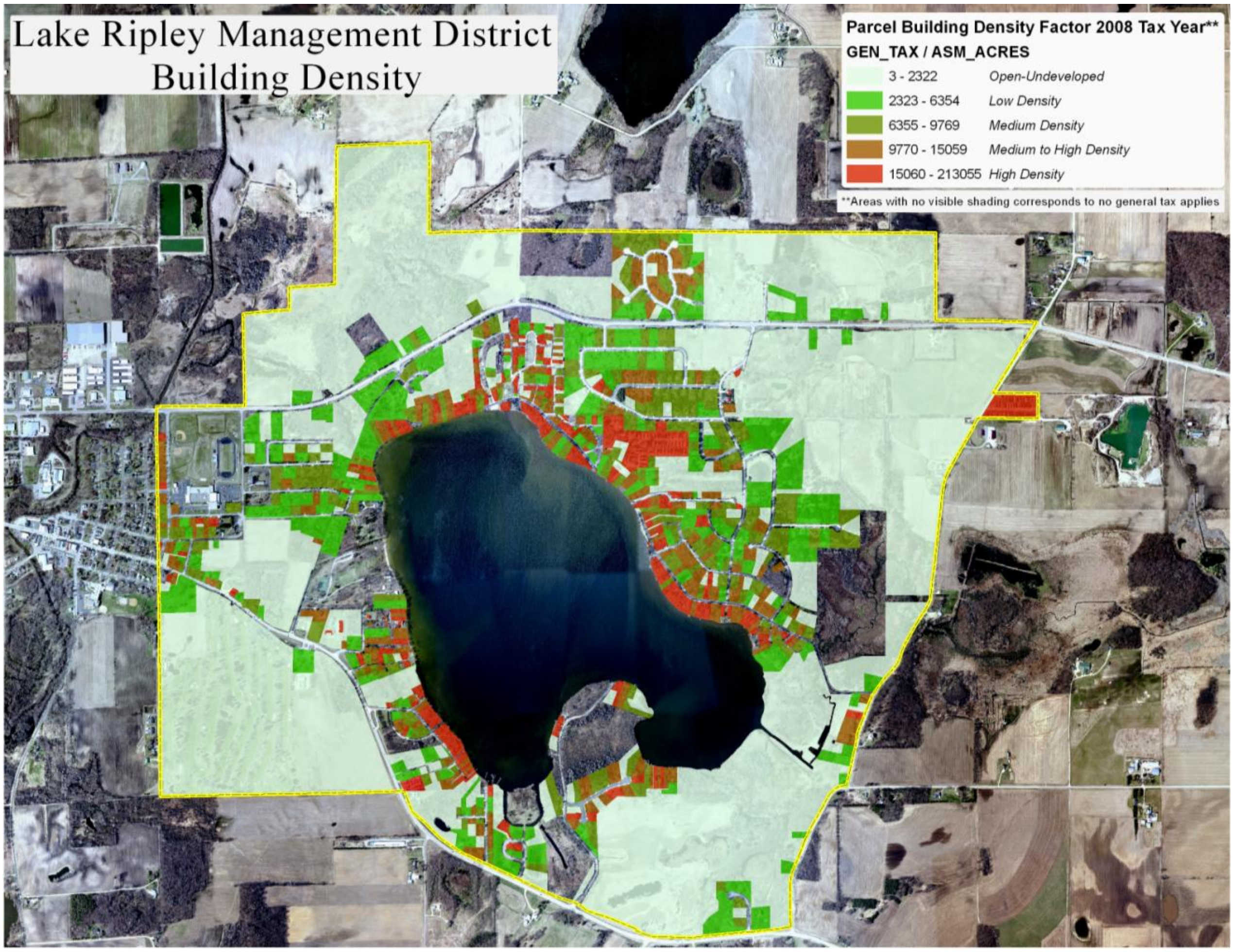

Figure 9: Parcel Building Density in Lake Ripley Management District as Defined by Property Tax-to-Acreage Ratios[44]

[44] Map produced by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department (2009)

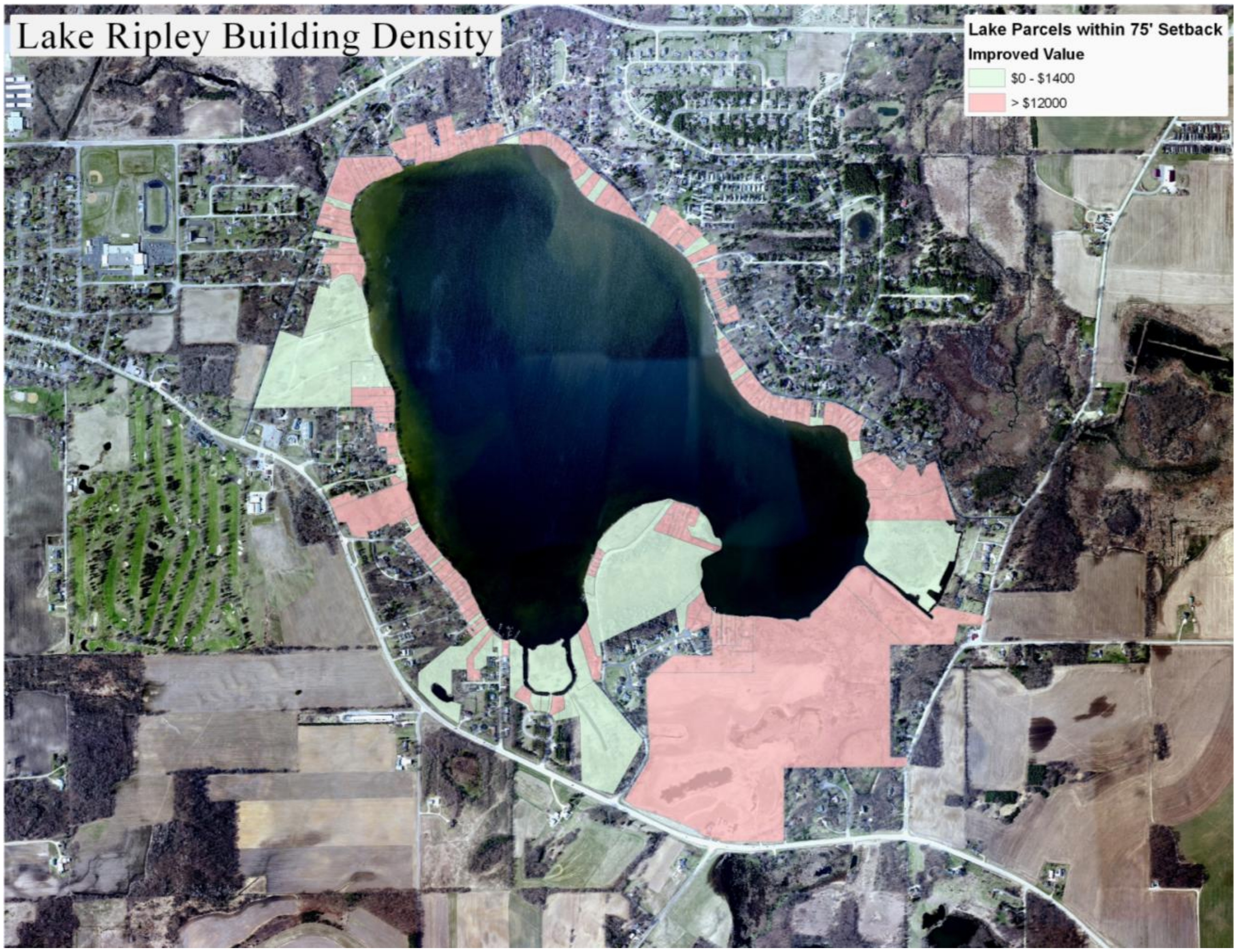

Figure 10: Improved and Unimproved Parcels within Lake Ripley's 75-ft. Building Setback[45]

[45] Map produced by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department (2009)

Table 3: Buildings, parcels and property owners around Lake Ripley[46]

Demographic segment	Address points[f]	Parcels	Part-time residency[g]
Lakefront[a]	160	211	65%
Lake District[b]	942	1,269	49%
Watershed[c]	845	1,253	58%
Lake District + Watershed[d]	1,023	1,470	
½-mile of lake[e]	872	1,203	
Town of Oakland	1,401	2,240	

[a] = parcels containing land within 75-ft. buffer of lake edge
[b] = parcels within Lake District taxing district
[c] = parcels touching or within Lake Ripley watershed boundaries
[d] = parcels within Lake District boundary plus those containing land within Lake Ripley watershed boundaries
[e] = parcels touching or within half-mile buffer of lake edge
[f] = homes and buildings with associated fire numbers
[g] = estimated based on primary mailing address information listed in 2009 tax-parcel records

A 2007 property owner survey revealed an average respondent age of 57 years old, which was based on a 23% response rate. The survey also suggested an average household size of 2.8 individuals. Most respondents indicated living within one-quarter mile of the lake, with 37% owning lakefront property. Full-time residents accounted for 57% of respondents, while the remaining 43% were seasonal/part-time residents. According to the survey, part-time residency tended to increase as property ownership moved closer to the lake. Slightly more than half of those living off the lake claimed to have deeded lake-access rights. Length of property ownership varied widely, although a majority (58%) owned their property for over a decade.[47]

2-5 WATERSHED DRAINAGE PATTERNS

Lake Ripley lies at the terminus of a 7.3-square-mile watershed that drains predominantly agricultural land (see Figure 13). As a drainage lake, it is primarily fed by stream flow, as well as groundwater, precipitation and direct surface runoff. The lake has an outlet that discharges to Koshkonong Creek, which is a tributary of the Rock River. Compared to other lake types, drainage lakes are more affected by surface runoff problems, generally have shorter residence times, and often require more intensive watershed protection to manage water quality.

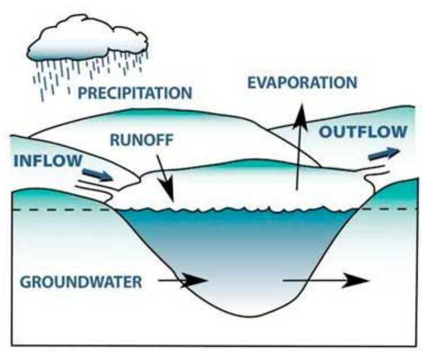

Illustration showing the movement of water through a drainage lake. Source: Wisconsin Lakes Partnership

[46] 2009 Jefferson County tax-parcel records
[47] Lake Ripley Management District. 2007. Lake Ripley Property Owner Opinion Survey.

Because Lake Ripley reflects the condition of the surrounding landscape from which it derives surface water, it can be viewed as largely a product of its watershed. Watershed-to-lake surface area ratios are used to estimate the level of influence the surrounding landscape has on water quality. Lake Ripley has a watershed-to-lake surface area ratio of 11:1. Lakes with ratios greater than 10:1 more often experience water quality problems when compared to lakes with smaller ratios. This is especially true in developed watersheds that are dominated by fertile, erodible soils. As watershed area increases in relation to the size of the lake, the greater the potential volume of pollutants entering the lake in the form of surface runoff. This runoff is generated from snowmelt, precipitation and groundwater discharge that does not evaporate or infiltrate into the soil. The actual amount of pollutants, sediment and other material delivered to the lake depends on watershed size, soil types, topography, type of land cover and other factors.

Both surface water and regional groundwater generally flow from east to west toward the lake. Figure 14 shows individual subwatersheds and generalized flow paths for surface drainage. Although Lake Ripley is part of the more extensive Lower Rock River and Upper Mississippi Drainage Basins, it is not directly influenced by hydrologic connectivity to other upstream surface waters. However, it is linked to other surface waters from an outlet perspective (via Koshkonong Creek and the Rock River), which may allow fish and other free-swimming aquatic organisms to migrate back and forth between water bodies. Koshkonong Creek is classified as a warm water sport fishery dominated by rough fish. It was returned to a free-flowing stream following the removal of the Rockdale dam in 2001.[48]

[48] Jefferson County Land and Water Conservation Department. 2005. Jefferson County Land and Water Resources Management Plan: 2006-2010.

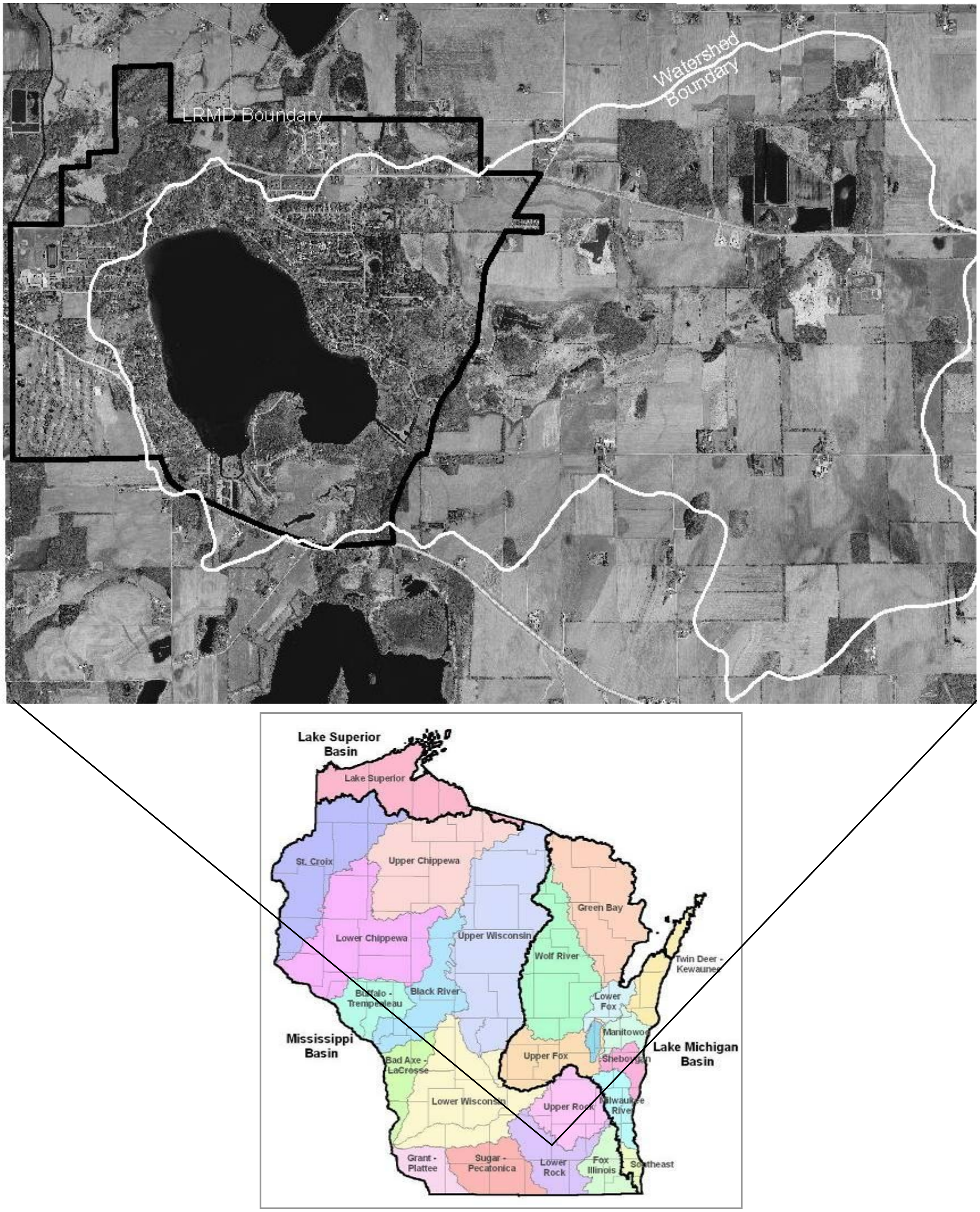

Figure 11: 2005 Aerial Photograph of Lake Ripley Watershed Shown in Context of Regional Drainage Basins

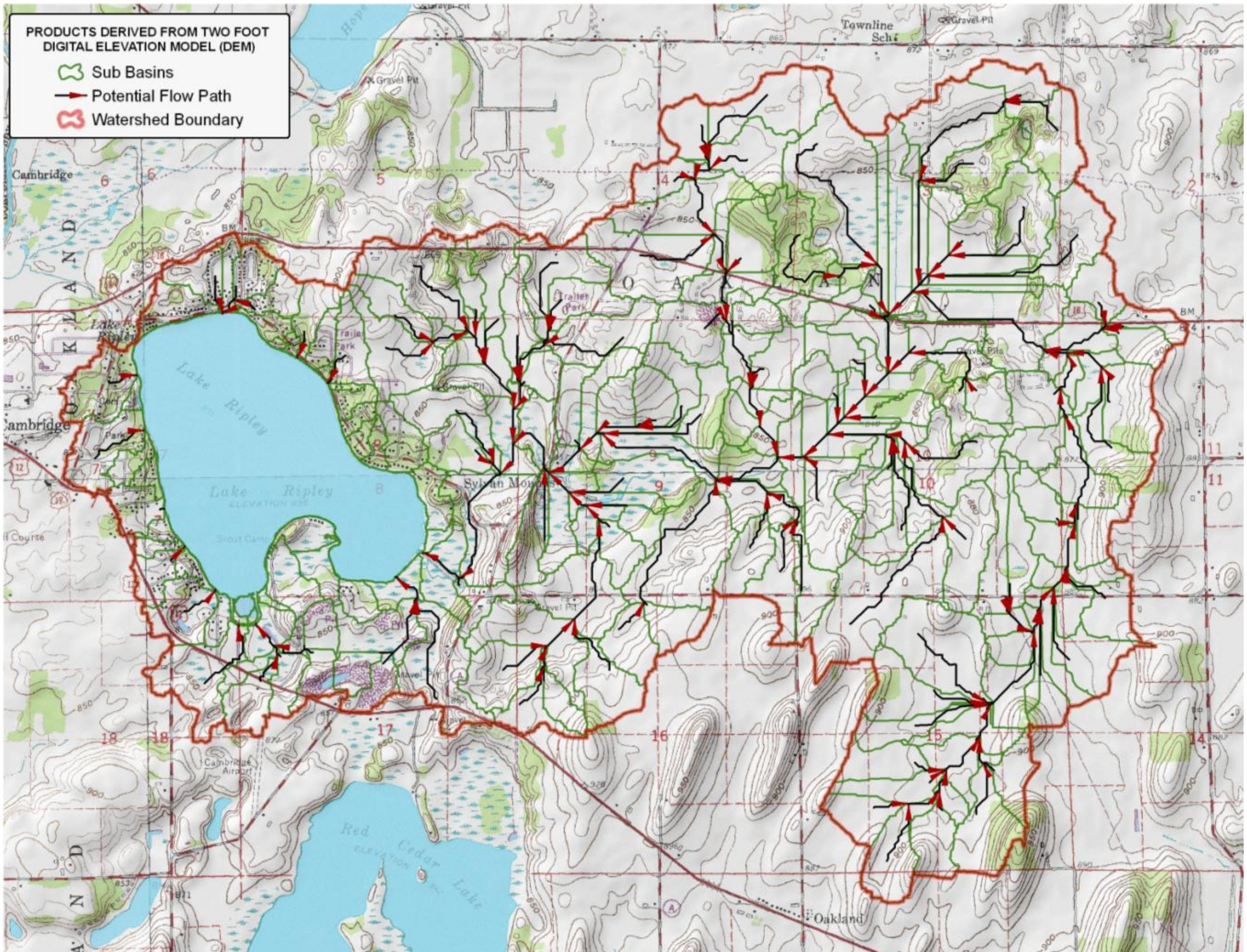

Figure 12: Lake Ripley Subwatersheds and Overland Flow Paths[49]

2-6 WATERSHED GEOLOGY AND SOILS

Glacial features largely control the topography and hydrology in the Lake Ripley Watershed. Lake Ripley itself is situated in a kettle depression formed by the retreating glaciers about 12,000 years ago.[50] The lake is part of an extensive outwash plain that stretches from south of Lake Ripley to Lake Mills. This area incorporates all the features associated with a stream-built, or melt-water terrace. Water that was apparently trapped by the kettle moraine to the east and the terminal moraine to the south formed large areas of shallow lakes that have long since drained away. As a result, there are extensive areas around Lake Ripley that are low in elevation and nearly flat in topography. Consequently, wetlands are common throughout the region. A network of drainage ditches and tile systems have historically been used to convert wetlands into cropland.

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[49] Map produced by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department (2009), and based on Jefferson County LIDAR Project using 2005-derived Digital Elevation Model

[50] Wisconsin Department of Natural Resources. 2002. The State of the Rock River Basin. PUBL #WT-668-2002.

The watershed predominantly consists of the Fox and St. Charles Silt Loam soil types on 2-6% slopes, which accounts for 31% (2,013 acres) of the watershed. Houghton Muck (9.5%, 615 acres) and Casco Loam on 6-12% slopes (9%, 585 acres) are also well represented. Table 4 lists the different soil types found within the Lake Ripley watershed.

Table 4: Type and aerial extent of soils found within the Lake Ripley watershed

Soil Type	Acres	% of Total
Fox silt loam, 2 to 6 percent slopes	1085.07	16.75%
St. Charles silt loam, moderately well-drained, gravelly substratum, 2 to 6 percent slopes	928.16	14.33%
Houghton muck	615.11	9.49%
Casco loam, 6 to 12 percent slopes, eroded	584.61	9.02%
Wauconda silt loam, 0 to 2 percent slopes	319.59	4.93%
Casco-Rodman complex, 12 to 20 percent slopes, eroded	298.86	4.61%
Fox loam, 6 to 12 percent slopes, eroded	278.88	4.30%
Matherton silt loam, 0 to 3 percent slopes	274.73	4.24%
Wacousta silty clay loam	266.98	4.12%
Boyer sandy loam, 1 to 6 percent slopes	196.20	3.03%
Fox silt loam, 0 to 2 percent slopes	189.37	2.92%
Kidder loam, 6 to 12 percent slopes, eroded	146.81	2.27%
McHenry silt loam, 6 to 12 percent slopes, eroded	142.13	2.19%
St. Charles silt loam, moderately well-drained, 0 to 2 percent slopes	106.78	1.65%
Dodge silt loam, 2 to 6 percent slopes	96.06	1.48%
Moundville loamy sand, 1 to 6 percent slopes	93.39	1.44%
Virgil silt loam, gravelly substratum, 0 to 3 percent slopes	91.39	1.41%
Rotamer loam, 12 to 20 percent slopes, eroded	88.80	1.37%
McHenry silt loam, 2 to 6 percent slopes	78.78	1.22%
Grays silt loam, 2 to 6 percent slopes	63.04	0.97%
Lamartine silt loam, 2 to 6 percent slopes	49.25	0.76%
Watseka variant loamy sand, 0 to 3 percent slopes	47.41	0.73%
Pits, gravel	40.96	0.63%
Wasepi sandy loam, 0 to 3 percent slopes	35.88	0.55%
Palms muck	35.06	0.54%
Adrian muck	34.94	0.54%
Radford silt loam, 0 to 3 percent slopes	33.56	0.52%
St. Charles silt loam, moderately well-drained, 2 to 6 percent slopes	31.72	0.49%
Kidder loam, 2 to 6 percent slopes	30.97	0.48%
Kidder loam, 12 to 20 percent slopes, eroded	29.93	0.46%
Sebewa silt loam	26.37	0.41%
Whalan variant silt loam, 0 to 3 percent slopes	19.44	0.30%
Juneau silt loam, 1 to 6 percent slopes	17.42	0.27%
Casco-Rodman complex, 20 to 45 percent slopes	16.49	0.25%
Casco loam, 2 to 6 percent slopes, eroded	13.95	0.22%
Udorthents	12.44	0.19%
Tuscola silt loam, 2 to 6 percent slopes	8.96	0.14%

Whalan loam, 2 to 6 percent slopes	8.39	0.13%
Rotamer loam, 20 to 30 percent slopes, eroded	8.08	0.12%
Sisson fine sandy loam, 6 to 12 percent slopes, eroded	7.17	0.11%
Kidder sandy loam, 6 to 12 percent slopes, eroded	7.09	0.11%
Kidder loam, moderately well-drained, 2 to 6 percent slopes	6.41	0.10%
Otter silt loam	5.27	0.08%
Elvers silt loam	3.89	0.06%
Wauconda silt loam, 2 to 6 percent slopes	1.94	0.03%
Gilford sandy loam	0.74	0.01%
Total Acres	**6478.47**	

The most common soil associations found in the watershed are Houghton-Adrian, and Fox-Casco-Matherton.[51] Houghton-Adrian soils are found in the depressions of old glacial lake basins and stream valleys. They are poorly drained and nearly level, and typically have a black to dark brown organic layer of about 51 inches in thickness. If adequately drained, these soils have a fair to good potential to support corn and specialty crops. Wetness is a severe limitation, making these soils often unsuitable for residential or similar development.

Fox-Casco-Matherton soils are found on outwash plains and terraces, and tend to be well drained and gently sloping to very steep. The surface layer is typically dark, grayish brown silt loam about 10 inches in thickness. These soils have fair to good potential to support commonly grown farm crops. In addition, they have fair to good potential for residential and other urban uses. As a result of the permeability of the underlying sand and gravel, pollution of groundwater is a hazard if the soils are used for waste disposal.

A detailed soils map of the Lake Ripley watershed is shown as Figure 15, with an accompanying soils legend included on the following page.

[51] U.S. Department of Agriculture. 1979. Soil Survey of Jefferson County.

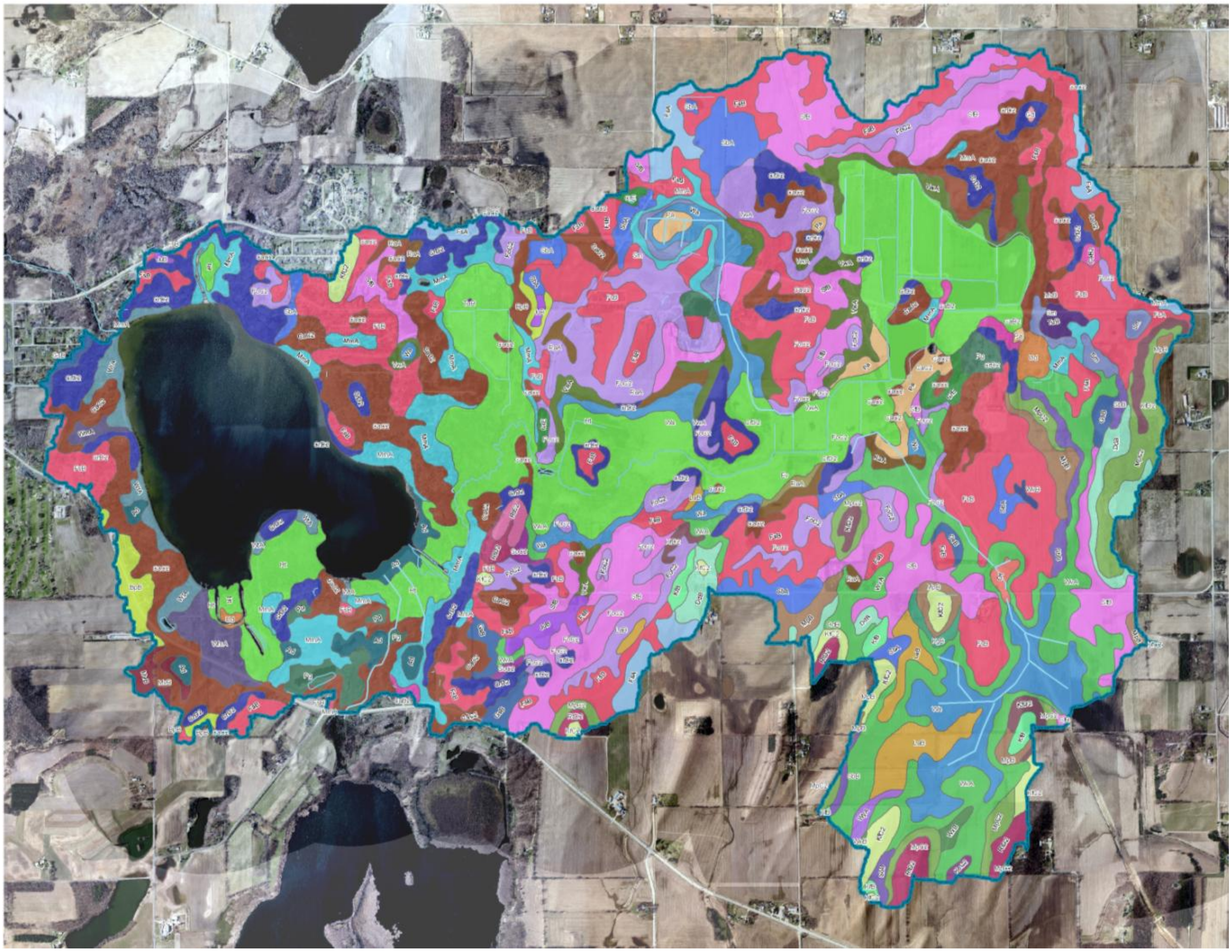

Figure 13: Lake Ripley Watershed Soils Map[52] (Note: Map legend shown on next page)

[52] Map produced by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department (2009), and based on U.S. Department of Agriculture Soil Survey

Soils

Abbr,	Name
Ad,	Adrian muck
BpB,	Boyer sandy loam, 1 to 6 percent slopes
CaB2,	Casco loam, 2 to 6 percent slopes, eroded
CaC2,	Casco loam, 6 to 12 percent slopes, eroded
CrD2,	Casco-Rodman complex, 12 to 20 percent slopes, eroded
CrE,	Casco-Rodman complex, 20 to 45 percent slopes
DdB,	Dodge silt loam, 2 to 6 percent slopes
Ev,	Elvers silt loam
FoC2,	Fox loam, 6 to 12 percent slopes, eroded
FsA,	Fox silt loam, 0 to 2 percent slopes
FsB,	Fox silt loam, 2 to 6 percent slopes
Gd,	Gilford sandy loam
GsB,	Grays silt loam, 2 to 6 percent slopes
Ht,	Houghton muck
JuB,	Juneau silt loam, 1 to 6 percent slopes
KeC2,	Kidder sandy loam, 6 to 12 percent slopes, eroded
KfB,	Kidder loam, 2 to 6 percent slopes
KfC2,	Kidder loam, 6 to 12 percent slopes, eroded
KfD2,	Kidder loam, 12 to 20 percent slopes, eroded
KgB,	Kidder loam, moderately well-drained, 2 to 6 percent slopes
LaB,	Lamartine silt loam, 2 to 6 percent slopes
MmA,	Matherton silt loam, 0 to 3 percent slopes
MpB,	McHenry silt loam, 2 to 6 percent slopes
MpC2,	McHenry silt loam, 6 to 12 percent slopes, eroded
MvB,	Moundville loamy sand, 1 to 6 percent slopes
Ot,	Otter silt loam
Pa,	Palms muck
Pg,	Pits, gravel
RaA,	Radford silt loam, 0 to 3 percent slopes
RtD2,	Rotamer loam, 12 to 20 percent slopes, eroded
RtE2,	Rotamer loam, 20 to 30 percent slopes, eroded
SbA,	St. Charles silt loam, moderately well-drained, 0 to 2 percent slopes
SbB,	St. Charles silt loam, moderately well-drained, 2 to 6 percent slopes
SfB,	St. Charles silt loam, moderately well-drained, gravelly substratum, 2 to 6 percent slopes
Sm,	Sebewa silt loam
SoC2,	Sisson fine sandy loam, 6 to 12 percent slopes, eroded
TuB,	Tuscola silt loam, 2 to 6 percent slopes
Ud,	Udorthents
VwA,	Virgil silt loam, gravelly substratum, 0 to 3 percent slopes
Wa,	Wacousta silty clay loam
WmA,	Wasepi sandy loam, 0 to 3 percent slopes
WtA,	Watseka variant loamy sand, 0 to 3 percent slopes
WvA,	Wauconda silt loam, 0 to 2 percent slopes
WvB,	Wauconda silt loam, 2 to 6 percent slopes
WxB,	Whalan loam, 2 to 6 percent slopes
WyA,	Whalan variant silt loam, 0 to 3 percent slopes

2-7 WATERSHED LAND USE

CURRENT LAND-USE REPRESENTATION

Agriculture represents the watershed's dominant land use, with heavy residential development mostly confined to within about a half-mile radius of the lake's periphery (see Figure 16). Land-use cover in the watershed currently consists of 48.42% (2,270 acres) cropland, 12.63% (592 acres) urban/residential, 11.58% (543 acres) wetland, 9.47% (444 acres) surface water, 6.32% (296 acres) upland woods, 4.21% (197 acres) streets, 4.21% (197 acres) rural uncultivated land, and 3.16% (148 acres) gravel pits.

PRE- TO POST-SETTLEMENT LANDSCAPE CHANGES

Prior to European settlement, lands draining to the lake were predominantly oak savanna that supported extensive wetlands. Wetlands and other natural areas in the watershed are considered critical for providing flood attenuation, pollutant filtration, wildlife habitat, and even spawning and nursery areas for certain types of fish like northern pike. The native prairies, for example, were rich in plant diversity with deep-penetrating root systems that greatly enhanced the porosity of the soil and its ability to infiltrate rainfall (see Figure 17). While there is no empirical data on pre-settlement infiltration rates in the Lake Ripley watershed, research has demonstrated that such rates are considerably higher in forests and meadows as compared to farmlands.[53] As infiltration rates decrease, groundwater recharge also decreases and surface runoff increases.

Since European settlement, agricultural and residential development have eliminated most of the area's woodlands and prairies, as well as about two-thirds of the original 1,500 acres of wetlands, mostly through ditching, land filling and drain tiling. Wetlands that still remain continue to be threatened by polluted runoff, sedimentation, groundwater depletion, and the spread of invasive species (i.e., buckthorn, reed canary grass, purple loosestrife, and narrow-leaf and hybrid cattails). In addition, the length of the lake's inlet tributary stream has been artificially extended as a result of ditching and channelization. Over the last century, the inlet has increased from 2.5 miles[54] to 4.25 miles in length.

Increased stream length and use of drain tiling have resulted in greater surface water runoff, sediment delivery and nutrient transport to Lake Ripley and area wetlands. In fact, farm drainage ditches that connect to Lake Ripley's inlet were all found to be eroding in the mid-1990s, contributing an estimated 2,654 tons or 75% of the total sediment load to the lake.[55] Most

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[53] U.S. Soil Conservation Service. 1972. National Engineering Handbook, Section 4: Hydrology. Washington: U.S. Department of Agriculture, Soil Conservation Service.
Knox, J.C. 1977. Human impacts on Wisconsin stream channels. *Annals of the Association of American Geographers* 67(3):323-342.
Knox, J.C. and J. Hudson. 1995. Physical and cultural change in the Driftless Area of southwest Wisconsin. In *Geographical Excursions in the Chicago Region*, ed. M.P. Conzen, pp. 107-131. Chicago: Association of American Geographers.

[54] 1907 U.S. Geological Survey topographic map

[55] Wisconsin Department of Natural Resources, Wisconsin Department of Agriculture, Trade and Consumer Protection, Lake Ripley Management District, and Jefferson County Land Conservation

of these inventoried ditches were subsequently either repaired (i.e., Long Sod Farms north of USH 18) or plugged (i.e., two ditches at the Lake District Preserve) using Priority Lake Project grants and other funding mechanisms. The stream segment lying between the lake and the mid-point of the Preserve is considered mainly a sediment-depositional area.

The management of some ditches and drainage routes within the watershed are governed by drainage districts. The locations of these special districts were determined using engineering maps supplied to Jefferson County and the Farm Drainage Commission (Figure 18). Two of the three districts located southeast of the lake are now in residential or otherwise non-agricultural land use. The other district is located approximately two miles east of the lake and is greater than 90% underground drain tile that outlets into a well-maintained drainage ditch. None of the three drainage districts were found to be contributing sediment to Lake Ripley.[56]

IMPACTS OF DEVELOPMENT AND LAND-USE CHANGE

Development and associated hard surfaces have also decreased the soil's capacity to infiltrate rainfall and recharge the groundwater aquifer. Much of the water that once filtered through the soil and replenished the groundwater supply now runs off of farm fields, transporting sediment and algae-producing phosphorus into drainage ditches, wetlands and Lake Ripley. This increased volume of surface drainage has also created a more incised and unstable inlet channel, diminishing the functionality of adjacent wetlands as natural water quality buffers.

Agricultural runoff is estimated to contribute the greatest volume of phosphorus (in total) to Lake Ripley. It is estimated that nearly 76% of phosphorus loading originates from agricultural land uses, and mostly from row-cropped areas.[57] However, the lake is also heavily impacted by residential development around its periphery. These urbanized areas are estimated to contribute 17% of the total phosphorus loads to the lake.[58] Since the watershed is of modest size and fairly flat, the urbanized shorelands right next to the lake are likely to exert a relatively significant influence on lake condition. In fact, the rate and amount of runoff can increase by a factor of ten under typical lakeshore-development scenarios. Research has demonstrated that once watershed development reaches a 10-12% impervious-cover threshold, waterways often experience declines in certain fish species, among other problems.[59] Impervious cover in the Lake Ripley watershed is currently estimated to be 11% (see Table 5).

Studies also show that largemouth bass nesting success declines and green frogs begin to disappear along shorelines with housing densities greater than 30 homes per mile.[60] Lake Ripley

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Department. 1998. Nonpoint Source Control Plan for the Lake Ripley Priority Lake Project. Wisconsin Nonpoint Source Water Pollution Abatement Program. Publication WT-512-98.

[56] Ibid

[57] 2009 analysis using Wisconsin Lake Modeling Suite (WiLMS), Version 3.3.18.1

[58] 2009 phosphorus-loading analysis using Wisconsin Lake Modeling Suite (WiLMS), Verison 3.3.18.1

[59] Wang, L., J. Lyons, P. Kanehl, and R. Bannerman. 2001. Impacts of Urbanization on Stream Habitat and Fish Across Multiple Spatial Scales. Springer Series in Environmental Management, Vol. 28, No. 2, pp. 255-266.

[60] Meyer, M., J. Woodford, S. Gillum, and T. Daulton. 1997. Shoreland zoning regulations do not adequately protect wildlife habitat in northern Wisconsin. U.S. Fish and Wildlife Service, State Partnership Grant P-1-W, Segment 17, Final Report, Madison, Wisconsin.

has already surpassed this particular threshold, with a current lakeshore building density of about 39 lakefront homes per mile (160 lakeshore address points divided by 4.1 shoreline miles). As housing density increases, the number of littoral treefalls per mile decreases, as does the abundance of emergent and floating-leaved aquatic plants due to typical shoreline-grooming practices. According to the Wisconsin Department of Natural Resources, nearly 80% of Wisconsin's threatened and endangered plant and animal species spend all or part of their life in the lake's littoral and shoreland zones.[61] Therefore, development-related habitat alterations and other near-shore disturbances threaten to cause local extinctions of such sensitive biota. Preserving natural shoreline vegetation or restoring native, vegetative "buffers" can help minimize these impacts (see Figure 19).

WATERSHED AREAS CRITICAL TO LAKE HEALTH

A map showing the location of areas critical to watershed health is shown as Figure 20. Areas classified as "critical" include wetlands, lands supporting hydric soils (indicative of wetland-supporting conditions), 100-year floodplains, perennially flowing streams and ditches, 10 acres or more of contiguous forest (important for groundwater recharge and woodland habitat), and 12% or greater slopes (lands most susceptible to erosion). These areas represent a combined 1,519 acres (32% of the watershed), of which 254 acres are identified as being publicly owned (161 acres), deed restricted (47 acres), or institutionally managed for conservation purposes (46 acres).[62] Of the remaining "critical area" acreage, land-use threats are generally greatest to the north and east of the Lake District Preserve, and around the East Bay wetland complex. Protecting or restoring the condition of critical areas is important for absorbing and filtering storm runoff, preserving groundwater recharge, controlling soil erosion, providing fish and wildlife habitat, and maintaining downstream water quality.

OTHER AREAS OF INTEREST

Farmland parcels in the watershed that are currently enrolled in soil and water conservation programs are shown on a map in Figure 21. Highlighted parcels include those that were enrolled in the Farmland Preservation and Conservation Reserve Programs in 2008, and those that have nutrient management plans on file in Jefferson County. These types of government programs offer various incentives to participating landowners who implement specific conservation-farming practices. The map also marks the locations of significant livestock and commercial operations within the watershed. Livestock operations were identified through a 2009 roadside survey conducted by the Jefferson County Land and Water Conservation Department, and should be monitored given their potential of generating water quality challenges (e.g. manure runoff) if not properly managed. At least one livestock operation that was not mapped ("beef 25-50 animals") is located between the Oakland Town Hall, a partially reclaimed gravel pit, and the Lake District Preserve.

Woodford, J. E., and M. W. Meyer. 2003. Impact of Lakeshore Development on Green Frog Abundance. Biological Conservaton 110: 277-284.

[61] Wisconsin Department of Natural Resources. 1996. Northern Wisconsin's Lakes and Shorelands: A report examining a resource under pressure.

[62] Figures derived by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land and Water Conservation Department (2009)

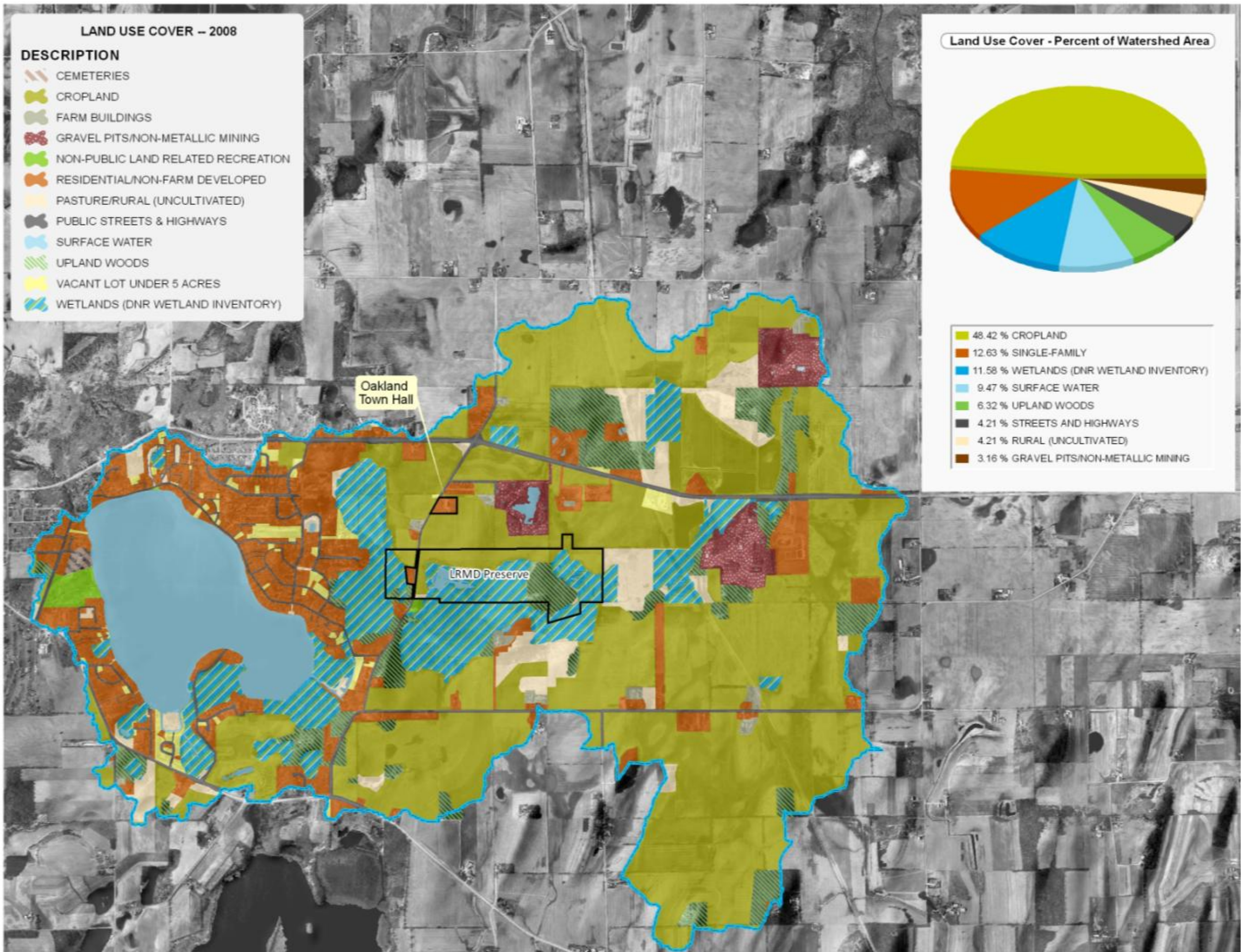

Figure 14: Lake Ripley Watershed Land-Use Cover[63]

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[63] Map produced by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department using Jefferson County 2008 Land-Use Inventory data

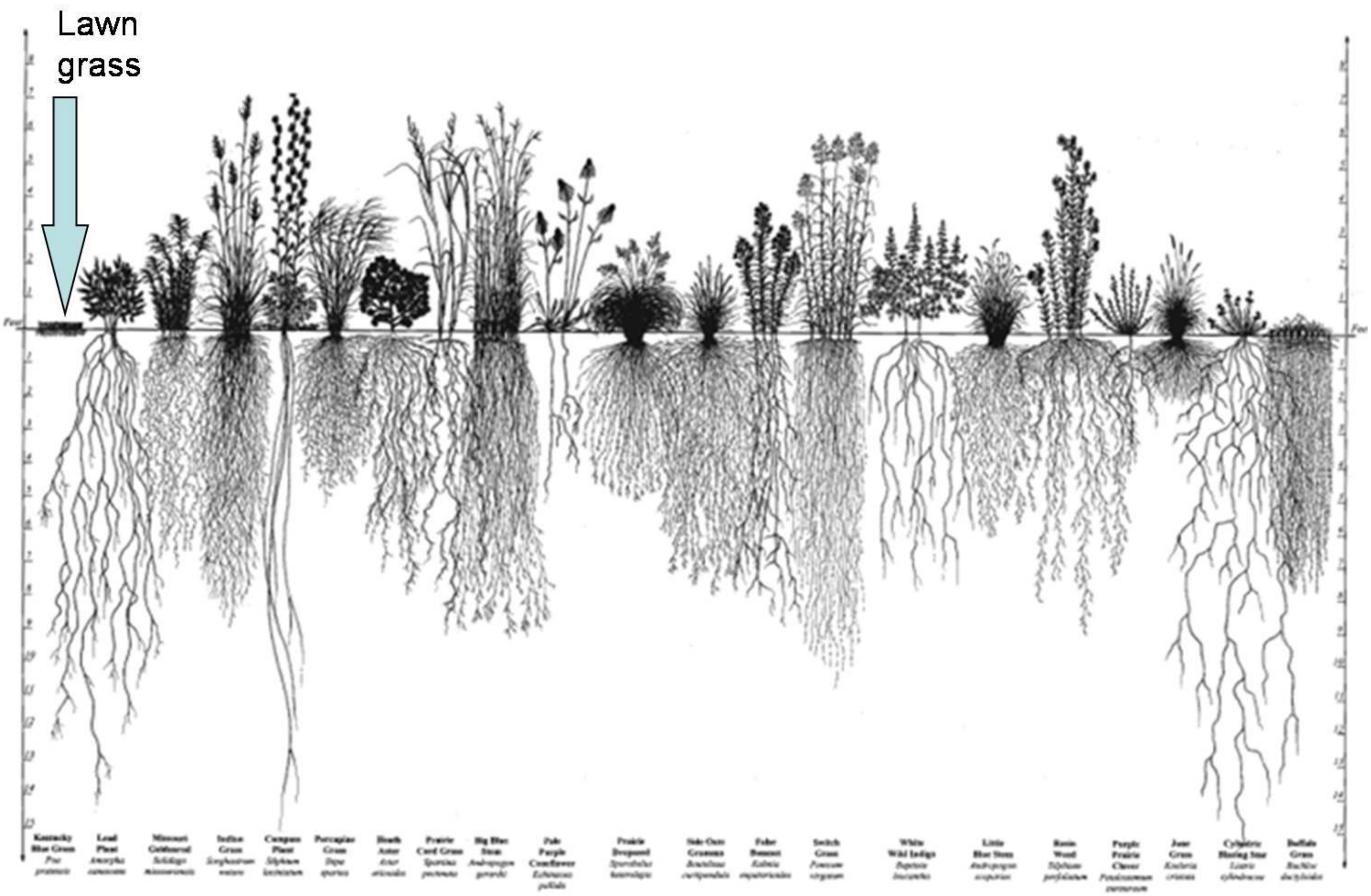

Figure 15: Rooting Depths of Native Prairie Plants Compared to Turf Grass[64]

[64] Illustration from U.S. Department of Agriculture’s Natural Resource Conservation Service

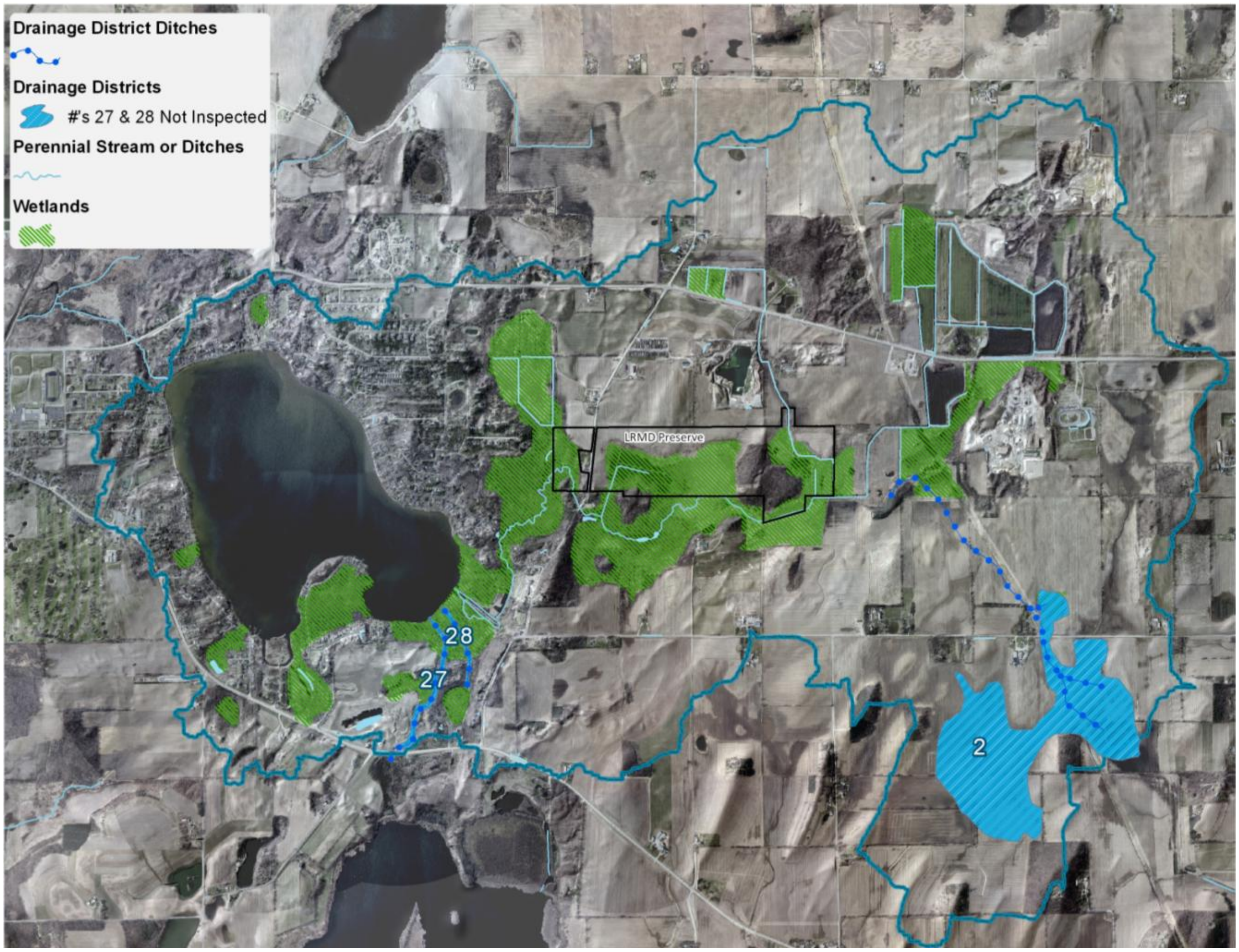

Figure 16: Farm Drainage Districts in Relation to Watershed Wetlands, Streams and Ditches[65]

[65] Map produced by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department (2009), and based on engineering maps on file with Jefferson County and the Farm Drainage Commission

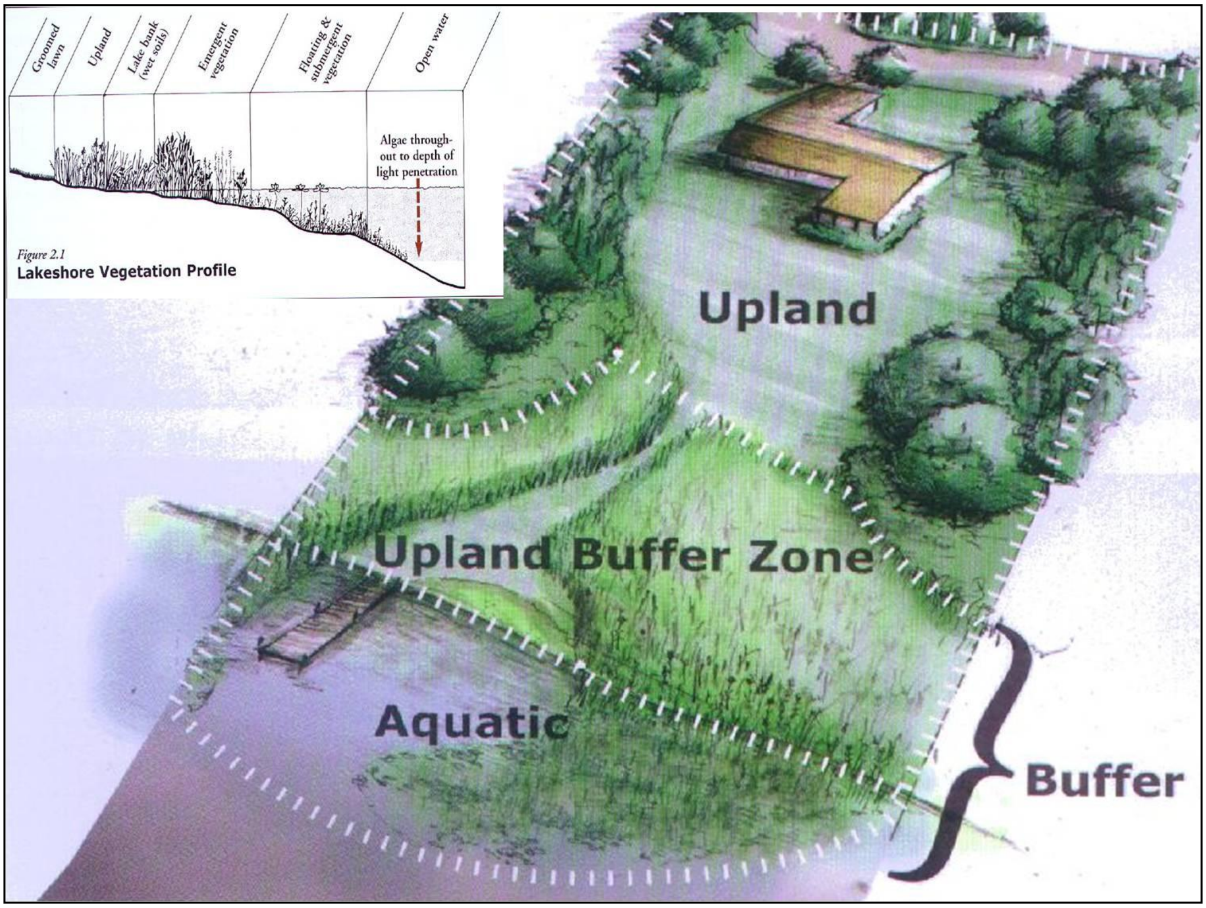

Figure 17: Illustration of Lakeshore Buffer[66]

[66] Illustration credit: Roxanna Esparza and Steve Adams

Table 5: Estimated impervious cover by land-use type in the Lake Ripley watershed[67]

LAND USE DESCRIPTION	ACRES	% LAND AREA	IMPERVIOUS COVER COEFFICIENT[a]	TOTAL IMPERVIOUS COVER (ACRES)	TOTAL IMPERVIOUS COVER (%)[b]
CROPLAND	2163.12	46.14	9.25	200.09	38.85
PUBLIC STREETS AND HIGHWAYS	179.67	3.83	53.40	95.94	18.63
RURAL RESIDENTIAL (>2.5 ACRES)	373.82	7.97	10.60	39.62	7.69
LOW-DENSITY RESIDENTIAL (0.5-0.99 ACRES)	168.77	3.60	21.20	35.78	6.95
QUARRY/GRAVEL MINE	144.05	3.07	21.20	30.54	5.93
MEDIUM-DENSITY RESIDENTIAL (0.26-0.49 ACRES)	105.74	2.26	27.80	29.40	5.71
SUBURBAN RESIDENTIAL (1-2.49 ACRES)	154.31	3.29	14.30	22.07	4.28
HIGH-DENSITY RESIDENTIAL (0.14-0.25 ACRES)	53.49	1.14	30.00	16.05	3.12
WETLANDS (DNR WETLAND INVENTORY)	523.73	11.17	1.90	9.95	1.93
URBAN RESIDENTIAL (0.07-0.139 ACRES)	25.98	0.55	32.60	8.47	1.64
RESIDENTIAL BUSINESS	32.36	0.69	21.20	6.86	1.33
COMMUNICATION AND UTILITIES	8.07	0.17	72.20	5.83	1.13
UPLAND WOODS	286.50	6.11	1.90	5.44	1.06
NON-PUBLIC GOLF COURSES, GUN CLUBS	24.16	0.52	12.50	3.02	0.59
LIMITED BUSINESS	4.46	0.10	44.40	1.98	0.38
MUNICIPAL FACILITIES	4.70	0.10	35.40	1.67	0.32
MULTIFAMILY LOW RISE (1-3 STORIES)	7.24	0.15	21.20	1.54	0.30
CEMETERIES	7.29	0.16	8.30	0.60	0.12
LIMITED COMMERCIAL	0.31	0.01	44.40	0.14	0.03
MULTIFAMILY LOW RISE (1-3 STORIES)	0.11	0.00	44.40	0.05	0.01
SURFACE WATER	420.10	8.96	0.00	0.00	0.00
TOTALS:	**4687.99**	**100%**	**---**	**515.03**	**100%**

Total estimated percent impervious cover in watershed: **11%**

[a] = factor by which a specific land-use acreage is multiplied to arrive at an estimated acres of impervious cover (higher values suggest greater amounts of impervious cover per unit of area)
[b] = percentage of total watershed impervious cover represented by the specific land-use category

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[67] Information generated by Jefferson County Land & Water Conservation Department using 2008 land-use data and the Monroe County of Indiana methodology for Impervious Cover Coefficient distinction

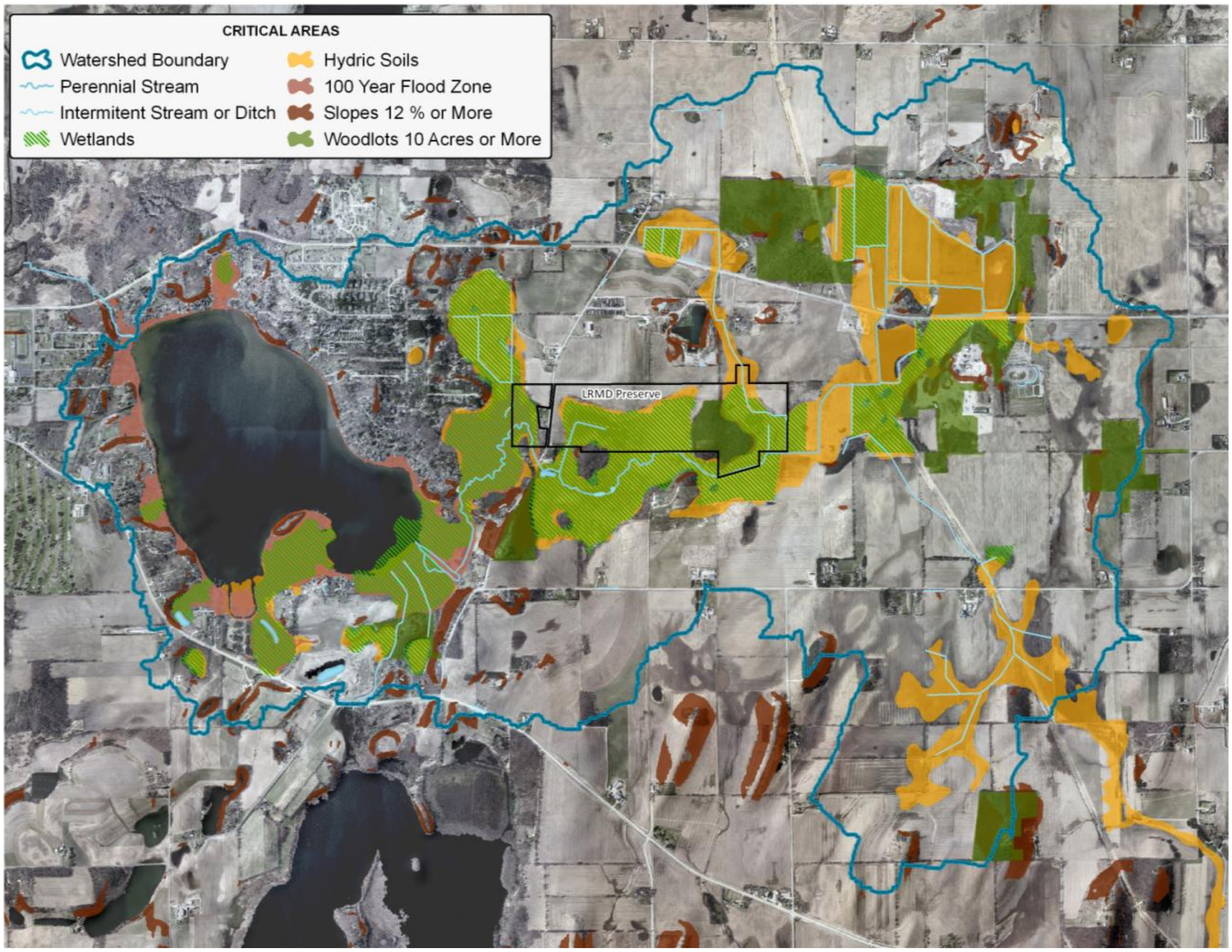


Figure 18: Lake Ripley Watershed Critical Areas[68]

[68] Map prepared by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department (2009)

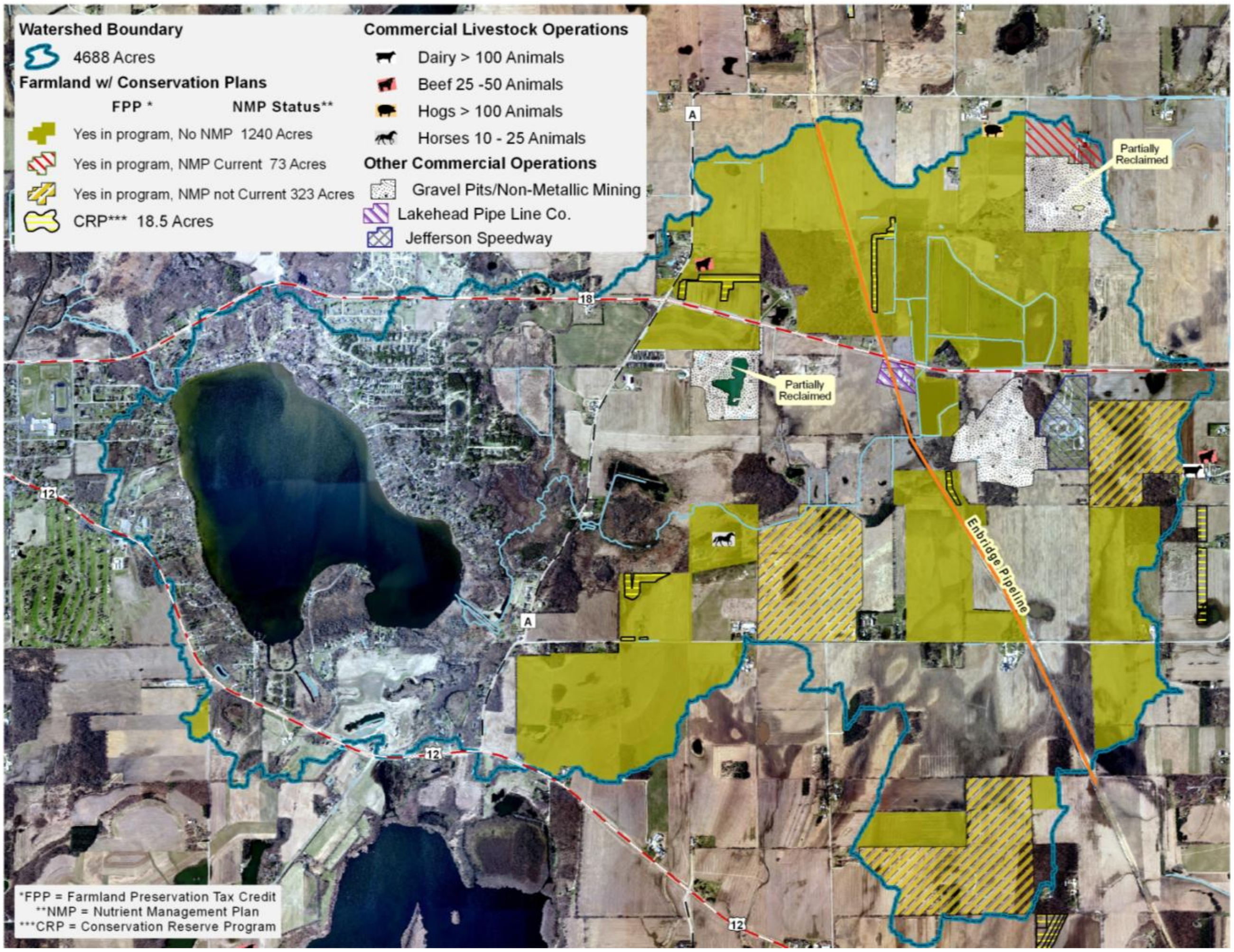


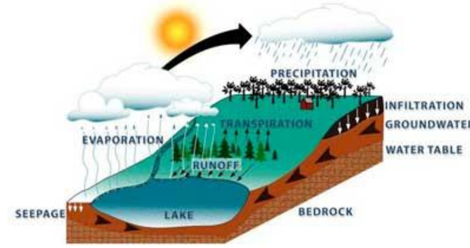
Figure 19: Livestock and Commercial Operations, and Farmland Enrolled in Soil and Water Conservation Programs[69]

2-8 GROUNDWATER

ROLE OF GROUNDWATER

Groundwater and surface water are interconnected and should not be viewed in isolation. Lake Ripley's groundwatershed, while not precisely delineated, is another factor influencing its status. A groundwatershed is an underground drainage area. Just as surface water flows over the surface of the land in response to gravity, groundwater flows much more slowly through permeable soils and fractures in bedrock in response to gravity.

[69] Map produced by Gerry Kokkonen, GIS/Land-Use Specialist, Jefferson County Land & Water Conservation Department (2009)



Source: Wisconsin Lakes Partnership

It is estimated that groundwater supplies as much as 30% of the lake's water, contributing significantly to the lake's hydrologic budget.[70] Much of this groundwater is believed to originate from permeable, upland recharge areas—mostly comprised of glacial till—found within or in close proximity to the topographic watershed boundaries. Groundwater generally flows east to west, and from higher to lower elevations in the Lake Ripley watershed area. Groundwater helps maintain steady water volumes in the lake's tributary stream (called baseflow), as well as lake levels during periods of severe drought. It is also a stable source of cool, clean, calcium-rich water that replenishes water lost through evaporation or outflowing stream discharge.

FACTORS INFLUENCING GROUNDWATER QUANTITY

Because there is a relatively short groundwater flow path to the lake, yearly weather changes can have a sizable impact on the hydrologic system. Wet years will lead to an elevated groundwater table and increased groundwater flows, as well as increased surface runoff under saturated soil conditions. Drought years will have the opposite effect. Multiple, consecutive years of abnormally wet or dry weather can have a sizable impact on the quantity of groundwater reaching the lake and area wetlands.

Groundwater withdrawal is another controlling factor. The amount of groundwater entering the lake can be reduced from well pumping and hard-surface development that prevents or restricts groundwater recharge. The rate of water use can be approximated (but underestimated) by evaluating effluent discharge volumes from the local wastewater treatment facility. In 2005, the Town of Oakland Sanitary District reported a total of 83,340,258 gallons (or 255.6 acre-feet) of effluent discharge.[71] This translates into a volume of water equal to almost 10% of the lake's total annual hydraulic loading.[72] Much of this water is estimated to originate from the Lake Ripley groundwatershed, and represents a debit on the lake's water budget as it gets used and discharged outside of the basin.

Finally, groundwater quantity is affected by landscape condition. While some types of land cover have porous soils and a high capacity to infiltrate water, others act as barriers that impede or prevent infiltration. Undeveloped natural areas such as woodlands and prairies possess a tremendous capacity, on a per unit area basis, to intercept and infiltrate rainfall. These landscapes produce limited surface runoff while facilitating the recharge of the local groundwater aquifer. The reverse is true with the proliferation of hard, water-impervious surfaces as a consequence of development and urban sprawl.

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[70] Wisconsin Department of Natural Resources, Wisconsin Department of Agriculture, Trade and Consumer Protection, Lake Ripley Management District, and Jefferson County Land Conservation Department. 1998. Nonpoint Source Control Plan for the Lake Ripley Priority Lake Project. Wisconsin Nonpoint Source Water Pollution Abatement Program. Publication WT-512-98.
[71] Personal communication with Ken Raymond, Oakland Sanitary District (Sept. 2006)
[72] Using figures generated through Wisconsin Lake Modeling Suite (WiLMS)

FACTORS INFLUENCING GROUNDWATER QUALITY

The quality of groundwater can be jeopardized by the over-application of fertilizers and pesticides. For example, nitrate (NO_3) is often found as a contaminant in groundwater when water originates from manure pits, fertilized fields (or lawns), or from septic systems. Nitrate is an inorganic form of nitrogen which is necessary for plant growth. However, high levels of nitrate have been linked to water-quality and human-health problems. Also, a concentration of nitrate-nitrogen (NO_3-N) plus ammonium-nitrogen (NH_4-N) of 0.3 mg/L in the spring is adequate to support summer algal blooms if sufficient phosphorus is also present.

In 1989, elevated levels of nitrates and chlorides were reported in domestic well samples taken from the Lake Ripley watershed, indicating that groundwater was being affected by land-use activities.[73] A total of 33 area wells were then analyzed for nitrate (measured as NO_3-N) and the presence of triazine pesticides as part of the Lake Ripley Priority Lake Project around 1993. Nitrate levels were found to range from "not detected" to 33.2 ppm. The groundwater quality enforcement standard is 10 ppm as defined in NR 140, Wisconsin Administrative Code. There were five water samples at the time that exceeded this standard, representing 15% of the wells sampled. Triazine concentrations ranged from "not detected" to 0.6 ppb. No samples exceeded the groundwater quality enforcement standard of 3 ppb at the time of the study.[74]

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[73] Kenter, A. W. and F. W. Madison. 1989. Groundwater Quality Investigation of Selected Towns in Jefferson County. Wisconsin Department of Natural Resources.

[74] Wisconsin Department of Natural Resources, Wisconsin Department of Agriculture, Trade and Consumer Protection, Lake Ripley Management District, and Jefferson County Land Conservation Department. 1998. Nonpoint Source Control Plan for the Lake Ripley Priority Lake Project. Wisconsin Nonpoint Source Water Pollution Abatement Program. Publication WT-512-98.