Des Moines
County SWCD

Des Moines County
Conservation

Final Big Hollow Watershed Management Plan
Des Moines County, Iowa

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ACPF	Agricultural Conservation Planning Framework
BMP	Best Management Practice
CDL	Crop Data Layer
CCB	Des Moines County Conservation Board
IDALS	Iowa Department of Agriculture and Land Stewardship
IDNR	Iowa Department of Natural Resources
L	Liter
lbs	Pounds
m	Meter
NAIP	National Agriculture Imagery Program
NAVD 88	North American Vertical Datum 1988
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NRS	Nutrient Reduction Strategy
RASCAL	Rapid Assessment of Stream Conditions Along Length
RUSLE	Revised Universal Soil Loss Equation
SRF	State Revolving Fund
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
SWCD	Des Moines County Soil & Water Conservation District
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
ug	Micro-grams
USDA	U.S. Department of Agriculture
WASCOBs	Water and Sediment Control Basins
WMP	Watershed Management Plan
WQIP	Water Quality Improvement Plan
WQI	Water Quality Initiative
yr	Year

1.0 INTRODUCTION

Big Hollow Lake is in Franklin Township in Des Moines County and is five miles southwest of Mediapolis. The lake was constructed in 2008 and is owned and managed by Des Moines County Conservation Board (CCB). The lake provides many recreational activities such as camping, fishing, hunting, and more to the community. The lake is a valuable resource for residents and citizens from around the region, which is why it is important to protect and improve Big Hollow and the surrounding watershed. Water quality is a primary concern due to elevated algae and pH levels. Big Hollow Lake is listed as impaired on Iowa's 2020 Section 303(d) Impaired Waters List for not supporting its primary contact recreation designated use. The impairment is due to elevated levels of algae and pH, caused by overly abundant nutrients (primarily phosphorus) and sediment. This plan references information from the Big Hollow Water Quality Improvement Plan (WQIP) which was completed in February 2021 by the Iowa Department of Natural Resources (DNR). The WQIP includes the Total Maximum Daily Load (TMDL) for algae and pH. The TMDL addressed both impairments by requiring pollutant load reductions for total phosphorus.

The Big Hollow Lake Watershed Management Plan (WMP) is a cooperative effort between the Des Moines County Soil and Water Conservation District (SWCD), CCB, Iowa Natural Resource Conservation Service (NRCS), the Iowa Department of Agriculture and Land Stewardship (IDALS), and the Iowa Department of Natural Resources (DNR). The purpose of the WMP is to identify the sources of water quality problems and develop a management strategy for improving the lake's condition. This WMP utilizes a watershed approach to improve water quality in Big Hollow Lake and includes implementation recommendations for land management and lake restoration activities over the next twenty years.

A Technical Advisory Committee (TAC) made up of representatives from natural resources and conservation partners was formed (Table 1-1) to guide the planning process and provide input related to available technical and financial assistance. Feedback was received from stakeholders through a public engagement process that included online surveys and a public meeting held at the lake. The technical information used to develop the WMP utilized and expanded upon the Big Hollow Lake Water Quality Improvement Plan (WQIP), which includes the Total Maximum Daily Load (TMDL) produced by Iowa DNR and approved by the United States Environmental Protection Agency (EPA).

Table 1-1. Technical Advisory Committee Members

Name	Affiliation	Role
Chris Lee	Des Moines CCB	Lake/park management, public engagement
Tyler Shipley	NRCS	Conservation guidance, landowner outreach
James Martin	IDALS	Plan development, implementation guidance
Chad Dolan	DNR Fisheries	Fisheries expertise, public engagement
George Antoniou Michelle Balmer	DNR Lake Restoration	Technical support and financial assistance
Andrew Frana/Andy Asell Miranda Haes/Kyle Ament	DNR Watershed Improvement	TMDL data/models, GIS support, Section 319 assistance, 9-element compliance

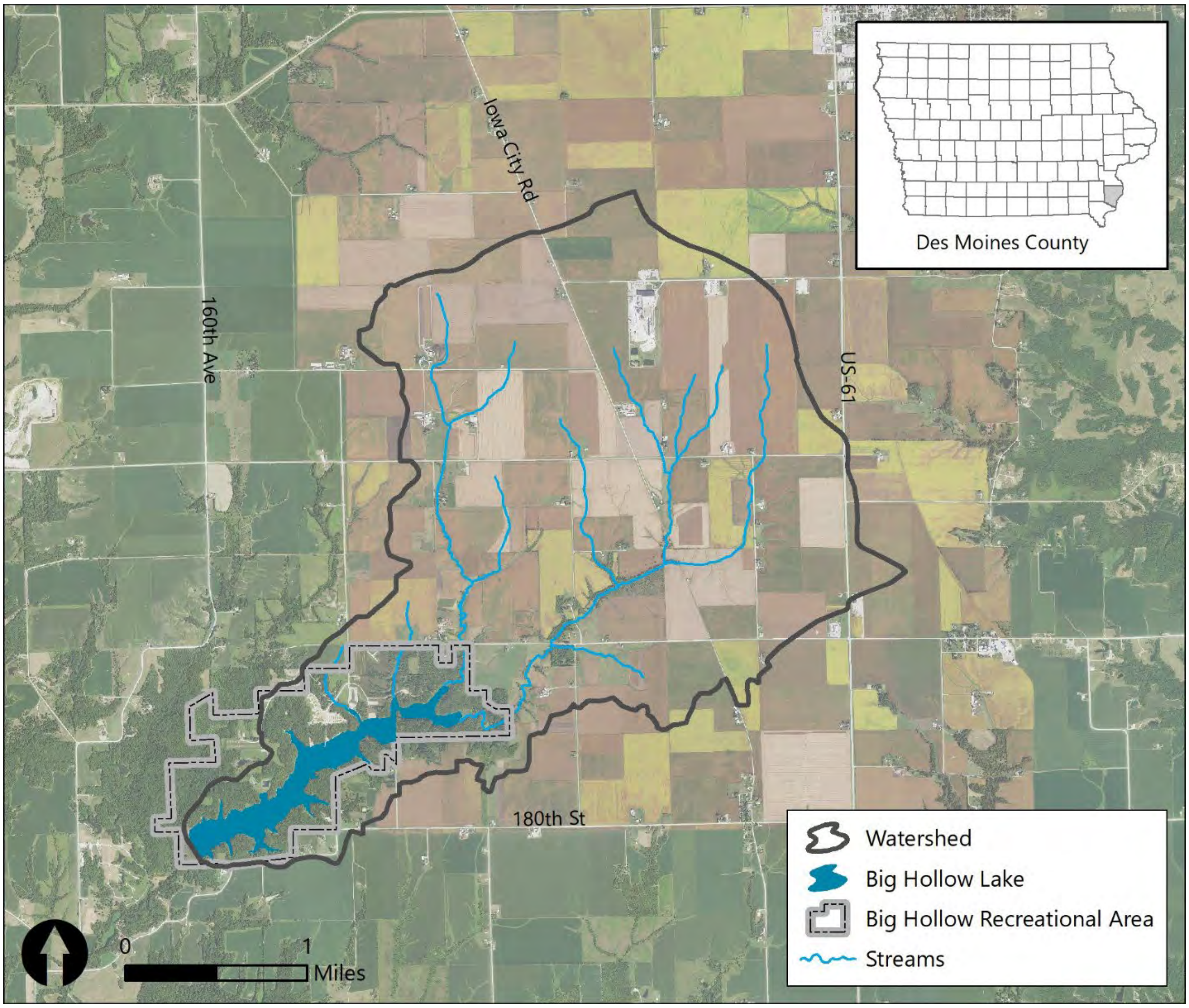
A primary goal of this plan is for it to be an approved, 9-Element Plan, as required by EPA. The 9 elements are listed in Table 1-2 below, along with a corresponding element letter and symbol. Symbols have been inserted throughout the document to indicate information that fulfills each of the 9 required elements.

Table 1-2. Required 9-Elements

Element ID	Element Description
a	Identify causes and sources of pollution
b	Estimate load reductions expected
c	Describe management measures and targeted critical areas
d	Estimate technical and financial assistance needed
e	Develop information and education plan component
f	Develop a project schedule
g	Describe interim, measurable milestones
h	Identify indicators to measure progress
i	Develop a monitoring component

2.0 WATERSHED DESCRIPTION

The Big Hollow Lake watershed is within the 12-digit Hydrologic Unit Code (HUC) 070801041203. The segment ID for Big Hollow Lake is 6496. The watershed encompasses 4,600 acres (Figure 2-1). The watershed-to-lake ratio is 29:1, which means that for every acre of lake surface, 29 acres of watershed contribute runoff, sediment, and potential pollutants to the lake. Approximately 373,300-feet of shoreline surround the 154-acre lake. In recent years, additional amenities have been added to Big Hollow Recreation Area (park), including multiple docks, a beach, and a shooting range. The improvements have increased the popularity and use of this important recreational resource.



Source: 2017 U.S. Department of Agriculture (USDA), National Agriculture Imagery Program (NAIP)

Figure 2-1. Big Hollow Lake and Watershed Map

2.1 Physical and Natural Features

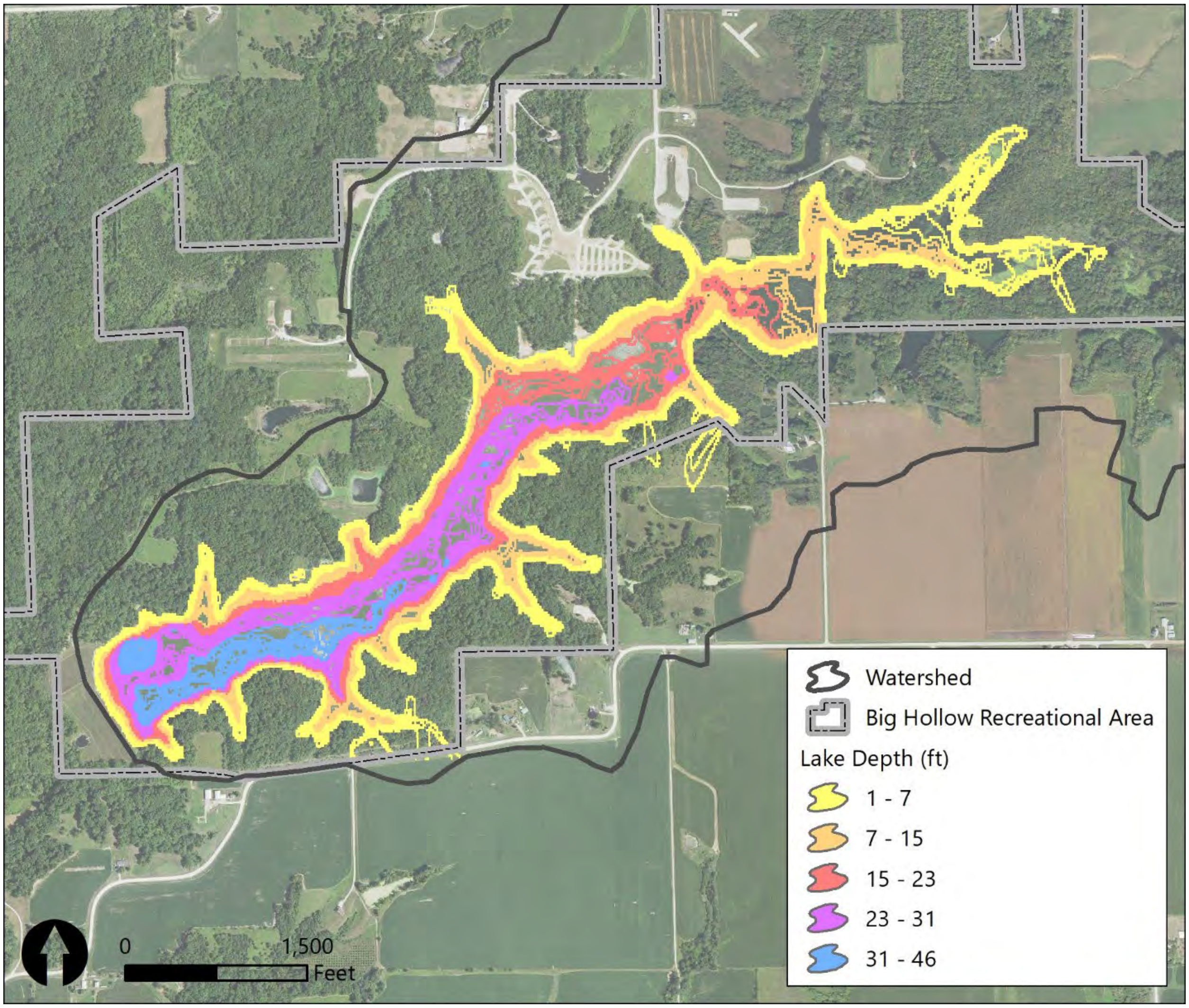
2.1.1 Ecoregion/Landform Region

The Big Hollow Lake watershed lies in the Rolling Loess Prairies ecoregion. Loess deposits in this region are typically less than 25-feet thick - shallower than the Loess Hills of the western part of the state near the Missouri River. The watershed is in the Southern Drift Plain landform region, which is dominated by glacial deposits. The deposits were carved by episodes of stream erosion so that only a horizon line of hill summits marks the once-continuous glacial plain. Rills, creeks, and rivers branch out across the landscape creating steeply rolling hills and valleys. The uplands and upper hill slopes are loess covered. The upland areas in the watershed are extremely flat and suitable for row crop cultivation. The land surrounding the lake consists of sharp features with alternating peaks and saddles.

2.1.2 Hydrology and Bathymetry

Big Hollow Lake is a 154-acre lake fed by tributaries to Big Hollow Creek, a small stream that originates in central Des Moines County (Big Hollow-Flint Creek watershed, HUC-070801041204). With a watershed area of 4,600 acres, the watershed to lake ratio is 29:1. This ratio suggests that a successful lake restoration program will be based on both watershed and lake-based solutions.

Lake bathymetry (a depth map of the lake) reveals that the lake's shallowest areas are the northeastern arm, and the deepest area is the southwestern portion near the dam (Figure 2-2). The mean depth of the lake is 16.1 feet, and the lake volume is estimated to be 2,701 acre-feet (Source: DNR WQIP).



Source: 2013 Bathymetric survey data by Iowa DNR

Figure 2-2. Big Hollow Lake Bathymetric Map

2.1.3 Soils

Primary soils include the Taintor and Mahaska soil series, as shown in Figure 2-3. These associations are characterized by flat to very flat uplands and poorly to somewhat poorly drained soils formed on loess. Slope ranges from 0 to 5 percent. These soils are generally well suited or moderately well suited to row crop, small grain, and hay production.

Taintor, Mahaska, and Clinton soils are the dominant soil types in the watershed (Table 2-1), comprising 63.9 percent of the watershed. Table 2-1 shows the soils, map units, area, percent area of the watershed, general description, and typical slopes of each soil. The large extents of Hydrologic Soil Groups C and D (Figure 2-4) indicate high runoff potential. Additionally, the majority of soils present are considered highly erodible and susceptible to sediment and associated phosphorus transport.

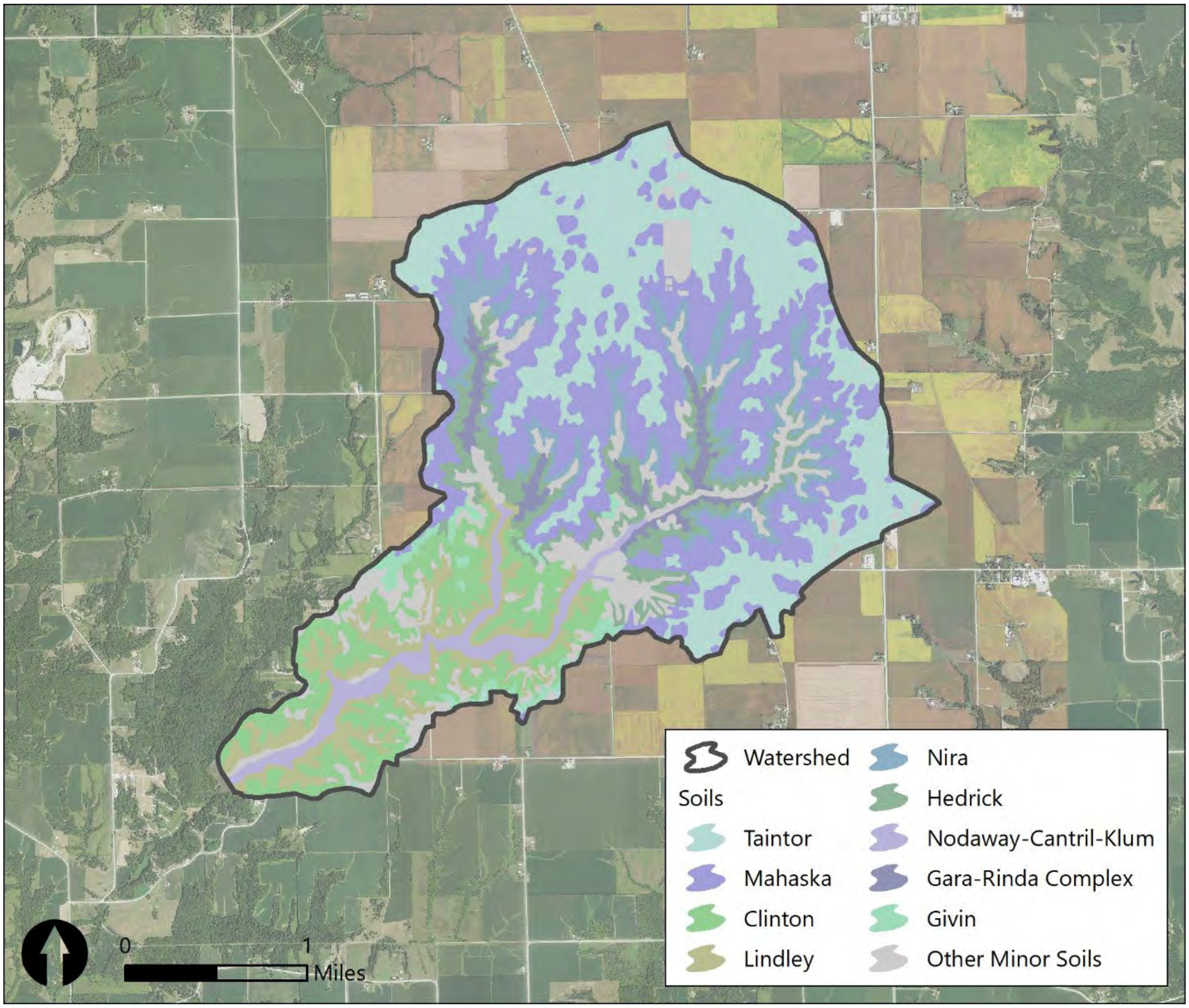


Figure 2-3. Watershed Soils Map

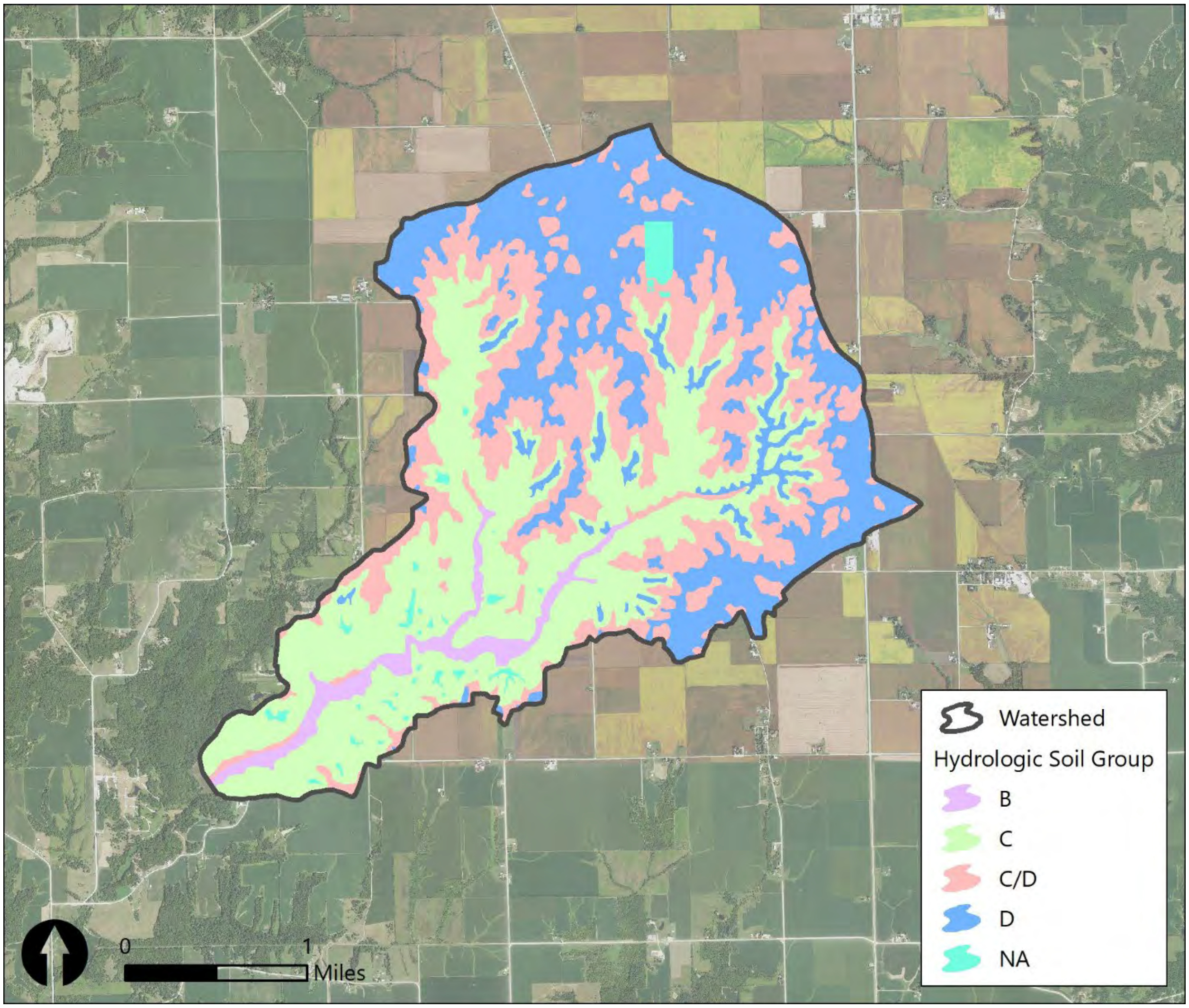


Figure 2-4. Watershed Hydrologic Soil Group Map

Table 2-1. Watershed Soil Types

Soil Name	Map Units	Area (ac)	Area (%)	Description	Hydrologic Soil Group	Typical Slopes
Taintor	279	1,333	28%	Very deep, poorly drained, formed in loess	D	0-2%
Mahaska	280	1,237	26%	Very deep, somewhat poorly drained, loess	C/D	0-2%
Clinton	80C; 80C2	456	10%	Very deep, moderately well drained, loess	C	2-9%
Lindley	424	322	7%	Very deep, well drained, upland positioned glacial till	C	14-40%
Nira	570	301	6%	Very deep, moderately well drained, loess	C	2-9%
Hedrick	571	269	6%	Very deep, moderately well drained, loess	C	2-5%
Nodaway-Cantril-Klum	730B	158	3%	Shares characteristics of each soil in complex	B	2-5%
Gara-Rinda Complex	893D2	115	2%	Shares characteristics of each soil in complex	C	9-14%
Givin	75	77	2%	Very deep, somewhat poorly drained, loess	C/D	1-3%
Other Minor Soils	-	465	10%	Minor soils, complexes, quarry, water	N/A	-
Total		**4,733**	**100%**			

2.1.4 Topography

This upland, northern half of the watershed is flat and well-suited for row crop cultivation. Closer to the lake the landscape transitions to steep slopes with rills, creeks, and gullies. Elevations in the watershed range from a maximum of 800 feet North American Vertical Datum 1988 (NAVD 88) to a minimum of 670 feet (Figure 2-5). The average slope class of the watershed is Class A with nearly flat (0 - 2 percent slope) regions making up a sizable percentage of the watershed (53.3%). Table 2-2 shows the percentage breakdown of slope classifications throughout the watershed and Figure 2-6 illustrates variation of steepness across the watershed.

Table 2-2. Watershed Slope Class

Slope Class	Area	Description of Slope Class
Class A (0-2%)	56.5%	Nearly Flat
Class B (2-5%)	17.6%	Gently sloping
Class C (5-8%)	15.0%	Moderately Sloping
Class D (8-15%)	3.5%	Strongly Sloping
Class E (15-30%)	6.6%	Moderately Steep
Class F (> 30%)	0.8%	Steep to Very Steep

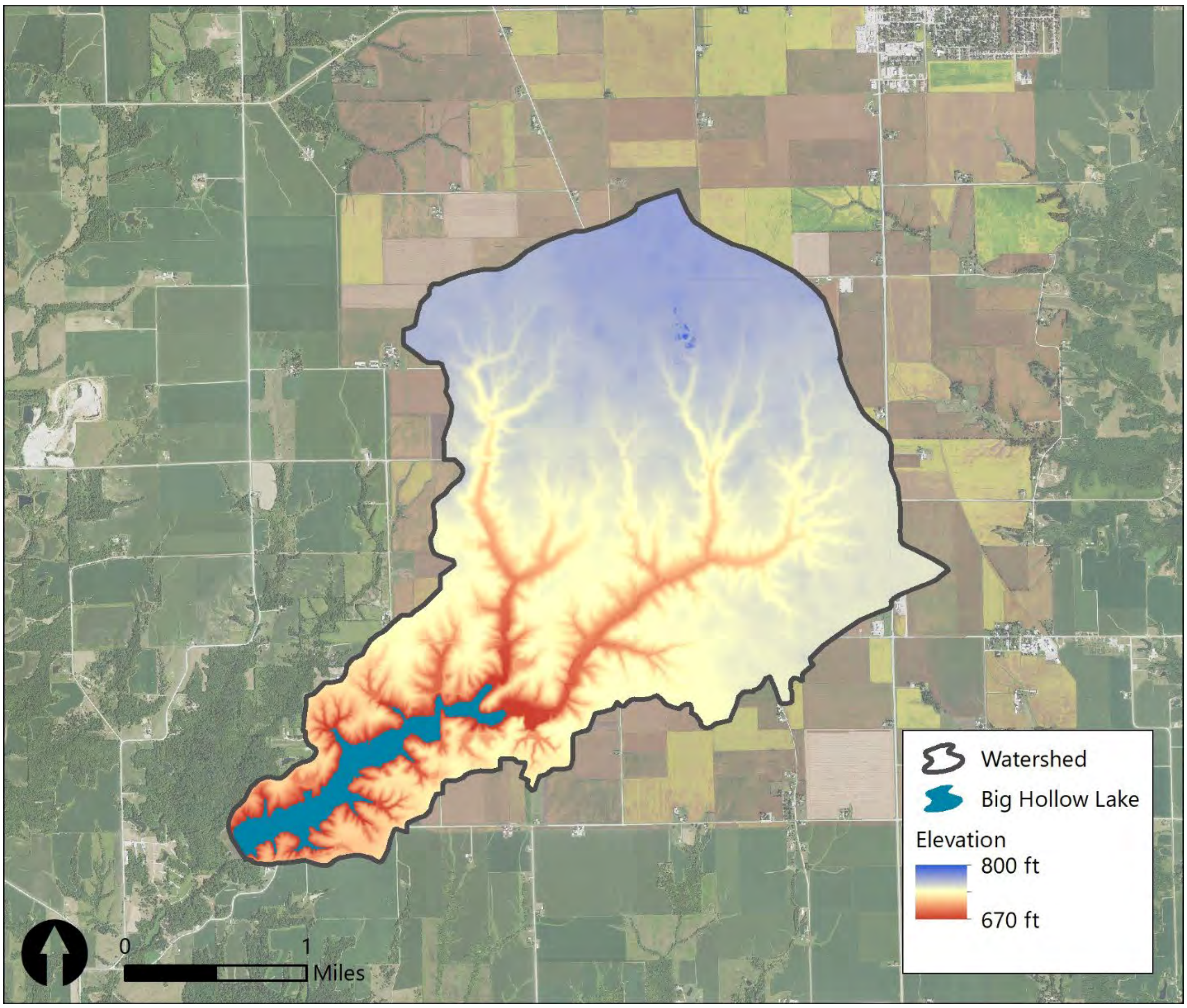


Figure 2-5. Watershed Topographic Map

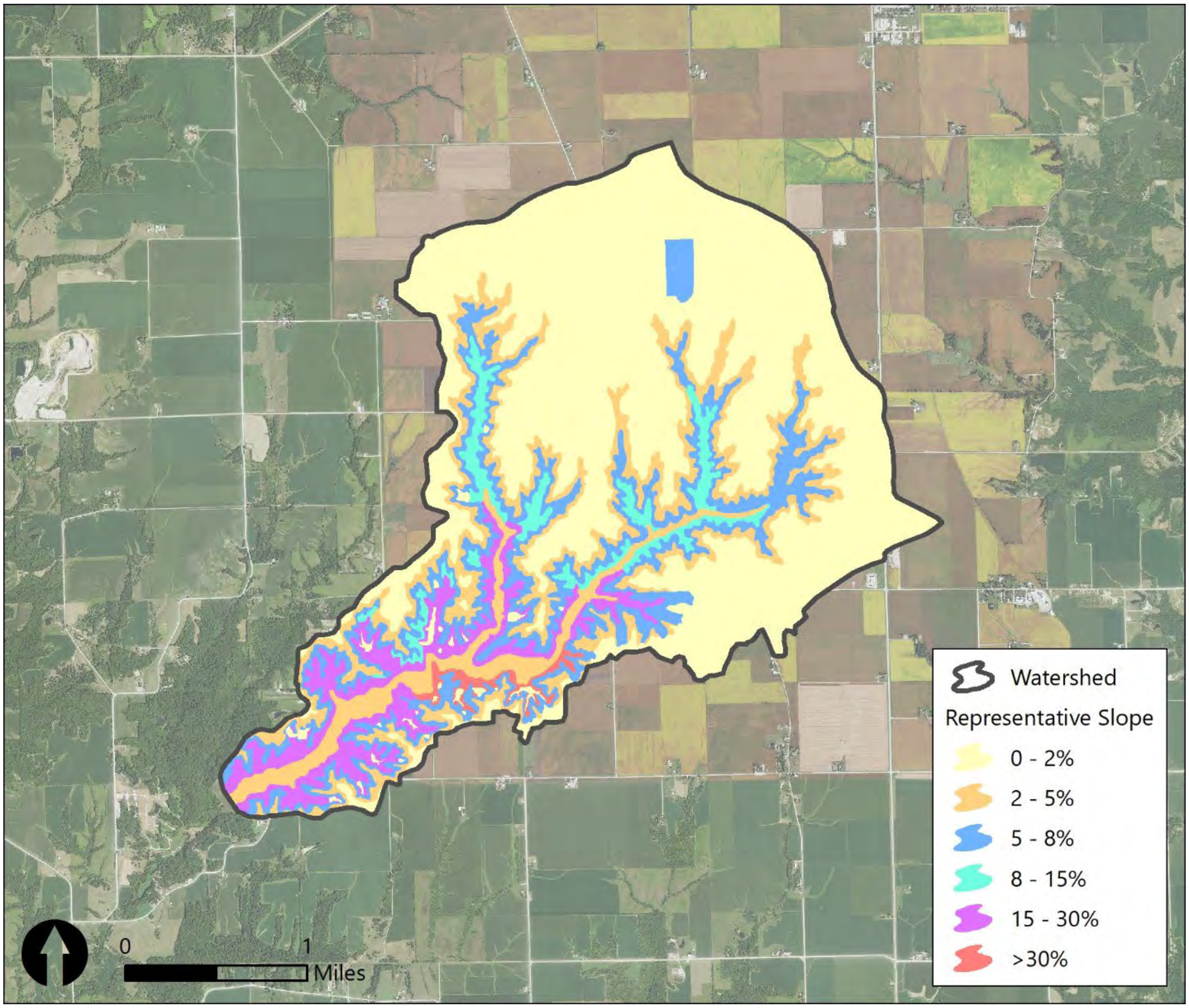


Figure 2-6. Watershed Slope Map

2.1.5 Climate

The average annual precipitation from 2011-2020 near Big Hollow Lake was 38.5-inches, consistent with the 30-year average of 38.4 inches. The driest month is January, averaging 1.3 inches of precipitation and the wettest month is May with an average of 5.7 inches. Typical of the Midwest, the wettest months are May and June, with winter months remaining relatively dry (Figure 2-7). This pattern aids crop production, but large rainfall events in late spring before vegetation cover develops can cause significant erosion and nutrient losses to downstream waterbodies.

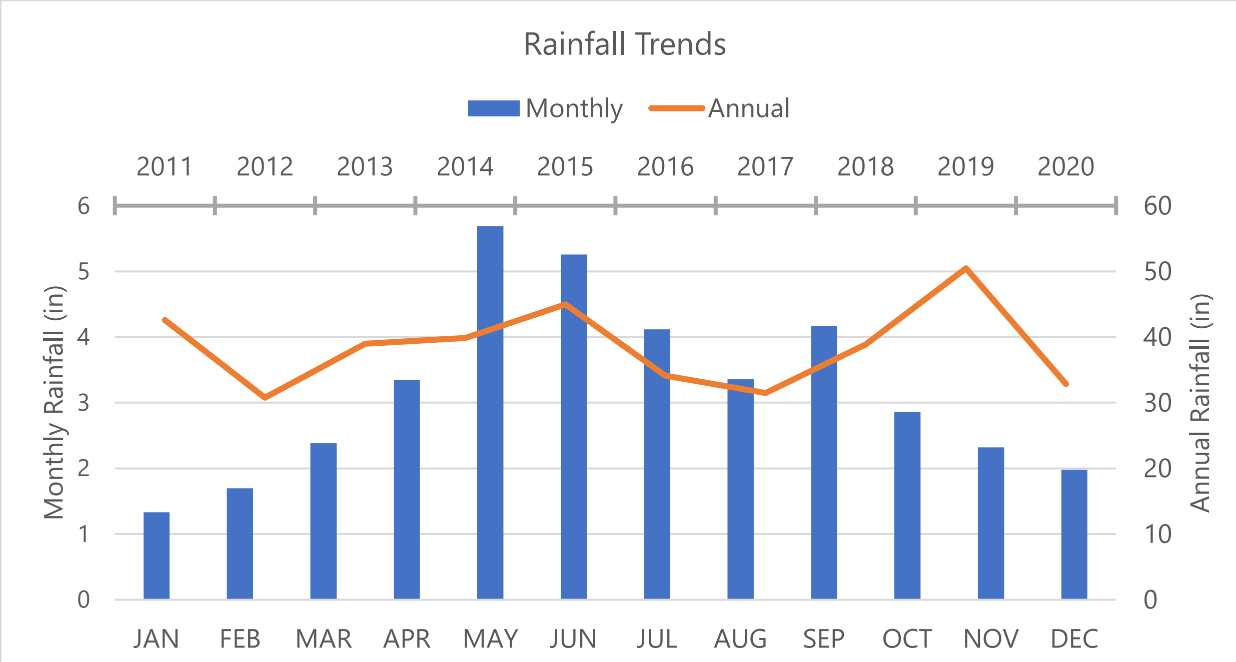


Figure 2-7. Average Rainfall (2011 to 2020)

2.2 Land Use and Land Cover

Land use information for the area was created from a windshield survey conducted of the area in the 2019 and 2020, from various aerial photography, and from crop data layer (CDL) sets from 2017-2020 through ArcGIS. The predominate land use is corn and soybean row crops, with row crops making up approximately 70% of the watershed (Table 2-3 and Figure 2-8). Grassland is an aggregate of alfalfa/hay, ungrazed land, and conservation programs. Prior to construction of the lake in 2008, the main land use in the watershed was also predominately row crop, specifically corn and soybeans.

Table 2-3. Watershed Land Use

Land Use	Description	Area (acres)	Percentage (%)
Row Crop	Corn and Soybeans	3,193	69%
Forested	Bottomland, Coniferous, Deciduous	532	12%
Urban	Farmstead, Roads	323	7%
Grassland	Un-grazed Grassland, Alfalfa/Hay	187	4%
Pasture	Grazed grasslands	183	4%
Water/Wetland	Water and Wetland (including Big Hollow Lake)	183	4%
Total		**4,604**	**100%**

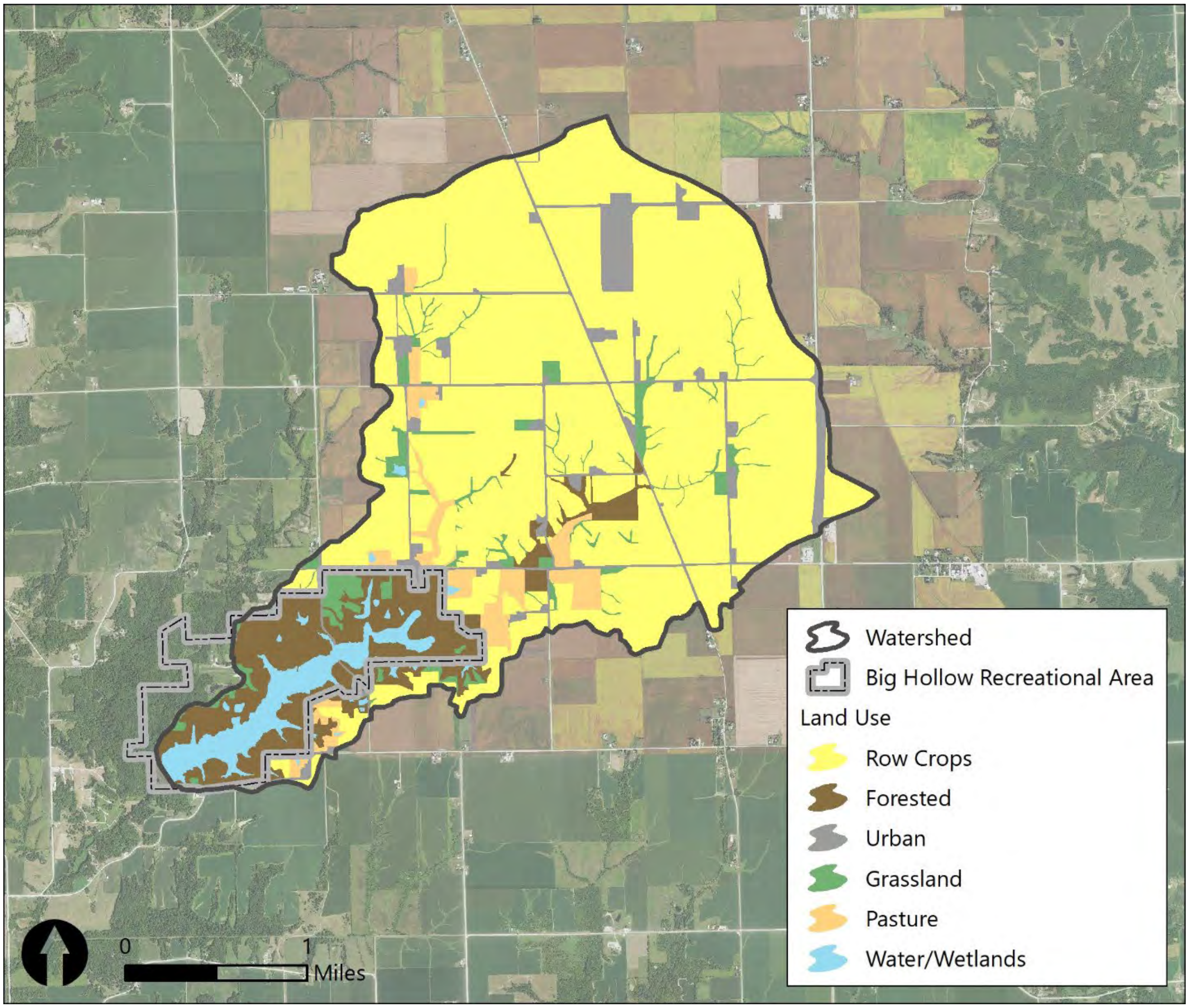


Figure 2-8. Watershed Land Use

2.3 Demographic Characteristics

Big Hollow Lake is in Des Moines County and is an important recreational area for the surrounding communities. The population of Des Moines County is 38,910 (2020 Census). Approximately 15% of the Des Moines County population is minority, which is consistent with the State of Iowa's overall minority population of approximately 16%. About 15% of the population lives at or below the poverty level, which is higher than the statewide percentage of 11% (2019 SAIPE).

2.4 Big Hollow Recreation Area

2.4.1 Recreational Opportunities

Big Hollow Recreation Area is the premiere outdoor recreation destination for Des Moines County. The 98-acre park offers many recreation activities including camping, hunting, fishing, boating, hiking, and swimming. The 178-acre lake was constructed in 2008 and includes a boat ramp, beach, and multiple fishing jetties. The campground includes 32 full hookup RV sites, a dump station, a shower house, and 11 tent sites. Other amenities include an off-grid cabin, shooting range, over 10 miles of trails, an observatory operated by Southeast Iowa Astronomy Club, prairies, wetlands, and forests. Popular fish at Big Hollow Lake include Black Crappie, Bluegill, Channel Catfish, Largemouth Bass, and Redear Sunfish.

3.0 HISTORY OF WATERSHED IMPROVEMENT ACTIVITIES

3.1 Water Quality Improvement Plan & TMDL

The WQIP prepared by the Iowa DNR for Big Hollow Lake was submitted to EPA in February 2021. The WQIP includes a TMDL, which is required by the Federal Clean Water Act for impaired water bodies. The WQIP and associated TMDL provided a foundation for the pollutant source assessment, pollutant reduction target, and improvement strategies set forth in this WMP.

3.2 Watershed Assessment and Conservation Planning

A Watershed Assessment was performed by the DNR for the Big Hollow Lake watershed. The Agricultural Conservation Planning Framework (ACPF) tool was utilized to identify appropriate Best Management Practices (BMPs) and their locations in the watershed. The DNR also completed a Revised Universal Soil Loss Equation (RUSLE) assessment to estimate upland erosion. RUSLE outputs include the estimated average sheet and rill erosion and sediment delivery. A third component of the watershed assessment was the application of the Rapid Assessment of Stream Conditions Along Length (RASCAL) tool. This stream assessment identified observed outfalls, erosion observation sites, annual erosion per observation site, and erosion per gully or streambank complex. Results and maps from these assessments are provided in Appendix A.

4.0 WATERSHED CONDITIONS

4.1 Big Hollow Lake – Designated Uses & Impairments

Big Hollow Lake appears on Iowa's 303(d) List of Impaired Waters in the 2016, 2018, and 2020 reporting cycles. Big Hollow Lake's Designated Uses are A1- Primary Recreation, B(LW) – Aquatic Life, and HH – Human Health (fish consumption). The Primary Contact Recreation designated use is "Not Supported" due to nuisance algae growth and pH. The Aquatic Life designated use is also "Not Supported" due to high pH. The Human Health designated use is "Fully Supported." The TMDL attributes algal growth and high pH to excess phosphorus entering the lake, therefore the TMDL and WMP focus on phosphorus reduction.

Table 4-1. Designated Uses and Impairments

Designated Uses	Cause of Impairment	Magnitude of Impairment
Primary Contact Recreation	Algal growth/ Chlorophyll a	Moderate
Primary Contact Recreation	pH	Slight
Aquatic Life		Slight

4.2 Water Quality Conditions

The water quality data used for Big Hollow Lake's impairment listing are from the ambient lake program which are the results of available statewide surveys of Iowa lakes sponsored by DNR and conducted by Iowa State University from 2011-2018. Data were collected three times a year during the growing season, typically once in May, once in July, and once in August.

Carlson's Trophic State Index (TSI) was used to evaluate the relationships between Total Phosphorus, algae (measured by Chlorophyll-a), and transparency (measured by Secchi Depth) in Big Hollow Lake. The Carlson Trophic State Index (1977) considers several water quality parameters to evaluate 'trophic state,' or the level of ecosystem productivity of a lake, typically measured in terms of algal biomass. High TSI values typically indicate high productivity and subsequently lower water clarity. TSI values for Secchi depth and Chlorophyll-a can be used as a guide to establish water quality improvement targets. TSI values range from 0 to 100, with higher values indicating poor water quality.

Table 4-2 is modified from the DNR's WQIP and ties TSI values to corresponding impacts on the lake system, recreation, and aquatic life. Big Hollow Lake's TSI values ranged from 39-77 during the 2011 – 2019 sampling period. The 303(d) threshold for Chlorophyll-a and Secchi depth is 65. Figure 4-1 shows the individual TSI values throughout the sampling period of 2011-2019 and Figure 4-2 shows the average annual TSI values and trends. Assessment period average TSI values for Secchi Depth, Chlorophyll-a, and Total Phosphorus (Table 4-3) indicate the lake is very productive. The Total Phosphorus TSI (70) is at the lower end of hypereutrophic conditions, Chlorophyll-a TSI indicates eutrophication, and Secchi depth levels are at the lower end of eutrophic conditions. High Chlorophyll-a TSI relative to Secchi Depth suggests that algal or other floating aquatic plants (e.g., duckweed) are large-celled varieties that allow higher Secchi Depth measurements despite occurrence of eutrophication.

Table 4-2. TSI Values and Impacts

TSI Value	Attributes	Primary Contact Recreation	Aquatic Life (Fisheries)
50-60	Eutrophy: anoxic hypolimnion; macrophyte problems possible	None	Warm water fisheries only; percid fishery, bass may be dominant
60-70	Blue green algae dominate; algal scums and macrophyte problems occur	Weeds, algal scums, and low transparency discourage swimming and boating	Centrarcid fishery
70-80	Hyper-eutrophy (light limited). Dense algae and macrophytes	Weeds, algal scums, and low transparency discourage swimming and boating	Cyprinid fishery (e.g., common carp and other rough fish)
>80	Algal scums; few macrophytes	Weeds, algal scums, and low transparency discourage swimming and boating	Rough fish dominate; summer fish kills possible

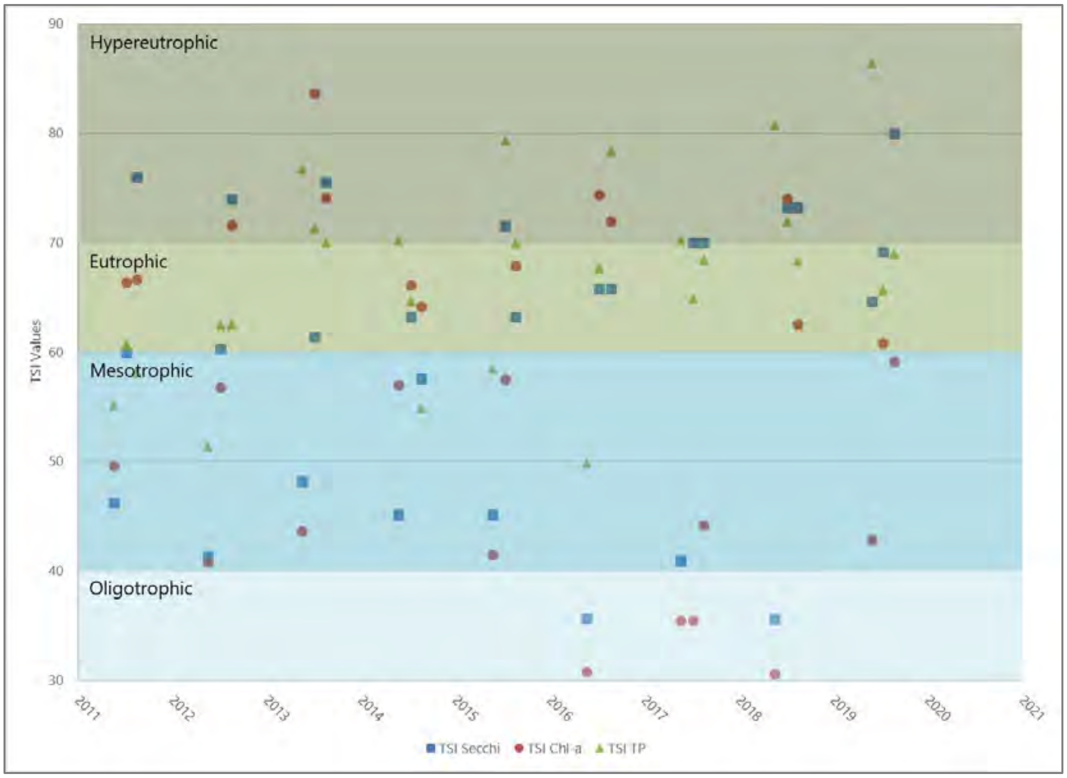


Figure 4-1. TSI Values Throughout Sampling Period

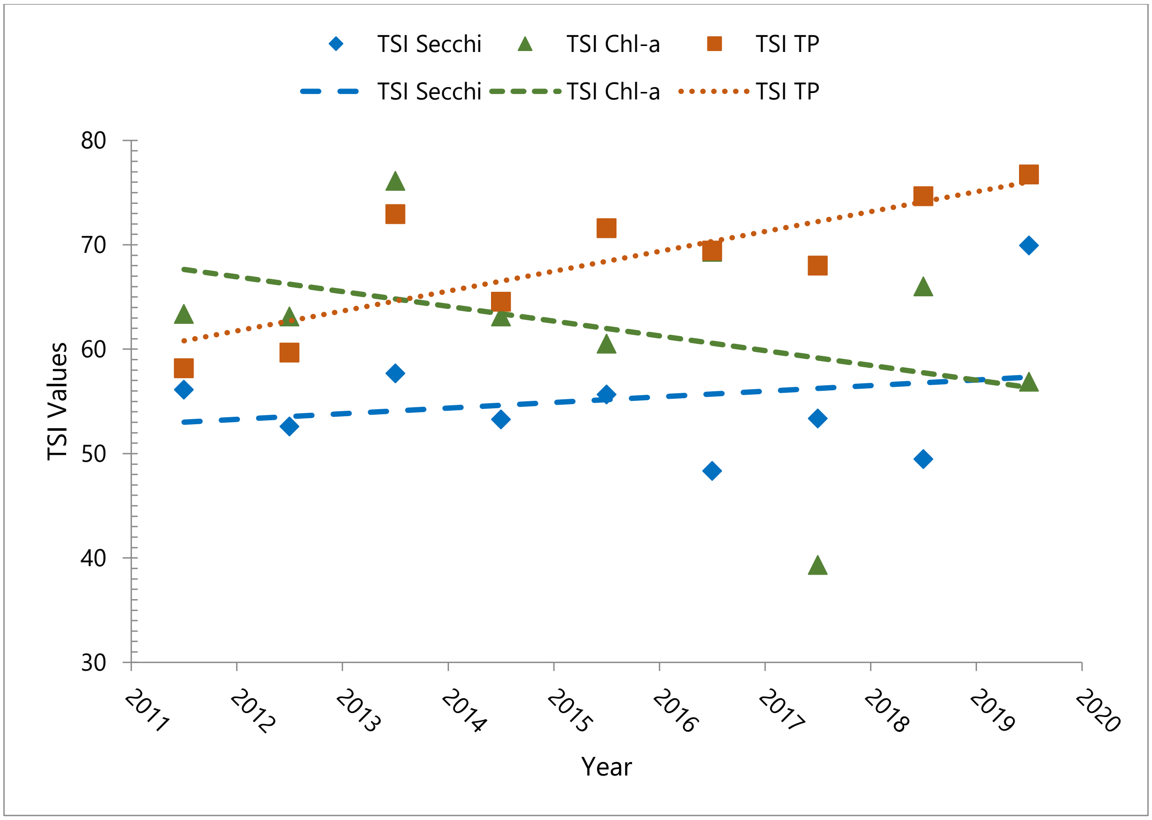


Figure 4-2. Average TSI Values

Table 4-3. Average TSI Values

	Secchi Depth	Chlorophyll-a	Total Phosphorus
Average TSI Values	54	66	70

Chlorophyll is a green substance found in plants that is essential for photosynthesis. Chlorophyll-a is a specific pigment commonly used to measure algal biomass present in lakes. Chlorophyll-a TSI scores exceed the 303(d)-list threshold of 65 approximately 40% of the time during the assessment period of 2011-2019 (Figure 4-3). Chlorophyll-a concentrations ranged from 1.0 ug/L to 223.4 ug/L. To be delisted, Chlorophyll-a TSI scores need to be 63 or lower for two consecutive years, which is equivalent to a concentration of 27.2 ug/L or lower (see concentrations and red line in Figure 4-3).

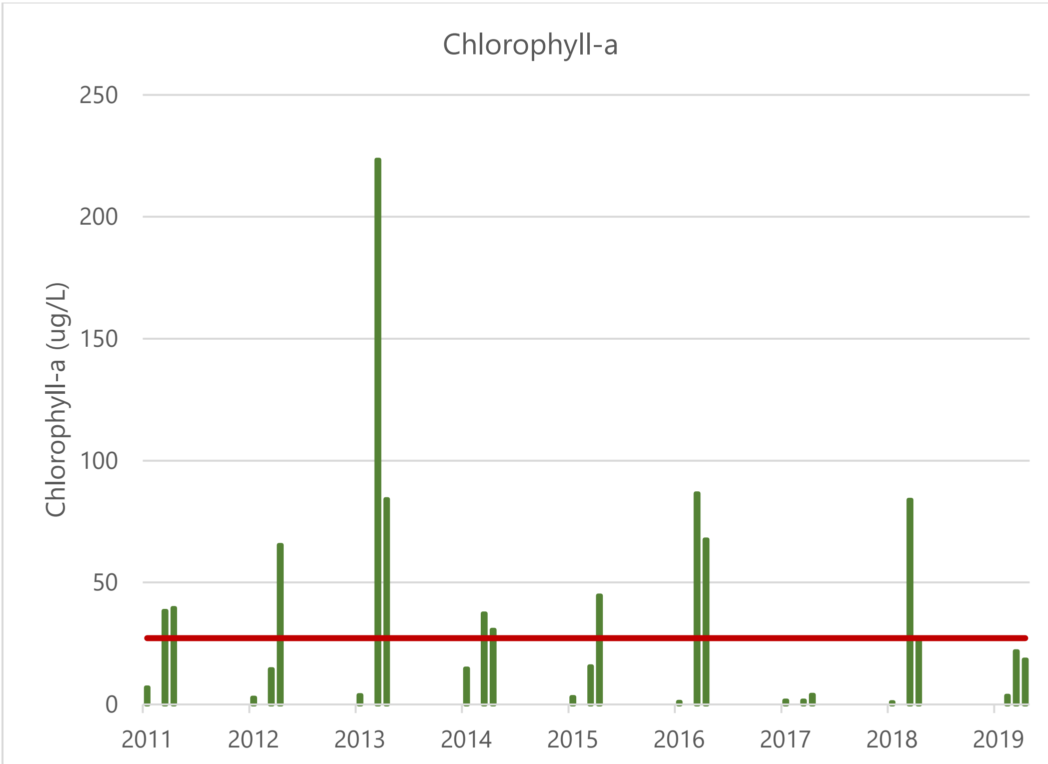


Figure 4-3. Chlorophyll-a Concentrations

Phosphorus is a nutrient that is critical to plant growth. It is often a limiting nutrient in freshwater ecosystems. Excessive amounts of phosphorus can trigger algae blooms and lowering phosphorus can lessen the density and frequency of nuisance algae. From 2011-2019, Total Phosphorus concentrations in Big Hollow Lake increased significantly (Figure 4-4). Concentrations exceeding 100 ug/L are considered extremely high and reflective of hypereutrophic conditions. The lake had concentrations at or above this level in 7 consecutive years (2013-2019). This was sufficient to cause extreme algal growth, and blooms would have been even more severe during this period but were limited by other factors, such as turbidity caused by fine, clay particles that block sunlight. Even if high Total Phosphorus levels are not currently causing extreme algal blooms and Chlorophyll-a concentrations, over time, much of this phosphorus will accumulate in the sediment at the bottom of the lake and could cause future water quality problems. Additional water quality data is provided in Appendix B.

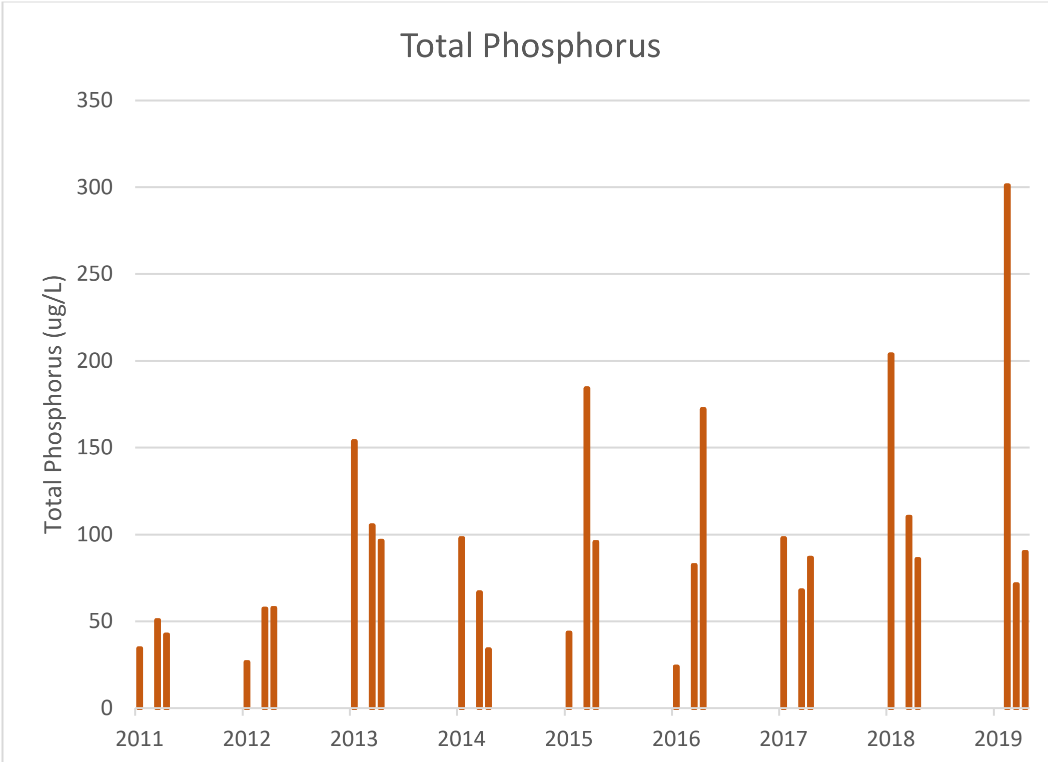


Figure 4-4. Total Phosphorus Concentrations

a

5.0 POLLUTANT SOURCE ASSESSMENT & LOADING

b

This section of the WMP summarizes pollutant sources and loads to Big Hollow Lake. This information is important because it describes existing/baseline conditions, helps establish pollutant reduction goals, and is required to measure progress towards water quality targets and implementation goals. The existing and target TMDL conditions for water quality parameters are shown in Table 5-1.

Table 5-1. Summary of TMDL Water Quality Conditions/Targets

Parameter	Existing Value	TMDL Target Conditions
Phosphorus Load	6,760 (lbs/yr)	≤ 2,629 (lbs/yr)
Chlorophyll-a Concentration	37.4 (ug/L)	27.1 (ug/L)
Secchi Depth	1.6 (m)	≥ 2.1 (m)
Total Phosphorus (TSI)	68.5	≤ 62
Chlorophyll-a (TSI)	66	≤ 63
Secchi (TSI)	54	≤ 50

5.1 Phosphorus

Phosphorus is the primary pollutant of concern in Big Hollow Lake due to its direct effect on algae growth. Phosphorus is a nutrient essential to plant growth and excessive amounts contribute to nuisance algal blooms. Large amounts of algal growth can also cause pH levels to fluctuate. Plants obtain phosphorus from the soil, which is supplemented through application of synthetic fertilizers and manure. Some of this phosphorus is lost from the landscape through runoff and erosion and/or leaching to shallow groundwater.

The DNR WQIP utilized the Spreadsheet Tool for Estimating Pollutant Loads (STEPL) and BATHTUB models to simulate the average annual conditions between 2011-2018. The baseline Total Phosphorus load was estimated to be 6,759.5 pounds per year (lbs/yr). The TMDL target, also called the loading capacity) was calculated through a formula that identifies the point sources, nonpoint sources, and a margin of safety. In the Big Hollow Lake watershed, the existing Total Phosphorus load comes entirely from nonpoint sources. The resulting Total Phosphorus target load is 2,628.5 lbs/yr or 22.4 lbs/day (maximum daily load). This is a reduction of 4,391 lbs/yr or 61% of the existing TP load (Table 5-2). This number represents the phosphorus reduction required to reduce algal levels sufficiently to meet water quality standards (WQS) and delist the lake from the impaired waters list.

Table 5-2. Total Phosphorus (TP) Loads

Existing TP Load:	6759.9 lbs/yr
Target TP Load:	2628.5 lbs/yr
Required Reduction:	**4,391 lbs/yr (61%)**

Phosphorus sources are categorized into external loads that enter from the watershed and internal loads from sediment at the bottom of the lake. Most of the external phosphorus enters the lake attached to sediment from erosion and sediment transport. Phosphorus is also present in fertilizers and animal waste/manure. When runoff events occur in the watershed, phosphorus from these sources contribute to the external total phosphorus load.

Nonpoint sources of phosphorus to Big Hollow Lake include erosion from land in pasture and row crop production, land applied manure, erosion from grasslands, erosion from woodland areas, transport from developed areas, wildlife defecation, atmospheric deposition (from dust and rain), and subsurface tiles and groundwater contributions. Septic systems in the watershed can fail or drain illegally to ditches and contribute phosphorus, nitrogen, and bacteria to the lake. Based on the STEPL modeling, the major sources of phosphorus to Big Hollow Lake include erosion from row crops, non-grazed grassland, and pastureland (Table 5-3). Row crops comprise 70% of the watershed while contributing 79% of the phosphorus loads to the Lake.

Table 5-3. Total Phosphorus (TP) Loads by Source

Source	Descriptions	TP Load (lb/yr)	Percent (%)
Pastureland	Seasonally grazed grasslands	105.30	2%
Row Crops	Sheet and rill erosion from corn and soybeans dominated agriculture	5,308.10	79%
Grassland	Ungrazed grassland, alfalfa/hay	51.70	1%
Forest	Forested park grounds surrounding lake	108.20	2%
Urban	Urban areas, roads, and farmsteads	663.00	10%
Groundwater	Agricultural tile discharge, natural groundwater flow	248.10	4%
Streambank	Streambank erosion into channel	11.60	0%
Gully	Gully formation and incision	144.30	2%
All Others	Wildlife, atmospheric deposition, septic	119.60	2%
Total		**6,759.90**	**100%**

Source: IDNR WQIP (2021 IDNR)

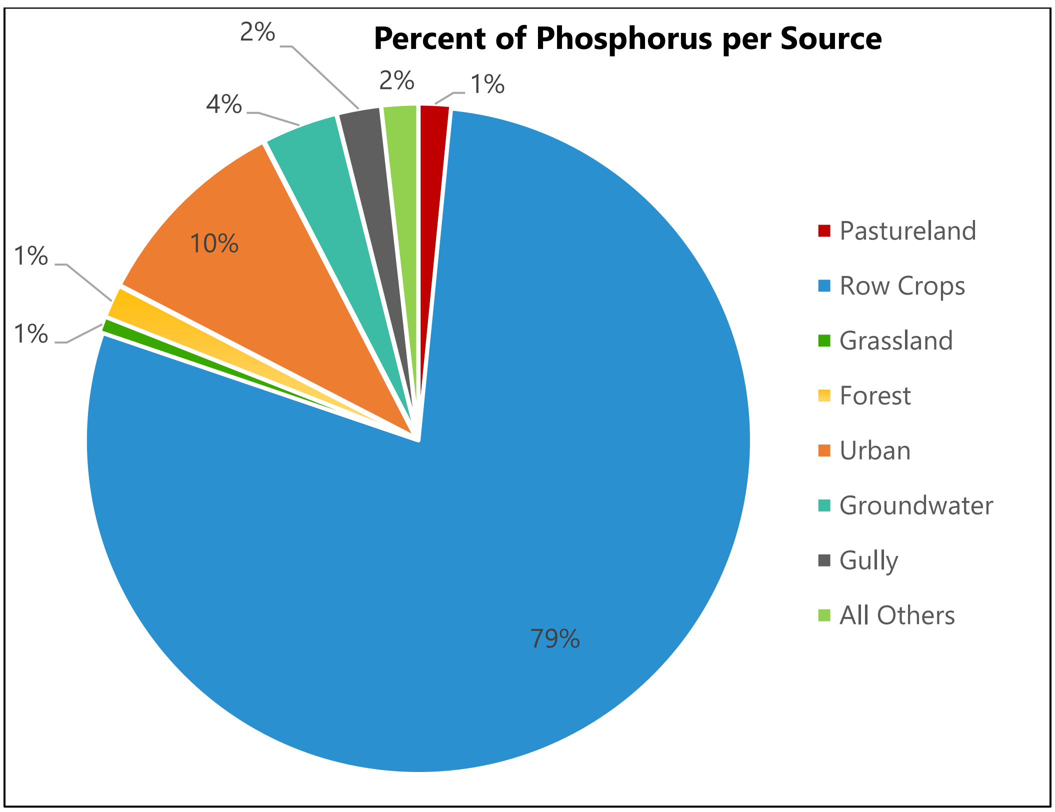


Figure 5-1. Percent of Phosphorus per Source

Although there are no permitted sources of phosphorus in the Big Hollow Lake watershed, there is one permitted facility that has pH restrictions on effluent discharge. The United States Gypsum facility has a National Pollutant Discharge Elimination System (NPDES) permit for a controlled discharge lagoon, program ID 2900103. This lagoon has a permit to discharge effluent from April 15 to June 15 and again from October 1 to December 21. The effluent is required to maintain a pH between 6.5 and 9.0, which is the same range as the WQS for Big Hollow Lake and therefore should not influence pH to unacceptable levels in the lake. Phosphorus levels in the discharge are not a concern; therefore, this facility is not a direct contributor to the existing impairments. However, gypsum is present in the discharge. Gypsum is calcium sulfate ($CaSO4$), and accumulation of gypsum in the bottom sediments of the lake over time could impact sediment chemistry and potentially water quality.

In addition to potential concerns about gypsum in lake sediments, sediments also accumulate phosphorus. Under certain conditions, phosphorus can be released from bottom sediment and fuel algal blooms. The TMDL did not explicitly quantify internal loading in Big Hollow Lake because "external loads are large enough to account for observed phosphorus levels in the lake." However, the WQIP also noted that reduction of internal loads in the lake is a valid water quality improvement/protection strategy. Although the focus of this WMP is to address watershed sources to ensure water quality improvements sustainable in the long-term, additional sediment information was collected and evaluated for two reasons. First, collection of sediment-phosphorus data will help confirm or adjust the TMDL finding that internal phosphorus loads are currently low. Second, local and state lake managers desired to learn whether gypsum transported from the quarry may have an impact on sediment and water quality. An assessment of sediment-phosphorus and gypsum in Big Hollow Lake sediment is summarized in Appendix C of this watershed plan.

5.2 Sediment

Sediment is a pollutant of concern in the Big Hollow Lake watershed because phosphorus is attached to sediment transported to the lake from sheet/rill, gully, and stream bed/bank erosion. Additionally, the accumulation of sediment in lakes create undesirable, shallow areas, negatively impacts fish and aquatic habitat, and eventually leads to sediment-phosphorus release to the water column (internal loading).

The modeling used to develop the TMDL estimated that majority (over 85%) of sediment loading to the lake is from sheet and rill erosion (Iowa DNR WQIP). Land use and land treatment measures recorded during the 2019 and 2020 windshield assessments were included in the calculation of sheet and rill erosion and sediment delivery rates. Ephemeral gullies, classic gully formation, and streambank erosion make up the remaining portion of the sediment load. Best management practices (BMPs) and conservation measures to reduce sediment are included in the implementation recommendations of this WMP, as are proposed sediment reductions. However, water quality goals and milestones will be determined primarily through attainment of phosphorus reduction, consistent with the TMDL.

Sheet and rill erosion hotpots are illustrated in Figure 5-2, and Figure 5-3 shows areas with the highest amount of sediment delivery downstream. These hotspots are "critical areas" of the watershed where BMP implementation should be focused. The original assessment maps developed by Iowa DNR are provided in Appendix A, which provide additional information regarding critical areas, including subwatershed priorities and potential BMP locations. The maps will be useful to conservation officials in targeting critical areas to focus implementation efforts.

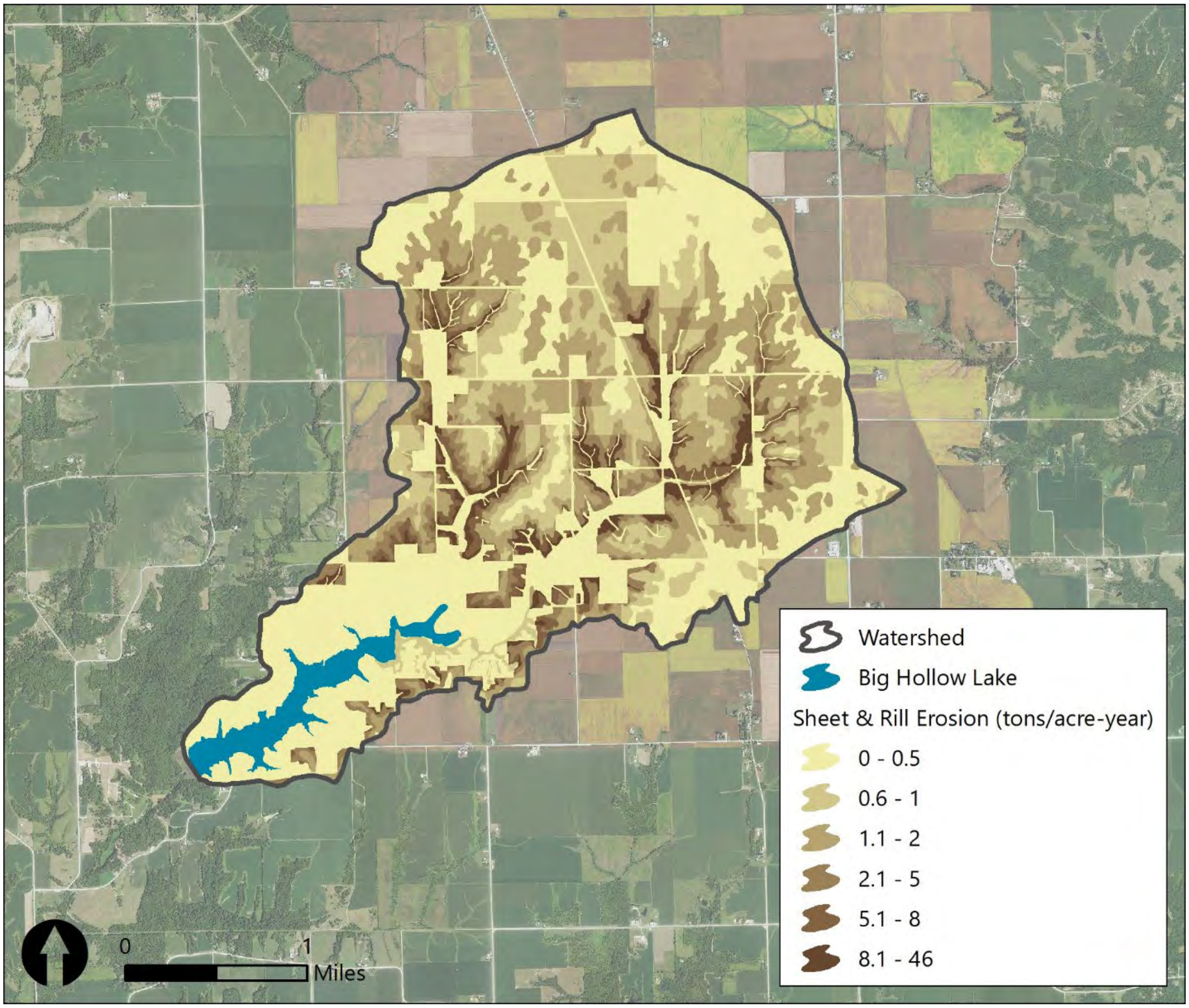


Figure 5-2. Sheet and Rill Erosion

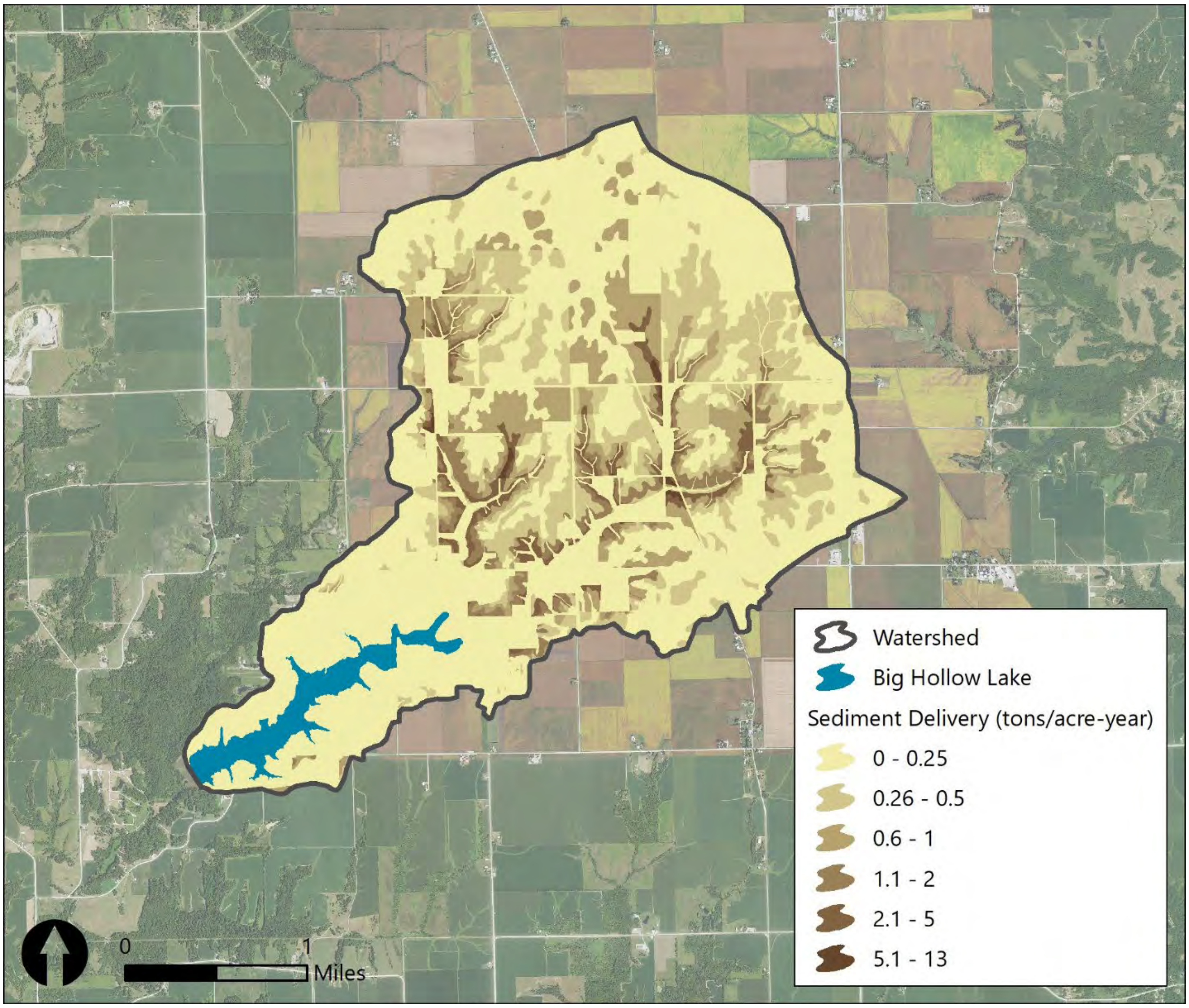


Figure 5-3. Sediment Delivery

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6.0 MANAGEMENT STRATEGIES

6.1 Potential Best Management Practices

Attaining the phosphorus load reduction target from the TMDL to meet water quality goals will require a combination of structural and land management alternatives and BMPs. Potential BMPs have been identified through modeling and outreach/engagement activities as part of the planning process. This WMP prioritizes BMPs and other strategies and lays out a phased and adaptive implementation approach designed using knowledge about landowner interests, priority areas and BMPs, and financial opportunities and constraints. Priority areas were determined using sheet and rill erosion hotspots (Figures 5.2 and 5.3) and known opportunity areas for BMP construction. The TMDL subwatershed priorities and ACPF output (included in Appendix A) were also used to target critical areas. This approach will create momentum through short term adoption of popular and fundable alternatives while spreading out implementation and investments to facilitate adoption of mid-term and long-term alternatives. The WMP has a 20-year horizon comprised of three phases: an initial 5-year phase, and second 5-year phase, and a 10-year phase. Implementation milestones (practices adopted, other achievements, and water quality improvements) and the overall WMP will be reviewed annually, documented, and used to guide future implementation. An annual evaluation form is included in Appendix F. Technical partners will collaborate with landowners and stakeholders proactively in all phases to encourage adoption of suitable BMPs in target locations to optimize phosphorus and sediment load reduction effectiveness and costs.

Realization and documentation of significant water quality benefits may take 10 years or longer, depending on weather patterns, amount of water quality data collected, and the success of selection, location, design, construction, and maintenance of BMPs. This is especially true for impairments caused by phosphorus loading, as legacy phosphorus that builds up in soil and sediment over decades takes time to work its way through the landscape. Monitoring should continue throughout implementation of BMPs and beyond to document water quality improvement.

No stand-alone BMP will be able to sufficiently reduce phosphorus loads to Big Hollow Lake. Rather, a comprehensive package of BMPs will be required to meet water quality goals. Most phosphorus enters the lake via nutrient loss from cropland, non-grazed grassland and forested land through sheet/rill and gully erosion. Potential BMPs considered for inclusion in this WMP include land management (prevention strategies), structural BMPs (trap and treat strategies), and in-lake BMPs (mitigation strategies).

6.2 Agricultural and Upland BMPs

6.2.1 Land Management (Prevention Strategies)

Many agricultural BMPs are designed to reduce erosion and nutrient loss from the landscape. These in-field BMPs provide the highest level of soil conservation and soil health benefits because they prevent erosion and nutrient loss from occurring. Land management alternatives implemented in row crop areas include conservation practices such as in-field buffers, no-till methods, cover crops, extended rotations, and annual-perennial conversion. Removal efficiencies and costs for these practices are quantified in the WMP. Improved manure management (e.g., application methods and timing) also protects water quality and are included in the plan, but potential reductions are not explicitly quantified because the TMDL did not quantify this potential source. Definitions for each Land Management BMP considered in this WMP are below.

- No-Till – Tillage practices affect soil erosion, which is the primary transport process of phosphorus delivery in Iowa. No till involves planting and growing crops with little soil disturbance. The crop is directly planted into crop residue or vegetative cover.
- Cover crops – Cover crops prevent erosion and the transport of nutrients by planting and growing cereal crops without harvesting them.
- Extended rotation – An extended rotation includes a primary row crop of corn or soybeans with at least three years of a different crop, such as alfalfa or legume-grass mixtures.

- Perennial conversion – This practice is when land use changes to perennial crops or pasture from annual crops. Several perennial crops produce biomass that can be used as a bio-energy feedstock as well as provide good soil cover, reduce erosion, and reduce phosphorus loss.

6.2.2 Structural BMPs (Trap and Treat Strategies)

Although they do not address the underlying generation of sediment or nutrients, structural BMPs such as sediment control basins, terraces, grass waterways, saturated buffers, riparian buffers, and wetlands can play a valuable role in reduction of sediment and nutrient transport to Big Hollow Lake. These edge-of-field BMPs attempt to mitigate the impacts of soil erosion and nutrient loss by intercepting them before they reach a stream or lake. Structural BMPs should be targeted to priority areas to increase their cost effectiveness and maximize pollutant reductions. Landowner willingness and the physical features of potential sites must also be considered when targeting structural practices. Potential BMPs (structural and non-structural) and their assumed phosphorus and sediment reduction efficiencies are listed in Table 6-1. Efficiencies were obtained from a variety of sources, including the Iowa Nutrient Reduction Strategy (2013), NRCS, Tyndall and Bowman (2016), and others. Definitions for each Structural BMP considered in this WMP are below.

- Grassed waterways – Grassed waterways are constructed channels with appropriate vegetation designed to intermittently carry runoff at a nonerosive rate. The vegetation slows the water.
- Wetlands – A nutrient removal wetland is a wetland designed to target water quality and remove nitrogen and phosphorus. Wetlands can also be designed to target sediment removal.
- Sediment ponds– Sediment ponds are a practice used to capture sediment and phosphorus from a field or waterways.
- Terraces – Terraces are designed earth embankments constructed across the field slope to intercept runoff and reduce sediment transport.
- WASCOBs – Water and sediment control basins are structural erosion control practices. They are embankments that store runoff and sediment is settled out in the basin. Water is released slowly through an underground outlet.
- Riparian buffers – This practice is an area of grass, shrubs, and/or trees next to stream, ponds, and wetlands. Riparian buffers reduce excess sediment and nutrients to the waterbody while also increases riparian habitat for wildlife.

Table 6-1. Best Management Practice Efficiencies

BMP	Removal Efficiency (%)	
	Sediment	Phosphorus
Bioreactors	5%	25%
Contoured Buffer Strips	95%	90%
Grassed Waterways (WW)	75%	75%
Nutrient Reduction Wetlands	25%	20%
Sediment Retention Ponds	90%	80%
Terraces	85%	75%
[1]WASCOBs	90%	80%
No-Till	90%	80%
Cover Crops	70%	29%
Extended Rotations	25%	25%
Annual-Perennial Conversion	55%	45%
Riparian Buffers/Filter Strips	86%	65%
Saturated Buffers	5%	5%
Streambank Stabilization	[2]90%	[2]80%
Gully Stabilization	[2]90%	[2]80%
[3]Fencing	N/A	N/A

[1]Water and Sediment Control Basins
[2]Removal efficiency based on bank and gully sources only
[3]Fencing included to protect other BMPs (e.g., wetlands, ponds, buffers, and stabilization) from livestock.

Up front and annualized costs of potential BMPs (per acre of land treated) were adapted from the Iowa NRS, related supporting documentation, and NRCS Practice Scenarios (Table 6-2). Capital costs include land/easement requirements, construction costs, and other one-time expenses. Annual costs reflect annual maintenance, landowner payments, and other recurring costs. Annual costs are greater for BMPs requiring significant maintenance or those that take large areas of land out of production (which increases costs of required landowner payments).

Table 6-2. Best Management Practice Costs

BMP	Implementation Costs	
	[1]Capital ($/ac)	[2]EAC ($/ac)
Bioreactors	300	15
Contoured Buffer Strips	435	35
Grassed Waterways (WW)	100	6
Nutrient Reduction Wetlands	380	20
Sediment Retention Ponds	550	25
Terraces	1,223	90
[1]WASCOBs	1,700	125
No-Till	10	10
Cover Crops	50	50
Extended Rotations	60	30
Annual-Perennial Conversion	384	192
Riparian Buffers/Filter Strips	325	325
Saturated Buffers	210	360
Streambank Stabilization ($/ft)	[3]200	10
Gully Stabilization ($/ft)	[3]100	5
Fencing ($/ft)	4	0

[1]Up-front costs of land, construction, etc. Adopted from NRCS practice scenarios and/or Iowa NRS documentation.
[2]Equivalent Annual Costs of BMP over lifetime (adopted from the Iowa NRS and supporting documents).
[3]Costs per foot of stabilized streambank or gully

6.3 Near-Lake and In-Lake BMPs

A combination of upland BMPs will be implemented to prevent and minimize the loss of sediment and phosphorus from the landscape that drains to Big Hollow Lake. Even with a successful campaign to adopt in field and edge-of-field practices, pollutant transport from the watershed is a natural process that cannot be entirely eliminated. Therefore, this WMP includes alternatives and strategies to capture and treat pollutants just before they enter the lake and mitigate sediment and phosphorus that accumulates in the lake over time.

6.3.1 Sediment Ponds and Forebays in Big Hollow Recreation Area (Trap and Treat Strategies)

There are eight existing ponds on Big Hollow Recreation Area property and several more just outside the property boundary that help trap sediment before it enters the lake. Ponds provide high sediment and phosphorus removal efficiencies and favorable benefits in terms of dollars per pound of reduction. Like all structural BMPs, ponds have a finite lifespan and require routine maintenance and rehabilitation. Appendix D of this plan includes a Technical Memorandum that was developed in parallel with this watershed plan, which highlights maintenance recommendations for the six primary existing sediment removal ponds located on Des Moines CCB property.

Inspections focused on maintenance and safety issues of the existing dam embankments and the associated outlet infrastructure. Maintaining these structures in good conditions are vital to current and future protection of Big Hollow Lake, because dam failures would release substantial amounts of sediment and nutrients that have been deposited in the ponds. Future maintenance of ponds could include dredging of existing sediment to increase storage volume and trapping efficiency, which decrease over time with sediment accumulation. New (or restored) pond trapping efficiencies are reported in Table 6-1.

6.3.2 In-Lake Water Quality Improvement Alternatives (Mitigation Strategies)

Land Management (Prevention Strategies)

6.4 BMP Prioritization and Selection

To obtain the necessary reductions in phosphorus loads to meet water quality targets, land management strategies and upland structural BMPs should be implemented to obtain the largest and most cost-effective water quality benefit. Targeting efforts should consider priority areas with the highest potential phosphorus loads to the lake. Factors affecting phosphorus contribution include land cover, steepness of slopes, proximity to the waterbody, tillage practices, and the method, timing, and amount of manure and commercial fertilizer application.

The Agricultural Conservation Planning Framework (ACPF) was used to identify suitable locations in the landscape for each of the BMPs identified in Table 6-1. ACPF is based on land use, topography, and other landscape-related parameters. ACPF output helps watershed planners ensure that the type and number of practices selected for implementation are feasible given watershed characteristics. ACPF output was used to generate the Watershed Implementation Plan described in Section 7 of this WMP, along with local knowledge and feedback related to landowner interest, conservation economics, and modeling tools used to target BMPs to critical areas with the highest sediment and phosphorus losses.

Some BMPs were excluded from the implementation plan due to low landowner/tenant interest or lack of suitable locations in the Big Hollow Lake watershed. Although considered, practices not selected for implementation include:

- Bioreactors – more suitable for areas with extensive subsurface tile drainage systems
- Contoured buffer strips – low landowner interest and lack of suitable topography
- Saturated buffers – more suitable for areas with extensive subsurface tile drainage systems

Conversely, the following BMPs are designated as high priorities due to their popularity with landowners, availability of funding, and/or cost-effective nutrient and sediment reductions.

- Grassed waterways (Goal = 33% adoption on suitable acres)
- Sediment Ponds (Goal = 33% adoption on suitable acres)
- Terraces (Goal = 25% adoption on suitable acres)
- Water and sediment control basins (WASCOBs) (Goal = 25% adoption on suitable acres)
- No-till (Goal = 25% adoption on suitable acres)

- Cover crops (Goal = 25% adoption on suitable acres)

Goals and milestones for treatment/adoption extents are outlined in Section 7 of this WMP.

7.0 WATERSHED IMPLMENTATION PLAN

7.1 Goals and Objectives

- Goal 1: Develop and implement an effective Watershed Management Plan (WMP)
  - Objectives
    1. Connect the WMP to the TMDL and identify and quantify pollutant sources and loads and required reductions
    2. Connect the WMP to feedback obtained through a proactive stakeholder engagement process to ensure plan is community-driven
    3. Ensure WMP includes and addresses all nine required WMP elements for EPA Section 319 funding eligibility
  - Outcomes:
    1. Technical and funding partners, citizens, and lake users are aware of the water quality issues and solutions for improving Big Hollow Lake
    2. Conservation practices and improvement alternatives are implemented at scale in the watershed.
  - Measure(s) of Success
    1. Obtain EPA approval of the WMP
    2. Hire a watershed coordinator to implement the plan

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- Goal 2: Enhance public and stakeholder awareness of Big Hollow Lake and its watershed
  - Objectives
    1. Educate Big Hollow Recreation Area visitors about the connection between lake water quality and recreational opportunities
    2. Educate watershed residents and agricultural landowners about the connection between land management and lake water quality
  - Outcomes
    1. Park and lake users are aware and understand potential water quality threats to the lake, can spread awareness to others, and create a user community that more actively participates in promoting a healthy Big Hollow Lake and watershed.
    2. Farmers, landowners, and residents have an increased understanding of the impact land management and other activities can have on Big Hollow Lake and can be a more active part of lake improvement and protection.
  - Measure(s) of Success

1. Number of signs and water quality demonstration or educational areas around the lake
2. Number of resident, farmer, and/or landowner contacts made by the Watershed Coordinator and conservation partner agency staff.

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- Goal 3: Improve water quality of Big Hollow Lake by implementing watershed and in-lake improvement alternatives
    - Objectives
        1. Increase water clarity and reducing nuisance algal blooms and the dense growth of other aquatic vegetation.
        2. Achieve removal of Big Hollow Lake from the State of Iowa's impaired waters list.
        3. Reduce sediment and nutrient transport to Big Hollow Lake
    - Environmental Outcomes
        1. Big Hollow Lake achieves a Chlorophyll-a Trophic State Index (TSI) value of 63 or less for two consecutive 305(b) assessment cycles
        2. Big Hollow Lake is currently listed as a Category 5 impairment for algal growth due to Chlorophyll-a. Elevated levels of algae are due to the amount of phosphorus being transported to the lake from the surrounding watershed. A TMDL was written for Algae (and pH) with a goal to reduce the total phosphorus loading capacity.
        3. Reduced amount/rates of sediment accumulation are observed where streams enter the lake
    - Measures of Success
        1. Reducing Total Phosphorus loads to the lake by 4,098 pounds per year through combination of land management, structural, and in-lake BMPs
        2. Reduce Sediment loads to the lake by 1,466 tons per year through combination of land management, structural, and in-lake BMPs
        3. Extent and degree of BMP implementation (e.g., acres treated, pounds reduced) in the watershed and lake.

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7.2 Implementation Schedule

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The Big Hollow Lake WMP will be implemented in phases, with a total project length of 20 years. Each phase will begin and end with a meeting attended by TAC members, including the SWCD, CCB, IDALS, DNR, and other stakeholders to review goals and objectives, discuss progress, and lay out actions for the current phase of implementation. To meet the 9-Element requirements, the WMP must include interim milestones to help measure progress towards goals and outcomes. A four-phase plan was developed for Big Hollow with specific implementation goals and costs for each phase of implementation (Table 7-1).

Table 7-1. Implementation Milestones, Goals, and Costs

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	20-Year Plan		Phase 1	Phase 2		Phase 3		Phase 4	
# Years	20		1	4		5		10	
Practice[1]	Goal	Cost[2]	Cost[2]	Phase Goal	Phase Cost[2]	Phase Goal	Phase Cost[2]	Phase Goal	Phase Cost[2]
Watershed Coordinator	N/A	$2,084,466	$70,000	N/A	$309,143	N/A	$461,285	N/A	$1,244,038
Water Quality Monitoring	N/A	$160,000	$8,000	N/A	$32,000	N/A	$40,000	N/A	$80,000
OU	N/A	$7,000	$2,500	N/A	$1,500	N/A	$1,500	N/A	$1,500
Grassed WW	334	$35,430	$0	84	$8,857	84	$8,857	167	$17,715
Wetlands	316	$126,416	$0	79	$31,604	79	$31,604	158	$63,208
Sediment Ponds	490	$281,917	$0	123	$70,479	123	$70,479	245	$140,958
Terraces	205	$269,384	$0	51	$67,346	51	$67,346	103	$134,692
WASCOBs	130	$237,633	$0	33	$59,408	33	$59,408	65	$118,817
No-Till	580	$5,799	$0	145	$2,900	145	$2,900	290	$5,799
Cover Crops	828	$41,425	$0	207	$20,712	207	$20,712	414	$41,425
Extended Rotation	298	$8,948	$0	75	$6,711	75	$6,711	149	$13,422
Perennial Conversion	166	$31,814	$0	41	$23,861	41	$23,861	83	$47,722
Riparian Buffers	8	$5,178	$0	2	$1,346	2	$1,346	4	$2,693
Streambank stabilization (ft)	270	$56,700	$0	68	$14,175	68	$14,175	135	$28,350
Gully stabilization (ft)	1708	$179,314	$0	427	$44,828	427	$44,828	854	$89,657
Access Control (Fencing, ft)	5000	$15,000	$0	1,250	$3,750	1,250	$3,750	2,500	$7,500
Park pond rehab (# ponds)	6	$300,000	$0	0	$0	0	$0	6	$300,000
Lake forebays (# forebays)	2	$500,000	$0	0	$0	0	$0	2	$500,000
Total		**$4,346,424**	**$80,500**		**$666,382**		**$826,525**		**$2,773,017**

[1]Practice units are all in acres treated unless otherwise noted.
[2]Up-front capital plus sum of annualized costs incurred over plan/phase period. Potential cost-share is detailed in Table 7-3 of Section 7.4.
[3]Stakeholder Engagement/Outreach includes outreach to park & lake users, homeowners, and farmers as detailed in the Information and Education plan in Section 7.2.1.

Milestone reviews will be led by the watershed coordinator working with TAC members. The plan is specific but must also be dynamic to reflect changes in real world conditions, including changes in policy that affects agricultural practices, regulations, funding, water quality, stakeholder concerns, and many others. The four-phase plan for Big Hollow was developed to:

- Identify short-term actions to hire a coordinator and establish momentum
- Allow time for increased outreach to promote BMP adoption over time
- Provide the watershed coordinator time to gather additional information, funding, and engineering and permitting services required for long-term BMP adoption and construction of proposed structural practices identified in later phases of implementation.

7.2.1 Information and Education Plan

Development of the WMP included public and stakeholder engagement through online surveys and a public meeting at the park. Appendix G includes a handout provided to meeting attendees and several poll questions and results from the survey. The purpose of this section is to provide a framework for future information and education efforts that will support the implementation of the plan. Information and education refers to the on-going process of informing and involving the watershed's population in the development and implementation of improving water quality and watershed planning efforts. This process is essential to effective watershed resources management, as the success of this plan is dependent on the efforts of the public and stakeholders. An informed and involved public is necessary for the implementation of the plan, as well as the long-term acceptance, adoption, and maintenance of BMPs within the watershed.

One of the most important goals in the implementation plan is to "enhance public and stakeholder awareness of Big Hollow Lake and its watershed." This goal outlines the objectives to achieve the goal, the outcomes if the goal is successful, and the measures of success. The objective of this goal is to educate Big Hollow Recreation Area visitors, watershed residents, and agricultural landowners about the connection of their actions within the watershed to lake water quality.

The following information and education strategies were identified as priorities for the first phase of the plan (Year 1) and will guide the efforts of the Information and Education plan in the coming phases.

- Outreach to park and lake users about the importance of water quality and how they can have an impact on protection and improvement of Big Hollow Lake.
- Outreach to homeowners in the watershed to identify and secure funds, potentially from the State Revolving Fund (SRF) to repair and/or replace failing septic systems – a potential source of nutrients to the lake.
- Outreach to farmers that land apply livestock manure to encourage use of manure management plans to minimize nutrient losses to surface and groundwater.

The information and education plan should include public education and outreach as well as public participation and involvement activities. Some public education and outreach activities include newsletters, website with educational information about the watershed, educational speakers, event displays or kiosks, and school classroom education. Some public participation and involvement activities include park and/or lake cleanup, park festival/celebration, agricultural stakeholder groups, water quality monitoring program, workshops, and watershed citizen advisory group.

The target audience for the information and education plan include groups like the watershed public, students and schools in the watershed, homeowners/landowners and farmers, park and lake users, local government staff, local elected officials, and builders/developers. These target groups can be reached by several delivery methods including website, email, streaming media, printed materials, mass media, workshops and events, and promotional items.

The information and education plan should be re-evaluated at least every five years for relevance and effectiveness. The plan will need to adapt over time to accommodate the community members and watershed.

Table 7-2. Information and Education Plan Implementation and Goals

	20-Year Plan	Phase 1	Phase 2	Phase 3	Phase 4
# Years	20	1	4	5	10
Practice	Goal	Phase Goal	Phase Goal	Phase Goal	Phase Goal
Public meeting to update watershed residents on plan and project	8	1	2	2	3
Provide news article on project status	5	1	1	1	2
Send out newsletter to watershed residents on project updates	20	1	4	5	10
Install sign at park for conservation practices in watershed	8	0	2	2	4
Conduct septic system educational forum	5	1	1	1	2
Field day to display BMPs for community members	4	0	1	1	2
Additional survey to community members	5	1	1	1	2
Field days/monitoring days for local schools	20	1	4	5	10
Public presentation at Big Hollow Lake Recreation Area in inform park and lake users	20	1	4	5	10
Conduct individual meetings/discussion/presentations with local farmers and homeowners in the watershed	20	1	4	5	10

7.2.2 Phase 1 (Year 1)

The first phase of work will commence following submittal and/or approval of this WMP and includes meeting with the TAC to begin aligning funding sources, hire a watershed coordinator, coordinate with stakeholders, and begin landowner/farmer outreach. A water quality monitoring program has been initiated in conjunction with WMP development but monitoring efforts will intensify in Phase 1 to provide data that reflects pre-implementation (baseline) conditions. Goal 1 objectives accomplished this phase of implementation, including WMP approval, landowner/farmer and park user outreach/education, and aligning a watershed coordinator, TAC members, and key stakeholders.

Engagement activities will continue for the duration of the 20-year plan to keep momentum and ensure maximum adoption of BMPs. Engagement efforts will include:

- Outreach to park and lake users about the importance of water quality and how they can have an impact on protection and improvement of Big Hollow Lake. Examples include signage and special events at the park.
- Outreach to homeowners in the watershed to identify and secure funds, potentially from the State Revolving Fund (SRF) to repair and/or replace failing septic systems – a potential source of nutrients to the lake. Examples include mailings, announcements using local media resources, and providing information at local/community events.
- Outreach to farmers that land apply livestock manure to encourage use of manure management plans to minimize nutrient losses to surface and groundwater. Examples include leveraging field days through NRCS and Iowa State Extension.

7.2.3 Phase 2 (4 Years)

Phase 2 will involve implementation of the "low-hanging fruit" BMPs and management strategies. These include working with the most aware and willing landowners that recognize the need for conservation on their properties, with emphasis on the most popular and easy-to-adopt practices. Outreach efforts will include annual announcements and/or special events described for Phase 1.

7.2.4 Phase 3 (5 Years)

The watershed coordinator and the TAC will continue collaboration and work with landowners and producers in the watershed in Phase 3 to adopt BMPs in critical areas, with an emphasis on practices that require more education and active management to implement successfully. Outreach efforts will include annual announcements and/or special events described for Phase 1.

7.2.5 Phase 4 (10 Years)

Phase 4 milestones are laid out to meet plan objectives by implementing and adopting practices and structures on remaining land requiring additional treatment. This may include doubling back to landowners and properties where BMPs were not adopted in Phase 1 or Phase 2 after continued outreach to those hesitant to adopt new practices previously. Outreach efforts will include annual announcements and/or special events described for Phase 1.

Phase 4 may also involve adding additional BMPs for a "treatment train" approach in areas with willing landowner participation. Additionally, after substantial progress is made on watershed goals in Phases 1-3, other coordination with TAC members, such as the DNR Lake Restoration Program, will take place to implement larger structural practices in and/or near the lake on park property. These may include:

- Rehabilitation of existing or construction of new sediment ponds on tributaries entering the lake. Associated load reduction estimates assume a 20% increase in phosphorus and sediment removal over existing ponds due to improved storage capacity and function.
- Sediment forebays in upper reaches of the lake to intercept sediment and phosphorus transport not stopped by watershed BMPs. Removal efficiencies are assumed to be 20% for phosphorus and 30% for sediment, which is relatively low for this practice, due to exceptionally large watershed to surface area ratios.
- In-lake alternatives are not included as they have not historically been funded by 319; however, other partners such as the DNR Lake Restoration program may choose to explore potential in-lake options after the watershed is significantly improved. In-lake options include:
    - Targeted dredging to remove sediment
    - Sediment treatment to inactivate/control internal phosphorus loading
    - Shoreline improvement to improve water quality, habitat, and recreational use.
    - Improvement of the fishery to remove rough fish, which reduces internal loading and turbidity

7.3 Milestones and Outcomes

Plan milestones, costs, and outcomes are presented in this section for the entire 20-year implementation period and by phase of implementation. Metrics are based on the phosphorus load reductions required by the TMDL to meet water quality standards set forth in Goal 1 (Section 7.1). Sediment reduction milestones were included to help with farmer outreach/engagement efforts tracking progress because erosion and soil loss are more easily understood and recognized than phosphorus dynamics. Sediment reduction is also included in Goal 1 to minimize future siltation of the lake. Phosphorus and sediment load reduction milestones are identified in Table 7-3.

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Table 7-3. Load Reduction Targets and Milestones

	20-Year Plan		Phase 2		Phase 3		Phase 4	
# Years	Reductions		4		5		10	
Practice	P (lbs)	Sediment (tons)	P (lbs)	Sediment (tons)	P (lbs)	Sediment (tons)	P (lbs)	Sediment (tons)
Grassed WW	428	104	107	26	107	26	214	52
Wetlands	100	30	25	7	25	7	50	15
Sediment Ponds	670	183	167	46	167	46	335	92
Terraces	223	79	56	20	56	20	112	40
WASCOBs	151	49	38	12	38	12	75	25
No-Till	714	220	179	55	179	55	357	110
Cover Crops	370	244	92	61	92	61	185	122
Extended Rotation	115	31	29	8	29	8	57	16
Perennial Conversion	115	38	29	10	29	10	57	19
Riparian Buffers	8	3	2	1	2	1	4	1
Streambank stabilization	7	15	2	4	2	4	3	7
Gully stabilization	87	186	22	47	22	47	43	93
Fencing	*	*	*	*	*	*	*	*
Park pond rehab (# ponds)	107	44	0	0	0	0	107	44
Lake forebays (#)	1,089	322	0	0	0	0	1,089	322
Total	**4,183**	**1,549**	**747**	**296**	**747**	**296**	**2,689**	**958**

*Fencing does not have a direct reduction associated with it but is a necessary component of other BMPs.

d

7.4 Technical and Financial Assistance

Multiple partner agencies have expressed interest in assisting Des Moines County CCB with watershed and water quality improvement efforts for Big Hollow Lake. The Iowa DNR Fisheries and Lake Restoration programs provide both technical and financial assistance with projects to improve and protect Iowa's publicly owned lakes. These programs may be potential partners throughout the implementation process but will have specific interest in helping with projects on park property and/or in the lake once progress is demonstrated in the watershed.

Further, the SWCD works together with NRCS to engage and educate rural landowners and farmers and promote adoption of in-field, edge-of-field, and structural BMPs on private lands to improve water quality, but also benefit soil by reducing nutrient loss, erosion, and improving soil health. The SWCD would assist a watershed coordinator, hired in Phase 1 of implementation, with outreach and promotional efforts.

Section 319 funds, in addition to aiding with development of this WMP, could also be used to provide cost-share for implementation alternatives outlined in Table 7-4. Additionally, the IDALS basin coordinator will continue to work with the CCB to obtain funding from statewide programs related to the state's Nutrient Reduction Strategy, such as the Water Quality Initiative (WQI), which funds wetlands, bioreactors, cover crops, and other BMPs included in the WMP for Big Hollow Lake. Finally, there are funds available through the State Revolving Fund (SRF) to address nonpoint source pollution through funding for projects such as streambank stabilization, buffers, livestock manure management, and low interest loans for on-site wastewater (septic) system replacement.

There is strong support from the local community for Big Hollow Lake water quality improvement efforts and a high potential for community involvement and assistance. Community involvement could count towards local and in-kind contributions through volunteering of labor for lake and park cleanups and other donations. A survey of the local community was conducted with over 400 participants with 77% of respondents indicating possible willingness to contribute time and/or money to clean up the lake. The survey also showed that 75% of respondents support additional government spending to clean up the lake, with an additional 19.5% supporting it if it did not directly affect their taxes.

Table 7-4. Implementation Alternatives

d

Practice	Cost	Cost-Share Goals
Watershed Coordinator	$2,084,466	N/A
Water Quality Monitoring	$160,000	N/A
Stakeholder Engagement/ Outreach	$7,000	N/A
Grassed WW	$73,534	75% (50% from NRCS EQIP or IDALS/SWCD IFIP + 25% from 319)
Wetlands	$183,303	90% (75% from NRCS EQIP or IDALS WQI + 15% from 319)
Sediment Ponds	$343,203	75% (50% from NRCS EQIP or IDALS/SWCD IFIP + 25% from 319)
Terraces	$194,908	75% (50% from NRCS EQIP or IDALS/SWCD IFIP + 25% from 319)
WASCOBs	$247,399	75% (50% from NRCS EQIP or IDALS/SWCD IFIP + 25% from 319)
No-Till	$115,990	Flat Rate of $10/ac from WQI, EQIP or 319
Cover Crops	$331,399	Flat Rate of $25/ac from WQI, EQIP or 319
Extended Rotation	$238,608	Flat Rate of $40/ac from WQI, EQIP or 319
Perennial Conversion	$497,099	75% (50% from FSA CRP, NRCS EQIP or IDALS/SWCD REAP + 25% from 319)
Riparian Buffers/Filter Strips	$19,055	90% (75% from FSA CRP, NRCS EQIP or IDALS/SWCD WQI + 15% from 319)
Streambank stabilization	$108,000	90% (319)
Gully stabilization	$341,550	75% (50% from NRCS EQIP or IDALS/SWCD IFIP or WQI + 25% from 319)
Access Control (Fencing)	$15,000	75% (50% from either NRCS EQIP or IDALS/SWCD IFIP + 25% from 319)
Park pond rehab (# ponds)	$300,000	50% (DNR Lake Restoration and/or 319)
Lake forebays (#)	$500,000	50% (DNR Lake Restoration and/or 319)
Total	**$5,760,514**	**$3,692,072 (64%)**

7.5 Monitoring

Des Moines CCB, with funding from the Iowa DNR Watershed Improvement Section (WIS) has initiated a water quality monitoring program for the streams draining to Big Hollow Lake. The goal of the monitoring plan is to establish baseline water quality for pre-implementation conditions and measure progress towards pollutant reduction and in-lake water quality goals over the 20-year duration of the project. This plan was developed in 2020, implemented in 2021, and will intensify in 2022 and future years. The monitoring location sites may be modified slightly due to accessibility issues and/or observations indicate low to non-existing flows one ore more monitoring sites. The monitoring plan is included in Appendix E of this WMP.

In addition to watershed/tributary monitoring, the DNR will continue collecting water quality samples from Big Hollow Lake as part of its Ambient Monitoring Program of publicly owned lakes. Sampling will be conducted three times per year between Memorial Day and Labor Day. Analyses cover a full suite of limnological parameters, including various forms of nitrogen and phosphorus, pH, dissolved oxygen, solids, chlorophyll-a, and many more, as described at the following link:
http://publications.iowa.gov/22278/1/WFS-2016-1.pdf

8.0 REFERENCES

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J. Tyndall and T. Bowman. Department of Ecology & Natural Resource Management, Iowa State University. *Nutrient Reduction Strategy Decision Support Tool.* 2016.

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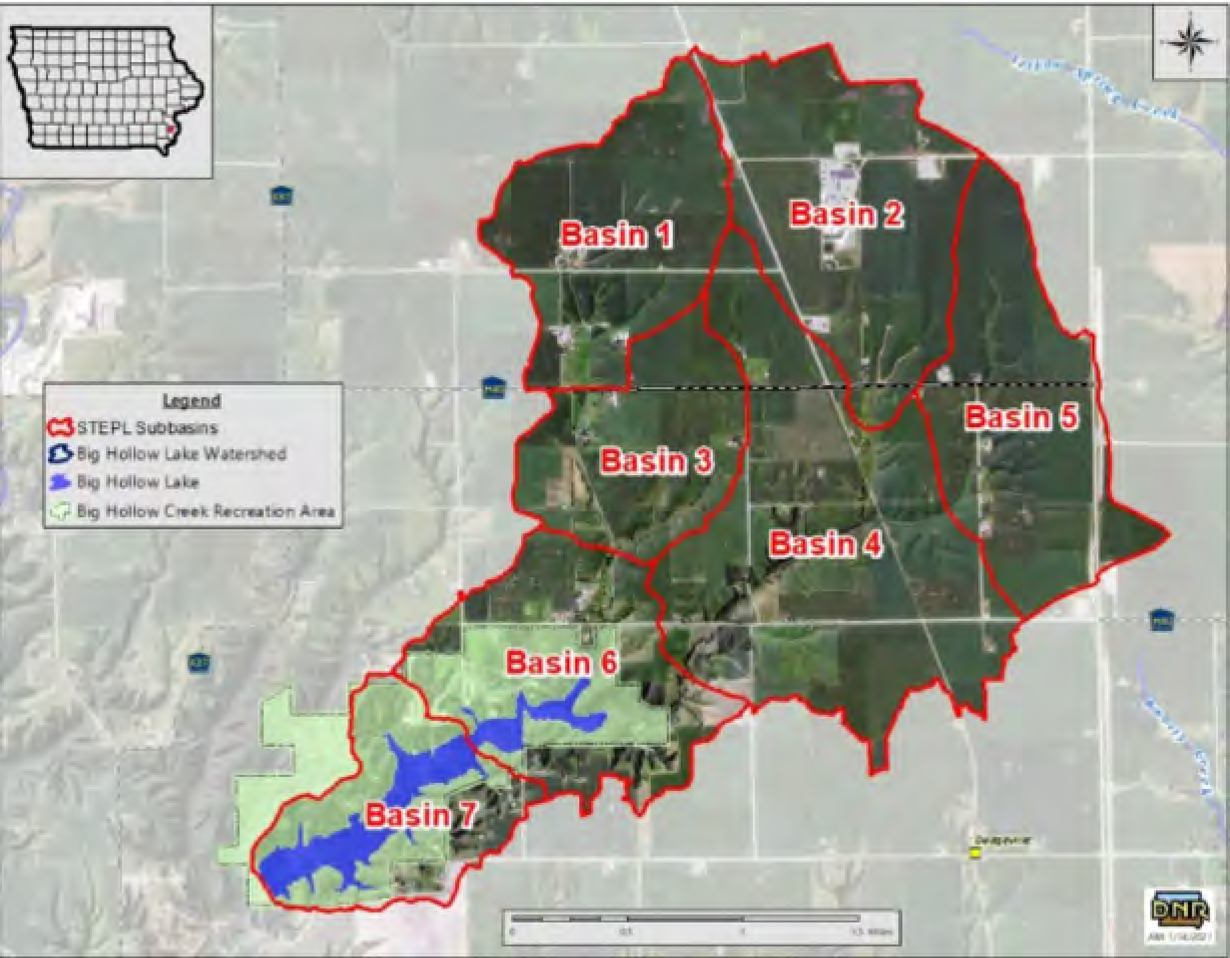
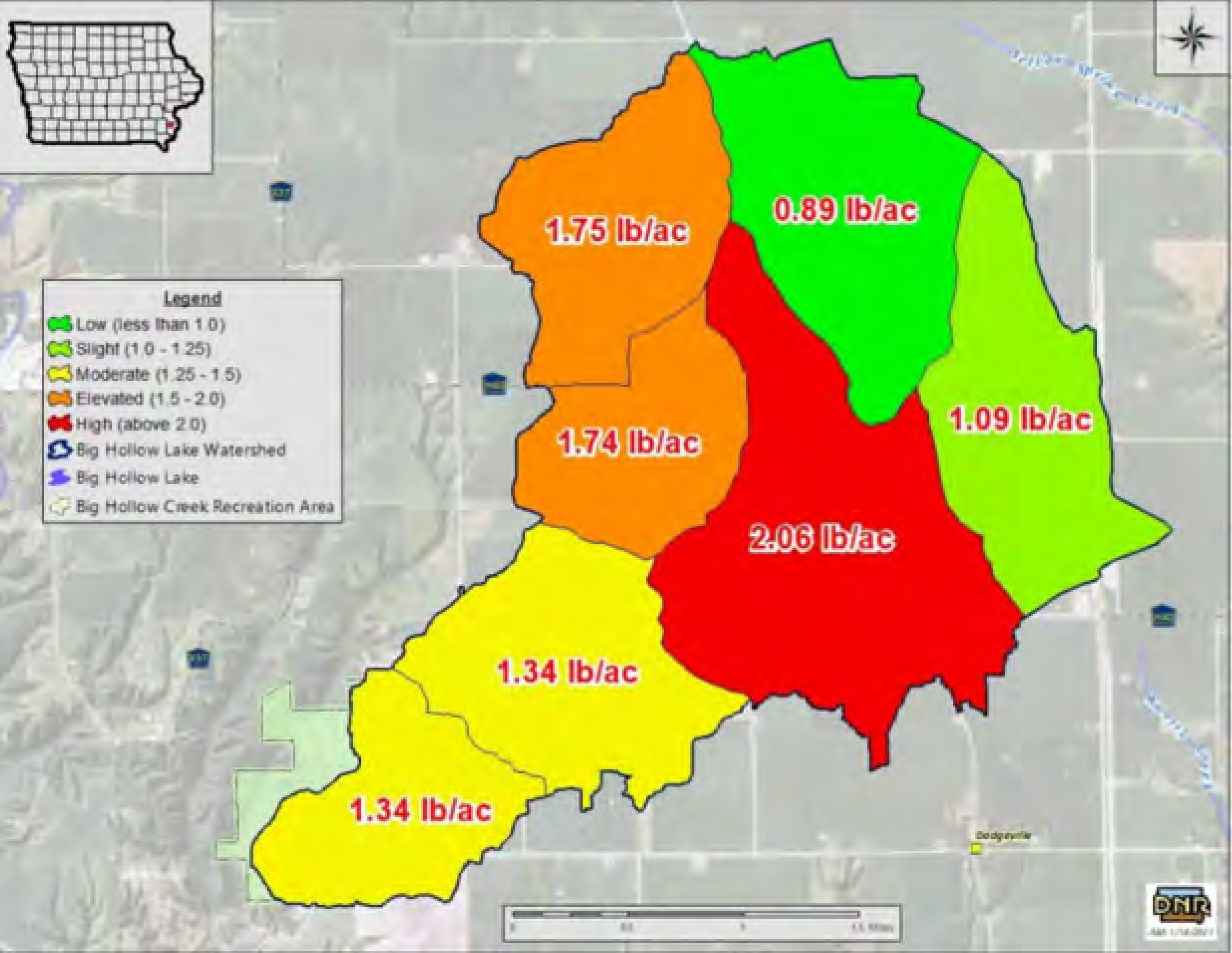
c

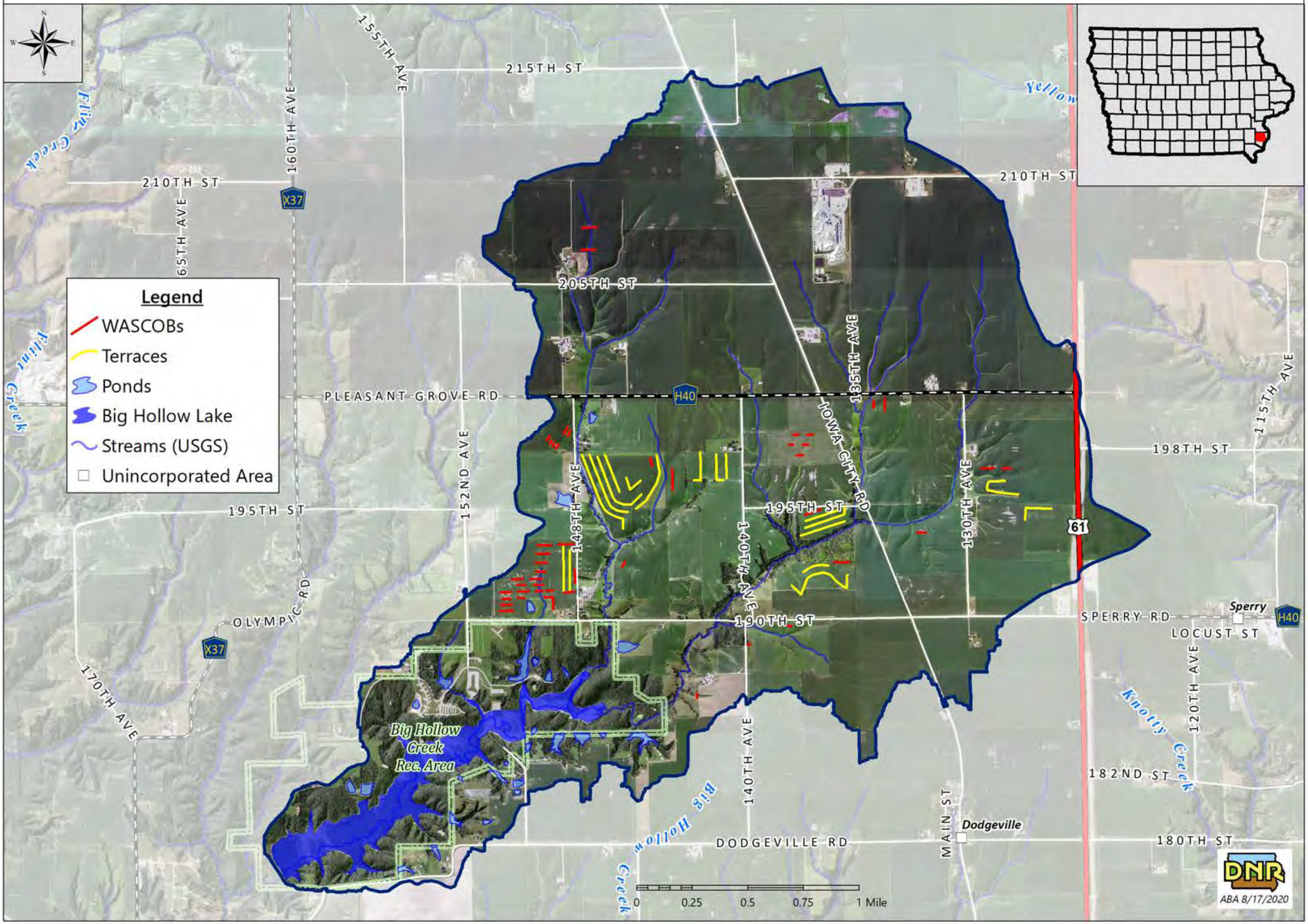
APPENDIX A – PRIOR WATERSHED ASSESSMENT RESULTS BY IOWA DNR

Assessment maps and figures from Iowa DNR provided on following pages.

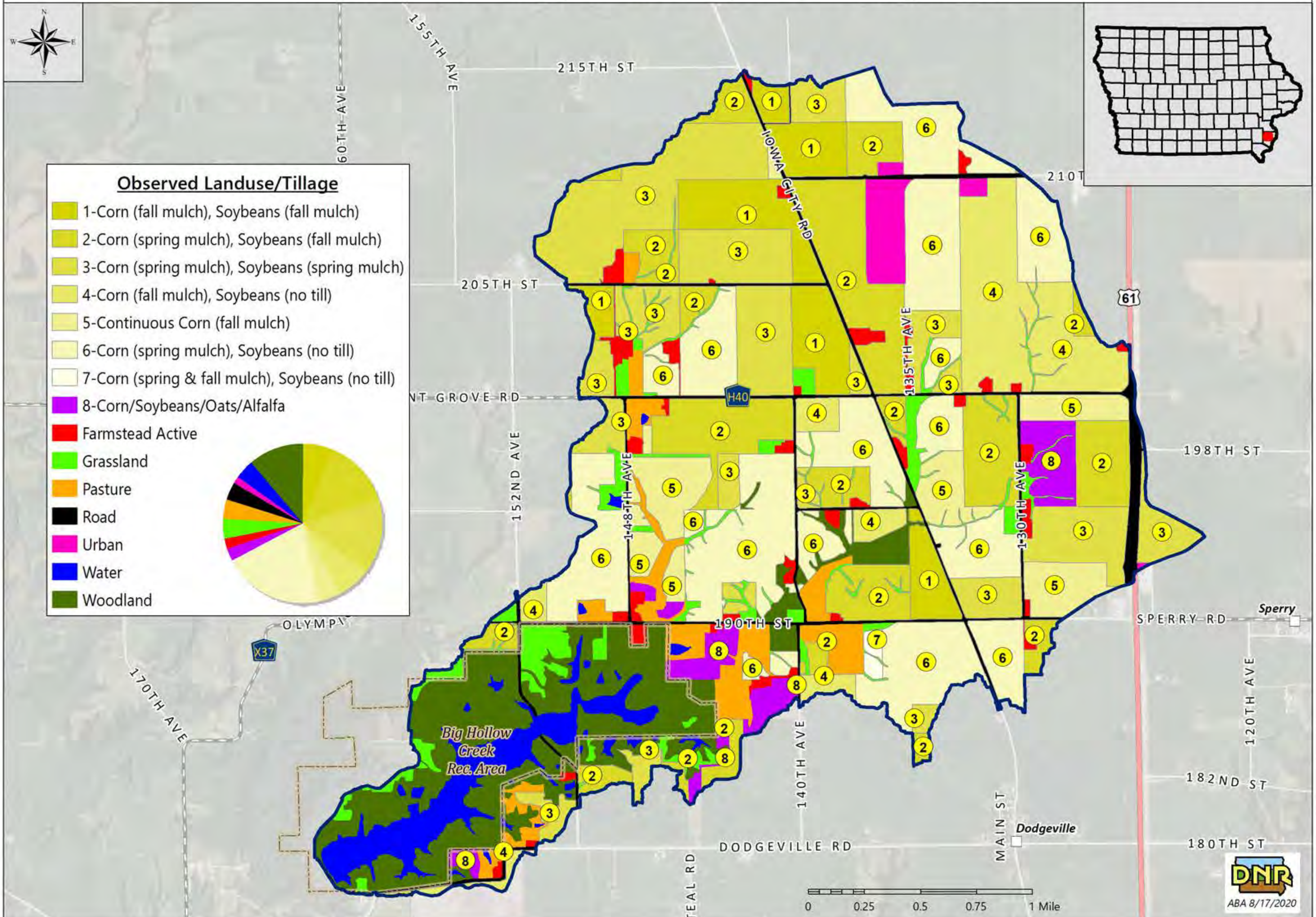

Basin 1
Basin 2
Basin 3
Basin 4
Basin 5
Basin 6
Basin 7
Legend
STEPL Subbasins
Big Hollow Lake Watershed
Big Hollow Lake
Big Hollow Creek Recreation Area
DNR


Legend
Low (less than 1.0)
Slight (1.0 - 1.25)
Moderate (1.25 - 1.5)
Elevated (1.5 - 2.0)
High (above 2.0)
Big Hollow Lake Watershed
Big Hollow Lake
Big Hollow Creek Recreation Area
1.75 lb/ac
0.89 lb/ac
1.74 lb/ac
1.09 lb/ac
2.06 lb/ac
1.34 lb/ac
1.34 lb/ac
DNR

Big Hollow Lake Watershed, Des Moines County
Aerial View, 2019



Big Hollow Lake Watershed, Des Moines County
Observed Landuse & Tillage, 2020



Entire Watershed WITH Lake

Landuse/Rotation	Field Boundary Count	Acres	Pct	Rank
6-Corn (spring mulch), Soybeans (no till)	489	954.8	20.2%	1
3-Corn (spring mulch), Soybeans (spring mulch)	266	726.5	15.3%	2
2-Corn (spring mulch), Soybeans (fall mulch)	356	664.5	14.0%	3
Woodland	365	534.0	11.3%	4
4-Corn (fall mulch), Soybeans (no till)	96	325.7	6.9%	5
1-Corn (fall mulch), Soybeans (fall mulch)	41	280.5	5.9%	6
5-Continuous Corn (fall mulch)	139	227.5	4.8%	7
Grassland	356	190.2	4.0%	8
Water	100	182.9	3.9%	9
Pasture	169	182.7	3.9%	10
Road	185	169.4	3.6%	11
8-Corn/Soybeans/Oats/Alfalfa	118	123.4	2.6%	12
Farmstead Active	176	99.1	2.1%	13
Urban	13	64.6	1.4%	14
7-Corn (spring & fall mulch), Soybeans (no till)	17	11.0	0.2%	15
Totals	**2,886**	**4,737.0**	**100.0%**	

Entire Watershed WITHOUT Lake

Landuse/Rotation	Field Boundary Count	Acres	Pct	Rank
6-Corn (spring mulch), Soybeans (no till)	489	954.8	20.8%	1
3-Corn (spring mulch), Soybeans (spring mulch)	266	726.5	15.9%	2
2-Corn (spring mulch), Soybeans (fall mulch)	356	664.5	14.5%	3
Woodland	365	534.0	11.7%	4
4-Corn (fall mulch), Soybeans (no till)	96	325.7	7.1%	5
1-Corn (fall mulch), Soybeans (fall mulch)	41	280.5	6.1%	6
5-Continuous Corn (fall mulch)	139	227.5	5.0%	7
Grassland	356	190.2	4.1%	8
Pasture	169	182.7	4.0%	9
Road	185	169.4	3.7%	10
8-Corn/Soybeans/Oats/Alfalfa	118	123.4	2.7%	11
Farmstead Active	176	99.1	2.2%	12
Urban	13	64.6	1.4%	13
Water	100	28.9	0.6%	14
7-Corn (spring & fall mulch), Soybeans (no till)	17	11.0	0.2%	15
Totals	**2,886**	**4,583.1**	**100.0%**	

Cultivated Cropland Aggregated

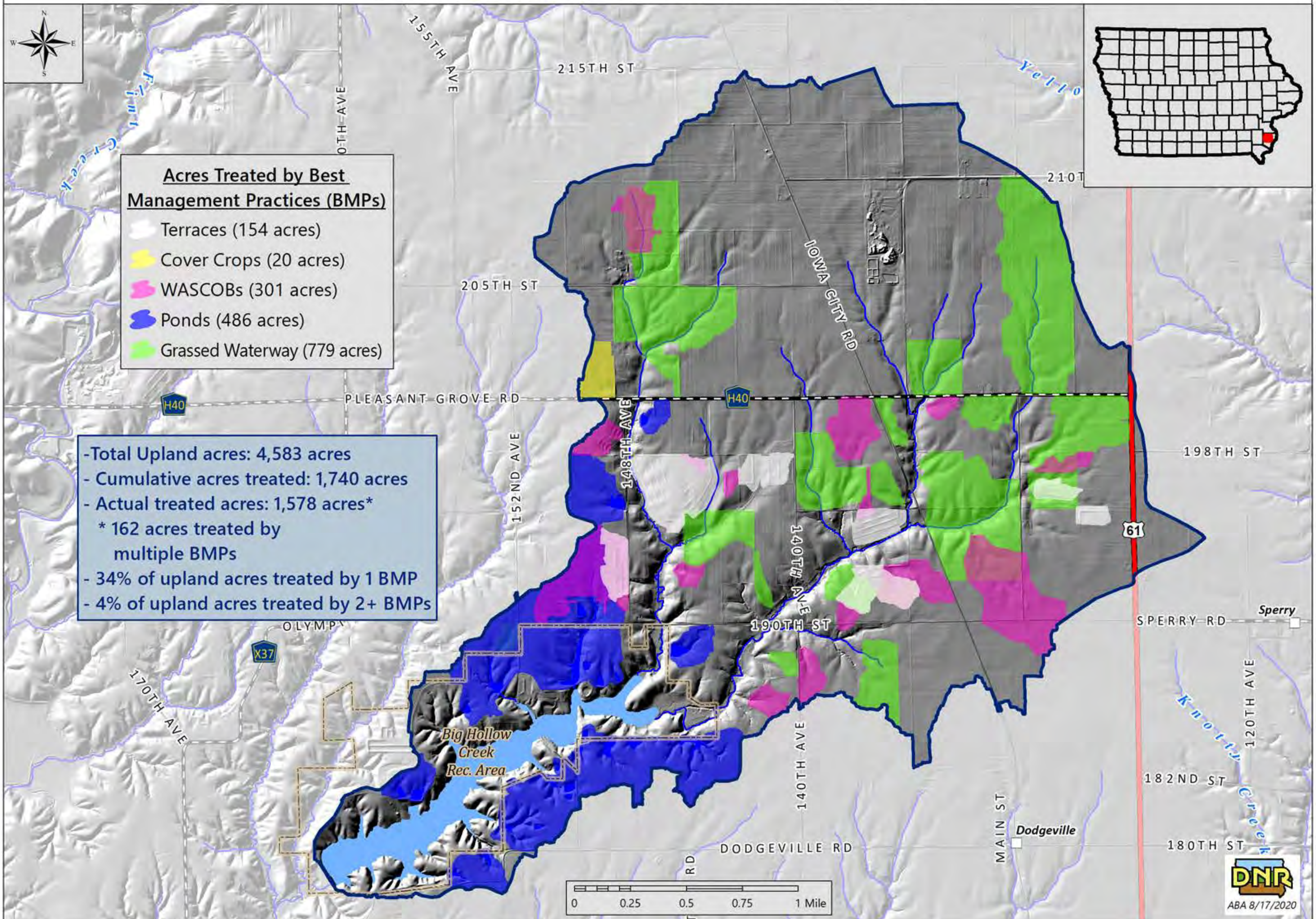
Entire Watershed WITH Lake

Landuse/Rotation	Field Boundary Count	Acres	Pct	Rank
Cultivated Cropland (no Alfalfa)	1,404	3,190.6	67.4%	1
Woodland	365	534.0	11.3%	2
Grassland	356	190.2	4.0%	3
Water	100	182.9	3.9%	4
Pasture	169	182.7	3.9%	5
Road	185	169.4	3.6%	6
8-Corn/Soybeans/Oats/Alfalfa	118	123.4	2.6%	7
Farmstead Active	176	99.1	2.1%	8
Urban	13	64.6	1.4%	9
Totals	2,886	4,737.0	100.0%	

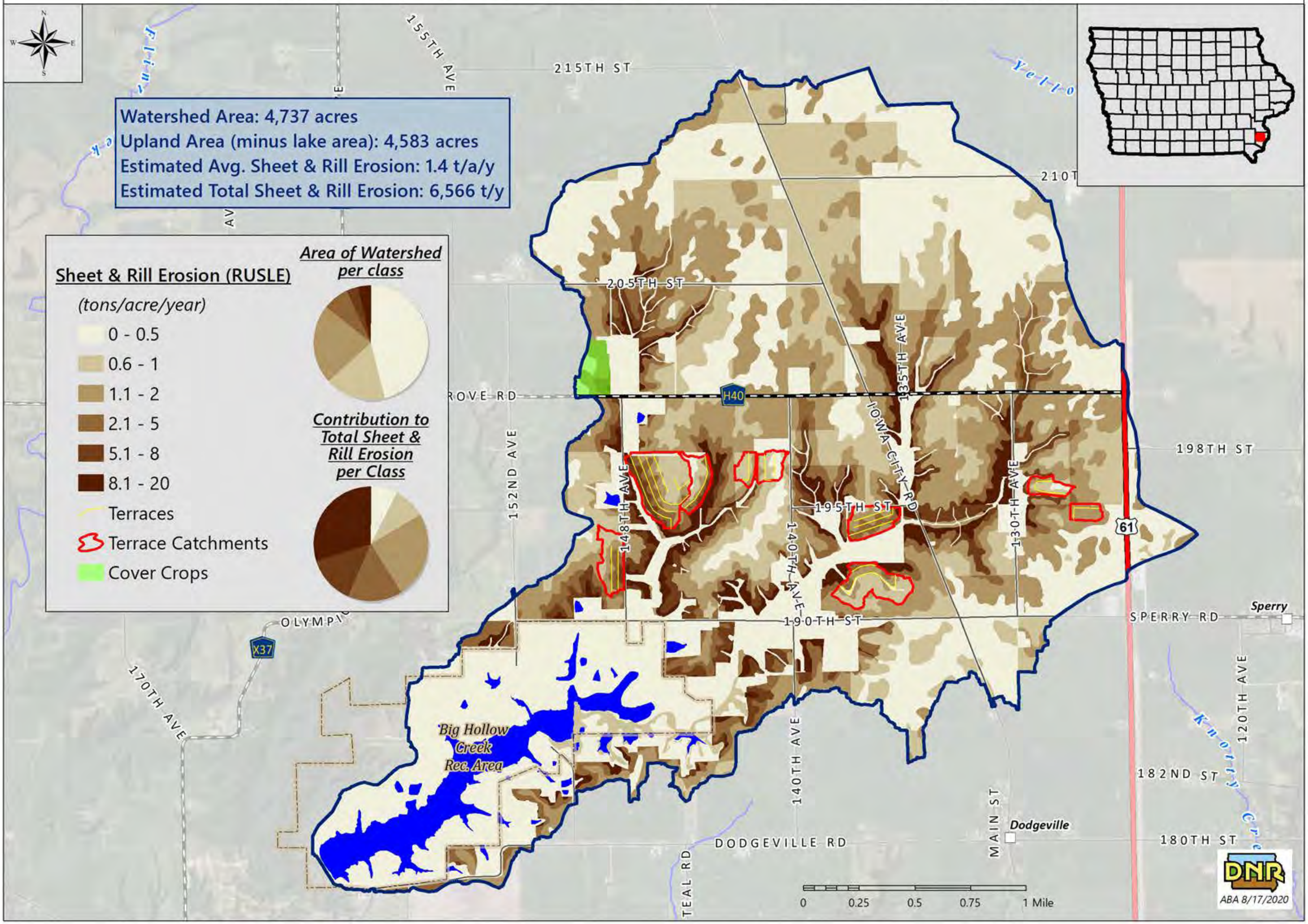
Entire Watershed WITHOUT Lake

Landuse/Rotation	Field Boundary Count	Acres	Pct	Rank
Cultivated Cropland (no Alfalfa)	1,404	3,190.6	69.6%	1
Woodland	365	534.0	11.7%	2
Grassland	356	190.2	4.1%	3
Pasture	169	182.7	4.0%	4
Road	185	169.4	3.7%	5
8-Corn/Soybeans/Oats/Alfalfa	118	123.4	2.7%	6
Farmstead Active	176	99.1	2.2%	7
Urban	13	64.6	1.4%	8
Water	100	28.9	0.6%	9
Totals	2,886	4,583.1	100.0%	

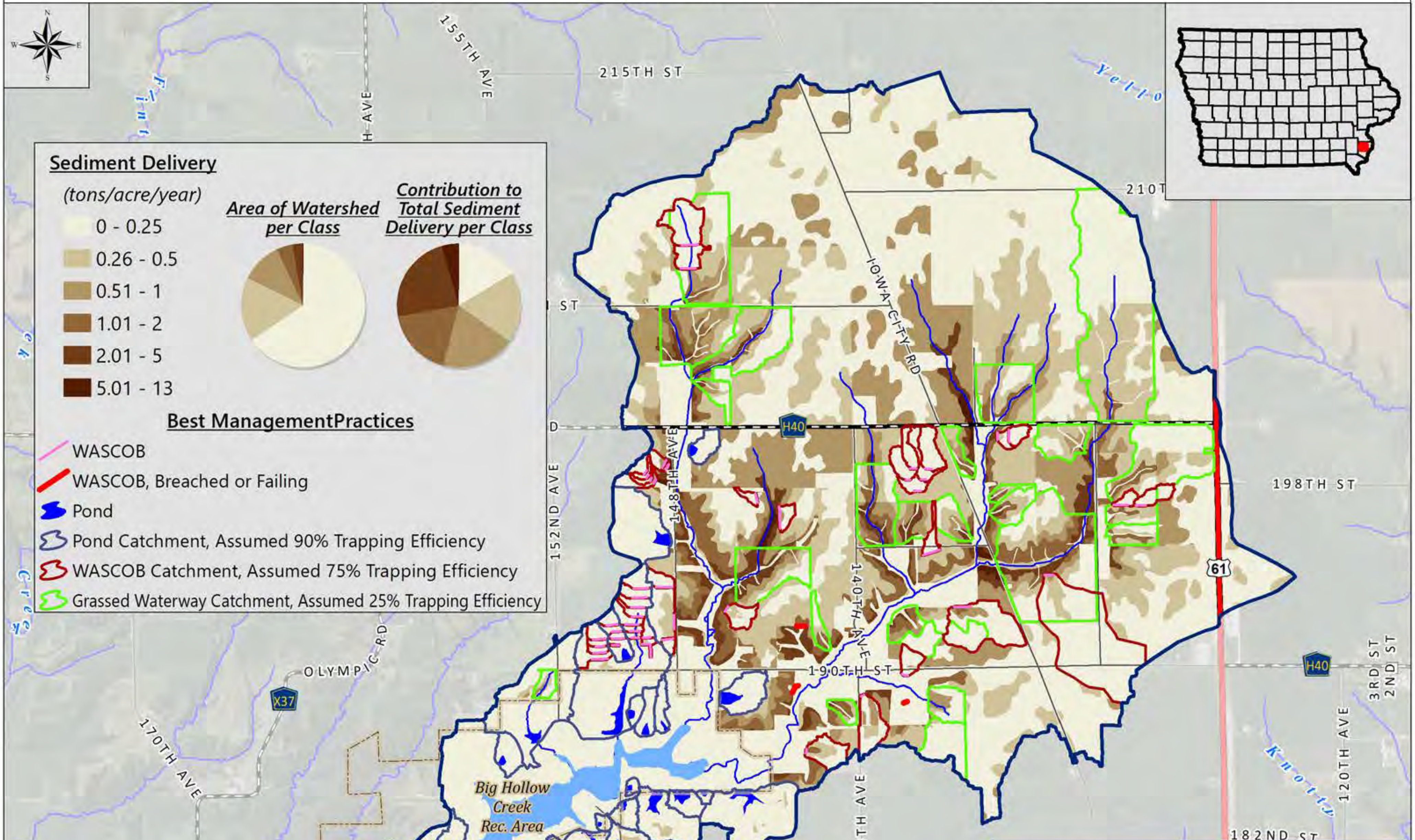
Big Hollow Lake Watershed, Des Moines County
Area Treated by BMPs, 2020



Big Hollow Lake Watershed, Des Moines County
Estimated Sheet & Rill Erosion, 2020



BIG HOLLOW LAKE WATERSHED, DES MOINES COUNTY
ESTIMATED SEDIMENT DELIVERY, 2020



Watershed Area: 4,737 acres
Upland Area (minus lake area): 4,583 acres
Estimated Avg. Sediment Delivery: 0.3 t/a/y
Estimated Total Sediment Delivery: 1,504 t/y
Sediment Delivery Ratio: 28.4%

SHEET & RILL

Sheet & Rill Class (t/a/y)	CLU Segment Count	Acres	% of Upland Acres	Aggregated Acreage %	Total S&R (t/y)	% of S&R	Aggregated S&R %
8.0 to 20.0	222	167	3.7%	***3.7%***	1,949	29.7%	***29.7%***
5.0 to 8.0	157	153	3.3%	***7.0%***	899	13.7%	***43.4%***
2.0 to 5.0	294	334	7.3%	***14.3%***	1,019	15.5%	***58.9%***
1.0 to 2.0	477	1,025	22.4%	***36.7%***	1,623	24.7%	***83.6%***
0.5 to 1.0	267	786	17.2%	***53.8%***	591	9.0%	***92.6%***
0.0 to 0.5	1453	2,117	46.2%	***100.0%***	485	7.4%	***100.0%***
	2870	4,583	100.0%		6,566	100.0%	

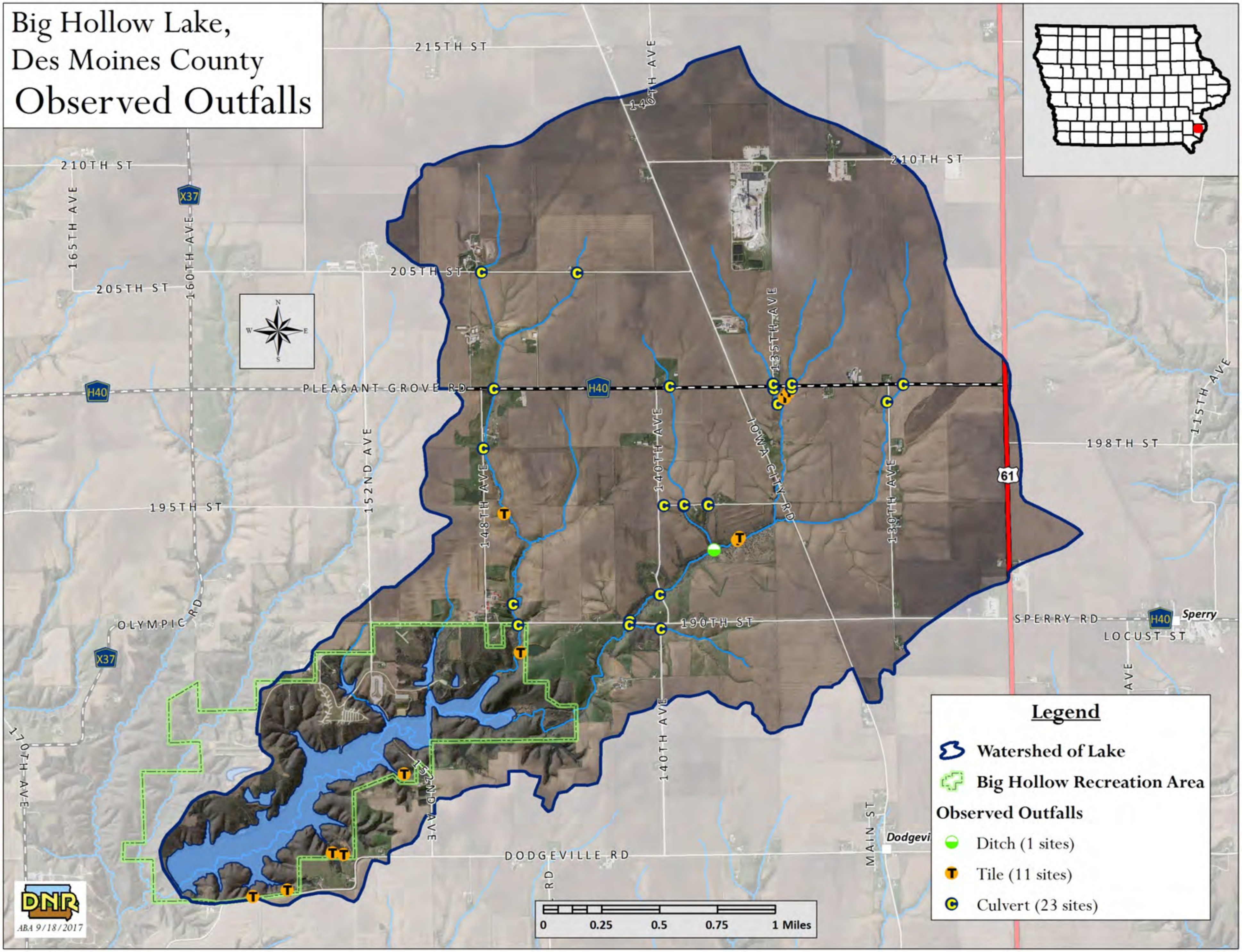
14% of acreage accounting for 59% of Sheet & Rill

SEDIMENT DELIVERY

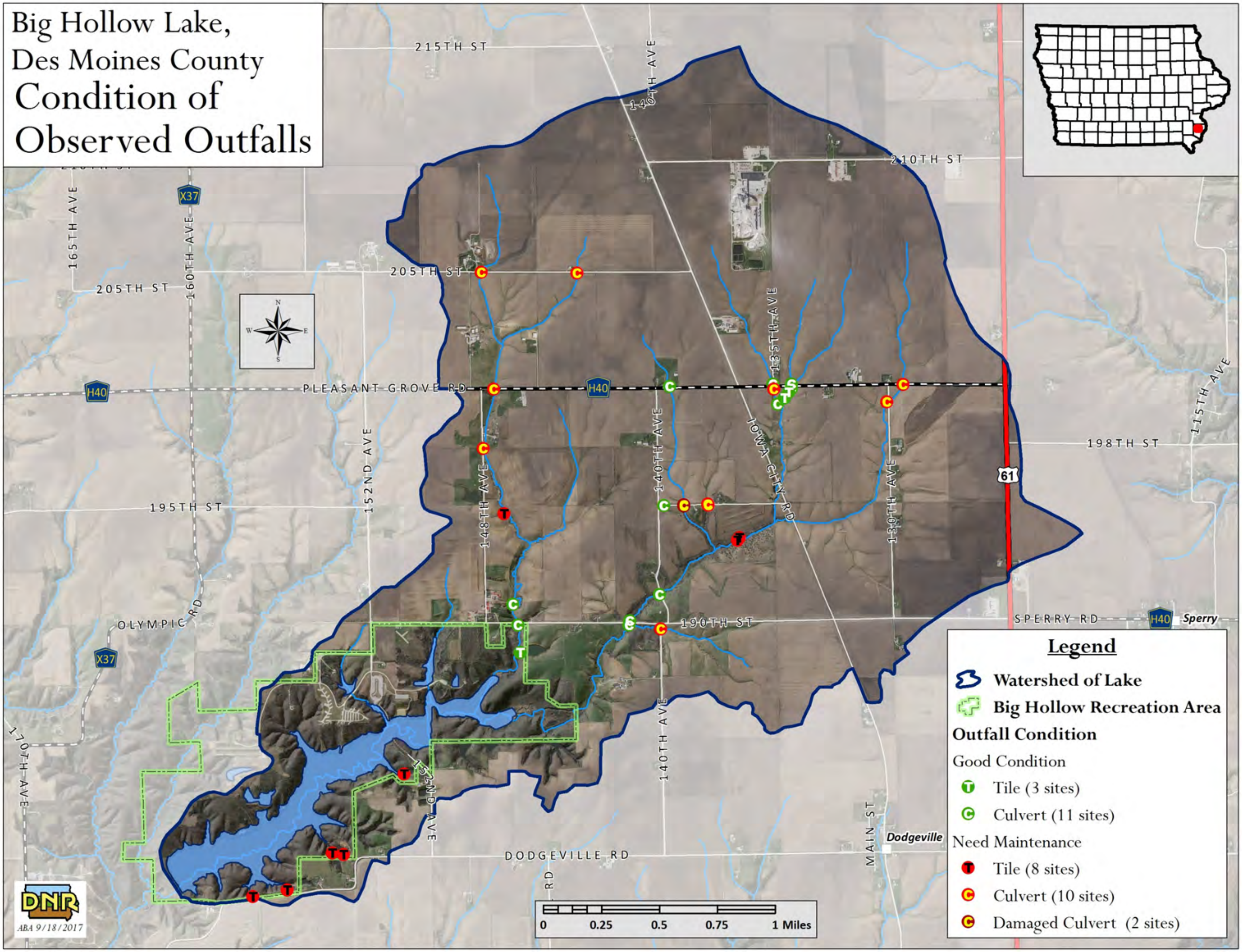
Sediment Delivery Class (t/a/y)	CLU Segment Count	Acres	% of Upland Acres	Aggregated Acreage %	Total SD (t/y)	% of SD	Aggregated SD %
5.0 to 20.0	15	12	0.3%	***0.3%***	69	4.6%	***4.6%***
2.0 to 5.0	145	119	2.6%	***2.9%***	349	23.2%	***27.8%***
1.0 to 2.0	158	188	4.1%	***7.0%***	270	18.0%	***45.8%***
0.5 to 1.0	233	483	10.5%	***17.5%***	293	19.5%	***65.2%***
0.25 to 0.5	325	768	16.8%	***34.3%***	277	18.4%	***83.6%***
0.0 to 0.25	1994	3,012	65.7%	***100.0%***	246	16.4%	***100.0%***
	2870	4,583	100.0%		1,504	100.0%	

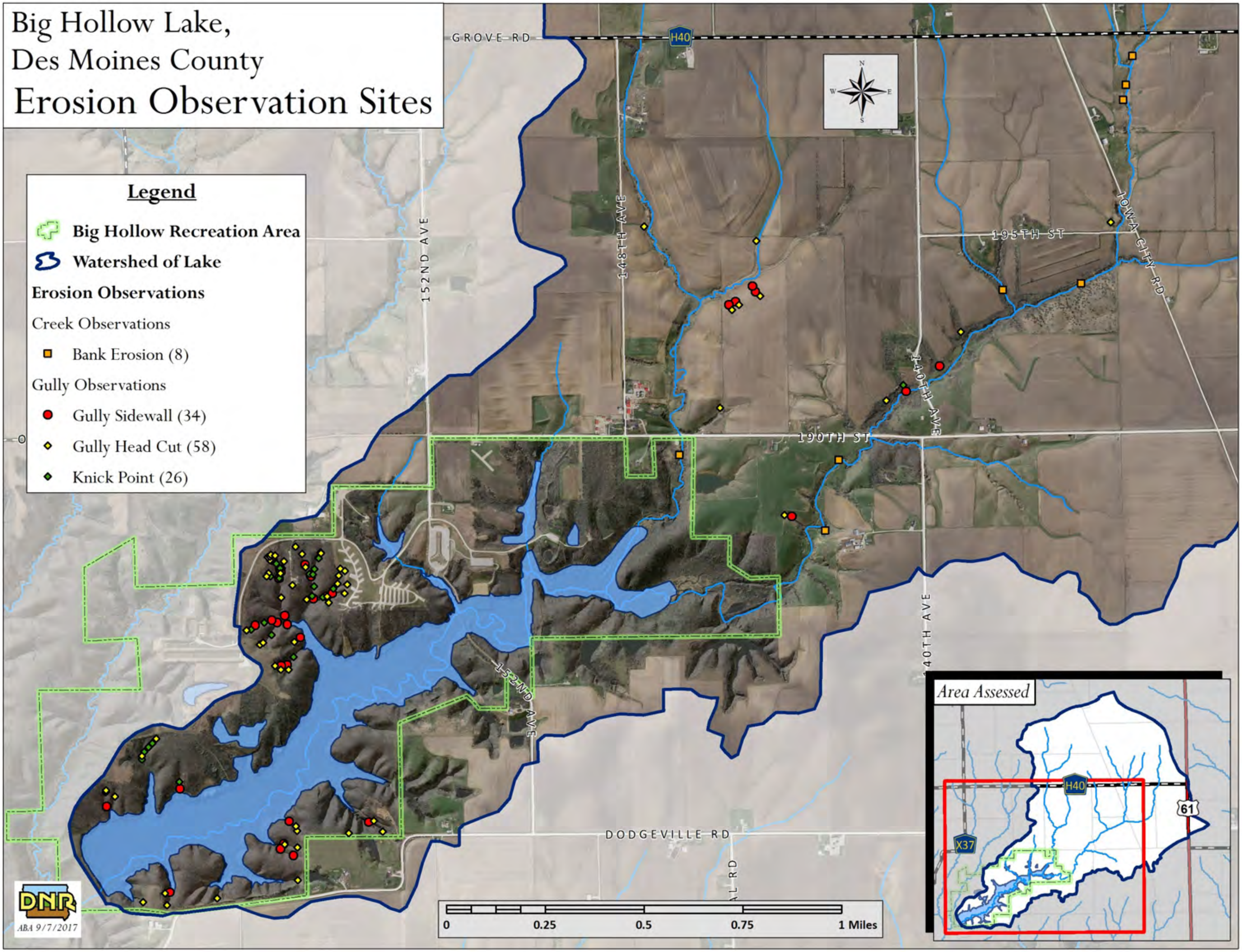
18% of acreage accounting for 65% of Sediment Delivery

Big Hollow Lake, Des Moines County
Observed Outfalls

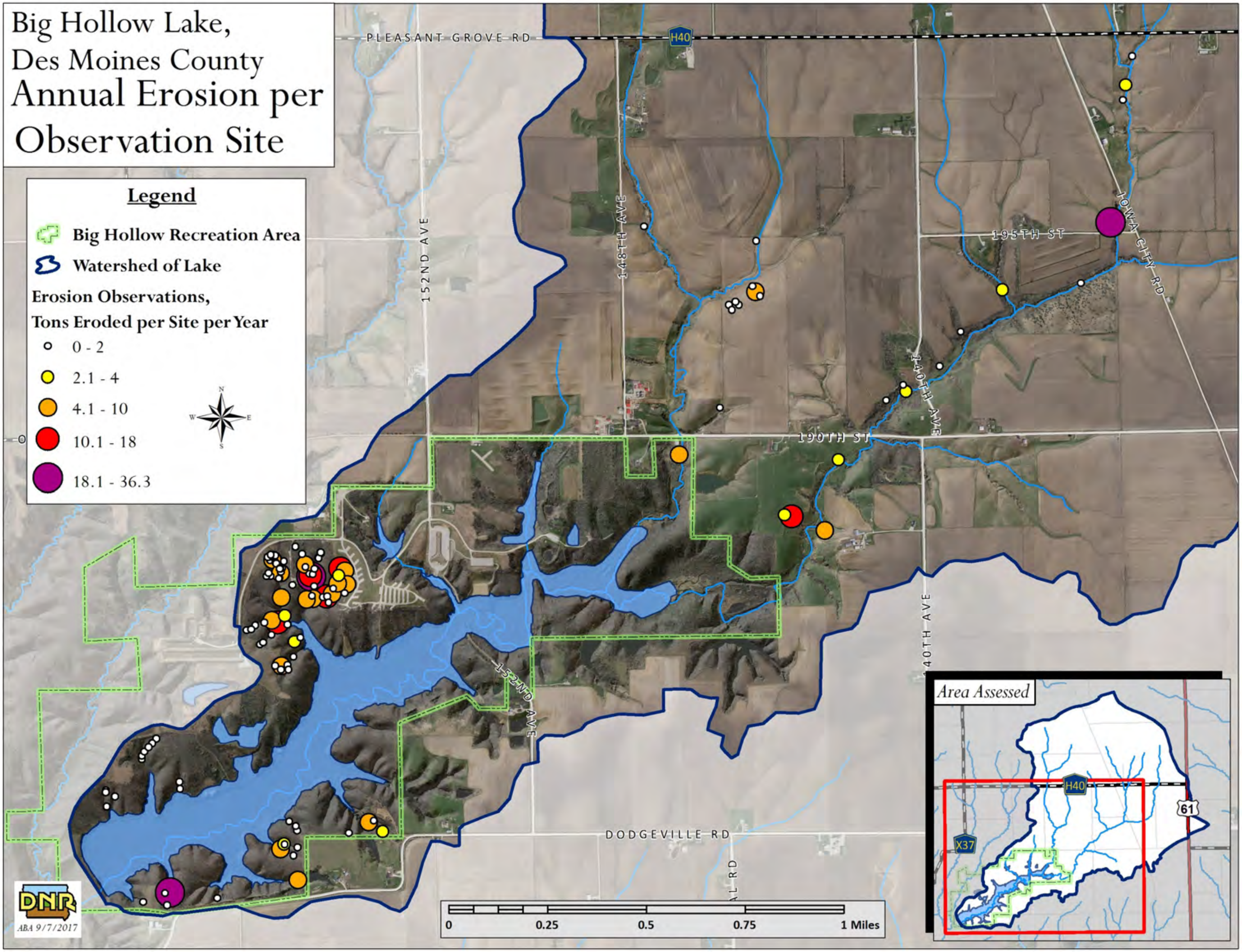


Big Hollow Lake, Des Moines County
Condition of Observed Outfalls



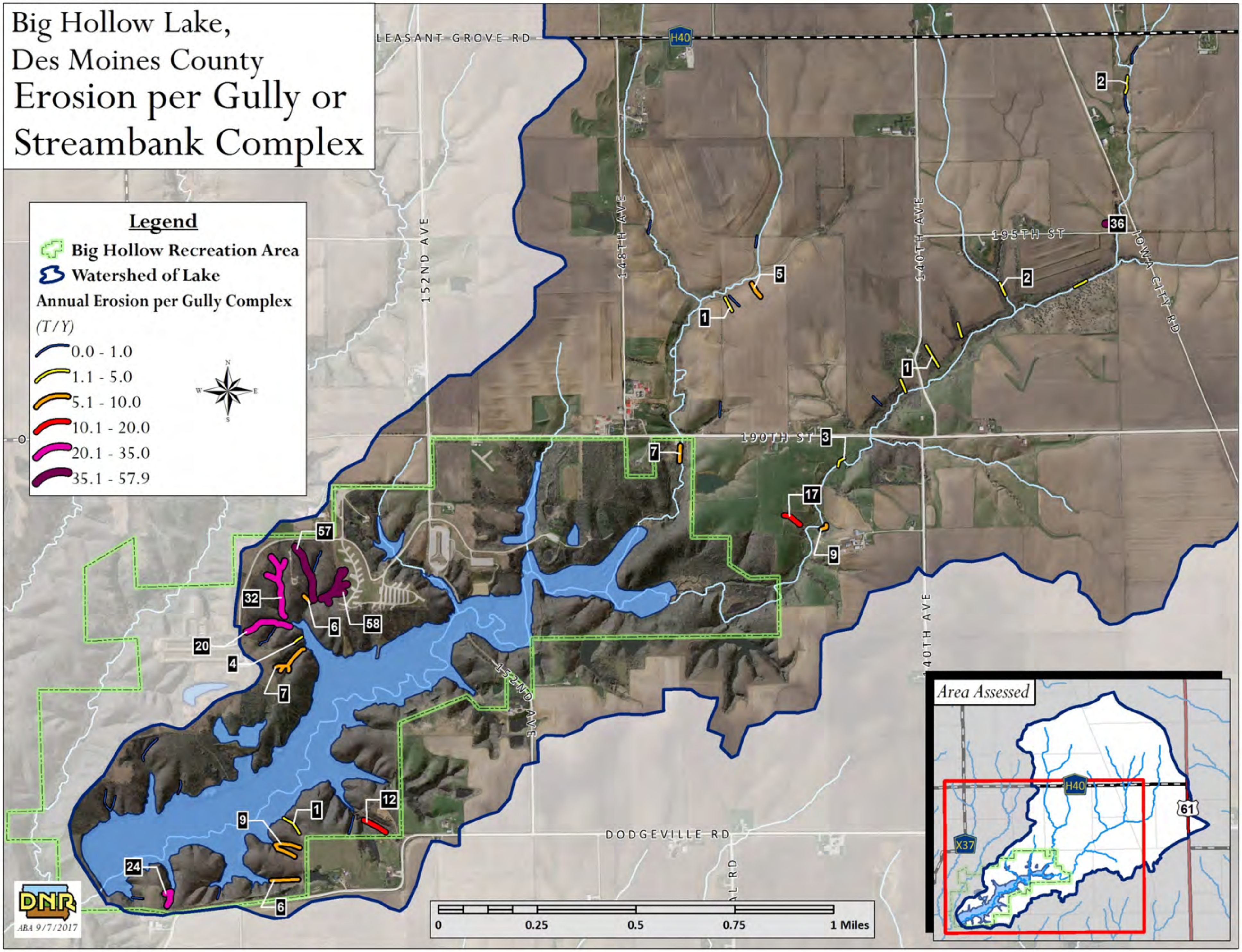


Big Hollow Lake,
Des Moines County
Erosion Observation Sites
Legend
Big Hollow Recreation Area
Watershed of Lake
Erosion Observations
Creek Observations
Bank Erosion (8)
Gully Observations
Gully Sidewall (34)
Gully Head Cut (58)
Knick Point (26)
GROVE RD
H40
152ND AVE
148TH AVE
140TH AVE
195TH ST
190TH ST
IOWA CITY RD
DODGEVILLE RD
Area Assessed
61
X37
0
0.25
0.5
0.75
1 Miles
DNR
ABA 9/7/2017



Big Hollow Lake,
Des Moines County
Annual Erosion per
Observation Site
Legend
Big Hollow Recreation Area
Watershed of Lake
Erosion Observations,
Tons Eroded per Site per Year
0 - 2
2.1 - 4
4.1 - 10
10.1 - 18
18.1 - 36.3
PLEASANT GROVE RD
H40
152ND AVE
148TH AVE
195TH ST
IOWA CITY RD
140TH AVE
190TH ST
DODGEVILLE RD
0
0.25
0.5
0.75
1 Miles
Area Assessed
61
X37
DNR
ABA 9/7/2017

Big Hollow Lake, Des Moines County Erosion per Gully or Streambank Complex



APPENDIX B – ADDITIONAL WATER QUALITY DATA

Table B-1. Summary of Eutrophication-Related Water Quality Parameters

Date	Total Phosphorus (ug/L)	Total Nitrogen (mg/L)	N:P Ratio	Chlorophyll-a (ug/L)	Chl-a TSI	TP TSI
5/25/2011	34.4	3.0	87	6.9	49.6	55.1
7/13/2011	50.7	12.5	247	38.4	66.4	60.7
8/23/2011	42.4	5.4	126	39.5	66.7	58.1
5/23/2012	26.5	3.9	149	2.8	40.8	51.4
7/11/2012	57.3	2.2	39	14.5	56.8	62.5
8/23/2012	57.6	1.4	24	65.4	71.6	62.6
5/22/2013	153.7	9.0	58	3.8	43.7	76.7
7/10/2013	105.4	5.8	55	223.4	83.7	71.3
8/21/2013	96.3	1.7	18	84.2	74.1	70.0
5/28/2014	97.9	0.6	6	14.8	57.0	70.2
7/16/2014	66.7	1.2	18	37.3	66.1	64.7
8/24/2014	33.9	0.9	25	30.6	64.2	54.9
5/28/2015	43.5	1.6	37	3.0	41.5	58.5
7/15/2015	184.2	3.0	16	15.6	57.6	79.3
8/23/2015	95.8	2.1	22	44.7	67.9	69.9
5/25/2016	24.0	4.1	172	1.0	30.8	49.9
7/13/2016	82.3	1.8	21	86.6	74.4	67.7
8/26/2016	172.3	1.9	11	67.7	72.0	78.4
5/24/2017	97.9	4.1	42	1.7	35.5	70.2
7/10/2017	67.9	2.0	30	1.7	35.5	64.9
8/20/2017	86.6	1.9	22	4.0	44.2	68.4
5/21/2018	203.7	2.1	10	1.0	30.6	80.8
7/9/2018	110.3	2.3	20	84.0	74.1	71.9
8/19/2018	85.9	1.7	19	26.0	62.6	68.3
6/3/2019	301.2	4.9	16	3.5	42.9	86.4
7/15/2019	71.4	3.7	52	21.8	60.8	65.7
8/26/2019	90.0	1.7	19	18.4	59.2	69.0

Table B-2. Additional Eutrophication-Related Water Quality Parameters

Date	Depth (m)	Thermo -cline (m)	Temp (C)	Dissolved Oxygen (mg/L)	pH	Ortho-phosphate (ug/L)	TKN (mg/L)	Ammonia (ug/L)	NOX (mg/L)
5/25/2011	9.2	2.3	21.7	11.9	8.7	5.5	0.3	72.5	1.2
7/13/2011	7.0	1.8	27.6	0.3	8.3	5.5	2.7	72.5	3.5
8/23/2011	8.5	2.4	26.6	16.2	9.3	5.5	1.6	72.5	1.0
5/23/2012	7.0	1.5	22.2	9.7	8.5	5.0	1.1	30.7	2.9
7/11/2012	10.2	2.2	29.0	10.1	8.9	5.0	1.2	20.4	1.0
8/23/2012	9.8	4.0	22.0	7.0	8.1	5.0	1.4	7.0	0.0
5/22/2013	7.2	1.1	20.9	9.5	8.1	114.1	0.9	85.6	8.1
7/10/2013	8.9	1.7	28.9	20.8	9.7	7.0	2.8	14.4	3.1
8/21/2013	7.0	2.2	24.4	17.2	9.4	7.0	1.7	26.7	0.1
5/28/2014	8.3	2.3	22.3	13.0	8.6	40.3	0.6	21.3	0.0
7/16/2014	8.1	2.5	24.0	14.6	9.2	2.8	1.2	7.0	0.0
8/24/2014	8.2	Nil	16.2	5.3	7.9	2.8	0.8	7.0	0.0
5/28/2015	8.3	2.0	22.5	12.9	8.4	2.2	0.9	70.8	0.7
7/15/2015	7.7	1.2	27.0	20.2	9.6	2.2	2.2	8.4	0.8
8/23/2015	8.3	2.0	23.1	9.9	8.3	2.2	1.3	33.8	0.9
5/25/2016	8.2	1.2	22.2	10.5	8.2	1.4	0.7	44.9	3.4
7/13/2016	8.1	4.0	25.5	10.4	8.5	1.4	1.3	5.8	0.4
8/26/2016	8.3	3.0	25.2	19.2	8.8	32.8	1.8	0.3	0.0
5/24/2017	8.1	4.2	17.7	9.0	8.1	61.3	0.8	185.1	3.3
7/10/2017	7.7	1.7	26.3	10.0	8.3	5.0	1.8	31.0	0.2
8/20/2017	8.0	2.8	26.1	9.1	8.3	2.4	1.9	115.0	0.0
5/21/2018	8.1	2.7	22.0	9.2	8.2	138.5	0.8	73.0	1.3
7/9/2018	8.1	1.6	27.7	18.4	8.7	2.9	2.2	12.0	0.0
8/19/2018	7.6	1.7	27.0	7.5	8.6	2.9	1.7	15.0	0.0
6/3/2019	8.2	1.3	21.8	8.6	7.5	218.0	1.1	86.0	-
7/15/2019	7.9	1.6	28.4	12.3	8.7	10.8	1.4	37.3	-
8/26/2019	8.4	2.6	23.1	8.6	8.5	10.8	1.7	2.4	-

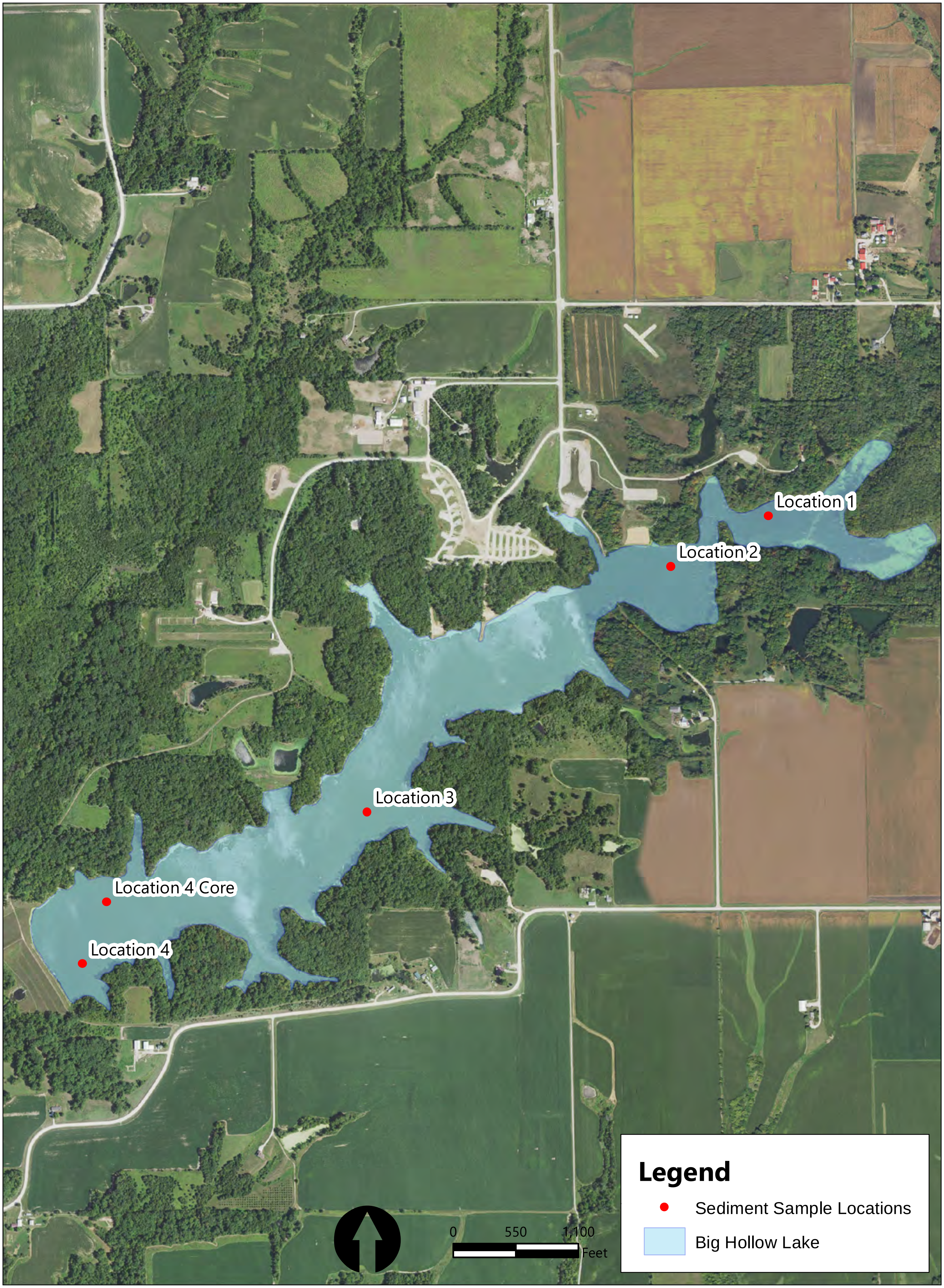
Table B-3. Additional Water Quality Sampling Results

Date	Conductivity (umhos/cm)	Turbidity (NTU)	Alkalinity (mg/L)	TDS (mg/L)	DOC (mg/L)	ISS (mg/L)	TVSS (mg/L)	TSS (mg/L)
5/25/2011	490	2.7	132	-	3.8	2.5	4.0	3
7/13/2011	210	10.3	72	-	3.8	8.0	9.0	17
8/23/2011	370	21.3	74	-	3.8	2.5	9.3	13
5/23/2012	510	0.5	116	330	5.9	1.0	1.6	1
7/11/2012	480	4.7	83	310	5.1	6.7	3.4	10
8/23/2012	570	19.2	106	370	6.5	5.6	8.8	14
5/22/2013	480	2.1	103	310	6.6	1.7	1.2	1
7/10/2013	350	17.5	62	230	5.1	5.2	23.6	29
8/21/2013	370	13.0	71	240	5.9	1.7	9.2	10
5/28/2014	520	2.8	121	340	6.5	1.0	1.8	2
7/16/2014	430	16.8	81	280	6.1	2.2	11.8	14
8/24/2014	570	6.4	74	370	7.0	2.4	4.4	7
5/28/2015	670	-	137	440	5.8	0.7	3.1	4
7/15/2015	390	23.5	84	250	6.5	6.5	15.0	22
8/23/2015	470	9.4	117	300	31.9	0.7	8.8	10
5/25/2016	700	0.2	146	450	29.8	0.4	1.4	2
7/13/2016	660	4.6	102	430	24.9	0.8	8.6	9
8/26/2016	470	12.7	109	300	27.0	0.4	10.2	11
5/24/2017	581	0.6	154	378	-	0.3	3.0	3
7/10/2017	513	7.3	122	334	-	2.0	15.0	17
8/20/2017	558	6.2	96	363	-	15.0	4.0	19
5/21/2018	716	-	121	466	-	3.5	1.5	5
7/9/2018	631	-	75	410	-	0.6	0.6	1
8/19/2018	677	21.2	78	440	-	8.0	7.0	15
6/3/2019	383	11.8	-	249	-	-	-	2
7/15/2019	384	13.9	-	250	-	-	-	12
8/26/2019	294	9.9	-	191	-	-	-	42

APPENDIX C – BIG HOLLOW LAKE SEDIMENT ANALYSIS

A complete sediment analysis with findings and implications will be appended to the watershed plan when this information becomes available. The data was collected and is being analyzed using funds from the Iowa DNR Lake Restoration Program and Des Moines County CCB. No Section 319 funds supported the sediment analysis but the information will be very useful in the long-term implementation efforts to protect and improve Big Hollow Lake.

Preliminary laboratory results were obtained on 12/1/2021 and are included on the following page, but additional analyses are still in-process.


Location 1
Location 2
Location 3
Location 4 Core
Location 4
0
550
1,100
Feet
Legend
Sediment Sample Locations
Big Hollow Lake

IEH ANALYTICAL LABORATORIES

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	**1726043**		**PAGE**	**1**
REPORT DATE:	**12/01/21**			
DATE SAMPLED:	**07/29/21**	**DATE RECEIVED:**		**08/12/21**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM FYRA ENGINEERING

CASE NARRATIVE

Two sediment samples were received by the laboratory in good condition and analyzed according to the chain of custody. Phosphorus fractions were determined according to the method of Rydin and Welch. Successive extractions with NH4Cl, Bicarbonate/Dithionate, NaOH, and HCL were performed and analyzed for phosphorus. One part of Organic P was determined by digesting the residue after the inorganic fractions were extracted. Organic P includes the P after the inorganic fractions plus Biogenic P. Total P is the sum of all fractions minus Biogenic P, which is part of the Organic P fraction. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows, while QA/QC data is contained on subsequent pages.

SAMPLE DATA - SEDIMENTS (DRY WT. BASIS)

SAMPLE ID	% SOLIDS	% WATER	TOC (%)	TOTAL-P (mg/kg)	LOOSELY BOUND P (NH4CL) (mg/kg)	FE BOUND P (DITHIONATE) (mg/kg)	AL BOUND P (NAOH) (mg/kg)	BIOGENIC P (mg/kg)	CA BOUND P (HCL) (mg/kg)	ORGANIC P (mg/kg)
Big Hollow 1-1 (top 10 cm)	48.3%	51.7%	PENDING	1241	<2.00	83.3	763	31.9	158	236
Big Hollow 2-1 (top 10 cm)	36.3%	63.7%	PENDING	1366	<2.00	119	839	69.7	125	283

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CASE FILE NUMBER:	**1726043**	**PAGE**	**2**
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FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM FYRA ENGINEERING			

QA/QC DATA- SEDIMENTS

QC PARAMETER	% SOLIDS	TOTAL-P	LOOSELY BOUND P	FE BOUND P	AL BOUND P	BIOGENIC P	CA BOUND P	ORGANIC P
			(NH4CL)	(DITHIONATE)	(NAOH)		(HCL)	
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
METHOD	SM18 2540B	CALCULATED	SM18 4500PF	SM18 4500PF	SM18 4500PF	EPA 365.1	SM18 4500PF	EPA 365.1
DATE PREPARED	08/30/21	09/07/21	09/01/21	09/01/21	09/01/21	09/07/21	09/01/21	09/07/21
DATE ANALYZED	1.00%	5.00	2.00	2.00	2.00	2.00	2.00	2.00
DETECTION LIMIT								
DUPLICATE								
	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH
SAMPLE ID	30.0%	1072	<2.00	107	75.0	253.2	473	417
ORIGINAL	28.0%	1124	<2.00	110	83.4	276.8	487	443
DUPLICATE	6.80%	4.71%	NC	2.53%	10.63%	8.90%	2.84%	6.27%
RPD								
SPIKE SAMPLE								
SAMPLE ID								
ORIGINAL								
SPIKED SAMPLE								
SPIKE ADDED	NA	NA	NA	NA	NA	NA	NA	NA
% RECOVERY								
QC CHECK								
(mg/l)								
FOUND			0.040	0.040	0.040	0.091	0.040	0.091
TRUE			0.039	0.039	0.039	0.094	0.039	0.094
% RECOVERY	NA	NA	102.56%	102.56%	102.56%	96.81%	102.56%	96.81%
BLANK	NA	NA	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski
Project Manager

APPENDIX D – BIG HOLLOW RECREATION AREA POND ASSESSMENT

The pond assessment Technical Memorandum and photo log is provided on following pages.

Technical Memorandum

To: Des Moines County Conservation
C/O Chris Lee, Director
From: FYRA Engineering
Re: Dam Inspection Findings and Recommendations
Date: 23 June 2021

1 BACKGROUND

FYRA Engineering was contracted by Des Moines County Conservation (DMCC) to provide inspections for 6 dam structures in the Big Hollow Lake watershed (Figure 1). The purpose of these inspections was to evaluate the structures for any current deficiencies related to regulated dam safety and the function of the structures in accordance with the intended dam operation. This memo is to report on the observations made in the field of these structures. A more in-depth engineering analysis should be completed to detail any required rehabilitation of the priority structures identified in this technical memorandum (TM).

These structures are owned, operated, and maintained by Des Moines County Conservation. The purpose of these structures is to protect water quality in Big Hollow Lake by trapping sediment and nutrients before they reach the lake. These structures are approximately forty years old, constructed in the 1980s according to aerial imagery and personal accounts given by DMCC staff. FYRA Engineering performed an inspection of the structures along with Chris Lee of DMCC on 20 April 2021. A standard checklist that examines the components of a dam structure was used to log observations, and each completed checklist is attached in the Appendix. Many of the dam components that were reviewed on the checklist are shown in Figure 2 and many of the typical sources of dam failure can be seen in Figure 3.

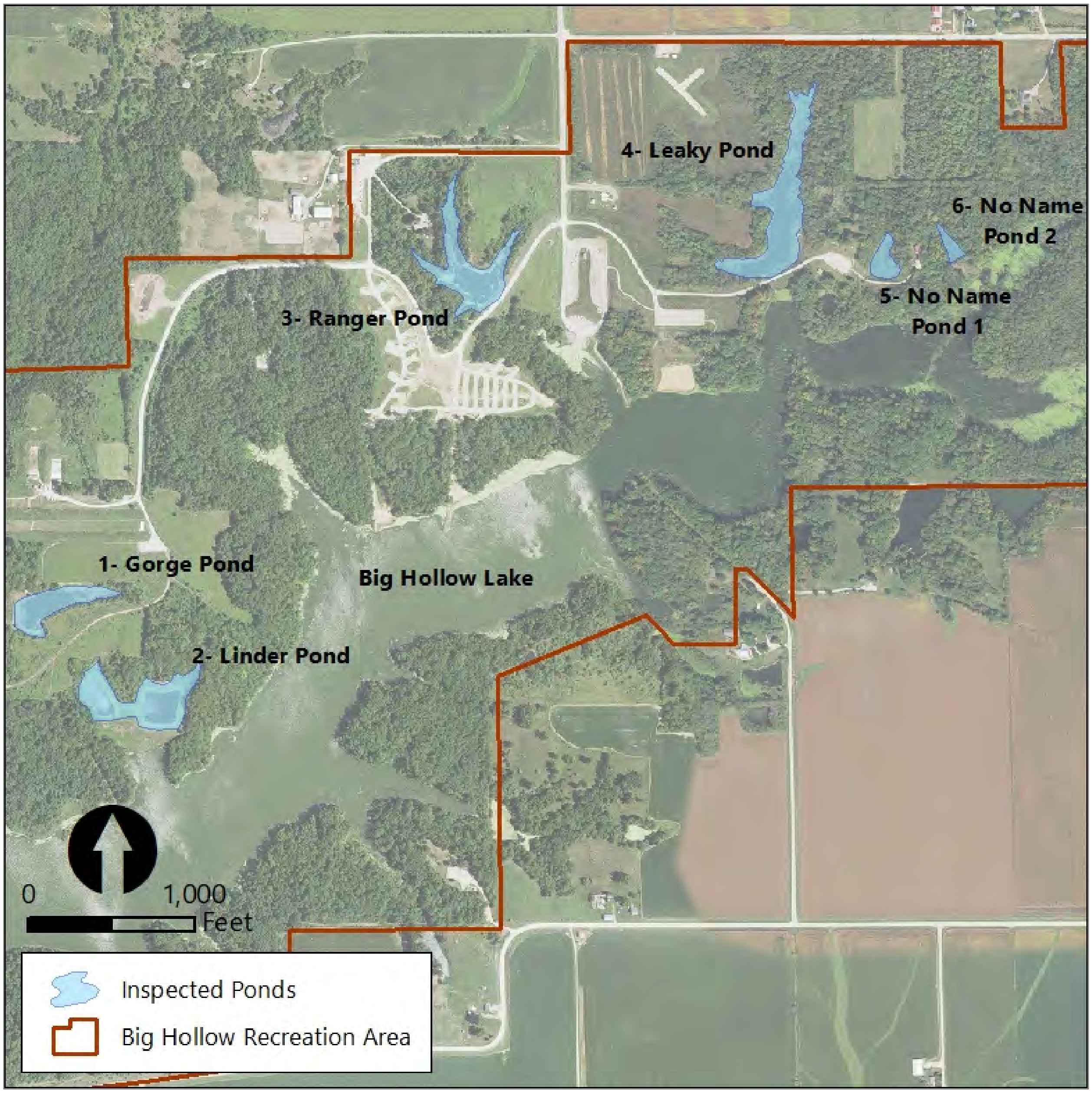

Figure 1. **Overview of the dams inspected by FYRA Engineering**

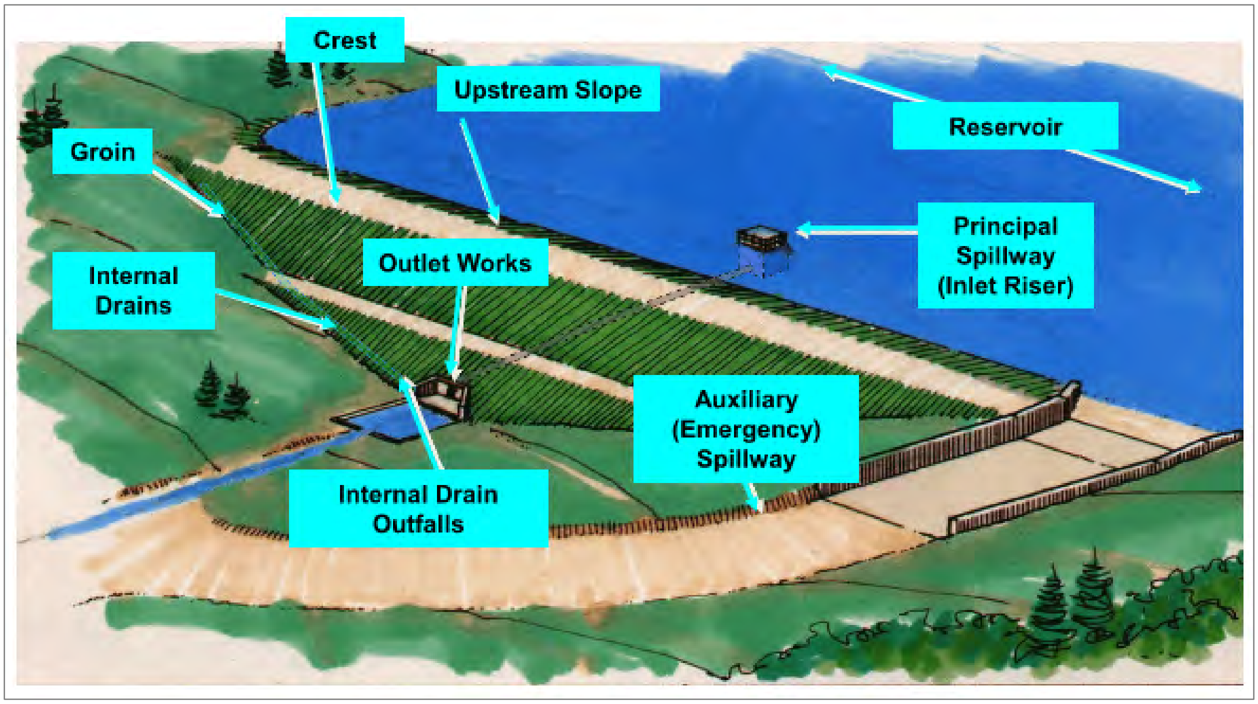

Figure 2. Typical Components of Earthen Embankment Structure
Source: Iowa DNR, Dam Safety

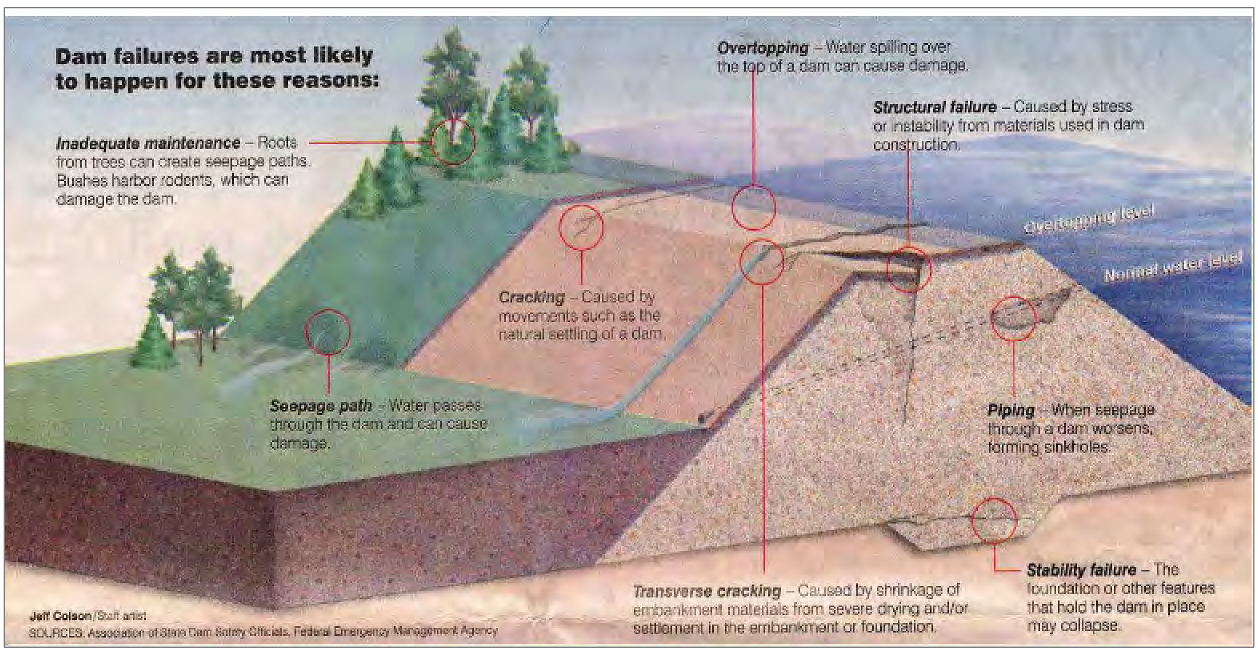

Figure 3. Typical Sources of Failure for Dam Structures.
Source: Iowa DNR, Dam Safety

There were no as-built drawings to compare with the in-field conditions of the structures. These structures are currently not listed on Iowa DNR's Dam inventory, however, given their height and storage capacity these structures would be subject to Dam Safety operation and maintenance standards if permitted according to current regulations.

2 ASSESSMENT

2.1 Gorge Pond

Gorge Pond (Site 1 in Figure 1). This structure includes a principal spillway comprised of 6" diameter corrugated metal pipe (CMP) and an earth cut right abutment auxiliary spillway approximately 30 feet wide.

The pond's pool appeared to be higher than the design elevation, likely due to a partially clogged principal spillway pipe inlet. The principal spillway inlet could not be located as it was submerged under the water surface and/or buried within the vegetation on the front face of the dam. Seepage was observed on the downstream face of the dam with moving water along the principal spillway pipe alignment (Figure 8 in Appendix). This is likely from "piping" of water along the pipe or a leaking pipe joint, which can cause internal erosion within the dam as water picks up sediment particles near the pipe and transports them causing erosion. Over time, this void can grow larger and compromise the structural integrity of the dam embankment (Figure 4). Piping is the most common cause of failure in earthen dams.

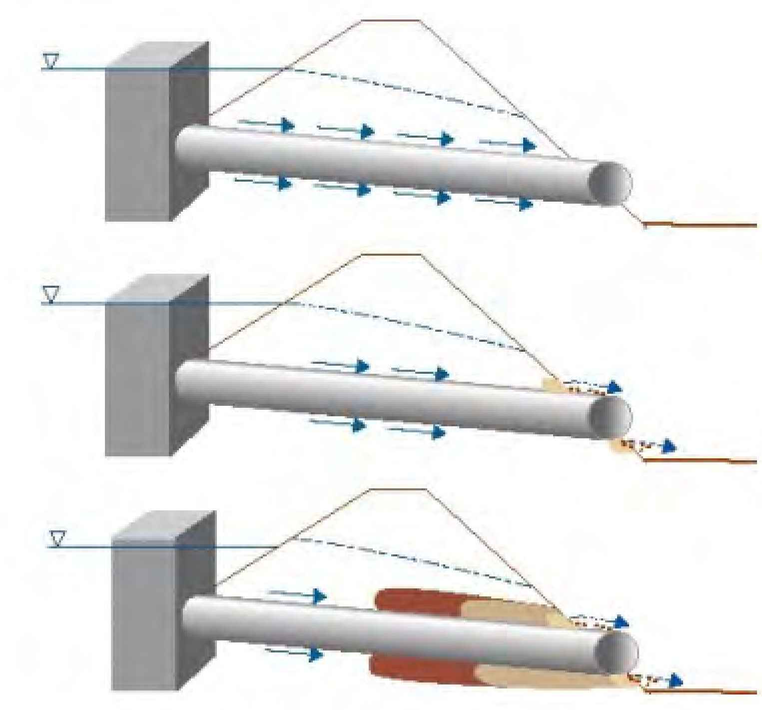

Figure 101.—Failure Mode No. 3.—Backward erosion piping or internal erosion of soils along a conduit at the interface between the conduit and surrounding soils.

Figure 1. Internal Erosion Along a Conduit of a Dam
Source: https://dev.damsafety.org/sites/default/files/files/fema484.compressed.pdf

Trees and brush were observed growing on the embankment. The roots of the trees and brush can penetrate deep into the embankment, act as seepage paths for water through the embankment, harbor animals, and hide any other deficiencies on the structure. Additionally, if the trees are ever uprooted, they can create large voids in the embankment. Trees and woody brush and their root systems should be cleared from the embankment to prevent future damage to the structure and help the future maintenance and ease of inspections. The outlet pipe was hidden under debris and the outlet channel is slightly degraded with some scouring.

The piping condition combined with the (likely) clogged spillway pipe, elevated pool, brush on the embankment, make this structure the highest priority for dam safety concerns and the need for rehabilitation.

2.2 Linder Pond

This structure known as Linder Pond (Site 2 in Figure 1) has a 6″ diameter CMP straight pipe principal spillway and no observable auxiliary spillway. The outlet pipe was not visible at the time of inspection because it either enters Big Hollow Lake under the water surface or is buried in vegetation along the downstream toe.

The deficiencies noticed on this structure include trees/brush growing on the embankment and at the waterline. Small animal burrows were present on the embankment. A possible microslide on the upper 2/3rds of the downstream slope was observed (Figure 15 in Appendix). Given the dam's height and steep backslope combined with a wet toe from Big Hollow Lake, conditions suggest a microslide may be forming. The microslide was noticed by a bare patch on the dam embankment parallel to the dam centerline over a noticeable stretch of the dam face which indicates the start of possible sloughing of the downstream slope and could potentially lead to a more significant slide of the downstream embankment face. Figure 5 below shows the progression of a complete slide resulting in much larger failure.

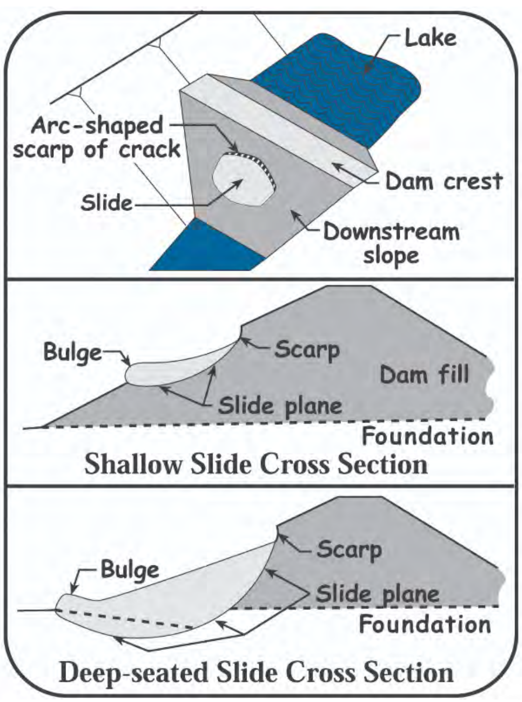

Figure 2. Example of Embankment Slide
Source: American Society of Dam Safety Officials

Linder Pond recommendations include repairing animal burrows, clearing the embankment of trees/brush, and monitoring/documenting conditions annually for the potential microslide identified.

2.3 Ranger Pond

Ranger Pond is located along the park road (Site 3 in Figure 1) and the principal spillway is comprised of a 12" diameter steel straight pipe with a rebar trash rack. There is no auxiliary spillway on this structure.

Issues observed at Ranger Pond include very minor trees and brush growing on the embankment, moderate erosion along the right groin of the downstream embankment due to local concentrated flow, minor corrosion of the principal spillway conduit, and minor scouring at the outlet of the pipe. These are relatively minor deficiencies, and this dam is expected to perform safely under anticipated conditions. Annual inspections and routine maintenance are recommended.

2.4 Leaky Pond

The principal spillway on this structure is an 18" diameter steel straight pipe and is located along the park road (Site 4 on Figure 1). There is no auxiliary spillway, and the principal spillway outlet drains directly into Big Hollow Lake.

Chris Lee mentioned this pond was fully rehabilitated approximately eight years prior (2012/2013). The pond was drained and a new embankment and spillway pipe were constructed. A bentonite seal was used to help prevent prior/documented leaking. Chris mentioned the pond still leaks even after the rehabilitation. Shoreline protection rock on the downstream end was placed when the lake was formed and serves as outlet protection for the spillway pipe.

The inspection revealed the pond is maintaining its water level with no evident seeps or holes in the embankment. There was a small microslide on the downstream embankment signified by bare line across the upper 2/3rds of the embankment (Figure 37 in Appendix).

Minor maintenance recommendations include clearing any trees and brush from the embankment and making sure the trash rack is clear of any obstructions at the inlet of principal spillway pipe. Continue to monitor the small microslide on the downstream side of the embankment and monitor the water level in the pond while checking the embankment for any wet spots where a leak may be present.

2.5 No Name Pond 1

No Name Pond 1 is part of the park road on the east side of the park (Site 5 in Figure 1). The principal spillway on this structure consists of a 6" diameter CMP straight pipe with no trash rack. The inlet on this structure is slightly damaged and bent (Figure 44 in Appendix), and there was no auxiliary spillway on this structure.

The structure seemed to be in satisfactory condition and no serious deficiencies we noted. There are a few minor issues, including large amounts of brush growing on the downstream slope (Figure 42 in Appendix), minor corrosion of the spillway pipe, and small scouring at the outlet.

The principal spillway pipe inlet should be repaired to maintain hydraulic capacity. To prevent future damage with any maintenance equipment, make sure the area around the pipe is clear of brush and tall vegetation. This will also help with better conveyance of water through the pipe. Rock rip rap can also be added at the outlet for erosion control and to prevent any future scouring. Lastly, clear the large amounts of trees and brush from the embankment. Overall, this structure was in a satisfactory condition and maintenance is recommended in a timely manner.

2.6 No Name Pond 2

This is the eastern most structure inspected by FYRA (Site 6 in Figure 1). It has a 6" diameter CMP straight pipe with a hooded inlet as the principal spillway, with no auxiliary spillway. There were minor items identified that should be addressed. Vegetation growing on the embankment contained many trees and brush. There was also minor corrosion in the spillway pipe and a small scour hole at the pipe outlet.

Trees and brush should be cleared and pipe condition monitored regularly to ensure maintains proper function. Rock rip rap can also be added at the outlet for erosion control and to prevent any future scouring. Overall, this structure was in a satisfactory condition and is anticipated to continue to operate safely as long as maintenance listed in this TM are implemented in a timely manner.

3 REHABILITATION PRIORITIES

The highest priority recommended for rehabilitation for Des Moines County Conservation is Gorge Pond. There were many items on the Gorge Pond structure in need of repair including the (likely) clogged principal spillway inlet, seepage along the spillway pipe, degraded outlet channel, and woody brush on the embankment. Significant hydrologic events can exacerbate these deficiencies and intensify damages even further and immediate actions are recommended above to repair the structure.

The other structures were in satisfactory condition and expected to continue to function properly with routine maintenance. Maintenance activities that should be performed at all structures on an ongoing basis include:

- Clearing trees and brush from embankment, spillway areas, and outlet channel.
- Backfill rodent burrows and mitigate future rodent infestation.
- Repair and stabilize eroded areas.
- Monitor spillway pipes for blockage and degradation.
- Monitor embankments for progression of microslides and possible sloughing.

For more information on dam ownership responsibilities, see the Maintenance Manual for Dam Owners from the Iowa DNR Dam Safety Section.

4 REFERENCES

https://www.iowadnr.gov/Environmental-Protection/Land-Quality/Dam-Safety

https://dev.damsafety.org/sites/default/files/files/fema484.compressed.pdf

APPENDIX- PHOTO LOG:

Structure 1 – Gorge Pond

Figure 1: Photo taken on 4/20/21 showing the dam alignment with trees and brush growing on upstream and downstream slopes.

Figure 2: Photo taken on 4/20/21 showing the trees and brush growing on downstream slope of the dam.

Figure 3: Photo taken on 4/20/21 showing the upstream slope of the dam and elevated pool.

Figure 4: Photo taken on 4/20/21 at approximate location of the submerged principal spillway inlet.

Figure 5: Photo taken on 4/20/21 showing debris surrounding the spillway outlet.

Figure 6: Photo taken on 4/20/21 showing earth cut auxiliary spillway.

Figure 7: Photo taken on 4/20/21 showing trees growing at the water line.

Figure 8: Photo taken on 4/20/21 showing seepage hole with running water along the principal spillway alignment.

Structure 2 – Linder Pond

Figure 9: Photo taken on 4/20/21 showing the top of dam crest.

Figure 10: Photo taken on 4/20/21 showing trees and brush growing on downstream slope.

Figure 11: Photo taken on 4/20/21 showing the upstream slope of the dam.

Figure 12: Photo taken on 4/20/21 showing 6" CMP principal spillway inlet with rebar trash rack.


Figure 13: Photo taken on 4/20/21 showing approximate location of submerged principal spillway outlet.


Figure 14: Photo taken on 4/20/21 showing minor erosion at water line.

Figure 15: Photo taken on 4/20/21 showing signs of possible microslide on downstream slope signified by small bare grass line approximately 2/3rds up the embankment

Figure 16: Photo taken on 4/20/21 showing rodent burrow on downstream slope.

Figure 17: Photo taken on 4/20/21 showing trees and brush growing at water line

Figure 18: Photo taken on 4/20/21 showing an animal burrow on the dam crest.

Structure 3 – Ranger Pond

Figure 19: Photo taken on 4/20/21 showing the dam crest.

Figure 20: Photo taken on 4/20/21 showing the dam crest

Figure 21: Photo taken on 4/20/21 showing the upstream slope of the dam.

Figure 22: Photo taken on 4/20/21 showing the principal spillway with hooded inlet and rebar trash rack.

Figure 23: Photo taken on 4/20/21 showing the downstream slope of the dam.

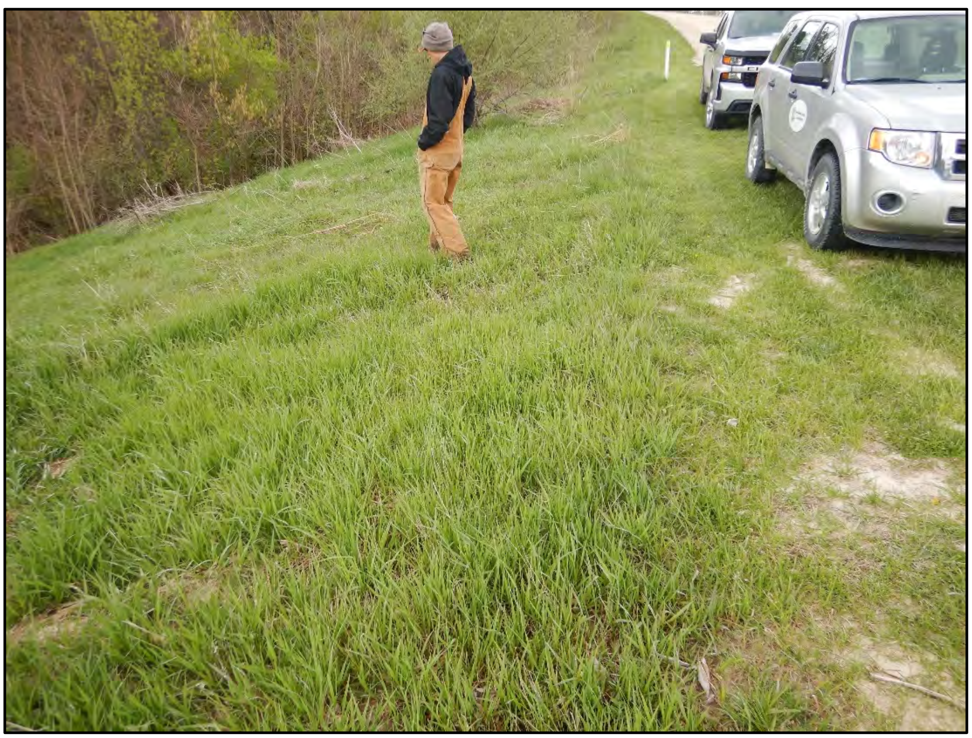

Figure 24: Photo taken on 4/20/21 showing the downstream slope of the dam.

Figure 25: Photo taken on 4/20/21 showing the principal spillway outlet with rodent guard and small scour hole.

Figure 26: Photo taken on 4/20/21 showing minor erosion from local drainage along the groin of the downstream slope.

Figure 27: Photo taken on 4/20/21 showing minor trees and brush on the downstream slope of the dam.

Figure 28: Photo taken on 4/20/21 showing a stump from cut tree on downstream slope of the dam.

Structure 4 – Leaky Pond

Figure 29: Photo taken on 4/20/21 showing the top of dam crest.

Figure 30: Photo taken on 4/20/21 showing the top of dam crest.

Figure 31: Photo taken on 4/20/21 showing the upstream slope of the dam.

Figure 32: Photo taken on 4/20/21 showing the upstream slope of the dam.

Figure 33: Photo taken on 4/20/21 showing the downstream slope of the dam.

Figure 34: Photo taken on 4/20/21 showing the 18” diameter steel principal spillway inlet pipe with rebar trash rack and minor brush growing around inlet.

Figure 35: Photo taken on 4/20/21 showing the principal spillway outlet.

Figure 36: Photo taken on 4/20/21 showing the principal spillway outlet with rock riprap outlet and shoreline protection.


Figure 37: Photo taken on 4/20/21 showing possible microslide signified by line of bare earth 2/3rds up the downstream slope of the dam.


Figure 38: Photo taken on 4/20/21 showing possible microslide signified by line of bare earth 2/3rds up the downstream slope of the dam.

Structure 5-Noname Pond 1

Figure 39: Photo taken on 4/20/21 showing the top of dam crest.

Figure 40: Photo taken on 4/20/21 showing the top of dam crest.


Figure 41: Photo taken on 4/20/21 showing the upstream slope of the dam.


Figure 42: Photo taken on 4/20/21 showing the large amounts of trees and brush growing on downstream slope of the dam.

Figure 43: Photo taken on 4/20/21 showing the principal spillway inlet with brush growing around the inlet.

Figure 44: Photo taken on 4/20/21 showing the bent 6″ CMP principal spillway inlet.

Figure 45: Photo taken on 4/20/21 showing 6" CMP principal spillway outlet with small scour hole.

Figure 46: Photo taken on 4/20/21 showing the large amount of brush on the downstream slope of the dam.

Structure 6- Noname Pond 2

Figure 47: Photo taken on 4/20/21 showing the top of dam crest.

Figure 48: Photo taken on 4/20/21 showing the upstream slope and a few trees and brush growing at the water line.

Figure 49: Photo taken on 4/20/21 showing large amounts of trees and brush on the downstream slope of the dam.

Figure 50: Photo taken on 4/20/21 showing the 6″ CMP with hooded inlet.

Figure 51: Photo taken on 4/20/21 showing some trees and brush growing at the water line on the upstream slope.

Figure 52: Photo taken on 4/20/21 the 6" CMP outlet with minor scour hole.

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APPENDIX E – BIG HOLLOW RECREATION AREA WATERSHED MONITORING

The draft water quality monitoring plan is provided on the following pages. Note that the plan is dynamic and monitoring locations/parameters may shift due to land access issues and/or real-time insights gained provided by preliminary results.

Big Hollow Lake
Tributary Monitoring Plan (2020)

Prepared by: Jen Kurth, IDNR Watershed Project Monitoring Coordinator

1.0 Project Personnel

Local Project Monitoring Staff:	Des Moines County Conservation Chris Lee, Executive Director 13700 Washington Rd. West Burlington, IA 52655 (319) 753-8260
Iowa DNR Project Officer:	Mary Beth Stevenson 323-4 Stanley Hydraulics Lab Iowa City, IA 52245 (319) 325-8593 marybeth.stevenson@dnr.iowa.gov
Iowa DNR Watershed Project Monitoring Coordinator	Jennifer Kurth 502 E 9th St Des Moines, IA 50319 (515) 725-8381 Jennifer.kurth@dnr.iowa.gov
State Hygienic Laboratory (SHL) Contact:	Mike Schueller SHL – Iowa City 102 Oakdale Hall #101 OH Iowa City, IA 52242 (319) 335-4500

2.0 Background and Rationale

2.1 General Background and Rationale for Monitoring

In the fall of 2006, the U.S. Environmental Protection Agency (USEPA) conducted a Program Review of Iowa's Non-Point Source (NPS) Management Program. Seven issues and concerns emerged from this review. Two of these concerns related to water quality monitoring associated with watershed projects. In summary, USEPA recommended that 1) steps be taken to increase communication and cooperation between the water monitoring and nonpoint source programs at the Department; and 2) projects funded with incremental funds (following the nine elements of a watershed plan) need to include a water quality monitoring component as part of their project implementation plans.

The NPS Program has been working with USEPA and coordinating with the Watershed Improvement Section on implementing water quality monitoring for all watershed projects receiving a planning grant for development of a nine element watershed plan.

The goal of this plan is to gather data to inform a watershed plan for Big Hollow Lake. This monitoring program will collect data to document the current water quality in the lake, and will serve as pre-project baseline data for any future work in the watershed.

2.2 Project Background and Objectives/Goals:

Big Hollow Lake is a relatively new lake. Located in Des Moines County, construction of the dam finished in 2008 and the 178 acre lake had filled in by 2009. Recreation facilities include swimming beach, boat ramp, campground, picnic area and playground, trail system, hunting, and a shooting range.

Big Hollow Lake is subject to extreme algae blooms that can lead to poor visibility and make the lake unappealing to users. This violates Iowa's narrative water quality standard protecting against aesthetically objectionable conditions. Additionally, the algal blooms are likely contributing to the pH impairment as well. Water sampling has found very high levels of suspended algae, chlorophyll a, and total phosphorus, which are causing the poor water transparency. Sampling has found that 96 percent of the algal biomass is comprised of cyanobacteria. Algal blooms and cyanobacteria can make swimming or wading unpleasant or hazardous, as well as discouraging use of the lake.

2.3 Monitoring Needs:

1. Monitor in the tributaries to assess the influence of row crop agriculture, livestock management activities and household septic systems on the nutrient balance of the lake in order to develop a nine element watershed plan.

3.0 Monitoring Locations

Monitoring will focus on the tributaries to assess the influence of the watershed on lake dynamics. Five monitoring locations have been selected on the east and west tributary branches (Table 1; Figure 1).

Table 1. Monitoring locations for Big Hollow Lake Watershed Project.

SITENAME	UTM_X	UTM_Y	STORET
BH-1 – West branch trib at 190th St.	650577.45	4535618.86	14000315
BH-2 – East branch trib at 190th St.	651363.64	4535617.13	14000316
BH-3 – East branch trib at Iowa City Rd.	652495.49	4536315.62	14000317
BH-4 – West Fork East branch trib at Pleasant Grove Rd.	652354.84	4537220.01	14000318
BH-5 – West branch trib at Pleasant Grove Rd.	650406.55	4537190.13	14000319

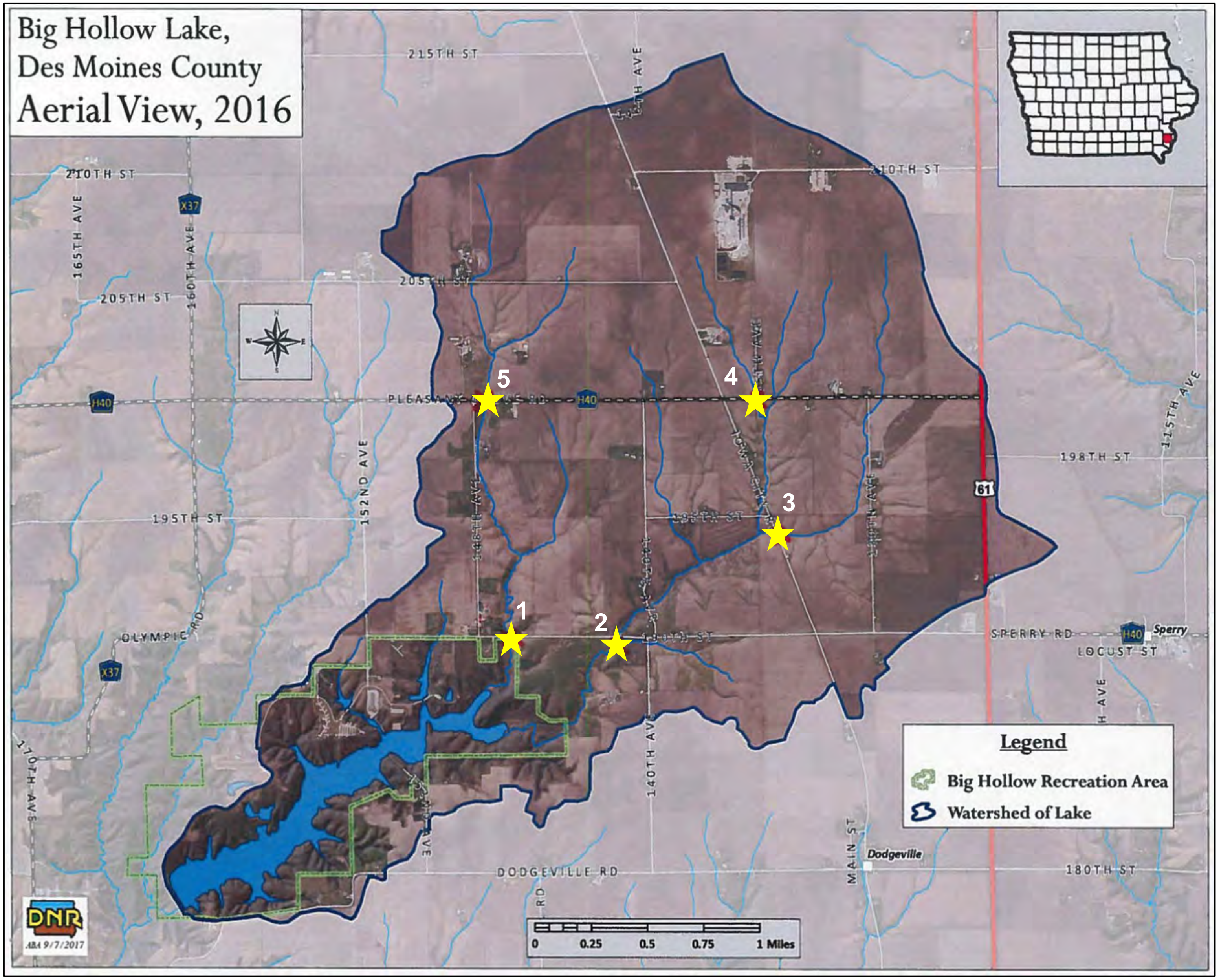

Figure 1. Big Hollow Lake monitoring locations.

4.0 Monitoring Plan and Schedule

FREQUENCY	START/END DATES	LOCATION	PARAMETERS COLLECTED	PERSONNEL AND EQUIPMENT
Every 2 weeks if consistent flow is present	March 1-Nov. 30, 2020 (Sampling can occur Mon.-Thurs. only)	All stream locations	Parameters collected that are of interest to this project include: Total phosphorus Orthophosphate Total suspended solids Nitrate + Nitrite nitrogen **Future sampling (not 2020)** Chloride *E. coli*	Des Moines County Conservation staff will collect the samples and ship them to SHL so that samples arrive at the lab within the 30 hour holding time, and SHL will analyze the samples.
			Field Parameters to be collected include: Temperature Dissolved Oxygen Flow pH	Field Parameters will be collected by Des Moines County Conservation staff, recorded on field data sheets, and sent to the Watershed Project Monitoring Coordinator
Event Sampling: 2 times during the sampling season as soon as possible after a rainfall event larger than 0.35 inches over a 24 hour period. There must be at least one week between event samples.	March 1-Nov. 30, 2020 (Sampling can occur Mon.-Thurs. only)	All stream locations	Parameters collected that are of interest to this project include: Total phosphorus Orthophosphate Total suspended solids Nitrate + Nitrite nitrogen **Future sampling (not 2020)** Chloride *E. coli*	Des Moines County Conservation staff will collect the samples and ship them to SHL so that samples arrive at the lab within the 30 hour holding time, and SHL will analyze the samples.
			Field Parameters to be collected include: Temperature Dissolved Oxygen Flow pH	Field Parameters will be collected by Des Moines County Conservation staff, recorded on field data sheets, and sent to the Watershed Project Monitoring Coordinator

5.0 Monitoring Personnel and Equipment

5.1 Sampling Personnel

Monitoring for Big Hollow Lake will be conducted as shown in the table above. Every two weeks local staff from the Des Moines County Conservation Department will collect the samples in the watershed. Sample bottles will be provided by the SHL. Samples will be collected at each of sites and immediately be put on ice. Staff will use the SHL Chain of Custody form to document time of collection. Samples will be sent via FedEx overnight to the SHL as soon as sampling is completed for analysis. Sampling will only occur between Monday and Thursday to meet SHL operating hours.

5.2 Sampling Equipment and Personnel Training

The sampling activities outlined in this monitoring plan do require Iowa DNR sampling equipment to be completed. The Iowa DNR watershed project monitoring coordinator and other Watershed Improvement Section staff will train local project staff how to collect samples and use equipment prior to the start of the sampling season and will also complete an audit of the local project staff's sampling performance early in the sampling season to ensure that samples are being collected and shipped to SHL correctly.

Bottle Orders

Iowa DNR staff will order bottles for this project at the start of the sampling season for the local project coordinator to use in the project.

6.0 Quality Assurance

Monitoring completed by the Des Moines County Conservation staff will include the following QA measures:

1. One field replicate will be collected at a randomly selected site during a sampling event once a month.
2. The field replicate will be collected at the same location and time as the regular sample and will be coded with the site ID and the tag "dup" to indicate that it is a duplicate sample.
3. The duplicate sample will be processed the same way all normal samples are processed.
4. Duplicate data will be compared by the Iowa DNR technical consultant to original samples for quality assurance compliance at the end of the sampling season.

Detailed quality assurance procedures are documented in the QAPP for the Big Hollow Lake Monitoring Project.

7.0 Field Data Collection Instructions

Des Moines County Conservation staff will collect samples in the watershed according to the training they receive by Iowa DNR staff and the Big Hollow Lake Watershed Monitoring Sampling Instructions (attached).

8.0 Transmission of Data

Data analyzed by the SHL will be made available to Iowa DNR and Des Moines County Conservation as soon as analyses are completed through OpenELIS. The Iowa DNR monitoring coordinator will then download all data at the end of each sampling season for data analysis.

9.0 Budget

Monitoring Activity:	Parameters:	Parameter and Sampling Costs:	Total:
Every 2 weeks March 1-Nov. 30, 2020 if consistent flow is present (collected by CCB staff)- 8 months (up to 20 collection trips)	Total phosphorus	$14.50 per sample x 5 samples per sampling date (= $72.5), for a maximum of 20 sampling dates (=$1,450); plus 1 duplicate once a month ($14.50), 8 times (=$116)	$1,566
	Orthophosphate	$14.50 per sample x 5 samples per sampling date (= $72.5), for a maximum of 20 sampling dates (=$1,450); plus 1 duplicate once a month ($14.50), 8 times (=$116)	$1,566
	Total suspended solids	$14.50 per sample x 5 samples per sampling date (= $72.5), for a maximum of 20 sampling dates (=$1,450); plus 1 duplicate once a month ($14.50), 8 times (=$116)	$1,566
	Nitrate + Nitrite nitrogen	$14.50 per sample x 5 samples per sampling date (= $72.5), for a maximum of 20 sampling dates (=$1,450); plus 1 duplicate once a month ($14.50), 8 times (=$116)	$1,566
Event Sampling: 2 times as soon as possible after a rainfall event >0.35 inches over a 24 hour period. March 1-Nov. 30, 2020	Total phosphorus	$14.50 per sample x 5 samples per event (= $72.5), for a maximum of 2 events	$145
	Orthophosphate	$14.50 per sample x 5 samples per event (= $72.5), for a maximum of 2 events	$145
	Total suspended solids	$14.50 per sample x 5 samples per event (= $72.5), for a maximum of 2 events	$145
	Nitrate + Nitrite nitrogen	$14.50 per sample x 5 samples per event (= $72.5), for a maximum of 2 events	$145
Shipping			$500
Sub-total:			$7,344
SHL indirects (8%):			$588
Total:			**$7,932**

10.0 References

9.1 None

11.0 Attachments (to be added)

11.1 SHL Chain of Custody (COC) Form

11.2 Big Hollow Lake Watershed Monitoring Sampling Instructions

THE UNIVERSITY OF IOWA | STATE HYGIENIC LABORATORY

ANALYTICAL REPORT

1-800-421-IOWA (4692)

Collection Location	Collector and Phone	Client Reference	Accession #
stream	rogge pat 319/759-4779	site #1 big hollow	1836188
	Collected	Received	Project
SPERRY, IA	2021-09-08 13:49	2021-09-08 16:49	

Report To	Sample Information
JAMIE STEWART DES MOINES CO SWCD 3625 FLINT RIDGE DR BURLINGTON, IA 52601	Sample Description: water sample Sample Type: Non-Drinking Water Sample Source: Sample Note(s): 1

RESULTS OF ANALYSIS - FINAL REPORT

TEST	RESULT (mg/L)	QUANT LIMIT	ANALYSIS NOTE(S)
Nitrate + Nitrite as N, LAC 10-107-04-1J			
Nitrate + Nitrite nitrogen as N	11	0.1	
ortho-Phosphate as P, LAC 10-115-01-1A			2
ortho-Phosphate as P	0.30	0.02	
Total Phosphorus as P, LAC 10-115-01-1F			
Total Phosphorus as P	0.34	0.02	
Total Suspended Solids, USGS I-3765-85			
Total Suspended Solids	18	1	

SAMPLE AND ANALYSIS NOTES

1. Upon arrival, sample met container and preservation requirements for the analysis requested. Please review carefully your sample results for additional analyte comments or method exceptions.

2. Sample was not field filtered per method and was filtered for analysis after receipt by the laboratory.

ANALYSIS INFORMATION

TEST	ANALYZED	SITE	RELEASED	ANALYSIS PREP
1. Nitrate + Nitrite as N, LAC 10-107-04-1J	2021-09-10 15:28 SLS	3201	2021-09-13 12:58 JAE	
2. ortho-Phosphate as P, LAC 10-115-01-1A	2021-09-09 11:40 MGB	3201	2021-09-14 07:50 JAE	
3. Total Phosphorus as P, LAC 10-115-01-1F	2021-09-10 09:05 MLS	3201	2021-09-10 16:18 DLS	
4. Total Suspended Solids, USGS I-3765-85	2021-09-09 09:20 KAR	3201	2021-09-10 16:31 DLS	

DESCRIPTION OF UNITS

mg/L = Milligrams per Liter

SITE(S) PERFORMING TESTING

3201 STATE HYGIENIC LABORATORY ANKENY, IOWA LABORATORIES COMPLEX, 2220 S ANKENY BLVD, ANKENY, IA 50023; Phone 515/725-1600; Fax 515/725-1642; Michael D. Schueller, M.S., Associate Director; Wade K. Aldous, Ph.D. (D)ABMM, Associate Director; IOWA ENVIRONMENTAL LAB ID #397

THE UNIVERSITY OF IOWA | STATE HYGIENIC LABORATORY

ANALYTICAL REPORT

1-800-421-IOWA (4692)

Collection Location	Collector and Phone	Client Reference	Accession #
stream	rogge pat 319/759-4779	site #3 big hollow	1836190
	Collected	**Received**	**Project**
SPERRY, IA	2021-09-08 14:52	2021-09-08 16:49	

Report To

JAMIE STEWART
DES MOINES CO SWCD

3625 FLINT RIDGE DR
BURLINGTON, IA 52601

Sample Description	water sample
Sample Type	Non-Drinking Water
Sample Source	
Sample Note(s)	1

RESULTS OF ANALYSIS - FINAL REPORT

TEST	RESULT (mg/L)	QUANT LIMIT	ANALYSIS NOTE(S)
Nitrate + Nitrite as N, LAC 10-107-04-1J			
Nitrate + Nitrite nitrogen as N	**4.8**	**0.1**	
ortho-Phosphate as P, LAC 10-115-01-1A			*2*
ortho-Phosphate as P	**0.070**	**0.02**	
Total Phosphorus as P, LAC 10-115-01-1F			
Total Phosphorus as P	**0.10**	**0.02**	
Total Suspended Solids, USGS I-3765-85			
Total Suspended Solids	**8**	**1**	

SAMPLE AND ANALYSIS NOTES

1. Upon arrival, sample met container and preservation requirements for the analysis requested. Please review carefully your sample results for additional analyte comments or method exceptions.

2. Sample was not field filtered per method and was filtered for analysis after receipt by the laboratory.

ANALYSIS INFORMATION

TEST	ANALYZED	SITE	RELEASED	ANALYSIS PREP
1. Nitrate + Nitrite as N, LAC 10-107-04-1J	2021-09-10 15:28 SLS	3201	2021-09-13 12:58 JAE	
2. ortho-Phosphate as P, LAC 10-115-01-1A	2021-09-09 11:40 MGB	3201	2021-09-14 07:50 JAE	
3. Total Phosphorus as P, LAC 10-115-01-1F	2021-09-10 09:05 MLS	3201	2021-09-10 16:18 DLS	
4. Total Suspended Solids, USGS I-3765-85	2021-09-09 09:20 KAR	3201	2021-09-10 16:31 DLS	

DESCRIPTION OF UNITS

mg/L = Milligrams per Liter

SITE(S) PERFORMING TESTING

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THE UNIVERSITY OF IOWA | STATE HYGIENIC LABORATORY

ANALYTICAL REPORT 1-800-421-IOWA (4692)

Collection Location	Collector and Phone	Client Reference	Accession #
site #4 stream	rogge pat 319/759-4779	site #4	1836191
	Collected	Received	Project
SPERRY, IA	2021-09-08 15:02	2021-09-08 16:49	

Report To	
JAMIE STEWART DES MOINES CO SWCD 3625 FLINT RIDGE DR BURLINGTON, IA 52601	**Sample Description** water sample **Sample Type** Non-Drinking Water **Sample Source** **Sample Note(s)** 1

RESULTS OF ANALYSIS - FINAL REPORT

TEST	RESULT (mg/L)	QUANT LIMIT	ANALYSIS NOTE(S)
Nitrate + Nitrite as N, LAC 10-107-04-1J			
Nitrate + Nitrite nitrogen as N	**1.3**	**0.1**	
ortho-Phosphate as P, LAC 10-115-01-1A			*2*
ortho-Phosphate as P	**<0.020**	**0.02**	
Total Phosphorus as P, LAC 10-115-01-1F			
Total Phosphorus as P	**0.34**	**0.02**	
Total Suspended Solids, USGS I-3765-85			
Total Suspended Solids	**26**	**1**	

SAMPLE AND ANALYSIS NOTES

1. Upon arrival, sample met container and preservation requirements for the analysis requested. Please review carefully your sample results for additional analyte comments or method exceptions.

2. Sample was not field filtered per method and was filtered for analysis after receipt by the laboratory.

ANALYSIS INFORMATION

TEST	ANALYZED	SITE	RELEASED	ANALYSIS PREP
1. Nitrate + Nitrite as N, LAC 10-107-04-1J	2021-09-10 15:28 SLS	3201	2021-09-13 12:58 JAE	
2. ortho-Phosphate as P, LAC 10-115-01-1A	2021-09-09 11:41 MGB	3201	2021-09-14 07:50 JAE	
3. Total Phosphorus as P, LAC 10-115-01-1F	2021-09-10 09:05 MLS	3201	2021-09-10 16:18 DLS	
4. Total Suspended Solids, USGS I-3765-85	2021-09-09 09:20 KAR	3201	2021-09-10 16:31 DLS	

DESCRIPTION OF UNITS

mg/L = Milligrams per Liter

SITE(S) PERFORMING TESTING

3201 STATE HYGIENIC LABORATORY ANKENY, IOWA LABORATORIES COMPLEX, 2220 S ANKENY BLVD, ANKENY, IA 50023; Phone 515/725-1600; Fax 515/725-1642; Michael D. Schueller, M.S., Associate Director; Wade K. Aldous, Ph.D. (D)ABMM, Associate Director; IOWA ENVIRONMENTAL LAB ID #397

The result(s) of this report relate only to the items analyzed. Where the laboratory has not been responsible for the sampling stage the results apply only to the sample as received. This report shall not be reproduced except in full without the written approval of the laboratory. If you have any questions, please call Client Services at 800/421-IOWA (4692) or 319/335-4500.

THE UNIVERSITY OF IOWA | STATE HYGIENIC LABORATORY

ANALYTICAL REPORT

1-800-421-IOWA (4692)

Collection Location	Collector and Phone	Client Reference	Accession #
stream	rogge pat 319/759-4779	site 5 big hollow	1836192
SPERRY, IA	**Collected** 2021-09-08 15:08	**Received** 2021-09-08 16:49	**Project**

Report To	
JAMIE STEWART DES MOINES CO SWCD 3625 FLINT RIDGE DR BURLINGTON, IA 52601	**Sample Description** water sample **Sample Type** Non-Drinking Water **Sample Source** **Sample Note(s)** 1

RESULTS OF ANALYSIS - FINAL REPORT

TEST	RESULT (mg/L)	QUANT LIMIT	ANALYSIS NOTE(S)
Nitrate + Nitrite as N, LAC 10-107-04-1J			
Nitrate + Nitrite nitrogen as N	**3.7**	**0.1**	
ortho-Phosphate as P, LAC 10-115-01-1A			*2*
ortho-Phosphate as P	**0.090**	**0.02**	
Total Phosphorus as P, LAC 10-115-01-1F			
Total Phosphorus as P	**0.16**	**0.02**	
Total Suspended Solids, USGS I-3765-85			
Total Suspended Solids	**7**	**1**	

SAMPLE AND ANALYSIS NOTES

1. Upon arrival, sample met container and preservation requirements for the analysis requested. Please review carefully your sample results for additional analyte comments or method exceptions.

2. Sample was not field filtered per method and was filtered for analysis after receipt by the laboratory.

ANALYSIS INFORMATION

TEST	ANALYZED	SITE	RELEASED	ANALYSIS PREP
1. Nitrate + Nitrite as N, LAC 10-107-04-1J	2021-09-10 15:28 SLS	3201	2021-09-13 12:58 JAE	
2. ortho-Phosphate as P, LAC 10-115-01-1A	2021-09-09 11:46 MGB	3201	2021-09-14 07:50 JAE	
3. Total Phosphorus as P, LAC 10-115-01-1F	2021-09-10 09:05 MLS	3201	2021-09-10 16:18 DLS	
4. Total Suspended Solids, USGS I-3765-85	2021-09-09 09:20 KAR	3201	2021-09-10 16:31 DLS	

DESCRIPTION OF UNITS

mg/L = Milligrams per Liter

SITE(S) PERFORMING TESTING

3201 STATE HYGIENIC LABORATORY ANKENY, IOWA LABORATORIES COMPLEX, 2220 S ANKENY BLVD, ANKENY, IA 50023; Phone 515/725-1600; Fax 515/725-1642; Michael D. Schueller, M.S., Associate Director; Wade K. Aldous, Ph.D. (D)ABMM, Associate Director; IOWA ENVIRONMENTAL LAB ID #397

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APPENDIX F – BIG HOLLOW WATERSHED MANAGEMENT PLAN EVAULATION FORM

Evaluator:________________________

Date:_____________________________

- Goal 1: Develop and implement an effective Watershed Management Plan (WMP)
  - Objectives
    - Connect the WMP to the TMDL and identify and quantify pollutant sources and loads and required reductions
    - Connect the WMP to feedback obtained through a proactive stakeholder engagement process to ensure plan is community-driven
    - Ensure WMP includes and addresses all nine required WMP elements for EPA Section 319 funding eligibility

List of accomplishments and achievements advancing progress towards this goal:___________________

____

____

- Goal 2: Enhance public and stakeholder awareness of Big Hollow Lake and its watershed
  - Objectives
    - Educate Big Hollow Recreation Area visitors about the connection between lake water quality and recreational opportunities
    - Educate watershed residents and agricultural landowners about the connection between land management and lake water quality

List of accomplishments and achievements advancing progress towards this goal:___________________

____

____

- Goal 3: Improve water quality of Big Hollow Lake by implementing watershed and in-lake improvement alternatives
  - Objectives
    - Increase water clarity and reducing nuisance algal blooms and the dense growth of other aquatic vegetation.
    - Achieve removal of Big Hollow Lake from the State of Iowa's impaired waters list.
    - Reduce sediment and nutrient transport to Big Hollow Lake

List of accomplishments and achievements advancing progress towards this goal:___________________

Other:

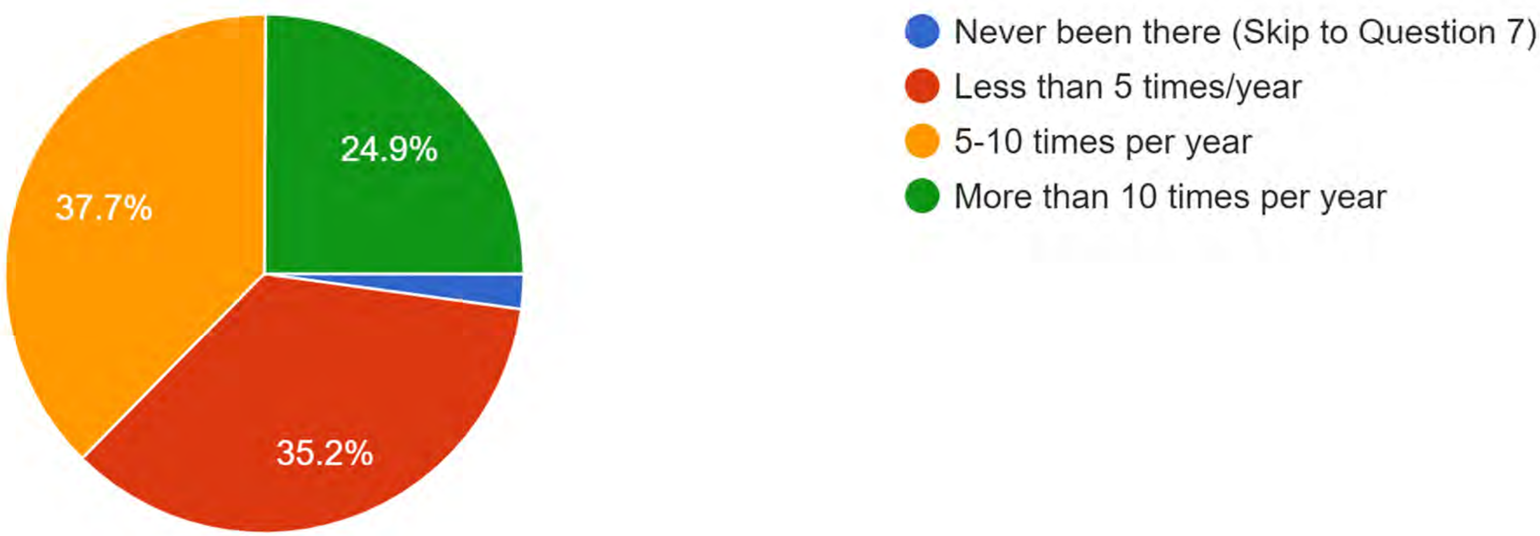
APPENDIX G – INFORMATION & EDUCATION MATERIALS

Public/Stakeholder Feedback

SURVEY RESULTS

2. How often do you normally visit Big Hollow Recreation Area annually?

321 responses



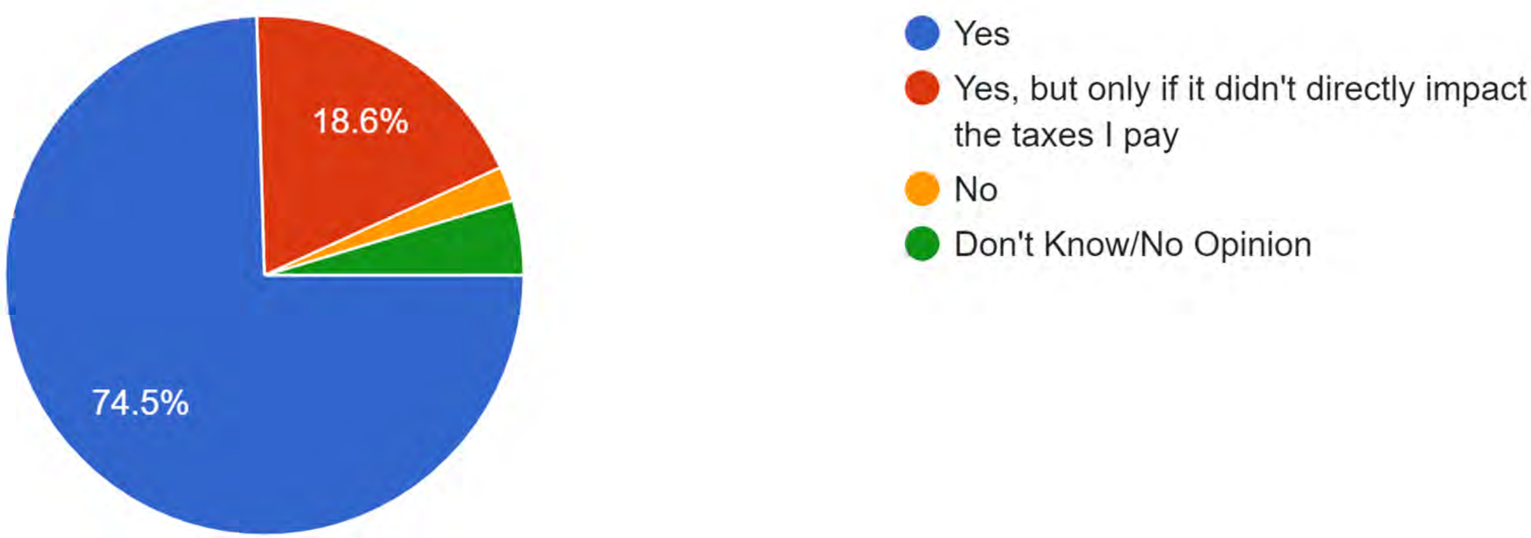
FYRA ENGINEERING

Public/Stakeholder Feedback

SURVEY RESULTS

10. Would you support additional government funding to improve the water quality at Big Hollow Lake?

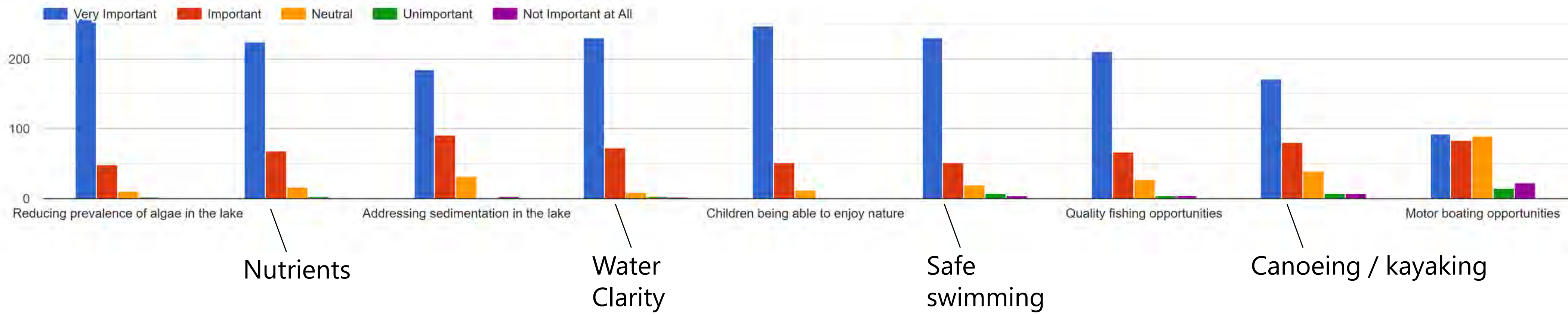
322 responses



Public/Stakeholder Feedback

SURVEY RESULTS

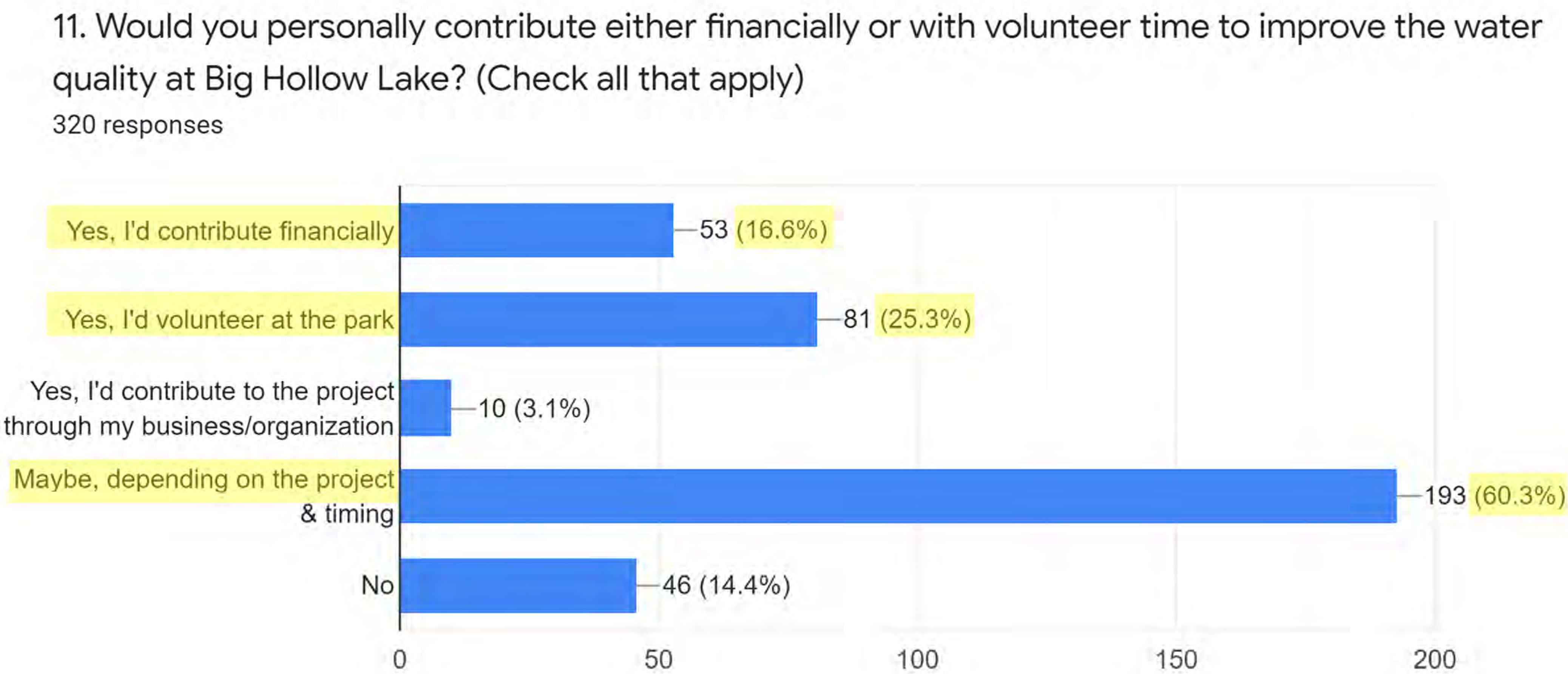
7. Regarding Big Hollow Recreation Area, please indicate how important the following issues are to you.



FYRA ENGINEERING

Public/Stakeholder Feedback

SURVEY RESULTS

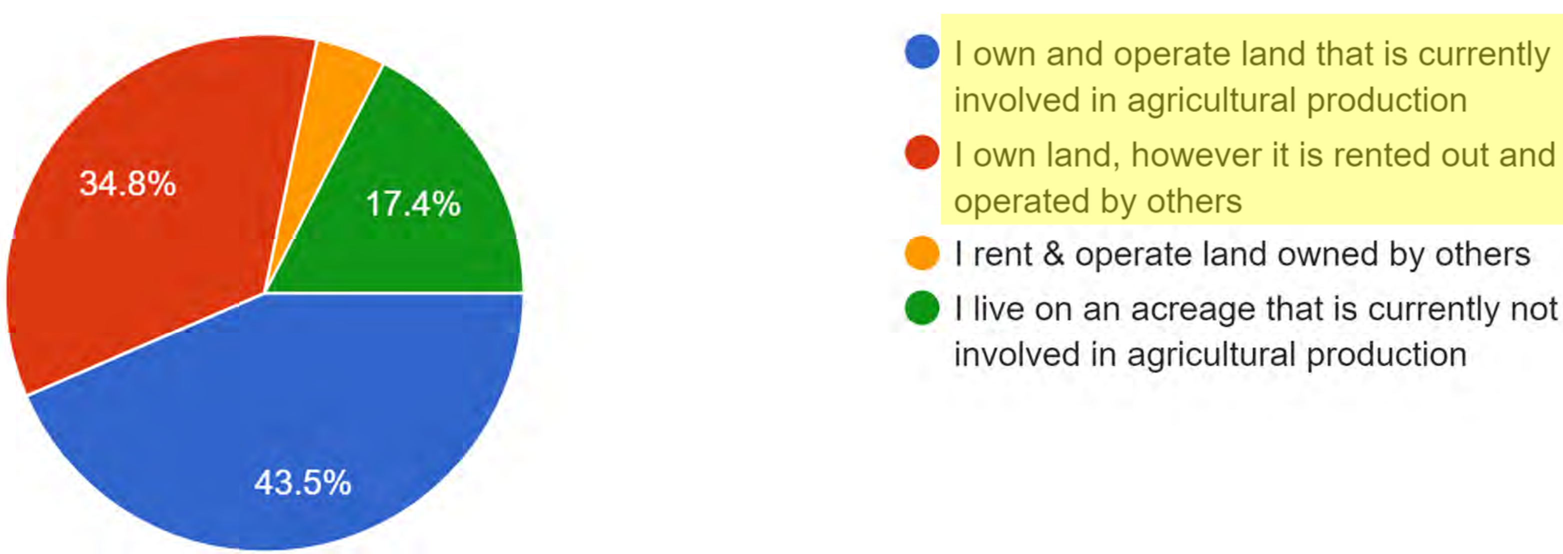


Landowner Feedback

SURVEY RESULTS

1a: To assist us to better understand your point-of-view, values, etc. please indicate which of the following best represents your role within this watershed:

23 responses

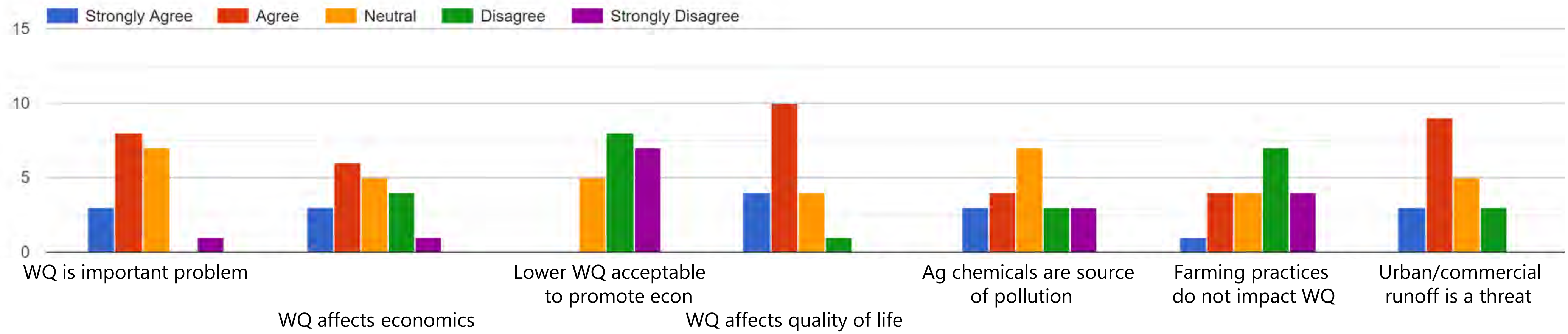


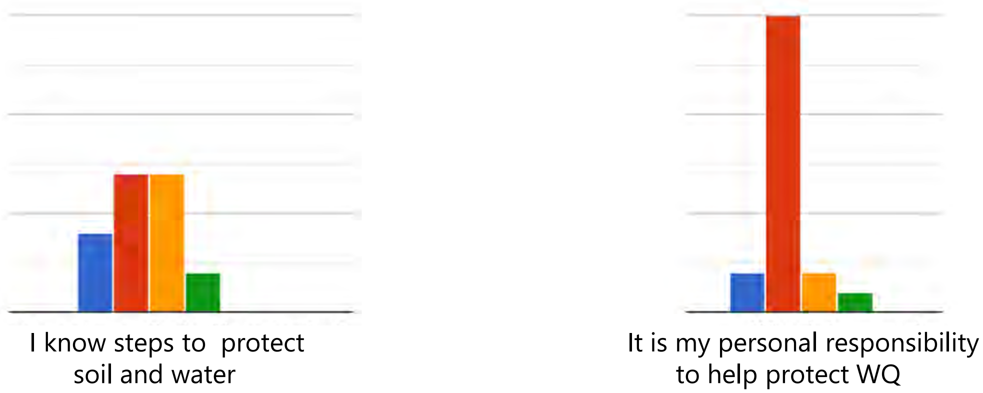
FYRA ENGINEERING

Landowner Feedback

SURVEY RESULTS

3: In order to assist us in better understand the values/opinions of those living/working in the watersheds, please check your level of agreement or disagreement.

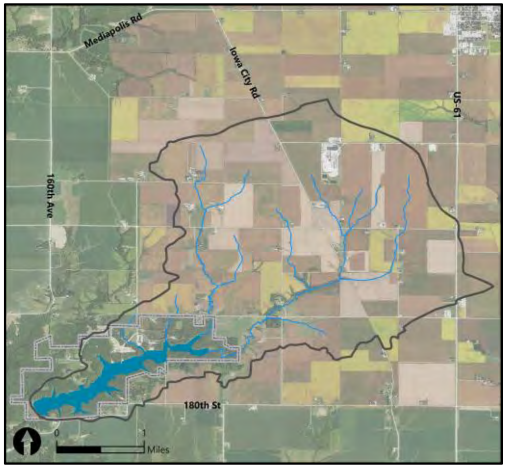




FYRA ENGINEERING

Thank you for your interest in the Big Hollow Lake Management Plan. The overall goals of this project include improving and protecting the watershed and water quality in and around Big Hollow Lake for future generations. This summary describes the project and answers some frequently-asked questions. Please submit your questions or comments to Chris Lee by emailing him at **leec@dmcounty.com**.

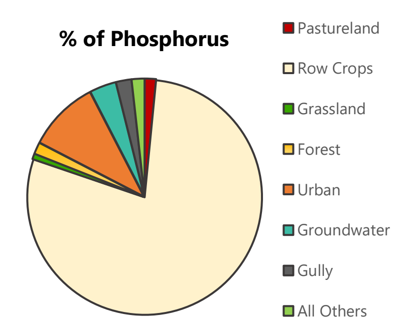
Project Summary The Big Hollow Lake Management Plan is a cooperative effort between Des Moines County Soil and Water Conservation District, Des Moines County Conservation Board, NRCS, IDALS, and Iowa DNR. The project includes development of an EPA 9-Element watershed management plan and assessment/planning for the watershed. The watershed management plan will include watershed characteristics, assessment of issues, goals/objectives, next actions, and an implementation plan.



Project Background The Big Hollow Watershed consists of 4,600 acres that outlet to Big Hollow Lake. Big Hollow Lake is a 154-acre lake that is owned and operated by Des Moines County Conservation. The lake is currently impaired for algae due to phosphorus and pH.

Who is funding this project? Funding for this effort is provided by EPA Section 319 funding through the DNR, as well as support from IDALS and the Des Moines County SWCD.

What is wrong with Big Hollow Lake? Big Hollow Lake is impaired for not supporting its primary contact recreation designation use. The impairment is due to increased levels of algae and pH, which are caused by an over abundance of nutrients and sediment, especially sediment-bound phosphorus. The DNR developed a Total Maximum Daily Load (TMDL) for Big Hollow Lake. The TMDL outlines current conditions, a reduction target, and pollution sources. An overall reduction of 61% of the total phosphorus load is required to meet the TMDL.



What is the project schedule? The first phase of this project is completing the watershed management plan by December 2021. There will be an implementation schedule in the plan that lays out the next 5, 10, and 20 year goals for implementation of the watershed BMPs.

How to Learn More about the Project

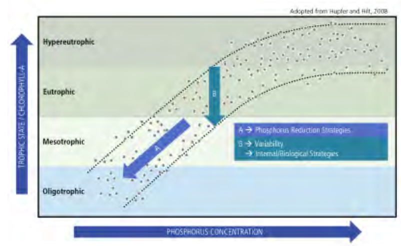
Chris Lee, Executive Director
Des Moines County Conservation
319.753.8260

The presentation will be available for later viewing at the link below:
www.DMCconservation.com

Project Background

What is a Watershed? A watershed is the area of land that drains water from rain events to the lake. Big Hollow Lake's watershed includes surrounding farm ground, homesteads, roadways, pasture, and parkland surrounding the lake.

How do nutrients affect Big Hollow Lake?
Nutrients such as nitrogen and phosphorus cause aquatic plants to grow in streams and lakes (much like your yard or corn field). Too many nutrients can lead to algal blooms, which impair water quality. Phosphorus is the nutrient primarily responsible for excessive algal growth in Big Hollow Lake.



What is a Watershed Best Management Practice (BMP)? A watershed BMP is a management practice designed to prevent sediment and/or nutrient transport to a lake or stream. Examples of BMPs being utilized for restoration of Big Hollow Lake include sediment basins, buffer strips, cover crops, terraces, and grassed waterways.