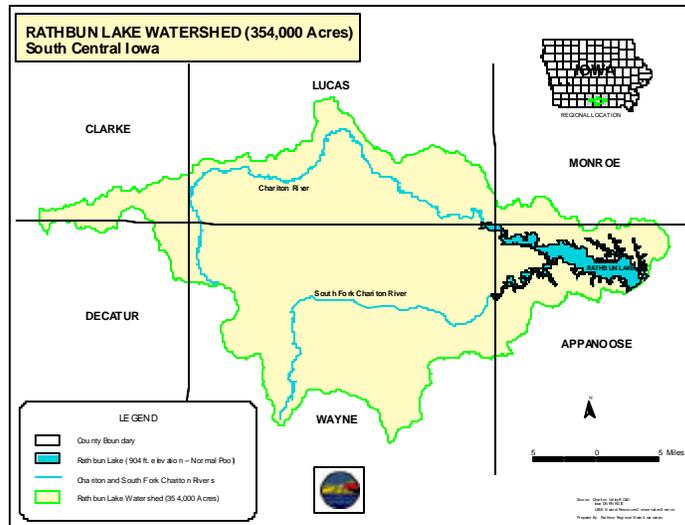


Assessment and Management Strategies for the Rathbun Lake Watershed



A COOPERATIVE EFFORT BY THE MEMBERS AND PARTNERS OF THE
RATHBUN LAND AND WATER ALLIANCE



DECEMBER 2001

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SECTION I CONTD.

Project Cooperators

The assessment and management strategies for the Rathbun Lake watershed have been a cooperative effort by members and partners of the Rathbun Land and Water Alliance.

Alliance members include:

- *Rathbun Regional Water Association, Inc.*
- *Appanoose, Clarke, Decatur, Lucas, Monroe, and Wayne Soil and Water Conservation Districts*
- *Appanoose, Clarke, Decatur, Lucas, Monroe, and Wayne Counties*
- *Chariton Valley Resource Conservation and Development, Inc.*

Alliance partners include:

- *City of Corydon*
- *Iowa Farm Bureau Federation*
- *ADLM Counties Environmental Health*
- *Leopold Center for Sustainable Agriculture*
- *Iowa Association of Water Agencies*
- *Trees Forever*
- *Iowa State University*
- *Texas Tech University*
- *Iowa Department of Agriculture and Land Stewardship's Division of Soil Conservation*
- *Iowa Department of Natural Resources*
- *Iowa Department of Economic Development*
- *Southern Iowa Development and Conservation Authority*
- *US Army Corps of Engineers*



Alliance members and partners discuss findings of the assessment.

- *USDA Natural Resources Conservation Service*
- *USDA Farm Service Agency*
- *USDA Rural Development*
- *US Department of Energy*
- *US Environmental Protection Agency*
- *US Geological Survey*

Alliance members and partners that contributed funds and technical assistance to perform the assessment and develop management strategies included:

- *Rathbun Regional Water Association, Inc.*
- *Appanoose, Clarke, Decatur, Lucas, Monroe, and Wayne Soil and Water Conservation Districts*
- *Iowa State University*
- *Iowa Department of Agriculture and Land Stewardship's Division of Soil Conservation*
- *Iowa Department of Natural Resources*
- *US Army Corps of Engineers*
- *USDA Natural Resources Conservation Service*
- *US Department of Energy (DE-FC36-96GO10148)*
- *US Environmental Protection Agency (CP99758401)*

The assessment and management strategies document was assembled for the Alliance by:

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For additional copies, revisions, and information contact these individuals.

Assistance from the Rathbun Land and Water Alliance is provided on a nondiscriminatory basis. The information in this document has been subjected to the US EPA's peer and administrative review process and has been approved for publication as an EPA document. Support provided by the US DOE does not constitute an endorsement of views expressed in this document.

SECTION II

SECTION II INTRODUCTION

Purpose of the Assessment and Management Strategies for the Rathbun Lake Watershed

The Rathbun Land and Water Alliance's mission is to foster a voluntary approach driven by landowners, water users, and public and private organizations to protect and enhance land, water, and economic resources in the Rathbun Lake region. The assessment and management strategies for the Rathbun Lake watershed provide the Alliance the knowledge and direction needed to assemble the financial and technical resources required to accomplish this mission.

Rathbun Lake is the water supply for the Rathbun Regional Water Association (RRWA). RRWA is the largest rural water system in Iowa. Rathbun Lake also provides recreation, flood damage reduction, fish and wildlife habitat, downstream water quality improvement, storage for supplementing navigational flows, and water for the Iowa Department of Natural Resources' (DNR) Rathbun Fish Hatchery.

Rathbun Lake's ability to support these uses is threatened by sources of water pollution in its watershed. This pollution is caused by eroded soil, nutrients, pesticides, and bacteria. The assessment for Rathbun Lake identifies and prioritizes potential sources of pollution in the lake's watershed. Assessment results have been used to develop management strategies for the watershed that will reduce and prevent water pollution from these potential sources.

The assessment identifies and prioritizes potential sources of water pollution in Rathbun Lake.

State of Iowa's Source Water Assessment and Protection Program

The assessment and management strategies are intended to fulfill requirements of the Source Water Assessment and Protection Program and Implementation Strategy for the State of Iowa. The Source Water Assessment and Protection Program and Implementation Strategy was prepared by the Iowa DNR to address the 1996 Safe Drinking Water Act Amendments' requirements for source water delineation and assessment (P.L. 104-182, Section 1453).

Sections of the Assessment and Management Strategies

The assessment and management strategies for the Rathbun Lake watershed consists of the following sections:

Background on Rathbun Lake and watershed: Information has been assembled that describes the general features of Rathbun Lake and its importance as a drinking water supply, characteristics of the lake's watershed, water quality issues in the lake, and water quality protection efforts underway.

Delineation of the Rathbun Lake watershed: The boundaries of the entire watershed of Rathbun Lake have been identified as well as the boundaries of sub-watersheds and other priority areas such as buffer zones that were used to perform the assessment.

Inventory of potential contaminant sources in the Rathbun Lake watershed: An inventory has been completed to identify all potential sources of contaminants such as sediment, nutrients, chemicals, and bacteria that could cause water pollution in Rathbun Lake.

Analysis of the susceptibility of Rathbun Lake to potential contaminant sources: The potential sources of contaminants have been evaluated and prioritized based on such factors as location in the watershed and type of contaminant source to reflect the relative risk of these sources to cause water pollution in Rathbun Lake.

Management strategies for the Rathbun Lake watershed: Alternative strategies have been developed for reducing and preventing water pollution in Rathbun Lake from potential sources of contaminants in the watershed.

Assessment results have been used to develop management strategies that will reduce and prevent water pollution in Rathbun Lake.

SECTION III

SECTION III BACKGROUND ON RATHBUN LAKE AND WATERSHED

Rathbun Lake

Rathbun Lake is the primary source of water for the Rathbun Regional Water Association (RRWA). In addition to being an important source of drinking water, the 11,000 acre lake provides recreational opportunities for one million visitors annually, flood damage reduction for 150,000 acres of downstream land, and fish and wildlife habitat in the lake and on 21,000 acres of adjacent public land. Rathbun Lake also provides downstream water quality improvement, storage for supplementing navigational flows, and water for the Iowa Department of Natural Resources' (DNR) Rathbun Fish Hatchery.



Rathbun Lake provides recreation for one million visitors annually. (Photo courtesy ACOE)

Rathbun Lake is located on the Chariton River in south central Iowa. Figures 1 and 2 at the end of this section identify the location of Rathbun Lake and its watershed. Rathbun Lake was developed in the late 1960s by the US Army Corps of Engineers (ACOE). The ACOE is responsible for managing Rathbun Lake, associated lake facilities, and adjacent public land. The Iowa DNR has designated the segment of the Chariton River on which Rathbun Lake is located a high quality resource water that warrants special protection.

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Rathbun Regional Water Association (RRWA)

RRWA is one of the largest rural water systems in the United States and the largest system in Iowa. RRWA provides close to six million gallons of water daily to over 60,000 people for residential, agricultural, and business use in 18 counties and more than 40 communities in Iowa and Missouri. Figure 3 at the end of this section identifies the service area of RRWA.

RRWA is one of the largest rural water systems in the United States and the largest system in Iowa.

RRWA's water treatment plant draws raw water from the Chariton River directly below Rathbun Lake. RRWA has expanded its water treatment plant capacity to over eight million gallons per day in response to continued growth in the demand for water. In addition to the water treatment plant, the RRWA system currently consists of nearly 6,500 miles of pipeline, 30 elevated storage tanks, and 33 pumping stations.



RRWA water treatment plant located downstream of Rathbun Lake. (Photo courtesy RRWA)

SECTION III CONTD.

Watershed Characteristics

Land use: The Rathbun Lake watershed consists of over 354,000 acres. Row crop production is the principal land use in the watershed. Corn and soybeans are the most commonly grown crops. Pasture and hayland are present on over one third of the land in the watershed and consist primarily of cool season grasses. Woodland in the watershed is concentrated along upland drainageways and in lowland areas and usually includes stands of oak, hickory, eastern cottonwood, and silver maple. Table 1 presents land use information for the Rathbun Lake watershed.

The counties in the Rathbun Lake watershed are among the least prosperous in Iowa. These counties suffer some of the highest poverty and unemployment rates and lowest levels of income and farm sales in the state. Approximately 15,000 people live in the Rathbun Lake watershed. There are nine communities and an estimated 857 farms in the watershed. The majority of farms are family owned and operated. Almost all of the residents in the watershed rely on Rathbun Lake for their drinking water.

Table 1. Land Use in the Rathbun Lake Watershed

	Cropland	Cropland in the Conservation Reserve Program	Pasture and Hayland	Woodland	Other (Urban, Water, Road, etc.)
Percent of Watershed	30	12	38	13	7
Acres	106,910	40,985	135,685	44,183	26,297

Approximately 468 livestock operations are located in the watershed. The majority of these are beef cattle operations that rely primarily on pasture for grazing. There are 13 publicly owned areas in the watershed consisting of over 24,000 acres. Most notable in terms of size are the Rathbun Lake Project Area, Honey Creek State Park, Colyn Marsh Area, Bobwhite State Park, and Lucas County Greenbelt Complex.

Demographics: The six counties in the Rathbun Lake watershed include Appanoose (52,063 acres, 15 percent of the watershed), Clarke (15,500 acres, four percent of the watershed), Decatur (7,280 acres, two percent of the watershed), Lucas (90,997 acres, 26 percent of the watershed), Monroe (6,523 acres, two percent of the watershed) and Wayne (181,697 acres, 51 percent of the watershed).

Counties in the Rathbun Lake watershed suffer from some of the highest poverty and unemployment rates and lowest levels of income and farm sales in Iowa.

Geology, soils, and climate: The landscape in the Rathbun Lake watershed is characterized by rolling uplands, integrated drainage, and occasional broad alluvial plains. Most soils in the watershed formed in loess, glacial till, or alluvium. A few of the soils formed in colluvium, eolian sand, or shale residuum. The majority of soils in the Rathbun Lake watershed have characteristics that limit their potential uses. This limitation arises from a prevalence of soils that are highly erosive, shallow to root-restrictive zones, excessively wet, and inherently low in fertility. Table 2 on the following page presents general information about some of the more common soils in the Rathbun Lake watershed.

The climate in south central Iowa and the Rathbun Lake watershed is classified as humid continental. Winters are cold and summers are quite hot. In winter the average temperature is 27 degrees Fahrenheit. In summer the average temperature is 73 degrees Fahrenheit. Total annual precipitation averages 35 inches of which nearly 70 percent usually falls in April through September. The average seasonal snowfall is 27 inches. The average length of a growing season is 160 days.

SECTION III CONTD.

Table 2. Common Soils in the Rathbun Lake Watershed

Soil	Percent of Watershed	Slope	Land Capability Class	Corn Suitability Rating
Adair	5%	5 - 14%	IIIe and IVe	5 to 35
Arispe	5%	5 - 9%	IIIe	50 to 55
Armstrong	2%	5 - 14%	IIIe and IVe	5 to 31
Clarinda	11%	5 - 14%	IVe	10 to 30
Edina	5%	0 - 2%	IIIw	60
Gara	5%	9 - 25%	IVe and VIe	5 to 43
Grundy	8%	2 - 9%	IIe and IIIe	50 to 75
Haig	3%	0 - 2%	IIw	70
Lamoni	5%	5 - 14%	IIIe, IVe, and VIe	5 to 35
Olmitz	1%	5 - 9%	IIIe	57 to 72
Pershing	2%	5 - 14%	IIIe and IVe	31 to 67
Seymour	9%	2 - 9%	IIIe	35 to 60
Shelby	9%	9 - 18%	IIIe, IVe, and VIe	13 to 50
Vesser	1%	0 - 2%	IIw	66 to 71

Water Quality Issues

Available sources of information indicate that Rathbun Lake is being impacted by sources of water pollution in the lake's watershed:

Iowa DNR assessment for Rathbun Lake: The Iowa DNR's assessment of lakes and streams has determined that Rathbun Lake and water bodies in its watershed, such as the Chariton River, Bob White Lake, Corydon Reservoir, and Honey Creek, are impacted by agricultural non-point sources of pollution. The assessment indicates that the ability of Rathbun Lake and these waters to be used for recreation, habitat, and drinking water is either threatened, partially supported, or not supported. Primary causes of this impairment include sediment accumulation, turbidity, pesticides, bacteria, and nutrients.

Rathbun Lake water quality monitoring program: Results of water quality monitoring in Rathbun Lake and its tributaries indicate that high to very high levels of nutrients, suspended solids, herbicides, and bacteria impact the lake's water supply, recreational, and habitat uses. A review of the monitoring results by the ACOE and Iowa State University (ISU) indicates that Rathbun Lake could reach a point at which it is unable to assimilate continued loading of silt, nutrients, and pesticides unless there is a reduction in sediment, herbicide, and fertilizer in runoff from the watershed.

Water quality monitoring indicates that Rathbun Lake could reach a point at which it is unable to assimilate continued loading of silt, nutrients, and pesticides unless there is a reduction in sediment, herbicide, and fertilizer in runoff from the watershed.

Sediment studies in Rathbun Lake: Sediment studies conducted by the ACOE indicate that Rathbun Lake has lost a considerable portion of its sediment storage capacity. According to the studies, soil erosion on land in the watershed and erosion of the lake's shoreline have caused sedimentation to occur in Rathbun Lake at a rate that is faster than that anticipated and used for the original sediment storage allocation. The ACOE estimates that this continued rate of loss in sediment storage could require a reallocation of the lake's remaining capacity. A reallocation of Rathbun Lake's storage capacity due to sedimentation may have detrimental impacts on the lake's ability to support its many uses including water supply, recreation, wildlife habitat, and flood protection.

SECTION III CONTD.

US EPA Section 303(d) List of Impaired Waters in Iowa: Rathbun Lake has been identified as a high priority water body on the US Environmental Protection Agency's (EPA) Section 303(d) List of Impaired Waters in Iowa. According to the EPA, Rathbun Lake is on the impaired waters list primarily due to information indicating that levels of the herbicide atrazine in the lake exceed water quality standards. Water resources located in the Rathbun Lake watershed that are also included on the EPA Section 303(d) list include Bob White Lake, Corydon Reservoir, Brown's Slough, and Colyn Marsh. Pollutants of greatest concern in these waters include sediment, nutrients, and atrazine.

Water Quality Protection Efforts

Local residents, city and county governments, and private organizations have been joined by public agencies at the state and federal levels to initiate efforts that will protect and improve water quality in Rathbun Lake. Water quality protection efforts underway include:

- *Creation and support of the Rathbun Land and Water Alliance.*
- *Water quality monitoring program.*



Water quality monitoring on a tributary stream that flows into Rathbun Lake. (Photo courtesy NRCS)

- *Surveys of landowners in the watershed and water users in the RRWA service area.*
- *Development of a geographic information system for the watershed.*
- *Best management practice demonstration projects.*
- *Application of best management practices in priority areas.*



Installation of a terrace system on cropland in the Rathbun Lake watershed.

- *Construction of community wastewater treatment facilities.*
- *Restoration of riparian and wetland habitat.*
- *Development of markets for farm products that encourage land use protective of water quality.*
- *Water quality information and education activities.*

Fact sheets that describe current efforts to protect water quality in Rathbun Lake are included in Appendix A.

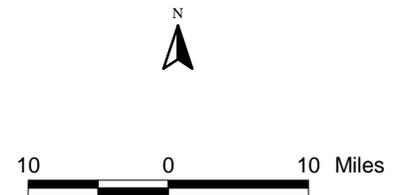
**UPPER CHARITON HU #10280201 (870,133 Acres)
RATHBUN LAKE WATERSHED (354,000 Acres)**

Figure 1



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-  Rathbun Lake Watershed (354000 Acres)
-  Upper Chariton River Watershed (HU #10280201) (870133 Acres)



Source: Chariton Valley RC&D
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
ESRI Data and Maps Aug. 1999
US EPA

Prepared By: Rathbun Regional Water Association

RATHBUN LAKE WATERSHED (354,000 Acres) South Central Iowa

Figure 2

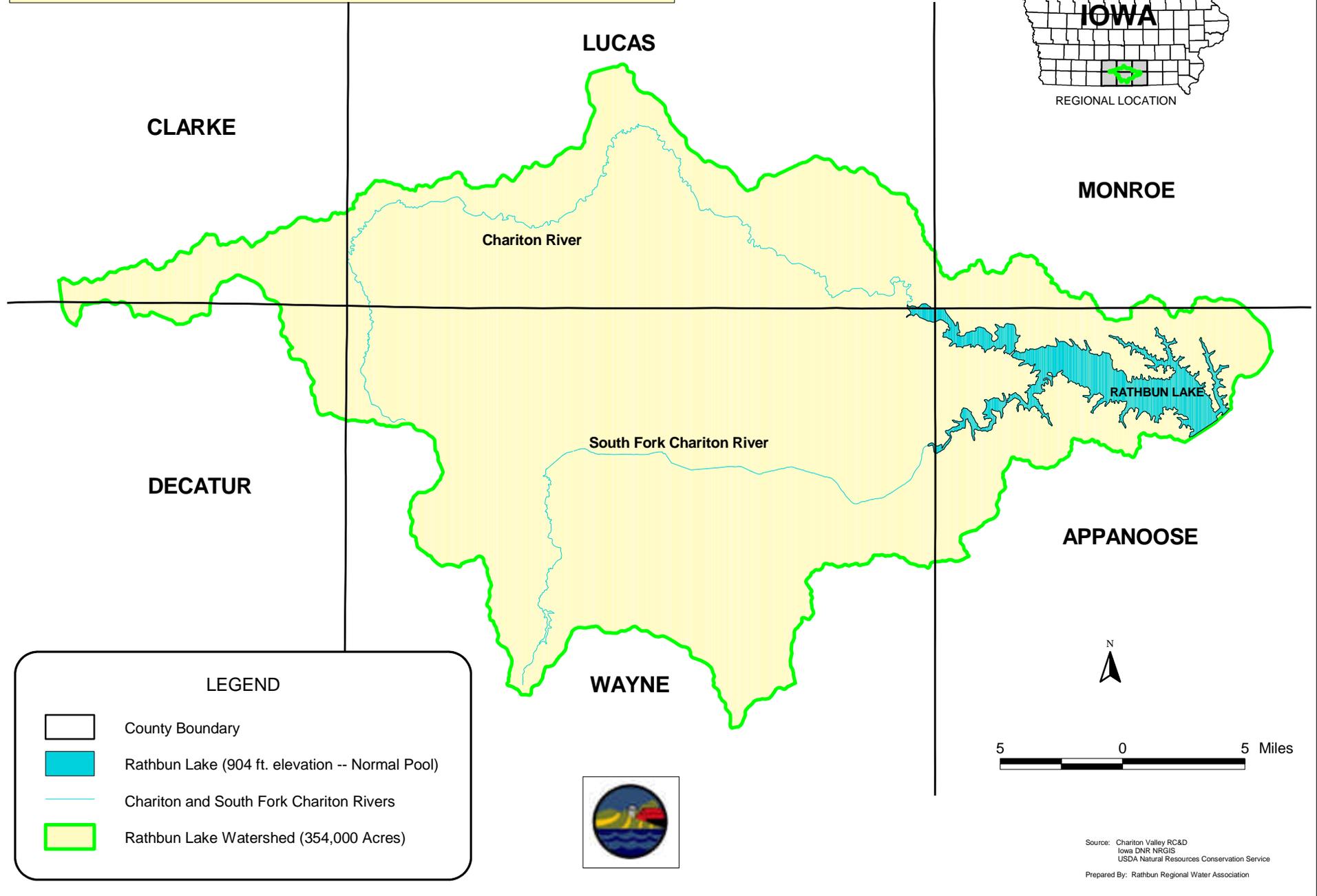
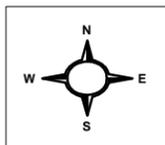


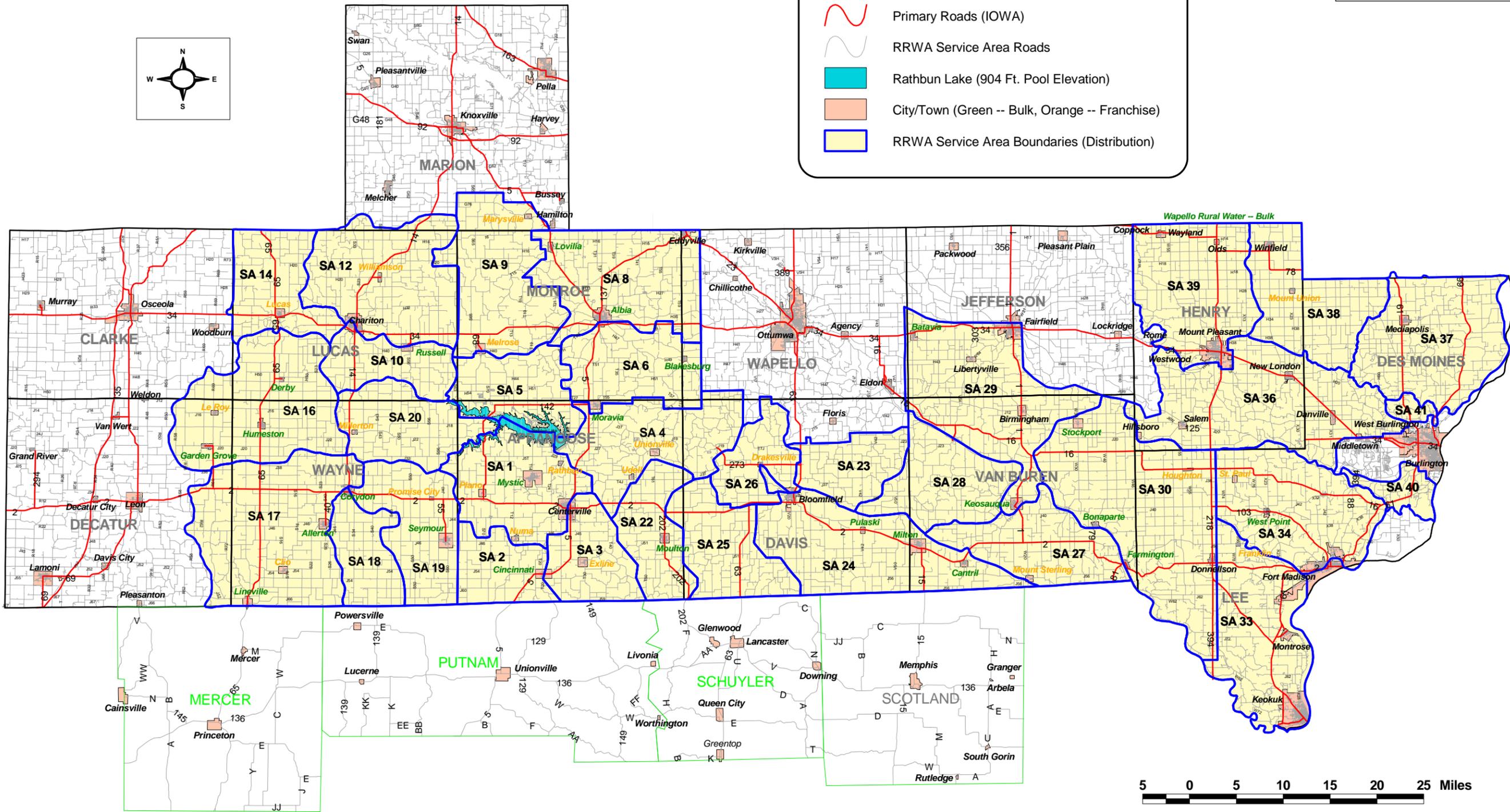
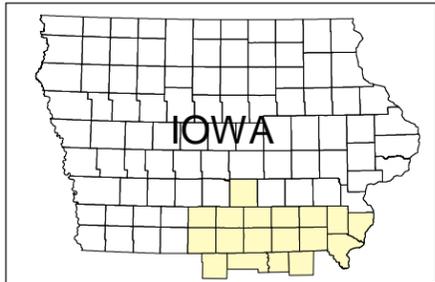
Figure 3

RATHBUN REGIONAL WATER ASSOCIATION Service Area Map



LEGEND

- RRWA Service Area Counties
- IOWA (White box)
- MISSOURI (Bulk or Potential Service) (Green outline)
- Primary Roads (IOWA) (Red line)
- RRWA Service Area Roads (Blue line)
- Rathbun Lake (904 Ft. Pool Elevation) (Cyan area)
- City/Town (Green -- Bulk, Orange -- Franchise) (Colored squares)
- RRWA Service Area Boundaries (Distribution) (Blue outline)



Source:
Rathbun Regional Water Association
Iowa DNR NRGIS, Iowa DOT CAD
ESRI Data and Maps, Aug. 99 Ed.

RATHBUN REGIONAL WATER ASSOCIATION
Prepared By: Tyler J. Jacobsen, RRWA
6/26/2001



SECTION IV

SECTION IV DELINEATION OF THE RATHBUN LAKE WATERSHED

The boundaries of the watershed of Rathbun Lake have been identified. The Rathbun Lake watershed has also been divided into 61 sub-watersheds. In addition, areas of special interest in the watershed have been identified. These areas include a buffer zone that is approximately one-quarter mile wide located next to Rathbun Lake and the rivers and streams in the watershed. Activities in the buffer zone have a relatively high potential to impact water quality due to their location next to rivers, streams, and the lake. The area of the watershed from which water in the rivers and streams flows into Rathbun Lake in 24 hours or less under average flow conditions has also been identified. This area provides an indication of the length of time that would be required for contaminants carried in water from the watershed to reach the lake.

The sub-watersheds, buffer zone area, and 24-hour time of travel area identified in the Rathbun Lake watershed have been used in this assessment to locate, evaluate, and prioritize potential sources of contaminants that could cause water pollution in the lake. These areas have also been used to develop management strategies to reduce and prevent water pollution in Rathbun Lake from potential sources of contaminants in the watershed.

The sub-watersheds, buffer zone, and time of travel area have been used to prioritize potential sources of contaminants in the watershed...and develop management strategies to reduce and prevent water pollution in Rathbun Lake from these sources.

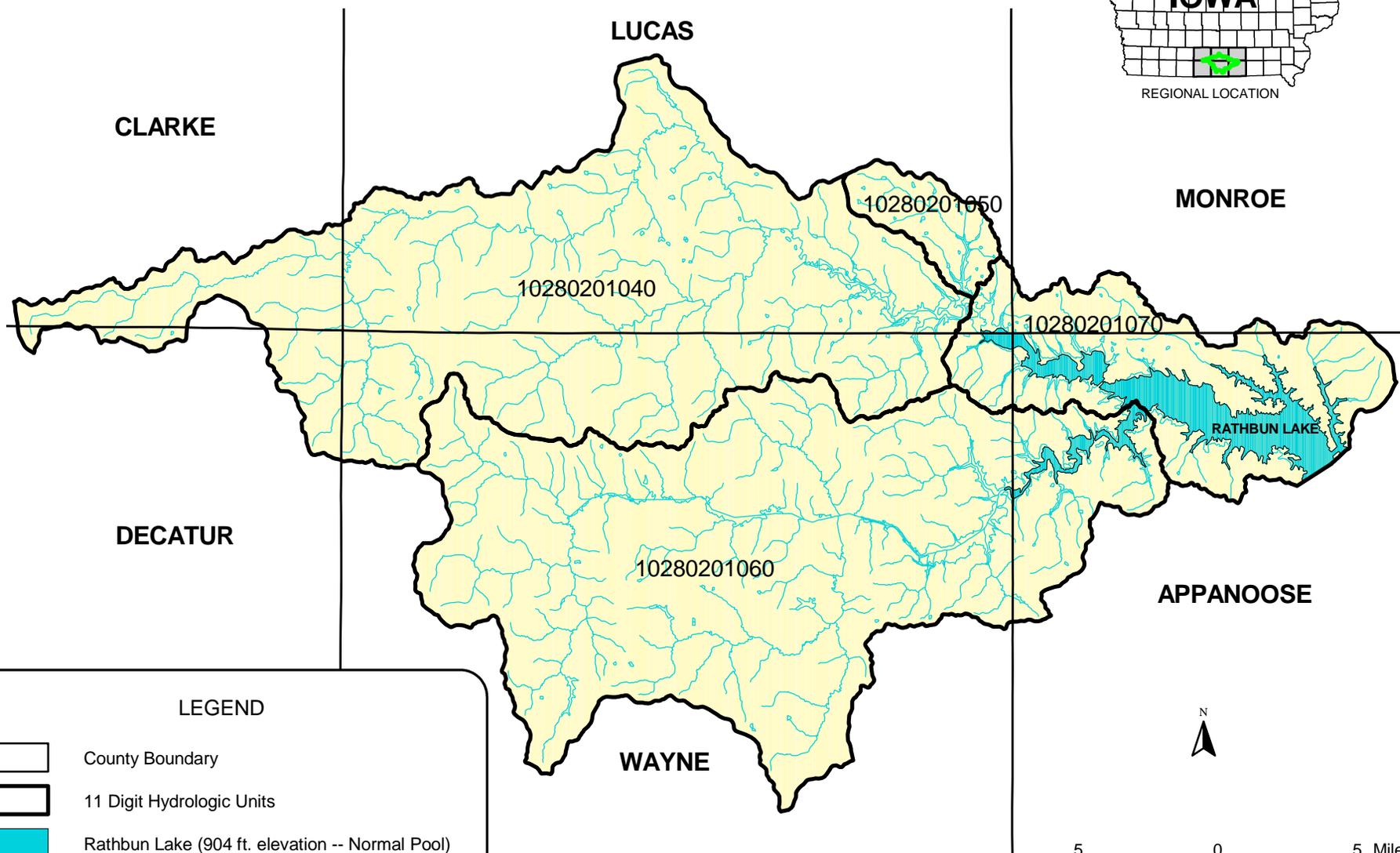
Table 3 presents information about the Rathbun Lake watershed, sub-watersheds, buffer zone area, and 24-hour time of travel area. Figures 4, 5, 6, and 7 and Table 4 at the end of this section identify and describe the Rathbun Lake watershed, sub-watersheds, buffer zone area, and 24-hour time of travel area. The procedure used to determine the 24-hour time of travel area is described in Appendix B.

Table 3. Rathbun Lake Watershed Delineation Information

• Rathbun Lake watershed size:	354,062 acres
• Number and size of larger sub-watersheds in the Rathbun Lake watershed:	Four larger sub-watersheds, each of which is assigned a unique 11 digit hydrologic unit code
• Range in size of larger sub-watersheds:	8,706 acres to 151,612 acres
• Number and size of smaller sub-watersheds in the Rathbun Lake watershed:	61 smaller sub-watersheds, each of which is assigned a unique 14 digit hydrologic unit code
• Range in size of smaller sub-watersheds:	2,590 acres to 16,430 acres
• Size of the buffer zone area in the Rathbun Lake watershed:	226,122 acres or approximately 64% of the Rathbun Lake watershed
• Size of the 24-hour time of travel area in the Rathbun Lake watershed:	288,240 acres or approximately 81% of the Rathbun Lake watershed

RATHBUN LAKE WATERSHED 11 Digit Hydrologic Units Map South Central Iowa

Figure 4



LEGEND

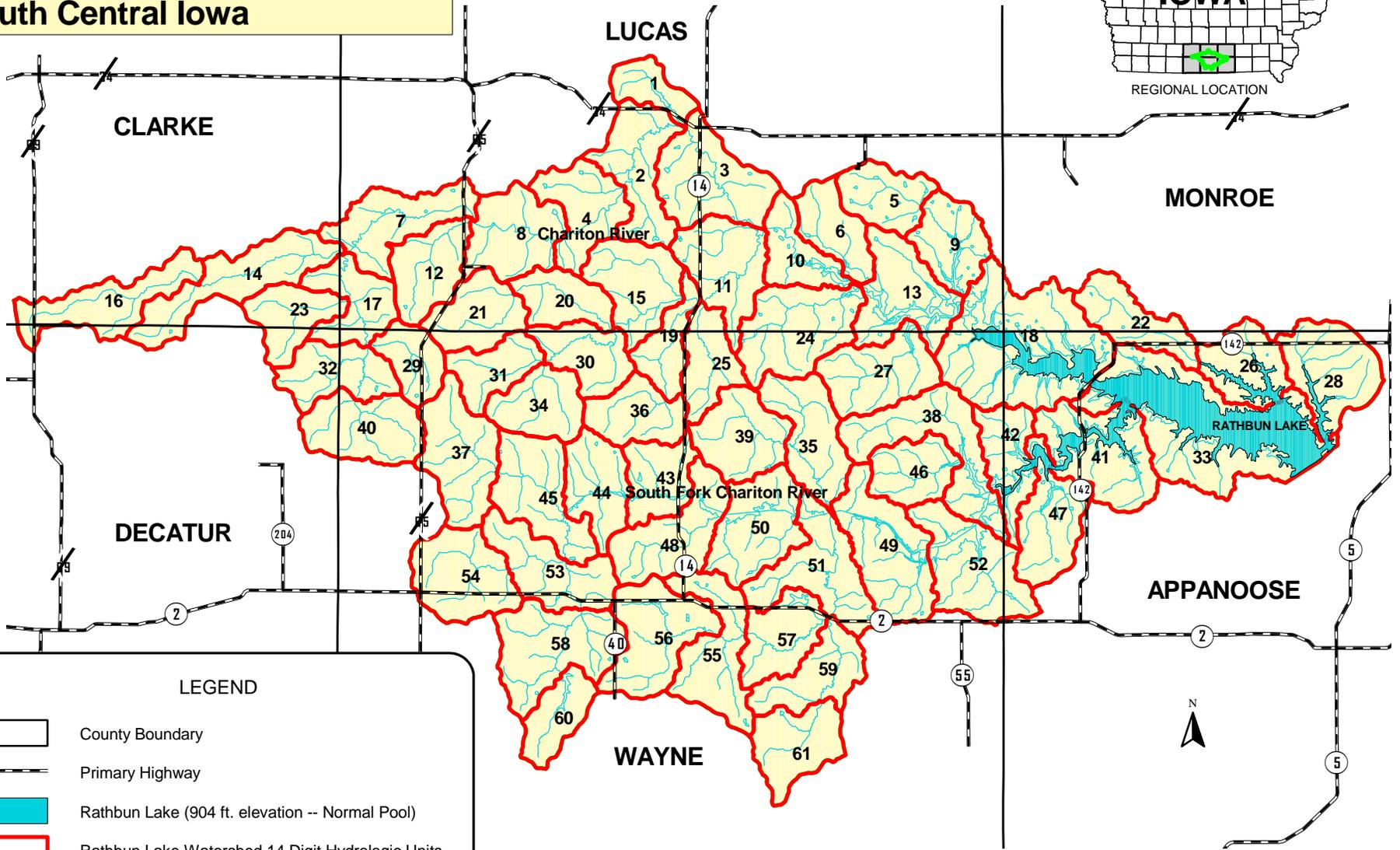
- County Boundary
- 11 Digit Hydrologic Units
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage
- Rathbun Lake Watershed (354,000 Acres)



Source: Chariton Valley RC&D
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
Prepared By: Rathbun Regional Water Association

**RATHBUN LAKE WATERSHED
14 Digit Hydrologic Units Map
(Rathbun Lake Subwatersheds)
South Central Iowa**

Figure 5



LEGEND

- County Boundary
- Primary Highway
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Rathbun Lake Watershed 14 Digit Hydrologic Units
- Drainage
- Rathbun Lake Watershed (354,000 Acres)



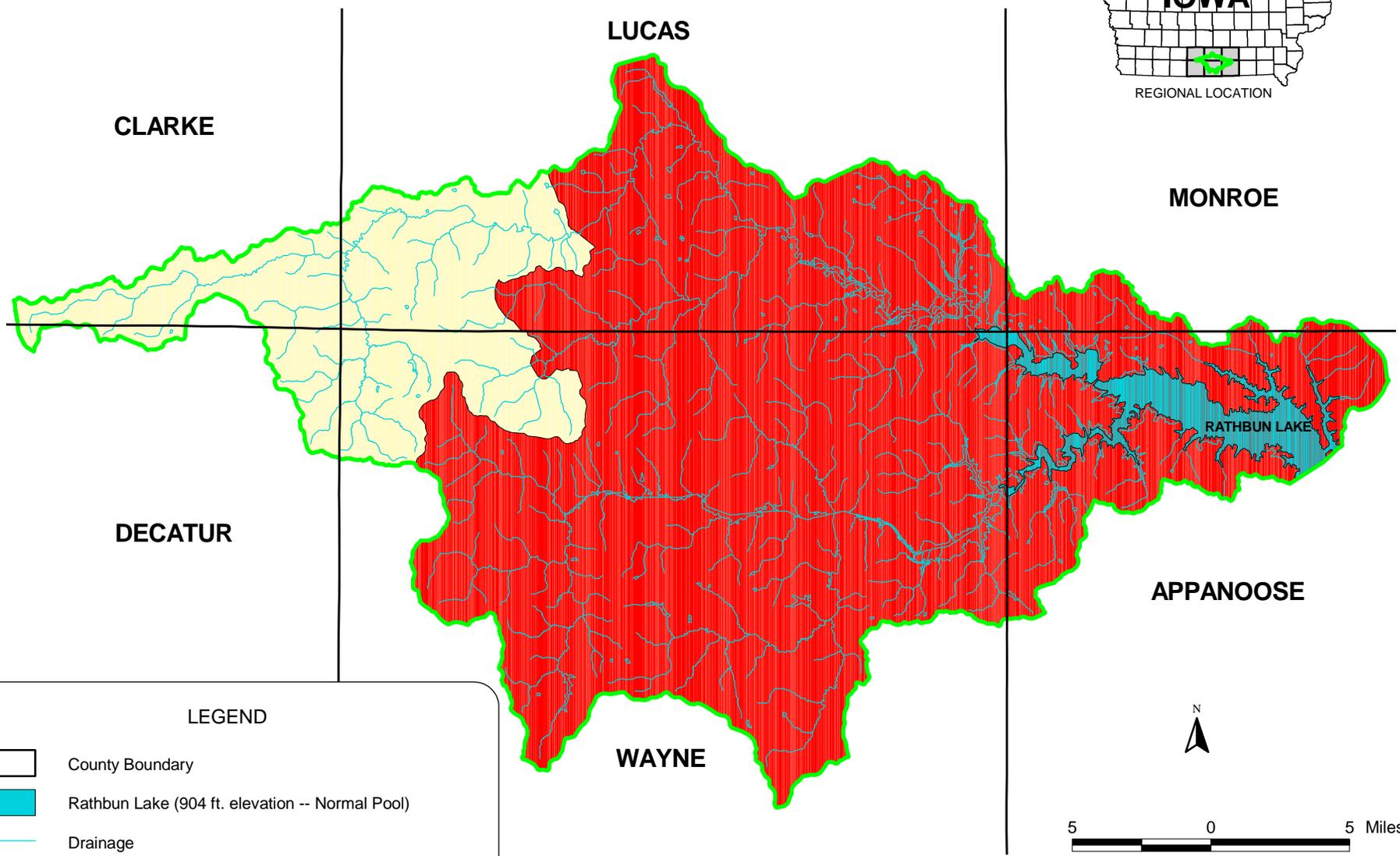
Source: Chariton Valley RC&D
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
Prepared By: Rathbun Regional Water Association

Table 4

11 Digit Hydrologic Units				14 Digit Hydrologic Units (Rathbun Lake Subwatersheds)		
Rathbun Lake Watershed				Rathbun Lake Watershed		
11 Digit	Name	Acres	8 Digit HUC	ID	Acres	14 Digit HUC #
10280201040	Chariton River	146948.2	10280201	1	2589.632	10280201040210
10280201050	Chariton River	8705.68	10280201	2	6089.331	10280201040200
10280201070	Chariton River	46796.94	10280201	3	7369.71	10280201040220
10280201060	Chariton River	151611.6	10280201	4	5256.643	10280201040160
	Total	354062.4		5	4131.235	10280201050010
				6	3952.532	10280201040260
				7	6058.842	10280201040080
				8	5994.875	10280201040100
				9	4574.445	10280201050020
				10	3811.165	10280201040250
				11	6233.26	10280201040230
				12	4875.068	10280201040090
				13	6682.223	10280201040290
				14	7150.129	10280201040020
				15	5867.948	10280201040170
				16	5927.301	10280201040010
				17	4473.032	10280201040070
				18	14653.218	10280201070010
				19	3244.32	10280201040190
				20	3786.118	10280201040120
				21	4802.341	10280201040110
				22	4522.996	10280201070020
				23	4066.431	10280201040060
				24	7615.624	10280201040270
				25	4013.994	10280201040240
				26	4688.849	10280201070030
				27	6160.15	10280201040280
				28	6501.523	10280201070040
				29	3281.54	10280201040050
				30	4311.228	10280201040150
				31	3634.747	10280201040130
				32	4816.463	10280201040040
				33	16430.353	10280201070050
				34	4565.551	10280201040140
				35	5935.393	10280201060140
				36	4335.033	10280201040180
				37	6883.071	10280201060010
				38	7910.099	10280201060210
				39	5576.803	10280201060120
				40	5982.886	10280201040030
				41	7723.94	10280201060250
				42	4321.065	10280201060230
				43	4167.369	10280201060080
				44	4808.781	10280201060070
				45	6616.879	10280201060030
				46	4107.997	10280201060200
				47	5722.339	10280201060240
				48	6382.636	10280201060090
				49	7909.58	10280201060190
				50	6588.024	10280201060130
				51	7024.243	10280201060180
				52	7613.36	10280201060220
				53	5955.127	10280201060040
				54	6499.691	10280201060020
				55	6627.548	10280201060110
				56	7179.184	10280201060100
				57	4732.007	10280201060170
				58	7897.647	10280201060060
				59	4841.025	10280201060160
				60	3531.366	10280201060050
				61	5056.498	10280201060150
				Total	354062.41	

RATHBUN LAKE WATERSHED
24 Hour Time of Travel Area (Mean Flow)
South Central Iowa

Figure 6



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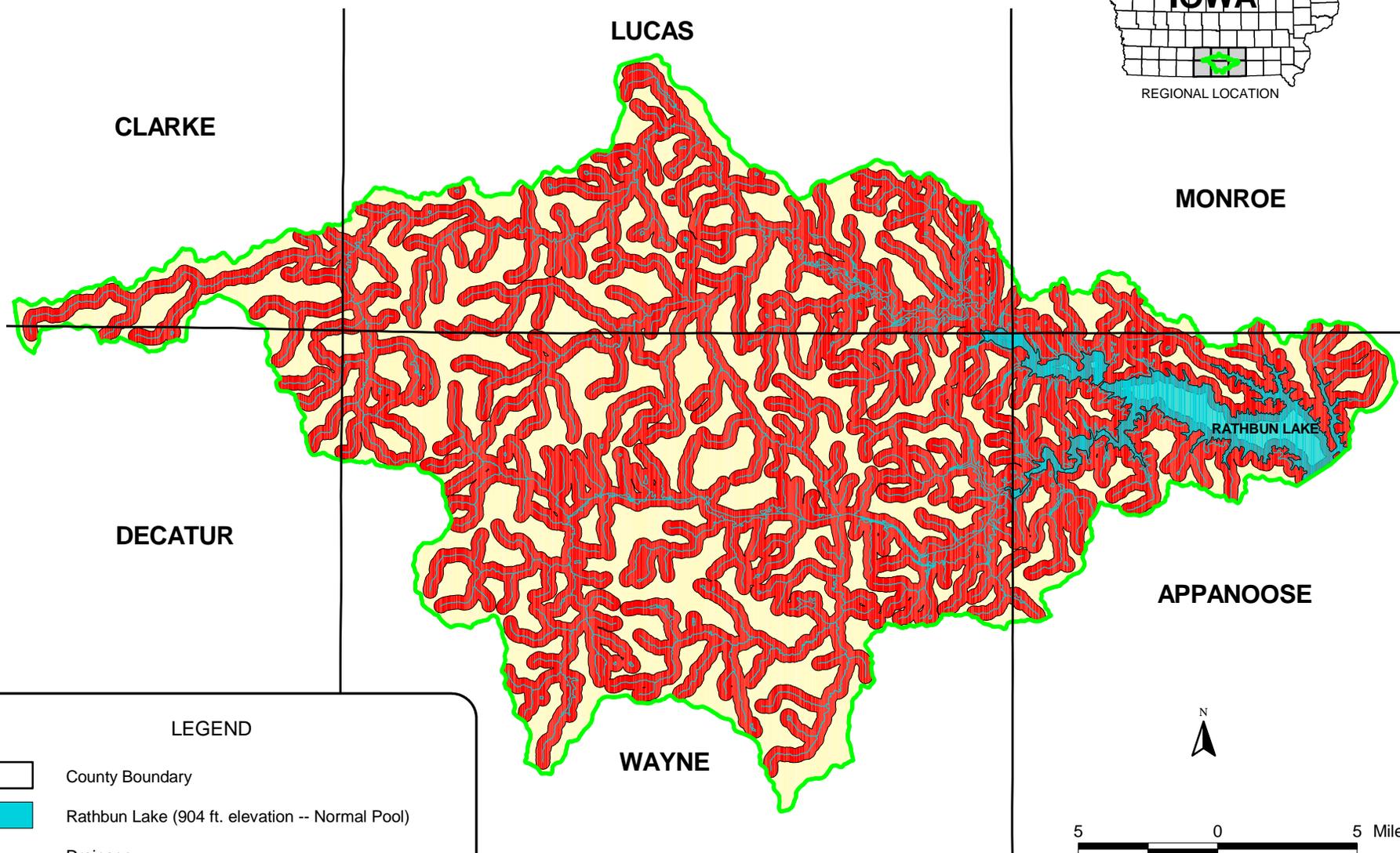
- County Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage
- Rathbun Lake 24 Hour Time of Travel Area (Mean Flow)
- Rathbun Lake Watershed (354,000 Acres)



Source: Chariton Valley RC&D
Iowa State University
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
Prepared By: Rathbun Regional Water Association

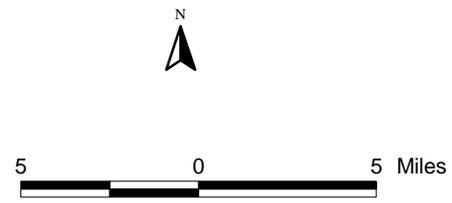
RATHBUN LAKE WATERSHED
1/4 Mile Buffer Zone Area
South Central Iowa

Figure 7



LEGEND

- County Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage
- Rathbun Lake Watershed 1/4 Mile Buffer Zone Area
- Rathbun Lake Watershed (354,000 Acres)



Source: Chariton Valley RC&D
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
Prepared By: Rathbun Regional Water Association

SECTION V

SECTION V INVENTORY OF POTENTIAL CONTAMINANT SOURCES IN THE RATHBUN LAKE WATERSHED

An inventory of all potential contaminant sources in the Rathbun Lake watershed has been completed. The purpose of this inventory was to identify and locate public and private facilities and land uses in the watershed that may be potential sources of contaminants such as sediment, nutrients, chemicals, and bacteria that could cause water pollution in Rathbun Lake. The inventory included potential point and non-point sources of water pollution. Point sources are those sources of water pollution that can be identified at specific locations, such as sewage discharge from an improperly functioning wastewater treatment facility. In contrast, non-point sources are sources of water pollution that cannot be identified as originating from a specific location, for example, farm chemicals in runoff from cropland in the watershed.

The inventory of potential contaminant sources was completed using information available from existing records, databases, and maps maintained by public agencies and private organizations. Table 5 at the end of this section presents a list of sources of information used to conduct the inventory. In addition, extensive fieldwork was performed to collect information about potential contaminant sources in the watershed to complete the inventory.

The inventory identifies facilities and land uses in the watershed that may be potential sources of water pollution in Rathbun Lake.



Information was collected in the field about potential sources of contaminants.

Inventory of Potential Point Sources

The potential point sources in the Rathbun Lake watershed that have been identified and located by the inventory include:

Livestock feeding operations: Animal wastes from relatively large livestock feeding operations that may enter streams, rivers, and the lake can contain levels of nutrients, suspended solids, and microorganisms that could impair water quality. The inventory found that a very small number of the livestock feeding operations in the watershed are of the size that may meet the definition of a concentrated animal feeding operation according to current Clean Water Act regulations. These few operations have been included with the larger number of livestock operations identified as potential non-point sources of water quality impairment that are described on page V-4. Information collected about livestock feeding operations included location, type, size, and the presence of practices to reduce any impact from animal wastes on water quality. Figure 17 at the end of this section presents the number of livestock operations by sub-watershed.

Road and railroad intersections: Accidents, construction, and maintenance activities along roads and railroads can be sources of contaminants such as petroleum products, chemicals, and sediment that may cause water pollution. A total of 1,032 road and railroad intersections with Rathbun Lake and the rivers and streams in its watershed have been identified. Information collected about the intersections included type such as bridge or culvert and road classification such as primary, secondary, or other. Figure 8 in this section identifies the location of these intersections in the watershed.

SECTION V CONTD.

Wastewater treatment facilities: Effluent that leaks or is discharged from lagoons and lines that are parts of wastewater treatment facilities may contain levels of nutrients, microorganisms, chemicals, and suspended solids that can impair water quality. Eight wastewater facilities are located in the watershed. Information collected about the facilities included type such as community or commercial. All of the facilities include lagoons. Figure 9 at the end of this section identifies the location of these facilities in the watershed.

Septic system concentration areas: Sewage that is discharged from poorly operating septic systems may also contain levels of nutrients, microorganisms, and chemicals that can cause water pollution. Eighty-nine areas have been identified in the watershed with a concentration of five or more septic systems per square mile. Information collected about these areas included type such as incorporated community, unincorporated community, or rural residences and the size of the areas. Figure 10 in this section identifies the location of these septic system concentration areas in the watershed.

Eighty-nine areas have been identified in the watershed with a concentration of five or more septic systems per square mile.

Institutional, retail, and industrial facilities: The storage, handling, use, and disposal of a variety of materials such as pesticides, paints, fuels, lubricants, solvents, and detergents by institutional, retail, and industrial facilities may be sources of contaminants that can impair water quality. A total of 74 institutional, retail, and industrial facilities are located in the watershed. Information collected about the facilities included type such as church, school, hospital, airports, government offices, retail agricultural businesses, and industrial plants. In addition, the locations of underground storage tanks have been identified. Figure 11 in this section identifies the location of these facilities in the watershed.

Recreational facilities: Visitor activities including the operation of vehicles and watercraft as well as construction and maintenance at recreational facilities may be sources of contaminants such as petroleum products, chemicals, sewage, and sediment that can cause water pollution. Fifty-four recreational facilities have been identified in the watershed. Information collected about the facilities included type such as boat ramps, campgrounds, marinas, and golf courses. Figure 12 in this section identifies the location of these facilities in the watershed.



Recreational facilities in the watershed such as boat ramps can be potential sources of contaminants that impair water quality. (Photo courtesy ACOE)

Residential and commercial areas: Runoff from residential and commercial areas may contain a variety of solid and liquid wastes such as chemical products used for household purposes and in retail businesses that can cause water pollution. Nine residential and commercial areas are located in the watershed. These areas are associated with the relatively more densely populated incorporated communities in the watershed. Figure 13 at the end of this section identifies the location of these areas in the watershed.

Quarry sites: The operation and maintenance of equipment and processing of rock and other materials at quarry sites may be sources of contaminants including fuel, oil, and sediment that can impair water quality. Eight quarry sites are located in the watershed. Figure 14 in this section identifies the location of these sites in the watershed.

SECTION V CONTD.

Shoreline erosion: Severe soil erosion caused by wave action and changes in pool elevation occurs on a large portion of the 150 miles of shoreline at Rathbun Lake. The US Army Corps of Engineers (ACOE) has determined that this shoreline erosion is the source of a significant portion of the soil that causes accelerated sedimentation and high levels of turbidity in Rathbun Lake.



Shoreline erosion is a significant source of the sediment that enters Rathbun Lake. (Photo courtesy NRCS)

Inventory of Potential Non-point Sources

The types of potential non-point sources of contaminants in the Rathbun Lake watershed that have been identified and located by the inventory include:

Eroded soil from land in the watershed: Information about soil properties, land use, vegetation, and farming practices has been collected and used to estimate the rates for sheet and rill erosion, gully erosion, and streambank erosion on land in sub-watersheds of the Rathbun Lake watershed. In addition, the amount of eroded soil that is carried in runoff from land in each sub-watershed to Rathbun Lake has been estimated. Procedures developed by the USDA Natural Resources Conservation Service (NRCS) were used to collect this information and make these estimates. The use of these procedures is described in Appendix C. Figure 15 at the end of this section identifies the locations of areas in the watershed where information about field conditions was collected.



Soil erosion on cropland in the watershed is a source of the sediment and chemicals that enter Rathbun Lake.

The amount of eroded soil that is carried in runoff from land in each sub-watershed to Rathbun Lake has been estimated.

Chemicals from land in the watershed: A model has been developed and used to estimate the amounts of farm chemicals that are carried in runoff to Rathbun Lake from land in each of the sub-watersheds of the Rathbun Lake watershed. This model is the Soil and Water Assessment Tool or SWAT. Information about weather, topography, soil properties, land use, and farming practices was collected for use in the SWAT model. This information allowed the model to estimate the amounts of phosphorus, nitrogen, and atrazine that are carried in runoff to Rathbun Lake. The development and use of the SWAT model are described in Appendix D.

The SWAT model was used to estimate the amounts of farm chemicals carried in runoff to Rathbun Lake.

SECTION V CONTD.

Impact of activities on riparian zones:

Information has been collected at sites along rivers and streams in the Rathbun Lake watershed to determine the impact of activities on riparian zones. Information collected about the riparian zones included physical changes to the channel such as straightening, evidence of livestock presence, bank stability, water appearance, and canopy cover. This information was used with the Stream Visual Assessment Protocol developed by the USDA NRCS to evaluate the condition of the riparian zones and the related impacts on water quality in Rathbun Lake. The use of this procedure is described in Appendix E. Figure 16 in this section identifies the locations of sites where information about riparian zones was collected.

Information collected along streams and rivers was used to evaluate the condition of riparian zones in the watershed and related impacts on water quality in Rathbun Lake.

Livestock operations: The inventory identified 468 livestock grazing and feeding operations in the Rathbun Lake watershed. Over 90 percent of these are beef cattle operations. The operations located in the watershed include:

Livestock grazing operations: Livestock grazing operations may be sources of nutrients, microorganisms, suspended solids, and sediment that can impair water quality, particularly when livestock access to streams and rivers is not managed. An estimated 350 of the 468 operations in the watershed rely primarily on pasture for grazing with little or no confinement of livestock. In addition to location and type, information collected about the operations included size and livestock access to riparian zones that may impact water quality. Figure 17 at the end of this section presents the number of livestock grazing operations by sub-watershed.

Livestock feeding operations: Runoff from livestock feeding operations may contain levels of nutrients, microorganisms, suspended solids, and sediment that can impair water quality. An estimated 118 of the 468 operations in the watershed confine livestock, for example, in lots or buildings, for at least a portion of the year. In addition to location and type, information collected about the operations included size and the presence of practices to reduce any impact from livestock wastes on water quality. Figure 17 in this section presents the number of livestock feeding operations by sub-watershed.



Livestock operations in the watershed are potential sources of water quality impairment. (Photo courtesy Chariton Valley Beef)

Table 5

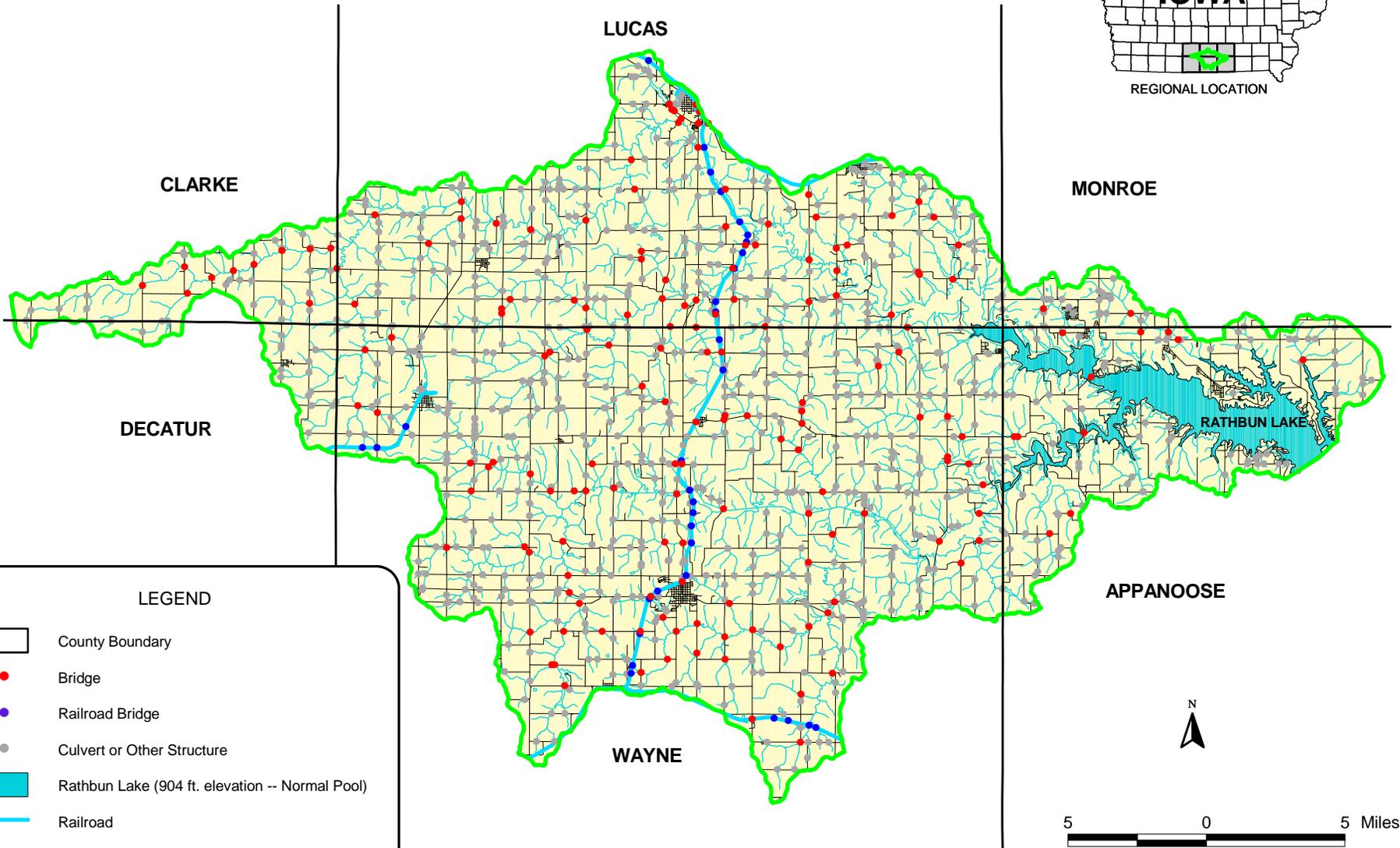
Source Water Assessment GIS Coverages -- Rathbun Lake Watershed					
Coverages Inventoried, Created, or Used for Rathbun Lake Watershed Assessment					
Point Source					
Parent Coverage Name or Type	Coverage Description	Type	Source	Scale	WWW Link To GIS Coverage and Metadata Holdings
Agdfac	Animal waste control facilities with operating permits	Point/Line	IDNR	Unknown	http://www.iqsb.uiowa.edu/nrgis/enviro.idc
Airports	Landing facilities in the state of Iowa as supplied by the FAA	Point	IDNR	Unknown	http://www.iqsb.uiowa.edu/nrgis/cultural.idc
Business Facilities	Additional business facilities	Point	RRWA	Unknown	None -- Contact RRWA for more information
Dnrlands	Lands owned or managed by IDNR	Polygon	IDNR	1:24000	http://www.iqsb.uiowa.edu/nrgis/cultural.idc
Hospital	Hospitals in Iowa	Point	IDNR	1:24000	http://www.iqsb.uiowa.edu/nrgis/cultural.idc
Industrial Facilities Discharge	Industrial facilities discharge	Point	EPA Basins	Unknown	http://www.epa.gov/ost/ftp/basins/gis_data/huc/
K12schls	PreK-12 Schools in Iowa	Point	IDNR	1:24000	http://www.iqsb.uiowa.edu/nrgis/cultural.idc
Mines96	Registered noncoal mineral production sites	Polygon	IDNR	1:100000	http://www.iqsb.uiowa.edu/nrgis/physical.idc
Recreational Facilities	Boat ramps, rec area lagoons, marinas, etc.	Point	RRWA	1:24000	None -- Contact RRWA for more information
Tiger Files Lndmkpnts for Counties	Landmark Points	Point	USBOC	1:100000	http://www.geographynetwork.com/data/tiger2000/
Toxic Release Inventory	Toxic release inventory sites	Point	EPA Basins	Unknown	http://www.epa.gov/ost/ftp/basins/gis_data/huc/
Ustsites	Regulated underground storage tanks	Point	IDNR	Varies	http://www.iqsb.uiowa.edu/nrgis/enviro.idc
Wwtp	Waste water treatment plants	Point	IDNR	1:24000	http://www.iqsb.uiowa.edu/nrgis/enviro.idc
Non-Point Source					
Parent Coverage Name or Type	Coverage Description	Type	Source	Scale	WWW Link To GIS Coverage and Metadata Holdings
USGS NLCD Land Use	Early 1990's Landuse/Landcover 30 meter cell grid	Grid	USGS	Unknown	http://landcover.usgs.gov/natl/landcover.html
Township Soils	Iowa Cooperative Soil Survey digital soils	Polygon	USDA NRCS	1:15840	http://icss.agron.iastate.edu/data.htm
Other Coverages					
Parent Coverage Name or Type	Coverage Description	Type	Source	Scale	WWW Link To GIS Coverage and Metadata Holdings
8 Digit Hydrologic Units	8 Digit hydrologic units	Polygon	EPA Basins	1:250000	http://www.epa.gov/ost/ftp/basins/gis_data/huc/
Basin_24	11 Digit hydrologic units	Polygon	USDA NRCS	1:24000	http://www.iqsb.uiowa.edu/nrgis/enviro.idc
14 Digit Hydrologic Units	14 Digit hydrologic units	Polygon	RRWA	1:24000	None -- Contact RRWA for more information
Rathbun Lake 24 Hour Time of Travel	24 Hour Time of Travel to Rathbun Lake Polygon Area	Polygon	RRWA	1:100000	None -- Contact RRWA for more information
Rathbun Lake 1/4 Mile Drainage Buffer	1/4 Mile Buffer of Stream Network	Polygon	RRWA	1:100000	None -- Contact RRWA for more information
Livestock Operations Inventory	Livestock Inventory by 14 Digit Hydrologic Unit	Point	RRWA	GPS to 1/4 Section	None -- Contact RRWA for more information
Septic Systems Concentrations	1/4 Mile Buffer of Potential Septic Tank Location -- 5 or more	Polygon	RRWA	Varies	None -- Contact RRWA for more information
Coverages for Individual Counties					
Parent Coverage Name or Type	Coverage Description	Type	Source	Scale	WWW Link To GIS Coverage and Metadata Holdings
PLSS (then county number)	County section boundaries	Polygon	IDNR	1:24000	http://www.iqsb.uiowa.edu/nrgis/county.htm
Roads (then county number)	County road network	Polyline	IDNR	1:100000	http://www.iqsb.uiowa.edu/nrgis/county.htm
Rivers (then county number)	County stream network	Polyline	IDNR	1:100000	http://www.iqsb.uiowa.edu/nrgis/county.htm
Topo (then county number)	County topo lines	Polyline	IDNR	1:100000	http://www.iqsb.uiowa.edu/nrgis/county.htm
Other Statewide Coverages					
Parent Coverage Name or Type	Coverage Description	Type	Source	Scale	WWW Link To GIS Coverage and Metadata Holdings
County	State/County boundaries of the state of Iowa	Polygon	IDNR	1:24000	http://www.iqsb.uiowa.edu/nrgis/cultural.idc
Incorp	Boundaries of Incorporated Cities and Towns in Iowa	Polygon	IDNR	Large Scale	http://www.iqsb.uiowa.edu/nrgis/cultural.idc
Township	Public Land Survey System Townships of Iowa	Polygon	IDNR	1:24000	http://www.iqsb.uiowa.edu/nrgis/referenc.idc
National Transportation Atlas Railroads	Railroads for United States	Line	ESRI	1:100000	None -- ESRI Data and Maps CD, August 1999
States	State Boundaries	Polygon	ESRI	Unknown	None -- ESRI Data and Maps CD, August 1999
Source Key					
EPA -- Environmental Protection Agency					
IDNR -- Iowa Department of Natural Resources					
ESRI -- Environmental Systems Research Institute, Inc.					
RRWA -- Rathbun Regional Water Association, Inc.					
USGS -- United States Geological Survey					
USDA NRCS -- United States Department of Agriculture Natural Resources Conservation Service					
USBOC -- United States Bureau of Census					
This digital data set was developed to support activities of the Rathbun Lake Watershed Assessment. Although efforts have been made to make it useful to the project, Rathbun Regional Water Association, Inc. (RRWA) and its partners working on the Assessment assume no responsibility for errors in the information. Similarly RRWA and its partners assume no responsibility for the consequences of inappropriate uses or interpretations of the data made by anyone to whom this data has been made available. RRWA and its partners assume no responsibility to inform users of any changes made to this data. Anyone using this data is advised that precision implied by the coverage may far exceed actual precision. Comments on this data are invited and RRWA would appreciate that documented errors be brought to staff attention.					

RATHBUN LAKE WATERSHED

Drainage Intersections With Roads and Railroads Inventory

South Central Iowa

Figure 8



LEGEND

-  County Boundary
-  Bridge
-  Railroad Bridge
-  Culvert or Other Structure
-  Rathbun Lake (904 ft. elevation -- Normal Pool)
-  Railroad
-  Roads
-  Drainage (1:24000)
-  Rathbun Lake Watershed (354,000 Acres)



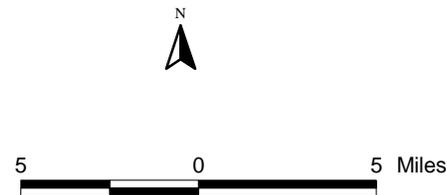
RATHBUN LAKE WATERSHED Wastewater Treatment Facilities Inventory South Central Iowa

Figure 9



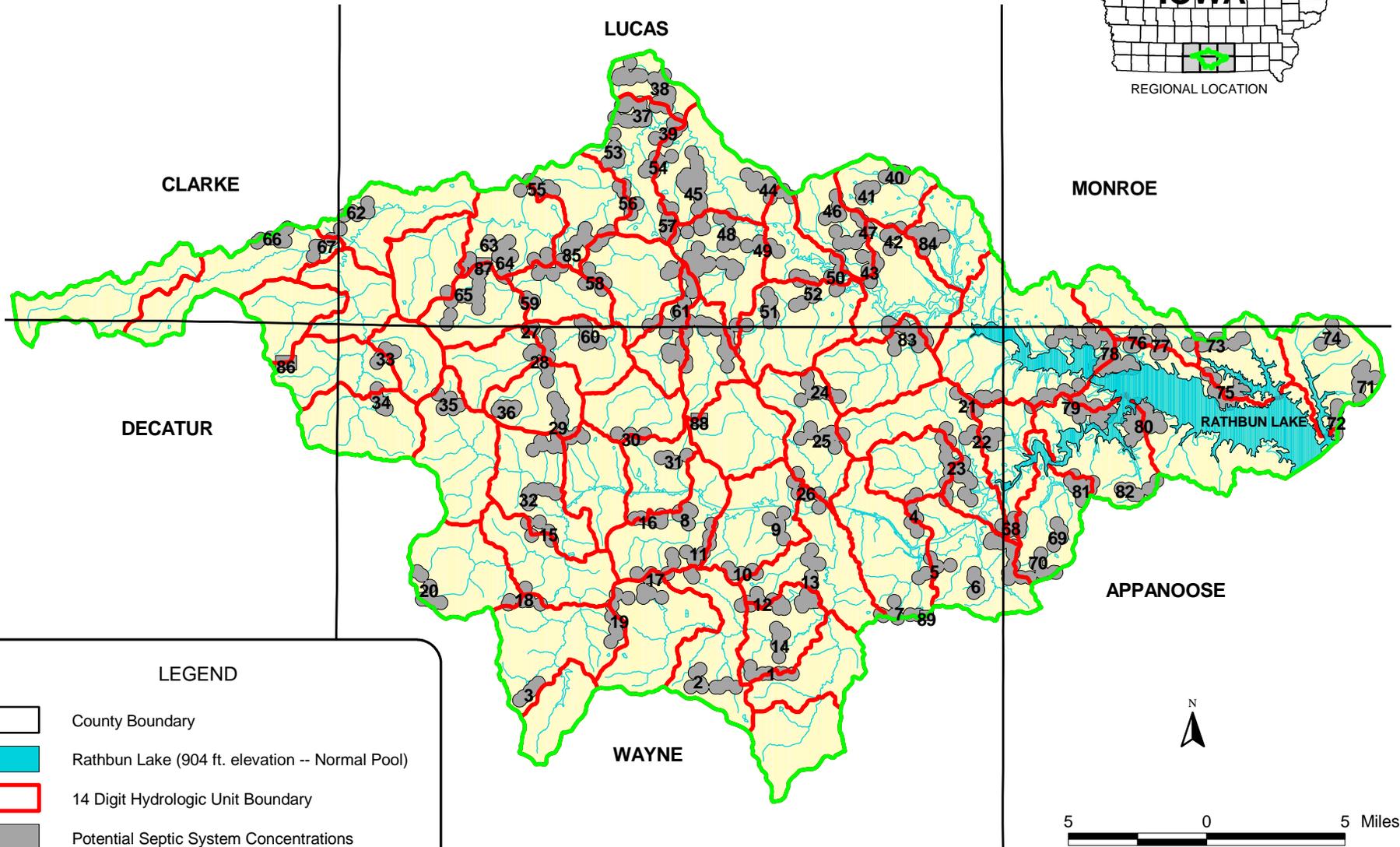
LEGEND

-  County Boundary
-  14 Digit Hydrologic Unit Boundary
-  Rathbun Lake (904 ft. elevation -- Normal Pool)
-  Wastewater Treatment Facility
-  Drainage
-  Rathbun Lake Watershed (354,000 Acres)



RATHBUN LAKE WATERSHED Potential Septic System Concentrations Inventory South Central Iowa

Figure 10



LEGEND

- County Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- 14 Digit Hydrologic Unit Boundary
- Potential Septic System Concentrations
- Drainage
- Rathbun Lake Watershed (354,000 Acres)

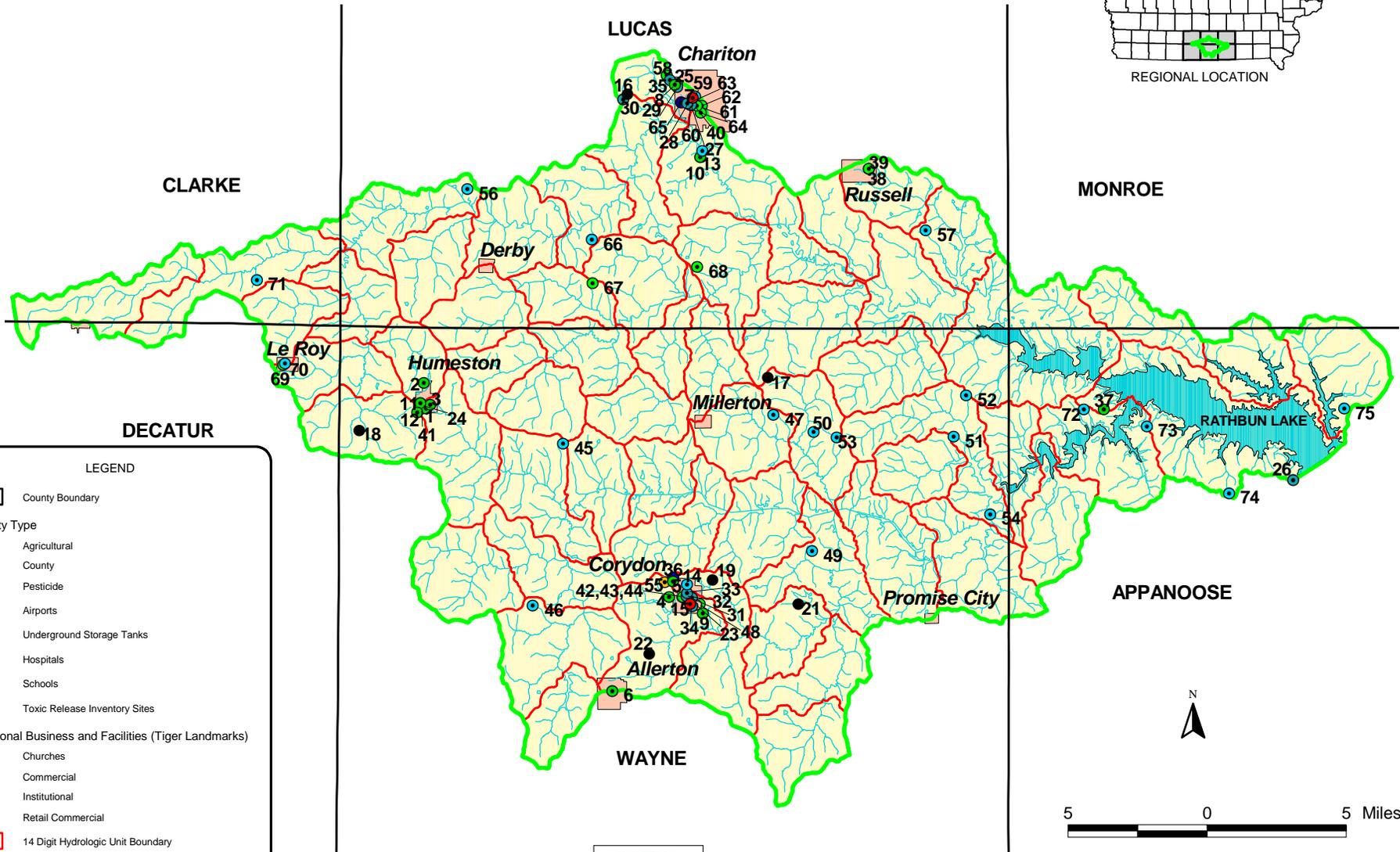


RATHBUN LAKE WATERSHED

Institutional, Retail, and Industrial Facilities Inventory

South Central Iowa

Figure 11



LEGEND

- County Boundary
- Facility Type**
 - Agricultural
 - County
 - Pesticide
 - Airports
 - Underground Storage Tanks
 - Hospitals
 - Schools
 - Toxic Release Inventory Sites
- Additional Business and Facilities (Tiger Landmarks)**
 - Churches
 - Commercial
 - Institutional
 - Retail Commercial
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage (1:24000)
- City or Town
- Rathbun Lake Watershed (354,000 Acres)

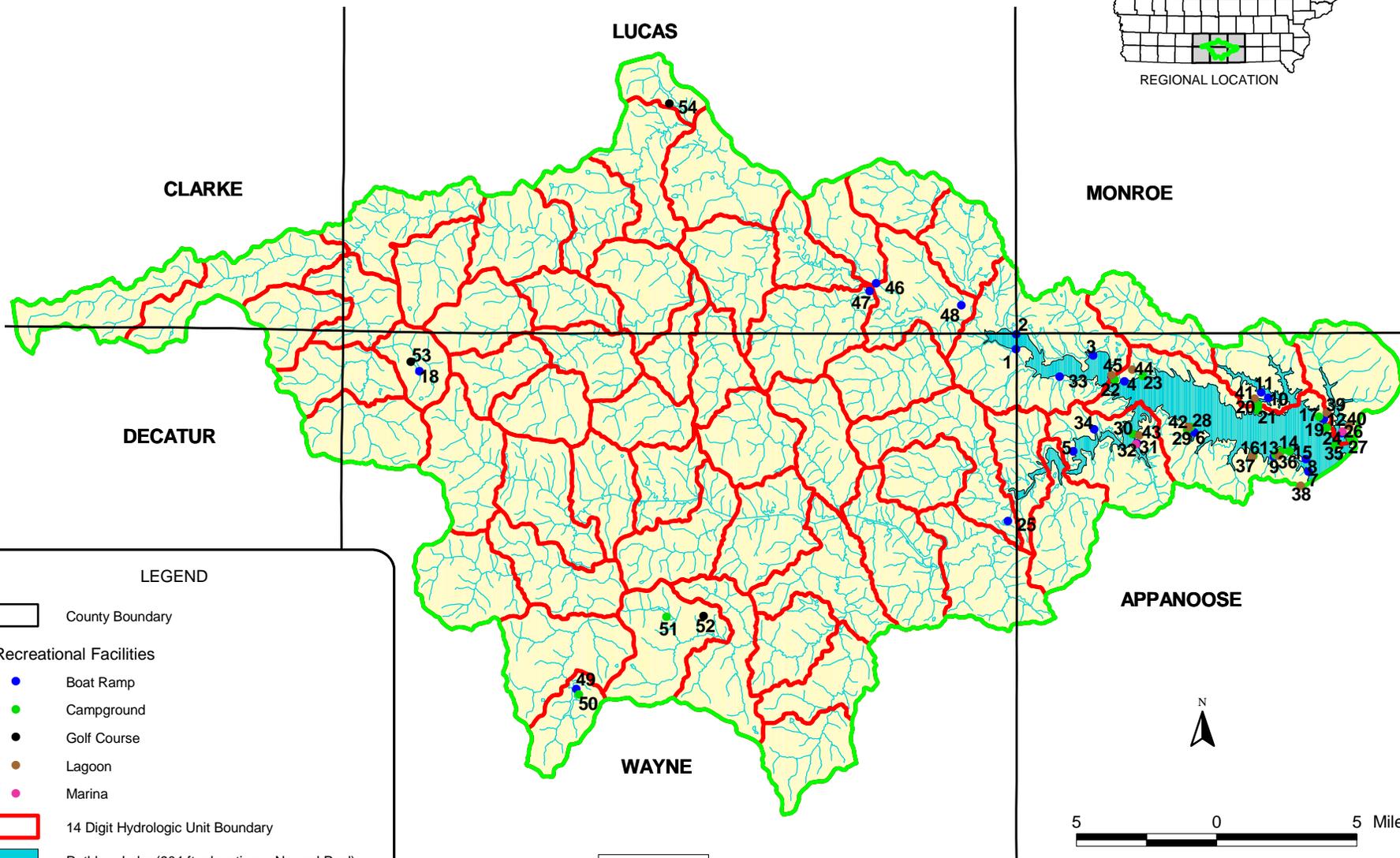


Source: Chariton Valley RC&D
Iowa DNR NRGIS
US Bureau of Census Tiger Data
US Army Corps of Engineers
Wayne County SWCD
EPA Basins Data

Prepared By: Rathbun Regional Water Association

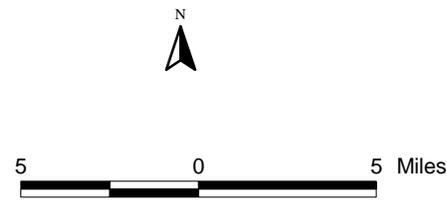
RATHBUN LAKE WATERSHED Recreational Facilities Inventory South Central Iowa

Figure 12



LEGEND

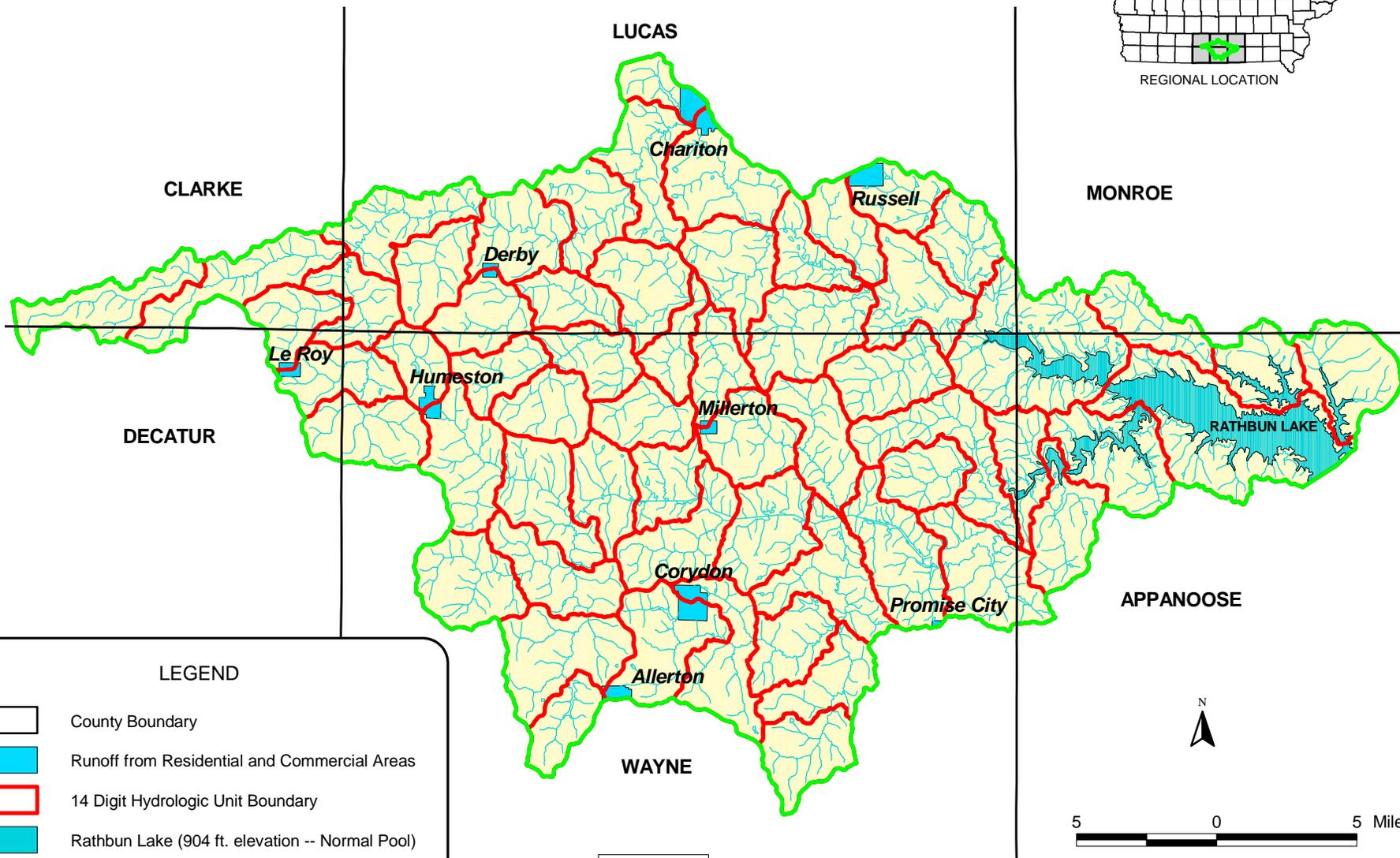
- County Boundary
- Recreational Facilities**
 - Boat Ramp
 - Campground
 - Golf Course
 - Lagoon
 - Marina
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage (1:24000)
- Rathbun Lake Watershed (354,000 Acres)



Source: Chariton Valley RC&D
Iowa DNR NRGIS
US Army Corps of Engineers
Wayne County SWCD
Prepared By: Rathbun Regional Water Association

RATHBUN LAKE WATERSHED Residential and Commercial Areas Inventory South Central Iowa

Figure 13



LEGEND

-  County Boundary
-  Runoff from Residential and Commercial Areas
-  14 Digit Hydrologic Unit Boundary
-  Rathbun Lake (904 ft. elevation -- Normal Pool)
-  Drainage (1:24000)
-  Rathbun Lake Watershed (354,000 Acres)



Source: Chariton Valley RC&D
Iowa DNR NRGIS
US Army Corps of Engineers
Wayne County SWCD
Prepared By: Rathbun Regional Water Association

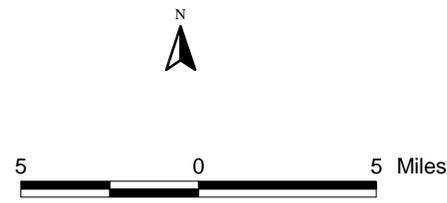
RATHBUN LAKE WATERSHED Quarry Sites Inventory South Central Iowa

Figure 14



LEGEND

- County Boundary
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage (1:24000)
- Quarry Sites
- Rathbun Lake Watershed (354,000 Acres)



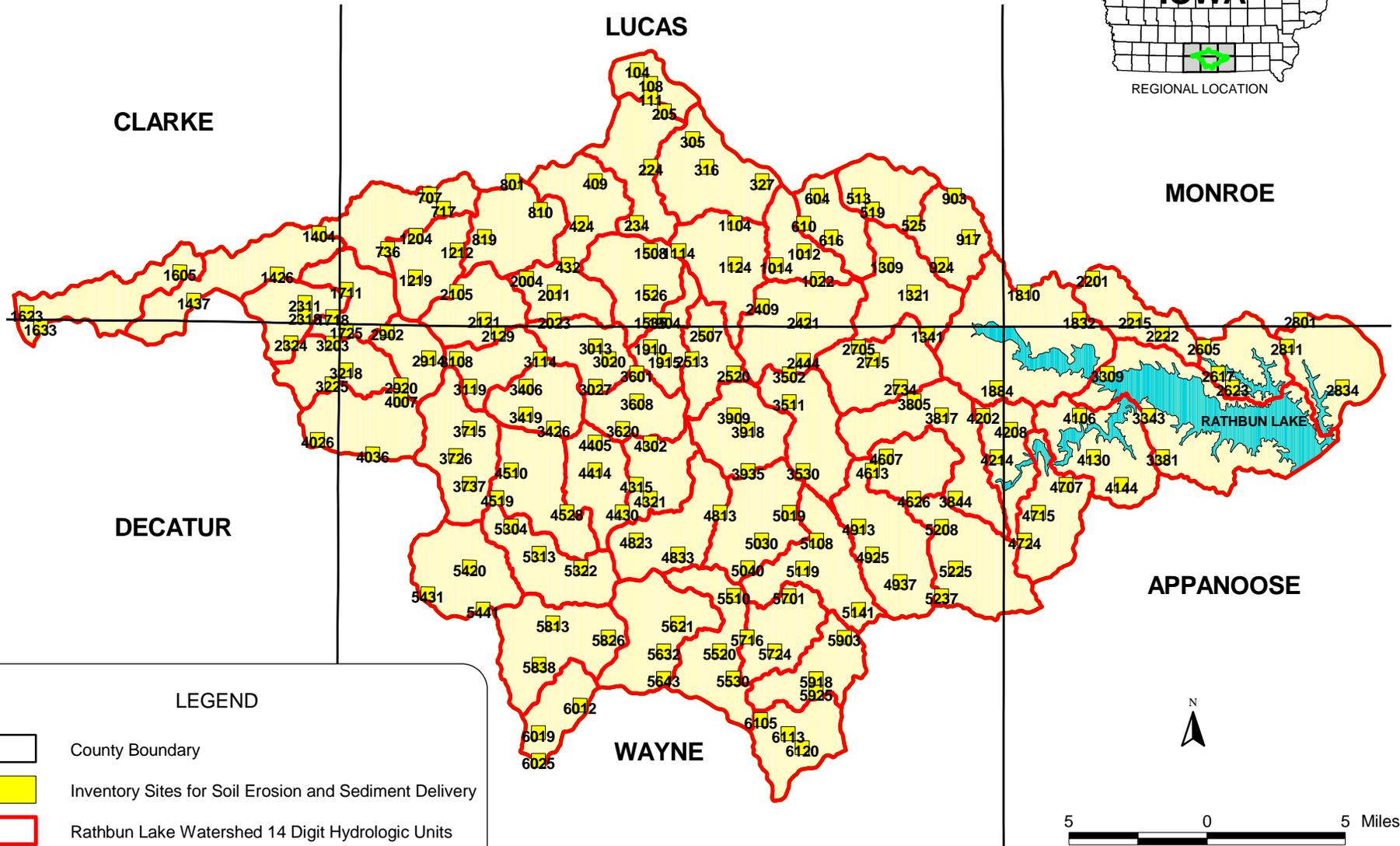
Source: Chariton Valley RC&D
Iowa DNR NRGIS
US Army Corps of Engineers
Wayne County SWCD
Prepared By: Rathbun Regional Water Association

RATHBUN LAKE WATERSHED

Inventory Sites for Soil Erosion and Sediment Delivery

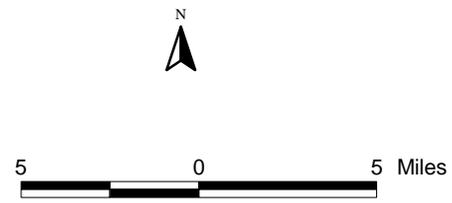
South Central Iowa

Figure 15



LEGEND

-  County Boundary
-  Inventory Sites for Soil Erosion and Sediment Delivery
-  Rathbun Lake Watershed 14 Digit Hydrologic Units
-  Rathbun Lake (904 ft. elevation -- Normal Pool)
-  Rathbun Lake Watershed (354,000 Acres)



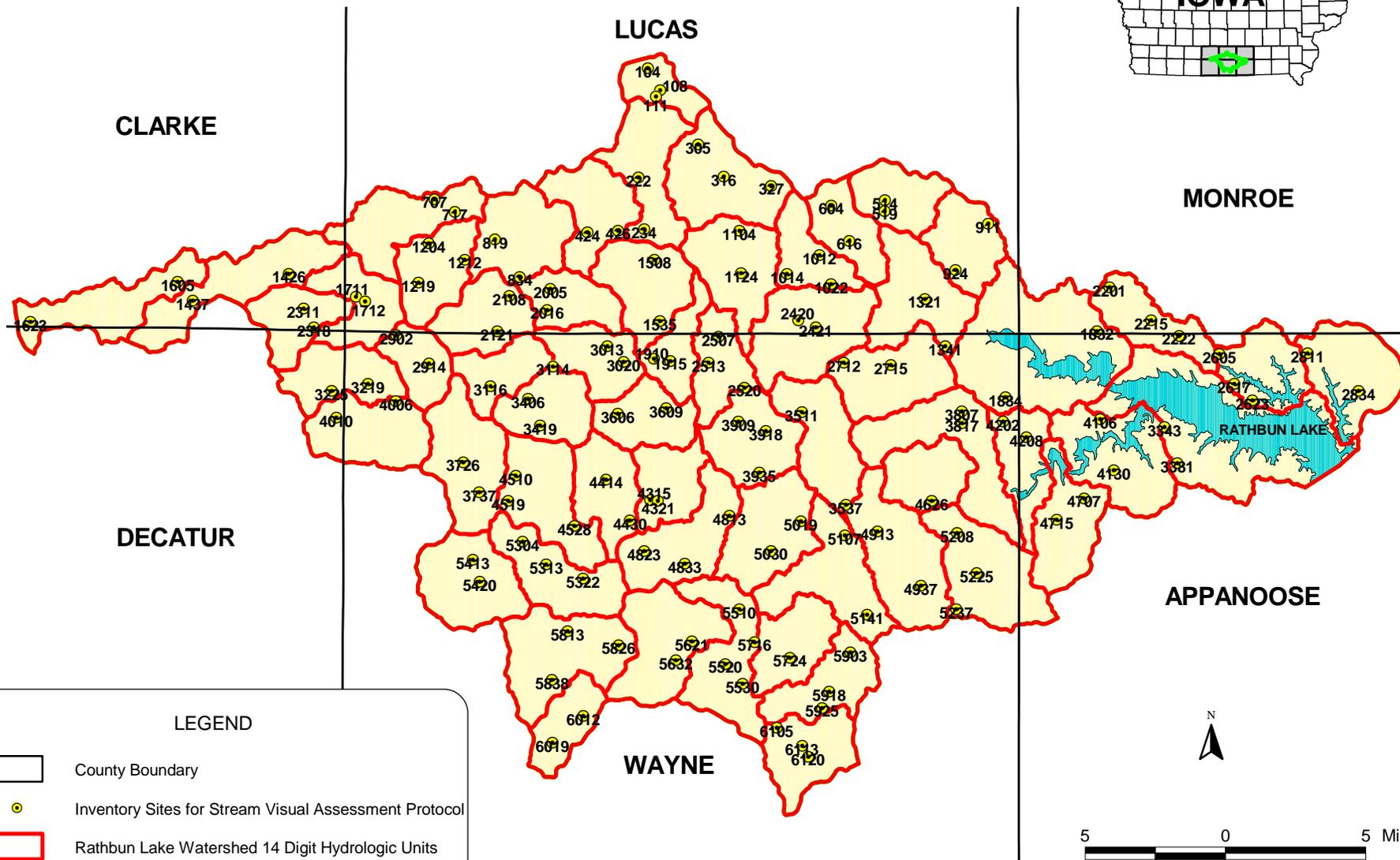
Source: Chariton Valley RC&D
Iowa State University
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
Prepared By: Rathbun Regional Water Association

RATHBUN LAKE WATERSHED

Inventory Sites for Stream Visual Assessment Protocol

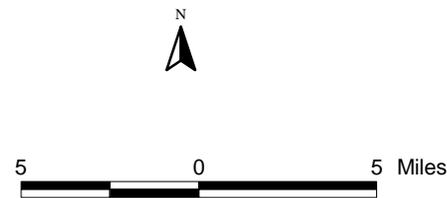
South Central Iowa

Figure 16



LEGEND

-  County Boundary
-  Inventory Sites for Stream Visual Assessment Protocol
-  Rathbun Lake Watershed 14 Digit Hydrologic Units
-  Rathbun Lake (904 ft. elevation -- Normal Pool)
-  Rathbun Lake Watershed (354,000 Acres)



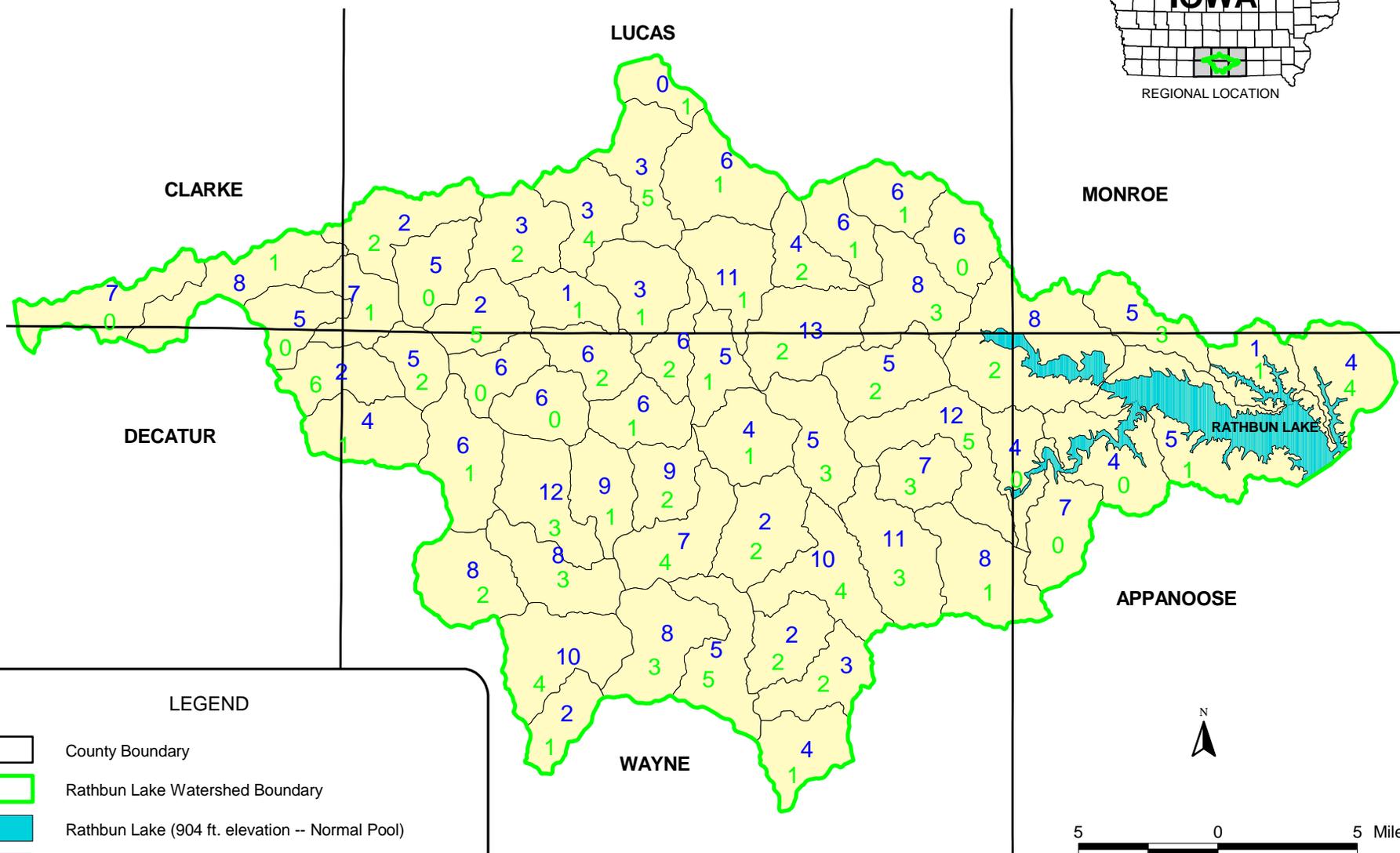
Source: Charlton Valley RC&D
 Iowa State University
 Iowa DNR NRGIS
 USDA Natural Resources Conservation Service
 Prepared By: Rathbun Regional Water Association

RATHBUN LAKE WATERSHED

Livestock Operations Inventory by Subwatershed

South Central Iowa

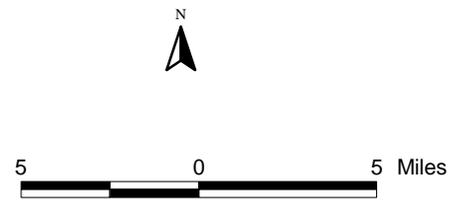
Figure 17



LEGEND

- County Boundary
- Rathbun Lake Watershed Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- 14 Digit Hydrologic Unit Livestock Operations Count

Blue Number -- Livestock Grazing Operations Count (350)
Green Number -- Livestock Feeding Operations Count (118)



Source: Chariton Valley RC&D
Wayne County Soil and Water Conservation District
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
Prepared By: Rathbun Regional Water Association

SECTION VI

SECTION VI ANALYSIS OF THE SUSCEPTIBILITY OF RATHBUN LAKE TO POTENTIAL CONTAMINANT SOURCES

A susceptibility analysis has been completed to determine the relative risk posed to water quality in Rathbun Lake by the potential point and non-point sources of pollution identified in the watershed. The susceptibility analysis combined the watershed delineations described in Section IV and the potential contaminant inventory information from Section V. The results of the analysis can be used to prioritize the potential point and non-point sources of pollution that are the greatest relative threat to water quality in Rathbun Lake. The following approaches have been developed and used to perform the susceptibility analysis of potential point and non-point sources of contaminants.

The analysis determined the relative risk to water quality in Rathbun Lake from potential sources of pollution in the watershed.

Susceptibility Analysis for Potential Point Sources

In general, two factors were used to analyze the relative risk to water quality in Rathbun Lake from potential point sources of pollution in the watershed. These factors included location of the potential point source in the watershed and type of contaminant source. A risk score based on location was assigned to each potential point source according to the guidelines in Table 6. The location risk score for any potential point source ranged from two for least risk to 10 for greatest risk. Figure 18 in this section identifies the areas of the watershed that correspond to the location risk scores described in Table 6.

The location risk score was added to a type of contaminant source risk score for each potential point source. The type of contaminant source risk scores ranged from one for least risk to five for greatest risk. The type of contaminant source risk scores were obtained from the Land-Use Risk Potential Table in the Iowa Department of Natural Resources' (DNR) Source Water Assessment and Protection Program and Implementation Strategy for the State of Iowa. Table 7 at the end of this section presents the type of contaminant source risk scores in the Land-Use Risk Potential Table.

In addition, the combined risk score based on location and type for certain potential point sources was modified to more accurately assess the relative risk between possible sources within the same contaminant type categories. For example, the location and type of contaminant source risk score for each livestock operation was modified by the assignment of an additional risk score based on the size of the operation and whether it was primarily a grazing or feeding operation. The results of the susceptibility analysis for potential point sources of contaminants in the Rathbun Lake watershed are presented on the following page.

Location in the watershed and type of contaminant source were used to analyze the relative risk to water quality from potential point sources of pollution.

Table 6. Location Risk Score for Potential Point Sources

Location of Potential Point Source	Location Risk Score
• Located within 24-hour time of travel area:	Risk score of 5
• Located beyond 24-hour time of travel area:	Risk score of 1
• Located within 1/4 mile buffer zone area:	Risk score of 5
• Located beyond 1/4 mile buffer zone area:	Risk score of 1

SECTION VI CONTD.

Livestock feeding operations: The analysis determined that the potential for livestock operations to impair water quality in Rathbun Lake is high in 15, moderate in 25, and low in 21 sub-watersheds. There are 186 livestock operations located in the 15 sub-watersheds with a high potential for impairing water quality. As described on page V-1, a very small number of the livestock feeding operations in the watershed are of the size that may meet the definition of a concentrated animal feeding operation according to current Clean Water Act regulations. These few operations have been included with the analysis of the larger number of livestock operations identified as potential non-point sources of water quality impairment described on page VI-4. Figure 39 and Table 17 at the end of this section present the results of the susceptibility analysis for livestock operations.

Road and railroad intersections: The analysis indicated that the potential for contaminants from road and railroad intersections to impair water quality is high for 282, moderate for 578, and low for 172 intersections. Figure 19 and Table 8 in this section present the results of the analysis for these intersections.

Wastewater treatment facilities: The analysis determined that the potential for water quality impairment is high for seven and moderate for one of the wastewater treatment facilities in the watershed. Figure 20 and Table 9 in this section present the results of the susceptibility analysis for wastewater treatment facilities.

Septic system concentration areas: The analysis found that the potential for water pollution from concentrations of septic systems in the watershed is high for 26, moderate for 56, and low for seven areas. Figure 21 and Table 10 at the end of this section present the results of the susceptibility analysis for septic systems.

Institutional, retail, and industrial facilities: The analysis determined that the potential for institutional, retail, and industrial facilities in the watershed to impair water quality is high for 12, moderate for 47, and low for 15 facilities. Figure 22 and Table 11 in this section present the results of the analysis for these facilities.

Recreational facilities: The analysis indicated that the potential for water pollution from recreational facilities in the watershed is high for 12, moderate for 23, and low for 19 facilities. Figure 23 and Table 12 at the end of this section present the results of the analysis for recreational facilities.

Residential and commercial areas: The analysis determined that the potential for contaminants carried in runoff from residential and commercial areas in the watershed to impair water quality is high for seven and moderate for two areas. Figure 24 and Table 13 in this section present the results of the susceptibility analysis for residential and commercial areas.

Quarry sites: The analysis found that the potential for water pollution from the eight quarry sites located in the watershed is high. Figure 25 and Table 14 in this section present the results of the susceptibility analysis for quarry sites.

Shoreline erosion: The US Army Corps of Engineers (ACOE) and Iowa DNR have identified 37 priority shoreline erosion control sites at Rathbun Lake. The sites have been identified based on potential for continued erosion and sediment delivery to the lake, quality of aquatic habitat in need of protection, impact to public facilities, and feasibility of installing and maintaining erosion control practices. Figure 26 at the end of this section identifies these sites.

Summary of potential point source susceptibility analysis: The analysis found that 391 possible point sources in the watershed have a relatively high potential to impair water quality in Rathbun Lake. Road and railroad intersections, shoreline erosion sites, and septic system concentration areas account for the majority of these potential point sources. At the same time, most of the wastewater treatment facilities, residential and commercial areas, and quarry sites have a high potential to impair water quality.

The analysis found that 391 possible point sources in the watershed have a relatively high potential to impair water quality in Rathbun Lake.

SECTION VI CONTD.

Susceptibility Analysis for Potential Non-point Sources

The susceptibility analysis for potential non-point sources compared the estimated amounts of eroded soil and chemicals carried in runoff from land used primarily for agricultural production in each of the 61 sub-watersheds in the Rathbun Lake watershed. The estimates of eroded soil and chemicals in runoff used in the analysis were obtained from the inventory of potential non-point sources described in Section V. In addition, the analysis used information collected during the inventory to evaluate the impact of activities on riparian zones in the 61 sub-watersheds as well as the potential for livestock operations in the sub-watersheds to impair water quality. The results of the susceptibility analysis for potential non-point sources of contaminants in the Rathbun Lake watershed are described below.

Eroded soil from land in the watershed: The analysis determined that the relative amounts of sediment from all types of soil erosion that are carried in runoff are very high in six sub-watersheds and high in 17 sub-watersheds. The analysis indicated that sheet and rill erosion accounts for an estimated 65 percent of the sediment carried in runoff from land in the sub-watersheds and that gully erosion and streambank erosion contribute nine percent and 26 percent respectively. While the analysis found that sheet and rill erosion is the primary source of sediment, relatively significant amounts of sediment were identified from gully erosion in 31 sub-watersheds and streambank erosion in 24 sub-watersheds. Figures 27, 28, 29, 30, and 31 and Table 15 at the end of this section present the results of the susceptibility analysis for eroded soil from land in the watershed.

The relative amount of sediment from soil erosion that is carried in runoff is very high in six sub-watersheds and high in 17 sub-watersheds.

Chemicals from land in the watershed: The analysis determined that the relative amounts of sediment-bound and soluble phosphorus carried in runoff are very high in 18 and high in 24 sub-watersheds. In addition, the analysis indicated that the relative amounts of sediment-bound and soluble nitrogen carried in runoff are very high in 17 and high in 31 sub-watersheds. According to the analysis, most of the phosphorus and nitrogen carried in runoff is sediment-bound. The analysis also found that the relative amount of sediment-bound and soluble atrazine in runoff is high to very high in 28 sub-watersheds. According to the analysis, most of the atrazine carried in runoff is in soluble form. The analysis identified 12 sub-watersheds in which the amounts of both phosphorus and nitrogen carried in runoff are very high. Six of these sub-watersheds also have high to very high amounts of atrazine in the runoff. The analysis identified 27 sub-watersheds in which the amounts of both phosphorus and nitrogen in runoff are high. Nine of these sub-watersheds also have high to very high amounts of atrazine in the runoff. Figures 32, 33, 34, 35, 36, and 37 at the end of this section present the results of the susceptibility analysis for chemicals from land in the watershed.



The relative amounts of farm chemicals carried in runoff are high to very high in 15 sub-watersheds. (Photo courtesy NRCS)

SECTION VI CONTD.

Impact of activities on riparian zones: The analysis found that riparian zone conditions in 13 sub-watersheds are relatively highly deteriorated. The impact of livestock use was the primary factor contributing to the degraded conditions in these riparian zones. Bank instability, channel alterations, limited natural vegetation, and reduced width also contributed to the degraded riparian zone conditions. These deteriorated riparian zones are less effective at filtering sediment and chemicals carried in runoff from adjacent land used for agricultural production and are potential sources of contaminants such as eroded soil and livestock wastes that can impair water quality. Figure 38 and Table 16 at the end of this section present the results of the susceptibility analysis for the impact of activities on riparian zones.



Deteriorated riparian zones are less effective at filtering sediment and chemicals carried in runoff from agricultural land.

Livestock grazing operations: According to the analysis, the potential for livestock operations to impair water quality in Rathbun Lake is relatively high in 15, moderate in 25, and low in 21 sub-watersheds. A total of 186 livestock operations are located in the 15 sub-watersheds with a high potential for impairing water quality. An estimated 139 of these operations rely primarily on pasture for grazing with little or no confinement of livestock. The analysis found that improved management of livestock access to riparian zones in most of these operations would help reduce any negative impact on water quality. Figure 39 and Table 17 in this section present the results of the susceptibility analysis for livestock operations.

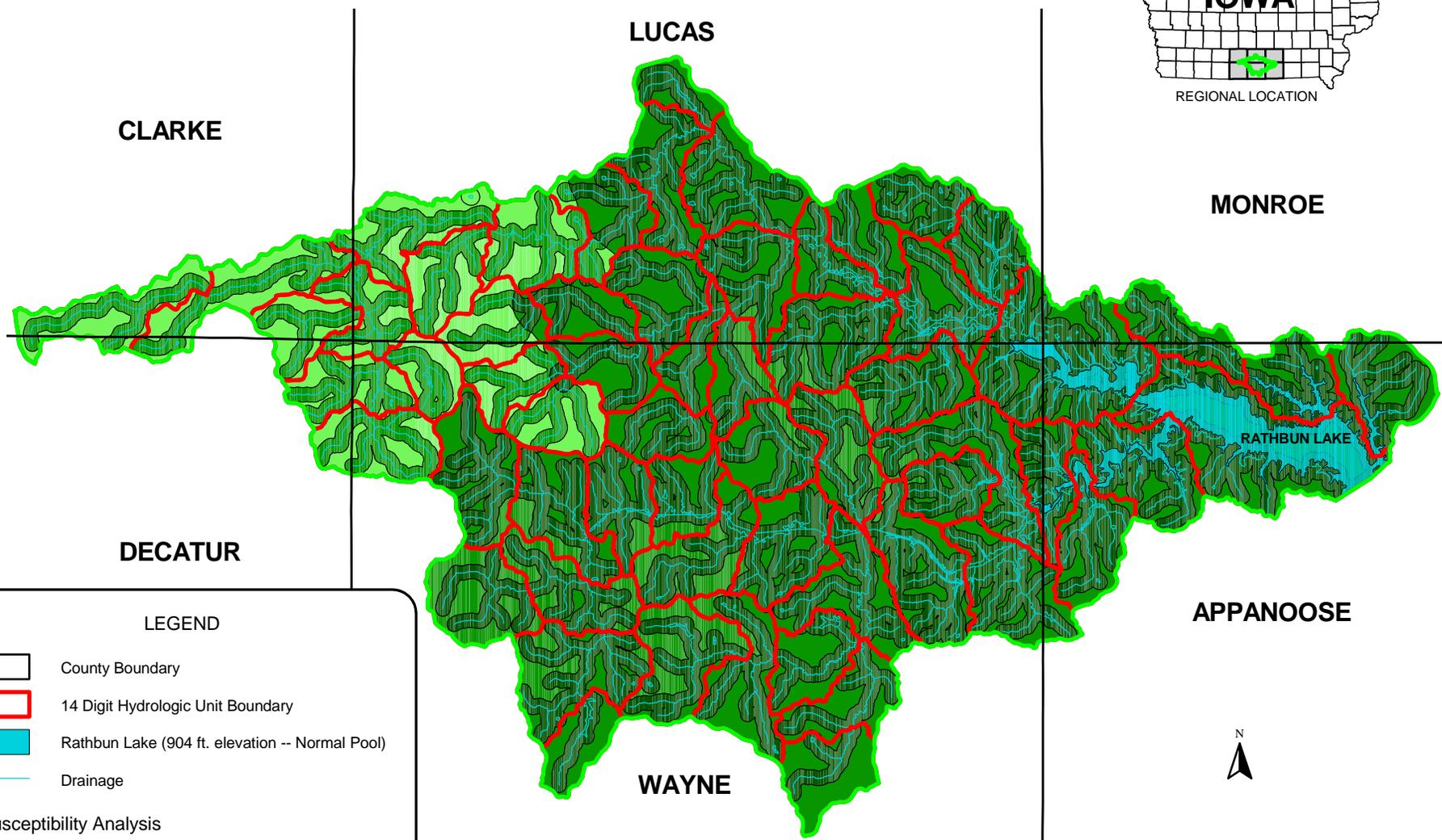
Livestock feeding operations: As stated above, the analysis determined that the potential for livestock operations to impair water quality in Rathbun Lake is high in 15 sub-watersheds. An estimated 47 of the 186 livestock operations that are located in the 15 sub-watersheds with a high potential for impairing water quality confine livestock, for example, in lots or buildings, for at least a portion of the year. The analysis found that many of these operations would benefit from the application of practices to control runoff and improve the storage, handling, and use of livestock waste. Figure 39 and Table 17 at the end of this section present the results of the susceptibility analysis for livestock operations.

Summary of potential non-point source susceptibility analysis: The analysis found that eroded soil in 23 sub-watersheds and farm chemicals in 15 sub-watersheds have a high to very high potential to impair water quality in Rathbun Lake. The analysis also found that riparian zone conditions in 13 sub-watersheds are relatively highly deteriorated and that the potential for livestock operations to impair water quality is high in 15 sub-watersheds. When considered together, the analysis determined that eroded soil and chemicals carried in runoff, deteriorated riparian zone conditions, and livestock operations in 12 sub-watersheds have a very high potential of impairing water quality in Rathbun Lake. The analysis identified an additional 15 sub-watersheds in which the combination of eroded soil, chemicals, riparian conditions, and livestock operations have a relatively high potential to impair water quality in the lake. Figure 40 and Table 18 at the end of this section present this summary of the susceptibility analysis for all potential non-point sources.

Eroded soil, chemicals, riparian conditions, and livestock operations in 12 sub-watersheds have a very high and in 15 sub-watersheds have a high potential to impair water quality in Rathbun Lake.

RATHBUN LAKE WATERSHED Susceptibility Analysis Areas South Central Iowa

Figure 18



CLARKE

LUCAS

MONROE

DECATUR

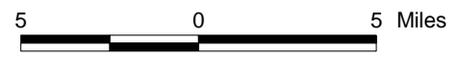
RATHBUN LAKE

APPANOOSE

WAYNE

LEGEND

-  County Boundary
-  14 Digit Hydrologic Unit Boundary
-  Rathbun Lake (904 ft. elevation -- Normal Pool)
-  Drainage
- Susceptibility Analysis**
-  Low Susceptibility
-  Moderate Suceptibility
-  High Suceptibility
-  Rathbun Lake Watershed (354,000 Acres)



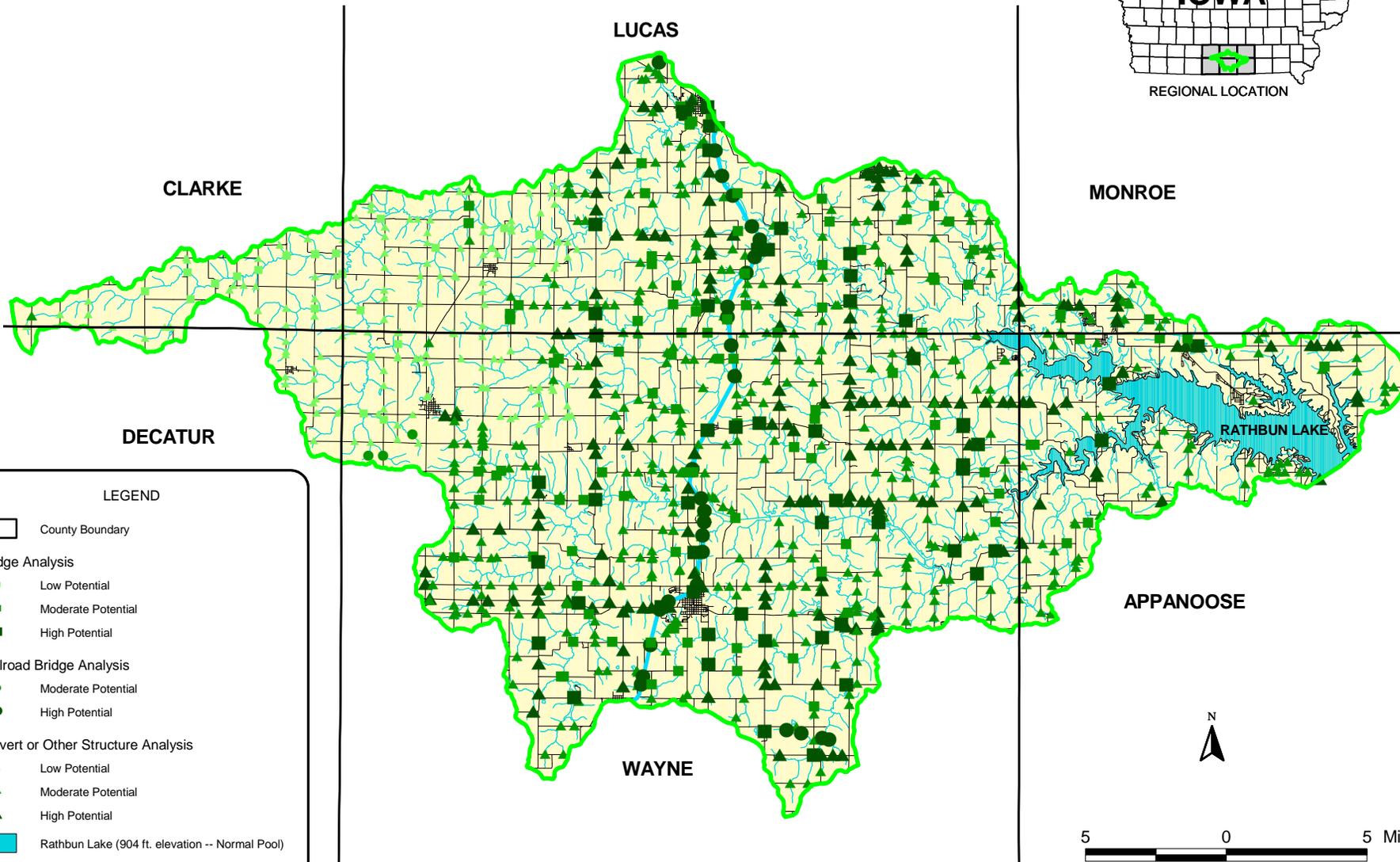
Source: Chariton Valley RC&D
Iowa DNR NRGIS
USDA Natural Resources Conservation Service
Prepared By: Rathbun Regional Water Association

RATHBUN LAKE WATERSHED

Drainage Intersections With Roads and Railroads Analysis

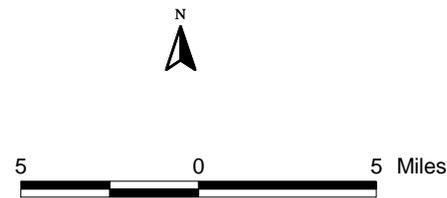
South Central Iowa

Figure 19



LEGEND

- County Boundary
- Bridge Analysis**
 - Low Potential
 - Moderate Potential
 - High Potential
- Railroad Bridge Analysis**
 - Moderate Potential
 - High Potential
- Culvert or Other Structure Analysis**
 - Low Potential
 - Moderate Potential
 - High Potential
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Railroad
- Roads
- Drainage (1:24000)
- Rathbun Lake Watershed (354,000 Acres)



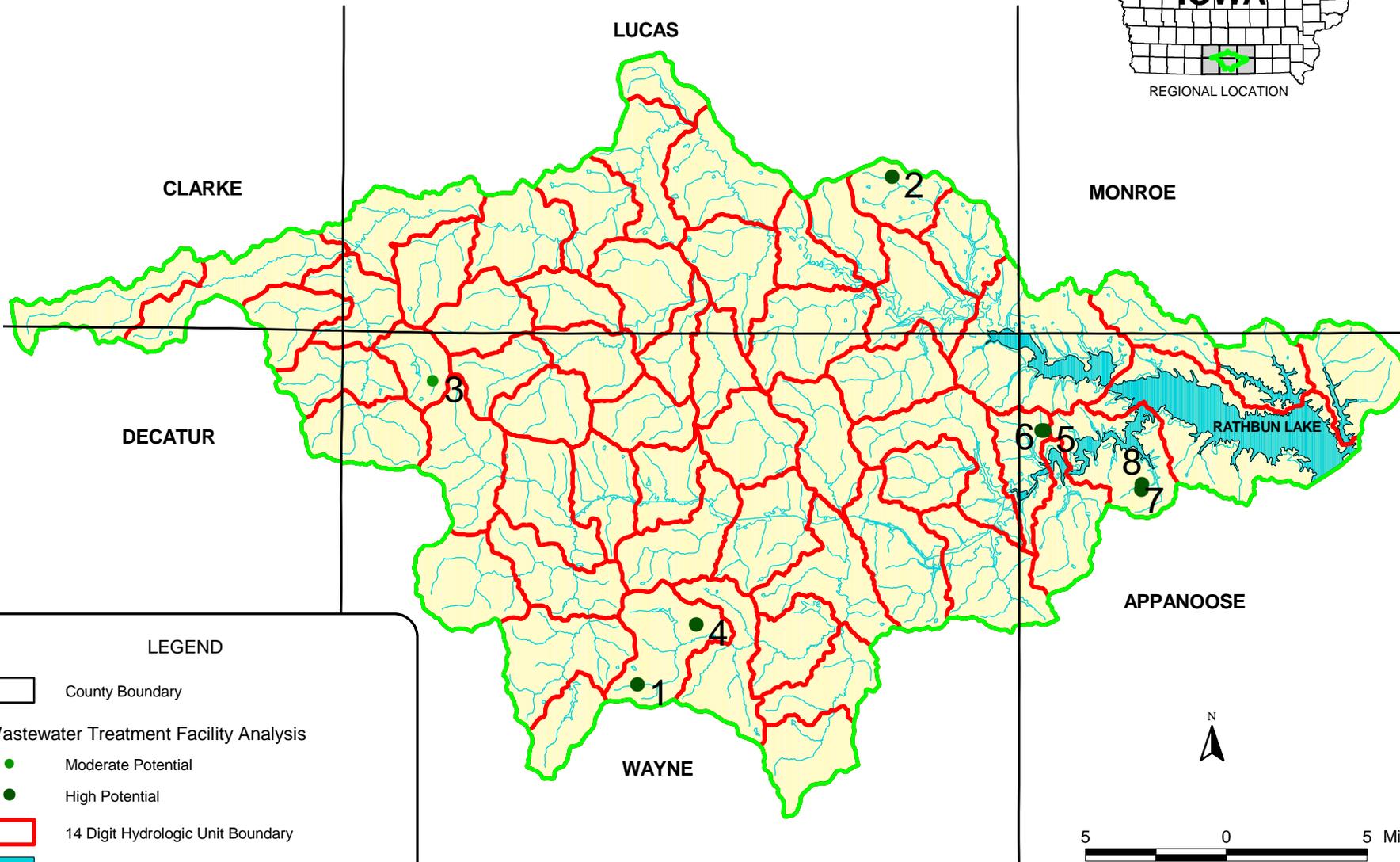
Source: Chariton Valley RC&D
Iowa DNR NRGIS
Iowa DOT Digital CAD Drawings
Prepared By: Rathbun Regional Water Association

Table 8

Roads, Railroads, and Streams Intersection Inventory and Analysis	
Rathbun Lake Watershed	
Bridge Intersections	Number
High Risk Potential	53
Moderate Risk Potential	101
Low Risk Potential	20
	Total
	174
Railroad Bridge Intersections	Number
High Risk Potential	29
Moderate Risk Potential	3
Low Risk Potential	0
	Total
	32
Culvert or Other Structure Intersections	Number
High Risk Potential	200
Moderate Risk Potential	474
Low Risk Potential	152
	Total
	826

RATHBUN LAKE WATERSHED Wastewater Treatment Facilities Analysis South Central Iowa

Figure 20



LEGEND

- County Boundary
- Wastewater Treatment Facility Analysis**
- Moderate Potential
- High Potential
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage
- Rathbun Lake Watershed (354,000 Acres)

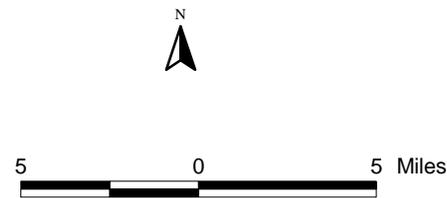
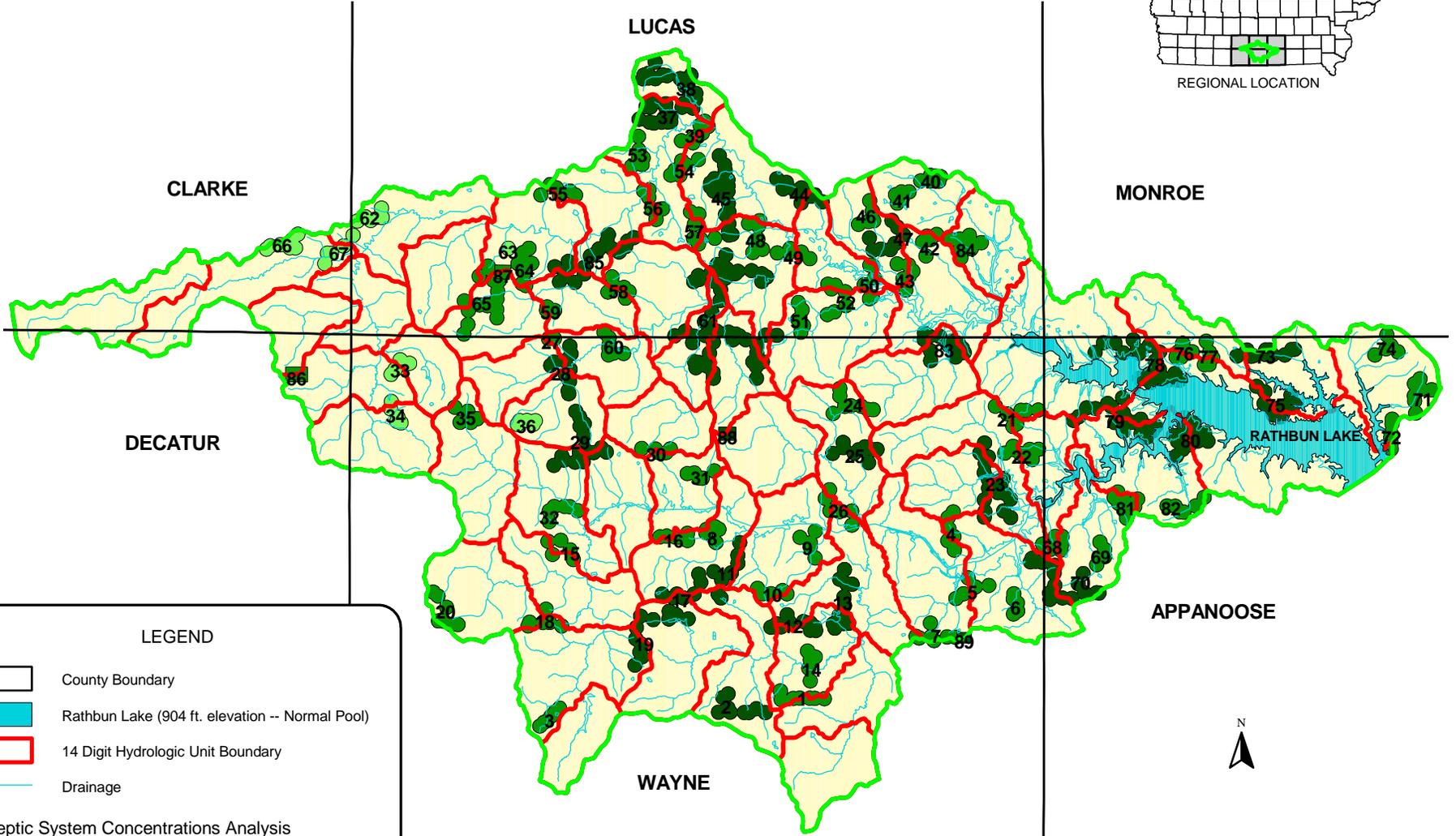


Table 9

Wastewater Treatment Facilities Inventory and Analysis				
Rathbun Lake Watershed				
ID	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score
1	5	5	5	15
2	5	5	5	15
3	1	5	5	11
4	5	5	5	15
5	5	5	5	15
6	5	5	5	15
7	5	5	5	15
8	5	5	5	15

RATHBUN LAKE WATERSHED Potential Septic System Concentrations Analysis South Central Iowa

Figure 21

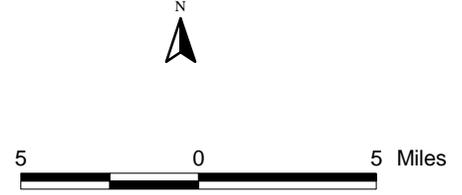


LEGEND

- County Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- 14 Digit Hydrologic Unit Boundary
- Drainage

Septic System Concentrations Analysis

- Low Potential
- Moderate Potential
- High Potential
- Rathbun Lake Watershed (354,000 Acres)



Source: Chariton Valley RC&D
Iowa DNR NRGIS
Prepared By: Rathbun Regional Water Association

Table 10

Potential Septic Systems Concentrations Inventory and Analysis							
Rathbun Lake Watershed							
ID	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score		Size of Area Score	Modified Score
1	5	5	2	12		2	14
2	5	5	2	12		3	15
3	5	5	2	12		1	13
4	5	5	2	12		2	14
5	5	5	2	12		2	14
6	5	5	2	12		1	13
7	5	5	2	12		2	14
8	5	5	2	12		1	13
9	5	5	2	12		2	14
10	5	5	2	12		1	13
11	5	5	2	12		3	15
12	5	5	2	12		3	15
13	5	5	2	12		3	15
14	5	5	2	12		1	13
15	5	5	2	12		2	14
16	5	5	2	12		1	13
17	5	5	2	12		3	15
18	5	5	2	12		2	14
19	5	5	2	12		3	15
20	5	5	2	12		2	14
21	5	5	2	12		2	14
22	5	5	2	12		2	14
23	5	5	2	12		4	16
24	5	5	2	12		2	14
25	5	5	2	12		3	15
26	5	5	2	12		2	14
27	5	5	2	12		1	13
28	5	5	2	12		3	15
29	5	5	2	12		4	16
30	5	5	2	12		1	13
31	5	5	2	12		1	13
32	5	5	2	12		2	14
33	1	5	2	8		1	9

Table 10

ID	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score		Size of Area Score	Modified Score
34	1	5	2	8		1	9
35	5	5	2	12		2	14
36	1	5	2	8		1	9
37	5	5	2	12		3	15
38	5	5	2	12		4	16
39	5	5	2	12		2	14
40	5	5	2	12		1	13
41	5	5	2	12		1	13
42	5	5	2	12		1	13
43	5	5	2	12		2	14
44	5	5	2	12		3	15
45	5	5	2	12		4	16
46	5	5	2	12		1	13
47	5	5	2	12		3	15
48	5	5	2	12		2	14
49	5	5	2	12		1	13
50	5	5	2	12		2	14
51	5	5	2	12		1	13
52	5	5	2	12		2	14
53	5	5	2	12		2	14
54	5	5	2	12		2	14
55	5	5	2	12		2	14
56	5	5	2	12		2	14
57	5	5	2	12		2	14
58	5	5	2	12		2	14
59	5	5	2	12		1	13
60	5	5	2	12		2	14
61	5	5	2	12		5	17
62	1	5	2	8		1	9
63	1	5	2	8		1	9
64	5	5	2	12		2	14
65	1	5	2	8		4	12
66	1	5	2	8		2	10
67	1	5	2	8		2	10
68	5	5	2	12		2	14
69	5	5	2	12		1	13

Table 10

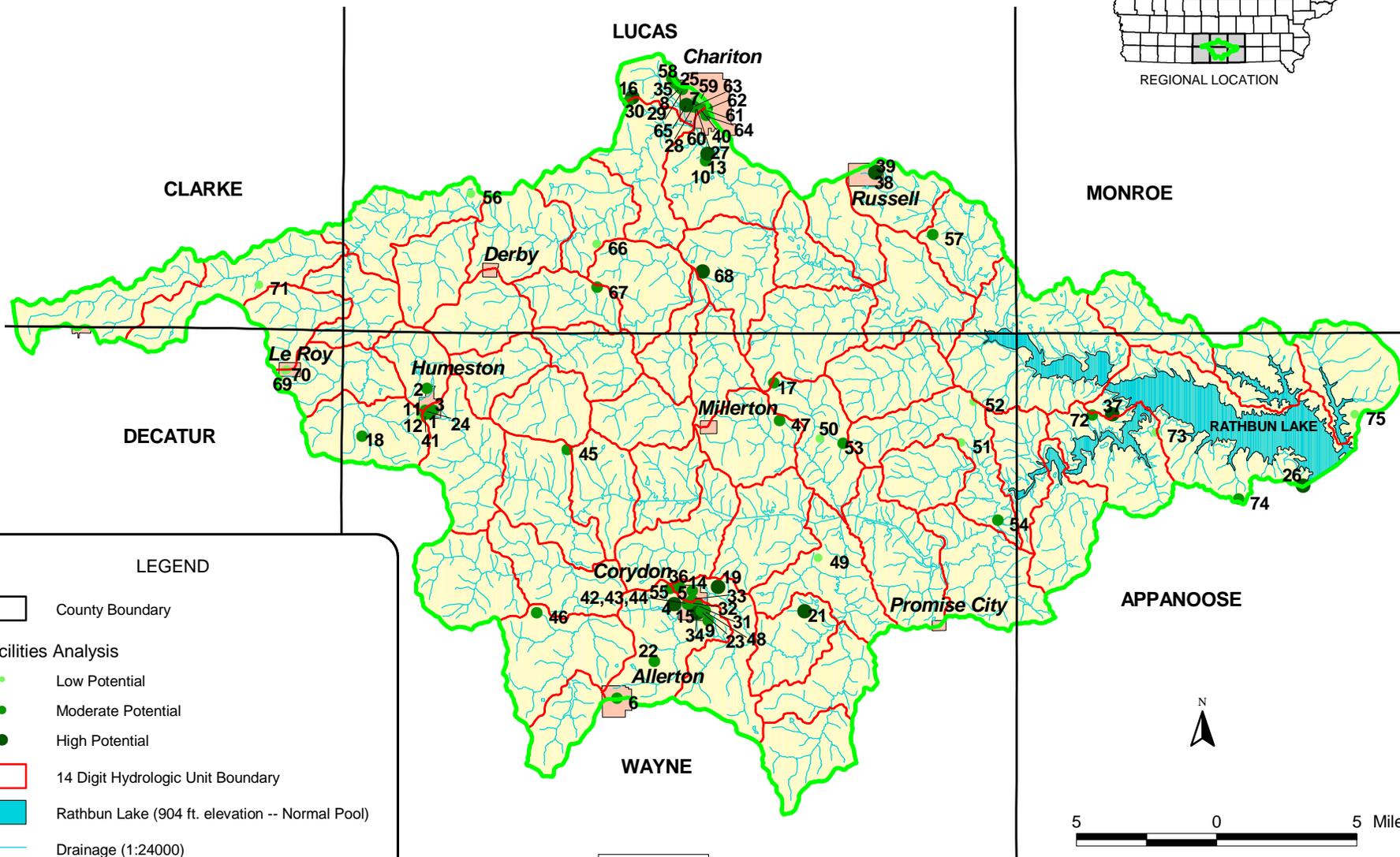
ID	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score		Size of Area Score	Modified Score
70	5	5	2	12		4	16
71	5	5	2	12		2	14
72	5	5	2	12		1	13
73	5	5	2	12		3	15
74	5	5	2	12		2	14
75	5	5	2	12		3	15
76	5	5	2	12		1	13
77	5	5	2	12		1	13
78	5	5	2	12		4	16
79	5	5	2	12		4	16
80	5	5	2	12		3	15
81	5	5	2	12		2	14
82	5	5	2	12		2	14
83	5	5	2	12		3	15
84	5	5	2	12		2	14
85	5	5	2	12		4	16
86	1	5	2	8		5	13
87	1	5	2	8		5	13
88	5	5	2	12		5	17
89	5	5	2	12		5	17

RATHBUN LAKE WATERSHED

Institutional, Retail, and Industrial Facilities Analysis

South Central Iowa

Figure 22



LEGEND

- County Boundary
- Facilities Analysis**
- Low Potential
- Moderate Potential
- High Potential
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage (1:24000)
- City or Town
- Rathbun Lake Watershed (354,000 Acres)



Source: Chariton Valley RC&D
Iowa DNR NRGIS
US Bureau of Census Tiger Data
US Army Corps of Engineers
Wayne County SWCD
EPA Basins Data
Prepared By: Rathbun Regional Water Association

Table 11

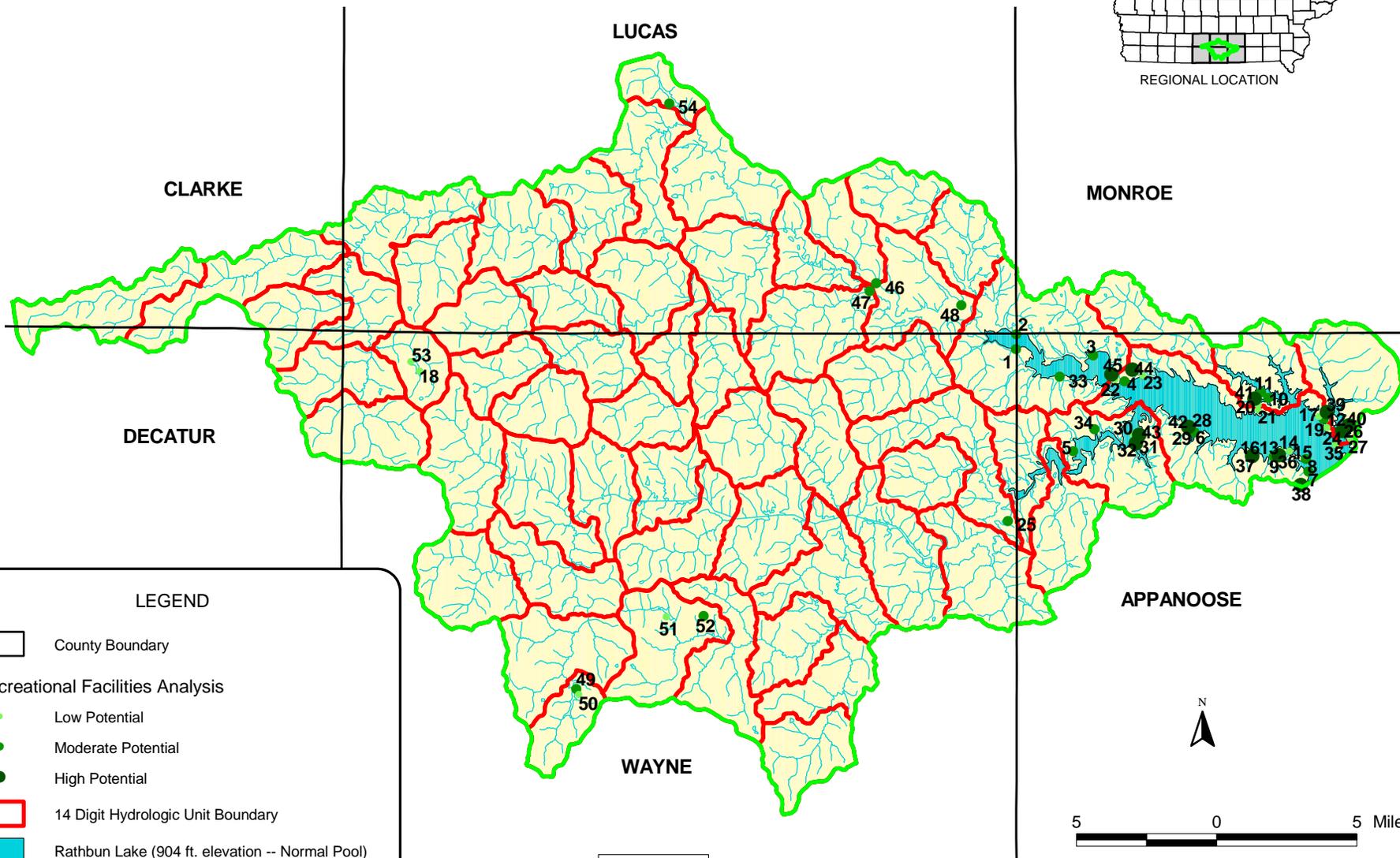
Institutional, Retail, and Industrial Facilities Inventory and Analysis						
Rathbun Lake Watershed						
ID	Type	Land Use Score Type	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score
1	Agricultural	Commercial	5	1	4	10
2	Agricultural	Commercial	1	5	4	10
3	Agricultural	Commercial	5	1	4	10
4	Agricultural	Commercial	5	5	4	14
5	Agricultural	Commercial	5	1	4	10
6	Agricultural	Commercial	5	1	4	10
7	Pesticide	Commercial	5	1	4	10
8	Agricultural	Commercial	5	1	4	10
9	Agricultural	Commercial	5	1	4	10
10	Agricultural	Commercial	5	1	4	10
11	Agricultural	Commercial	1	1	4	6
12	Agricultural	Commercial	1	1	4	6
13	County	Institutional	5	5	4	14
14	County	Institutional	5	1	4	10
15	Pesticide	Commercial	5	1	4	10
16	Airport	Commercial	5	5	4	14
17	Airport	Commercial	5	1	4	10
18	Airport	Commercial	1	5	4	10
19	Airport	Commercial	5	5	4	14
21	Airport	Commercial	5	5	4	14
22	Airport	Commercial	5	1	4	10
23	Hospital	Institutional	5	1	4	10
24	UST	Underground St. Tank	5	1	5	11
25	UST	Underground St. Tank	5	1	5	11
26	UST	Underground St. Tank	5	5	5	15
27	UST	Underground St. Tank	5	1	5	11
28	UST	Underground St. Tank	5	1	5	11
29	UST	Underground St. Tank	5	1	5	11
30	UST	Underground St. Tank	5	1	5	11
31	UST	Underground St. Tank	5	1	5	11
32	UST	Underground St. Tank	5	1	5	11
33	UST	Underground St. Tank	5	1	5	11
34	UST	Underground St. Tank	5	5	5	15
35	UST	Underground St. Tank	5	1	5	11
36	Industrial	Industrial	5	1	5	11
37	Agricultural	Commercial	5	5	4	14
38	Educational	Institutional	5	5	4	14

Table 11

ID	Type	Land Use Score Type	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score
39	Educational	Institutional	5	5	4	14
40	Educational	Institutional	5	1	4	10
41	Educational	Institutional	5	1	4	10
42	Educational	Institutional	5	1	4	10
43	Educational	Institutional	5	1	4	10
44	Educational	Institutional	5	1	4	10
45	Churches	Churches	5	5	2	12
46	Churches	Churches	5	5	2	12
47	Churches	Churches	5	5	2	12
48	Institutional	Institutional	5	1	4	10
49	Churches	Churches	5	1	2	8
50	Churches	Churches	5	1	2	8
51	Churches	Churches	5	1	2	8
52	Churches	Churches	5	1	2	8
53	Churches	Churches	5	5	2	12
54	Churches	Churches	5	5	2	12
55	Commercial	Commercial	5	1	4	10
56	Churches	Churches	1	1	2	4
57	Churches	Churches	5	5	2	12
58	Institutional	Institutional	5	1	4	10
59	Churches	Churches	5	1	2	8
60	Churches	Churches	5	1	2	8
61	Institutional	Institutional	5	1	4	10
62	Institutional	Institutional	5	1	4	10
63	Commercial	Commercial	5	1	4	10
64	Institutional	Institutional	5	1	4	10
65	Retail Commercial	Retail Commercial	5	5	5	15
66	Churches	Churches	5	1	2	8
67	Educational	Institutional	5	1	4	10
68	Educational	Institutional	5	5	4	14
69	Educational	Institutional	1	1	4	6
70	Churches	Churches	1	1	2	4
71	Churches	Churches	1	1	2	4
72	Churches	Churches	5	5	2	12
73	Churches	Churches	5	1	2	8
74	Churches	Churches	5	5	2	12
75	Churches	Churches	5	1	2	8

RATHBUN LAKE WATERSHED Recreational Facilities Analysis South Central Iowa

Figure 23



LEGEND

- County Boundary
- Recreational Facilities Analysis**
- Low Potential
- Moderate Potential
- High Potential
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage (1:24000)
- Rathbun Lake Watershed (354,000 Acres)

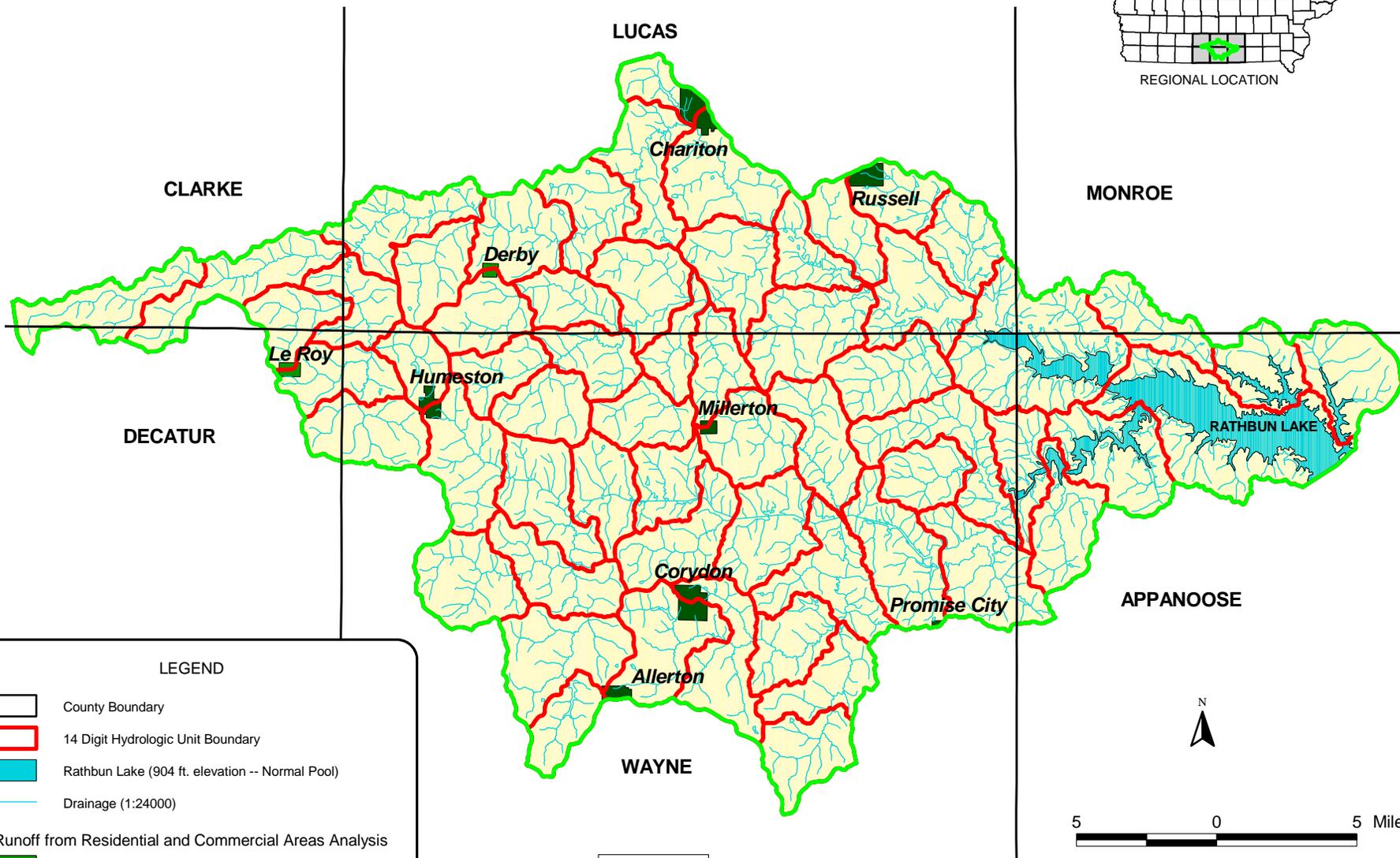


Table 12

Recreational Facilities Inventory and Analysis					
Rathbun Lake Watershed					
ID	Type	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score
1	Boat Ramp	5	5	2	12
2	Boat Ramp	5	5	2	12
3	Boat Ramp	5	5	2	12
4	Boat Ramp	5	5	2	12
5	Boat Ramp	5	5	2	12
6	Boat Ramp	5	5	2	12
7	Boat Ramp	5	5	2	12
8	Boat Ramp	5	5	2	12
9	Boat Ramp	5	5	2	12
10	Boat Ramp	5	5	2	12
11	Boat Ramp	5	5	2	12
12	Boat Ramp	5	5	2	12
13	Campground	5	5	1	11
14	Campground	5	5	1	11
15	Campground	5	5	1	11
16	Campground	5	5	1	11
17	Campground	5	5	1	11
19	Campground	5	5	1	11
20	Campground	5	5	1	11
21	Campground	5	5	1	11
22	Campground	5	5	1	11
23	Campground	5	5	1	11
24	Boat Ramp	5	5	2	12
26	Marina	5	5	5	15
27	Campground	5	5	1	11
28	Campground	5	5	1	11
29	Campground	5	5	1	11
30	Campground	5	5	1	11
31	Boat Ramp	5	5	2	12
32	Marina	5	5	5	15
33	Boat Ramp	5	5	2	12
34	Boat Ramp	5	5	2	12
35	Campground	5	5	1	11
36	Lagoon	5	5	5	15
37	Lagoon	5	5	5	15
38	Lagoon	5	5	5	15
39	Lagoon	5	5	5	15
40	Lagoon	5	5	5	15
41	Lagoon	5	5	5	15
42	Lagoon	5	5	5	15
43	Lagoon	5	5	5	15
44	Lagoon	5	5	5	15
45	Lagoon	5	5	5	15
46	Boat Ramp	5	5	2	12
47	Boat Ramp	5	5	2	12
48	Boat Ramp	5	5	2	12
49	Boat Ramp	5	5	2	12
50	Campground	5	5	1	11
51	Campground	5	5	1	11
25	Boat Ramp	5	5	2	12
18	Boat Ramp	1	5	2	8
52	Golf Course	5	5	3	13
53	Golf Course	1	5	3	9
54	Golf Course	5	5	3	13

RATHBUN LAKE WATERSHED Residential and Commercial Areas Analysis South Central Iowa

Figure 24

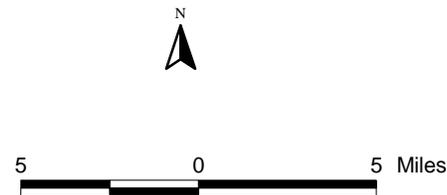


LEGEND

- County Boundary
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage (1:24000)

Runoff from Residential and Commercial Areas Analysis

- Moderate Potential
- High Potential
- Rathbun Lake Watershed (354,000 Acres)



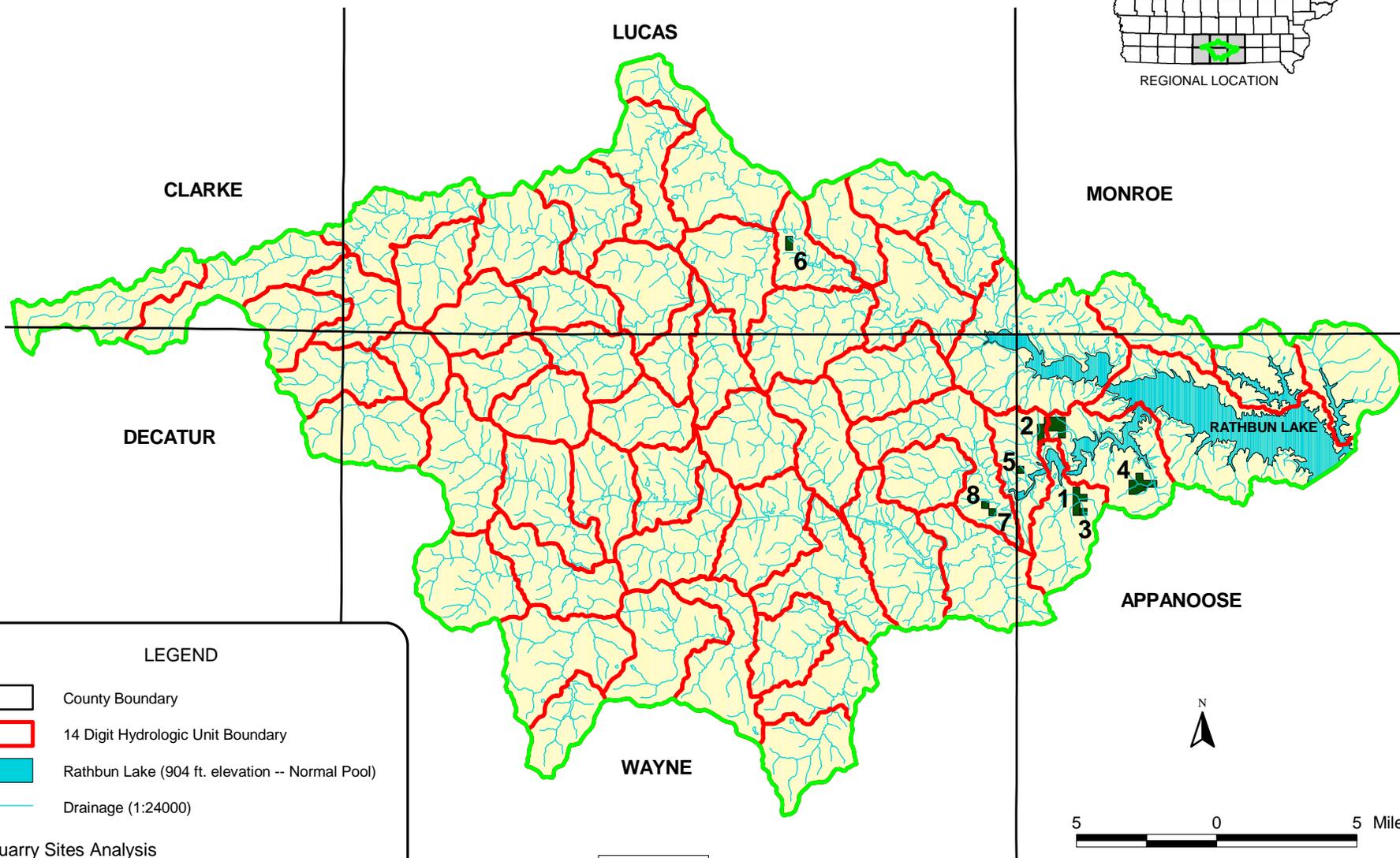
Source: Chariton Valley RC&D
Iowa DNR NRGIS
US Army Corps of Engineers
Wayne County SWCD
Prepared By: Rathbun Regional Water Association

Table 13

Runoff From Residential and Commercial Areas Inventory and Analysis					
Rathbun Lake Watershed					
ID	Place Name	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score
1	Derby	1	5	4	10
2	Le Roy	1	5	4	10
3	Humeston	5	5	4	14
4	Millerton	5	5	4	14
5	Corydon	5	5	4	14
6	Chariton	5	5	4	14
7	Russell	5	5	4	14
8	Allerton	5	5	4	14
9	Promise City	5	5	4	14

RATHBUN LAKE WATERSHED Quarry Sites Analysis South Central Iowa

Figure 25

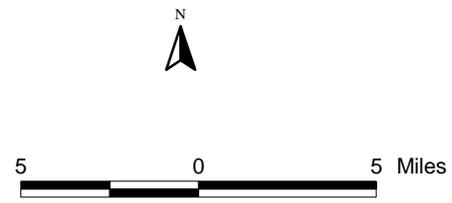


LEGEND

- County Boundary
- 14 Digit Hydrologic Unit Boundary
- Rathbun Lake (904 ft. elevation -- Normal Pool)
- Drainage (1:24000)

Quarry Sites Analysis

- High Potential
- Rathbun Lake Watershed (354,000 Acres)



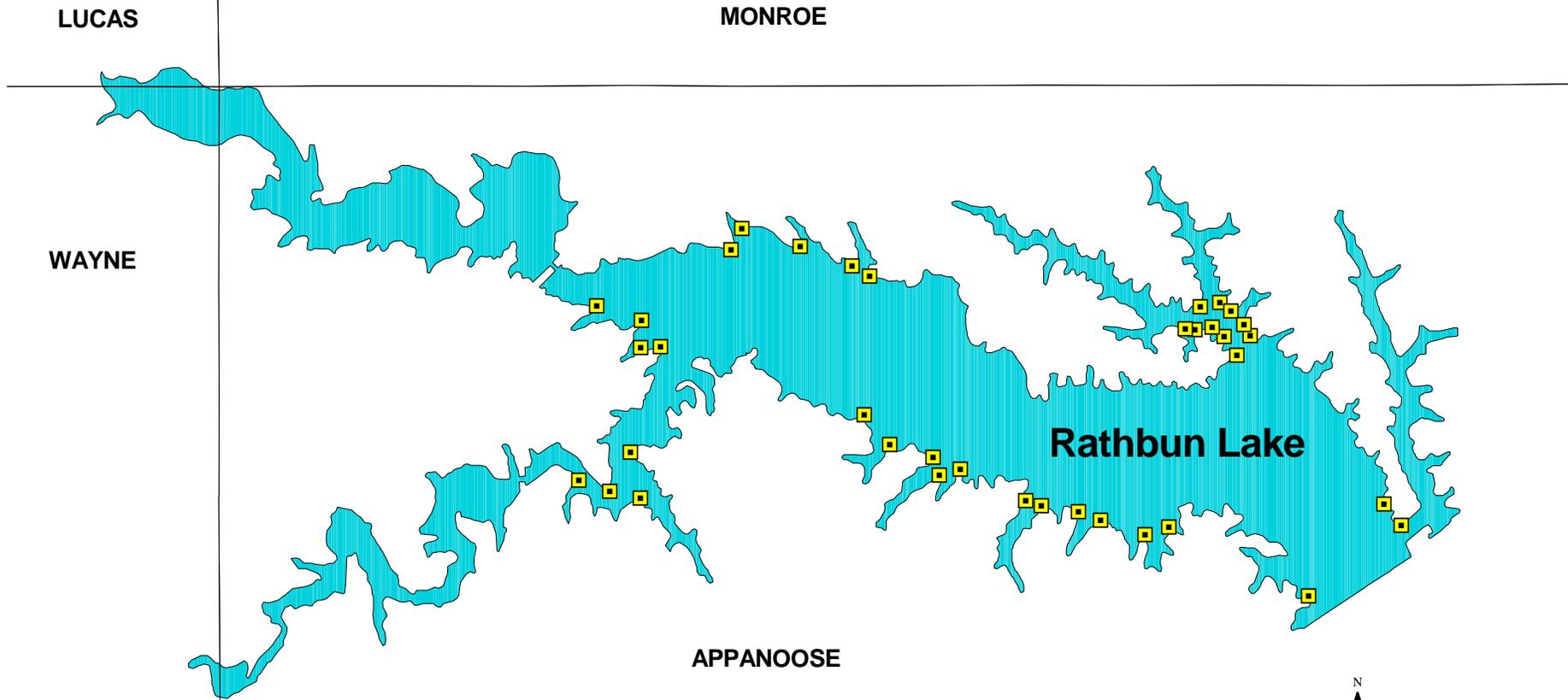
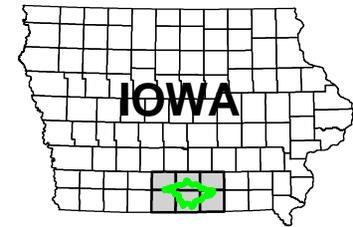
Source: Chariton Valley RC&D
Iowa DNR NRGIS
US Army Corps of Engineers
Wayne County SWCD
Prepared By: Rathbun Regional Water Association

Table 14

Quarry Sites Inventory and Analysis				
Rathbun Lake Watershed				
ID	24 Hour Time of Travel Score	1/4 Mile Buffer Score	Land Use Score	Total Score
1	5	5	3	13
2	5	5	3	13
3	5	5	3	13
4	5	5	3	13
5	5	5	3	13
6	5	5	3	13
7	5	5	3	13
8	5	5	3	13

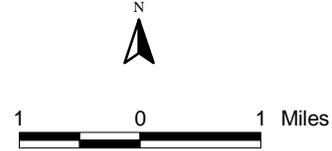
Shoreline Erosion Analysis Rathbun Lake South Central Iowa

Figure 26



LEGEND

-  County Boundaries
-  Priority Shoreline Erosion Control Sites
-  Rathbun Lake (904 Ft. Pool Elevation)

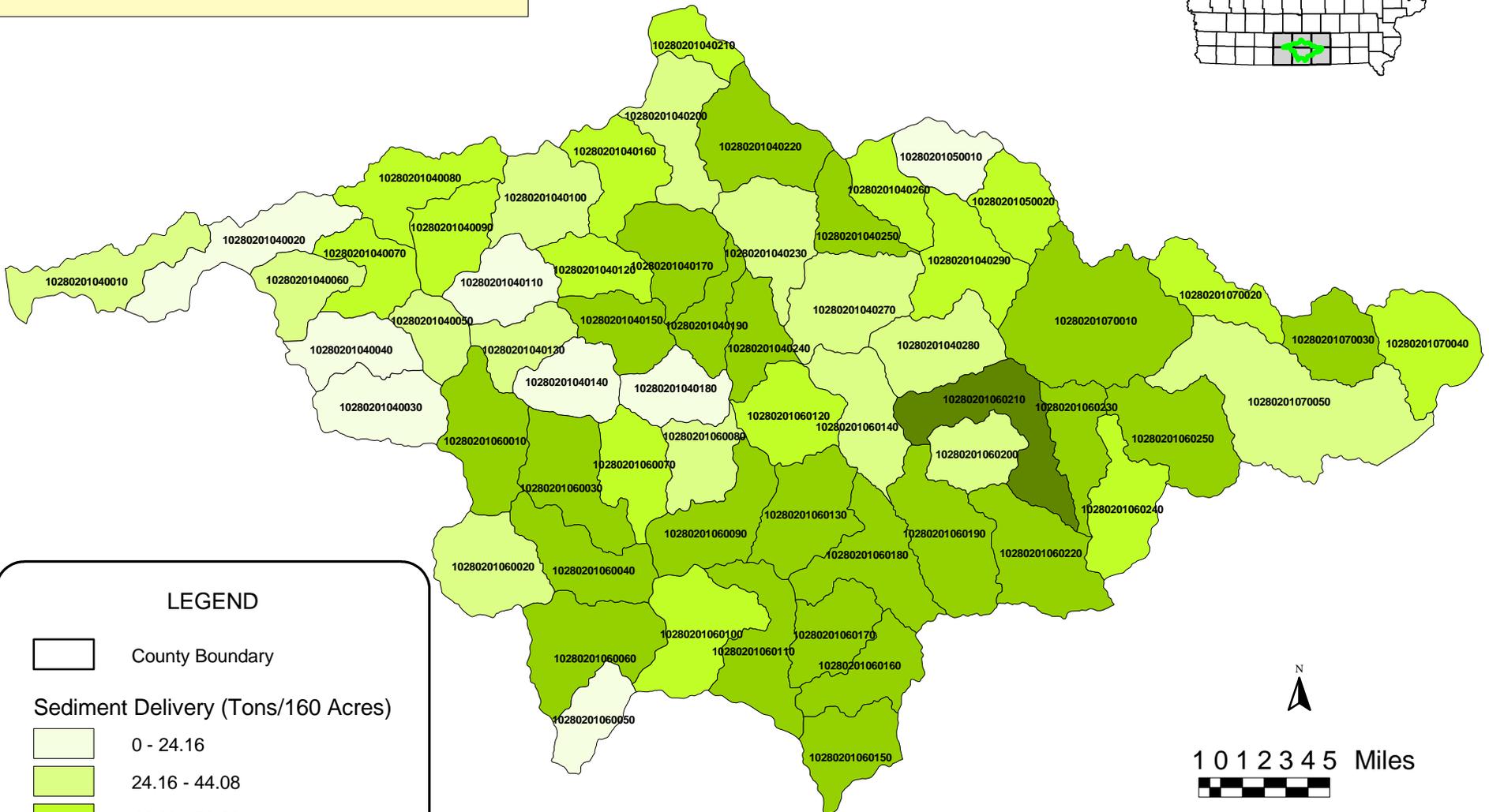
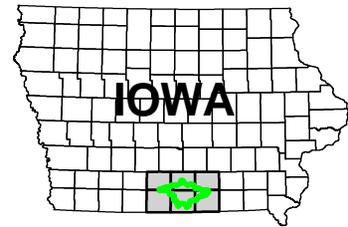


Source: Chariton Valley RC&D
Iowa DNR Fisheries Bureau, Larry R. Mitzner
US Army Corps of Engineers
Iowa DNR NRGIS

Prepared By: Rathbun Regional Water Association

Estimated Delivered Streambank Erosion 3 - 160 Acre Plot Average Rathbun Lake Subwatersheds

Figure 27



LEGEND

County Boundary

Sediment Delivery (Tons/160 Acres)

	0 - 24.16
	24.16 - 44.08
	44.08 - 56.06
	56.06 - 77.29
	77.29 - 96.92

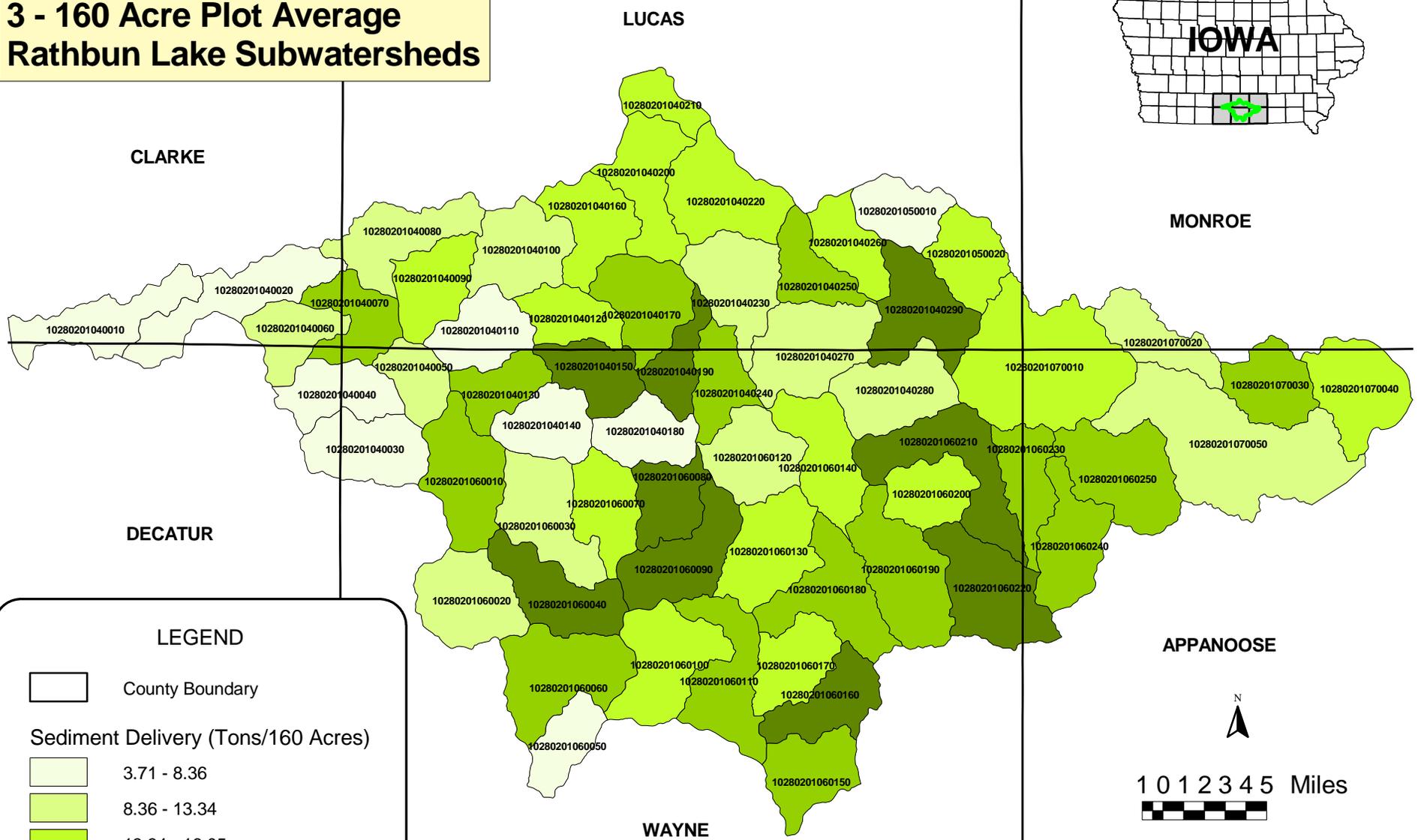


Source:
Iowa State University
Chariton Valley RC&D
Wayne County SWCD

Prepared By:
Rathbun Regional Water Association

Figure 28

**Estimated Delivered
Gully Erosion
3 - 160 Acre Plot Average
Rathbun Lake Subwatersheds**

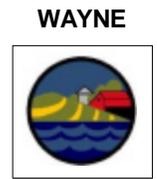


LEGEND

County Boundary

Sediment Delivery (Tons/160 Acres)

Lightest Green	3.71 - 8.36
Light Green	8.36 - 13.34
Medium Green	13.34 - 16.05
Dark Green	16.05 - 18.48
Darkest Green	18.48 - 22.75



APPANOOSE

N

1 0 1 2 3 4 5 Miles

Source:
Iowa State University
Chariton Valley RC&D
Wayne County SWCD

Prepared By:
Rathbun Regional Water Association