Union Grove Lake Watershed

Watershed Management Plan 2012-2026

June 2012

Tama Soil & Water Conservation District, Iowa

Union Grove Lake Watershed Management Plan

Executive Summary

Union Grove Lake in northwestern Tama County, Iowa, is a popular outdoor recreation destination within a one-hour drive of 1.2 million Iowans. The lake and adjoining state park amenities recorded nearly 163,000 visitor days in 2009.

Due to declining water quality, the lake was placed on Iowa's 303(d) Impaired Waters List beginning in 2004 because of algae, turbidity, pH, and bacteria. Union Grove Lake's designated uses of primary contact recreation, lake/wetland warm water wildlife and aquatic life, and human health moved from Partial Overall Use Support to Threatened in IDNR's 1994 Water Quality assessment and from Threatened to Not Supporting in 2004.

The lake's Water Quality Improvement Plan (TMDL), released in July 2009, identifies nonpoint sources and internal recycling of pollutants from bottom sediments as adversely affecting lake water quality due to phosphorus: agricultural activities, inadequate on-site septic tank treatment systems, wildlife (especially Canada geese), runoff from the lakeshore residential areas, atmospheric deposition, groundwater from fractured limestone, and re-suspension of lake bottom sediments. These sources affect turbidity either due to algal growth or inorganic suspended solids. The TMDL also cites nonpoint pathogen indicator sources of livestock, manure applied to fields, wildlife, and failed onsite septic tank systems as both episodic and continuous components.

Union Grove Lake's TMDL target for Total Phosphorus (TP) delivery to the lake is 3,006 lb/yr. Based on current watershed assessments of all phosphorus sources, the estimated amount of TP added to the Union Grove Lake system annually is 8,088 lb/yr, with nearly half of this amount contributed by watershed input and nearly half by the internal recycling of nutrients from lake bottom sediments. Meeting the TMDL target still requires an additional TP load reduction of 5,082 lb/yr in order to meet the TP goal. According to IDNR, reducing bacteria concentration during maximum and minimum flow conditions by approximately 80% of current conditions will help Union Grove Lake to meet its allowable daily pathogen daily loads as set in the TMDL.

The goal of this plan is to lay the foundation for future watershed efforts by meeting water quality goals, eradicating the lake's impairments, de-listing Union Grove Lake from Iowa's 303(d) Impaired Waters List, eliminating beach closing due to bacteria, meeting sediment delivery and TP load reduction needs, and lowering the lake's Trophic State Index values for chlorophyll, transparency, and TP, each to 63.

Union Grove Lake is one of 35 high-priority publicly-owned Iowa lakes poised for potential state funding based on the feasibility of lake restoration and the potential use of the lake if restored.

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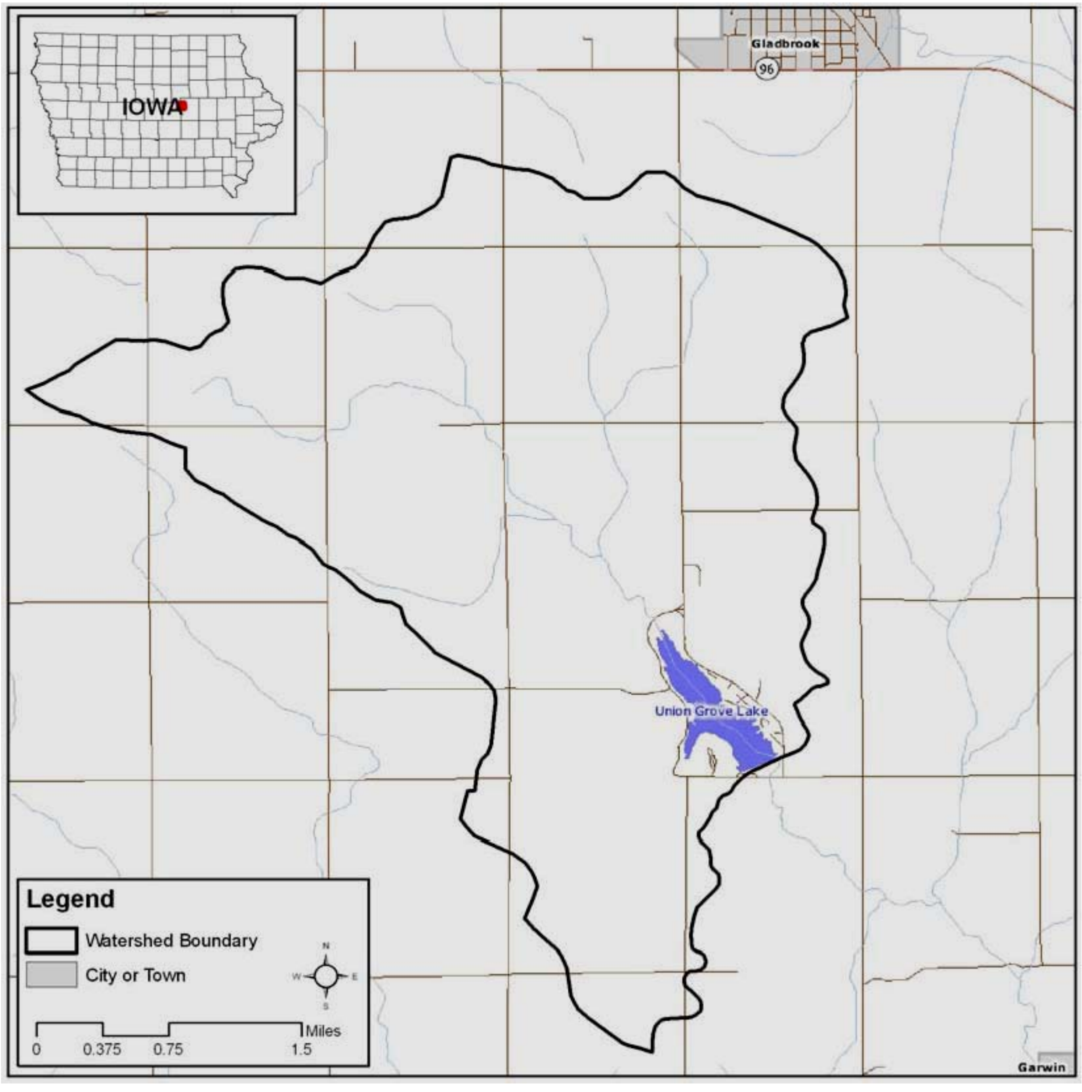
1.0 Introduction

1.1 Vision Statement

This watershed management plan will address Union Grove Lake's water quality impairments in order to remove the lake from Iowa's Impaired Waters List and to return the lake to a condition fitting the lake's 1935 Prospectus:

> *"With its rolling hills, limestone bluffs, and many springs of sparkling pure water shaded by oak, ash, and hickory trees and comprising one of the very few stands of virgin timber left in Central Iowa,....this location came immediately to mind."*
>
> Lake & Park Holding Corporation Prospectus, 1935

Figure 1



1.2 Watershed Location

Union Grove Lake is a shallow, constructed impoundment in Deer Creek located four miles south of Gladbrook and 2.5 miles northwest of Garwin in Tama County, Iowa. Union Grove Lake Watershed (Hydrologic Unit Code #070802080401) includes 6,949 acres in Tama and Marshall Counties and is found in the uppermost reaches of the Deer Creek basin in the Iowa River Watershed (Figure 1).

1.3 Union Grove Lake

1.3.1 Physical Characteristics

The lake has a surface area of 96 acres, excluding the sediment retention area at the influx of Deer Creek. It is the central feature of Union Grove State Park, a popular outdoor recreation area. The drainage area has a watershed-to-lake ratio of 59:1. Union Grove Lake has a mean depth of 7.5 feet, has a maximum depth of 13.1 feet, and stores 744 acre-feet of water.

1.3.2 Lake History

In 1935, a group of local citizens from Tama and Marshall Counties answered a request from the U.S. government for prospective projects suitable for parks and lakes. They formed a non-profit group, Lake & Park Holding Corporation, and in September 1936 submitted a lake project proposal to the federal Works Progress Administration. The plan included 45 workers, materials, and equipment for a total cost of $26,000.

The corporation sold certificates with future lakeside lots selling for between $100 and $300.

Figure 2

1936 photo, looking northwest from dam

Membership provided the $35,000+ needed to purchase 230 acres of land. 171 acres were deeded for the lake bed, shoreline, and public park required to meet WPA requirements. By August 1937 the lake was constructed and filled (Figure 2), and the corporation held a celebratory water carnival, complete with boat regatta and airplane rides. The lake was operated privately by the corporation for the next few years and proved a popular public recreation area. Amenities included boat and canoe rental, a bath house, and a small restaurant.

An original dam crest elevation of 937.6 feet provided for a 118-acre lake. The lake's outlet was created by removing limestone from near the east end of the 1320-foot dam, which still acts as Union Grove Lake's primary spillway (Figure 3). This stone was crushed and used for road construction within the park. In July 1940, the lake, shoreline, and park were sold to the State of Iowa for $10,000, creating Union Grove State Park. Lake & Park Holding Corporation remains a very active watershed group making financial, material, and labor donations to the lake and state park each year.

Figure 3

Union Grove Lake's primary outlet, Chapin Limestone Formation

As watershed land use changed, the lake began to fill with sediment. By its fourteenth year, the lake's surface area had decreased by 13 acres and the lake had lost 168 acre-feet of volume. In 1954, the lake was drained and the dam crest was raised by two feet, increasing the lake volume by 231 acre-feet and its surface area by 23 acres. The current park headquarters and the campground were constructed in the mid-1960s. In the early 1970s, the lake was drained again to remove rough fish, make beach improvements, repair the spillway, and construct eight jetties. Soon after this, a second boat ramp and a picnic shelter were added to the west shoreline.

By the 1980s, state park usage was down throughout Iowa due in part to state government finances and degraded lake water quality. Union Grove Lake's concession facilities closed in 1985. Local citizens expressed concern about Union Grove Lake's water quality and the rate at which the lake was filling with sediment.

1.4 Local History

Settlers first filed land claims in the vicinity in 1853, lured by the valley's abundant springs, limestone, and timber. The community of Spring Grove quickly materialized and included a school, cemetery, post office, blacksmith, attorney, general store, dance hall, and cheese factory (with "refrigeration" provided by one of the valley's many springs). It is said that hunting and trapping were excellent. In the late 1870s, residents changed their town's name to Union Grove in hope of luring the Union Pacific Railroad through their settlement. Instead, the railroad ran through nearby Gladbrook. Many of Union Grove's homes and businesses were moved to Gladbrook, and by 1890, all that remained of the Union Grove settlement were a few building foundations and the cemetery (Figures 4 and 5).

Figure 4

Union Grove Cemetery,
section 32, Spring Creek Township, Tama County

Figure 5

Headstone of Stephen King,
veteran of The War of 1812

1.5 Current Lake Use

Located within a one-hour drive of 1.2 million Iowans, Union Grove Lake is a popular outdoor recreation destination. Lake activities include boating, fishing, and swimming while the park provides a campground (Figure 6), two boat ramps, a beach, hiking trails, and several picnic sites, including a roofed picnic site adjacent to a handicap-accessible fishing jetty (Figure 7). On a typical summer weekend, 4,500 people will utilize the lake and park amenities with 162,740 park visitor days recorded in 2009 alone. This figure includes approximately 1,100 campground guest days, with nearly all of the camping guests taking advantage of lake activities. Union Grove State Park's campground anticipates much heavier use in the future due to major facility improvements begun in fall 2010 including improving toilet facilities, installing showers, upgrading electrical campsites to 50-amp service, and installing campsite and sewer hook-ups. There is also one newly-constructed rental cabin with plans for the completion of a second rental cabin in the future. Fishing activities yield black and white crappie, largemouth bass, bluegill, and channel catfish. According to local reports, fall crappie fishing has been exceptional in recent years.

Figure 6

Campground

Figure 7

Handicap-accessible picnic and fishing facilities

Union Grove Lake serves as a dry hydrant for local fire departments as well as the venue for a number of annual community activities such as an ice fishing competition, Gladbrook American Legion Memorial Day services (Figure 8), two summer car cruises for vintage car enthusiasts from throughout the state, and the Cornman Triathlon, which had almost 400 participants in 2009 (Figure 9).

According to Iowa State University's Center for Agricultural and Rural Development, from 2002 through 2005, Union Grove visitors spent $1.6 million annually in order to visit the lake and supported 32 local jobs.

Figure 8

Gladbrook American Legion Memorial Day Service

Figure 9

One wave of Cornman Triathlon participants

1.6 Iowa Department of Natural Resources (IDNR) Prioritization for Restoration

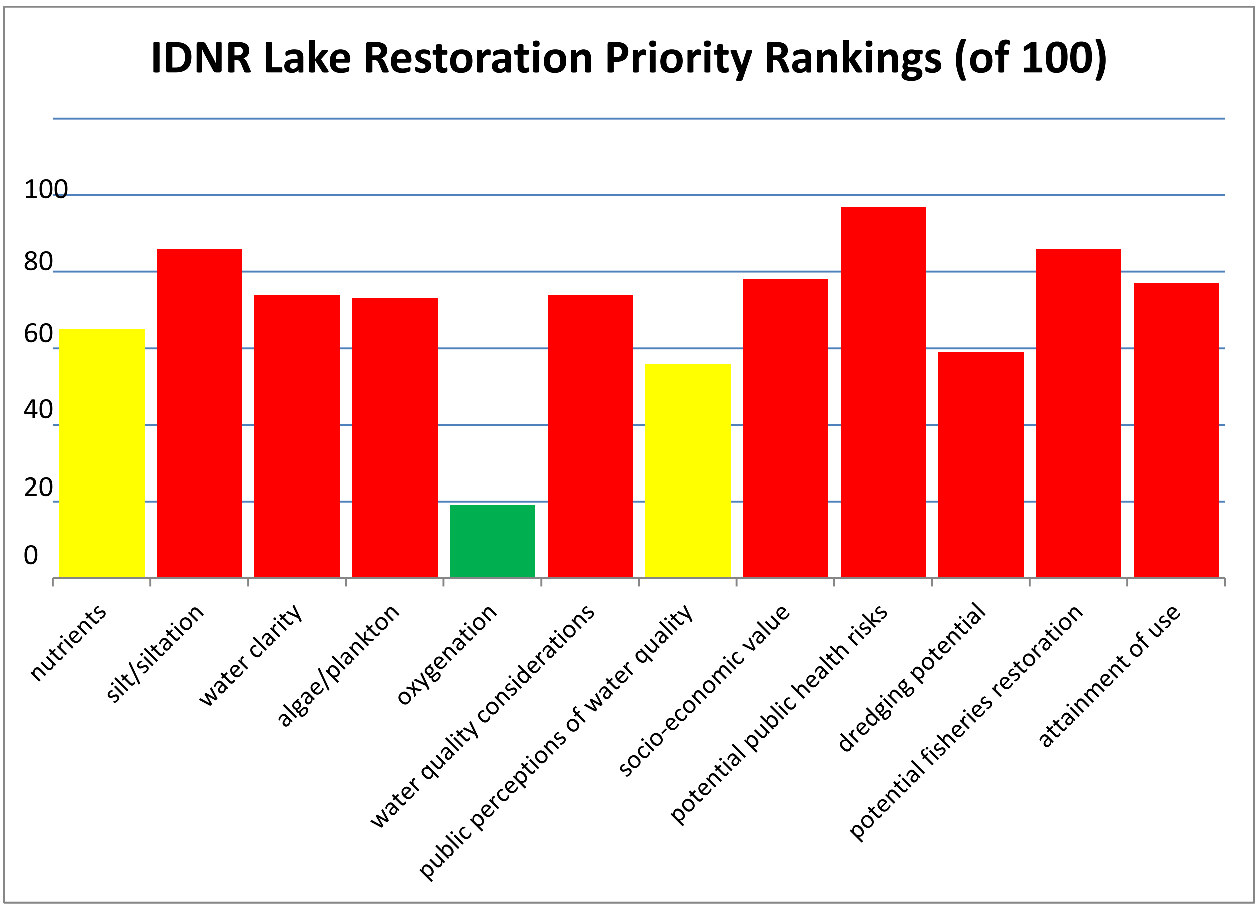
Union Grove Lake is one of 35 high-priority publicly-owned Iowa lakes poised for potential funding based on the feasibility of lake restoration and the potential use of the lake if restored. A few of the external factors influencing Union Grove Lake's prioritization include that it is a state-owned lake situated within a popular state park, it is on Iowa's Impaired Waters List, and its TMDL (Water Quality Improvement Plan) has been completed.

As of the drafting of this plan, Union Grove Lake is located on IDNR Lake Restoration's five-year restoration plan with roughly $1.4 million targeted for in-lake dredging, dredging upstream from the lake's sediment retention dike, and fishery improvement.

The lake's overall rank as a high priority (Figure 10) is the combination of a number of internal factors:

- water quality: nutrients, silt/siltation rate, water clarity, algae/plankton concentrations, and hypoxia/oxygenation supply
- benefit to the public: public perceptions of water quality, socio-economic value of the waterbody, and potential public health risks
- restoration potential: lake area and depth, dredging potential, rate of change in water quality, lake restoration effectiveness, fisheries restoration potential, and attainment of standards of designated use

Figure 10



red=highest priority third of percentile yellow=middle third of percentile green=lowest priority third of percentile

1.7 Watershed Project Background

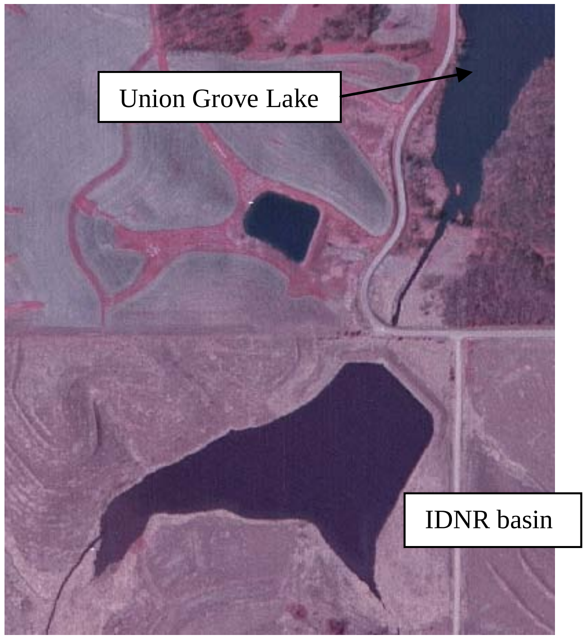
A restoration diagnostic/feasibility study of Union Grove Lake was completed in 1983, led by Dr. Roger Bachman of Iowa State University. The study found that siltation was a major problem in Union Grove Lake and that at the existing rate of siltation, the lake would lose most of its recreational capabilities by the year 2017. The study noted that the Toledo Field Office of the USDA Soil Conservation Service (SCS) estimated average soil losses on the watershed's cropland at 7.7 tons/acre/year with sediment delivery to the lake estimated over 15,000 tons/year. Lake health problems were also reported in the study, including high summer algal levels, reduced water clarity, occasional winter fish kills, and aquatic macrophytes interfering with recreational uses. The report recommended a lake restoration plan including dredging, implementing a watershed soil erosion control program, installing a lake aeration system to prevent winter kills, and biologically controlling macrophytes.

Watershed protection efforts began in 1984 with cost-share funding available through Iowa's Publicly Owned Lakes Program and U.S. EPA's Clean Lakes Program. By 1993, the following conservation practices had been installed on private cropland in Union Grove Lake Watershed: 10.8 miles of tile-outlet terraces, 90 acres of grassed waterways, 24 water and sediment control basins, four grade stabilization structures, and four acres of critical area seeding. Work within Union Grove Lake included dredging 275,000 cubic yards of sediment from the lake; constructing two 150-foot jetties; installing 2,400 feet of shoreline protection; constructing a 550-foot rip rap sediment-nutrient retention dike at the northwest end of the lake (Figure 11); installing a helixor aeration system in the deepest part of the lake; and building a sediment retention basin on the unnamed creek entering the southwest corner of the lake (Figure 12).

Figure 11

Sediment retention dike at northwest end of lake, looking southeast

Figure 12



Sediment retention basin near southwest corner of lake

The Clean Lakes Program final report noted the dredging activity increased Union Grove Lake's volume by 14%. It also reported that water quality testing showed the rip rap sediment-nutrient retention dike was successful in preventing mixing between water above the dike and the main body of the lake. Iowa Department of Natural Resources also found positive fishery response and increased lake and park use following restoration efforts.

A five-year Hydrologic Unit Area Project (HUA) was active in Union Grove Lake Watershed from 1990 through 1994. This project was funded by USDA, part of its Water Quality Initiative, and was a cooperative effort between SCS and Iowa State University Extension. Its purpose was to initiate voluntary changes in farm management practices, resulting in reduced non-point source inputs of sediment, nutrients, and pesticides to Union Grove Lake. The project provided technical assistance and a public outreach program in integrated crop and field management, including weekly crop scouting. By the time the HUA project was completed, recreational use of the lake had increased nearly 25% from lake usage in 1989.

In addition to the soil conservation practices installed with project cost-share funds, watershed participants voluntarily applied 875 acres of waste utilization; 4,772 acres of conservation tillage; 1,997 acres of contouring; 75,650 feet of field borders; 417 acres of stripcropping; and they utilized recordkeeping and integrated crop management on 1,400 acres. All 48 farmers in Union Grove Lake Watershed participated.

Participating farmers found that incorporating these practices lowered the cost of production and increased their profitability by an average of $15.79/acre/year. Nutrient management planning on 2,922 acres served by the HUA project estimated reducing annual application of nitrogen by over 42 tons/year. The average annual phosphorus application on these acres was reduced by nearly 77 tons/year.

Time has passed since the completion of these two projects, resulting in changes of farm ownership, operation, and management. The success of these efforts represent the commitment and adaptability of Union Grove Lake Watershed's farm owners and operators. In addition, from recent project communication with watershed landowners and operators, it is evident that many of them highly value the merits of conservation practices installed during previous watershed efforts and make great efforts to maintain them in working order (Figures 13 and 14).

Figure 13

2008 photo of terraces built in 1991. Note no-till in foreground. Section 20, Spring Creek Township, Tama County

Figure 14

2008 photo of waterway built in 1985. Section 21, Spring Creek Township, Tama County

1.8 Current Watershed Project 086-3.08

The watershed's current project, Union Grove Lake Nonpoint Source Watershed Project 086-3.08, began in April 2008 and will conclude in June 2012. Its goals are to:

- reduce sediment and phosphorus delivery to Union Grove Lake by 57%
- reduce livestock access to streams in the watershed by 30%
- eliminate runoff from open livestock feedlots by 50%
- promote participation in the project through a public outreach program

Since the project began, the following conservation practices have been installed: 10.3 acres of cover crop, one grade stabilization structure (pond), 10.3 acres of grassed waterways, 2.4 acres of critical area seeding, 72.3 acres of pasture interseeding, 72.3 acres of prescribed grazing and 8.6 acres of native grasses/forbs. These additional practices have funds obligated to be completed: 3.6 acres of grassed waterways; 2,584 feet of stream corridor fencing; 3,116 feet of pasture paddock fencing; 0.3 acre of heavy use protection; one livestock watering facility; one rock stream crossing; 1.3 acres of critical area seeding; and 90 acres of cover crop.

The project's public outreach has included hosting a project kick-off (Figure 15), the TMDL public meeting, and workshops on pastures and riparian areas, lawn care, crop residue and fertilizer management, rain gardens, and tree care (Figure 16). An information fair was also hosted with materials and experts available on a wide variety of topics from National Wildlife Federation's Certified Wildlife Habitat program to conservation tillage to well water safety. In addition, the project provided materials and personal contacts during Lake & Park Holding Corporation's 75th anniversary celebration and open house.

Figure 15

Lakeside resident learning about solar livestock waterer
Project Kick-off, 5/28/2008

Figure 16

Tree care workshop, 6/10/2009

The watershed coordinator has made personal contacts with the owner and/or operator of 67 out of 77 watershed agricultural tracts and with numerous lakeside residents. Over 200 newsletters have been delivered during each quarter of the project. Landowner and operator contacts have also been made by mail to promote workshops conducted by partner agencies, such as the Iowa Learning Farm's cover crop workshop and Iowa State University Extension's Forage Field Day. An information kiosk has been installed near the east boat ramp and beach, and numerous contacts have been made with lakeside homeowners regarding urban and runoff issues. The project coordinator has also mentored a local fifth grade Talented-and-Gifted student in water quality and recommended a local history project, recently completed by a lakeside resident.

A Rapid Assessment of Stream Condition Along Length (RASCAL, Figure 17) began on 4.3 miles of watershed stream corridor in the fall of 2007 and completed in the spring of 2008. This assessment recorded data on 24 parameters and helped the project to target priority areas in which to focus conservation efforts. During personal contacts with stakeholders, RASCAL data also helped farm owners and operators to visualize problem areas on their farms.

Figure 17

RASCAL assessment, tributary of Deer Creek, 2008
section 20, Spring Creek Township, Tama County

Figure 18

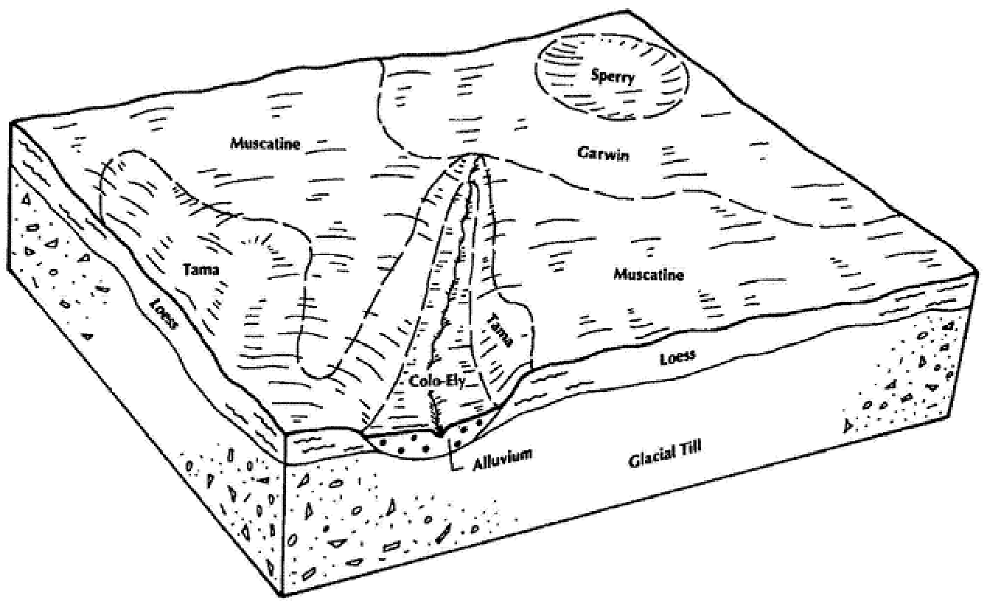
Annual goose banding and transplanting, June 2010
Union Grove Lake

2.0 Watershed Anatomy

2.1 Soils

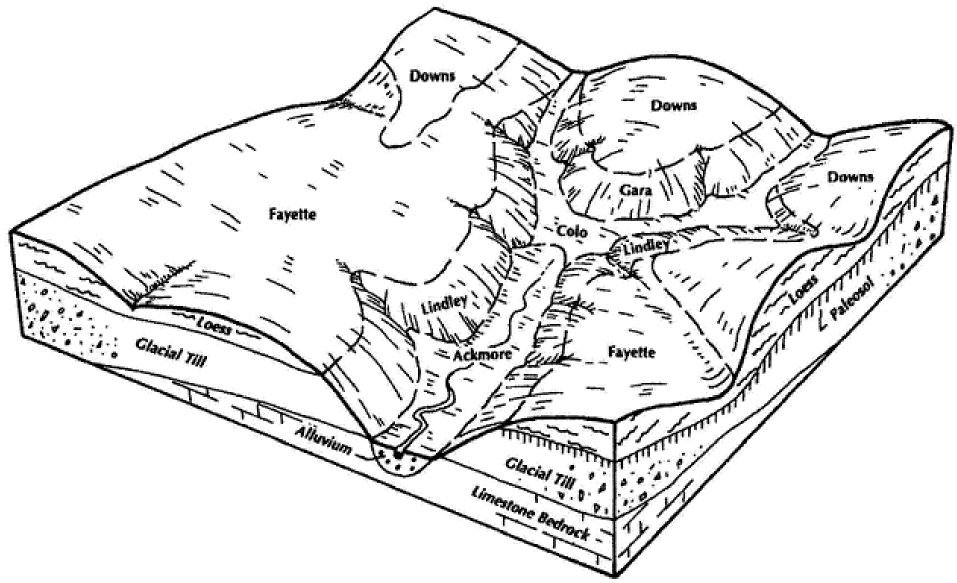
Three general soil types are found in Union Grove Lake Watershed from the Tama, Muscatine-Tama-Garwin (Figure 19), and Fayette-Downs Associations (Figure 20).

Figure 19



Soil associations in the headwaters of the watershed are of the Tama Association and the Muscatine-Tama-Garwin Associations. Soils in the Tama group are gently sloping to moderately steep, well drained, silty upland soils that formed in loess. This association's soils lie on broad, convex ridgetops and long, convex side slopes ranging from undulating to hilly. They are well suited or moderately well suited to producing row crops, small grains, and hay. The main management concerns in this association are controlling erosion and maintaining tilth and fertility. Soils in the Muscatine-Tama-Garwin Association are nearly level to moderately sloping, silty upland soils that formed in loess. Their drainage, however, ranges from well drained to poorly drained. These soils lie on broad, convex ridgetops and side slopes creating a nearly level to gently rolling land surface. They are well suited to the production of row crops, small grains, and hay. Their main management concerns are erosion in the moderately sloping areas and seasonal high water table in the poorly drained soils.

Figure 20



Closer to the lake, soil types are typically Fayette-Downs Association. Soils in this group are gently sloping to very steep, well drained, silty upland soils formed in loess. They are typically found on broad to narrow, convex ridgetops and long, convex side slopes which are dissected by numerous waterways. The landscape varies from undulating to very steep. These soils are generally well suited or moderately well suited to row crop, small grain, and hay production. The association's steeper slopes are unsuitable for crops but well suited for pasture and trees. Main management concerns in this association are controlling erosion, preventing gully formation, maintaining fertility, and managing pasture and timber.

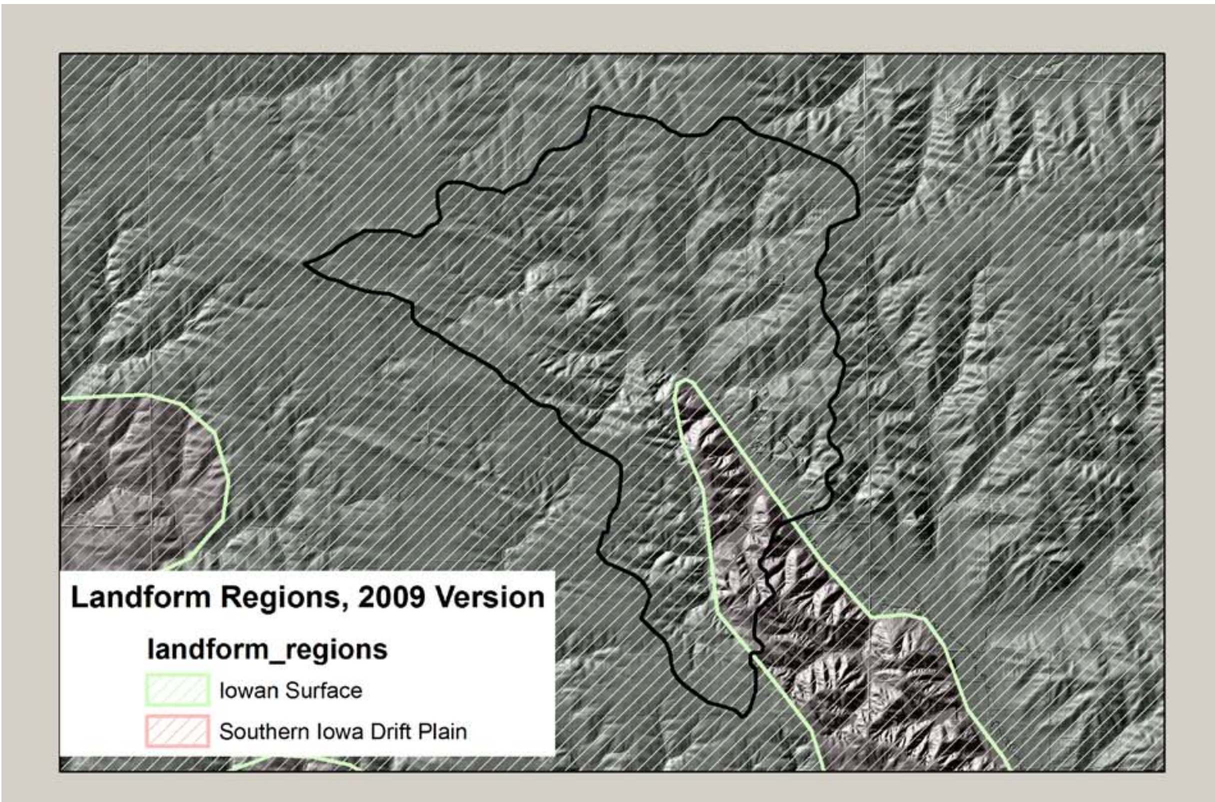
2.2 Geology and Ecoregions

Union Grove Lake Watershed is located in a transitional area between the Iowan Surface and the Rolling Loess Prairie ecoregion of the Southern Iowa Drift Plain (Figure 21). The headwaters and upstream reaches of Deer Creek and its tributaries are more characterized by the Iowan Surface with a Sediment Delivery Ratio of 13.7% while the remainder of the watershed is more typical of the Southern Iowa Drift Plain with a Sediment Delivery Ratio of 27.3%.

This geomorphic region is characterized by stepped erosion surfaces with both glacial till and loess occupying the uplands and alluvium filling the larger valleys. 75% of the watershed is loess while glacial till underlies 8% of the drainage area. The till and loess in the immediate vicinity of the lake is thin, resulting in exposures of Chapin Formation limestone. Many of these exposures have been quarried, including the location of Union Grove Lake's primary spillway.

The Chapin limestone was deposited in the shallow ocean that covered much of Iowa in the early Mississippian about 353 million years ago. The Chapin, which ranges in thickness from about 3 to 20 feet in central Iowa, is characterized by oolites mixed with fragments of fossils, especially crinoids but also with brachiopods and snails. The presence of oolites and broken fossil fragments with little lime mud indicates that currents in the sea kept the area swept clean of finegrained sediments. More recently, the rock was subjected to karstification. Numerous springs resulting from this limestone formation are present in the watershed area, including several which feed directly into Union Grove Lake.

Figure 21



2.3 Hydrology

Union Grove Lake has one major surface tributary. Deer Creek enters the northwest end of the lake and discharges over a 70-foot wide weir at the southeast corner of the lake. Union Grove Lake is in the headwaters of Deer Creek, which then flows into the Iowa River in the City of Tama. A secondary, unnamed tributary drains into an IDNR sediment detention basin before discharging into the southwest corner of the lake. Figure 22 shows wetlands designated in the National Wetlands Inventory. Uncrossable intermittent flow, perennial flow, and Deer Creek are shown in Figure 23.

Figure 22

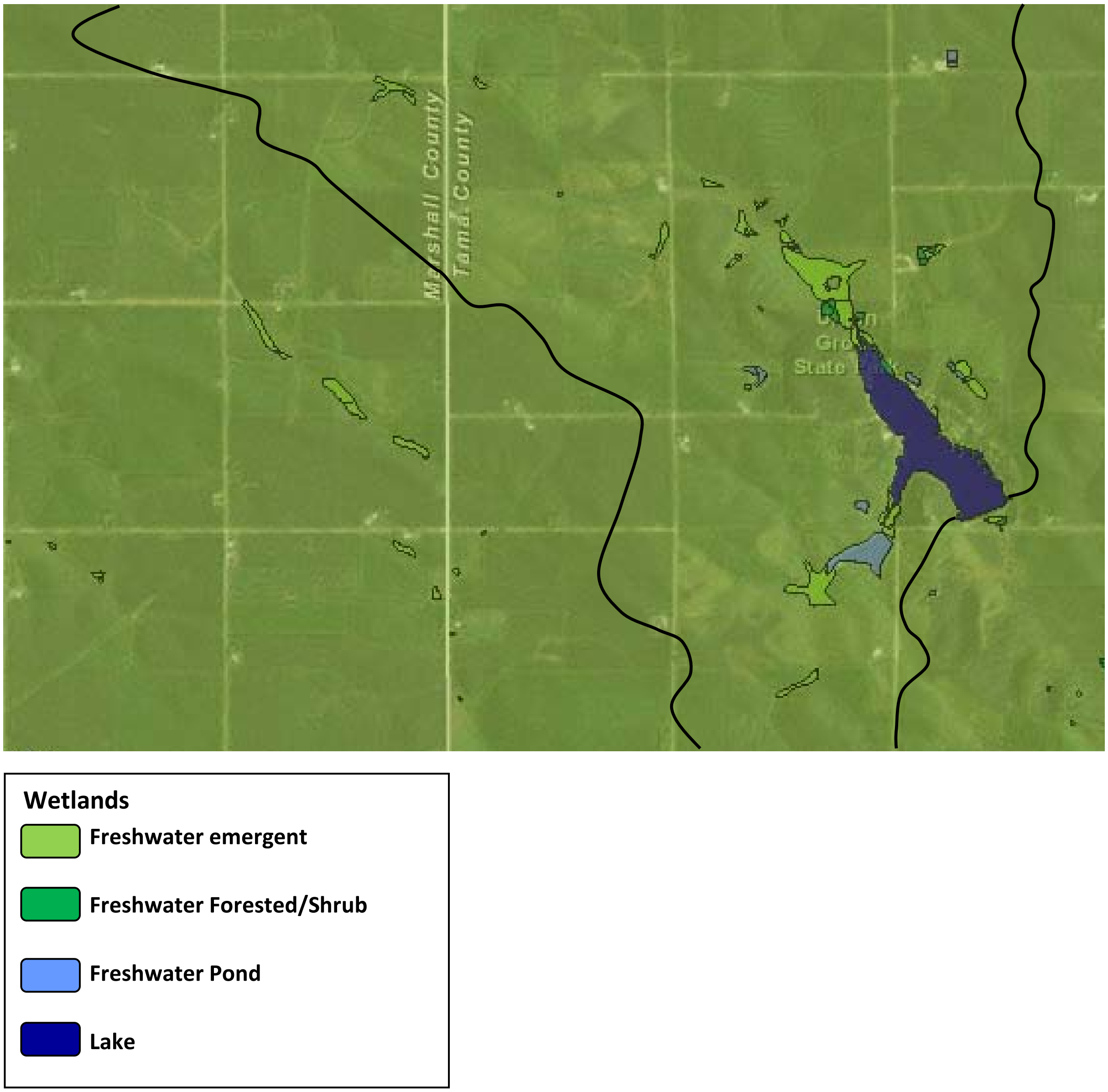
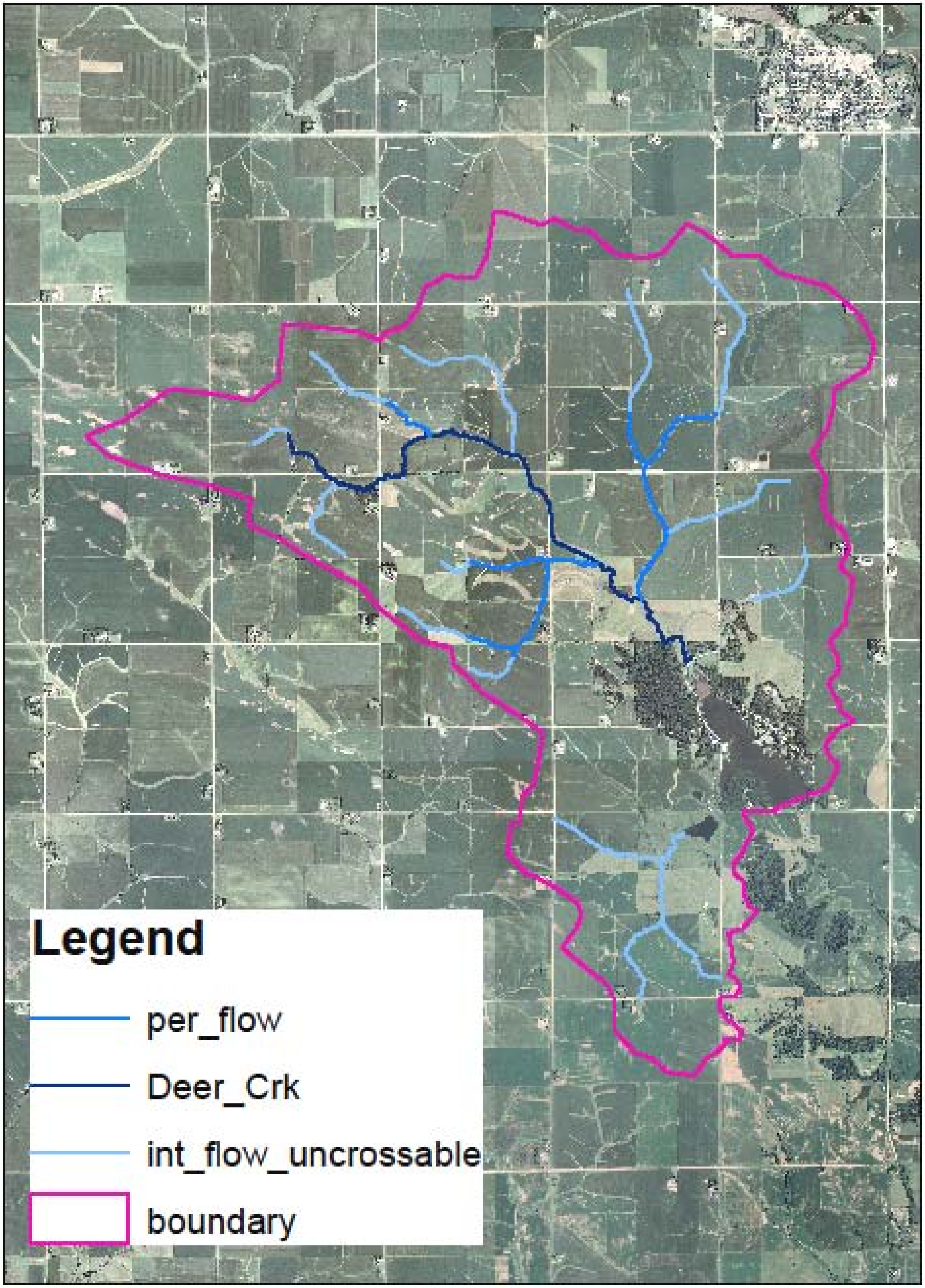

Marshall County
Tama County
Wetlands
Freshwater emergent
Freshwater Forested/Shrub
Freshwater Pond
Lake

Figure 23



2.4 Climate

Tama County receives an average of over 33 inches of rainfall equivalent per year including 31 inches of snow. Figure 24 shows precipitation data for the Marshalltown, Iowa weather station for the years 2000 through 2011. The average number of days with measurable precipitation is 95 per year. The average July high is 85 degrees Fahrenheit and the average January low is 9 degrees Fahrenheit.

Figure 24

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2000	1.03	0.9	1.05	1.07	3.71	9.88	8.38	2.53	1.89	1.23	2.17	1.85
2001	1.33	1.51	1.05	4.09	5.39	4.05	2.09	2.29	3.95	3.32	1.23	0.6
2002	0.32	0.88	0.58	3.04	3.43	4.1	5.51	4.77	1.18	3.23	0.27	0.18
2003	0.44	0.42	0.81	3.6	5.19	5.53	5.42	1.21	3.77	0.98	5.9	1.11
2004	1.01	1.65	3.07	2.69	8.34	2.85	2.24	5.32	0.73	2.01	3.13	0.59
2005	0.93	1.3	0.81	3.31	4.67	6.47	4.02	3.99	3.44	0.38	1.24	1.32
2006	0.52	0.18	2.82	3.69	3.58	1.55	3.94	7.42	4.98	1.93	1.84	2.17
2007	0.82	2.66	3.13	6.38	5.08	4.39	4.64	6.32	2.07	5.23	0.18	2.3
2008	0.43	1.73	0.77	8.11	6.79	11.07	8.42	1.69	3.51	2.9	1.79	2.04
2009	0.79	0.23	3.48	5.25	3.36	6.46	3.02	6.37	3.66	7.48	0.92	2.28
2010	1.18	1.06	0.75	4.35	5.53	7.93	6.29	5.92	8.02	0.38	1.73	0.75
2011	0.78	0.6	1.38	3.27	5.11	4.64	4.7	1.61	2.13	1.13	1.95	2.52
1893-2011												
Mean	1.05	1.08	2.13	3.21	4.31	4.87	3.99	3.81	3.75	2.42	1.74	1.18

2.5 Morphometry

The most recent bathymetry of Union Grove Lake was completed in 2006 by the IDNR (Figures 25 and 26) excluding the area upstream of the sediment detention dike. Union Grove Lake has a mean depth of 7.48 feet and a maximum depth of 13.1 feet. The lake surface area is 96 acres and storage volume is 744 acre-feet. Its detention time is 44 days based on estimated outflow.

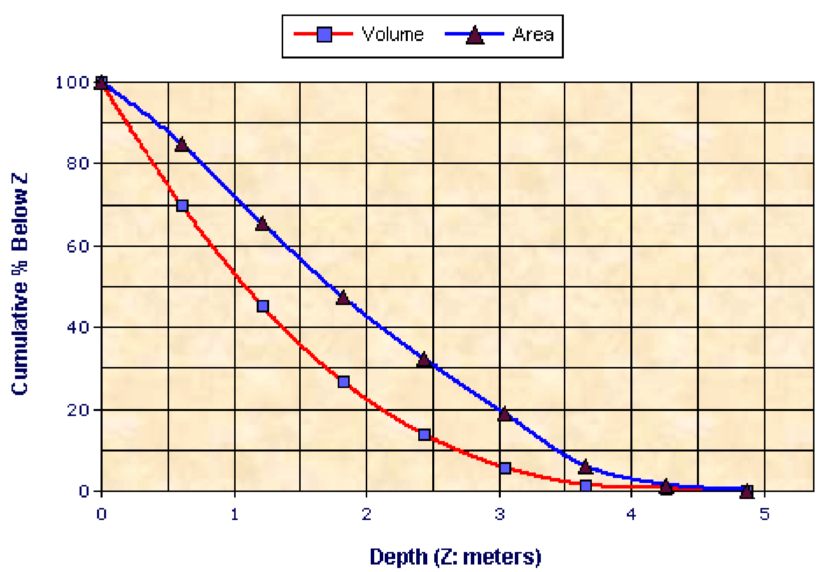


Figure 25

Figure 26

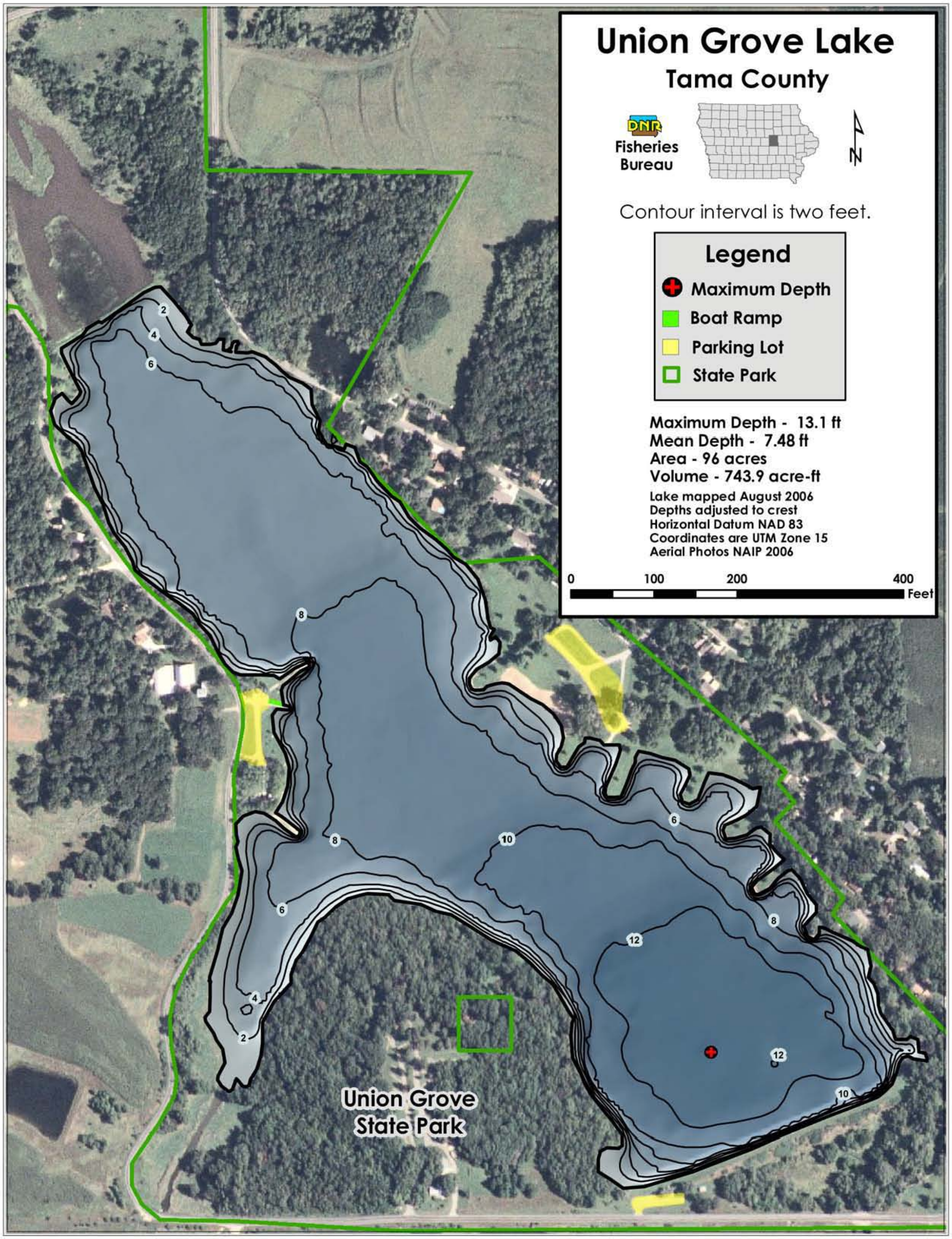

Union Grove Lake
Tama County
DNR
Fisheries
Bureau
N
Contour interval is two feet.
Legend
Maximum Depth
Boat Ramp
Parking Lot
State Park
Maximum Depth - 13.1 ft
Mean Depth - 7.48 ft
Area - 96 acres
Volume - 743.9 acre-ft
Lake mapped August 2006
Depths adjusted to crest
Horizontal Datum NAD 83
Coordinates are UTM Zone 15
Aerial Photos NAIP 2006
0
100
200
400
Feet
Union Grove
State Park

Figure 27

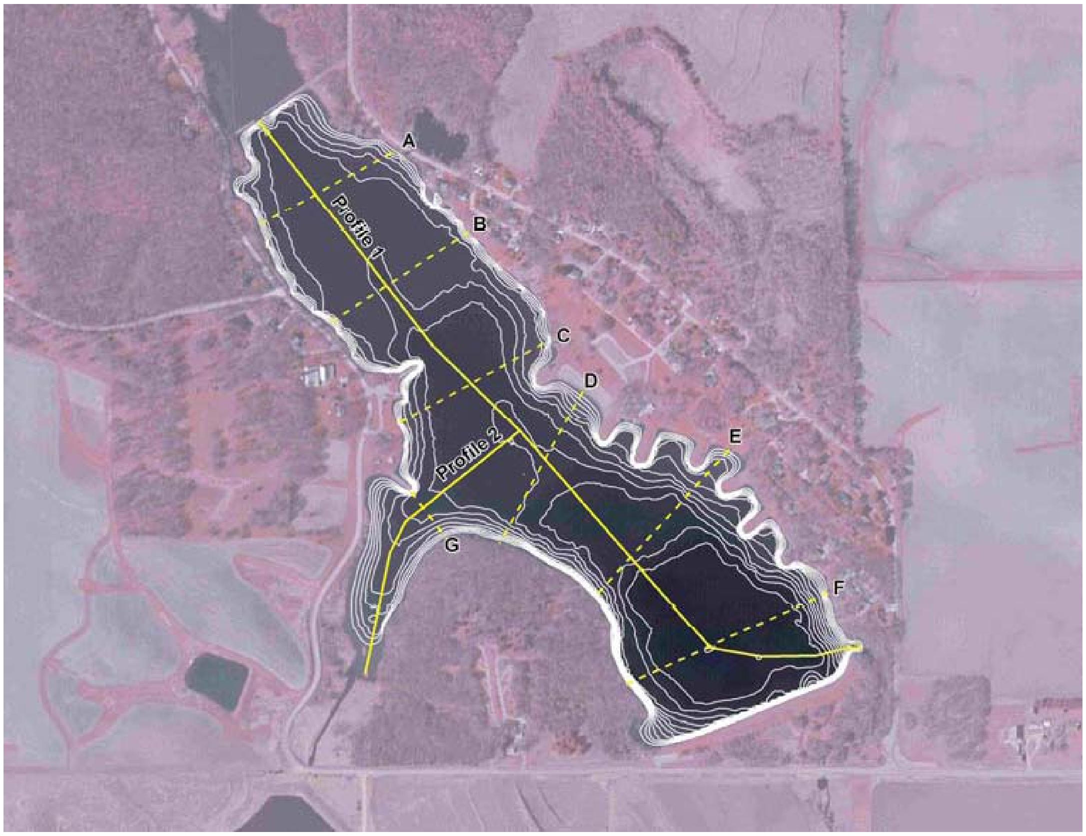
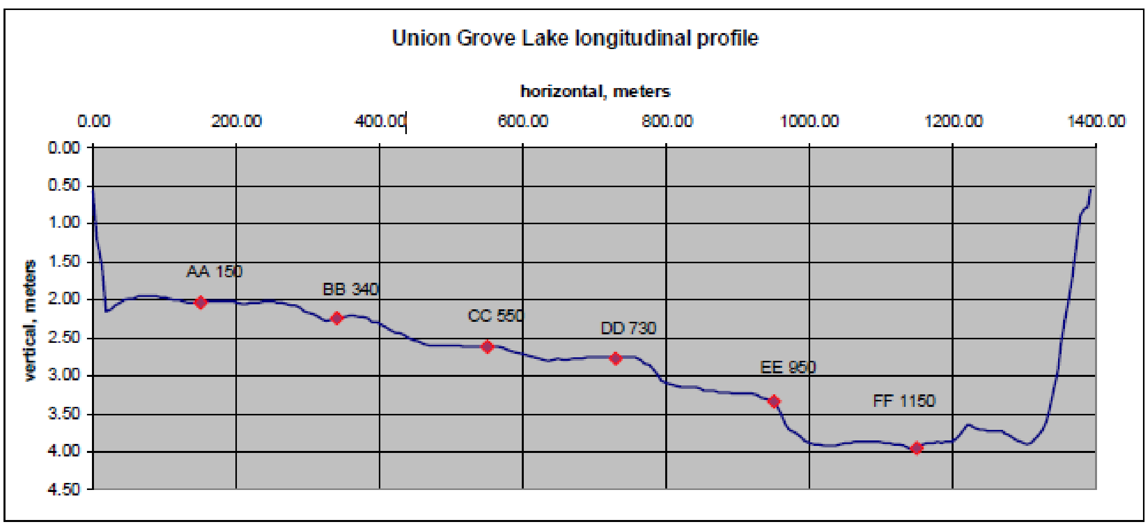


Figure 28



Bathymetry of the lake segments downstream of the sediment basin and the locations of the longitudinal profile and cross-sections used to approximate the lake mophometry for the Water Quality Improvement Plan model are shown in Figure 27. Slopes and depths for the segments were calculated from the profile illustrated in Figure 28.

2.6 Threatened & Endangered Species

State and federal threatened and endangered species listed for Tama and/or Marshall Counties are listed in Figure 29.

Figure 29

County	Common Name	Scientific Name	Class	State Status	Federal Status
Tama, Marshall	Bald Eagle	*Haliaeetus leucocephalus*	Birds	S	
Tama	Barn Owl	*Tyto alba*	Birds	E	
Tama	Short-eared Owl	*Asio falmmeus*	Birds	E	
Marshall	Red-shouldered Hawk	*Buteo lineatus*	Birds	E	
Marshall	American Brook Lamprey	*Lampetra appendix*	Fish	T	
Marshall	Topeka Shiner	*Notropis topeka*	Fish	T	E
Tama	Blanding's Turtle	*Emydoidea blandingii*	Reptiles	T	
Tama	Ornate Box Turtle	*Terrapene ornata*	Reptiles	T	
Tama, Marshall	Smooth Green Snake	*Liochlorophis vernalis*	Reptiles	S	
Tama	Missouri Lambsquarters	*Chenopodium missouriensis*	Plants (Dicots)	S	
Tama	Muskroot	*Adoxa moschatellina*	Plants (Dicots)	S	
Tama	Sensitive Briar	*Schrankia nuttallii*	Plants (Dicots)	S	
Tama	Softleaf Arrow-wood	*Viburnum molle*	Plants (Dicots)	S	
Marshall	Frost Grape	*Vitis vulpina*	Plants (Dicots)	S	
Marshall	Hill's Thistle	*Cirsium hillii*	Plants (Dicots)	S	
Marshall	Small Fringed Gentian	*Gentianopsis procera*	Plants (Dicots)	S	
Tama	Green Adder's Mouth	*Malaxis unifolia*	Plants (Monocots)	S	
Tama	Glomerate Sedge	*Carex aggregata*	Plants (Monocots)	S	
Tama	Oval Ladies' Tresses	*Spiranthes ovalis*	Plants (Monocots)	T	
Tama	Showy Lady's Slipper	*Cypripedium reginae*	Plants (Monocots)	T	
Tama	Large-leaf Pondweed	*Potamogeton amplifolius*	Plants (Monocots)	S	
Tama	Western Prairie Fringed Orchid	*Platanthera praeclara*	Plants (Monocots)	T	T
Marshall	Meadow Bluegrass	*Poa wolfii*	Plants (Monocots)	S	
Marshall	Field Sedge	*Carex conoidea*	Plants (Monocots)	S	
Marshall	Little Grape Fern	*Botrychium simplex*	Plants (Pteriodophytes)	T	
Marshall	Northern Adder's Tongue	*Ophioglossum pusillum*	Plants (Pteriodophytes)	S	

T=threatened E=endangered S=special concern

2.7 Land Use

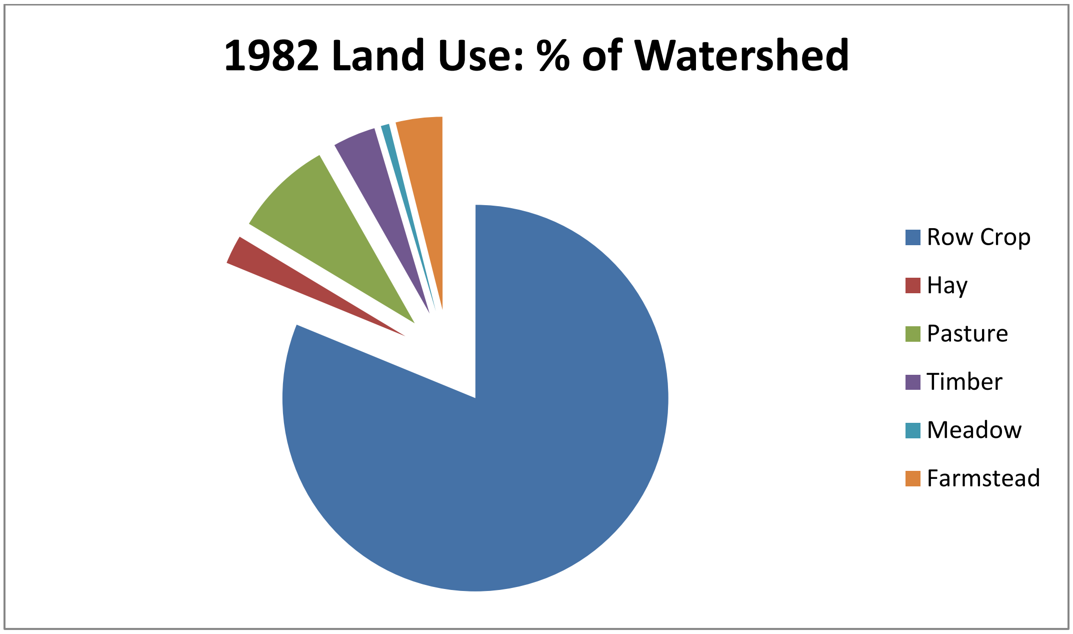
2.7.1 Historical Land Use

The watershed's uplands in the Tama and Muscatine-Tama-Garwin Associations had pre-settlement vegetation of tallgrass prairie while the Fayette-Downs soils closer to Union Grove Lake formed under a mixture of prairie grasses and deciduous trees.

According to Lake & Park Holding Corporation historical records, 75% of the watershed was in timber, pasture, or hay at the time that Union Grove Lake was built in 1936.

1982 land use data included in the Iowa Conservation Commission's Union Grove Lake Restoration Diagnostic/Feasibility Study (January 1983) is shown in Figure 30. The USDA Soil Conservation Service information used did not delineate watershed components such as roads, waterbodies, wetlands, or park and wildlife areas.

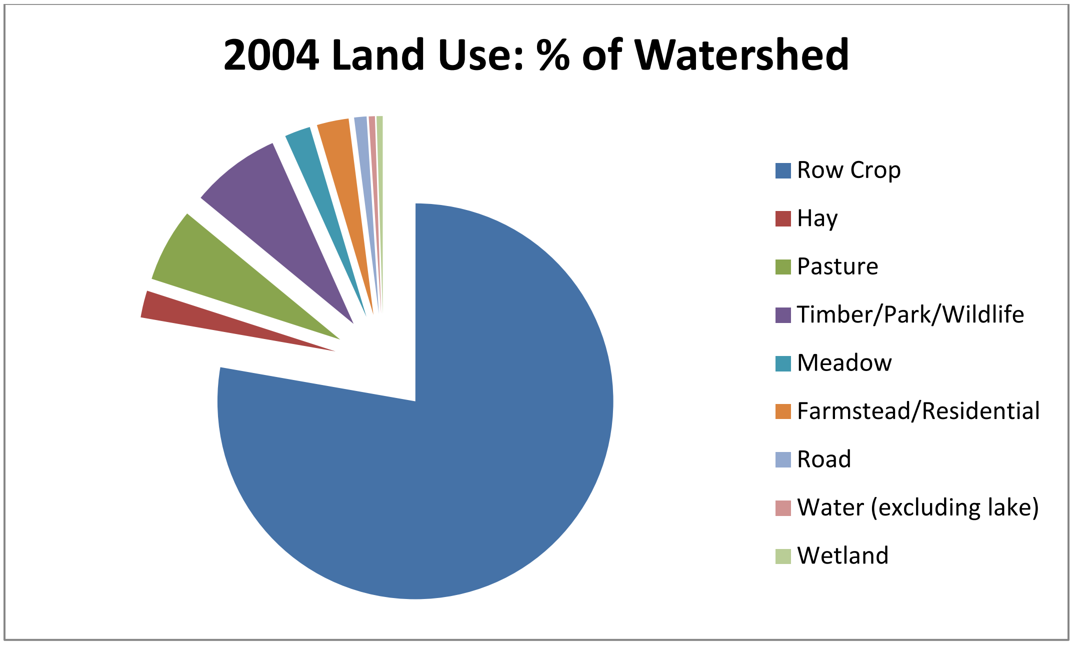
Figure 30



2.7.2 Current Land Use

IDNR utilized land use data from its 2004 land use assessment in Union Grove Lake's Water Quality Improvement Plan, completed in 2009. Figure 31 demonstrates this data with the lake's surface area removed to make the figures more compatible with the 1982 diagnostic study data. As in 1982, row crop agriculture is the predominant land use in the watershed.

Figure 31



From 1982 to 1994, the acreage in hay remained relatively unchanged. The amount of pasture decreased somewhat, most likely due to changes in the number of watershed cooperators involved in livestock production. The percentage of watershed in row crop decreased slightly while the percentage in meadow increased, most likely due to acres that became enrolled in the Conservation Reserve Program.

Figure 32

Southwest quarter section, Section 29 Spring Creek Township

One significant land use change since the 2004 assessment is the completion of a constructed wetland complex (aka Umphrey property) on Deer Creek in the southwest quarter section of Section 29 Spring Creek Township (T85N R16W). This complex (Figure 32) in the northwest portion of Union Grove Lake Watershed has very likely dramatically affected the subwatershed's contribution of sediment delivered to the lake. After this document was first drafted, the current project's coordinator was contacted by the landowners regarding storm damage. They have since completed necessary repairs to the main structure and are considering further improvements. Discussion regarding the overall effectiveness of this site will be addressed in Section 4.3.

There are approximately 100 households in the watershed, approximately 75 lakesides residences and 25 rural. About half of the lakeside homes are full-time residences.

3. Lake Impairments

3.1 Designated Uses

Union Grove Lake's Water Quality Standard designated uses include:

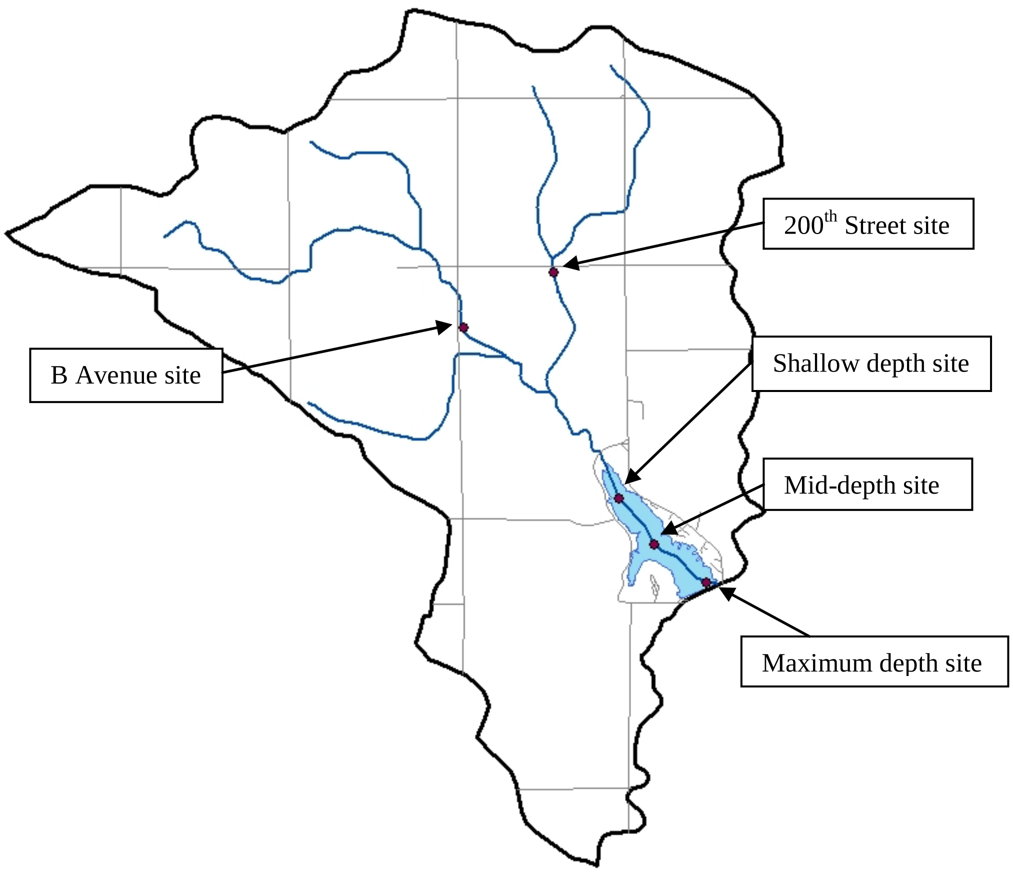
- primary contact recreation (Class A1)- waters in which recreational or other uses may result in prolonged and direct contact with the water
- lake and wetland warm water wildlife and aquatic life uses [Class B(LW)]- artificial impoundments and natural lakes with lake-like conditions that support warm water game fish and associated aquatic communities
- human health (Class HH)- waters in which fish are harvested for human consumption.

3.2 Impairments

Union Grove Lake was placed on Iowa's 303(d) Impaired Waters List beginning in 2004 for algae, turbidity, pH, and bacteria. The lake's Overall Use Support moved from Partial to Threatened in IDNR's 1994 Water Quality Assessment and from Threatened to Not Supporting in the 2004 Assessment.

3.3 Water Quality Data

Figure 33



3.3.1 Project 086-3.08 Assessments

Water quality testing was conducted by personnel from the current project or the State Hygienic Laboratory (University of Iowa) at the 200th Street and B Avenue (Deer Creek) tributary sites and the maximum depth in-lake site July through October 2008, May through October 2009, and May through October 2010. Shallow and mid-depth in-lake sites were sampled only during the 2008 sampling season. A storm event sampler was utilized at the B Avenue tributary sampling site during the 2009 and 2010 sampling seasons. Sampling sites may be found in Figure 33.

Figure 34

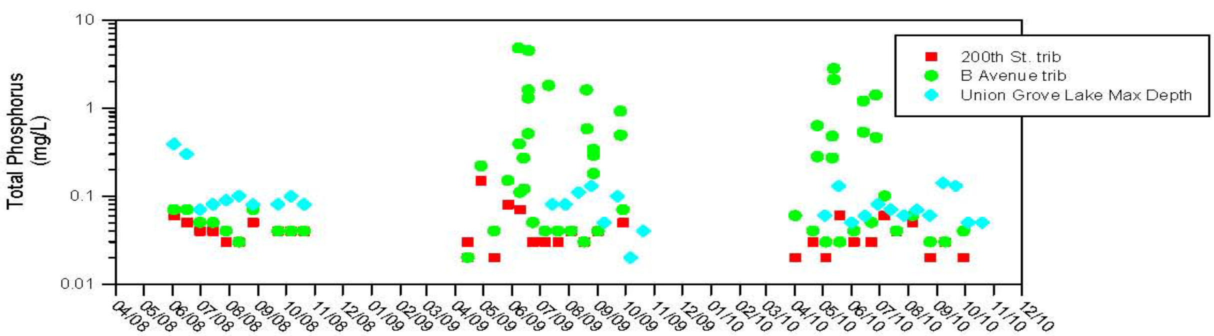


Figure 34 shows results for Total Phosphorus from all three sampling sites used throughout the life of the project. Data for orthophosphate, the soluble and reactive form of phosphorus utilized by plants, may be found in Figure 35.

Figure 35

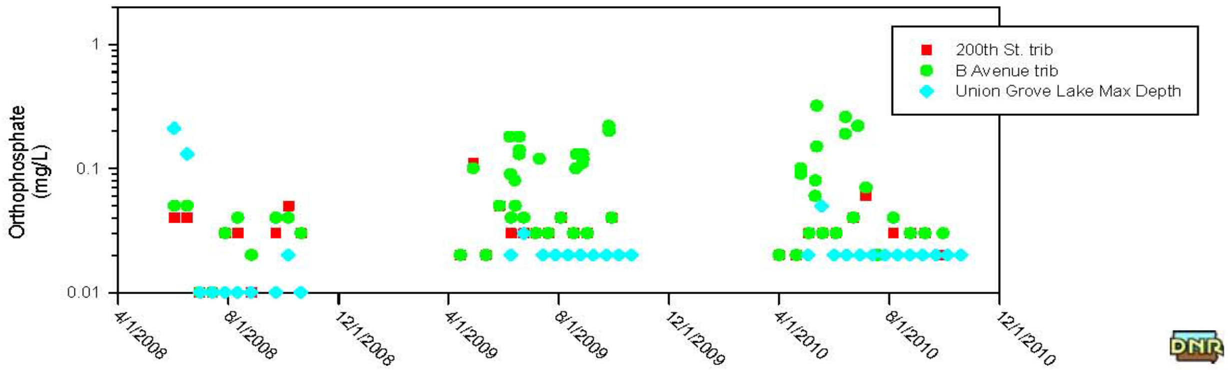
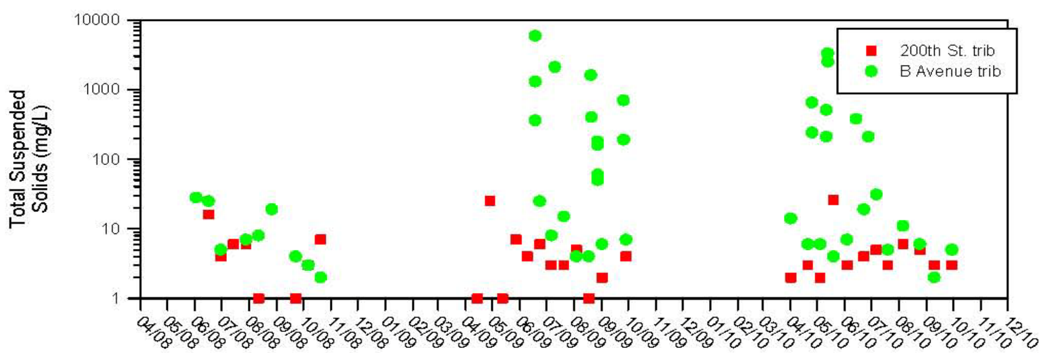


Figure 36



Total Suspended Solids (TSS) data from the current project's tributary sampling sites are found in Figure 36. TSS was not sampled in-lake. TSS measures the total filterable material in the water, including sediment and algae. Total Volatile Suspended Solids (TVSS) is a measure of solids lost on ignition, providing a good estimate of the amount of organic matter in the water. Total Fixed Suspended Solids (TFSS), which measures inorganic suspended solids in the water, and TVSS data were collected only at the tributary sampling sites during 2008. Both TVSS and TFSS results were very low and neither were graphed for this plan.

Figure 37

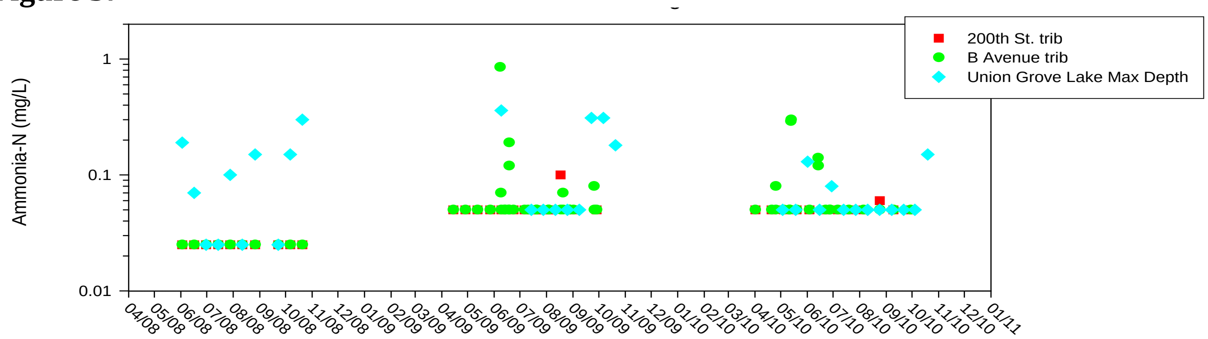
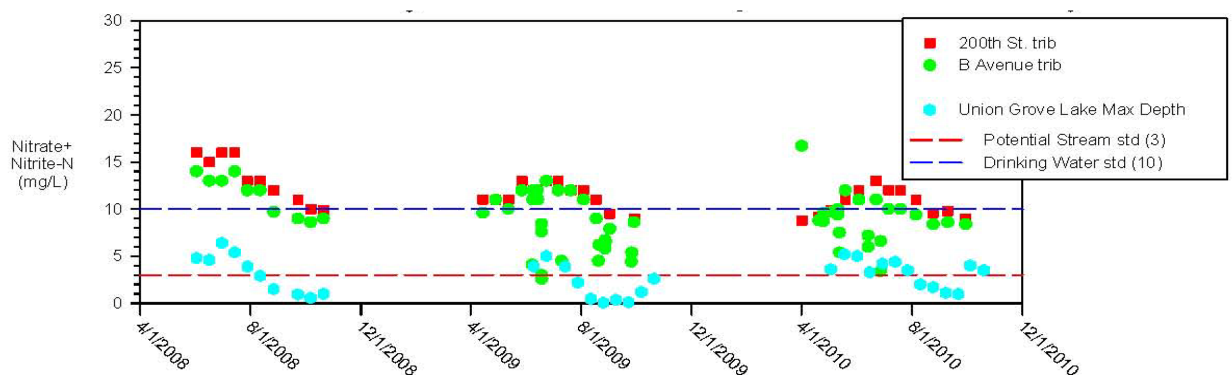


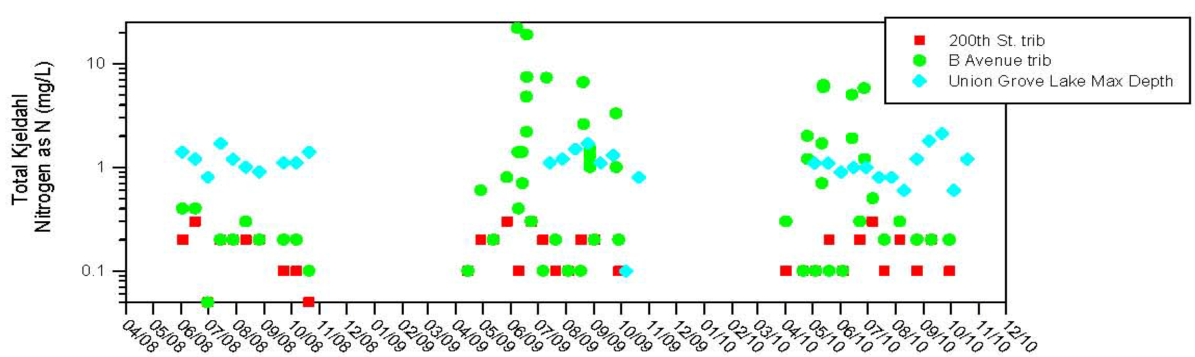
Figure 37 shows test results for ammonia nitrogen, the least stable form of nitrogen in water. It is readily converted to nitrate in well-oxygenated water and can be toxic to fish and aquatic macroinvertebrates. Its toxicity is dependent upon pH and temperature conditions.

Figure 38



In Figure 38, project results may be found for Nitrate + Nitrite Nitrogen, an inorganic form of nitrogen which is very water soluble and therefore is easily transported off the landscape by precipitation.

Figure 39



Total Kjeldahl Nitrogen (TKN) measures water's organic nitrogen, such as the nitrogen found in amino acids, proteins, and peptides. These forms are released into water by living organisms and through decomposition. TKN data may be found in Figure 39.

Figure 40

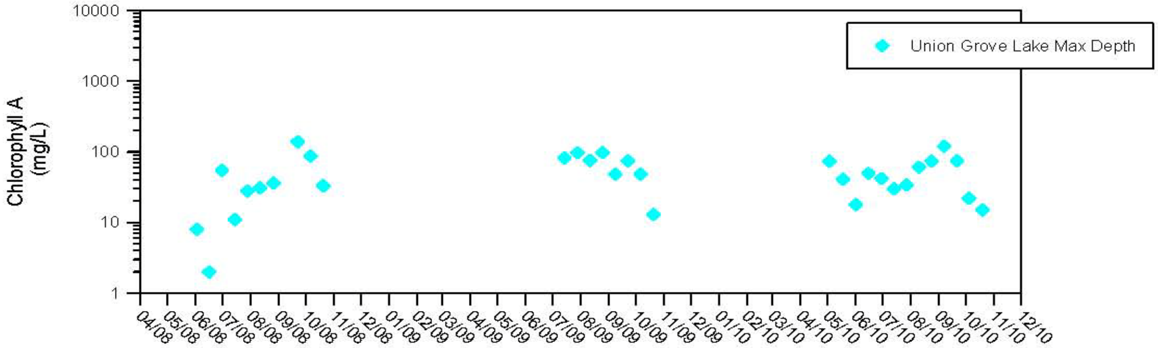


Figure 40 shows project results for chlorophyll sampling at Union Grove Lake's maximum depth site. Chlorophyll *a* concentration is often used to approximate algal biomass and can indicate the relative productivity and condition of a lake. Potential problems with high chlorophyll *a* concentrations include unsightly surface blooms, itching upon skin contact, foul odor, and toxicity from certain cyanobacteria, or blue-green algae.

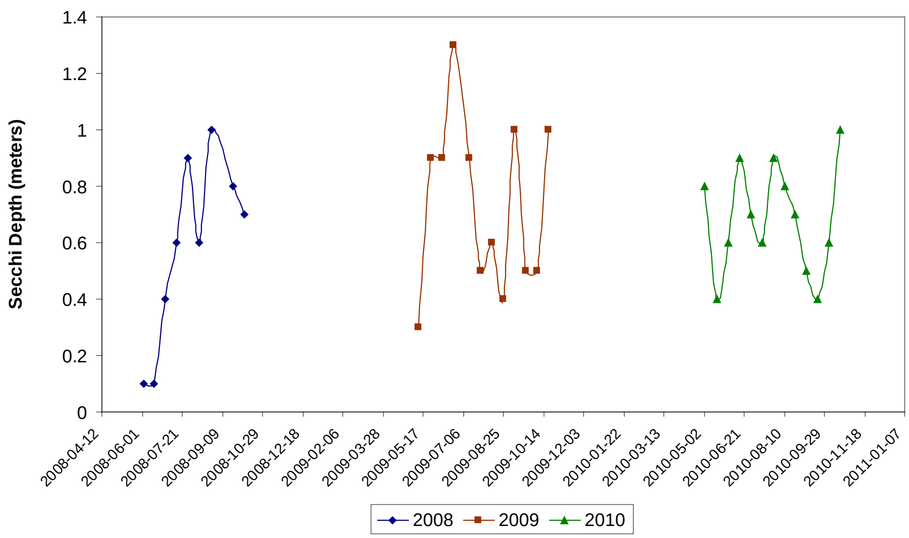
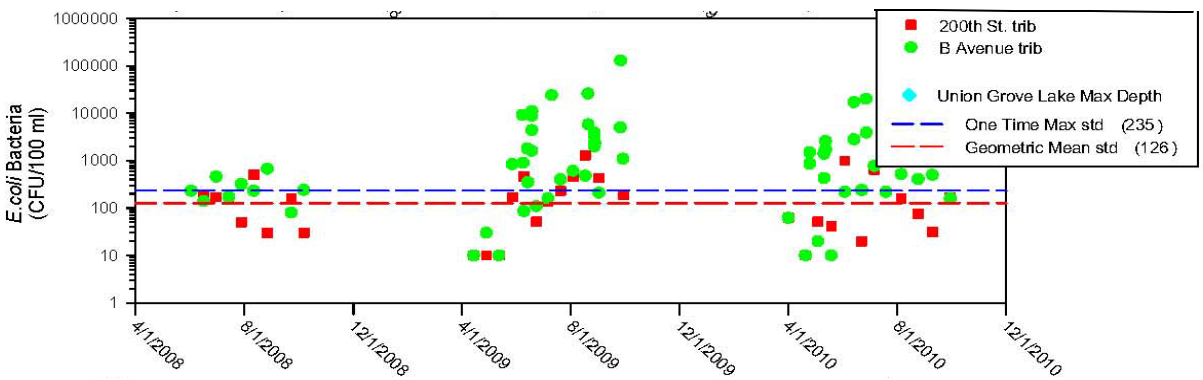


Figure 41

Secchi depth is used to determine the clarity of a lake by lowering a special disc into the water and recording the depth at which it is no longer visible. Water clarity is affected by the color of the water and by organic and inorganic materials suspended in the water column. Secchi depth is often used as an indicator of overall algal abundance and an estimator of general lake productivity. Figure 41 shows Secchi data from all three sampling seasons of the project. A smaller Secchi value indicates poorer clarity conditions.

Figure 42



The U.S. Environmental Protection Agency has recommended that *E. coli* bacteria be used to assess the likelihood of risks to human health from exposure to water containing E. coli. The presence of this indicator merely suggests that as *E. coli* bacteria levels increase in water, there is an increased likelihood that disease-causing pathogens may be present. *E. coli* concentrations at the two tributary sampling sites may be found in Figure 42. Figure 43 depicts *E. coli* sampling results from Union Grove Lake's beach with the Single Sample Maximum Standard of 235 MPN/100ml indicated in red. Figure 44 shows data from the same timeframe with the Geometric Mean Standard of 126 MPN/100 ml indicated in red.

Figures 45 through 47 (2008 through 2010) show the correlation between local rainfall (Toledo, Iowa weather station) and Union Grove Lake beach *E. coli* levels during Project 086-3.08.

Figure 43

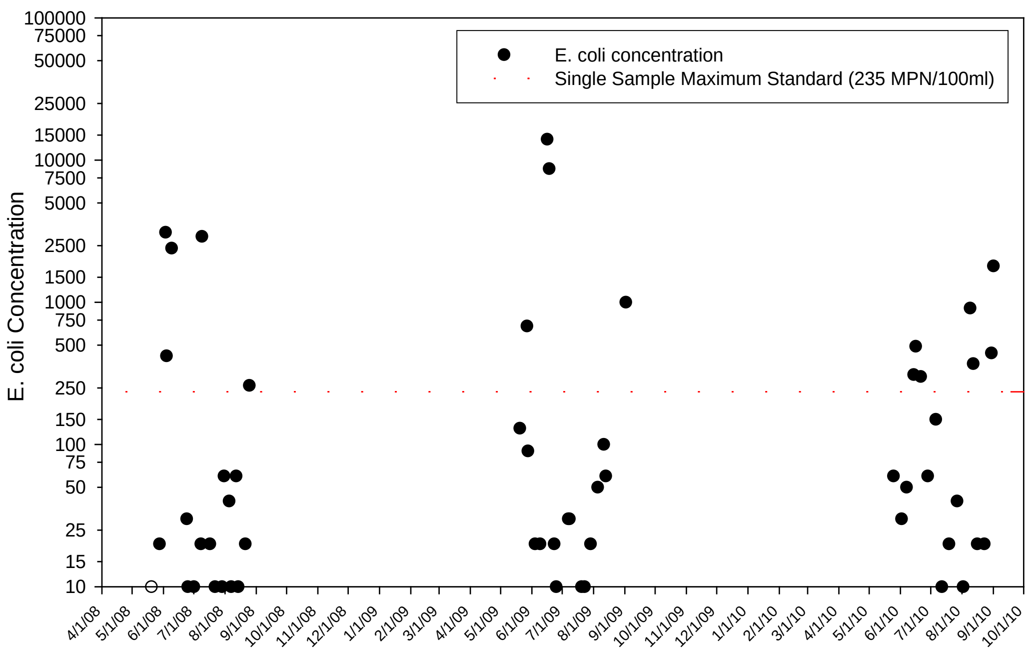


Figure 44

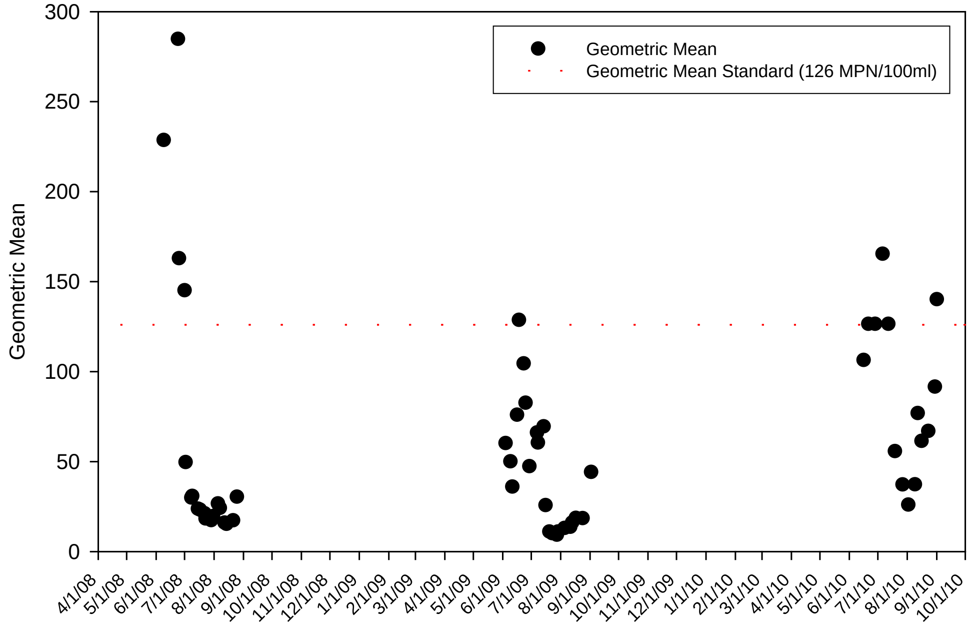


Figure 45

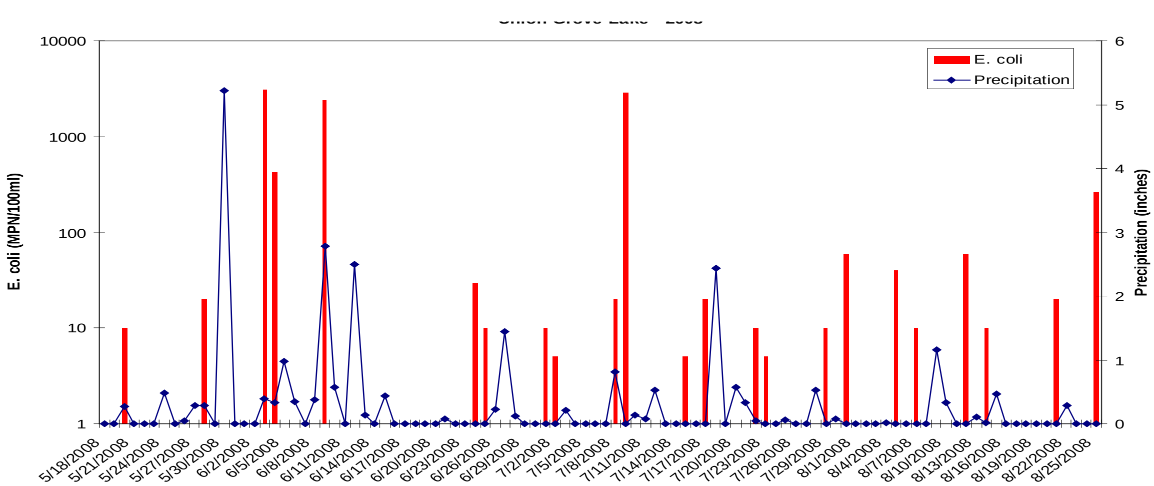


Figure 46

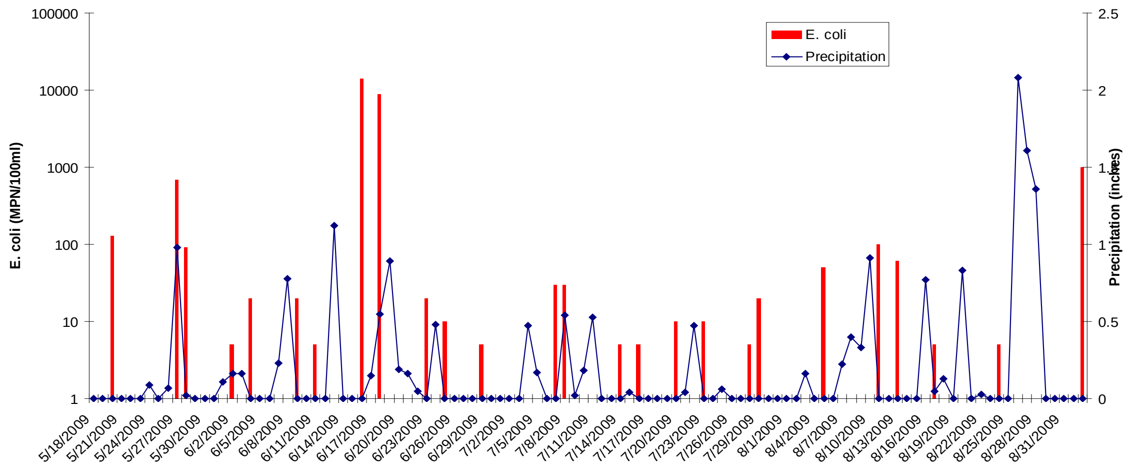
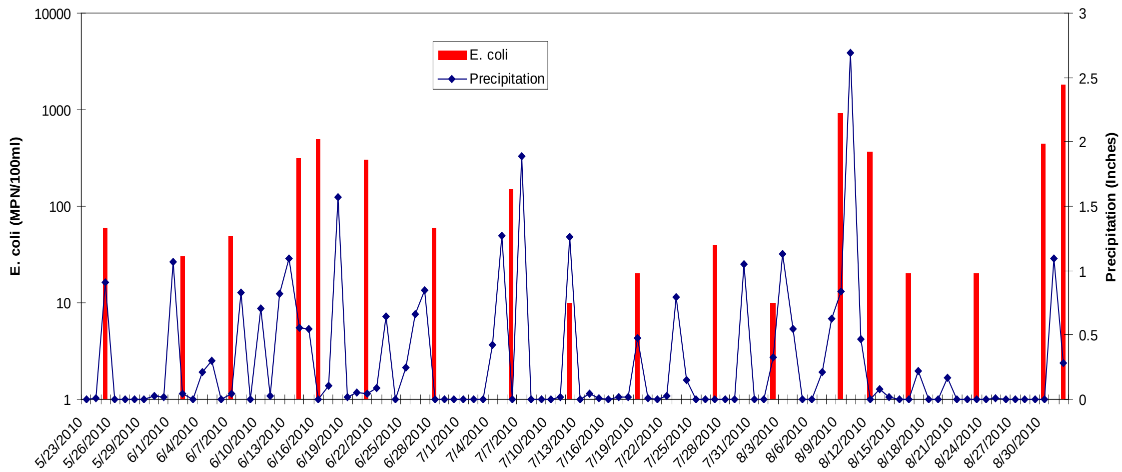


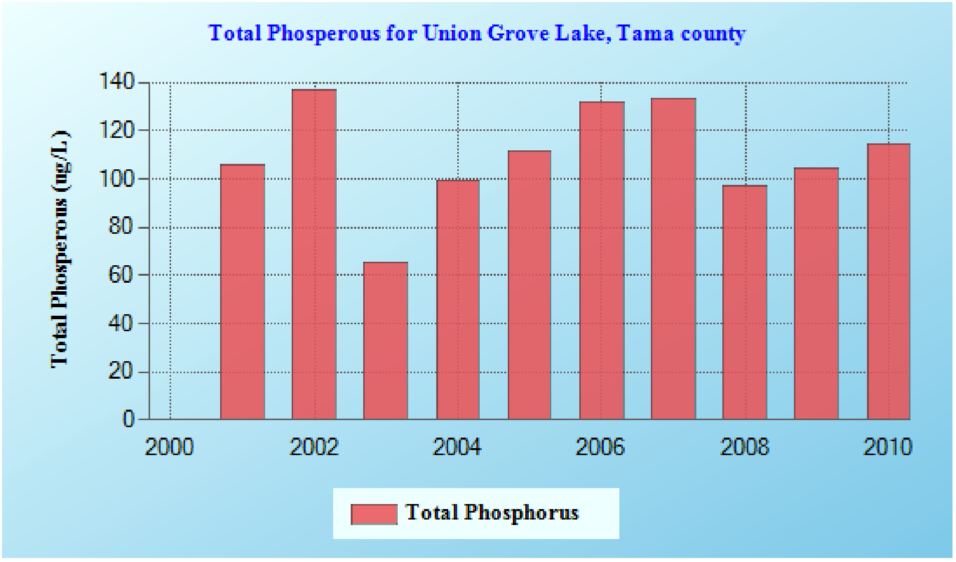
Figure 47



3.3.2 Iowa State University Assessments

Iowa State University (ISU) assessments have been conducted routinely by the Limnology Laboratory in the university's Department of Ecology, Evolution, and Organismal Biology since 2000.

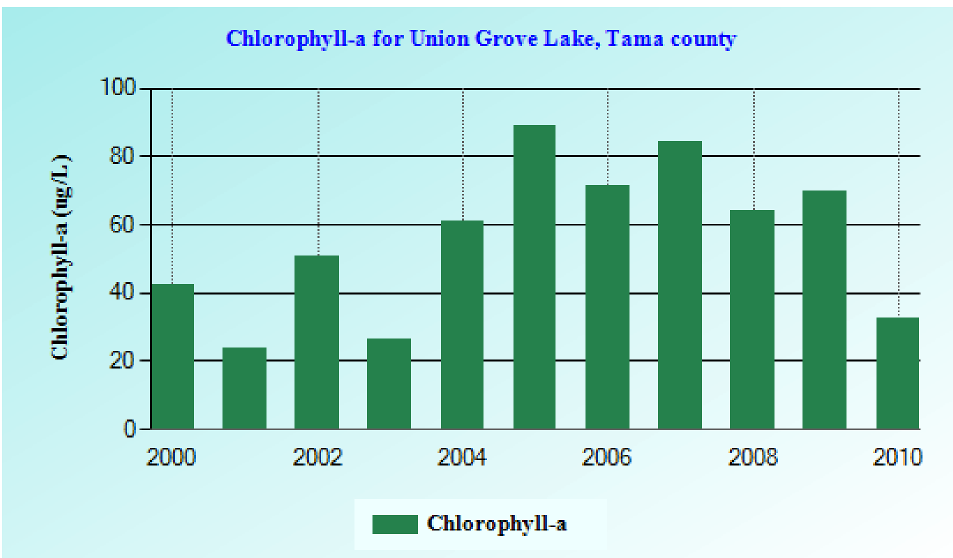
Figure 48



Total Phosphorus results for Union Grove Lake may be found in Figure 48. Phosphorus is often the limiting nutrient for algal growth, and at values above 30 parts per billion (ppb), lakes generally begin to exhibit conditions indicative of eutrophic, or highly productive, systems.

Figure 49 shows data regarding Union Grove Lake's chorophyll *a* concentrations.

Figure 49



The Limnology Laboratory also sampled phytoplankton from 2000 to 2011. Its 2011 composition results presented as percentages of total wet mass are found in Figure 50. It shows the phytoplankton genera for three 2011 sampling dates, June 22, August 10, and September 21.

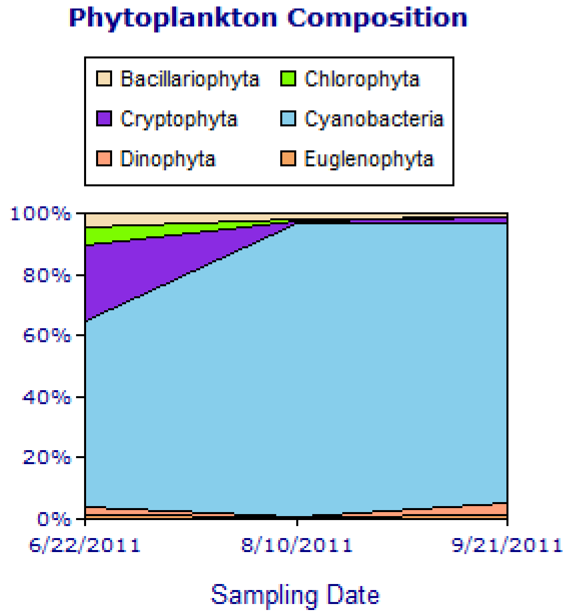


Figure 50

Union Grove Lake's water clarity values ranged from 1.4 to 0.3 meters (4.6 to 1.0 feet) during this 11-year period with a summer mean Secchi depth of 0.6 meters (2.1 feet) from 40 data observations. Figure 51 shows each year's mean as depth from the lake surface.

A more complete table of Iowa State University's results may be found in Figure 52.

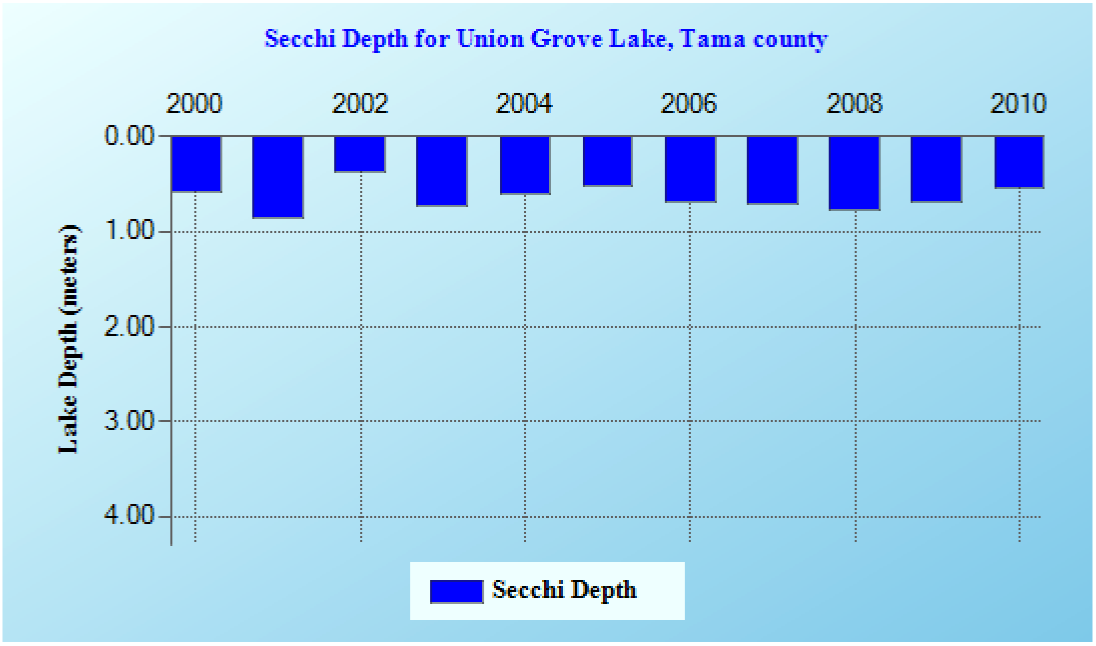


Figure 51

Figure 52

Parameter	2011	2010	2009	2007	2006	2005	2004	2003	2002	2001	2000
Lake Depth (m)	3.5	3.7	3.7	3.7	3.6	3.8	3.8	3.4	3.7	4	3.8

Thermocline Depth (m)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Secchi Disk Depth (m)	0.4	0.5	0.7	0.5	0.6	0.5	0.6	0.7	0.4	0.9	0.6
Temperature(^{o}C)	21.9	22.1	24.7	26.9	23.6	26	23.6	24.4	25.3	24.4	25
Dissolved Oxygen (mg/L)	7.9	9.1	9.9	15.2	7.6	12.9	10.6	11.6	7.5	7.1	9.7
Dissolved Oxygen Saturation (%)	91.4	105.6	119.6	190.1	89.6	162	125.8	139.1	91.5	91.6	118.3
Specific Conductivity (µS/cm)	360	395	380	344.5	341.6	375.2	519.9	419.2	368.4	330.7	311.4
Turbidity (NTU)	41.2	16.5	13.8	21.1	35	27.8	52.2	20.7	99.7	21.3	25.6
Chlorophyll *a* (µg/L)	51.3	32.6	70	103.3	78.9	138.8	61	26.2	50.7	23.6	42.5
Total Phosphorus as P (µg/L)	186.7	114.1	103.9	109	149	89	99	65	137	106	213
TN:TP ratio	-	-	39	147	45	55	42	88	21	123	14
pH	8.3	8.4	8.6	9	8.7	8.5	8.7	8.5	8.6	8.5	7.9
Alkalinity as $CaCO_3$ (mg/L)	148	178	157	132	137	148	164	116	130	147	123
Dissolved Organic Carbon (mg/L)	<7.6	<6.4	<6.2	4.3	3.98	4.41	3.69	6.28	8.86	-	-
Inorganic Suspended Solids (mg/L)	14	11	7	6	8	10	11	11	14	10	18
Volatile Suspended Solids (mg/L)	17	<9	10	9	11	11	9	8	10	7	13
Total Suspended Solids (mg/L)	32	19	17	15	20	20	20	19	25	16	31
Carlson Trophic State Index (Secchi)*	73	69	65	69	66	69	67	64	74	62	68
Carlson Trophic State Index (Chl a)*	69	65	72	76	73	79	71	63	69	62	67
Carlson Trophic State Index (TP)*	80	72	71	72	76	69	70	64	75	71	81

*Index values generally range between 0 and 100, with increasing values indicating more eutrophic conditions.

Iowa State University's 2011 water column profiles for Dissolved Oxygen (Figure 53), pH (Figure 54), temperature (Figure 55), and turbidity (Figure 56) follow:

6/23/2011 **9/23/2011**

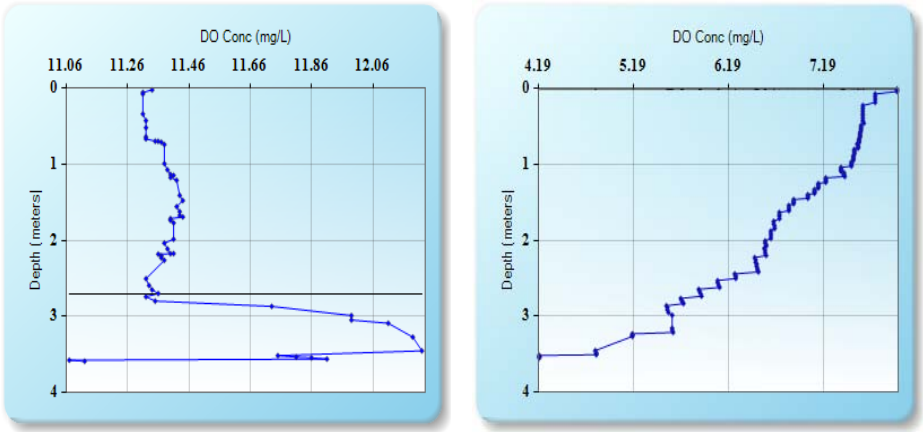


Figure 53

6/23/2011 **9/23/2011**

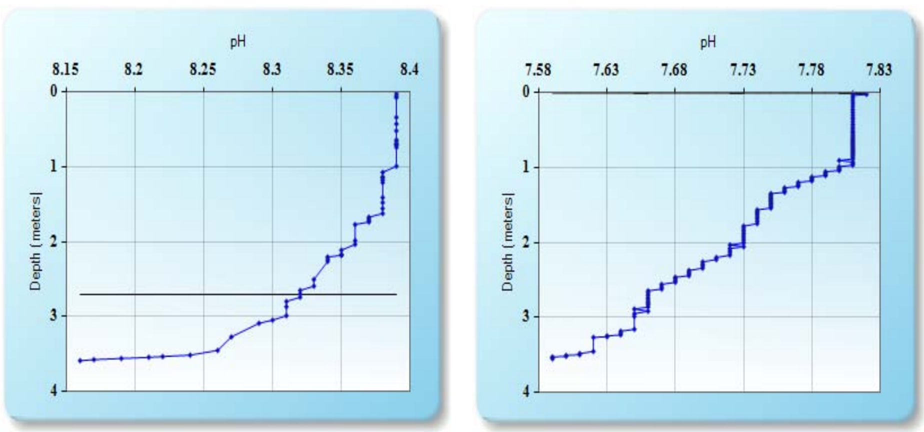


Figure 54

6/23/2011 **9/23/2011**

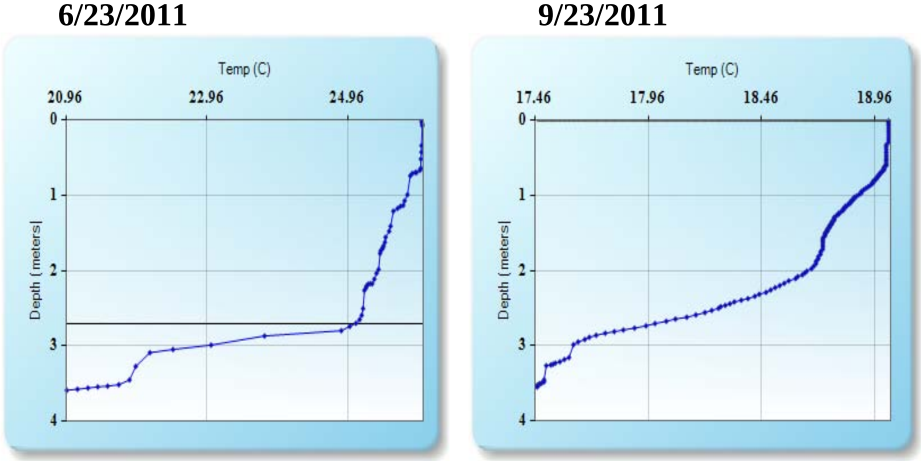


Figure 55

6/23/2011 **9/23/2011**

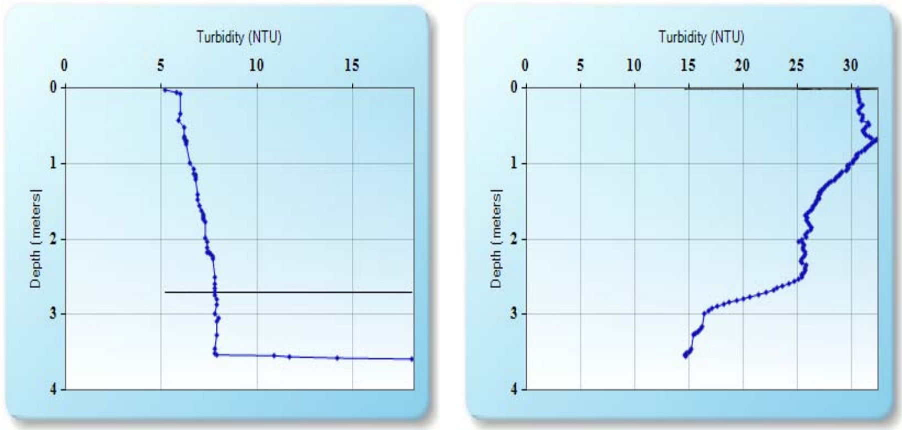


Figure 56

The Limnology Lab's 2010 report notes that of 29 samplings, a thermocline was observed 66% of the time. In late summer, when stratification is most common, the thermocline was formed at an average depth of 7.4 feet. Fish and fish-food organisms have difficulty living in bottom oxygen concentrations <5 mg/l and may die at <2 mg/l. A region of less than 5 mg/l was observed four out of six visits at an average depth of 9.9 feet. A region of <2 mg/l was observed two out of six visits at average depth of 10.3 feet.

3.3.3 Assessments Cited in the Water Quality Improvement Plan (TMDL)

Several data sources were utilized in the development of Union Grove Lake's TMDL: ISU Lake Study, University Hygienic Laboratory (2005-2008), and U.S. Geological Survey, or USGS (2007-2008).

Carlson's Trophic State Index (TSI) is used to relate algae, as measured by chlorophyll; transparency, as measured by Secchi depth; and total phosphorus to one another and to set water quality improvement targets. TSI from ISU Lake Study data may be found in Figure 57 with the seasonal averages in Figure 58.

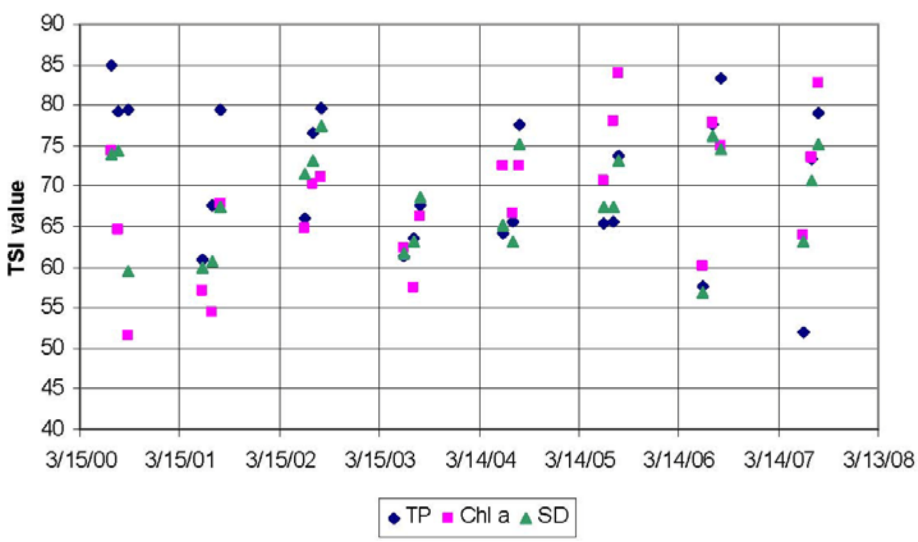
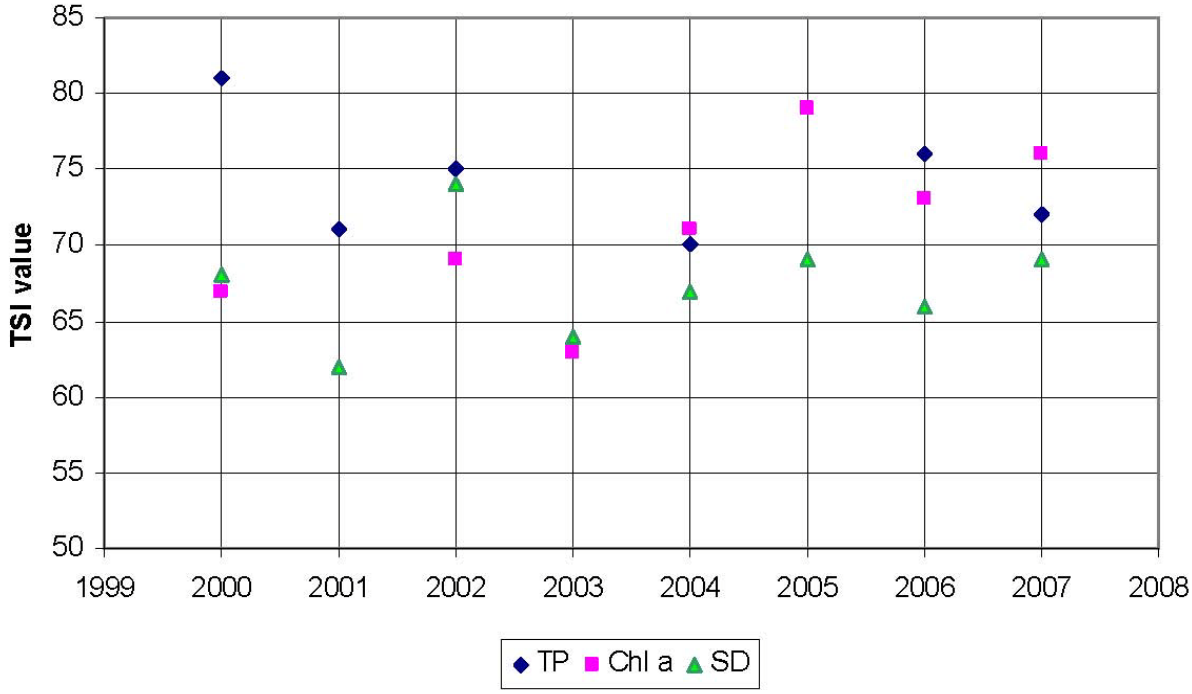


Figure 57

Figure 58

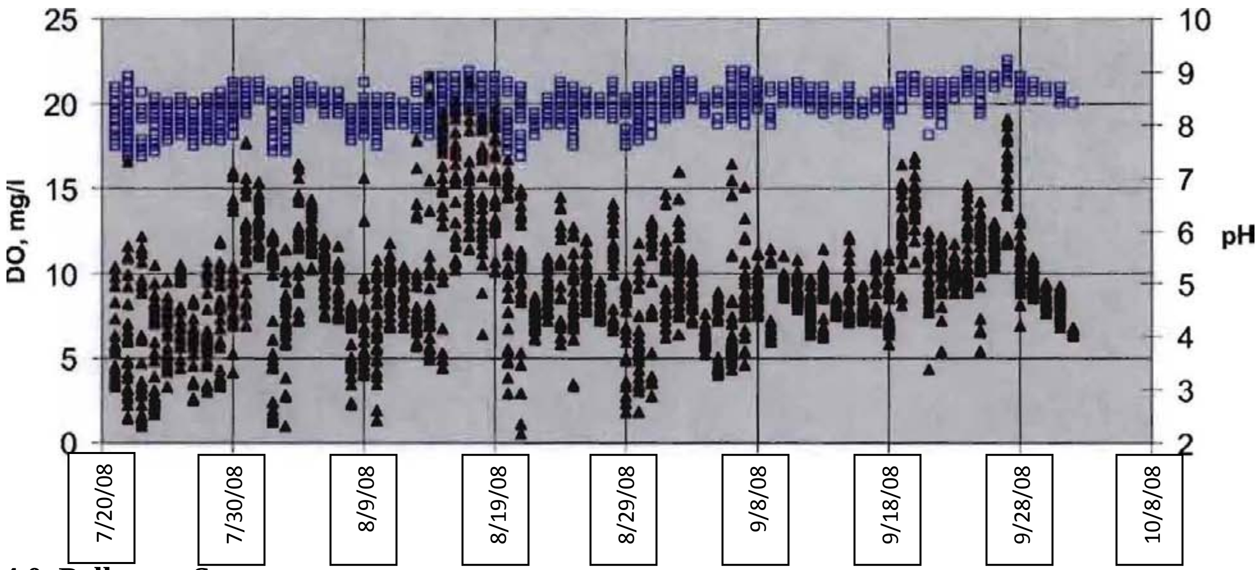


Algal photosynthesis and metabolism cause inverse diurnal variations in dissolved oxygen and carbon dioxide concentrations. In daylight, photosynthesizing algae remove dissolved carbon dioxide from, and add dissolved oxygen to, the upper level of the water column. At night, the opposite occurs during algal respiration.

The major influence on the pH of natural waters is the carbonate system. Shifts in equilibrium between aqueous and atmospheric carbon dioxide, bicarbonate, and carbonate act to shift the pH as the relative concentration of the three carbonate species changes. As carbon dioxide is removed from the system during the day, the hydrogen ion concentration decreases and the pH increases. At night as algae respire, the hydrogen ion concentration increases causing the pH to decrease. Thus, the dissolved oxygen concentration is inversely proportional to the carbon dioxide concentration.

High pH, defined as over the Water Quality Standards criterion of 9.0, was measured in 23% of Union Grove Lake samples between 2002 and 2006. USGS data collected for continuous dissolved oxygen, temperature, and pH from July 21 through October 2, 2008 clearly show a response an algal productivity and respiration. In Figure 59, the dark triangles represent dissolved oxygen, while the blue squares signify pH. Each day's data are displayed as a column for both. The graph clearly shows the relationship between the dissolved oxygen concentration and pH and the algal metabolic link between them. The spread between the highest and lowest oxygen and pH measurements represents the shift in the light available for photosynthesis. As shown, the pH increases when the dissolved oxygen increases from the removal of dissolved carbon dioxide.

Figure 59



4.0 Pollutant Sources

4.1 Assessment Results

4.1.1 Project 086-3.08 Water Quality Assessment Implications

Total Phosphate base flow concentrations at the two tributary sites (Figure 33) were typically low compared to good quality streams in the same region of Iowa. However, large amounts of phosphorus moved through the tributary system during storm events. The lake's maximum depth site showed Total Phosphate concentrations similar to those collected by Iowa's ambient lake monitoring program. The project's lowest median concentration occurred in 2010. Total Phosphate was generally higher in Union Grove Lake than in its tributaries with the exception of the B Avenue site during storm event conditions.

Orthophosphate also showed higher concentrations during storm events at the B Avenue site (Figure 35). This might suggest that phosphorus-laden sediment not only enters Union Grove Lake and its tributaries during storm events but that dissolved phosphorus is also entering the watershed's watercourses. Orthophosphate was also found during base flow conditions at both tributary sites at levels considered "normal" for Iowa streams, but possibly indicating input from field drainage tile. Orthophosphate concentrations at the lake's maximum depth site were fairly consistent throughout the three sampling seasons and were similar to those found in Iowa's ambient lake monitoring program.

During regularly scheduled sampling, both tributary locations had Total Suspended Solids results that were low compared to "good quality" streams during all three sampling seasons (Figure 36). The watershed's TSS medians during the project ranged from 3 to 4 mg/L at the 200th Street site and 6 to 8 mg/L at the B Avenue site. These figures are well below the median concentration for "good quality" streams in this region, which is 27 mg/L. Storm event data from B Avenue, however, showed large amounts of suspended material moving through Deer Creek with median TSS concentrations of 360 mg/L in 2009 and 580 mg/L in 2010. These results are high, even when compared to storm event sampling in other impaired watersheds in Iowa.

Ammonia levels are generally below the detection limit in streams throughout Iowa. Tributary samples taken during scheduled sampling (Figure 37) were all below the detection limit except for one occurance in each data set from 2009 and 2010 at the 200th Street location. Storm event sampling at B Avenue shows ammonia levels occasionally over the detection limit during storm events, but the majority of storm samples were either below or very near the detection limit. The 2008 maximum depth in-lake site samples were high when compared to Iowa's ambient lake monitoring program, but lake samples from 2009 and 2010 were comparable to the median from the ambient lakes program. 2009 samples were generally below the detection limit, possibly due to late spring crop nitrogen application. Lake results from 2010 were very similar.

Scheduled sampling levels for Nitrate + Nitrite Nitrogen at both tributary sites were elevated compared to "good quality" streams in the same region, possibly suggesting input from field drainage tile (Figure 38). Storm event sampling from B Avenue had lower levels, most likely due to dilution. Concentrations from in-lake sampling were much higher compared to most other lakes in the ambient lake monitoring program.

Figure 39 shows Total Kjeldahl Nitrogen levels at both tributary sampling sites that are low compared to "good quality" streams in the same region. Storm sampler results from B Avenue showed higher concentrations of TKN during storm events during both years the sampler was used. All in-lake samples were similar to those collected by Iowa's ambient lake monitoring program.

Chlorophyll *a* levels in Union Grove Lake (Figure 40) were elevated throughout sampling when compared to concentrations from waterbodies in the ambient lake monitoring program. Concentrations in 2009 were consistently higher, perhaps due to relatively lower rainfall causing more stagnant water, allowing increased algae production.

Frequent and heavy rains early in the 2008 sampling season most likely contributed to the low Secchi readings during that time (Figure 41). Other data responses were probably due to heavy rains and algae blooms. Late-season decreases in Secchi values were probably due to algal blooms during fall lake turnover.

Sampling at the tributary sites showed *E. coli* levels slightly higher at B Avenue than 200th Street (Figure 42). During three seasons of scheduled sampling, 14 of 33 B Avenue samples exceeded the state water quality standard. Storm event samples from this site revealed concentrations even more pronounced. *E. coli* tended to increase rapidly after rainfall events and levels were always higher in samples collected as the stream rose compared to samples collected as the stream fell back to normal. During base flow conditions, *E. coli* levels were generally below Iowa's single-sample maximum water quality standard, which is uncommon for streams of their size.

Union Grove Lake beach bacteria levels (Figures 43 and 44) appeared highest in the spring during 2008 and 2009 and were more widespread during 2010. The beach had bacteria warnings posted four times each in 2008, 2009, and 2010. High levels of bacteria in 2008 (Figure 45) paralleled very closely with rainfall events. 2009 (Figure 46) and 2010 (Figure 47) bacteria counts did not correspond as well with the rainfall data. 2009 showed the highest bacteria levels in spring, with relatively low levels present until September. In 2010, late summer and fall rains may have caused increases in *E. coli* levels, but for the remainder of the sampling season, bacteria levels stayed very consistent.

4.1.2 Iowa State University Water Quality Assessment Implications

Union Grove Lake's Total Phosphorus values (Figure 48) ranged from 28 to 280 ppb during the 10-year sampling period with a summer mean Total Phosphorus of 112 ppb from 35 observations. This compares to an average of 108 ppb for all Iowa lakes.

Union Grove Lake's chorophyll *a* concentrations (Figure 49) ranged from 5 ppb to 231 ppb during this 10-year period with a summer mean of 64 ppb from 38 observations. The average for all Iowa lakes is 44 ppb. These data indicate that Union Grove Lake may have higher chlorophyll *a* concentrations and lake productivity compared to other Iowa lakes during normal summer conditions.

Union Grove Lake's mean Secchi depth of 0.6 meter (Figure 51) compares to an average of 1.2 meters for all Iowa lakes surveyed, suggesting that during normal summer conditions, Union Grove Lake may have higher abundance of algae and lake productivity.

Carlson's Trophic State Index values for Secchi disc, chlorophyll a, and Total Phosphorus are indicated in the blue section of Figure 52. The 2010 values indicate that Union Grove Lake is between eutrophic and hypereutrophic classes, utilizing Carlson's Trophic State Index for Secchi depth (64), chlorophyll a (66), and Total Phosphorus (66).

4.1.3 TMDL Source Implications

Based on values from ISU sampling 2000-2007, the mean ratio of total nitrogen to Total Phosphorus is 67:1. The median ratio is 29:1. This ratio suggests that nitrogen is not the limiting nutrient in Union Grove Lake.

Review of Inorganic Suspended Solids data from the ISU sampling shows that Union Grove Lake is subject to episodes of high non-algal (inorganic) turbidity. The median ISS for this lake was 9.4 mg/l, which ranked Union Grove Lake the 24th highest of the 132 Iowa lakes compared in the 2008 305(b) water quality assessment.

If the Trophic State Index values for all three variables are the same, this indicates the relationships between Total Phosphorus, algae, and transparency are strong. If the TSI value for TP is higher than for chlorophyll, there are limitations to algal growth besides phosphorus. The TSI values plotted in Figure 58 indicate some limitation of algal growth attributable to light reduction from elevated levels of suspended solids. Of the years shown in this figure, 2003 showed the best water quality and relatively little variation throughout the summer.

Evaluation of the Union Grove Lake monitoring data indicates the lake's limiting nutrient for algae growth is phosphorus. A plot that compares the three TSI variables and interprets the differences between them is shown in Figure 60. Union Grove Lake's variables show this lake system plots in the lower right quadrant. A point in this location (4.3, -1.6) indicates that there is a slight surplus of phosphorus, meaning that not all available TP is expressed as algae. This plot also indicates non-algal turbidity is a factor and that zooplankton is grazing on the algae.

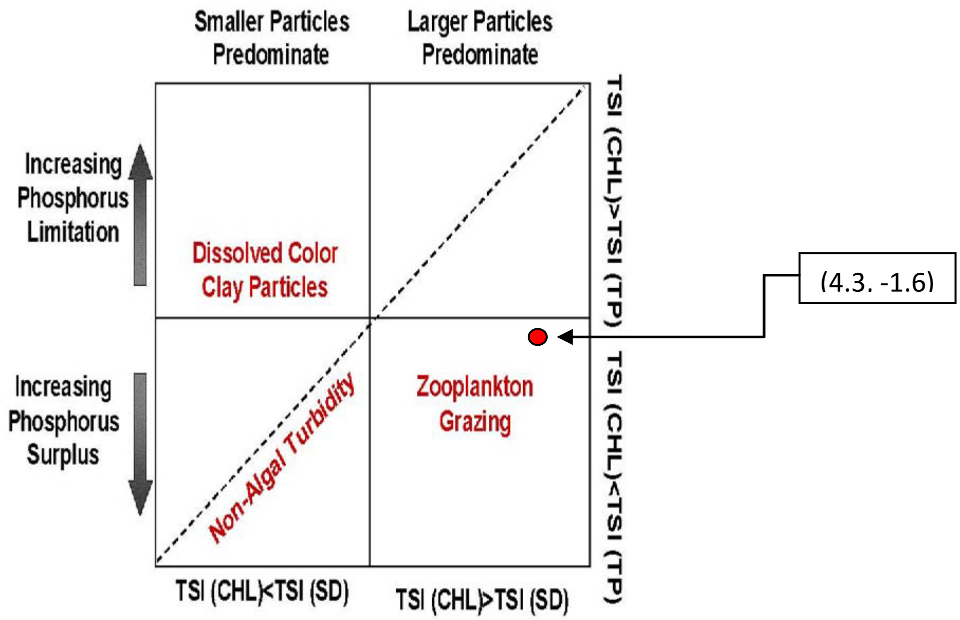


Figure 60

A logarithmic plot of the data in Figure 59 reveals a statistical regression of the relationship between the log dissolved oxygen and pH. The relationship is significant in that the correlation coefficient indicates 76.5% of the rise in Union Grove Lake's pH is explained by the dissolved oxygen concentration.

The USGS continuous data set from Summer 2008 does not include measurements of dissolved carbon dioxide, but ISU Lake Study 2000-2007 data do. The regression shown in Figure 61 shows a strong inverse correlation between pH and carbon dioxide. This is predicted in a natural water system where pH is driven by carbonate equilibrium. As shown in the WASP modeling section of the TMDL's Appendix D, the dissolved oxygen-dissolved carbon dioxide dynamics are the consequence of algal photosynthesis and respiration. Therefore, decreasing the mass and duration of algal blooms in Union Grove Lake will control the diurnal rises in pH that exceed the water quality standard criteria.

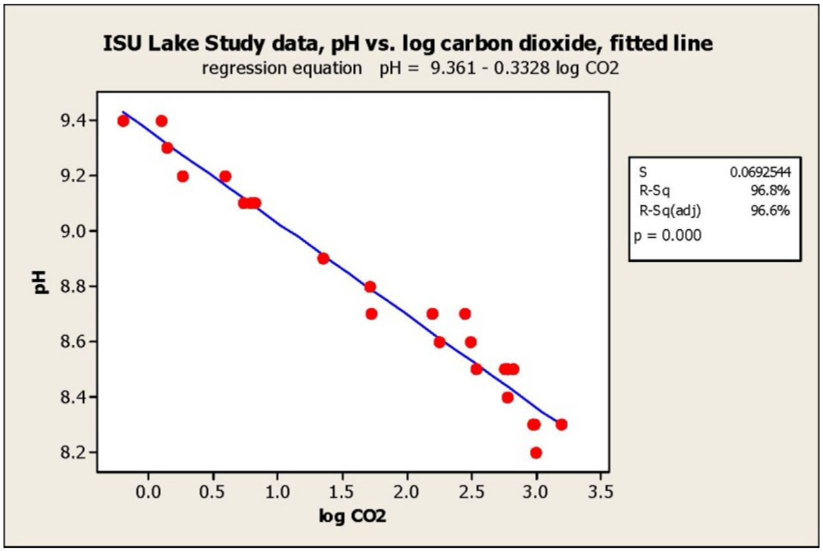


Figure 61

4.1.4 Rapid Assessment of Stream Conditions Along Length (RASCAL)

Of the 24 stream and buffer parameters examined during the watershed's RASCAL, five key parameters--stream substrate, streambank stability, riparian buffers, adjacent land cover, and knickpoints--were determined illustrative of existing conditions and were used for evaluating potential water quality threats in the watershed. For RASCAL purposes, Figure 62 illustrates how the surveyed steams are divided into segments according to common conditions.

Figure 62

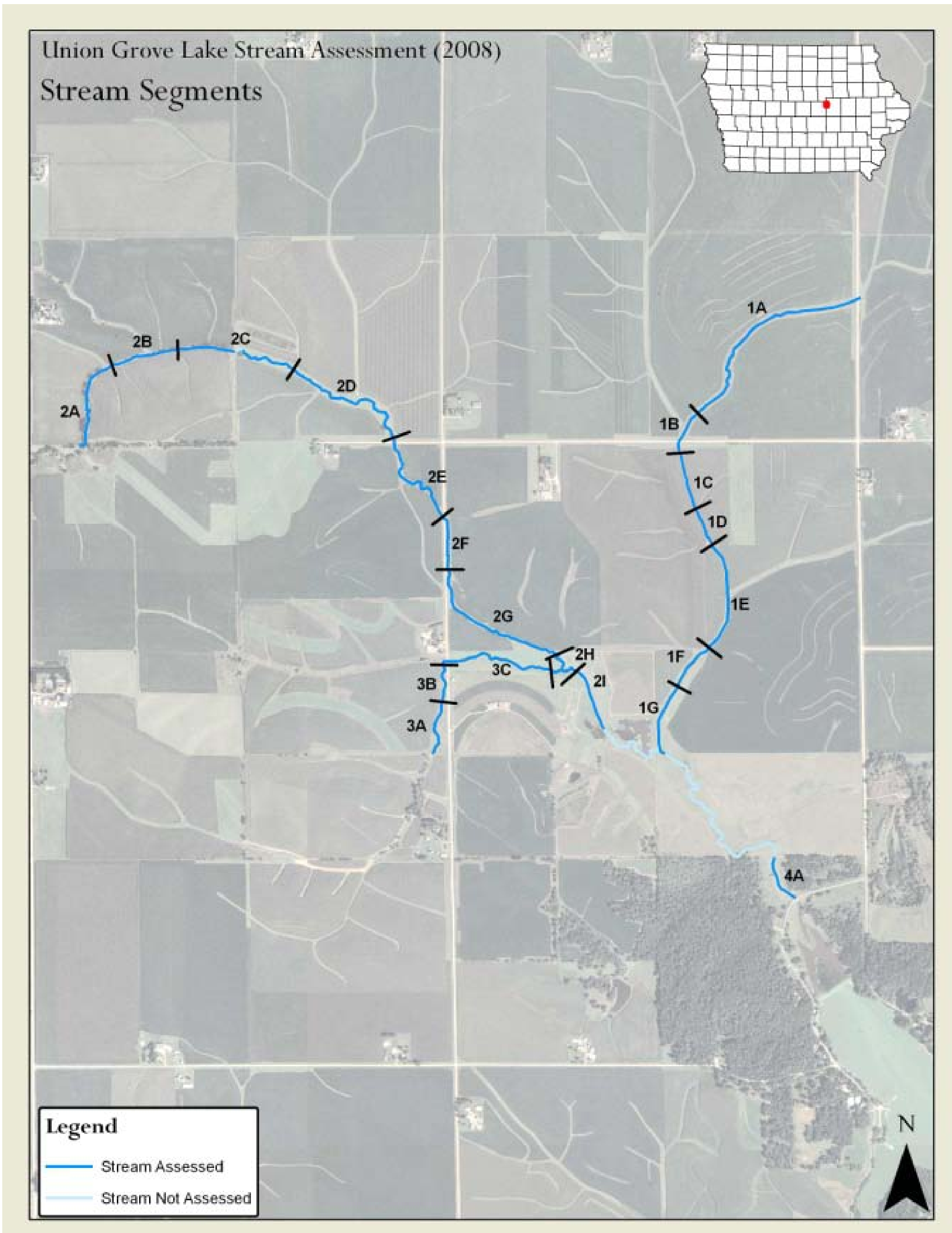


Figure 63

Stream Segment	Limiting Substrate Issues	Streambank Stability Issues	Lack of Riparian Buffers	Adjacent Land Cover Issues	Presence of Knickpoints
1A			X	X	
1B	X		X	X	
1C			XX	X	
1D	X		X	X	
1E	X		XX	X	
1F	X		X	X	
1G	X			X	
2A	X		X	X	
2B	X	X	X	X	
2C		X	X	X	
2D		X	X	X	XX
2E		XX	XX	X	
2F		X	X	X	
2G			X	X	
2H	X		X		
2I	X				
3A			X	X	
3B	X		X	X	
3C	X		X	X	
4	X				

Figure 63 shows where a problem existed (X) within a particular stream segment. XX indicates where a severe problem or limitation existed.

For the most part, the streambanks in Stream Segments 1,3, and 4 are relatively stable. However, according to the RASCAL data and LiDAR imagery, several problems exist along Segments 2B through 2E. There are numerous knickpoints within these segments along with areas of channel degradation and streambank erosion. These issues result from significant hydrologic changes in a watershed. Of the potential causes, the most probable is stream straightening. Straightening a stream may make the adjacent farmland more farmable, but it also shortens the overall length of the stream, increasing the streambed slope and the rate of flow within the channel. It is likely this increased rate of flow generated the numerous knickpoints found in Segments 2C through 2E. As knickpoints cut further down into the streambed, the toes of adjoining streambanks typically erode, causing the bank themselves to become unstable and slough into the stream. The RASCAL found this in Segments 2B through 2E and is further supported by the channel gradient chart found in Figure 64. The streambed elevation data indicates major grade changes are occurring within Segments 2B and 2C.

According to historical aerial photographs, an attempt to straighten Deer Creek occurred in Section 29 of Spring Creek Township (T85N R16W) on Segment 2G sometime between 1930 and 1990 (Figures 65 and 66). Another occurred around 2005 in Spring Creek Township's Section 30 on Segment 2E (Figures 67 and 68).

Figure 64

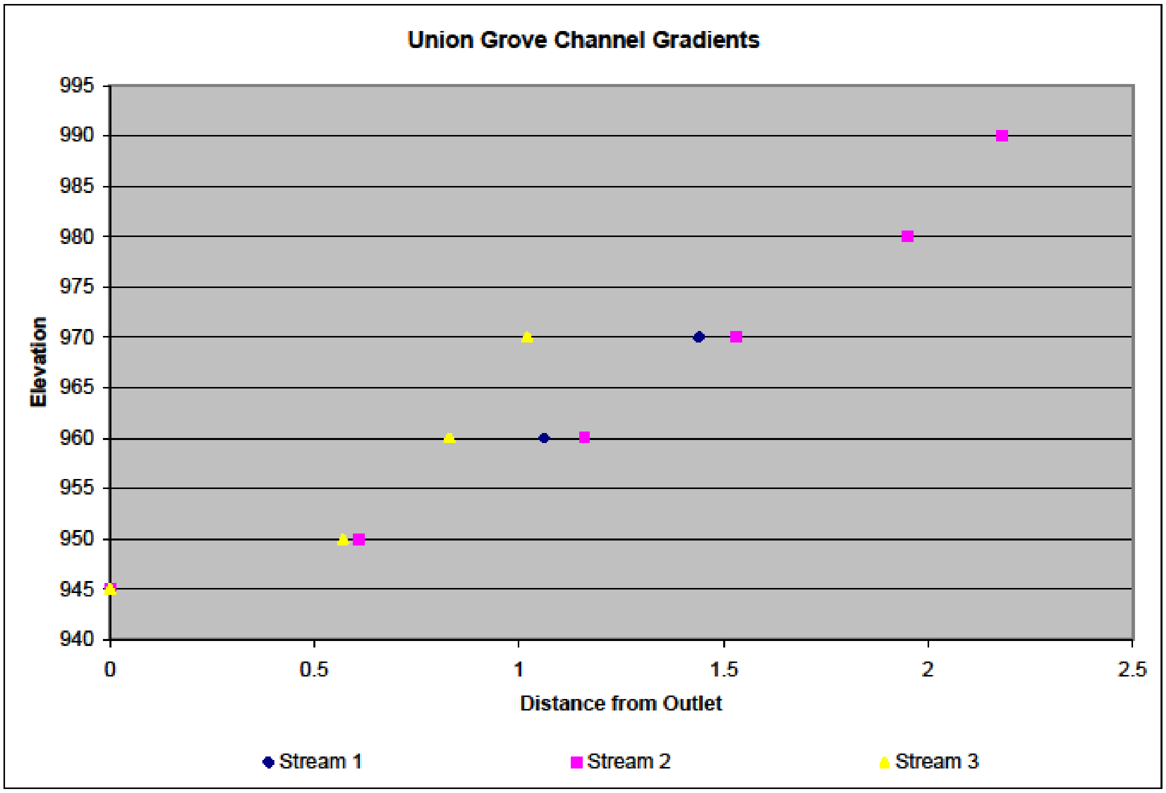
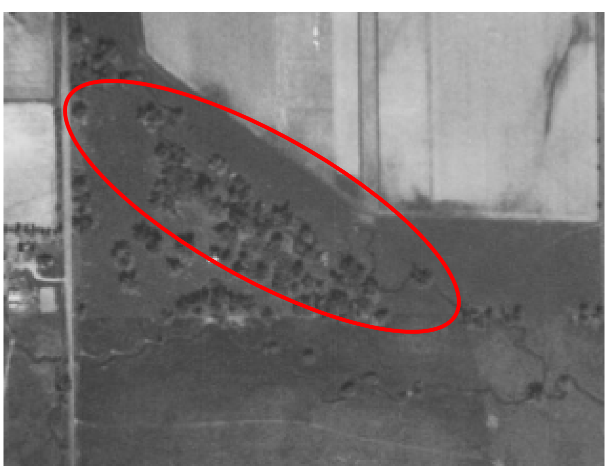


Figure 65



Deer Creek ~1937, NW ¼ Section 29, Spring Creek Township

Figure 66

same site, 1990

Figure 67

Figure 68

Deer Creek 2002, NE ¼ Section 30, Spring Creek Twp same site, 2006

4.2 Water Quality Improvement Plan (TMDL)

All information in this section is from Union Grove Lake's TMDL, released in July 2009. The TMDL data presented here were accurate for the conditions existing in the 2004 land use assessment and thus do not take into account the sediment-trapping complex presented in Sections 2.7.2 and 4.4 of this document.

No permitted point sources are located in Union Grove Lake Watershed.

Nonpoint sources and internal recycling of pollutants (Figure 69) from bottom sediments adversely affect lake water quality due to phosphorus: agricultural activities, inadequate on-site septic tank treatment systems, wildlife (especially Canada geese), runoff from the lakeshore residential areas, atmospheric deposition, groundwater from fractured limestone, and re-suspension of lake bottom sediments. These sources affect turbidity either due to algal growth or inorganic suspended solids.

Figure 69

Current Load Source	TP Load (lb/year)	Percent of Total
watershed	5,870	57.7
septic tank systems	13	0.1
geese	68	0.7
groundwater seepage	449	4.4
atmospheric deposition	31	0.3
internal recycling	3,739	36.8
total	**10,170**	**100.0**

The TMDL also lists nonpoint pathogen indicator sources of livestock, manure applied to fields, wildlife, and failed onsite septic tank systems as two components:

- episodic- livestock and wildlife fecal material transported periodically during precipitation events
- continuous- discharges from inadequate septic treatment systems and manure from cattle in/near streams.

According to the TMDL, the maximum existing load to Union Grove Lake occurs during precipitation events when maximum runoff and runoff flow bacteria concentrations are highest. These high loads and flows cause the lake bacteria concentration to exceed the water quality criteria. The other condition leading to criteria violations occurs when there is a long hydraulic residence time in the lake. At such times, flows are minimal, and the continuous loads from livestock in the stream, local wildlife, and lakeshore septic systems accumulate and cause a problem.

4.3 Livestock and Manure

Note that due to crop rotations, cattle manure is not applied to, nor is livestock winter grazed on, every acre of a livestock owner's operation every year (Figure 70).

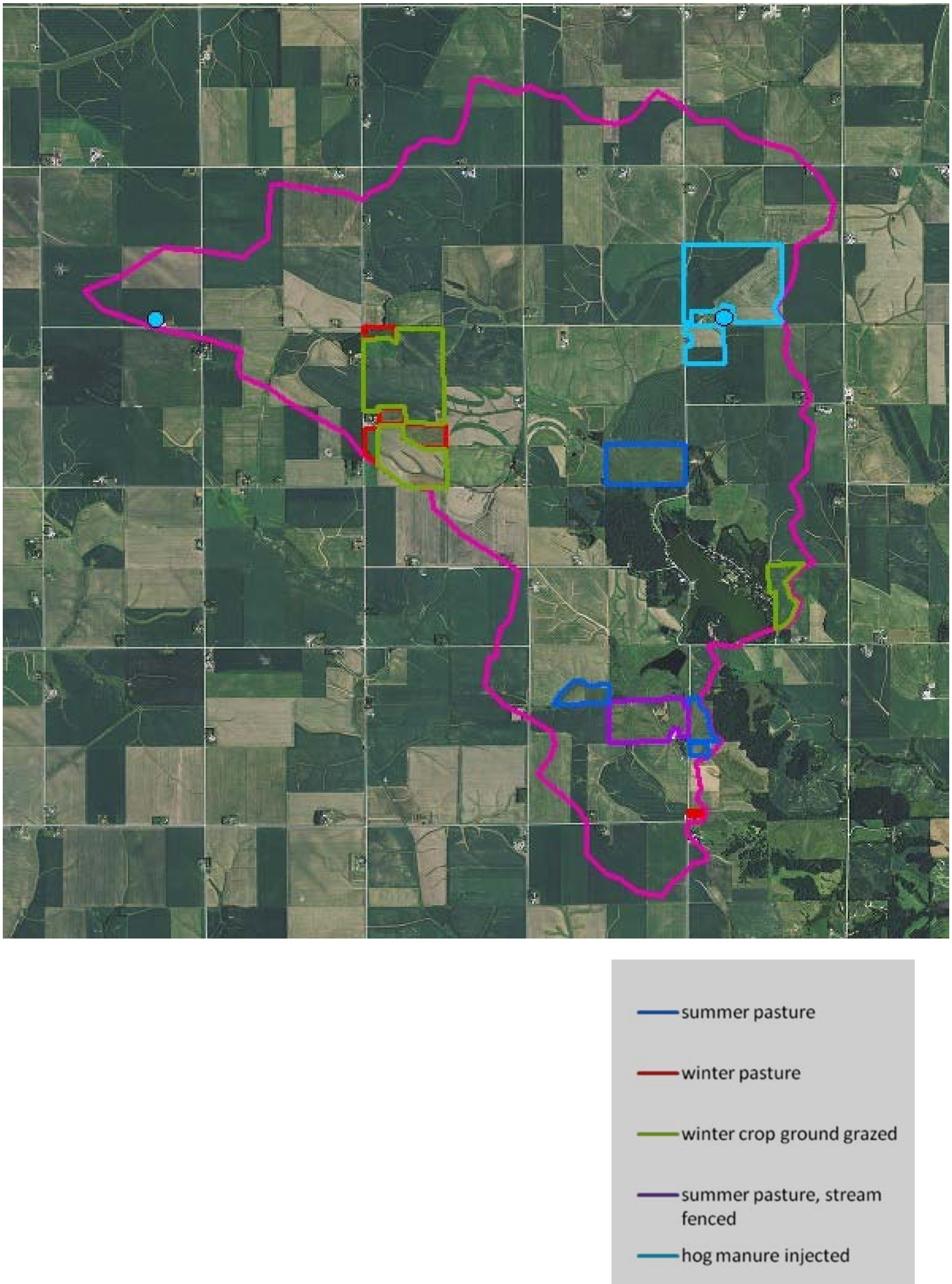
Union Grove Lake Watershed is home to approximately 40 year-round cow/calf pairs. These are pastured June through October in an 80-acre pasture with uncontrolled access to Deer Creek. November through May, this same herd is mostly winter grazed in the west-central portion of the watershed on fields which contain corn stalks from the previous crop. The stakeholder also utilizes a small acreage of winter pasture with no stream access in the upper reaches of the watershed. This producer's feedlot manure is field-applied in upper portions of the watershed with no stream access.

Three additional stakeholders pasture a total of approximately 57 cow/calf pairs on summer pasture (usually July through September) and are removed from the watershed each September.

One final cattle producer with a 70-acre pasture on the southwestern stream tributary is in the process of installing paddock and stream corridor fencing to limit livestock access to the tributary. A pond has already been constructed on the property which has stabilized erosion in a large gully and will be used to feed a remote livestock watering system. The livestock are excluded from access to the pond. This producer's 45 cow-calf pairs occasionally winter graze corn stalks on property east of Union Grove Lake's spillway.

In addition to cattle, two confinement hog operations are located in Union Grove Lake Watershed. One operation in the northwestern extreme of the watershed removes all manure from the watershed. The second operation, in the northeastern watershed quadrant, injects its manure on the contour in crop fields adjacent to the operation.

Figure 70


summer pasture
winter pasture
winter crop ground grazed
summer pasture, stream fenced
hog manure injected

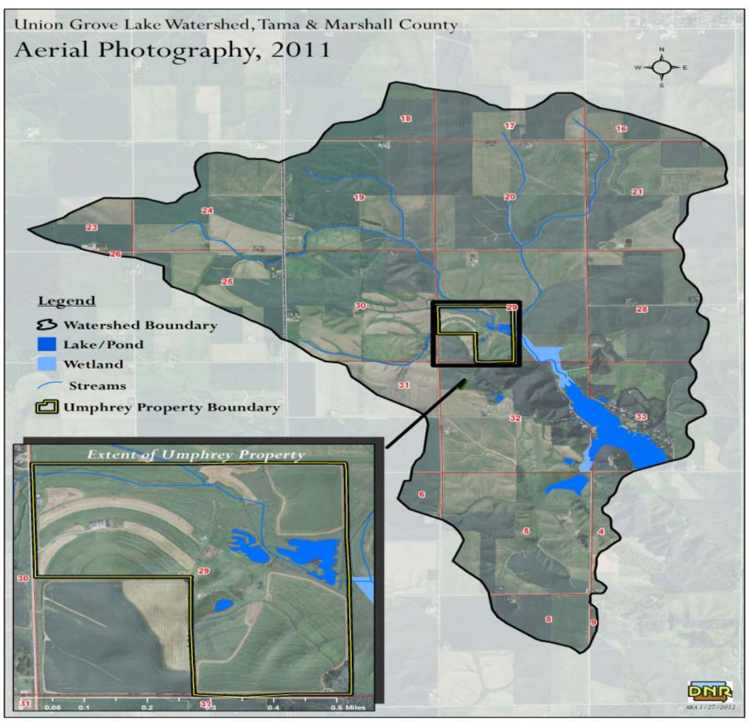
4.4 Influence of Recent Changes in Land Use

As mentioned in Section 2.7.2, a wetland complex was constructed on Deer Creek in the southwest quarter section of Spring Creek Township's Section 29 beginning in 2003 (Figure 71). It was not included in the 2004 land use assessment conducted by the IDNR nor utilized in Union Grove Lake's Water Quality Improvement Plan. The structure's sub-watershed of 2,892 acres is nearly 42% of Union Grove Lake's watershed.

The primary impoundment structure on Deer Creek's main channel has a small surface outlet, therefore its sediment retention capability is not as high as the IDNR's temporary impoundment structure off the southwest corner of Union Grove Lake. Still, due to its water retention capacity, the structure's sediment retention is likely very high, though not as high as a full impoundment structure. The main structure's normal pool is approximately five acres. With roughly two feet of stage, it has about 15 acre-feet of storage. According to Iowa Natural Resources Conservation Service State and Area 3 Engineers, a sediment trapping efficiency estimate of 75% is an extremely conservative trapping rate for a structure of this nature. Data assuming this approximation was utilized in the revised sediment delivery estimates to be covered in Section 4.5 of this document.

Over the past few years rumors of potential change in ownership has caused some interest in pursuing a conservation easement or land acquisition for the property. To justify this potentially hign expesnse, IA DNR GIS staff calculated 9 different land use scienarios. Each scienario shows the potential change in sediment and phosphorus delivery to Union Grove Lake.

<u>Deer Creek Wetland Catchment (83 acres) – Also known as Umphrey Property</u>



Scenario	Change Area	Acres Changed	Sed. Delivery	Change
#1 (Baseline condtions)	None	None	438	0
#2 (CRP to CB)	Terraced Fields	32	452	+15
#3 (CRP to CB)	Entire Property	83	479	+40
#4 (CRP to CB, Wetland Removed)		83	1910	+1472

4.5 Updated Erosion and Sediment Delivery

Through personal contact with the owner and/or operator of nearly all of the watershed's agricultural tracts, it has been found that most of the terraces installed prior to the current project have been well-maintained, with the terraces' storage areas periodically cleaned of sediment and the spoil added to the terrace fills to help compensate for minor erosion. Storm damage has been repaired as needed. While not new structures, most of the watershed's terraces appear to be functioning well, despite their age.

With the inclusion of LiDAR data, sheet and rill erosion information was updated by IDNR in December 2008 (Figure 72). The watershed's average sheet and rill soil loss was estimated to be about 1 ton/acre/year. Sediment delivery to Union Grove Lake from sheet and rill erosion throughout the watershed was updated at the same time and estimated to be just over 600 tons/year, or under 0.1 ton/acre/year. Areas experiencing significant sheet and rill erosion are indicated in red.

Considering this data and the constructed wetland complex discussed in Section 4.4, IDNR updated the watershed's estimated total sediment delivery in January 2012 (Figure 73). The data indicates the watershed's total sediment delivery is approximately 2,658 tons/year, or about 0.4 ton/acre/year. Areas contributing sediment, and therefore phosphorus, to Union Grove Lake are found in darker shades of brown.

This total sediment delivery corresponds with an estimated Total Phosphorus load from the watershed of 3,788 lb/year. Substituting this updated data for the watershed's contribution to the lake's TP load found in the TMDL's Section 3, the estimated TP loads to Union Grove Lake are as found in Figures 74 and 75. According to these estimated figures, while the watershed still contributes to the lake's TP load, internal recycling within the lake itself appears to be contributing almost half of the system's Total Phosphorus, as significant a contributor as the entire watershed.

Please note the existing wetland, in its existing condition, is preventing approximately 1472 tons of sediment from reaching Union Grove Lake each year, and thus 1767 pounds of TP annually.

Figure 71

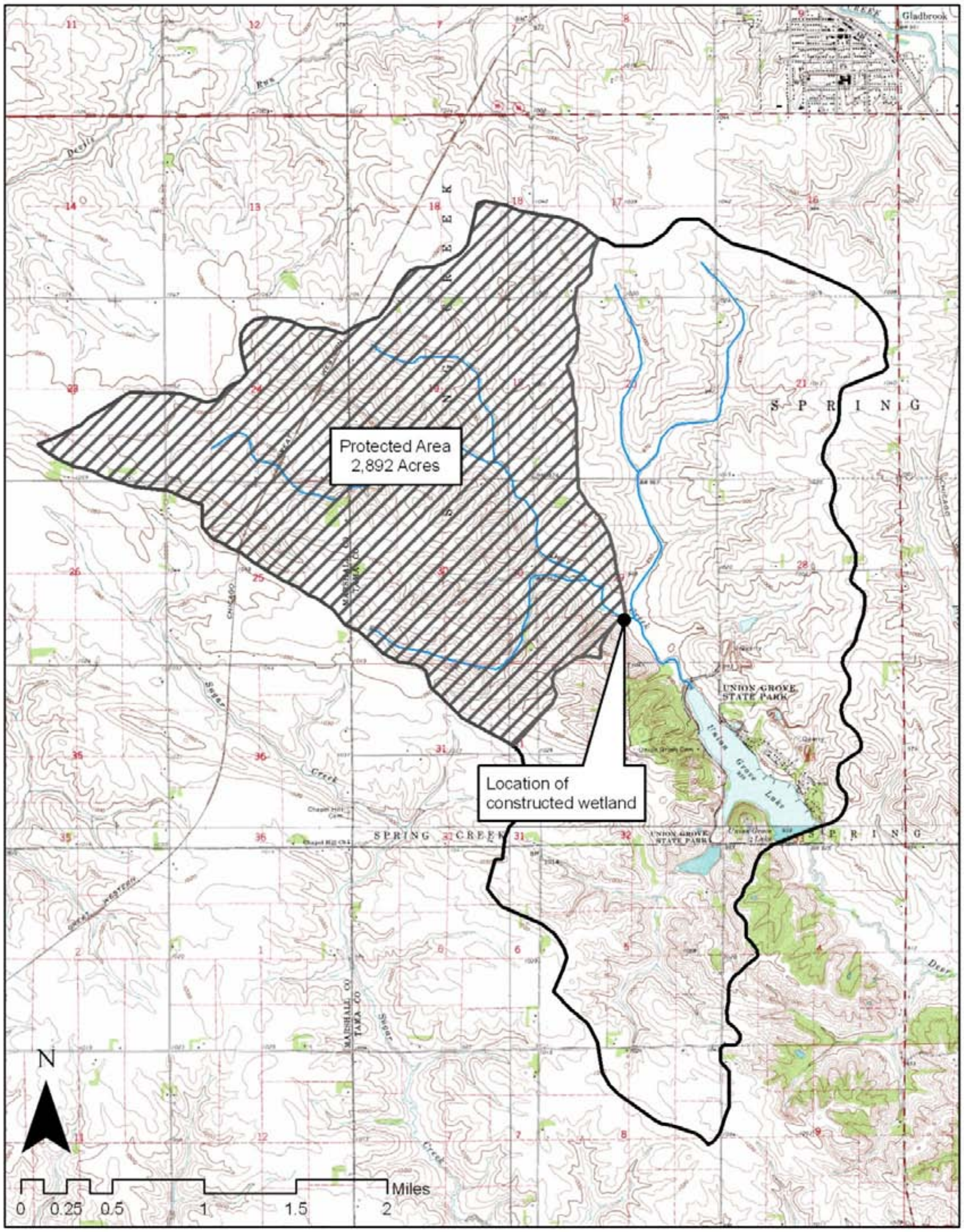
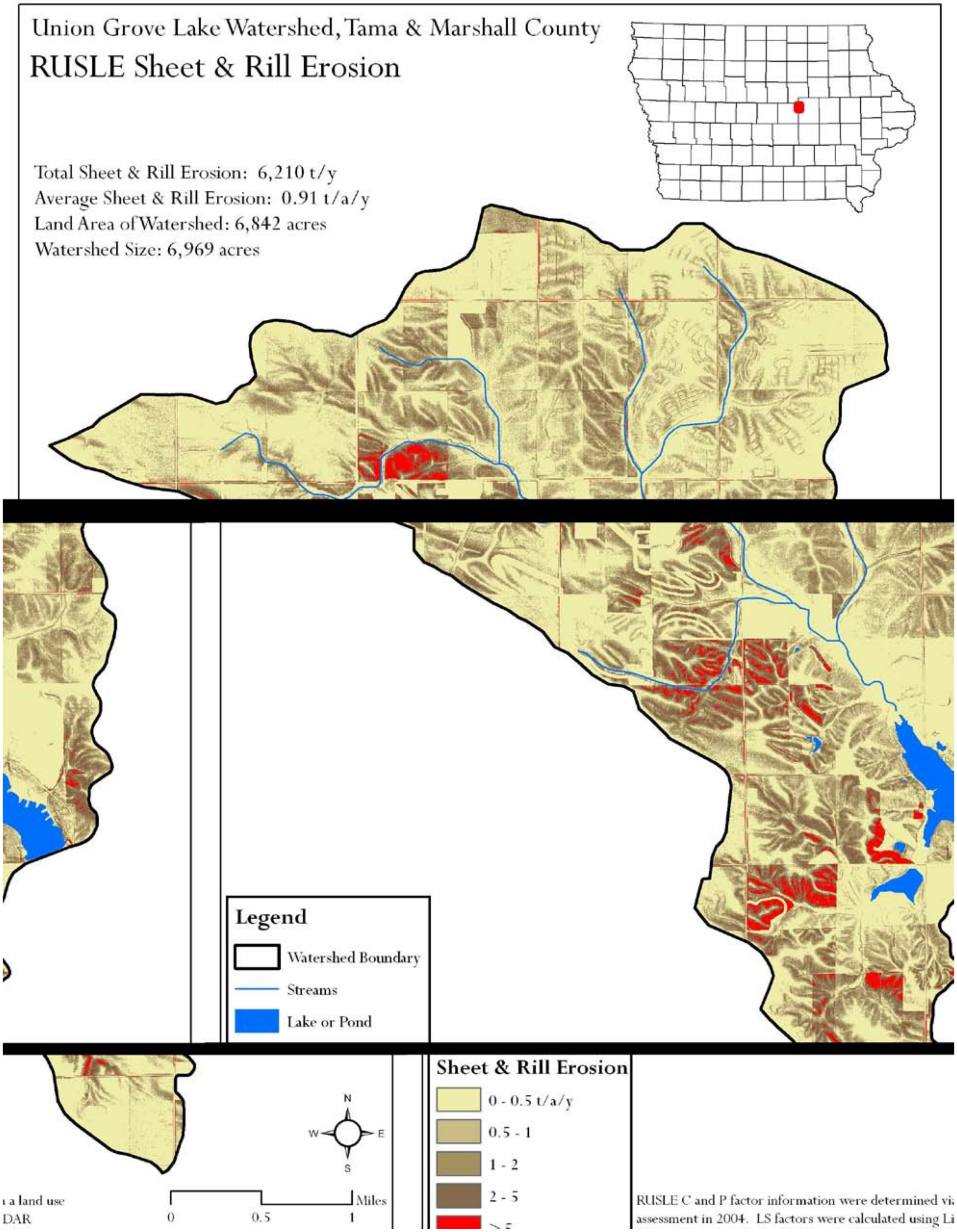

Protected Area
2,892 Acres
Location of
constructed wetland
UNION GROVE
STATE PARK
Union Grove Lake
SPRING
SPRING CREEK
Gladbrook
N
0
0.25
0.5
1
1.5
2
Miles

Figure 72



Union Grove Lake Watershed, Tama & Marshall County
RUSLE Sheet & Rill Erosion
Total Sheet & Rill Erosion: 6,210 t/y
Average Sheet & Rill Erosion: 0.91 t/a/y
Land Area of Watershed: 6,842 acres
Watershed Size: 6,969 acres
Legend
Watershed Boundary
Streams
Lake or Pond
Sheet & Rill Erosion
0 - 0.5 t/a/y
0.5 - 1
1 - 2
2 - 5
N
W
E
S
0
0.5
1
Miles
a land use
DAR
RUSLE C and P factor information were determined vi
assessment in 2004. LS factors were calculated using Li

Figure 73

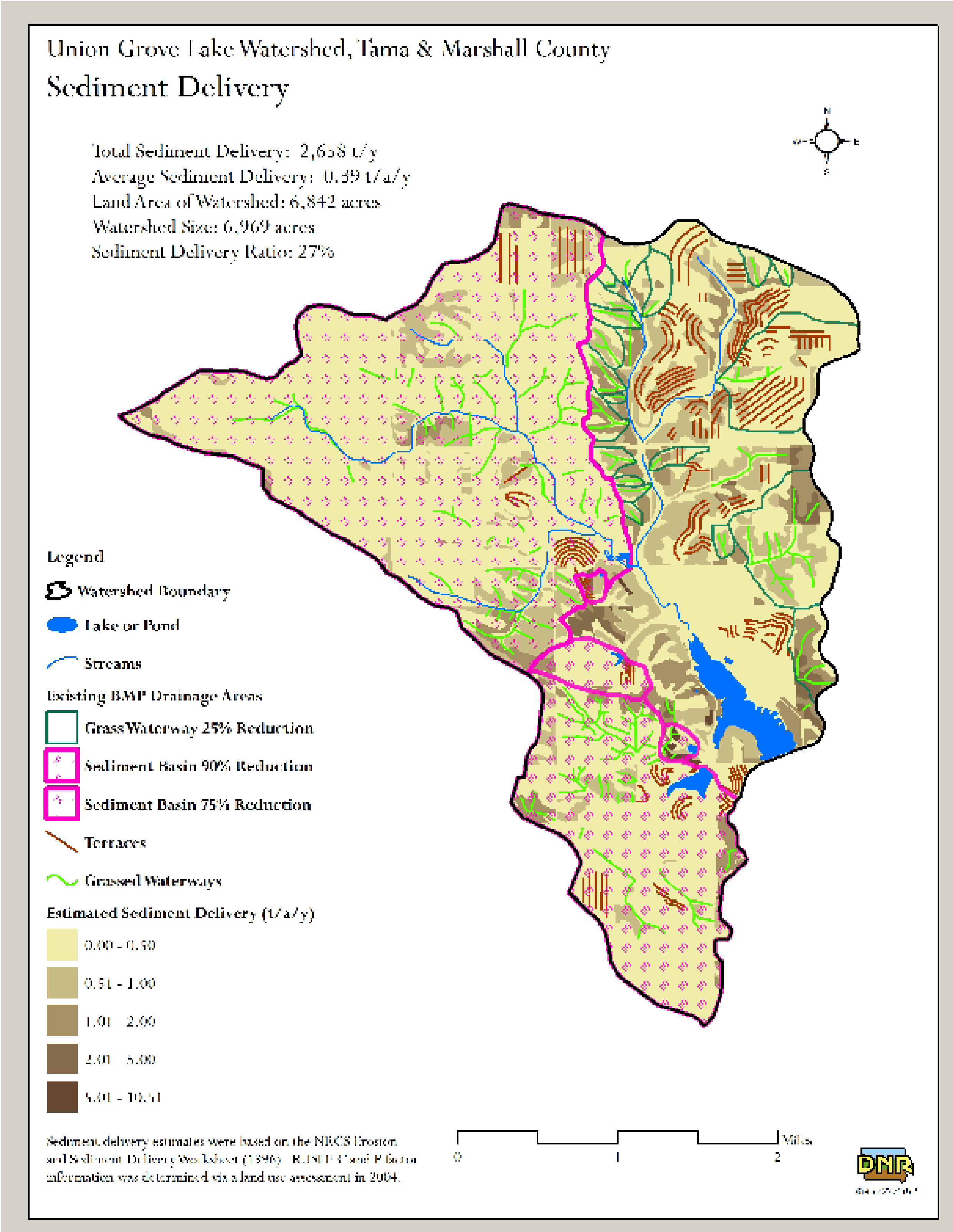
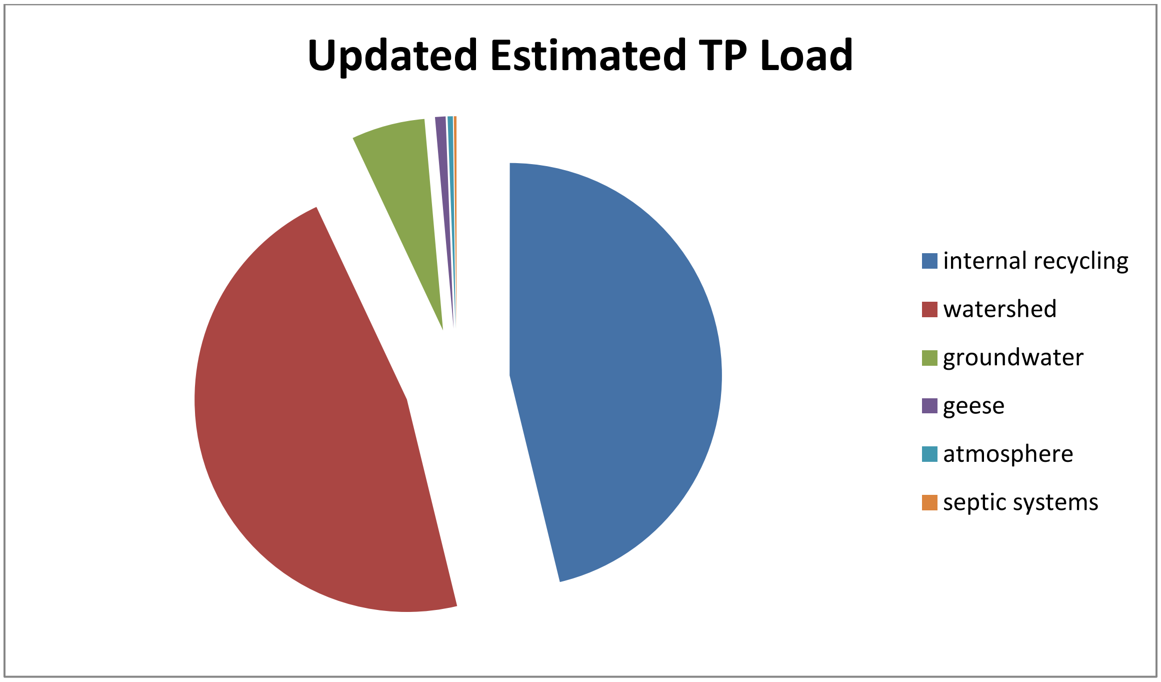

Union Grove Lake Watershed, Tama & Marshall County
Sediment Delivery
Total Sediment Delivery: 2,658 t/y
Average Sediment Delivery: 0.39 t/a/y
Land Area of Watershed: 6,842 acres
Watershed Size: 6,969 acres
Sediment Delivery Ratio: 27%
Legend
Watershed Boundary
Lake or Pond
Streams
Existing BMP Drainage Areas
Grass Waterway 25% Reduction
Sediment Basin 90% Reduction
Sediment Basin 75% Reduction
Terraces
Grassed Waterways
Estimated Sediment Delivery (t/a/y)
0.00 - 0.50
0.51 - 1.00
1.01 - 2.00
2.01 - 5.00
5.01 - 10.51
Sediment delivery estimates were based on the NRCS Erosion and Sediment Delivery Worksheet (1996). RUSLE C and P factor information was determined via a land use assessment in 2004.
0
1
2
Miles
DNR

Figure 74 **Updated Estimated TP Load**

Load Source	TP Load (lb/year)	Percent of Total
watershed	3,788	46.8
septic tank systems	13	0.2
geese	68	0.8
groundwater seepage	449	5.6
atmospheric deposition	31	0.4
internal recycling	3,739	46.2
total	**8,088**	**~100.0**

Figure 75



4.6 Sub-watershed Sediment Delivery Reduction

Figure 73 details the sub-watershed drainage areas and percent sediment load reductions for several impoundment structures within the Union Grove Lake Watershed including the constructed wetland complex in Section 29 of Spring Creek Township, the IDNR basin in Section 5 of Carlton Township, and three smaller grade stabilization structures. This map also includes all tile-outlet terraces and many of the grassed waterways within the watershed.

According to the watershed's TMDL, the Sediment Delivery Ratio of the Ecoregion 47c Transition Iowan Surface (Figure 21) is 13.7%. Note from Figure 73 that the majority of the watershed in this ecoregion is terraced or impounded by a 75% sediment reduction structure. The TMDL reports the Sediment Delivery Ratio of the Ecoregion 47f Transition Southern Iowa Drift Plain portion of the watershed is 27.3%. Much of this area is also impounded or is timbered.

5.0 Community Based Planning

The current Project 086-3.08 has built upon the relationship already established between the Tama Soil & Water Conservation District and Lake & Park Holding Corporation. An annual administrative review meeting was held in 2009, 2010, and 2011 to which invitations where extended to the following individuals/groups: Tama and Marshall Soil & Water Conservation Districts; USDA Natural Resources Conservation Service District Conservationists, Toledo and Marshalltown Field Offices; IDNR State Parks Bureau; IDALS/IDNR Northeast Iowa Basin Coordinator; Lake & Park Holding Corporation; IDALS-DSC Field Representative; IDNR Watershed Improvement Project Officer; and IDNR Lake Restoration. It has been through conversation at these meetings that the project's approaches to certain issues have been adjusted and that portions of the project's focus have been changed. For example, it was at one of these annual meetings that it was questioned whether or not Union Grove Lake's TMDL took into account the constructed wetland complex discussed in Sections 2.7.2 and 4.2. Further investigation revealed that it had not. As a result, IDNR adjusted sediment delivery figures which should more accurately depict current watershed conditions. This also helped the group to realize that perhaps a larger portion of the project's focus should be on livestock and lake restoration issues.

Any future watershed projects should include a watershed advisory council with members representing watershed farm operators and operators, rural acreage owners, Lake & Park Holding Corporation, the Tama and Marshall Soil & Water Conservation Districts, the Toledo and Marshalltown USDA-NRCS Field Offices, and IDNR State Parks Bureau and Lake Restoration. This council should meet at least semi-annually. Its purpose should be to keep current on changing water quality and land use concerns, to share local attitudes toward and public perceptions of lake and watershed issues, to develop effective public outreach, and to communicate sub-watershed concerns.

Future projects should also include a technical advisory council which meets at least semi-annually. This technical council should include, but not be limited to, the following members: USDA NRCS local management and appropriate specialist staff; IDNR Geographic Information Systems specialist; IDALS/IDNR Basin Coordinator; IDNR Fisheries Bureau; IDNR Lake Restoration; IDNR Watershed Improvement Project Officer; IDNR State Parks Bureau, local and district representatives; IDALS-DSC Field Representative; Central Iowa Water Association Communities & Expansion Project Coordinator; IDNR Forestry Bureau; and IDNR Ambient Watershed Monitoring & Assessment Program. This council's purpose should be to monitor current and emerging water quality and land use conditions and threats, to share and analyze data, and to develop long-range resource conservation planning.

Future projects will likely have the best chances of success if administered through the Tama Soil & Water Conservation District with support of the Marshall Soil & Water Conservation District, as was Project 086-3.08. These local, publicly-elected boards have extensive prior experience working with water quality projects.

6.0 Watershed Management Plan

6.1 Targets and Load Reductions

Figure 76 contains the Total Phosphorus loads and target loads from various sources as reported in Section 3 of Union Grove Lake's TMDL. Also listed are the watershed's estimated current conditions, which were updated by IDNR in June 2011, and the resulting needed load reduction, which is the difference between the TMDL's target load and the estimated current conditions. These are appropriate load reduction goals for any future Union Grove Lake Watershed project.

Figure 76

TP Load Source	Load Reported in TMDL (lb/y)	TMDL Target Load (lb/y)	Estimated Current Conditions (lb/y)	Needed Load Reduction (lb/yr)
watershed	5,870	2,115	3,788	1,673
septic tank systems	13	3	13	10
geese	68	34	68	34
groundwater seepage	449	449	449	0
atmospheric deposition	31	31	31	0
internal recycling	3,739	374	3,739	3,365
total	**10,170**	**3,006**	**8,088**	**5,082**

In addition, Section 4 of the TMDL covers daily load for the pathogen indicator *E. coli*. Figure 77 includes estimated departure from capacity for four flow conditions taken from this TMDL section. According to personnel from the IDNR Ambient Watershed Monitoring & Assessment Program, bacteria levels are extremely variable, thus making it difficult to pinpoint load reductions, but reducing bacteria concentrations during maximum and minimum flow conditions by approximately 80% will help Union Grove Lake to meet allowable daily loads. Also noted, bacteria modeling is challenging, making target concentrations hard to pinpoint.

Figure 77

Flow Range (m^3/day)	Sample Maximum Allowable *E. coli* Load (org/day)	Estimated Existing *E. coli* (org/day)	Departure from Capacity (org/day)
90,361-1,128,836	3.13E+11	2.26E+12	1.95E+12
34,306-90,361	1.26E+11	4.55E+10	Meets criteria
940-34,306	2.53E+10	3.43E+10	9.00E+09
.002-940	3.17E+08	1.24E+09	9.23E+08

According to the TMDL, the maximum existing load to the lake occurs during precipitation events when maximum runoff and runoff flow bacteria concentrations are highest, causing the lake bacteria concentration to exceed water quality criteria. Another condition leading to criteria violations occurs when there is a long hydraulic residence time in the lake. With these minimal flow conditions, the continuous loads from livestock, wildlife, and septic systems accumulate and cause high lake concentrations. In addition, storm events have obvious potential detrimental effects to be kept in check with best management practices throughout the watershed.

6.2 Plan Goals and Objectives

This plan's long-term and primary objectives for Union Grove Lake include meeting water quality goals, eradicating its impairments, de-listing the lake from Iowa's 303(d) Impaired Waters List, eliminating beach closings due to bacteria, meeting sediment delivery and TP load reduction needs, and lowering the lake's Trophic State Index values for chlorophyll, transparency, and Total Phosphorus, each to 63, as indicated by IDNR personnel. Short-term plan goals include achieving all upland treatment in order to meet the needed watershed TP load reduction listed in Figure 76. Possibly overlapping the time period of accomplishing these short-term goals are the plan's mid-term goals of all lake restoration activities.

- Goal 1: Conduct in-lake restoration activities to reduce internal nutrient contribution such that Total Phosphorus is reduced by 3,365 lb/year.
  - Objective 1: Reduce internal nutrient recycling.
  - Objective 2: Reduce sediment delivery to the lake.
  - Objective 3: Improve lake fisheries.

  Action Items:
    - Conduct removal of desirable fish species via shocking, netting, and unlimited public fishing.
    - Lower lake level in order to conduct restoration activities and allow lake bottom solidification.
    - Chemically treat the lake in order to kill undesirable fish population.
    - Remove 387,000 yd^3 of lake bottom sediment in order to remove nutrient bank, create a mean depth of 10.0 feet to allow thermal stratification, and deepen strategic sites for fish habitat.
    - Improve fish habitat by installing practices such as rock habitats, bench jetties, tree structures, and gravel spawning beds.
    - Modify the lake's primary spillway in order to exclude undesirable species from moving upstream into the lake from Deer Creek.
    - Establish 25 acres of benthic aquatic vegetation to act as a nutrient sink, to improve fish habitat, and to reduce sediment resuspension.
    - Restock fishery with largemouth bass, bluegill, channel catfish, and black crappie.
    - Remove 50,000 yd^3 of sediment upstream from retention dike at Deer Creek influx (Figure 78) and replace shallow open-throat ingress with a constructed wetland complex capable of water level fluctuation.
    - Restock desirable fishery.

Figure 78

- Goal 2: Reduce the watershed contribution of sediment and phosphorus, such that the watershed's Total Phosphorus load is reduced by 1,673 lb/year.
  - Objective 1: Reduce stream contribution.
  - Objective 2: Reduce upland contribution.

  Action Items:
  - Install 5 in-channel grade and streambank stabilization practices to check channel grade deterioration and streambank erosion, especially in stream segments 2B through 2E.
  - Encourage the installation of 50 acres of filter strip and riparian buffer practices along all watershed stream corridors in cooperation with USDA Farm Service Agency, wildlife groups, and other non-profit habitat organizations, especially in stream segments 1C, 1E, and 2E.
  - Educate farm operators and homeowners in soil testing and fertilizer application timing and placement methods which protect water resources.
  - Install 500 acres of contour farming.
  - Install 500 acres of no-till farming.
  - Install 30 acres of grassed waterways.
  - Install 3000 feet of terraces.
  - Install 300 acres of cover crops.
  - Renovate 3000 feet of existing terraces and two existing grade stabilization structures with expired maintenance agreements to construction design specifications.
  - Upgrade existing wetland's sediment retention to 90%.
  - Reduce mowing on three acres and install seven acres of native plantings along Union Grove Lake's shoreline within Union Grove State Park.
  - Install 5.9-acre timber stand improvement plan for Lake & Park Holding Corporation.
  - Update farm conservation plans to facilitate application of best management practices which protect watershed resources.
  - Evaluate the effectiveness of practice application and land use considering water quality benefits and using the Sediment Delivery Calculator.

- Goal 3: Reduce bacteria concentrations in Union Grove Lake in order to fully support the lake's designated uses, eliminate beach closings, meet geometric mean and maximum sample concentration limits, and achieve threshold *E. coli* loads in Figure 77.
  - Objective 1: Reduce bacterial contributions from inadequate private septic systems.
  - Objective 2: Reduce bacterial contributions from livestock and pets.
  - Objective 3: Reduce bacterial contributions from wildlife.

  Action Items:
  - Implement a watershed septic system assessment program in cooperation with Tama and Marshall Counties and IDNR in order to facilitate repairs.
  - Reduce livestock access to watershed stream corridors with 4000 feet of fencing and installing four livestock watering systems.

- Reduce surface runoff from livestock lots by installing one roofed manure storage system.
- Educate livestock operators in manure nutrient testing and manure application timing and placement methods which protect water resources.
- Continue state park use of beach groomer to remove goose manure.
- Continue state park participation in annual goose transplanting to sites outside the watershed.
- Discourage the overwintering of geese by reducing winter aeration to reduce open water.
- Educate watershed residents in pet waste removal from household yards.
- Encourage the installation of a community sewage treatment facility by Lake & Park Holding Corporation.

- Goal 4: Assess, evaluate, and monitor water resources.
  - Objective 1: Conduct water quality monitoring at tributary, tile outlet, and lake sampling sites.

Action Items:

- Conduct a coordinated water quality sampling program in cooperation with IDNR, State Hygienic Laboratory, and Iowa State University. Guidelines may be found in Section 6 of the TMDL.
- Evaluate and interpret water quality sampling results in order to monitor water quality trends in tributary and lake water resources.

- Goal 5: Conduct a public outreach program.
  - Objective 1: Inform the public of current watershed issues.
  - Objective 2: Educate the public on best management practices which protect watershed resources.

Action Items:

- Publish a watershed newsletter at least quarterly.
- Facilitate workshops on best management practices applicable to watershed stakeholders.
- Inform stakeholders of applicable educational opportunities available through other other organizations and partner agencies.
- Make personal contacts with watershed stakeholders.

- Goal 6: Protect the existing private constructed wetland complex in order to reduce sediment and phosphorus delivery to Union Grove Lake.
  - Objective 1: Facilitate purchase or easement of private property containing the wetland complex.
  - Objective 2: Prioritize the wetland's sub-watershed in order to protect the complex and extend its effective lifetime.

Action Items:

- Facilitate IDNR and/or private non-profit group purchase or easement of private property containing the wetland complex.

- Focus outreach efforts and provide increased financial incentives percentage in this sub-watershed to encourage the application of BMPs which will reduce sediment and slow runoff delivery to the wetland complex.

6.3 Best Management Practices (BMPs)

Upland treatment will only have limited impact on Union Grove Lake's water quality without in-lake renovation goals realized. Likewise, due to influx of new sediment, any in-lake improvements will likely be short-lived without upland treatment.

A wide variety of best management practices are options to improve water quality and other identified resource concerns.

6.3.1. In-lake Practices

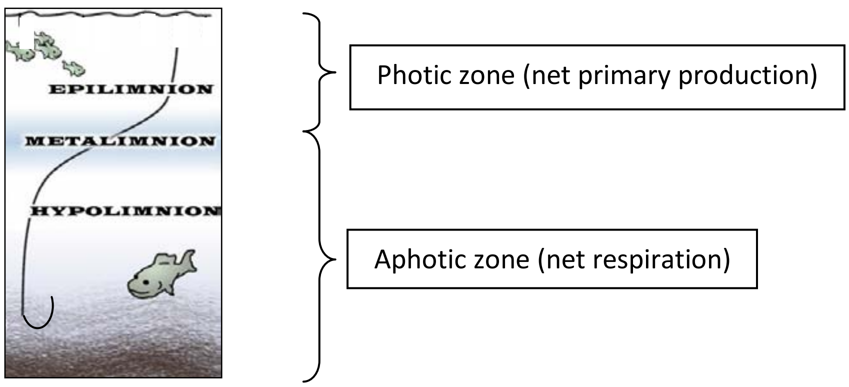


Figure 79

This plan's Section 3.3.2 notes that Union Grove Lake formed a thermocline (metalimnion) in 66% of Iowa State University's 2010 observations. A lake's hypolimnion (Figure 79) is the deep layer of a lake characterized by greatly reduced turbulence, and it usually has insufficient light to allow algal growth. It is typically the coldest lake stratum in the summer and the warmest during the winter. It is this layer's interface with lake sediments where most of a lake's internal nutrient recycling occurs.

As stated in the TMDL, restoration of Union Grove Lake will require extensive in-lake renovation in addition to upland practices which will further reduce the watershed's phosphorus load. According to the TMDL, the recycling of phosphorus within Union Grove Lake is the most direct and significant factor driving the lake's summer and fall algal blooms. If in-lake nutrient sources are not resolved, other watershed improvement activities are not likely to succeed in reducing lake phosphorus and chlorophyll concentrations.

Numerous water quality studies have confirmed these results as cited in Restoration and Management of Lakes and Reservoirs by Cooke, Welch, Peterson, and Nichols. Shallow lakes, such as Union Grove Lake, have been found to be less sensitive to significant reductions in external nutrient loading. This is because interactions at the sediment-water interface tend to maintain high nutrient levels in the water. It has also been found that nutrients released from accumulated sediments in shallow lakes tend to affect the entire water column, not just the lake's deepest water. Nutrient release at the interface in shallow lakes is also more greatly affected by the disturbance of sediments by living organisms, wind action, gas bubbles, high pH from higher photosynthesis, and deficits of dissolved oxygen. From Cooke, etal: "Diversion of external nutrient loading, while necessary, may not be sufficient to rehabilitate a shallow lake and a sediment treatment may be necessary." To summarize the research, shallow lakes are less responsive to the diversion of external loading, and their internal loading has a greater impact on the photic zone.

Efforts to achieve the lake's internal phosphorus load reduction will need to be focused and determined. The TMDL recommends any in-lake restoration include reducing populations of bottom-feeding fish, preventing reintroduction of bottom-feeding fish, minimizing turbulence in shallow areas, promoting rooted aquatic plant growth in shallow depths, and removing silt upstream from the sediment dike at Deer Creek's ingress. Iowa DNR – Lake Restoration Program will begin restoration activities in July 2013. During the first year of the 5 year lake restoration project, 1.5 million dollars will be allocated.

The IDNR Fisheries biologist serving Union Grove Lake estimates the lake's year-round average of common carp (family Cyprinidae) at 250 lb per acre of lake surface area. This translates to approximately 27,500 lb of carp in the lake. Based upon research findings that phosphorus comprises about 2.28% of cyprinid biomass, it is estimated that over 600 lb of phosphorus can be removed from the watershed's system by common carp removal alone. Nutrient loading and turbidity will decrease with carp eradication and will increase aquatic vegetation in the lake's shallower depths, thereby further increasing water clarity.

Figure 80

In-lake Practice	Comments	Relative TP Reduction
Carp removal and fisheries management	Significant internal TP load reductions will occur when the carp population is eradicated. This probably requires draw down of the lake as well as other procedures to remove undesirable fish. As water quality improves and desirable fish populations increase strong efforts to exclude carp from the lake should be made, including a barrier at the discharge weir to Deer Creek.	High (including ~ 630 lb P in Cyprinidae biomass through eradication)
Dredging to a mean depth of ten feet	If used as a water quality improvement technique, dredging should be focused on creating deep water areas that will maintain good thermal stratification through the summer and early fall. Dredging should also include areas of recent siltation such as upstream of the silt retention dike.	High
Aquatic vegetation establishment	Rooted vegetation competes with algae for available phosphorus and other nutrients, reduces a portion of open water areas of a lake, and requires water level manipulation. Overall impact of large wetland/marsh areas on water quality can be significant. Vegetation may require annual harvesting to remove accumulated nutrients.	Medium
Shoreline and riparian maintenance	The establishment and maintenance of lakeshore vegetation reduces sediment and pollutant runoff from the zone immediately adjacent to the water. It	Medium to low

and stabilization	also helps to reduce shoreline erosion from wave action. Maintenance should include removal of goose feces.	

The TMDL reports that additional lake dredging could have significant impact on the lake's water quality. It has been found that in deeper lakes with strong thermal stratification, phosphorus and silt are usually confined to the hypolimnion once the silt has settled. This greatly reduces the availability of recycled phosphorus. IDNR Fisheries biologists have a target mean depth of ten feet that they believe allows a lake to stratify strongly enough to positively impact water quality. Dredging Union Grove Lake to a mean depth of 10 feet would require the removal of 387,000 cubic yards of sediment. Dredging to establish a hypolimnion may be a possibility, especially since there is capacity remaining in the dredging spoils basin used during the dredging activities described in this document's Section 1.7. If stratification is achieved, there is the possibility lake aeration may be eliminated, which may discourage the overwintering of geese.

Figure 80 describes in-lake restoration measures and their TP reduction capabilities relative to each other as reported in this watershed's TMDL. These reductions are based upon past IDNR experience and projects.

IDNR Fisheries recommendations include fish rescue procedures prior to lake draw down which would include removal of desirable fish species via shocking, netting, and unlimited public fishing. Also, the lake bottom should be allowed to solidify during draw down to help prevent re-suspension of sediment in areas which will not be dredged. Fish habitat BMPs should be installed during lake draw down including installing rock habitats, bench jetties, tree structures, and gravel spawning beds and by deepening strategic sites in the lake bottom. Plans would include restocking the fishery with largemouth bass, bluegill, channel catfish, and black crappie.

6.3.2 Agricultural Practices

Many agricultural BMPs are designed to reduce erosion and/or capture sediment before it reaches a waterbody. Phosphorus adsorbs onto sediment, therefore reducing erosion and sediment delivery also reduces TP loads. Refer to watershed sediment delivery rates in Figure 73.

As found in Section 5.1 of the TMDL, Figure 81 lists several practices and their effects on Total Phosphorus reduction. While many of these practices are already in use by Union Grove Lake Watershed farm operators, future use of these practices has the potential to become even more widespread and used in combination with these and other management practices not listed in this table. Other management practices to be applied could include but are not limited to soil testing, manure testing and management, contouring, grassed waterways, water and sediment control basins, grade stabilization structures, in-stream structures, streambank protection, and livestock practices such as prescribed grazing, stream crossings, and watering facilities. Many of these BMPs also inhibit the release of bacteria into the watershed system from grazing livestock and manure application.

Figure 82 from the Union Grove RASCAL was developed in order to help the current project focus its resources and apply best management practices in key sub-watersheds where their implementation could have a significant water quality impact on the lake and the watershed's streams. ++ indicates where such implementations would likely have an even greater impact.

Refer to Figure 62 for the location of the RASCAL's stream segments. In-stream and streambank practices are included here since their application can greatly impact agricultural

Figure 81

BMP or Activity	**Potential TP Reduction** [1]
Conservation Tillage	
Moderate vs. Intensive Tillage	50%
No-till vs. Intensive Tillage	70%
No-till vs. Moderate Tillage	45%
Cover Crops	50%
Diversified Cropping Systems	50%
In-field Vegetative Buffers	50%
Terraces	50%
Pasture/Grassland Management	
Livestock Exclusion from Streams	75%
Rotational Grazing vs. Constant Intensive Grazing	25%
Seasonal Grazing vs. Constant Intensive Grazing	50%
Phosphorus Nutrient Application Techniques	
Deep Tillage Incorporation vs. Surface Broadcast [2]	-15%
Shallow Tillage Invorporation vs. Surface Broadcast [2]	-10%
Knife/Injection Invorporation vs. Surface Broadcast	35%
Phosphorus Nutrient Application Timing and Rates	
Spring vs. Fall Application	30%
Soil Test P Rate vs. Over-spplication Rates	40%
Application 1-month Prior to Runoff Event vs. 1-day	30%
Riparian Buffers	45%
Wetlands [3]	20%

[1] Source: IDNR and USDA-ARS, 2004. Actual reduction percentages may vary widely across sites and runoff events.
[2] Tillage incorporation can increase TP in runoff.
[3] TP reductions in wetlands vary greatly depending upon site-specific condition. Increasing surface area, implementing multiple wetlands in series, and managing vegetation can result in significantly higher TP reductions.

practices in adjacent farm ground. Upland treatment should include the application of no-till, contouring, and grassed waterways where they are not already being applied. The installation of terraces would further reduce sediment export from these sub-watersheds.

6.3.3 Lakeside and Residential Practices

While phosphorus sources such as lakeside residential runoff and geese are less significant, they can have impact in the critical late summer and fall time periods. It is this time frame when smaller loads in immediate proximity of the lake are more significant. The TMDL suggests management of these phosphorus sources should include correcting inadequate private septic tank systems to meet state design standards or constructing a community sewage treatment facility, removing pet feces from lakeside residential areas, using phosphorus-free lawn fertilizers, implementing lake aerator procedures that discourage geese from overwintering, and continuing the removal of goose feces from the beach and lakeside grassed areas.

In addition to these TMDL recommendations, watershed residents have the opportunity to reduce their impact on the watershed's phosphorus input by examining chemical content of household items such as cleansers and automatic dishwashing detergent. Yard management can also include removal of fallen tree leaves and creating a vegetative barrier, such as no-till flower beds or native plants, between their lawn and any surface water. Gutter planning and lawn care practices which increase water infiltration also reduce runoff.

Figure 82

Stream Segment	Streambank Stabilization Practices	In-Channel Grade Stabilization	Riparian Filter Strips	Upland Practices
1A			+	
1B			+	+
1C			++	+
1D			+	+
1E			++	+
1F			+	
1G				
2A			+	++
2B	+	++	+	++
2C	+	++	+	++
2D	+	++	+	++
2E	++		++	++
2F	+		+	
2G			+	
2H			+	
2I				
3A			+	++
3B			+	++
3C			+	
4				

6.3.4 Pathogen-inhibiting Practices

Since the watershed's bacteria problems occur at many flow conditions, solutions need to be implemented for nonpoint sources with event-driven transport and for continuous sources, such as cattle in streams and inadequate septic tank systems. Reductions in the watershed's nonpoint bacteria loads will require changes in the manner manure and other waste is managed and will take time to implement.

BMPs for reducing pathogen indicator concentrations include livestock exclusion from watercourses in pastures and providing alternate watering sources, controlling manure runoff via incorporation or subsurface application; installing buffer and filter strips along watercourses to slow and divert runoff from agricultural fields where manure is applied; removing pet feces from grounds, especially adjacent to the lake; and identifying and correcting inadequate private septic tank systems to meet state design standards. Alternatively from this latter option, a community wastewater treatment facility could be constructed to serve the watershed's sewage treatment needs while eliminating pathogen concerns from sewage sources.

A residential best management practice with potential to substantially reduce pathogen introduction to Union Grove Lake is a community sewage treatment system to replace individual storage and septic tank systems. The preliminary engineering report for wastewater collection and treatment was completed in December 2011 by Wastewater Management Services of Central Iowa, a division of Central Iowa Water Association. This report will be presented to the board of Lake & Park Holding Corporation in April 2012 for its consideration. Alternatives within the report include a collection and pumping system to deliver wastewater to the treatment facility in Gladbrook and a low pressure sewer system which would deliver wastewater to a controlled discharge lagoon treament facility outside of, but near, the lake watershed. Every effort should be made by Project 086-3.08, the Tama and Marshall Soil & Water Conservation Districts, and IDNR to encourage the corporation's pursuit of such a facility.

Another very practical approach to lowering *E. coli* concentrations is to apply agricultural and residential best management practices which reduce algal growth since most will also reduce pathogen concentrations. Algae shades the water column, preventing natural ultraviolet radiation penetration which would kill bacteria. It also provides sites for bacteria to attach, which decreases zooplankton predation upon the bacteria. In addition, algal growth hampers wind-driven oxygen exchange which is needed to support predator zooplankton populations.

Decreasing the amount of lake sediment available for re-suspension also has the potential to decrease *E. coli* concentrations in Union Grove Lake. Since sediment has polarity opposite that of bacteria, sediment has the potential to carry bacteria with it. Thus, best management practices with high sediment trapping percentages should have profound positive effects.

6.4 Priority Concerns

Project priorities should address the following concerns:

- in-lake practices (Section 6.3.1)
- the existing wetland's 2,892 acre sub-watershed (Figure 71)
- areas in need of additional upland treatment (Figures 72 and 73)
- priority stream segments (Figure 82)
- livestock exclusion from streams
- effective septic systems and lakeside community sewage treatment

The best management practice types in Figure 83 were selected to address project priorities following personal contacts with agricultural landowners and operators during Project 086-3.08 and taking into account historical application rates in Tama and Marshall Counties. Their potential sediment and TP reduction are shown in this figure. These practices have been shown to have considerable positive impact on water quality. They are also cost-efficient and relatively easy to maintain.

Figure 83

Watershed Best Management Practice	Potential Sediment Reduction (t/y) [1]	Potential TP Reduction (lb/y) [1]
Install 5 grade and streambank stabilization practices	31	41
Install 50 acres stream corridor buffers	52	68
Install 500 acres contouring	72	94
Install 500 acres no-till	353	458
Install 30 acres grassed waterways	187	243
Install 3,000 feet terraces	80	104
Install 300 acres cover crops	267	347
Reduce lakeside mowing on 3 acres	3	4
Install 7 acres shoreline native plantings	7	9
Install 4000 feet livestock exclusion	4	5
Upgrade existing wetland sediment retention capability to 90%	232 [2]	302 [2]
total	**1288**	**1675**

[1] data source: Sediment Delivery Calculator, Project 086-3.08 except where indicated
[2] data source: IDNR

Figure 84 demonstrates where the best management practices listed in Figure 83 would be applied most effectively within the watershed in order to meet the priority concerns found listed in this section. For further implementation information, consult Sections 9.0 and 10.0 of this document.

Compared to conditions prior to the construction of the existing wetland, IDNR estimates the structure, in its present condition, prevents an additional 1307 tons of sediment from reaching Union Grove Lake each year. This corresponds to nearly 1700 pounds of TP which is eliminated from the lake system annually. Construction to upgrade the existing wetland's trapping efficiency, essential to future lake restoration and preservation, could be engineered to design specifications of either IDNR or USDA-NRCS. The cost of this construction could vary widely.

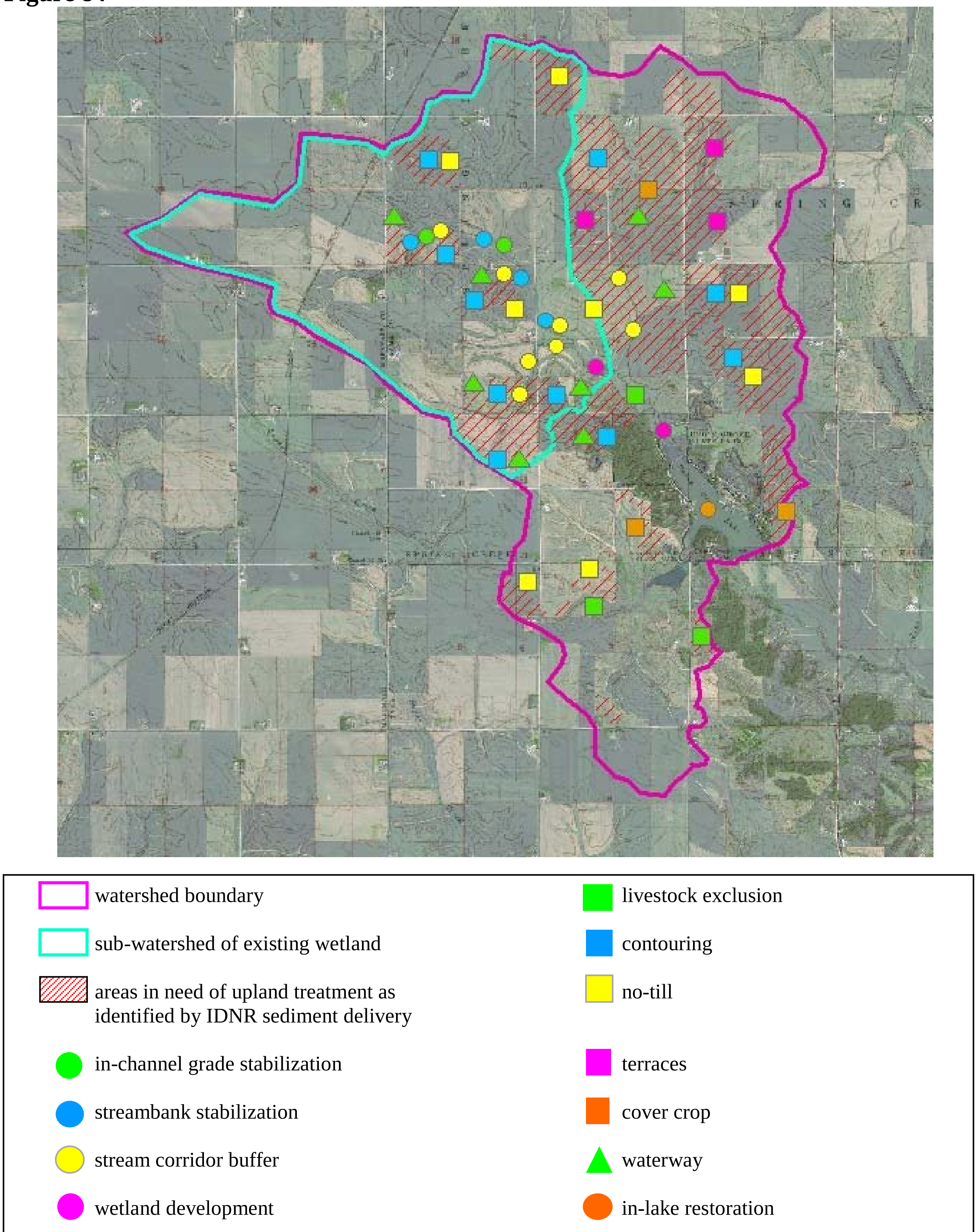
While best management practices installed in the existing wetland's sub-watershed may have a lesser impact on reducing sediment delivery to Union Grove Lake than practices incorporated in most other portions of the lake watershed, they will have a tremendous impact on sediment delivery to to wetland. These practices will extend the structure's effective lifespan and thus indirectly help to protect water quality in Union Grove Lake. The purchase and protection of the property the wetland is located on and the safeguarding of the structure itself is undoubtedly essential to the improvement and longevity of Union Grove Lake and its water quality.

7.0 Water Monitoring Plan

The purposes of a Quality Assurance Project Plan (QAPP) are to coordinate higher quality water monitoring efforts and to assure a project's data meets standards according to Iowa's Credible

Data Law, Sections 455B.193-455B.195. The QAPP for Union Grove Lake, developed by IDNR, focuses on physical/chemical monitoring of the lake and its tributaries and may be found with this document as Appendix C.

Figure 84



Protocol for a number of water quality monitoring parameters are documented in Union Grove Lake's QAPP including requirements for sample handling and custody; analytical methods; quality control; equipment testing, inspection, and maintenance; and data review, validation, and verification. It also contains protocol for documentation and records, sampling design, collection methods, data management, assessment and response action, and reports. These protocol standards help to maintain the integrity of a project's sampling and its data.

Water quality monitoring helps to target the most critical areas where conservation practice implementation can most effectively improve the lake's water quality. Monitoring is a tool that can ultimately help to remove Union Grove Lake from Iowa's Impaired Waters List. It also provides a baseline showing current conditions so that the effectiveness of BMP application can be measured, moving the lake closer to its goal of meeting its intended uses.

As described in Section 3 of this document, monitoring for Project 086-3.08 was conducted in 2008, 2009, and 2010, but sampling at Union Grove Lake has been an ongoing effort for many years. Project 086-3.08 sampled for the following parameters:

- lake only: Secchi depth, chlorophyll
- tributary only: turbidity, flow, Total Suspended Solids, Total Fixed Suspended Solids, Total Volatile Suspended Solids
- all sites: Ammonia as N, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Total Phosphate as P, Dissolved Orthophosphate as P, Dissolved Oxygen, *E. coli*, temperature, pH

During Project 086-3.08, monitoring was accomplished through a blend of fixed station, fixed sampling monitoring, and event sampling from ISCO automated samplers. These locations were chosen:

- to divide the watershed into subwatersheds that were likely to demonstrate measureable change in water quality during the life of the project
- to meet requirements of landowner access and permission
- to represent the condition of the impaired water and to provide the ability to reassess the waterbody for future 303d/305b reports

Any future water quality monitoring in this watershed should continue sampling for similar parameters at similar sites. This will contribute to continuing baseline data. Grab sampling and storm event sampling should be conducted according to IDNR Monitoring & Assessment discretion. Monitoring may also be conducted upstream and downstream of practices installed in order to monitor the effectiveness of applied upland and streamside BMPs, including the constructed wetland complex in Section 29 of Spring Creek Township.

IDNR Watershed Monitoring and Assessment staff has recommended any future watershed project could investigate the recycling of phosphorus within Union Grove Lake. Water samples could be taken one to two meters from the lake bottom in mid- and late summer when the lake is stratified. Sampling of this type could verify whether high levels of dissolved phosphorus, Orthophosphate, are being released from lake bottom sediment and might be used to quantify how much Orthophosphate the sediment contains.

Another water quality monitoring technique that could be examined in a future project would be to sample field tile discharge for Orthophosphate, as was addressed in this document's Section 4.1.1. This sampling could vary from simple IOWATER kit sampling to sample processing through University Hygienic Laboratory, depending upon availability of funding. Regardless of the analysis source, IDNR personnel will be able to interpret test results.

8.0 Public Outreach

Public involvement is important in a project since it is the land owners, tenants, and citizens who directly manage land, live, and recreate in the watershed that determine the water quality in Union Grove Lake. During the development of this plan, efforts were made to ensure that local stakeholders were involved in the decision-making process regarding goals and required actions for improving water quality in Union Grove Lake. The following plan will guide public outreach activities in the Union Grove Lake watershed. The plan has been organized in this manner to provide the greatest assistance to watershed project staff and partners.

The support and involvement of a number of individuals are key in order to make changes to the land and water:

- Agricultural landowners and operators
- Year-round and seasonal lakeside residents
- Rural residents
- Recreational users
- Managers of public owned land
- Board members of Lake & Park Holding Corporation
- City leaders of Gladbrook

Monetary, in-kind, support, and technical resources are critical from a number of sources:

- Watershed landowners and operators, residents, and recreational users
- Tama and Marshall Soil and Water Conservation Districts
- Iowa Department of Natural Resources
- USDA-Natural Resources Conservation Service
- USDA-Farm Service Agency
- U.S. Environmental Protection Agency
- Iowa Department of Agriculture & Land Stewardship-Division of Soil Conservation
- Lake & Park Holding Corporation
- Iowa Natural Heritage Foundation
- Local wildlife enthusiasts

Future watershed efforts are more likely to succeed with prominent individuals involved, supporting the project coordinator and the project's sponsors:

- Community leaders
    - Board members of Lake & Park Holding Corporation
    - Tama County Board of Supervisors
    - Local legislators
    - Farm Bureau

- Project partners and stakeholders
- Tama Soil and Water Conservation District
- USDA-Natural Resources Conservation Service
- Local media
    - Newspapers (Northern Sun-Print, Tama News-Herald, Times-Republican)
    - Radio stations (KFJB, KDAO, KGRN, KXIA)
- Iowa State Extension
- Tama County Sanitarian
- Tama County Economic Development

Potential barriers to project progress exist and are different for each watershed audience. Agricultural landowners and operators may find issues with the loss of rental income and/or crop production acreage, unfamiliarity with project administrative requirements and cost-share, absentee landowners, and high commodity and land prices. Lakeside residents may be uncertain of future wastewater treatment needs, expenses, and requirements and must learn to work together to solve residential sub-watershed issues. Continued changes in agency policy and programs are a barrier to all stakeholder audiences as is the heavy-handed approach by a partner agency during administration of the watershed's 1980s project. With knowledge of the potential barriers and motivators, public outreach tactics will be developed around the target audiences' preferred means of receiving information, which is most commonly through direct contact, media, or newsletter.

8.1 Personal Contacts

Watershed efforts which began with the previous project beginning in 1984 were initiated by a Soil Loss Complaint filed by IDNR against all of Union Grove Lake Watershed's agricultural landowners. All landowners were forced by Iowa code to become involved with the mandatory project. Enhanced cost-share availability and programming was embraced by a portion of the affected landowners. Unfortunately, another portion was angered and resisted meeting project guidelines. Because of this, USDA personnel found it beneficial to work with agricultural landowners individually or in small groups.

Several of the landowners discontented with the earlier project are still active in this watershed. With Project 086-3.08, working with individuals and small groups proved to generate less animosity toward the project. Those working with any future projects may find it helpful to also take this approach.

The current project also found one-on-one on-farm contacts to be a very beneficial means of updating real-time changes on the land and in farm management. This practice should be considered in any future watershed outreach efforts.

In a new watershed project it may be advantageous to make personal contacts in the early stages of the project in order to conduct a benchmark survey. Such a survey could include questions regarding opinions of the project, soil conservation, and water quality; perceived "ownership" and value of the lake; stakeholders' willingness to take action in order to improve Union Grove Lake; and the preferred means of communication. An interim survey could be implemented partway through the project with a follow-up survey conducted at the project's completion.

The current project coordinator has also been made available after hours to address lakeside residential sub-watershed issues, mostly involving runoff. These opportunities have been found invaluable to expose small groups of the watershed's non-farm community to a project presence and provided opportunities for personal contact. Any future project may similarly benefit from making itself available to this stakeholder segment beyond the realm of normal business hours.

8.2 Media

Radio station KFJB (Marshalltown) tends to be a very popular radio station for morning news and weather. During Project 086-3.08, the coordinator has utilized this station's morning interview slots in order to publicize upcoming events. The slots have included direct interviews with station personnel and weekly local event reports with the Gladbrook newspaper's editor and Tama County Economic Development Director. For each event, public service announcements have been sent to all area radio stations and press releases to all area newspapers. These measures have proven effective, and it is advised any future project take advantage of these resources.

8.3 Newsletter

Throughout the current watershed project, a quarterly newsletter has been delivered via mail or electronically to between 200 and 215 stakeholders and partner agency personnel. Very few watershed stakeholders have requested their newsletter be delivered electronically.

Response to the newsletter has always been very positive. A few responses to the webpage survey conducted in Fall 2010 included positive comments regarding the newsletter, even though no survey questions pertained to the newsletter. Personal contacts with stakeholders throughout the current project have also yielded numerous positive comments regarding the newsletter.

This communication avenue appears to have very effective for the current project with the current stakeholder demographics, and it is recommended that any future watershed projects utilize similar public outreach methods to disseminate information.

8.4 Partner Agency Events

Throughout the current project, the project coordinator has made contact with stakeholders via mail regarding pertinent events conducted by partner agencies. Most of these contacts have been with watershed livestock producers for related activities, such as an ISU pasture management workshop which was conducted at a Tama County site not far from the lake watershed. Routine contact needs to be made with partner agencies to keep abreast of changes withing their organizations and of events that pertain to watershed stakeholders.

8.5 Workshops and Events

Project 086-3.08 has held a number of events and educational workshops during its duration with mixed results. While attendance at these activities by watershed stakeholders has not proven overwhelming, the outreach has been very favorably received by those who participated. Similar outreach efforts by future projects may find these activities an effective means of reaching small groups of participants.

8.6 Watershed Organizations

While it has required work beyond normal work hours and days, the current project coordinator and some field office staff have participated in Lake & Park Holding Corporation events during the current project. These events have included the corporation's semi-annual board meetings, work days, and special events such as the organization's 75th anniversary celebration. Such activities have greatly enhanced the project's presence in the watershed and provided numerous opportunities for personal contacts.

8.7 Outreach Evaluation

Outreach success may be measured by meeting and workshop attendance and participation, follow-up surveys via mail/email, follow-up personal contacts, and application rate of best management practices.

9.0 Implementation Schedule

The following schedule should be flexible, adapting to shifting priorities, changing resource concerns, new opportunities, unexpected delays, and construction season weather conditions. It is intended to be used to chart plan progress, maintain focus on plan goals and objectives, and ensure timely goal and objective application.

Since action items may fulfill more than one objective, they are listed according to the objective they most significantly impact.

This plan will focus on two overlapping phases for future efforts:

- phase 1: upland treatment and watershed maintenance, in three three-year sub-phases
- phase 2: in-lake restoration, an estimated three to five years

Phase 2's start year is to be determined by IDNR to accommodate the Lake Restoration program and according to progress in best management practice application during Phases, 1a, 1b, and 1c.

The following schedule contains potential TP reduction by the watershed best management practices listed in Figure 83. For relative TP reduction by in-lake practices see Figure 80, and potential TP reduction by upland practices not utilized in this plan, see Figure 81. For pathogen-inhibiting practices, see Section 6.3.4 of this document.

Goal 1	Conduct in-lake restoration activities to reduce internal nutrient contribution	Number to apply	Units	Phase 1a Years 1-3	Phase 1a estimated TP load reduction (lb/y)	Phase 1b Years 4-6	Phase 1b estimated TP load reduction (lb/y)	Phase 1c Years 7-9	Phase 1c estimated TP load reduction (lb/y)	Total Phase 1 estimated TP load reduction (lb/y) by practice	Phase 2: five years (2013- 2017)
Objective 1	**Reduce internal nutrient recycling**										
Action item 1	Lower lake level	1	lake								1
Action item 2	Remove sediment	387,000	yd^3								387,000
Action item 3	Establish benthic aquatic vegetation	25	acres								25
Action item 4	Remove silt upstream of sediment dike	50,000	yd^3								50,000
Objective 2	**Reduce sediment delivery to the lake**										
Action item 1	Construct wetland complex upstream of sediment dike	1	wetland								1
Objective 3	**Improve lake fisheries**										
Action item 1	Remove desirable fishery	1	fishery								1
Action item 2	Kill undesirable fishery	1	fishery								1
Action item 3	Install fish habitat	12	habitat complexes								12
Action item 4	Modify primary spillway to deter entry of undesirable species	1	spillway								1
Action itme 5	Restock fishery	1	fishery								1

Goal 2	Reduce watershed sediment and phosphorus load	Number to apply	Units	Phase 1a Years 1-3	Phase 1a estimated TP load reduction (lb/y)	Phase 1b Years 4-6	Phase 1b estimated TP load reduction (lb/y)	Phase 1c Years 7-9	Phase 1c estimated TP load reduction (lb/y)	Total Phase 1 estimated TP load reduction (lb/y) by practice	Phase 2: five years (2013- 2017)
Objective 1	**Reduce stream contribution**										
Action item 1	Install grade and streambank stabilization	5	practices	1	**8**	1	**8**	3	**25**	**41**	
Objective 2	**Reduce upland contribution**										
Action item 1	Install filter strips and riparian buffers	50	acres	10	**12**	30	**42**	10	**14**	**68**	
Action item 2	Soil testing and fertilizer outreach	6,842	acres	2,280		2,280		2,281			
Action item 3	Install contour farming	500	acres	180	**35**	200	**30**	120	**29**	**94**	
Action item 4	Install no-till	500	acres	160	**172**	180	**186**	160	**101**	**459**	
Action item 5	Install grassed waterways	30	acres	15	**157**	15	**86**			**243**	
Action item 6	Install terraces	3,000	feet	1,000	**35**	2,000	**69**			**104**	
Action item 7	Install cover crops	300	acres	120	**139**	180	**208**			**347**	
Action item 8	Renovate terraces	3,000	feet	500		1,500		1,000			
Action item 9	Renovate grade stabilization structures	2	structures			1		1			
Action item 10	Reduce lakeside mowing	3	acres	3	**4**					**4**	
Action item 11	Install shoreline native plantings	7	acres	2	**3**	3	**4**	2	**2**	**9**	
Action item 12	Install timber stand improvement	5.9	acres			5.9					
Action item 13	Update farm conservation plans	6,842	acres	2,280		2,280		2,281			
Action item 14	Evaluate practices with sediment delivery calculator	6,842	acres	annually		annually		annually			
Action item 15	Upgrade existing wetland to 90% sediment retention	5	acres	5	**302**					**302**	

Goal 3	Reduce bacteria concentrations to support lake's designated uses	Number to apply	Units	Phase 1a Years 1-3	Phase 1a estimated TP load reduction (lb/y)	Phase 1b Years 4-6	Phase 1b estimated TP load reduction (lb/y)	Phase 1c Years 7-9	Phase 1c estimated TP load reduction (lb/y)	Total Phase 1 estimated TP load reduction (lb/y) by practice	Phase 2: five years (2013- 2017)
Objective 1	**Reduce contributions from septic systems**										
Action item 1	Inspect and evaluate all private septic systems	100	septic systems	33		33		34			
Action item 2	Facilitate septic systems repairs	20	septic systems	5		7		8			
Action item 3	Facilitate investigation of community sewage treatment	1	sewage treament system					1			
Objective 2	**Reduce contributions from livestock, pets**										
Action item 1	Install livestock exclusion fencing along streams	4,000	feet	1,000	**1**	2,000	**3**	1,000	1	**5**	
Action item 2	Install livestock watering systems	4	watering systems	1		2		1			
Action item 3	Install roofed manure storage systems	1	system					1			
Action item 4	Pet waste removal outreach	100	household	20		20		20			
Objective 3	**Reduce contributions from wildlife**										
Action item 1	Use groomer to clean beach	weekly during swim season	beach	12 times/yr		12 times/yr		12 times/yr			
Action item 2	Remove geese from watershed	100 annually	geese	100/yr		100/yr		100/yr			
Action item 3	Reduce year-round open water by retrofitting aerator	1	aerator	1							

Goal 4	Assess, evaluate, and monitor water resources	Number to apply	Units	Phase 1a Years 1-3	Phase 1a estimated TP load reduction (lb/y)	Phase 1b Years 4-6	Phase 1b estimated TP load reduction (lb/y)	Phase 1c Years 7-9	Phase 1c estimated TP load reduction (lb/y)	Total Phase 1 estimated TP load reduction (lb/y) by practice	Phase 2: five years (2013- 2017)
Objective 1	**Conduct lake and tributary water quality monitoring**										
Action item 1	Collect data from lake, beach and deep-lake sites	3	sites	yearly		yearly		yearly			
Action item 2	Collect data from tributary sites	2	sites	yearly		yearly		yearly			
Action item 3	Collect data from tile discharge	20	sites	yearly		yearly		yearly			
Action item 4	Evaluate and interpret sampling results	100	sample events	yearly		yearly		yearly			
Goal 5	**Conduct a public outreach program**										
Objective 1	**Inform the public of current watershed issues**										
Action item 1	Publish a quarterly newsletter	4	newsletter annually	12		12		12			
Action item 2	Inform stakeholders of educational opportunities by project partners	4	notices annually	12		12		12			
Objective 2	**Educate stakeholders of BMPs**										
Action item 1	Facilitate workshops on BMPs	2	workshop annually	6		6		6			

Goal 6	Protect existing private constructed wetland complex to secure sediment delivery to lake	Number to apply	Units	Phase 1a Years 1-3	Phase 1a estimated TP load reduction (lb/y)	Phase 1b Years 4-6	Phase 1b estimated TP load reduction (lb/y)	Phase 1c Years 7-9	Phase 1c estimated TP load reduction (lb/y)	Total Phase 1 estimated TP load reduction (lb/y) by practice	Phase 2: five years (2013- 2017)
Objective 1	**Facilitate purchase or easement of complex**										
Action item 1	Facilitate IDNR and/or private non-profit purchase or easement	120	acres	120	1860 lbs of preventive load reduction						
Objective 2	**Prioritize wetland sub-watershed to protect and extend effectiveness**	2,892	acres								
Action item 1	Focus outreach efforts	ongoing									
Action item 2	Provide additional financial incentives for BMPs	ongoing									
Total Phase 1 estimated TP load reduction (lb/y)					**868 lb/y = 23% reduction from current conditions**		**636 lb/y = 40 % reduction from current conditions**		**172 lb/y = 44% reduction from current conditions**	**Total potential TP load reduction = 1676 lb/y**	

10.0 In-lake Water Quality Milestones

Figure 85 shows the interim milestones set in order to measure the progress of attaining the water quality goals set by this plan for Union Grove Lake. The interim goals for each phase will be updated as modeling and more data become available.

Figure 85

	Estimated Fiscal Year	Chlorophyll *a* (TSI)	Secchi Depth (TSI)	Total Phosphorus (ug/L)
TMDL Target Values	-	65	61	56
2006-2008 Baseline Conditions (TMDL)	-	72	65	139
End of Phase 1a	2016	71	65	132
Lake Restoration acivities and Phase 1b completed	2018	68	63	92
End of Phase 1c	2022	64	60	56

By the end of Phase 1a, best management practices will be completed in priority areas outside of the existing wetland sub-watershed. Once IDNR Lake Restoration activities and Phase 1b are completed, the existing wetland will be enhanced to 90% sediment trapping efficiency, dredging will be completed in-lake and above the existing sediment dike, fishery renovation will be complete, and in-lake aquatic vegetation will be re-establishing. By the conclusion of Phase 1c, additional structures will be installed in priority areas and above the existing wetland in order to extend the effective life of that structure.

11.0 Resource Needs

The following resource needs reflect local estimated costs current 2010 and assume 75% cost-share for most practices installed by private landowners.

Wherever possible, the Tama Soil & Water Conservation District will secure funding sources other than 319 funding. Potential funding sources include U.S. EPA 319; IDNR Lake Restoration (IDNRLR), Wildlife (IDNRW), and Fisheries (IDNRF); Iowa's Water Protection Fund (WPF), Watershed Protection Fund (WSPF), Publicly Owned Lakes (POL); and Resource Enhancement and Protection (REAP); Iowa Department of Transportation (IDOT); Tama County (Tama); Ducks Unlimited (DU); USDA-FSA Conservation Reserve Program (CRP); USDA-NRCS Environmental Quality Incentives Program (EQIP); and Iowa Natural Heritage Foundation (INHF). It is assumed USDA-Natural Resources Conservation Service, IDALS-Division of Soil Conservation, and Tama Soil & Water Conservation District will provide office space, some materials, vehicles, equipment, and technical support. Technical assistance is also assumed provided by IDNR, USDA-Farm Service Agency, and Iowa Department of Transportation.

				Costs			
Goal	**Objective**	**Practice**	**Potential funding source**	**Phase 1a**	**Phase 1b**	**Phase 1c**	**Phase 2**
1	Reduce internal nutrient recycling	Lower lake, dredge, establish vegetation	IDNRLR, WPF, DU				$1,800,000
	Construct wetland upstream of sediment dike	Construct wetland upstream of sediment dike	319, IDNRLR, WPF, IDOT, Tama DU, EQIP				$80,000
	Improve fishery	Fishery renovation, install habitat, modify spillway	IDNRLR, IDNRF				$400,000
2	Reduce stream sediment and phosphorus load	Install 5 grade and streambank stabilization structures	319, WPF, WSPF, EQIP	$7,500	$7,500	$22,500	
	Reduce upland sediment and phosphorus load	Install 50 acres filter strips and riparian buffers @ $250/ac	POL, REAP, CRP	$2,500	$7,500	$2,500	
		Soil testing/fertilizer outreach	319, WSPF	$250	$250	$250	
		Install 500 ac contour farming @ $7.50/ac	POL, EQIP	$1,350	$1,500	$900	
		Install 500 ac no-till @ $75/ac	POL, EQIP	$12,000	$18,500	$12,000	
		Install 30 ac grassed waterways @ $2600/ac	319, WPF, WSPF, POL, EQIP	$39,000	$39,000		

				Costs			
Goal	**Objective**	**Practice**	**Potential funding source**	**Phase 1a**	**Phase 1b**	**Phase 1c**	**Phase 2**
2 cont'd	Reduce upland sediment and phosphorus load cont'd	Install 3,000 ft terraces @ $5/ft	319, WPF, WSPF, POL, EQIP	$5,000	$10,000		
		Install 300 ac cover crops @ $60/ac	319, POL, EQIP	$7,200	$10,800		
		Renovate 3,000 ft terraces @ $5/ft	319, WPF, WSPF, POL, EQIP	$2,500	$5,000	$7,500	
		Renovate 2 grade stabilization structures @ $5,000 each	319, WPF, WSPF, POL, EQIP		$5,000	$5,000	
		Install 7 ac shoreline native plantings @ $110/ac	WPF	$220	$330	$220	
		Install 5.9 ac timber stand improvement @ $750/ac	POL, REAP		$4,425		
		Upgrade existing wetland to 90% sediment retention	IDNRLR, IDNRW	$80,000			

				Costs			
Goal	**Objective**	**Practice**	**Potential funding source**	**Phase 1a**	**Phase 1b**	**Phase 1c**	**Phase 2**
3	Reduce bacterial contributions from septic systems	Inspect and evaluate 100 septic systems @ $500 each	IDNR, WPF, Tama	$15,000	$15,000	$20,000	
		Repair 20 septic systems @ $2,250 each	IDNR, WPF, Tama	$11,250	$15,750	$18,000	
		Investigate community treatment	WSPF			$3,500	
	Reduce bacterial contributions from pets, livestock	Install 4,000 ft streamside fencing @ $1.50/ft	WSPF, EQIP	$1,500	$3,000	$1,500	
		Install 4 livestock watering systems @ $2,250 each	WSPF, EQIP	$2,250	$4,500	$2,250	
		Install 1 roofed manure storage @ $10,000 each	WSPF, REAP, EQIP			$10,000	
		Pet waste outreach	WSPF	$250	$250	$250	
	Reduce bacterial contributions from wildlife	Retrofit aerator @ $1,000 each	IDNRLR	$1,000			

				Costs			
Goal	**Objective**	**Practice**	**Potential funding source**	**Phase 1a**	**Phase 1b**	**Phase 1c**	**Phase 2**
4	Monitor lake and tributary water quality	Collect data from lake, beach, deep-lake sites	IDNR, WPF, WSPF	$5,500	$6,000	$6,500	
		Collect data from tributary sites	IDNR, WPF, WSPF	$6,000	$6,200	$6,400	
		Collect data from tile discharge	IDNR, WPF, WSPF	$2,200	$2,300	$2,400	
		Evaluate and interpret results	IDNR	no cost	no cost	no cost	
5	Conduct public outreach	Publish quarterly newsletter @ $2,000/yr	319, WSPF	$6,000	$6,000	$6,000	
		Inform public of project partner opportunities	319, WSPF	$250	$250	$250	
		Facilitate 2 BMP workshops/yr @ $200 each	319, WSPF	$12,000	$12,000	$12,000	

				Costs			
Goal	**Objective**	**Practice**	**Potential funding source**	**Phase 1a**	**Phase 1b**	**Phase 1c**	**Phase 2**
6	Facilitate purchase or easement of private wetland complex	Facilitate IDNR and/or private purchase or easement	IDNR, IDOT, Tama, DU, INHF	~$700,000 purchase ~$300,000 easement			
	Prioritize wetland sub-watershed	Focus outreach efforts	319, WSPF	TBD	TBD	TBD	
		Provide additional financial incentives	319, WPF, WSPF, POL, REAP, CRP, EQIP	TBD	TBD	TBD	
Project administration	Salary/benefits	Full-time project coordinator	319	$228,761	$259,857	$292,578	
	Travel/training	Coordinator training	319	$2,000	$2,000	$2,000	
	Equipment/supplies	Equipment, supplies	319	$2,000	$2,000	$2,000	
	Indirect costs	Indirect costs	319	$43,007	$48,854	$36,205	
	Information/education	Public outreach	319, WSPF	$6,000	$6,000	$6,000	
Phase resource costs				$1,202,488	$499,766	$478,703	$2,280,000
Total resource costs				$4,460,957			