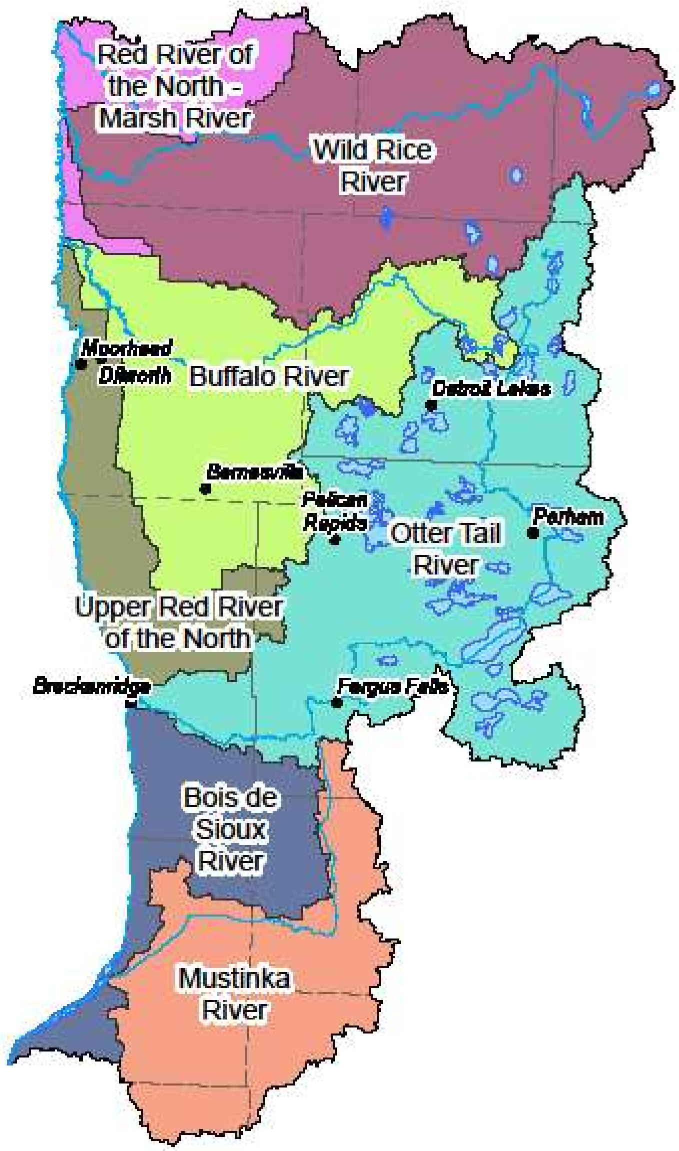
Prioritization of Wetland Restoration Opportunities in the Upper Red River Watershed - Baseline Conditions Report



U.S. Army Corps of Engineers, St. Paul District

Minnesota Board of Water and Soil Resources

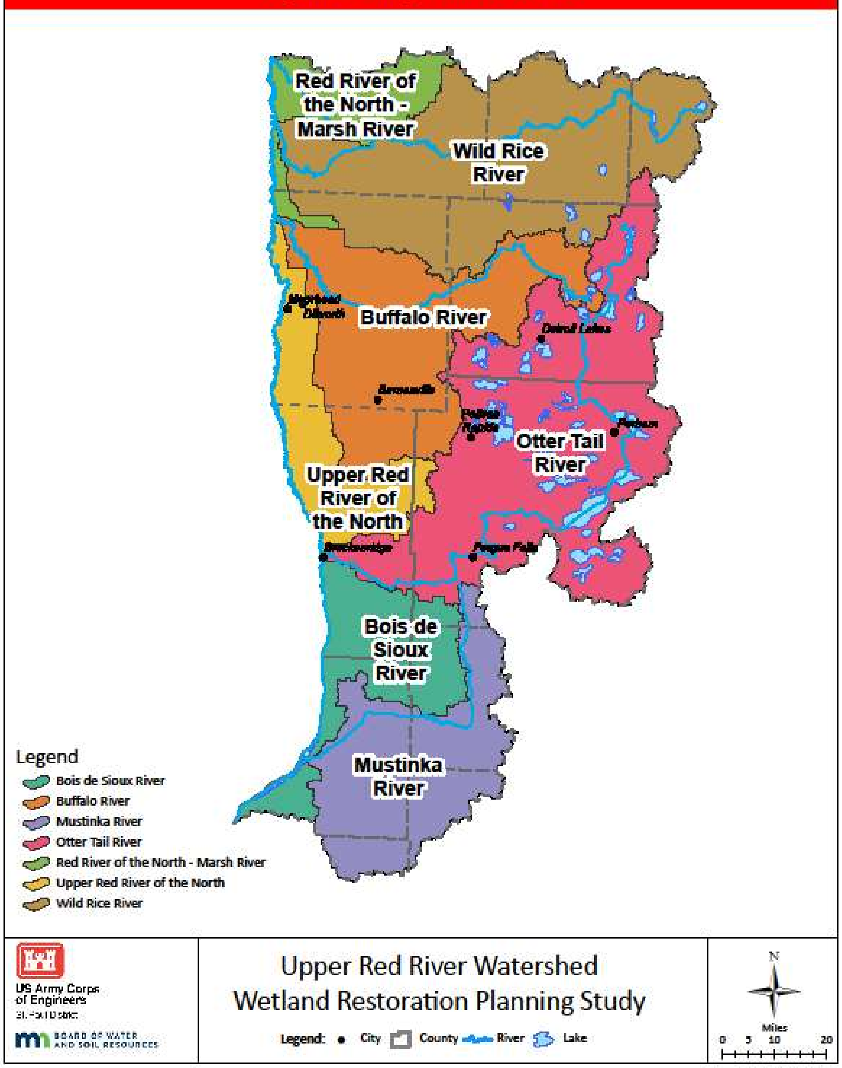
May 2021

Contents

Upper Red River Watershed

The Upper Red River Watershed (URRW) encompasses approximately 6,954 square miles in Western Minnesota. This area is also referred to as Bank Service Area 4 by the state and federal agencies that oversee wetland mitigation programs in Minnesota and represents the Upper Red River 6-digit Hydrologic Unit Code (HUC) within the State. The URRW contains seven major watersheds as defined by the Minnesota Department of Natural Resources (MnDNR)[1]. From south to north, the major watersheds include the Mustinka River, Bois de Sioux River, Otter Tail River, Upper Red River of the North, Buffalo River, Wild Rice River, and Red River of the North – Marsh River. Major watersheds are shown on Figure 1 and described below.

Figure 1: Major Watersheds



[1] The URRW contains a major watershed with an almost identical name. To avoid confusion, the acronym URRW will refer to the entire study area and references to the Upper Red River of the North major watershed will always include "major watershed" in the text.

Bois de Sioux River

The Bois de Sioux River and its source, Lake Traverse, form the boundary between Minnesota and South and North Dakota. The Bois de Sioux River flows north from Lake Traverse to Breckenridge where it joins with the Otter Tail River to form the Red River of the North. The Bois de Sioux River watershed includes approximately 355,936 acres (556 square miles) in the extreme southern portion of the URRW within Grant, Wilkin, Otter Tail, and Traverse counties. Approximately 87% of the watershed area is in row crop production of corn, soybeans, sugar beets, and wheat. According to the 2010 census data, this watershed is sparsely populated relative to the state as a whole and the population decreased 13% between 2000 and 2010 according to census data. The largest cities include Wendell (population of 167), Campbell (158) and Western (129).

Mustinka River

The Mustinka River watershed includes approximately 550,853 acres (861 square miles) in the southern portion of the URRW including areas of Otter Tail, Grant, Stevens, Big Stone, and Traverse Counties. The Mustinka River discharges into Traverse Lake, the headwater of the Bois de Sioux River. The predominant land use is cultivated cropland which accounts for 86% of the watershed area. The watershed has two distinct regions, the headwater region in the northeast characterized by steeper topography and many small lakes and wetlands, and the downstream agricultural region characterized by flat topography and cultivated cropland (MPCA 2016).The population in the watershed in 2010 was 6,505, a decrease of 724 (10%) from the 2000 census. The largest cities include Wheaton (1,424) and Elbow Lake (1,176).

Otter Tail River

The Otter Tail River watershed includes approximately 1,222,028 acres (1,909 square miles) in the eastern portion of the URRW. The majority of the watershed is within the counties of Otter Tail and Becker; however, smaller portions extend into Wilkin, Clearwater, Clay, and Mahnomen counties. The watershed contains over 1,300 lakes, more than any other Red River Basin Watershed. Many of these lakes are greater than 1,000 acres in size and considered high value recreational resources. The major land uses include crops (41%), forest (27%) and water (15%). The population in the watershed was 68,454 in 2010, an increase of 1,770 (2%) from the 2000 census. The largest cities include Fergus Falls (13,138), Detroit Lakes (8,569) and Breckenridge (3,386).

Upper Red River of the North

The Upper Red River of the North watershed is in the west central portion of the URRW and includes approximately 319,534 acres (499 square miles) covering four intermediate watersheds and 38 minor watersheds. It originates at the confluence of the Bois de Sioux and Otter Tail Rivers and culminates 133 river miles to the north at the outlet of the Buffalo River. Whiskey Creek and Wolverton Creek are the two main tributaries to the Upper Red River of the North in this major watershed. Both tributaries are characterized as extensively channelized low gradient systems with a significant number of drainage ditches contributing to them. The Upper Red River of the North major watershed includes portions of three Minnesota counties: Clay, Otter Tail and Wilkin. Agriculture is the dominant land use with 86% of the watershed in crops. The population in the watershed was 47,720 in 2010, an increase of 6,691 (16%) from the 2000 census. The largest cities include Moorhead (38,065) and Dilworth (4,024).

Buffalo River

The Buffalo River watershed is in the north central portion of the URRW and includes approximately 724,096 acres (1,131 square miles) within Clay, Becker, Wilkin, and Otter Tail counties. Land use within the watershed is predominantly agricultural, occurring in the west and central portions while the eastern portion of the watershed remains mostly forested. The population increased by 8% between 2000 and 2010 (from 15,924 to 17,221). The largest cities in the watershed include Barnesville (2,563), Hawley (2,067) and Glyndon (1,394).

Red River of the North – Marsh River

The Red River of the North – Marsh River watershed lies within the northwestern corner of the watershed in Norman and Clay counties and is the smallest at 231,542 acres (362 square miles) within the URRW. The watershed has 570 miles of stream length including 51 miles of the Marsh River in addition to multiple streams and small tributaries flowing into the Marsh River. There are no notable lakes in the watershed. Agriculture is the dominant land use, with 87% of the watershed area in crops. The population decreased slightly from 2000 to 2010 (from 3,987 to 3,735). The largest cities in the watershed are Ada (1,707) and Halstad (597).

Wild Rice River

The Wild Rice River watershed is in the northern portion of the URRW and drains approximately 1,047,068 acres (1,636 square miles) across six counties: Becker, Clay, Mahnomen, Norman, Clearwater, and Polk. The headwaters of the Wild Rice River originate within Upper Rice Lake in the White Earth State Forest and flows for 200 miles before reaching its confluence with the Red River of the North, 3 miles south of Halstad. The major land cover in the watershed is crops and pasture (60%) with other notables including forest (22%) and wetlands (9%). The population remained relatively stable between 2000 (13,082) and 2010 (13,002). The largest cities include Mahnomen (1,214), White Earth (828) and Twin Valley (821).

Ecological Classification

The Ecological Classification System was developed by the MnDNR and the U.S. Forest Service for mapping and classifying landscape ecosystems. The system provides a nested set of classification units which, from broadest to most detailed, includes provinces, sections, subsections and land type associations. The provinces, sections, and subsections for each major watershed are identified in Table 1 and are shown on Figures 2, 3, and 4.

The URRW lies within three ecoregions – the Eastern Broadleaf Forest (EBF ecoregion), Laurentian Mixed Forest (LMF ecoregion), and the Prairie Parkland (PPA ecoregion) (Figure 2). The provinces are generally oriented in a north to south orientation and have a significant effect on the distribution of resources and land use in the URRW. The LMF ecoregion lies along the eastern boundary of the URRW and is characterized by broad areas of conifer forest, mixed hardwood and conifer forests, and conifer bogs, and swamps. The landscape ranges from rugged lake-dotted terrain with thin glacial deposits over bedrock, to hummocky or undulating plains with deep glacial drift, to large, flat, poorly drained peatlands. Further west, the EBF ecoregion serves as a transition between semi-arid portions that were historically prairie and semi-humid mixed conifer-deciduous forests to the east. The western boundary of this province in the URRW is an abrupt transition from forest and woodland to the open grassland of the PPA ecoregion. The PPA ecoregion coincides with the portion of the state that was historically dominated by tallgrass prairie. The land surface of this province was heavily influenced by the most recent glaciation and was part of the largest pro-glacial lake in North America, Glacial Lake Agassiz. As a result, this portion of the URRW is characterized by a layer of deep-water sediments ranging anywhere from 100 to 600 feet thick. The geography of this area is fairly flat and featureless, and its fertile soils are well suited for agricultural purposes (pasture, hay, row crop production).

A brief description of each subsection of the URRW is provided in the following paragraphs.

Table 1
Ecological Classification System Provinces, Sections and Subsections
In the Upper Red River Watershed

	Provinces			Sections				Subsections				
Major Watershed	Eastern Broadleaf Forest	Laurentian Mixed Forest	Prairie Parkland	Minnesota & NE Iowa Morainal	N. Minnesota Drift & Lake Plains	North Central Glaciated Plains	Red River Valley	Chippewa Plains	Hardwood Hills	Minnesota River Prairie	Pine Moraines & Outwash Plains	Red River Prairie
Boix de Sioux	-	-	100	-	-	26.5	73.5	-	-	26.5	-	73.5
Mustinka	-	-	100	-	-	60.4	39.6	-	-	60.4	-	39.6
Otter Tail	62.2	20.5	17.3	62.2	20.5	2.5	14.8	-	62.2	2.5	20.5	14.8
Upper Red	-	-	100	-	-	-	100	-	-	-	-	100
Buffalo	16	0.4	83.6	16	0.4	-	83.6	-	16.0	-	0.4	83.6
Red River N - Marsh	-	-	100	1.6	-	-	98.4	-	1.6	-	-	98.4
Wild Rice	14.5	18.8	66.7	14.4	18.8	-	66.8	10.8	14.4	-	8.0	66.8

Chippewa Plains Subsection

Level to gently rolling lake plains and glacial till plains characterize this subsection. Currently, the majority of this subsection is forested. Forestry, tourism, recreation, and agriculture are the most common land uses. Total annual precipitation ranges from 23 inches in the northwest to 27 inches in the east, of which approximately 40 percent occurs during the growing season. The growing season ranges from 111 to 131 days.

Hardwood Hills

Steep slopes, high hills, and lakes formed in glacial end moraines and outwash plains characterize this subsection. Presettlement vegetation included maple-basswood forests interspersed with oak savannas, tallgrass prairies, and oak forests. Much of this region is currently farmed. Where lakes are present, tourism is common. Total annual precipitation ranges from 24 inches in the west to 27 inches in the east. Growing season precipitation ranges from 10.5 to 11.5 inches. The growing season ranges from approximately 122 days in the north to 140 days in the south.

Minnesota River Prairie

This subsection consists of a gently rolling ground moraine about 60 miles wide (Hobbs and Goebel 1982). The Minnesota River occupies a broad valley that splits the subsection in half. The presettlement vegetation was primarily tallgrass prairie, with many islands of wet prairie (Kratz and Jensen 1983; Marschner 1974). Forests of silver maple, elm, cottonwood and willow grew on floodplains along the Minnesota River and other streams. Today, agriculture is the dominant land use within this subsection as it occupies the area referred to as the Minnesota Corn Belt. Annual precipitation ranges from 25 inches in the west to 30 inches in the east, with 11 to 13 inches of growing-season precipitation. Growing-season length is approximately 147 to 152 days.

Pine Moraines & Outwash Plains

This subsection consists of large outwash plains, narrow outwash channels and end moraines (Hobbs and Goebel 1982). There are hundreds of lakes within this subsection and current land uses include tourism, forestry and agriculture. Total annual precipitation ranges from 23 inches in the northwest to 27 inches in the east. Approximately 40 percent of precipitation occurs during the growing season which varies in length from 111 to 131 days.

Red River Prairie

Topography in this subsection is level to gently rolling and the major landform is a large lake plain (Glacial Lake Agassiz). Presettlement vegetation consisted of tallgrass prairie and wet prairie. Today, the most important land use is agriculture and the lake plain has been intensively ditched for this purpose. Total precipitation ranges from 21 inches in the northwest to 23 inches in the east, with roughly 40% occurring during the growing season. The growing season ranges from 111 to 136 days and is longest in the south.

Figure 2: Ecological Provinces

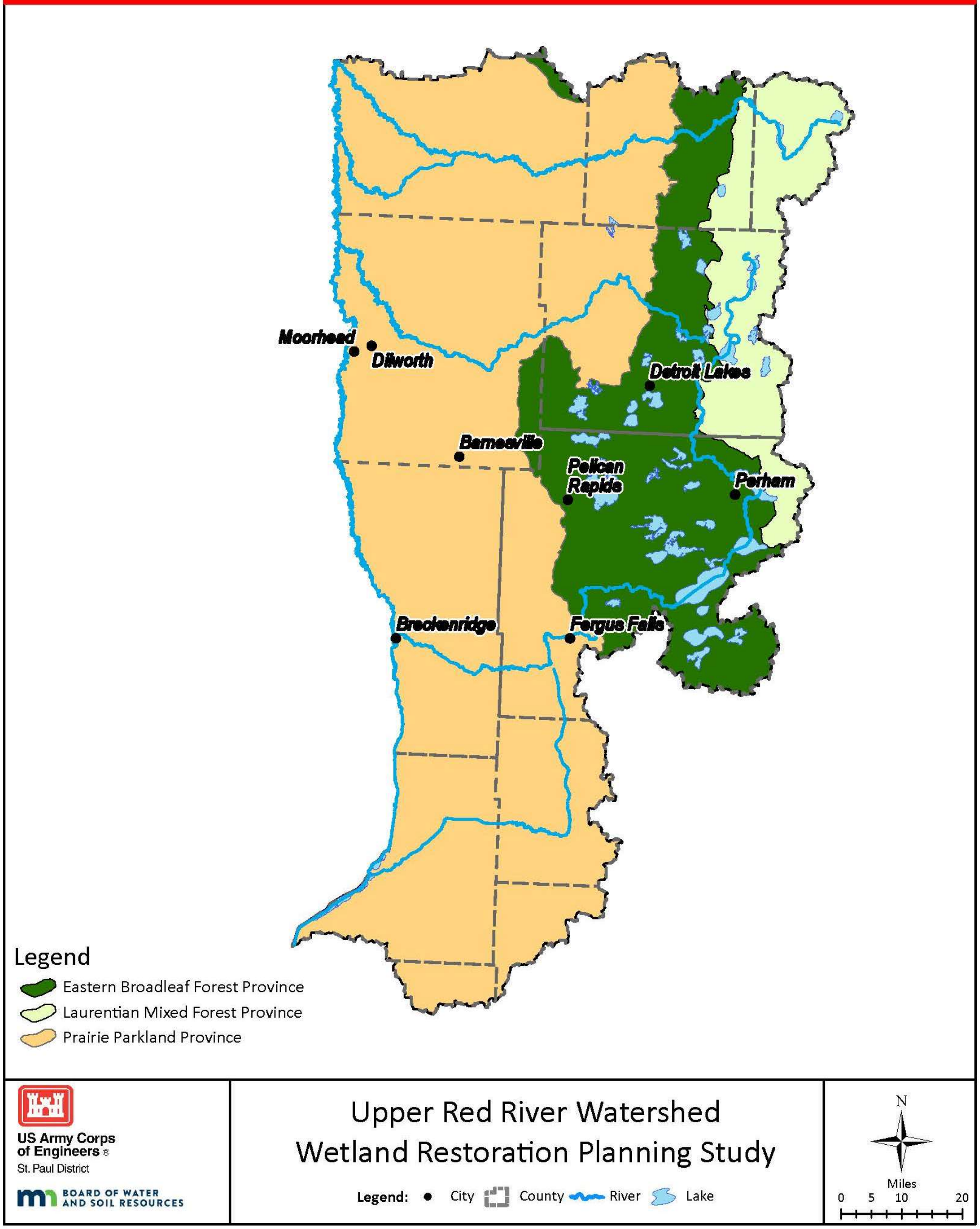


Figure 3: Ecological Sections

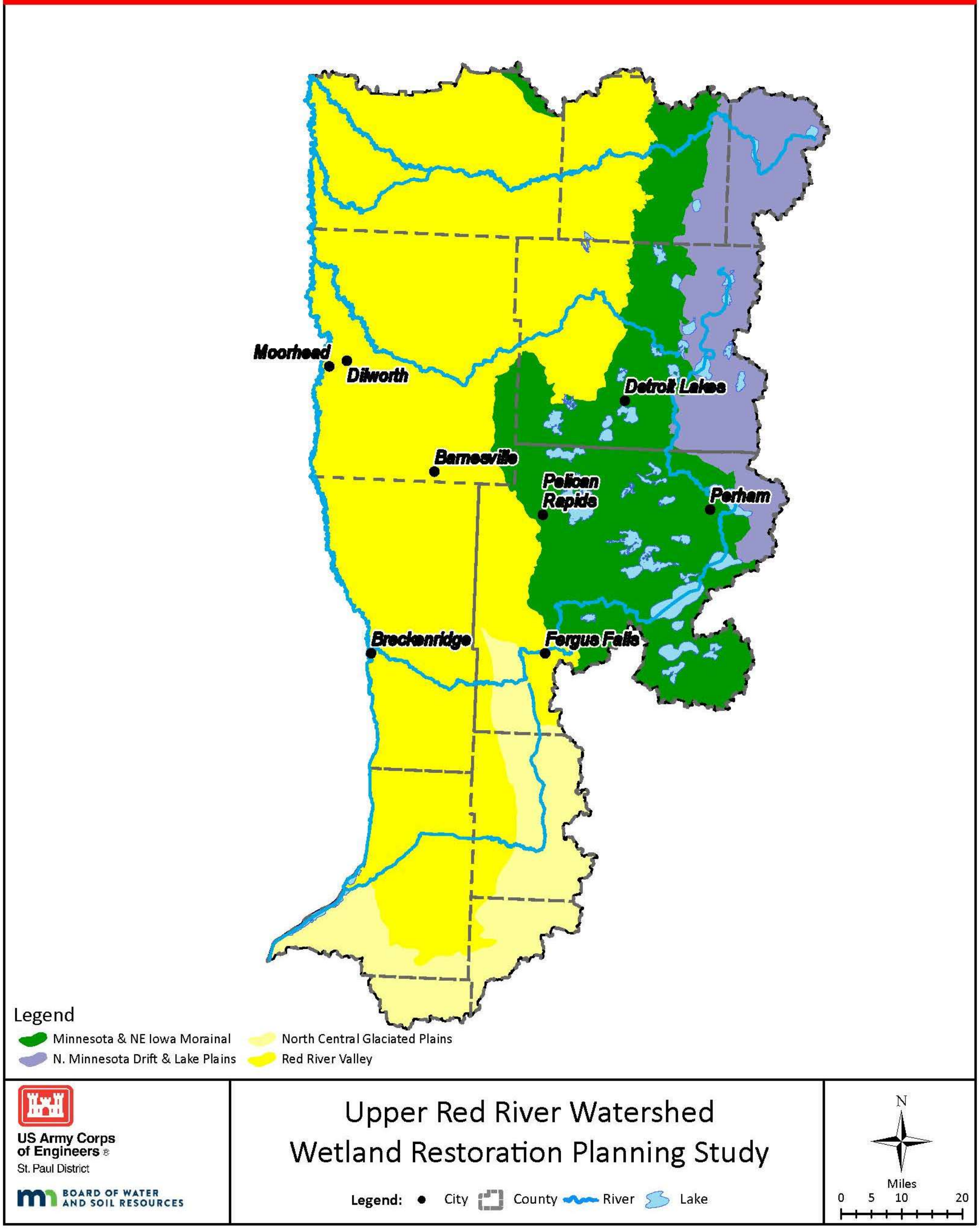
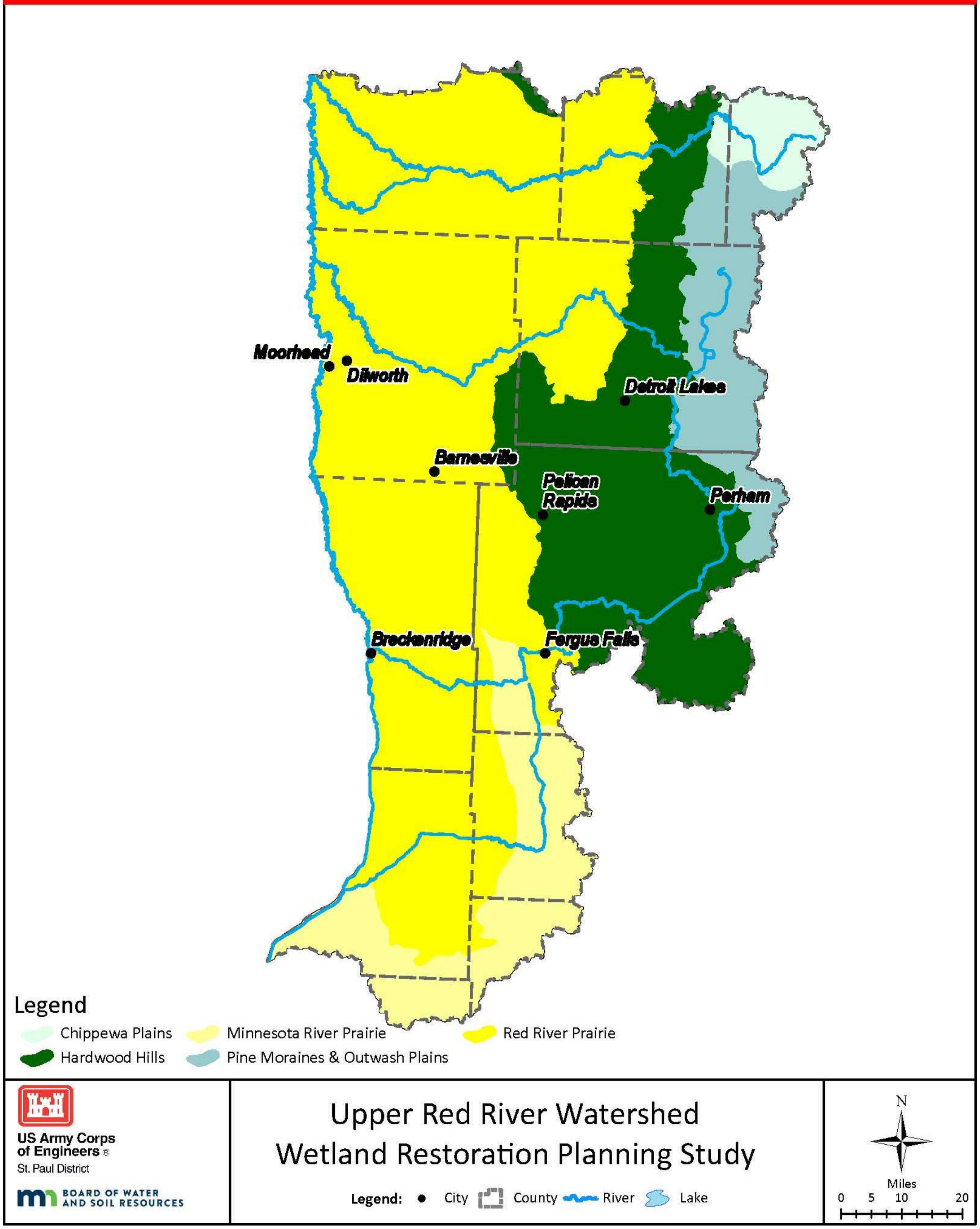


Figure 4: Ecological Subsections



Baseline Conditions

Pre-settlement Vegetation

The Watershed Health Assessment Framework (WHAF) compiled by the MnDNR contains an interpretation of Marschner's Early European Settlement Vegetation Map based on Public Land Survey notes from the 1890s. These maps provide an insight into the distribution of vegetation before European settlement resulted in significant changes to the landscape. A summary of the percent vegetative cover by Marschner land class in each major watershed is provided in Table 2.

Consistent with the ecological classification subsections for the major watersheds, the Marschner data illustrates that there are several distinct zones present within the URRW. While many of the natural communities have been significantly altered or removed by human induced disturbance the distribution of remaining vegetative communities is clearly associated with the landform and geology of the URRW. The major watersheds located in the PPA ecoregion (Bois de Sioux, Mustinka, Upper Red, and Red River – Marsh River) consisted primarily of prairie and wet prairie plant communities. These areas are located on mainly flat rich soils that originated from historic Glacial Lake Agassiz. The major watersheds that extend west of the PPA ecoregion are characterized by more rolling topography and less fertile soils. In the EBF ecoregion, prairie communities transition to brush prairie and forested communities containing aspens, oak, and conifers. Further east and upgradient Marschner described the plant communities of the LMF ecoregion as consisting of hardwood and conifer forests, bogs, and swamps along with a greater number of lakes. The Otter Tail, Buffalo, and Wild Rice watersheds encompass each of the three ecoregions which explains the differences in the Marschner land cover types between these watersheds and the others in the URRW.

Table 2
URRW Major Watershed Percent by Marschner's Pre-European Settlement Land Cover

Major Watershed	Prairie	Wet Prairie	Brush Prairie	Aspen-Oak Land	Aspen-Birch (trending to hardwoods)	Aspen-Birch (trending to Conifers)	Oak Openings and Barrens	Big Woods - Hardwoods (Oak, Maple, Basswood, Hickory)	White Pine	Mixed White Pine and Red Pine	Jack Pine Barrens and Openings	Conifer Bogs and Swamps	River Bottom Forest	Lakes (open water)
Bois de Sioux	78.8	17	-	-	-	-	0.7	0.1	-	-	-	-	0.4	3.1
Mustinka	95.8	4.3	-	-	-	-	-	<0.1	-	-	-	-	<0.1	<0.1
Otter Tail	65.2	4.5	2.9	0.9	0.4	1.4	5.7	8.6	<0 .1	4.5	0.5	1.6	0.3	3.3
Upper Red	95.4	3.9	-	-	-	-	<0 .1	-	-	-	-	-	0.7	-
Buffalo	74	7.1	0.7	0.6	<0.1	0.3	2.5	9.1	-	4.2	-	0.1	0.1	0.3
Red River of N - Marsh	91.7	6.1	<0.01	0.2	-	-	-	-	-	-	-	-	2	-
Wild Rice	72.2	5.2	0.6	2.4	0.2	1.4	0.7	8.9	-	4.1	0.6	1.3	1.7	0.6

Wetlands

Information on the extent of wetlands in the URRW was obtained from the National Wetland Inventory (NWI) Update for Minnesota. This represents the most current wetland mapping for the watershed and a useful tool for evaluating the resources remaining in the URRW and the extent of loss across the major watersheds. The wetland acreage and the percentage of the total land area as wetland in each major watershed is summarized in Table 3. Figures showing mapped wetlands for each of the major watersheds are provided in Appendix A. Based on the NWI mapping, the URRW has less wetlands as a percentage of total watershed area relative to the rest of the state (6.1% versus 19.1% statewide). None of the major watersheds within the URRW exceed the statewide average. With respect to wetland types, the vast majority of wetlands are identified as emergent (64%) followed by scrub shrub (15%), and forested (14%). Percentage of wetlands by area is low throughout the URRW, but especially low in watersheds where the dominant land use is crops. For example, land use in the Bois de Sioux, Mustinka, Upper Red and Red River of the North – Marsh watersheds are 86 to 87 percent crops and only 1.8 to 5.0 percent wetlands.

Table 3
URRW Summary of NWI Palustrine Class Wetlands

Major Watershed	Watershed Acres	Wetland Acres[1]	Wetland Area %	Emergent (acres)	Forest (acres)	Scrub Shrub (acres)	UB[2] & Aquatic Bed (acres)
Bois de Sioux	355,936	8,709	2.4	7,645	607	58	398
Mustinka	550,853	27,521	5.0	24,914	968	182	1,457
Otter Tail	1,222,028	149,656	12.2	85,094	26,680	26,542	11,317
Upper Red	319,534	5,882	1.8	5,092	148	236	406
Buffalo	724,096	57,553	7.9	45,046	3,296	4,917	4,295
Red River of N - Marsh	231,542	6,408	2.8	3,605	1,575	963	265
Wild Rice	1,047,068	108,239	10.3	63,360	19,058	21,165	4,657
Total	*4,451,057*	*363,968*	*6.1*	*234,756*	*52,332*	*54,063*	*22,795*

[1] – Wetland acreage identified as palustrine in the NWI
[2] – Unconsolidated bottom

Bois de Sioux

The Bois de Sioux River watershed has approximately 8,709 acres of wetland, which is equivalent to 2.4% of the total watershed area (Table 3). Approximately 88% of wetlands within the watershed are classified as emergent whereas, forest and scrub shrub wetlands only account for 7% and 0.7% respectively.

Special wetland features: The Otter Tail Prairie Scientific and Natural Area (SNA) is located within this watershed and is adjacent to the Doran and Prairie Ridge Wildlife Management Areas are adjacent to this site. The Otter Tail Prairie SNA is one of the few areas in western Minnesota with high quality mesic (moderately moist) and wet prairie.

Mustinka

The Mustinka River watershed has approximately 27,521 acres of wetland, which accounts for 5% of the watershed. Wetlands are predominantly emergent (24,914 acres). Minor wetland types include forest and scrub shrub wetlands which cover 968 acres and 182 acres respectively (Table 3).

Special wetland features: Two calcareous fens are located in the Mustinka River watershed, one in the Erlandson Wildlife Management Area (WMA). Calcareous fens are rare and distinctive wetlands characterized by a substrate of non-acidic peat and dependent on a constant supply of cold, oxygen-poor groundwater rich in calcium and magnesium bicarbonates. This calcium-rich environment supports a plant community dominated by “calciphiles,” or calcium-loving species.

Otter Tail

The Otter Tail River watershed has an estimated 149,656 acres of wetland, which is equivalent to 12.2% of the watershed area (Table 3). Emergent wetlands are the most abundant (85,094 acres), followed by forested (26,680 acres) and scrub shrub (26,542 acres). According to Minnesota Pollution Control Agency (MPCA 2019), approximately 4.7% of the wetland area is classified as “bog” which are common in the east and northeast region of the watershed. Bogs can occur as forested, shrub dominated, or as open herbaceous emergent dominated wetland communities, but substrates are predominantly peat.

Special wetland features: Greenwater Lake Scientific and Natural Area (SNA) is located in the Headwaters Otter Tail River subwatershed. State water quality standards classify all surface waters, including wetlands, within SNAs as Outstanding Resource Value Waters (ORVWs) and prohibited from receiving pollutant discharges. Though Greenwater Lake SNA is not specifically listed as an ORVW in state water quality standards, it is included as an unlisted Prohibited Discharge ORVW. Thus, any proposed activity that would result in surface water degradation, including increased pollutant loading is prohibited. Greenwater Lake SNA includes, several wetland communities, including alder and black ash swamps, sedge meadows, and rich fens (MPCA 2019).

Upper Red

The Red River watershed has the least amount of wetland area in the URRW at 5,882 acres or 1.8% of the total watershed area. Wetlands are predominantly emergent (5,092 acres) with small amounts of forest (148 acres) and scrub shrub (236 acres) (Table 3).

Special wetland features: Waterfowl Production Areas (WPAs) are located within the watershed. These wetland areas were acquired and are maintained by U.S. Fish and Wildlife Service (USFWS) for migratory waterfowl habitat.

Buffalo

Wetlands account for 7.9% of the Buffalo River watershed (57,553 acres). Similar to other major watersheds within the URRW, emergent wetlands are dominant (45,046 acres) followed by scrub shrub (4,917 acres) and forest (3,296 acres) (Table 3).

Special wetland features: Waterfowl Production Areas (WPAs) are located within the watershed. These wetland areas were acquired and are maintained by U.S. Fish and Wildlife Service (USFWS) for migratory waterfowl habitat.

Red River of the North – Marsh
The Red River of the North – Marsh River watershed has approximately 6,408 acres of wetland which is 2.8% of the total watershed area. Emergent wetlands are the most abundant at 3,605 acres followed by 1,575 acres of forest and 963 acres of shrub scrub (Table 3).

Special wetland features: The DNR has identified five calcareous fens in the watershed, one of which is designated as an ORVW (MPCA 2017a).

Wild Rice
Approximately 108,239 acres of wetland are found in the Wild Rice River watershed which accounts for 10.3% of the total watershed area. Emergent wetlands are the predominant cover type at 63,360 acres followed by 21,165 acres of scrub shrub and 19,058 acres of forest (Table 3).

Special wetland features: Wild rice populations have been documented on many lakes, ponds, and wetlands in the watershed as well as a portion of the Wild Rice River (MPCA Protecting Wild Rice Waters). In addition, calcareous fens are found in the watershed and are typically associated with the glacial lake beach ridges. Calcareous fens, an uncommon type of wetland with alkaline ($pH > 6.7$) peat that can form where groundwater discharge is mineral-rich, support a unique community of plant species (mostly rare) and receive additional protections as state Outstanding Resource Value Waters (ORVW). The DNR has identified 21 calcareous fens in the watershed, 10 of which are designated ORVW's (MPCA 2017b).

Lakes

The URRW contains 230,528 acres classified as lakes which is approximately five percent of the total land area. The largest lake in the URRW is Lake Traverse which spans 10,848 surface acres along the Minnesota and North Dakota border. It is a highly productive lake and popular recreational destination in the Bois de Sioux River watershed, well known for its high-quality walleye fishery. Mud Lake (2,448 acres) lies directly to the north and is connected to Lake Traverse but is not highly used by anglers due to the difficulty in accessing and navigating the lake. A summary of the lake resources in each major watershed is provided in Table 4. The Otter Tail River watershed has the greatest number of lakes within the URRW. Unlike the other watersheds within the URRW, the Otter Tail River watershed falls completely within the Eastern broadleaf forest and Laurentian mixed forest provinces. The western boundary of the Eastern broadleaf forest province, and Otter Tail River watershed, is defined as an abrupt transition from forest and woodland to open grassland which defines the remainder of the URRW.

Table 4
URRW Summary of Lake Resources

Major Watershed	Total Acres	Total Number	Number larger than 100 acres	Number larger than 500 acres
Bois de Sioux	14,842	21	9	6
Mustinka	7866	82	28	0
Otter Tail	163,804	921	227	56
Upper Red	177	5	0	0
Buffalo	17,457	265	38	3
Red River of N - Marsh	167	3	0	0
Wild Rice	26,215	276	55	12
Total	*230,528*	*1,573*	*357*	*77*

Watercourses

The MnDNR Rivers and Streams dataset was used to create a general inventory of all watercourses within each major watershed. The total amount of mapped watercourses along with the length identified as ditched and the flow regime (intermittent or perennial) is provided for comparison. A measure of the density of watercourses in each major watershed (the number of mapped watercourses divided by the watershed area) was also calculated to assess variability in the presence of the tributary network throughout the URRW. This information is presented in Table 5. Additional information on the condition of watercourses, and water quality in general, is provided in subsequent sections.

Table 5
URRW Watercourses Summary[1]

Major Watershed	Drainage Ditches	Intermittent	Perennial	Total	Watercourse Density[2]
Bois de Sioux	407 (54%)	261 (34.26%)	25 (3.3%)	693	1.2
Mustinka	472 (39.8%)	609 (51.4)	104 (8.8%)	1185	1.4
Otter Tail	235 (24.1%)	316 (32.3%)	426 (43.6%)	977	0.5
Upper Red	284 (43.2%)	77 (11.7%)	295 (44.9%)	656	1.3
Buffalo	338 (27.5%)	594 (48.3%)	300 (24.4%)	1232	1.1
Red River of N - Marsh	386 (71.7%)	47 (8.7%)	106 (19.7%)	539	1.5
Wild Rice	695 (33.7%)	18 (0.9%)	474 (23%)	1187	0.7
Total	*2817 (38%)*	*1922 (25.9%)*	*1730 (23.4%)*	*6469*	*0.9*

[1] – All information presented in miles. Numbers in parentheses indicate percentage of total for the major watershed.
[2] – Watercourse density is the total watercourse length divided by the major watershed area.

Altered Watercourses

The Minnesota Statewide Altered Watercourse Project was used to summarize the nature and extent of changes to natural streams and rivers in the watershed. This dataset classifies streams and rivers mapped by the National Hydrography Dataset (NHD) into four categories based on review of aerial photography. Altered watercourses are natural and artificial streams that have been compromised through hydrological alteration such as ditching, straightening, widening, etc. Impounded watercourses are streams with flow that has been dammed for human purposes. Watercourses classified as no definable channel include features such as swales or shallow waterways that were incorrectly identified as streams by the NHD, wetland and lakes where no evidence of draining or impounding is present, or streams that have disappeared or are now subterranean. Streams that do not meet the criteria to be classified as altered, impounded, or no definable channel are considered natural.

Table 6 provides a summary of altered watercourses by major watershed. The Mustinka River, Upper Red River and Red River of the North – Marsh River watersheds contain the greatest percentage of impacted streams whereas, the Otter Tail River watershed contains the greatest percentage of natural streams. These results are consistent with dominant land uses in the watersheds, where watersheds with a higher percentage of land in agriculture tend to have more impacted watercourses and watersheds with a lower percentage of land use in agriculture tend to have more natural watercourses.

Table 6 URRW Altered Watercourses Summary[1]				
Major Watershed	**Altered**	**Impounded**	**No Definable Channel**	**Natural**
Bois de Sioux	455 (63.5%)	140 (19.5%)	23 (3.2%)	99 (13.8%)
Mustinka	880 (72.3%)	80 (6.6%)	6 (.5%)	251 (20.6%)
Otter Tail	366 (28.5%)	383 (29.8%)	172 (13.4%)	364 (28.3%)
Upper Red	408 (62.5%)	105 (16.1%)	0 (0%)	140 (21.4%)
Buffalo	586 (45.9%)	427 (33.4%)	9 (0.7%)	255 (20.0%)
Red River of N - Marsh	311 (61.3%)	112 (22.1%)	0 (0%)	84 (16.6%)
Wild Rice	996 (46.5%)	627 (29.3%)	17 (0.8%)	500 (23.4%)
Total	*4002 (51.3%)*	*1874 (24.0%)*	*227 (2.9%)*	*1693 (21.7%)*
[1] – All information presented in miles. Numbers in parentheses indicated percentage of total for the major watershed.				

Watercourses have also been altered to address flooding in this part of the state. There are a total of 149 dams within the URRW (Table 7). The Otter Tail River has the highest number of dams (64) followed by the Wild Rice River watershed (34) and the Buffalo River watershed (28). Figures showing impoundments in each major watershed are provided in Appendix E.

Table 7 Impoundments			
		Total	
Watershed	**Number of Dams**	**Storage Capacity [1]**	**Drainage Area [2]**
Bois de Sioux	3	441,800	37.3
Mustinka	13	30,043	580.2
Otter Tail	64	1,502,192	15,892.30
Upper Red	5	512,502	15,040
Buffalo	28	156,009	857.2
Red River of N - Marsh	2	4,876	56
Wild Rice	34	106,361	1.468.9
Total	149	2,753,783	32,463
[1] - Storage capacity is in acre-feet			
[2] - Drainage area is in square miles			

Water Quality

The Minnesota Pollution Control Agency's (MPCA) list of assessed and impaired waters was used to summarize water quality in the URRW. These lists are prepared by MPCA on a biennial basis to determine whether streams and lakes in the state meet water quality standards. The U.S. Environmental Protection Agency approved 2018 list, was reviewed to determine the nature and extent of water quality impairments in the URRW.

Eleven impairment parameters are present in the URRW. In previous watershed mitigation planning efforts, stakeholders and agency staff discussed water quality impairments and agreed that there are a number of impairments/parameters not relevant to wetland restoration or mitigation planning and should not be considered in the formulation of these plans. This approach was employed for the URRW study and resulted in five of the eleven impairments being removed from consideration when determining the percentage of waters not meeting water quality standards in the baseline conditions section and in the catchment prioritization process. A complete list of the impairment parameters present in the URRW and whether each was carried forward in the planning effort described in this report is provided in Table 8.

Table 8 Water Quality Impairments in URRW		
Impairment Parameter	**Description**	**Include**
As	Arsenic	No
DO	Dissolved oxygen	Yes
E. coli	Escherichia coli	No
FC	Fecal coliform	No
FishesBio	Fishes bioassessment	Yes
Hg-F	Mercury in fish tissue	No
Hg-W	Mercury in water column	No
InvertBio	Aquatic macroinvertebrate bioassessments	Yes
Nutrients	Nutrient/eutrophication biological indicators	Yes
T	Turbidity	Yes
TSS	Total suspended solids	Yes

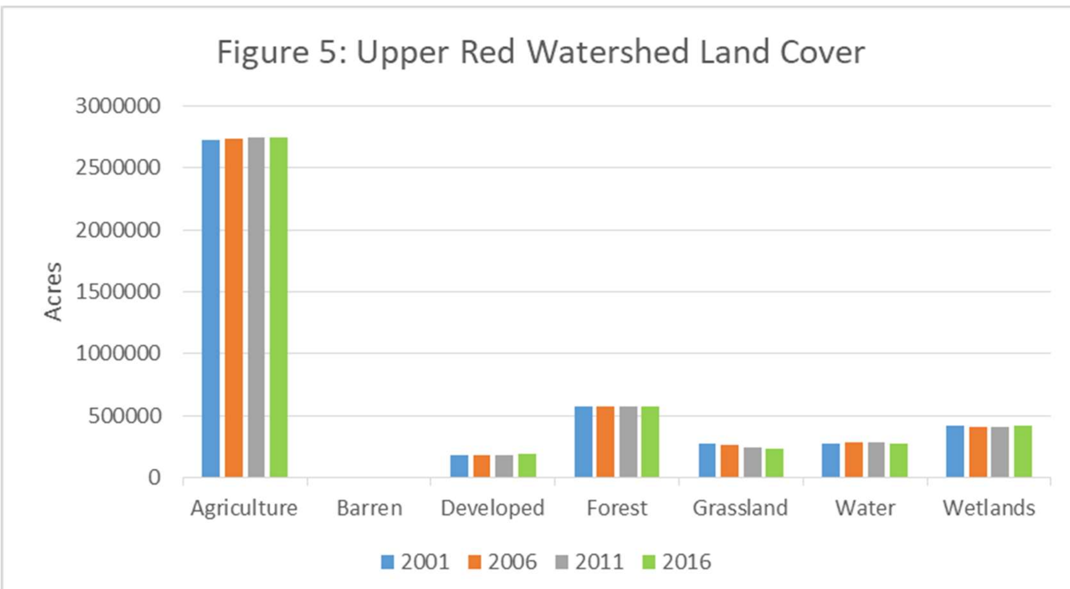
Impaired waters are summarized for the URRW in Table 9. The assessed values represent the area of lakes or length of streams that were evaluated for impairments for the 2018 listing. The impaired values represent the area of lakes or length of streams that are listed for at least one of the impairment parameters identified in Table 8. The percent impaired value is the proportion of assessed waters that were identified as impaired. The Red River of the North – Marsh River watershed, where the predominant land use is agriculture, has the most rivers and streams identified as impaired. This watershed has only three lakes, none of which were evaluated for impairments. The Wild Rice River, Otter Tail River and Buffalo River watersheds had the least number of waters identified as impaired. These watersheds have the least amount of land in crops and the most amount of land that remains forested which could explain the lower number of impaired waters.

Table 9 Water Quality Impairments in URRW						
Major Watershed	**Lakes**			**Rivers and Streams**		
	Assessed[1]	**Impaired[1,2]**	**% Impaired**	**Assessed[3]**	**Impaired[2,3]**	**% Impaired**
Bois de Sioux	8,266	2,394	29%	113	80	71%
Mustinka	3,874	1,138	29%	178	129	72%
Otter Tail	130,752	4,229	3%	258	37	14%
Upper Red	5	0	0%	128	86	67%
Buffalo	11,626	4,191	36%	1,718	259	15%
Red River of N - Marsh	0	0	0%	219	198	90%
Wild Rice	13,036	136	1%	458	134	29%
Total	*167,559*	*12,088*	*7%*	*3,072*	*923*	*30%*
[1] – Values are presented in acres. [2] – Quantity of assessed waters identified as impaired for dissolved oxygen, fishes bioassessments, aquatic macroinvertebrate bioassessments, nitrates, nutrient/eutrophication biological indicators, turbidity or total suspended solids. [3] – Values are presented in miles.						

Land Cover

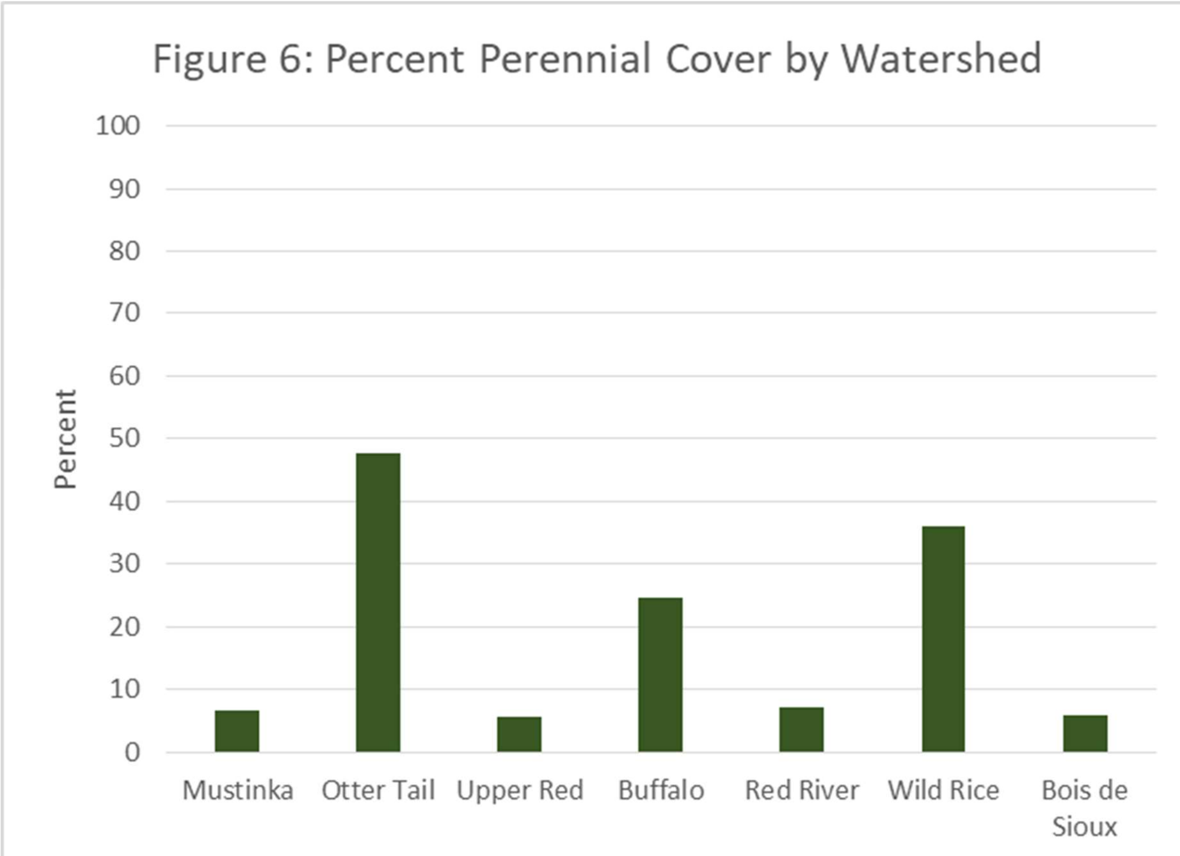
The National Land Cover Dataset (NLCD) was used to characterize land cover in the URRW. There are 20 land cover classes present in the NLCD, of which 15 classes are present in the study area. For purposes of this study these land cover classes were simplified into 7 classes: agriculture, barren, developed, forest, grassland, water, and wetlands.

Land cover using these simplified classes was summarized for the URRW using the 2001, 2006, 2011, and 2016 editions of the NLCD, as shown in Figure 5. Agriculture is the dominant land cover in the URRW, accounting for more than half of its total area. Grassland and barren land make up little area in the watershed. Major changes in land cover over this time period are difficult to identify at this scale but there is a consistent increase in agriculture and developed land acreage and a decrease in grassland acreage. Additional detail, including figures and maps for each major watershed, is provided in Appendix B.



Perennial Cover

The 2016 NLCD data was also used to assess the degree to which development in the watershed has removed perennial vegetation. Vegetative cover is an important characteristic when assessing watershed health because as perennial vegetation is removed there is greater potential for erosion, soil loss, flooding, water quality degradation, and loss of habitat. For this analysis, perennial cover was identified as any of the following: deciduous forest, evergreen forest, mixed forest, shrub/scrub, grassland/herbaceous, pasture/hay, woody wetlands, or emergent herbaceous wetlands. All other land use classes were considered to be non-perennial cover. The results of the perennial cover analysis are show on Figure 6. Maps showing perennial and non-perennial land cover for each of the major watersheds are provided in Appendix C. Percent perennial cover was 47 percent for the Otter Tail River watershed, 36 percent for the Wild Rice River watershed, 25 percent for the Buffalo River watershed and 5 to 8 percent for the other watersheds within the URRW.



Sensitive Species and Plant Communities

Identification of sensitive plant communities was based on Minnesota's Native Plant Community Classification, Version 2.0 (NPC). The classification is hierarchical and based strongly on plant species composition developed through an analysis of extensive field data collected from forests, prairies, wetlands, and other habitats. The NPC types and subtypes recognized in Minnesota have been assigned conservation status ranks (S-ranks) that reflect the risk of elimination of the community from Minnesota. There are five rankings:

S1 = critically imperiled
S2 = imperiled
S3 = vulnerable to extirpation
S4 = apparently secure; uncommon but not rare
S5 = secure, common, widespread, and abundant

These ranks are determined using methodology developed by the conservation organization NatureServe and its member natural heritage programs in North America. S-ranks were assigned to Minnesota's NPC types and subtypes based on information compiled by DNR plant ecologists on: 1) geographic range or extent; 2) area of range occupied; 3) number of occurrences; 4) number of good occurrences, or percent area of occurrences with good viability and ecological integrity; 5) environmental specificity; 6) long-term trend; 7) short-term trend; 8) scope and severity of major threats; and 9) intrinsic vulnerability. A range in rank (for example, S1S2) indicates there is uncertainty in conservation status but it falls within a given range.

The analysis of NPC types for the Compensation Planning Framework (CPF) focused on the subtypes assigned a ranking of S3, S2, or S1. There are 62,714.7 acres of native plant communities that have been assigned one of these conservation status ranks in the URRW. The Wild Rice watershed has the most total acres designated (28,384.8 acres) followed by the Buffalo (16,142 acres), Otter Tail (12,852.1 acres), Upper Red (2,329 acres), Marsh (1,282.90 acres), Bois de Sioux (1,234.1 acres) and the Mustinka (489.8 acres). The Wild Rice watershed also had the largest amount of wetland NPCs designated S1, S2, or S3 with 7,814.1 acres attributable primarily to the *Black Ash – Silver Maple Terrace Forest* (FFn57a), *Southern Tamarack Swamp* (FPs63a), and *Northern Wet Prairie* (WPn53c). As observed with other URRW characteristics, the Wild Rice, Buffalo and Otter Tail watersheds have the highest percent of wetland area and lowest percent of historic wetlands loss as compared to the other watersheds in the URRW. A summary of the wetland NPCs with S1, S2, or S3 rankings is provided in Table 10. Maps showing the location of these areas are provided in Appendix D.

Table 10
Native Plant Community Classification Acreage

Native Plant Community	S-rank	Bois de Sioux	Ottertail	Mustinka	Buffalo	Upper Red	Wild Rice	Marsh
APn91b - Graminoid Poor Fen (Basin)	S3		123.9		14.8		20.5	
FDc24a - Jack Pine - Woodland	S1S2S3		46.9					
FDc34a - Red Pine - White Pine Forest	S2		841.8				74.6	
FDc34b - Oak - Aspen Forest	S3		392.1				500.5	
FDs36a - Burr Oak - Aspen Forest	S3S4	108.8			702.4		5,614.7	92.8
FDs37b - Pin Oak - Bur Oak Woodland	S3	70.2	5025.7		164.2			
FDw34a - Aspen (Prairie Herb) Woodland	S3						545.6	
FDw44a - Aspen (Cordgrass) Woodland	S3				115.4		43.7	
FFn57a - Black Ash - Silver Maple Terrace Forest	S3				260.8		1,040.1	
FPn63b - White Cedar Swamp (Northcentral)	S3		105.5					
FPn63c - White Cedar Swamp (Northwestern)	S3						6.2	
FPs63a - Tamarack Swamp (Southern)	S2S3		2,098.2				2,171.7	
FPw63b - Tamarack Seepage Swamp (Aspen Parkland)	S3						13.1	
MHn44d - Aspen - Birch - Fir Forest	S3		817.6		33.7		3.4	
MHn47b - Sugar Maple - Basswood - (Horsetail) Forest	S3		5.4					
MHs38b - Basswood - Bur Oak - (Green Ash) Forest	S3	177.3	445.8		1,808.3		527.1	
MHw36a - Green Ash-Bur Oak - Elm Forest	S2				45.6		160.3	211.6
MRn83a - Cattail - Sedge Marsh (Northern)	S2		470.9				48.7	
MRn83b - Cattail Marsh (Northern)	S2		1,372.6	39.9	141.5			
MRn93a - Bulrush Marsh (Northern)	S3						0.5	
MRn93b - Spikerush - Bur Reed Marsh (Northern)	S2		1.3					
MRp83a - Cattail - Sedge Marsh (Prairie)	S1	3.4		5.1	2.9		764.7	26.6
MRp83b - Cattail Marsh (Prairie)	S1			4	2.8		50.5	
OPn93a (Spring Fen)	S2		1.3					
OPp91b - Rich Fen (Peatland)	S3		22.4				28.5	
OPp91c - Rich Fen (Prairie Seepage)	S3						58.1	
OPp93a - Calcareous Fen (Northwestern)	S2			2.1	189.1	83.5	366.1	19.4
RVx32b2 - Sand Beach/Sandbar (River), Permanent Stream	S3						2.5	
UPn12b - Dry Sand - Gravel Prairie (Northern)	S2		55.8		417.7		964.7	

UPn12c - Dry Sand - Gravel Brush - Prairie (Northern)	S1				3.3		3	
UPn12d - Dry Hill Prairie (Northern)	S1		23.4		834.6	77	335.5	
UPn13b - Dry Barrens Oak Savanna ((Northern)	S1							156.1
UPn13d - Dry Hill Oak Savanna (Northern)	S1						2.6	
UPn23a - Mesic Brush-Prairie (Northern)	S2						515.4	
UPn23b - Mesic Prairie (Northern)	S2	429.4	668.1		3,378.3	259.6	7,146.6	94.9
UPn24a - Mesic Oak Savanna (Northern)	S1				44.8			
UPs13b - Dry Sand - Gravel Prairie (Southern)	S2		253.9		988.3		1.4	
UPs13d - Dry Hill Prairie (Southern)	S2	246.6		289.3	105		7.5	
UPs23a - Mesic Prairie (Southern)	S2	2.3	17.8	130.1	243.7		3.4	
WFn55b - Black Ash - Yellow Birch - Red Maple - Basswood Swamp	S3		21.9		68.2			
WFn74a - Alder - (Red Currant-Meadow-Rue) Swamp	S3		19.5				15	
WMp73a - Prairie Meadow/Carr	S3		20.3				215.3	32.4
WMs83a - Seepage Meadow/Carr	S3				1901		992.3	333.9
WMs83a1 - Seepage Meadow/Carr, Tussock Sedge Subtype	S3	3.9					36.1	
WMs83a2 - Seepage Meadow/Carr, Aquatic Sedge Subtype	S3						29.1	53.3
WMs92a - Basin Meadow/Carr	S2				24.5		385.9	51.4
WPn53a - Wet Seepage Prairie (Northern)	S2				364.2	98.5	276.1	
WPn53b - Wet Brush-Prairie (Northern)	S3				25		587.1	210.5
WPn53c - Wet Prairie (Northern)	S3	116.7		19.3	4,051.7	1,796.4	4,602.3	
WPn53d - Wet Saline Prairie (Northern)	S2				202.4	14	113.5	
WPs54b - Wet Prairie (Southern)	S2	75.5			7.9		110.9	
TOTAL ACRES WITH S1, S2, or S3 RANKING		**1,234.1**	**12,852.1**	**489.8**	**16,142**	**2,329**	**28,384.8**	**1,282.9**
TOTAL WETLAND ACRES WITH S1, S2, OR S3 RANKING		**199.5**	**4,257.8**	**70.4**	**7,256.8**	**1,992.4**	**11,932.3**	**727.5**
WETLAND ACRES AS S1		3.4		9.1	5.7		815.2	26.6
WETLAND ACRES AS S2		75.5	3,944.3	42	929.6	196	3,472.9	70.8
WETLAND ACRES AS S3		120.6	2,411.7	19.3	6,321.5	1,796.4	9,815.9	630.1

Permitting

Issued permits under the Corps Regulatory program were reviewed for the four-year period between October 2014 and September 2018. This review focused on those authorized impacts to wetlands (e.g. filling or draining) that resulted in a permanent loss of the resource. Additional data was available which documented other types of impacts to wetlands such as excavation or impacts that were temporary in nature; however, this data either appeared unreliable or misrepresented the quantity and nature of impacts to wetlands without greater levels of analysis.

Table 11 provides a summary of authorized wetland impacts between 2014 and 2018. It is important to note that this information provides only a subset of wetland impacts over this period. For example, the placement of fill material into a wetland for a temporary road which would be restored to its preexisting condition at a later time, exempt activities and activities that do not require pre-construction notification to the Corps, would not be included in this summary. Lastly, the Corps does not regulate impacts to all wetlands. Certain wetlands that are considered isolated are not regulated by the Corps and would not be included in this summary. Considering these caveats, the Otter Tail River watershed, which has the greatest amount of current wetlands, experienced the greatest amount of wetland impacts over this period. Almost half (14.03 acres) of the impacts occurring in the Otter Tail River watershed were associated with the Detroit Lakes Airport (Becker County) runway improvement project. Lower amounts of wetland impacts were seen in the highly agricultural and wetland poor watersheds of the URRW.

Table 11
Authorized Wetland Impacts Between 2014 and 2018[1]

Major Watershed	Total Acres	Acres Per Year
Bois de Sioux River	0.29	0.07
Mustinka River	2.51	0.63
Otter Tail River	28.74	7.19
Upper Red River of the North	4.17	1.04
Buffalo River	2.31	0.58
Red River of the North – Marsh River	0.00	0.00
Wild Rice River	5.62	1.41
Total	*43.64*	*10.92*

[1]Authorized fill impacts to wetlands resulting in a permanent loss of the resource.

Aquatic Resource Loss

Anderson and Craig (1984) estimated the area of pre-settlement and current wetlands for each county in the State of Minnesota using soils mapping. There are 11 counties located wholly or partly in the URRW. A summary of pre-settlement wetlands area, current wetlands area and wetland loss by county is provided in Table 12.

Wetland loss was also calculated for the URRW using soils mapping and the NWI. The area of historic wetlands was determined for each soil map using the hydric rating value assigned from the soil survey, which were aggregated for the major watersheds and URRW. Current wetlands area was calculated using mapped wetlands from the NWI, excluding lakes. Table 13 shows the results of this analysis for the URRW.

Both wetland loss analyses suggest the URRW has lost at least 70 percent of its historic wetlands, including substantial losses in wetland quantity in the western portion of the URRW, which is dominated by agriculture. The least impacted areas of the watershed from a wetland loss perspective are in the eastern portion of the URRW which fall within the Eastern broadleaf forest and Laurentian mixed forest provinces.

Table 12 URRW Historic Wetland Loss by County				
County	**Percent Area Of County Within URRW**	**Pre-settlement Wetland Acres[1]**	**Current Wetland Acres[1]**	**% Wetland Loss**
Becker	71.8	195,829	99,821	49
Big Stone	16.2	17,963	4,570	75
Clay	100	258,940	34,212	87
Clearwater	22	40,438	29,644	27
Grant	65.6	91,536	12,820	86
Mahnomen	91.2	120,015	46,725	61
Norman	90.3	254,332	18,984	93
Otter Tail	62.9	176,954	93,784	47
Stevens	0.3	1,680	401	76
Traverse	24.9	30,021	5,833	81
Wilkin	93.3	107,190	10,393	90
Total	*--*	*143,548*	*12,343*	*70*
[1] – Wetland acres for each county were adjusted to represent the area within the URRW by multiplying the values from Anderson and Craig (1984) by the percent area of the county within the watershed.				

Table 13 URRW Historic Wetland Loss Summary[1]			
Major Watershed	**Historic Wetlands**	**Current Wetlands**	**% Wetland Loss**
Bois de Sioux River	105,945	8,709	92
Mustinka River	183,935	27,521	85
Otter Tail River	257,045	149,656	42
Upper Red River of the North	135,443	5,882	96
Buffalo River	221,311	57,553	74
Red River of the North – Marsh River	138,985	6,408	96
Wild Rice River	395,792	108,239	73
Total	*1,438,456*	*363,968*	*75*
[1] – All information presented in acres.			

Wetland Banking Analysis

Since passage of the Clean Water Act in 1972 and the Minnesota Wetland Conservation Act (WCA) in 1991, most wetland impacts are regulated by one or both programs and may require mitigation to offset the functions lost as a result of the authorized impacts. Today, credits obtained from wetland mitigation banks are the primary source of mitigation. Project-specific mitigation is also an agency accepted option, provided sequencing criteria are satisfied and the site meets other policy and technical eligibility requirements. To assess how wetland banking credits are being used to offset wetland impacts in the URRW, an analysis of wetland banking activity and the status of the private market and Local Government Road Wetland Replacement

Program (LGRWRP) accounts was completed. The analysis relied on data obtained from the State of Minnesota from 2016 through 2020 primarily through the processing of wetland bank withdrawal applications.

Focusing exclusively on credit withdrawals outside of agricultural wetland banking, the URRW has the second lowest amount of bank activity in Minnesota with an average credit withdrawal rate of 10 credits per year over this five-year period. This accounts for approximately 3% of the withdrawals statewide each year. A summary of credit withdrawals from each BSA is provided in Table 14.

Table 14
Wetland Credit Withdrawals by Bank Service Areas 2015-2019[1]

BSA	2015	2016	2017	2018	2019	Total	Average
1	17	9	32	30	14	102	20
2	26	7	9	6	18	66	13
3	38	35	85	14	41	213	43
4	15	0	27	3	7	52	10
5	159	29	82	30	64	364	73
6	28	20	6	10	4	68	14
7	116	46	75	96	77	410	82
8	35	58	45	22	42	202	40
9	45	33	54	50	63	245	49
10	0	0	1	0	0	1	0.2
Total	*479*	*237*	*416*	*261*	*330*	*1723*	*345*

[1] Withdrawal data obtained from BWSR wetland banking database

As a subset of the information in Table 14, only 3 of the 52 total credits withdrawn over the five-year period are associated with road projects (LGRWRP and Minnesota Department of Transportation (MnDOT) projects) resulting in annual withdrawal rate of less than a credit. However, it is important to understand that the average withdrawal rates for road projects may be misleading because they are based on where the credit is acquired and not on the location of the impact. Recent credit shortages for the LGRWRP have increased the frequency of credit use from accounts outside the BSA of impact which confounds any conclusions regarding where demand may be greatest based on the location of the impact. In the case of the URRW, credits from BSA 3 (Lower Red River of the North) have frequently been used as replacement for impacts when there are no in watershed options.

Current Status

Private wetland bank ledger information in the URRW was compiled and reviewed to provide a snapshot of the amount and types of credits currently available. This analysis focused solely on credits that were deposited into Minnesota wetland banks as of December 2020 and were identified as federally approved regardless of whether the account holder/sponsor has made them available for purchase. This analysis does not include data from MnDOT or the LGRWRP since neither of these programs has an account with federally approved credits in the URRW. The federally approved credits in the URRW broken down by major watershed is provided in Table 15.

Table 15
Federally Approved Credits by Major Watershed in the URRW[1]

	Bois de Sioux River	Mustinka River	Otter Tail River	Red River of the North - Headwaters	Buffalo River	Marsh River	Wild Rice River	Total
seasonally flooded basin	-	-	-	-	23.81	-	-	23.81
fresh (wet) meadow	-	-	-	-	1.30	-	4.18	5.48
wet mesic prairie	-	-	-	-	-	-	-	0
sedge meadow	-	-	-	-	-	-	-	0
shallow marsh	-	4.05	6.20		0.18	-	0.03	10.46
deep marsh	-	-	-	-	0.8021	-	-	0.80
shallow open water	-	-	-	-		-	-	0
shrub carr	-	-	-	-	4.29	-	-	4.29
hardwood or coniferous swamp	-	-	-	-	-	-	-	0
upland	-	-	-	-	1.28	-	-	1.28
Total	*0*	*4.05*	*6.20*	*0*	*31.66*	*0*	*4.21*	*46.12*
Percent of Total Credits	*0*	*8.8*	*13.5*	*0*	*68.6*	*0*	*9.1*	*100*

[1]Credit data show in the table is based on reports created on December 23, 2020.

As illustrated in Table 15, the URRW watershed has limited supply of federally approved wetland credits with the majority of those (68.6%) concentrated in the Buffalo River watershed. The available credits consist primarily of seasonally flooded basin and shallow marsh wetland plant community types. It is also worth noting that at the time this plan was drafted, only 8.33 were listed for sale on the BWSR website.

URRW Trends

Aerial Extent of Wetlands

The U.S. Fish and Wildlife Service's (USFWS) Wetlands Status and Trends project is the monitoring component of the National Wetland Inventory (NWI) program. It provides information on wetland and deepwater habitat type, location, and trends at a national scale that may also be occurring in the URRW. The most recent version of the Status and Trends Report examined recent trends in wetland extent and habitat type throughout the contiguous U.S. between 2004 and 2009. At a national scale, wetland area declined by 62,300 acres between 2004 and 2009 although this number was not statistically significant. Freshwater vegetated wetlands continued to decline but the annual rate of loss declined by nearly 50 percent relative to the 1998 to 2004 monitoring period. All freshwater wetland types except for forested wetlands had an increase in total area. Forested wetlands experienced their largest loss since the 1974-1985 time period with approximately 392,600 acres lost to upland land use types or conversion to deepwater and an overall decline of 633,100 acres. Overall, freshwater wetland losses were attributed primarily to urban and rural development and silviculture operations. Gains in freshwater ponds offset losses of vegetated wetland area with an estimated 207,200 acres of ponds created between 2004 and 2009. It is not known whether an increase in the acreage of ponds nationwide can be interpreted as a net gain in function relative to the losses identified in the report.

The State of Minnesota has a similar program to monitor long-term changes in wetland quantity and quality. Modeled after the USFWS program, the Minnesota Wetland Status and Trends Monitoring Program (WSTMP) assesses changes in wetland acreage and type using remote sensing and photointerpretation for 4,990 plots over 3-year sampling cycles. The most recent report covers the first two complete sampling cycles, 2006-2008 and 2009-2011.

The WSTMP identified a small but statistically significant net gain in wetland acreage of 123 acres between 2006 and 2011. When extrapolated from the plot scale to a statewide scale, the results indicate a net gain of 2,080 acres during the study period. Much like the USFWS study, the WSTMP identified that most of the observed gains were unconsolidated bottom wetlands (ponds). Another significant finding of the WSTMP was the net conversion of 1,890 acres of emergent wetlands to cultivated fields. Approximately 1,290 acres of this total occurred in the Prairie Parkland province which is a significant component of the URRW. The WSTMP did not identify this conversion as a net loss of wetlands.

Wetland Quality

The MPCA is the state agency responsible for monitoring the quality aspect of wetland status and trends monitoring in Minnesota. Their initial efforts were directed at a statewide and regional survey of depressional wetland condition completed between 2007 and 2009. On a statewide basis, the vegetation in almost half (46%) of Minnesota's depressional wetlands were determined to be in poor condition, 25% in fair, and 29% in good condition. Vegetation condition varied regionally with higher proportions of good conditions observed in north-central and northeastern Minnesota and more degraded conditions in the western and southern areas of the state.

The MPCA broadened their monitoring of the State's wetlands in with the initiation of the Minnesota Wetland Condition Assessment (MWCA) in 2011. The MWCA was modeled after (and done in conjunction with) the U.S. Environmental Protection Agency's (EPA) National Wetland Condition Assessment (Scozzafava et al. 2011). The goal of the MWCA was to provide an estimate of the current baseline condition of virtually all of Minnesota's wetlands. Overall, the vegetation condition in Minnesota's wetlands was determined to be high. An estimated 49 percent (± 8 percent) of the survey target population was in the exceptional condition category while an additional 18 percent (± 7 percent) of wetlands statewide were in good condition (vegetation composition and structure were similar to natural communities). Combined, wetlands in exceptional and good conditions totaled approximately two-thirds of the statewide wetland extent. The remaining wetlands were either classified as fair or poor. However, the statewide data masked the variation observed on a regional basis. The Mixed Wood Plains and Temperate Prairies ecoregions where the URRW is located had significantly lower percentages of wetlands with exceptional conditions and the percentage of wetlands with poor condition was significantly higher. Condition category proportion estimates for these two ecoregions were essentially the same with 6-7 percent exceptional, 11-12 percent good, 40-42 percent fair and 40-42 percent poor (MPCA 2015). Thus, most of the area within the URRW, the Mixed Wood Plains and Temperate Prairies ecoregions, have experienced both a significant loss in the extent of wetlands as well as a considerable decrease in condition (vegetative quality).

Altered Hydrology

All the recently completed comprehensive watershed management plans (CWMP) in the URRW identified altered hydrology as an issue of concern for the long-term health of the watershed. The Buffalo-Red River Watershed CWMP defines altered hydrology as "a change in the water quantity, timing, and variability of flow in water courses which impacts stream geomorphology and is a stressor for aquatic life." The Bois de Sioux – Mustinka CWMP notes that altered hydrology typically results from increased intensity of rainfall and/or changes to the landscape such as increases in the amount of impervious area, agricultural drainage, loss of wetlands, or other changes in land management practices. Although alterations to hydrology have been occurring in this area for over one hundred years, the more recent improvements changes in agricultural drainage technology and management have resulted in a dramatic increase in the amount of drain tile installed. For example, Bois de Sioux Watershed District permit records document just over 16,000 miles of drain tile installed since 2000 with over 80% of this occurring since 2011. Combined with the other sources mentioned previously, these changes seem likely to have a long-term effect on the quantity and quality of aquatic resources in the URRW watershed.

Description of Threats

A qualitative assessment of threats to aquatic resources was completed for the URRW using the results of the baseline condition assessment and information obtained from other studies prepared by local and state agencies. The most significant threat in the watershed today is the continued alteration of natural hydrology through surface and subsurface drainage. The practice of removing surface and shallow subsurface water using ditches and drain tile has several adverse effects on wetlands and aquatic resources. Artificial drainage increases peak flows and intensifies low flows which stresses aquatic life in the Red River of the North and its tributaries. When streambanks are destabilized by periodic maintenance activities and changes in the periodicity and intensity of flows phosphorus that is bound to the sediments is transported downstream. Research also suggests that subsurface drainage leaches nitrogen fertilizer from cropland transporting another nutrient downstream. On the landscape itself, drainage improvements continue to impact the remaining wetlands by reducing buffers around those that remain and by causing more loss and fragmentation. Although some of the drainage projects are regulated and some may require replacement in the case of regulated impacts to wetlands, continued efforts to manage and redirect surface and groundwater is considered a significant threat to aquatic resources in the URRW including the quality and quantity of the remaining wetlands.

Stakeholder Involvement

A stakeholder involvement process was included as part of the URRW watershed-based mitigation plan development. Potential stakeholders included all Wetland Conservation Act local government units within the URRW as well as the county soil and water conservation districts, MnDNR, and MPCA. Staff from the U.S. Army Corps of Engineers were also invited to participate. In recognition of the ongoing watershed planning at the major watershed scale in the URRW much of the stakeholder involvement was conducted through the One Watershed, One Plan (1W1P) process. This was the case for the Buffalo-Red River watershed, the Bois de Sioux River and Mustinka Watersheds, and the Wild Rice and Marsh River watersheds. For these areas, the results of their 1W1P stakeholder issue identification and prioritization processes served as the basis for the prioritization process for this plan. More specific information on how this was done for each of these watersheds is provided in the Prioritization Strategy section of this document.

Since the Upper Otter Tail River Watershed was not engaged in a planning process during the development of this plan, BWSR initiated a stakeholder involvement process focused on obtaining input that would shape the prioritization process for this portion of the URRW watershed. An initial meeting was held on February 24, 2020 in Fergus Falls, Minnesota. The purpose of the meeting was to familiarize stakeholders with watershed-based mitigation planning and the development of the URRW plan. BWSR staff also presented information on assessing baseline conditions in the watershed and solicited feedback from the attendees on the appropriateness of the topics covered in the baseline conditions section of the report and the identification of catchment prioritization criteria. The meeting was attended by representatives from Otter Tail County, Wilkin County, East Otter Tail Soil and Water Conservation District, West Otter Tail Soil and Water Conservation District, Buffalo-Red River Watershed District, Pelican River Watershed District, and the MnDNR. Because of the restrictions imposed by the COVID-19 pandemic no additional in person meetings were held and all stakeholder coordination was done via email. Additional information on how the stakeholder responses were factored into the prioritization process is provided in the following sections.

Prioritization Strategy for Selecting and Implementing Mitigation Activities

The geographic scale used to identify priority areas for wetland mitigation in this plan is the catchment. In Minnesota, the MnDNR has defined catchment to be “the smallest delineated and digitized drainage area mapped by the MnDNR Watershed Delineation Project that contains all land area(s), as well as noncontributing inclusions and water features, upstream from, or between Hydrologic Points of Interest (HPOI) defining other DNR Catchments.” The catchment scale was selected for two primary reasons. First, the prioritization process can be conducted at a finer scale which allows for more specific identification of areas where wetland mitigation may benefit watershed health. At the same time, the number of catchments in the URRW is not excessive and the process can be completed in a reasonable amount of time with meaningful results. Second, the MnDNR has developed large amounts of watershed data at the catchment level that can be easily accessed to support the prioritization process which reduces the time associated with the GIS-based analyses.

The URRW is made up of 790 unique catchments distributed across the seven major watersheds as follows: Mustinka River 44 catchments, Bois de Sioux River 131 catchments, Otter Tail River 339 catchments (36 in the Lower Otter Tail River and 303 in the Upper Otter Tail River), Upper Red River of the North 40 catchments, Buffalo River 129 catchments, Wild Rice River 200 catchments, and Red River of the North – Marsh River 38 catchments. In response to watershed district boundaries and ongoing planning efforts in the URRW, several of the major watersheds were combined for the prioritization process to better align the mitigation planning process with other management and planning approaches. This resulted in four distinct geographic areas used in the prioritization process as described in the following text.

Bois de Sioux – Mustinka Watershed: The Bois de Sioux and Mustinka River Watersheds cover approximately 1,413 square miles of predominately agricultural land in west-central Minnesota. Stakeholders from these two watersheds partnered to develop a Comprehensive Watershed Management Plan (CWMP) under the BWSR 1W1P program. The draft CWMP was published on September 8, 2020. Its purpose is to equip local governments tasked with managing natural and water resources with information necessary to identify issues specific to each watershed, set goals to address those issues, and take actions to fix (or make progress towards fixing) them. It also focuses on assisting landowners with implementing conservation practices by identifying locations where practices would have the greatest benefit, potential project sponsors and programs, and initial cost estimates.

Buffalo-Red River Watershed: The Buffalo-Red River watershed covers an area of 1,785 square miles and includes all or part of three major watersheds: the Buffalo River, the upper Red River of the North, and the Otter Tail River downstream of Orwell Dam. This area coincides with the legal boundary of the Buffalo-Red River Watershed District and is also the planning area for the Buffalo-Red River CWMP released as a draft plan in August of 2020. As with the Bois de Sioux and Mustinka River Watershed CWMP described in the previous section, the purpose of this plan is to build on existing plans and information to develop goals and targeted and measurable implementation actions to better manage water resources within the planning area.

Upper Otter Tail River Watershed: The Upper Otter Tail River Watershed includes 1,774 square miles of contributing drainage area upstream of Orwell Dam. Most of the watershed lies within the counties of Otter Tail and Becker. Water resource management in this area is currently done through county water management plans and the Pelican River Watershed District, however, the watershed was selected to receive a planning grant from the 1W1P program and development of a comprehensive watershed management plan is expected to begin in 2021.

Wild Rice – Marsh River Watershed: The Wild Rice - Marsh River Watershed area includes two major watersheds, the Wild Rice and the Marsh River – Upper Red River of the North. In 2019, the Wild Rice Watershed District and thirteen other entities in the watershed signed a memorandum of agreement to develop CWMP to guide the watershed managers (local counties and soil and water conservation districts) as they work to protect and restore the watershed's resources. The primary focus of this plan is to reduce erosion (sediment) and flooding in the watershed by retaining water, reducing runoff, and managing the land. The secondary focus includes flood damage reduction, agricultural productivity, and habitat enhancement. A draft of the CWMP was released in August of 2020.

The ongoing watershed planning efforts in three of these areas presented a unique opportunity to coordinate the 1W1P planning process with CPF development. After coordinating with each of the local watershed planning teams BWSR staff determined that pursuing this opportunity was possible from a timing and purpose standpoint (wetland restoration was an objective in the local plans) and would satisfy the requirements for CPF development. However, integrating the two planning processes would require a different approach from previous CPFs completed by BWSR in that each of the four planning areas within the URRW could utilize a different prioritization process with respect to methodology and/or prioritization criteria. Since this was determined to be more of a workload issue than a technical adequacy concern the decision was made to move forward with a process that focused on integrating the CPF development with the local planning processes. Although the decision to use this approach resulted in three separate prioritization methodologies for the URRW, there is greater consistency with local planning efforts and greater recognition of the goals of the CPF.

For each process, catchment prioritization criteria were identified through information obtained from stakeholders during outreach meetings conducted in 2019 and 2020. BWSR staff with experience in watershed planning and wetland mitigation siting served as facilitators or provided CPF related information during the stakeholder meetings. Each criterion identified during the meetings was evaluated to assess the availability and suitability of spatially explicit GIS data to represent it during the GIS-based process. As a rule, a potential criterion must have had the following qualities to be selected.

- The criterion represents a watershed health characteristic that affects or can be affected by the presence/absence of wetlands.

- The criterion represents a watershed characteristic that is generally present throughout the BSA which allows for comparison between and amongst catchments. There must also be enough variation in the criterion throughout the BSA such that comparisons are meaningful.

- GIS data at the catchment level was publicly available for the criterion.

The process employed for each of the four URRW planning areas is described in the following paragraphs.

Bois de Sioux – Mustinka Watershed and the Buffalo-Red River Watershed

At the time CPF development was initiated, local governments within the Bois de Sioux – Mustinka and Buffalo-Red River watersheds were in the final stages of their respective 1W1P planning process. Coordination with each of these planning teams revealed that wetland loss and degradation had been recognized as a priority issue in both watersheds and that stakeholders identified wetland restoration as either an implementation action with a measurable goal (Buffalo-Red River) or as an action that benefits another issue area such as altered hydrology (Bois de Sioux – Mustinka). With respect to prioritizing locations for wetland restoration, both planning efforts utilized the Minnesota Prairie Plan (MPP) to identify areas within their boundaries where wetland restoration should be targeted.

The MPP is the product of collaboration among Minnesota's conservation partners to develop a 25-year strategy for accelerating conservation in the Prairie Region of the state. Along with guidance in the existing Wildlife Management Area Plan, Pheasant Plan, Duck Plan, and other resource plans the MPP has a goal of protecting and restoring a total of 2.0 million acres of grassland and savanna, along with 1.3 million acres of wetlands and shallow lakes. The MPP lays out a three-pronged conservation approach for accomplishing these goals: prairie core area-based conservation, corridor-based conservation, and local conservation. The first two of these identify specific areas within the Prairie Region where conservation areas should be focused. The fact that the MPP specifically identifies wetland restoration as a goal and targets areas where protection and restoration would have the most benefit makes this a logical and defensible choice for use in a wetland restoration prioritization analysis for the Bois de Sioux –

Mustinka and Buffalo-Red River watersheds. The MPP definitions of Prairie Core Area and Prairie Corridor are provided below.

> *Prairie Core.* An area composed of at least 10,000 acres that retains at least some of the features of a functioning prairie system. At least 15% of the area is grassland, with a substantial portion being native prairie. Prairie core areas often contain other natural communities, including wetlands, aquatic systems, savannas, shrublands and a minor component of forest.
>
> *Prairie Corridor.* A linear stretch of habitat 6 miles wide that connect core areas and moderate the effects of a highly fragmented landscape. Corridors function as dispersal corridors that allow an exchange of individuals and genetics between populations.

Also noteworthy is the difference in scale between the CWMPs and this prioritization effort. In the 1W1P studies the wetland restoration prioritization methodologies based on the MPP were applied at the planning region scale. Each study had a slightly different definition for this term but in general planning regions were based on hydrologic boundaries and other physical characteristics and were established specifically for planning purposes to recognize the physical differences that have an impact on managing water resources. The Bois de Sioux – Mustinka study had five planning regions and the Buffalo – Red River study had nine.

The methodology used in the CWMPs is significantly different from the methods used by BWSR on other watershed-based mitigation plans. This is true from both a methodology perspective (multi-criteria versus single criteria) and a scale perspective (coarse versus fine). Following additional coordination with the CWMP teams a decision was made to utilize the same methodology (the single criteria approach using the MPP) but to apply it at the catchment scale. Although the MPP approach can be considered a single criteria method the MPP itself represents an extensive amount of research and evaluation covering many of the same factors frequently included in BWSR's wetland restoration planning studies. It also has considerable support from local and state agencies and is used as a guide for planning and implementing conservation projects in this part of the state. For these reasons, the MPP method was used in this planning study. With respect to the scale of analysis, the catchment scale resulted in a more detailed wetland prioritization output than the one in the CWMPs but overall, the results are consistent. The methodology based on the MPP used for this study is described in the following paragraphs.

For both the Bois de Sioux–Mustinka and Buffalo-Red River watersheds the MPP core and corridor areas were obtained in digital format from the Minnesota Geospatial Commons. Using GIS, the acres of prairie core areas within each catchment was determined and the percentage of the total area of the catchment represented as prairie core area was calculated (prairie core acres/total catchment acres). The results for each study area were then normalized by dividing each result by the highest calculated percentage of prairie core area. This process was repeated for the prairie corridor areas. The prioritization score for each catchment was then determined by adding the normalized prairie core value and the normalized prairie corridor value. These values were normalized by dividing each calculated catchment score result by the highest overall score. Because a single criterion was used for the catchment prioritization process in these areas no weighting analysis was performed, and the normalized summed catchment scores represent the results of the prioritization process. The results are shown in Figures 8 and 9.

Upper Otter Tail River Watershed

Catchment prioritization criteria were identified for the Upper Otter Tail River Watershed through information obtained from stakeholders at an outreach meeting held in February 2020. BWSR staff served as facilitators during the stakeholder meeting and provided input to the process. Each criterion identified during the meetings was evaluated to assess the availability and suitability of spatially explicit GIS data to represent it during the GIS-based process. Input was also obtained from the Corps of Engineers and other agency staff during the plan formulation process. The criteria are presented in Table 16 along with the rationale behind their selection and the source of data used to represent each criterion.

Table 16
Upper Otter Tail River Watershed Catchment Prioritization Criteria

Catchment Prioritization Criteria	Rationale for Inclusion
Criterion #1: Areas With High Potential for Groundwater Recharge	This criterion identifies areas with high potential for groundwater recharge. Wetlands play an important role in storing water and allowing surface water to slowly infiltrate which benefits recharge efforts. The pollution sensitivity of near-surface materials index from the WHAF was used to represent this criterion. The index score is an area weighted average for each catchment's rate of infiltration based on properties of the soil and surficial geology.
Criterion #2: Areas With Low Amounts of Perennial Cover	Vegetative cover is an important characteristic when assessing watershed health because as perennial vegetation is removed there is a greater potential for erosion, soil loss, and flooding, water quality degradation, and loss of habitat. Perennial cover was any land cover not identified as developed or in any form of agricultural use based on the 2011 National Land Cover Data. Hay and pasture were perennial cover. The amount of land with perennial cover was divided by the total area in each catchment to generate the index score.
Criterion #3: Areas With Poor Riparian Habitat Connectivity	Riparian refers to the land immediately adjacent to water features such as lakes and rivers. Access to this area is important to aquatic and terrestrial species particularly during seasonal high flow or flood events. Riparian lands are also important year-round as travel corridors and habitat connectors, often providing the only remaining natural land cover in developed landscapes. The Riparian Connectivity Index in the WHAF compares the amount of cropped or developed land cover to the amount of open land in the riparian area. The percent agricultural and developed land relative to the total riparian area was calculated and scored. Scores range from 0 (all lands within 200 meters of streams or in floodplains are in annual cropland or urban cover) to 100 (all lands are neither urban nor annual agriculture).
Criterion #4: Areas Where There Are High Quality/Value Habitats	Wetland mitigation projects completed in areas with high concentrations of high-quality habitats have greater potential to benefit Species of Greatest Conservation Need (SGCN). Using information from the MNDNR 2015-2025 Wildlife Action Plan a ratio of the high and medium high scored areas to total area was calculated for each catchment.

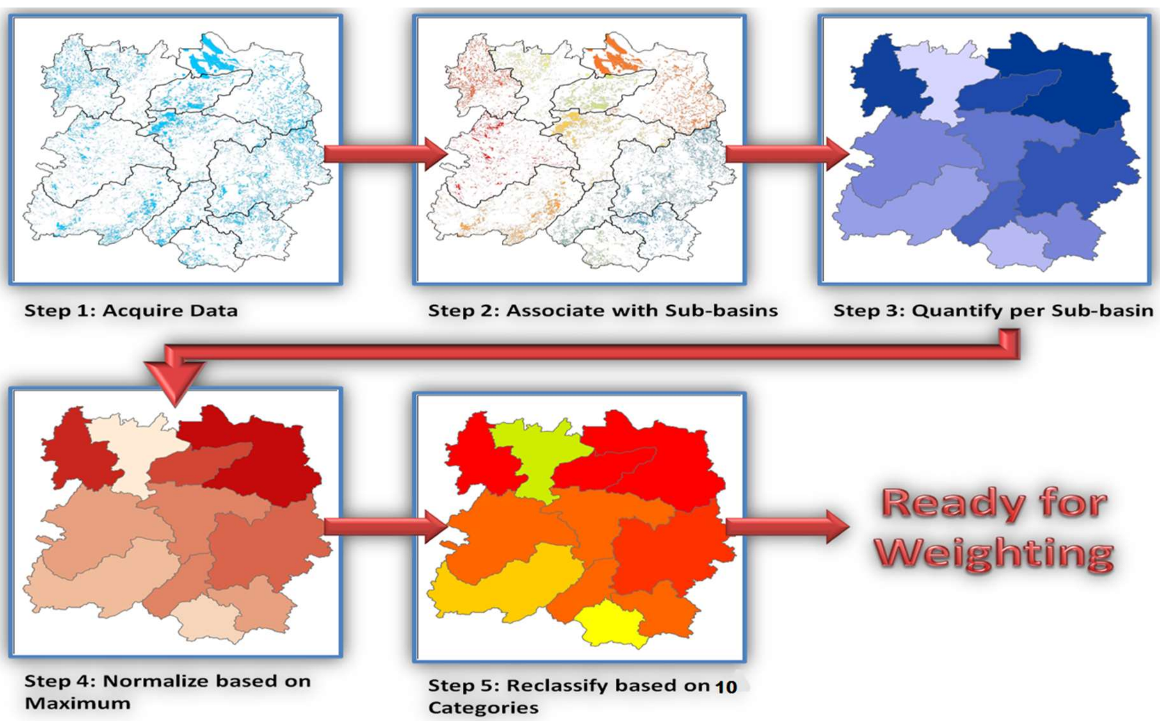
Criterion #5: Areas With Higher Amounts of Impaired Lakes and Streams	Water quality impairments are an indicator of lost watershed function, the presence of pollution sources, and the degree of landscape alteration. However, they are limited in that they only are representative of waters that have been assessed by the MPCA and the source of the impairment could be from an upstream area that is not identified as impaired. To address the potential for water quality impairments to other waters the WHAF catchment score for non-point source pollution risk was combined with data on lake and stream impairments (dissolved oxygen, fishes bioassessments, aquatic macroinvertebrate bioassessments, nitrates, nutrient/eutrophication biological indicators, turbidity, and total suspended solids) from the MPCA's Water Quality Assessment Database (2018) to calculate a value between 0 and 300 for each catchment with a score of 0 representing no impairments and little risk and a score of 300 representing significant water quality impairments and risk.
Criterion #6: Areas With More Degraded Wetlands	Wetland functions are affected by activities that degrade, but do not necessarily remove, wetlands from the landscape. Assessing the degree to which existing wetlands have been altered by ditching provides insight into the quality of the wetlands remaining in the catchment. The acreage of ditched wetlands in each catchment was determined using the "d" modifier in the updated NWI. The ditched wetland score was determined by dividing the area of ditched wetlands by the total area of wetlands in the catchment and multiplying the result by 100.
Criterion #7: Areas With Higher Amounts of Historic Wetland Loss	This criterion represents historic wetland loss as a percentage. Historic wetland area was calculated for each catchment using hydric ratings from the Soil Survey Geographic Database (SSURGO). Historic wetland area does not include map soil units identified as water since these areas are presumed to be lakes and not wetlands. Current wetland area was calculated for each catchment using the NWI. Current wetland area does not include lakes.
Criterion #8: Areas Identified as Priorities for Wetland Restoration in Other Watershed/Regional Plans	Identification of wetland restoration opportunities in other local/regional plans recognizes the value of planning being done by resource professionals who have more familiarity with the resources in their areas of jurisdiction.

Development of Criterion Maps

GIS transformation of spatially explicit data characterizing each criterion were normalized through a reclassification process to generate maps that captured the potential for a catchment to improve watershed health through wetland restoration. The geoprocessing for each criterion followed a straightforward and repeatable process (Figure 7).

First, GIS data representing each criterion was obtained and associated with each catchment in the URRW. If a catchment value had not been assigned (GIS data obtained from the WHAF typically had predetermined criterion scores for each catchment), a value was calculated for each catchment using raw data. For example, the number of ditched wetlands was determined by dividing the area of NWI wetlands with a "d" modifier by the total area of wetlands in the catchment and multiplying the result by 100. The resulting criterion scores were then normalized from 0 to 100 for each major watershed by dividing each catchment criteria value by the highest value in that major watershed. The normalized results were binned into ten classes using the natural breaks tool in ArcGIS in an ascending order of priority (Step 5 of Figure 7). In other words, low scores are catchments with lower potential for wetland mitigation to improve watershed health and high scores represent areas that would have a higher potential to improve watershed health.

Figure 7. Illustration of the geoprocessing procedures used in the BSA 6 catchment prioritization. In the URRW the procedures were applied at the catchment scale as opposed to the sub-basin scale referenced in the figure.



The process described above was used for all but the criterion for recognition of wetland restoration in other local and regional plans. For this criterion (identified as C8 in Table 16) each catchment was given a value of 0, 3, 5, 8, or 10 based on the scale at which plans recognizing wetland restoration opportunities had been completed. Plans done at a finer scale which identified specific sites or locations for wetland restoration were viewed as better than plans that identified larger areas or regions where wetland restoration in general was viewed as beneficial. If there were two or more plans at any scale within a catchment that specifically recognized wetland restoration as a management objective/priority that catchment received a score of 10. To represent this criterion in the prioritization process, a GIS data layer was created showing the geographic areas where plans with restoration identified as a goal, recommendation, or opportunity within the Upper Otter Tail River watershed exist.

Weighting Derived from Stakeholder Input

Although the criteria used in the catchment prioritization could be equally weighted, stakeholders were offered the opportunity to "weight" the individual criteria differently based on "value" preferences – i.e., performing tradeoffs amongst criteria using an approach referred to as Multi-Criteria Decision Analysis (MCDA). MCDA is a set of systematic and tractable procedures that offers a means of combining disparate (non-commensurable) criteria using weighting and straightforward mathematical algorithms. To elicit preferences, stakeholders were asked to gauge their perceptions of value of each criterion in relation to one another by independently responding to an email survey distributed on May 15, 2020. The results of the survey were used to assign surrogate weights according to the rank sum method with the number of dimensions equal to the number of prioritization criteria (8). The relative rank and weights for each criterion are provided in the Table 17.

Table 17
Upper Otter Tail River Watershed Stakeholder Weighting of Catchment Prioritization Criteria

	C1: Areas With High Potential for Groundwater Recharge (pollution sensitivity)	C2: Areas With Low Amounts of Perennial Cover	C3: Areas With Poor Riparian Habitat Connectivity	C4: Areas Where There Are High Quality/Value Habitats (Wildlife Action Plan)	C5: Areas With Higher Amounts of Impaired Lakes and Streams (Impaired Waters List)	C6: Areas With More Degraded Wetlands	C7: Areas With Higher Amounts of Historic Wetland Loss	C8: Areas identified as priorities for wetland restoration in other watershed/regional plans
Rank	2	5	8	4	5	7	3	1
Weight	0.1944	0.0972[1]	0.0278	0.1389	0.0972[1]	0.0556	0.1667	0.2222

[1] the rank sum weights for criteria 5 and 6 were combined and averaged in response to a tie in stakeholder ranking.

The criterion weights were applied to the score for each criterion to derive a weighted catchments prioritization score. The weighted values were summed, normalized, and binned from 1 to 10 to create a final value for each catchment in the watershed. Catchments with higher values (darker shades of orange and red on the prioritization map are a higher priority for the siting of wetland replacement/restoration projects than those that have middle or lower values. The weighted results of the prioritization process for the Upper Otter Tail River Watershed are shown on Figure G1 (Appendix G). The unweighted results are shown in Figure F2 (Appendix F).

Wild Rice – Marsh River Watershed

A 1W1P process was ongoing in this watershed concurrent with the CPF development process. After initial discussions about scope and schedules, BWSR Wetland Section staff were invited to attend an Advisory and Policy Committee meeting to present information on the CPF and discuss the possibility of using the catchment prioritization outputs in the comprehensive watershed plan. At the June 8, 2020 meeting there was agreement among the stakeholders that the CPF outputs would benefit the watershed plan which led to additional discussions about the criteria to be used in the prioritization process. The stakeholders ultimately decided on ten criteria for the CPF prioritization process including two criteria utilizing analyses conducted by the 1W1P planning team (sediment loading and water storage). The criteria are presented in Table 18 along with the rationale behind their selection and the source of data used to represent each criterion.

Table 18
Wild Rice and Marsh River Watersheds Catchment Prioritization Criteria

Catchment Prioritization Criteria	Rationale for Inclusion
Criterion #1: Areas With High Potential for Groundwater Recharge	This criterion identifies areas with high potential for groundwater recharge. Wetlands play an important role in storing water and allowing surface water to slowly infiltrate which benefits groundwater recharge. The pollution sensitivity of near-surface materials index from the WHAF was used to represent this criterion. The index score is an area weighted average for each catchment's rate of infiltration based on properties of the soil and surficial geology.
Criterion #2: Areas With Low Amounts of Perennial Cover	Vegetative cover is an important characteristic when assessing watershed health because as perennial vegetation is removed there is a greater potential for erosion, soil loss, flooding, water quality degradation, and loss of habitat. Perennial cover is any land cover not identified as developed or in any form of agricultural use based on the 2011 National Land Cover Data. Hay and pasture were perennial cover. The amount of land with perennial cover was divided by the total area in each catchment to generate the index score.
Criterion #3: Areas With Poor Riparian Habitat Connectivity	Riparian refers to the land immediately adjacent to water features such as lakes and rivers. Access to this area is important to aquatic and terrestrial species particularly during seasonal high flow or flood events. Riparian lands are also important year-round as travel corridors and habitat connectors, often providing the only remaining natural land cover in developed landscapes. The Riparian Connectivity Index in the WHAF compares the amount of cropped or developed land cover to the amount of open land in the riparian area. The percent agricultural and developed land relative to the total riparian area was calculated and scored. Scores range from 0 (all lands within 200 meters of streams or in floodplains are in annual cropland or urban cover) to 100 (all lands are neither urban nor annual agriculture).

Criterion #4: Areas Where There Are High Quality/Value Habitats	Wetland mitigation projects completed in areas with high concentrations of high quality habitats have greater potential to benefit Species of Greatest Conservation Need (SGCN). Using information from the MNDNR 2015-2025 Wildlife Action Plan a ratio of the high and medium high scored areas to total area was calculated for each catchment.
Criterion #5: Areas With Higher Amounts of Impaired Lakes and Streams	Water quality impairments are an indicator of lost watershed function, the presence of pollution sources, and the degree of landscape alteration. However, they are limited in that they only are representative of waters that have been assessed by the MPCA and the source of the impairment could be from an upstream area that is not identified as impaired. To address the potential for water quality impairments to other waters the WHAF catchment score for non-point source pollution risk was combined with data on lake and stream impairments (dissolved oxygen, fishes bioassessments, aquatic macroinvertebrate bioassessments, nitrates, nutrient/eutrophication biological indicators, turbidity, and total suspended solids) from the MPCA's Water Quality Assessment Database (2018) to calculate a value between 0 and 300 for each catchment with a score of 0 representing no impairments and little risk and a score of 300 representing significant water quality impairments and risk.
Criterion #6: Areas With More Degraded Wetlands	Wetland functions are affected by activities that degrade, but do not necessarily remove, wetlands from the landscape. Assessing the degree to which existing wetlands have been altered by ditching provides insight into the quality of the wetlands remaining in the catchment. The acreage of ditched wetlands in each catchment was determined using the "d" modifier in the updated NWI. The ditched wetland score was determined by dividing the area of ditched wetlands by the total area of wetlands in the catchment and multiplying the result by 100.
Criterion #7: Areas With Higher Amounts of Historic Wetland Loss	This criterion represents historic wetland loss as a percentage. Historic wetland area was calculated for each catchment using hydric ratings from the Soil Survey Geographic Database (SSURGO). Historic wetland area does not include map soil units identified as water since these areas are presumed to be lakes and not wetlands. Current wetland area was calculated for each catchment using the recently updated NWI. Current wetland area does not include lakes.
Criterion #8: Areas Identified As Priorities For Wetland Restoration In Other Watershed/Regional Plans	Identification of wetland restoration opportunities in other local/regional plans recognizes the value of planning being done by resource professionals who have more familiarity with the resources in their areas of jurisdiction.
Criterion #9: Areas with Higher Potential For Water Storage	This criterion represents the potential to increase water storage through the restoration of drained wetland basins. Water storage is a wetland function that has been identified as a priority in these watersheds. Water storage potential at the catchment level was determine by identifying drained wetland basins using the Restorable Wetland Inventory (RWI) LIDAR data

	and removing existing wetlands based on the NWI (old version) and the DNR public waters inventory.
Criterion #10: Areas with High Sediment Loading Potential	Wetland restorations provide opportunities to reduce sediment loading by re-establishing permanent native vegetation and by filtering surface water during snow melt and precipitation events. Cumulative sediment loading from each catchment was determined using PTMApp.

Development of Criterion Maps

Criterion maps for the Wild Rice – Marsh River Watershed were developed using the same methodology described for the Upper Otter Tail River watershed with the following exception. There was a data limitation issue associated with the criteria C9 (Areas with Higher Potential for Water Storage) and C10 (Areas with High Sediment Loading Potential). The spatial data associated with these criteria were developed as part of the 1W1P planning process. When this data was incorporated into the CPF catchment prioritization process it was apparent that the two studies had slightly different watershed boundaries. As mentioned previously, the CPF process was conducted using a DNR derived watershed boundary but the 1W1P study was using a LIDAR derived watershed boundary done specifically for that planning effort. The 1W1P watershed boundary did not include seven catchments located primarily in the lower (western) part of the watershed adjacent to the Red River of the North. The DNR identification numbers for these seven catchments are: 5900100, 5900200, 5900201, 5900300, 5900500, 5903600, and 6013401. Since it was not possible to determine scores for these catchments for criteria C9 and C10, a qualitative process was used to derive an estimated value. This was done by assessing the scores for each criterion in catchments that bordered the catchments missing quantitatively derived C9 and C10 values. If an adjacent catchment made up a majority of the border with the catchment in question and the catchments generally shared similar landforms and land use characteristics, then the value for the bordering catchment was used as an estimated value for the catchment with missing values. Similarly, if multiple bordering catchments had similar values for either C9 or C10 and the catchments generally shared similar landforms and land use characteristics then the value, or average value, for the bordering catchments was used as an estimated score for the catchment with missing values.

Weighting Derived from Stakeholder Input

Similar to the process used for the Upper Otter Tail River watershed, the stakeholders present at a meeting on July 13, 2020 completed an internet-based survey (using Microsoft Teams) to gauge their perceptions of value of each criterion in relation to one another. The results of the survey were used to assign surrogate weights according to the rank sum method with the number of dimensions equal to the number of prioritization criteria (10). The relative rank and weights for each criterion are provided in the following table.

Table 19 Wild Rice Marsh River Watersheds Stakeholder Weighting of Catchment Prioritization Criteria										
	C1: Areas With High Potential for Groundwater Recharge (pollution sensitivity)	C2: Areas With Low Amounts of Perennial Cover	C3: Areas With Poor Riparian Habitat Connectivity	C4: Areas Where There Are High Quality/Value Habitats (Wildlife Action Plan)	C5: Areas With Higher Amounts of Impaired Lakes and Streams (Impaired Waters List)	C6: Areas With More Degraded Wetlands	C7: Areas With Higher Amounts of Historic Wetland Loss	C8: Areas Identified As Priorities For Wetland Restoration In Other Watershed/Regional Plans	C9: Areas With Higher Potential for Water Storage (LIDAR)	C10: Areas With High Sediment Loading Potential (PTMApp)
Rank	4	10	9	1	6	8	7	3	5	2
Weigh	0.127	0.018	0.036	0.181	0.090	0.054	0.072	0.145	0.109	0.163

The criterion weights were applied to the score for each catchment to derive a weighted catchments prioritization score. The weighted results of the prioritization process for the Wild Rice and Marsh River Watershed are shown on Figure G2 (Appendix G). The unweighted results are shown in Figure F4 (Appendix F).

Designation of Priority Catchments

The analyses completed to this point separated catchments within each watershed planning area based on their expected potential to benefit watershed health through wetland restoration activities. The next step in the process was to take these results and identify the catchments that will be designated as prioritized for wetland mitigation projects. This required finding a breakpoint in the prioritization outputs that balanced the need for sufficient wetland mitigation opportunities with maximizing benefits to the watershed. For example, designating only a small number of catchments as high priority areas may not result in enough opportunities for projects when a search is initiated through a selection process. Similarly, identifying a large number of catchments as high priority areas may decrease the potential benefits to the watershed because the value of the prioritization process is diluted, and sites could be selected in catchments that scored markedly lower than others.

For the URRW CPF, all catchments with prioritization scores in the top third of the distribution for their respective planning area were identified as a high priority area. Using this method, a total of 309 catchments were identified as high priority areas in the URRW. Those prioritized include 68 in the Buffalo-Red River watersheds, 58 in the Bois de Sioux – Mustinka watersheds, 101 in the Upper Otter Tail River watershed, and 82 in the Wild Rice – Marsh River watershed. Reliance on the MPP to prioritize catchments in the Buffalo-Red River and Bois de Sioux – Mustinka watersheds resulted in a much wider range of scores for these watersheds and a lower average and median for the those identified as prioritized. Overall, the process designated a total of 2,081,254 acres (3,252 square miles) of lands as high priority in the URRW. A summary of the prioritized catchments is provided in Table 20. The prioritized catchments in each planning area are shown in Figures 8 through 11. As discussed previously, the normalized results were binned into ten classes using the natural breaks tool in ArcGIS (labeled as "BIN" in Figures 8 through 11). The figures have been edited to display only the BIN values of the prioritized catchments with the higher scores (darker shades) representing the greatest priority based on the analysis and the lower scores the lesser priority with respect to the prioritized catchments. Catchments that were not prioritized are shown as white (blank) in the figures.

Table 20
Summary of URRW Prioritized Catchments

Major Watershed	Catchments			Prioritized Catchment Scores		
	Number Prioritized	Prioritized Area (acres)[1]	Prioritized Acres (% of total)	Range	Average	Median
Bois de Sioux – Mustinka	58/175	250,361	28	29.8 - 100	71.2	65.4
Buffalo-Red River	68/205	694,372	55	0.33 - 100	36.9	30.8
Upper Otter Tail	101/303	476,697	43	68.4 – 100	76.5	74.6
Wild Rice – Marsh River	82/245	659,824	52	61.1 - 100	70.4	67.7
Total	309	2,081,254				

[1] Prioritized area is the total land area in the prioritized catchments within each major watershed.

Figure 8: Prioritized Catchments

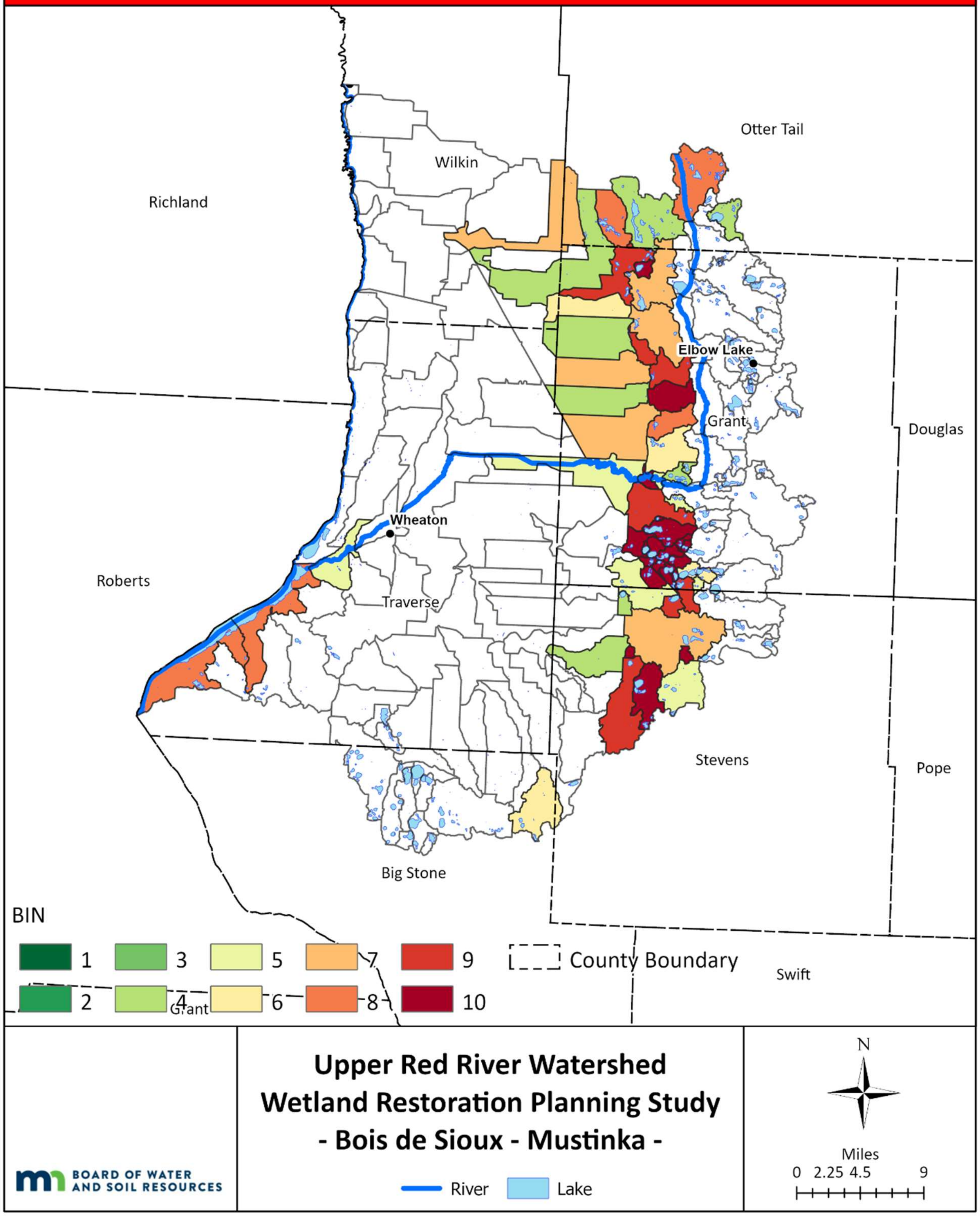
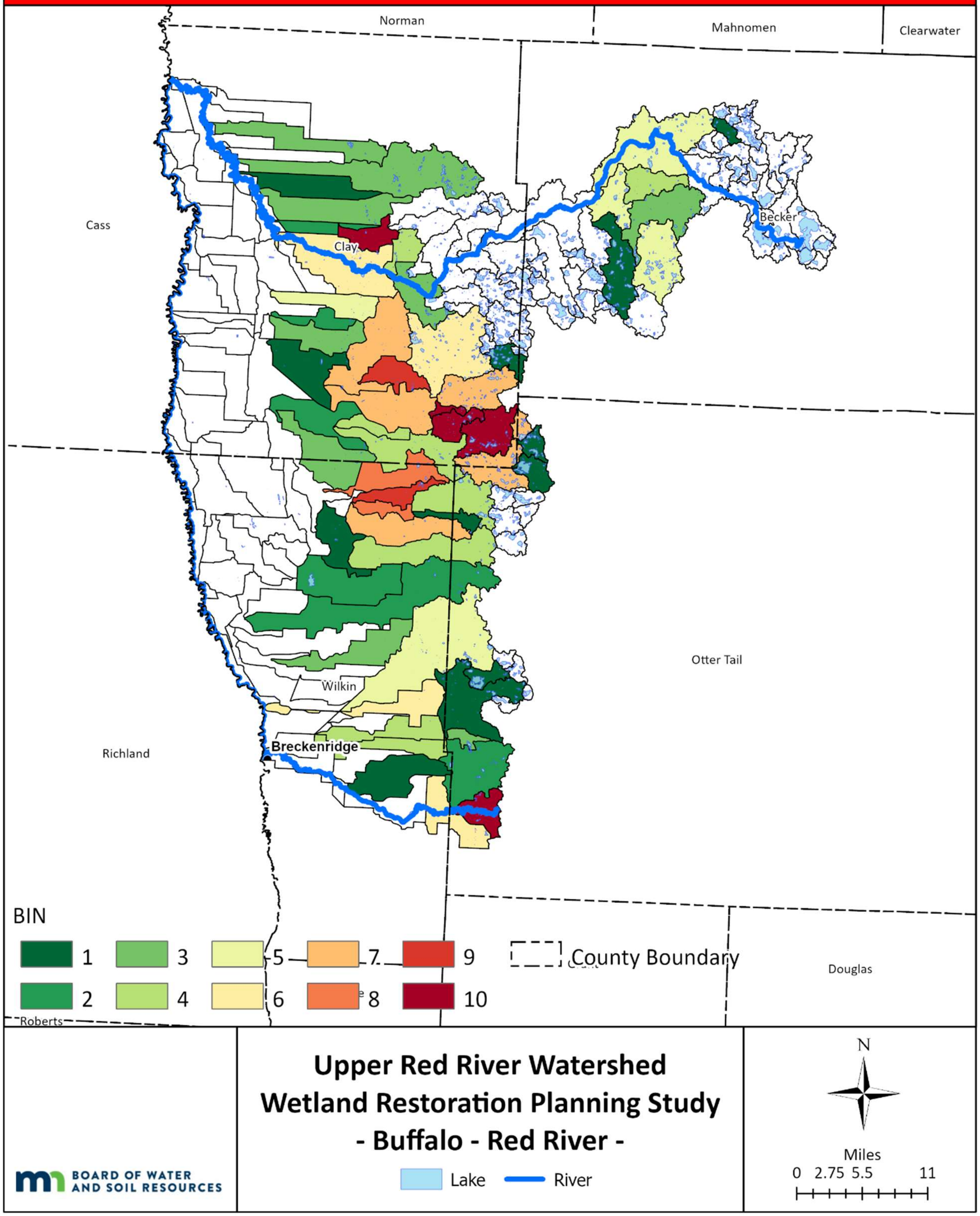


Figure 9: Prioritized Catchments



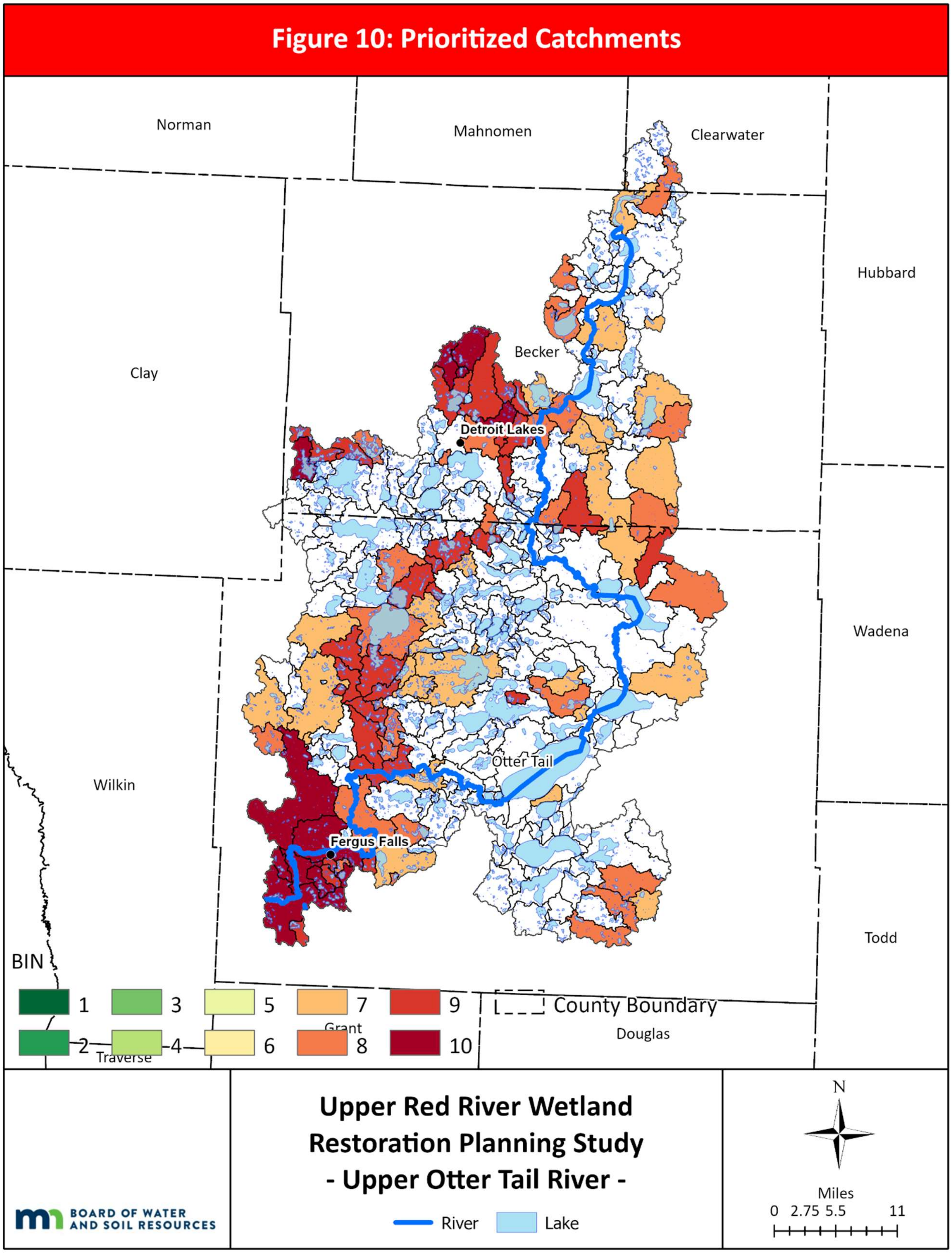


Figure 10: Prioritized Catchments
Norman
Mahnomen
Clearwater
Hubbard
Clay
Becker
Detroit Lakes
Wadena
Wilkin
Otter Tail
Fergus Falls
Todd
BIN
1
2
3
4
5
6
7
8
9
10
County Boundary
Grant
Traverse
Douglas
Upper Red River Wetland
Restoration Planning Study
- Upper Otter Tail River -
River
Lake
N
Miles
0 2.75 5.5 11
BOARD OF WATER
AND SOIL RESOURCES

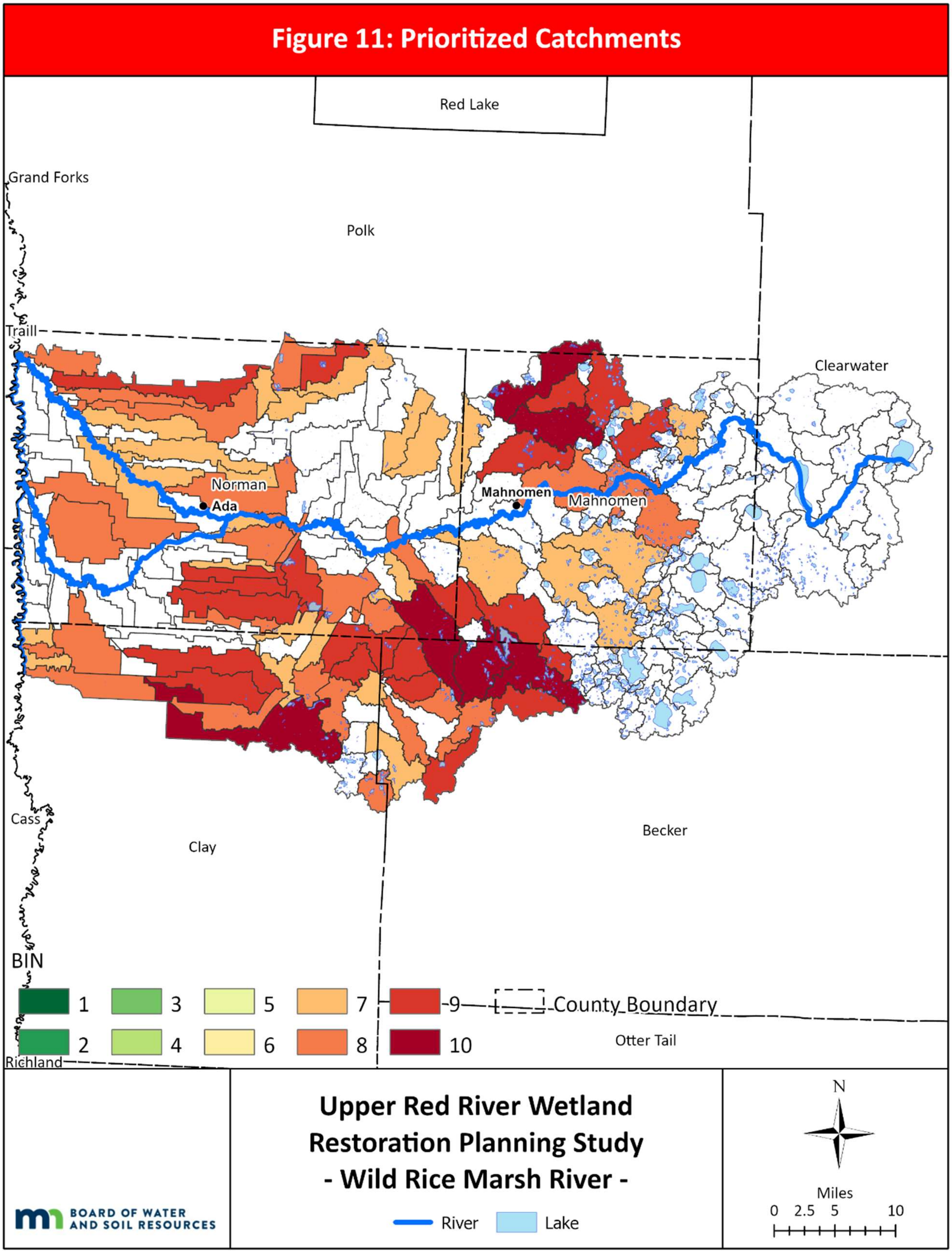


Figure 11: Prioritized Catchments
Red Lake
Grand Forks
Polk
Traill
Clearwater
Norman
Ada
Mahnomen
Mahnomen
Cass
Clay
Becker
BIN
1
2
3
4
5
6
7
8
9
10
County Boundary
Otter Tail
Richland
Upper Red River Wetland
Restoration Planning Study
- Wild Rice Marsh River -
River
Lake
BOARD OF WATER
AND SOIL RESOURCES
N
Miles
0 2.5 5 10

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Minnesota Pollution Control Agency (MPCA). 2017b. Wild Rice River Watershed Monitoring and Assessment Report. wq-ws3-09020108b Minnesota Pollution Control Agency, St. Paul, MN.

Minnesota Pollution Control Agency (MPCA). 2019. Otter Tail River Monitoring and Assessment Report. wq-ws3-09020103b Minnesota Pollution Control Agency, St. Paul, MN.

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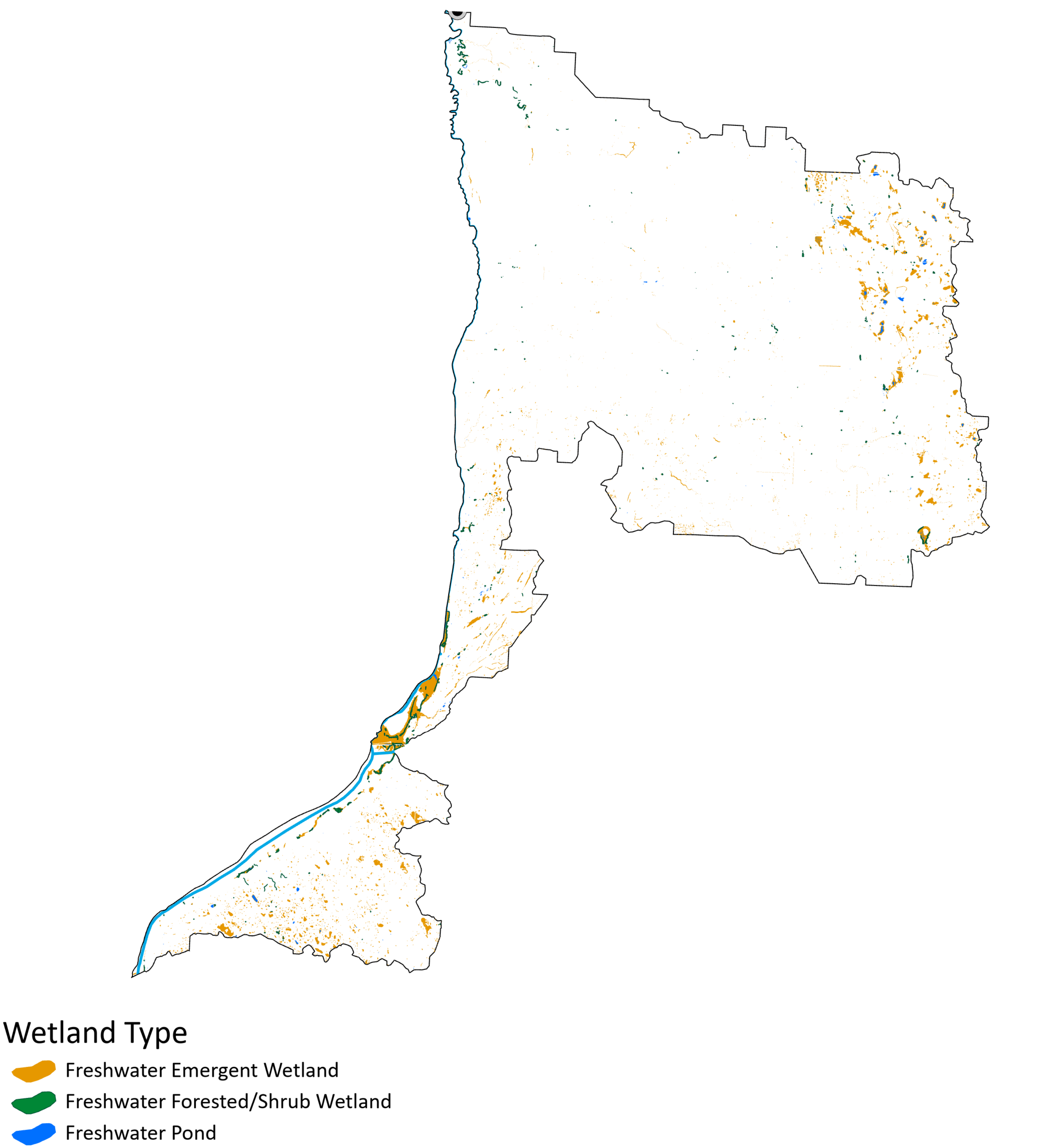
Appendix A

NWI Maps

Figure A1: National Wetland Inventory



BOARD OF WATER AND SOIL RESOURCES

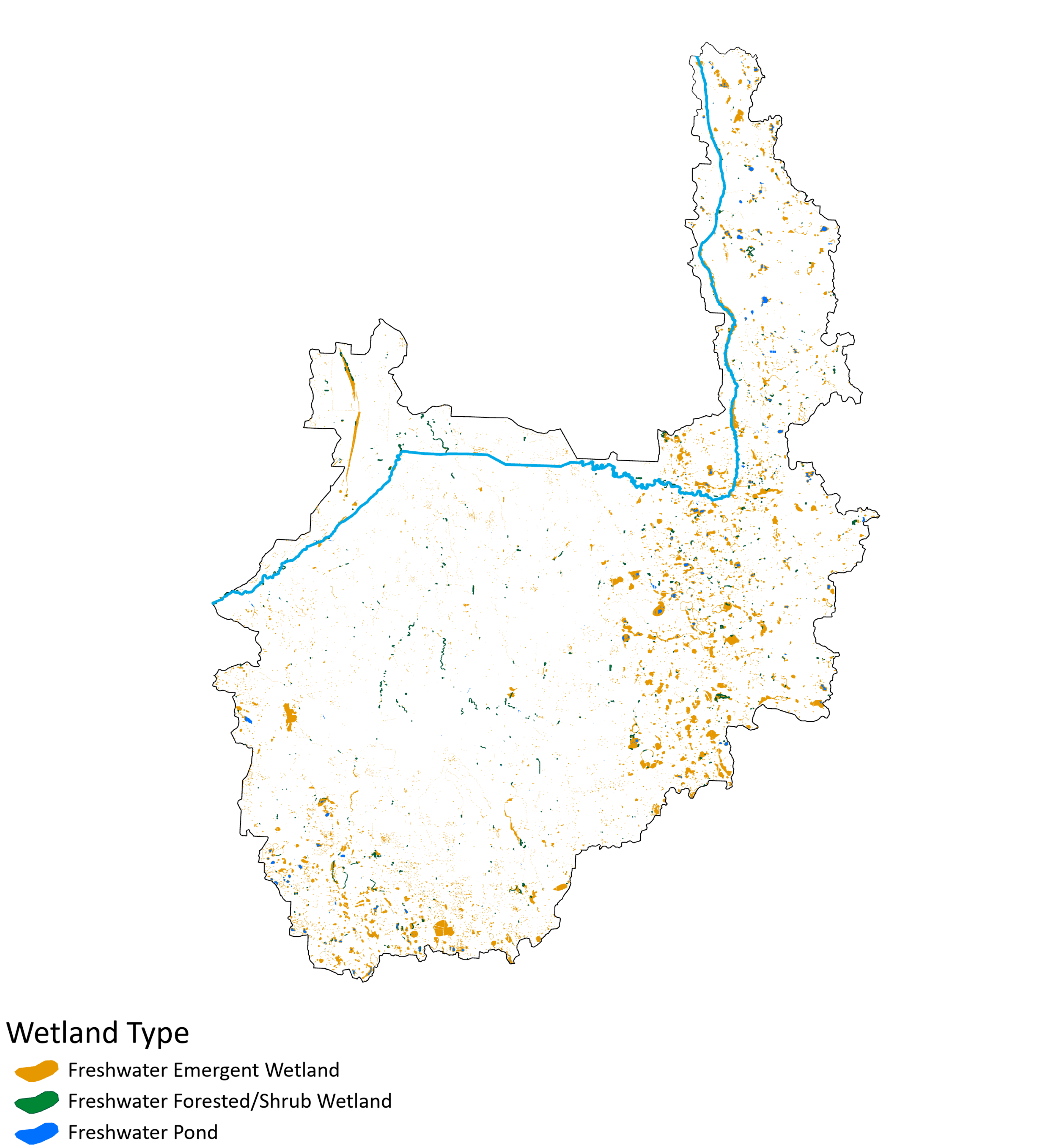
Upper Red River Watershed
Wetland Restoration Planning Study
- Bois de Sioux River -

Legend: City Watershed River Lake

N

Miles
0 1.5 3 6

Figure A2: National Wetland Inventory



BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Mustinka River -

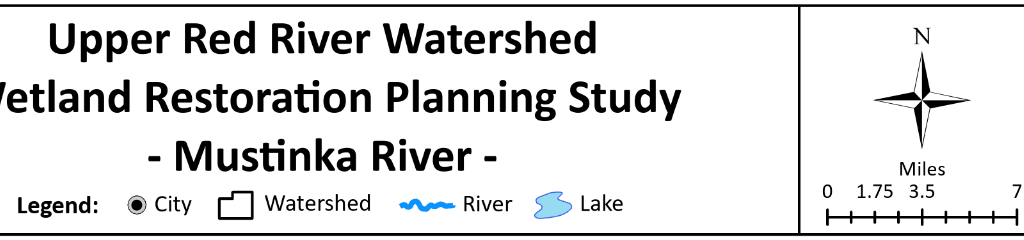
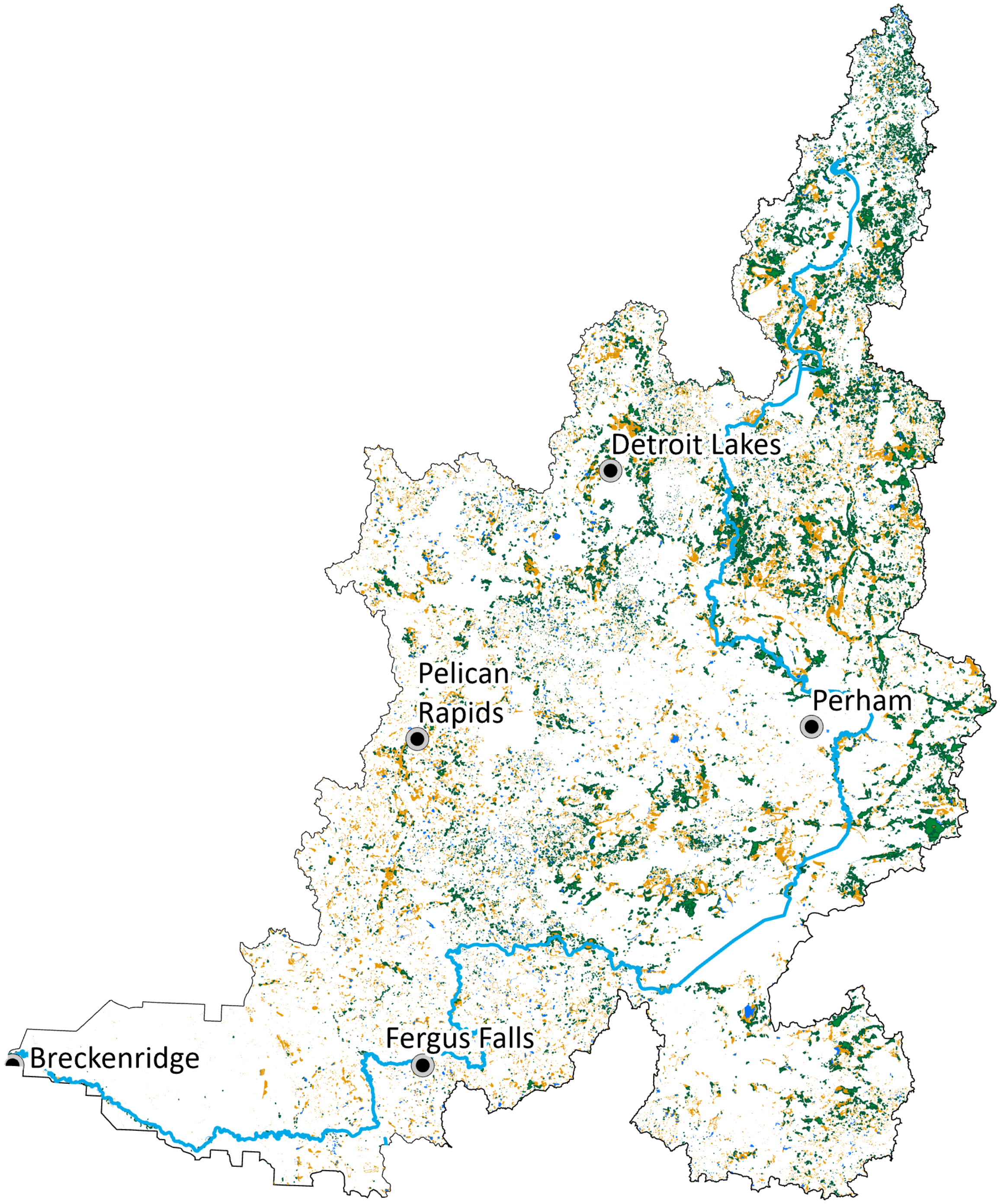


Figure A3: National Wetland Inventory



Wetland Type

BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Otter Tail River -

Legend: City, Watershed, River, Lake

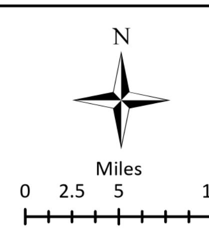
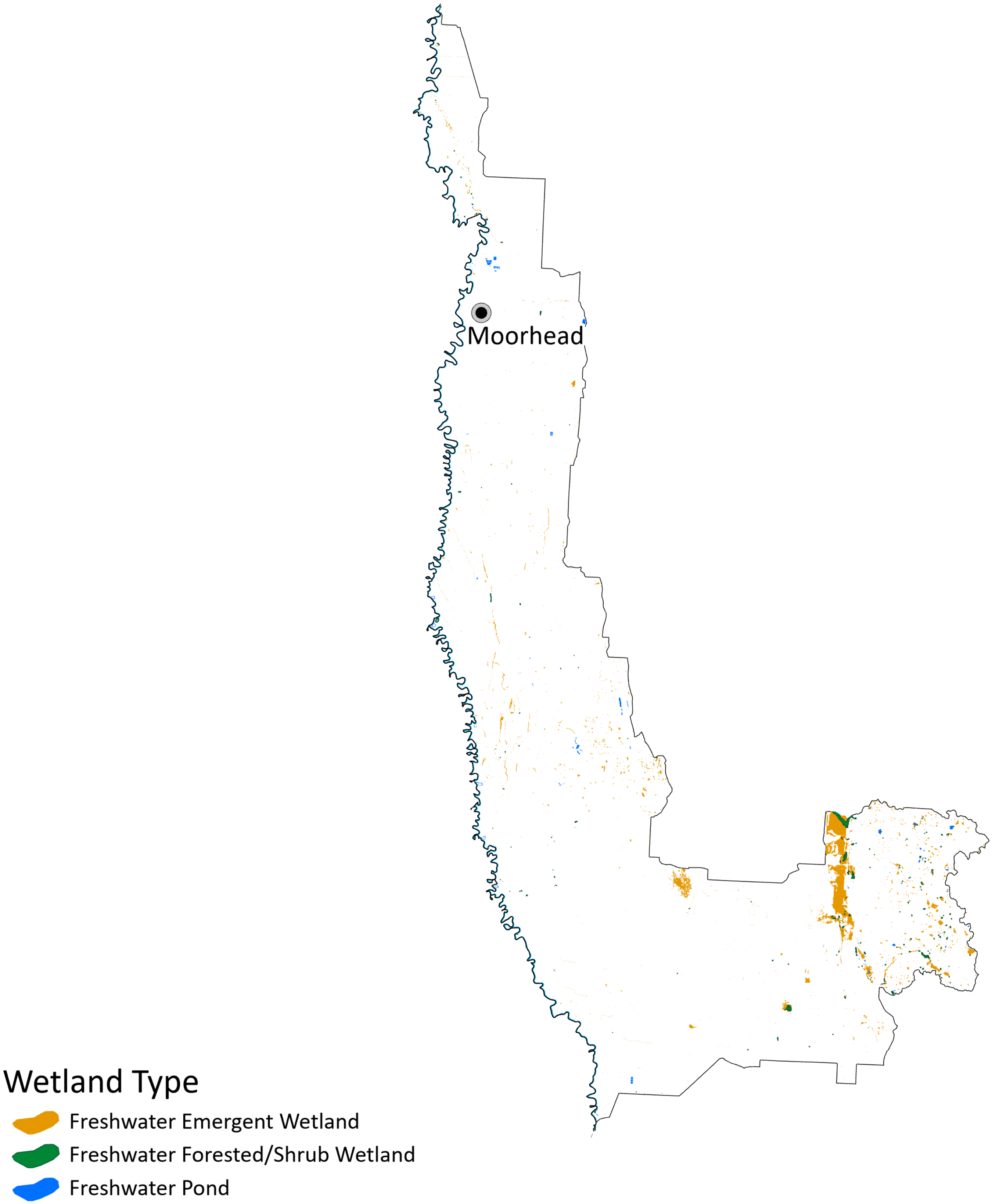


Figure A4: National Wetland Inventory



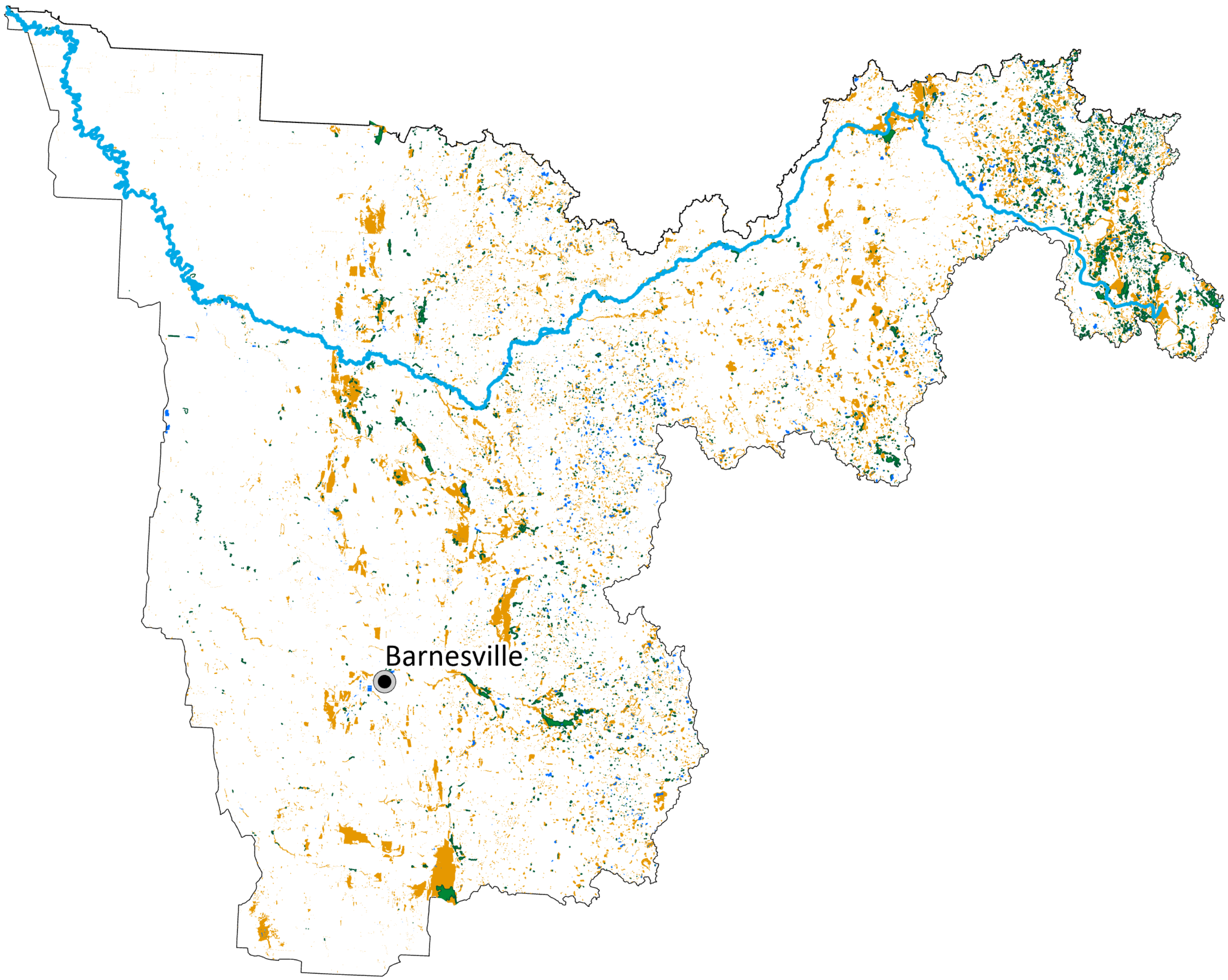
Upper Red River Watershed
Wetland Restoration Planning Study
- Upper Red River -

Legend: City Watershed River Lake

BOARD OF WATER AND SOIL RESOURCES

N
Miles
0 1.75 3.5 7

Figure A5: National Wetland Inventory



Wetland Type

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond

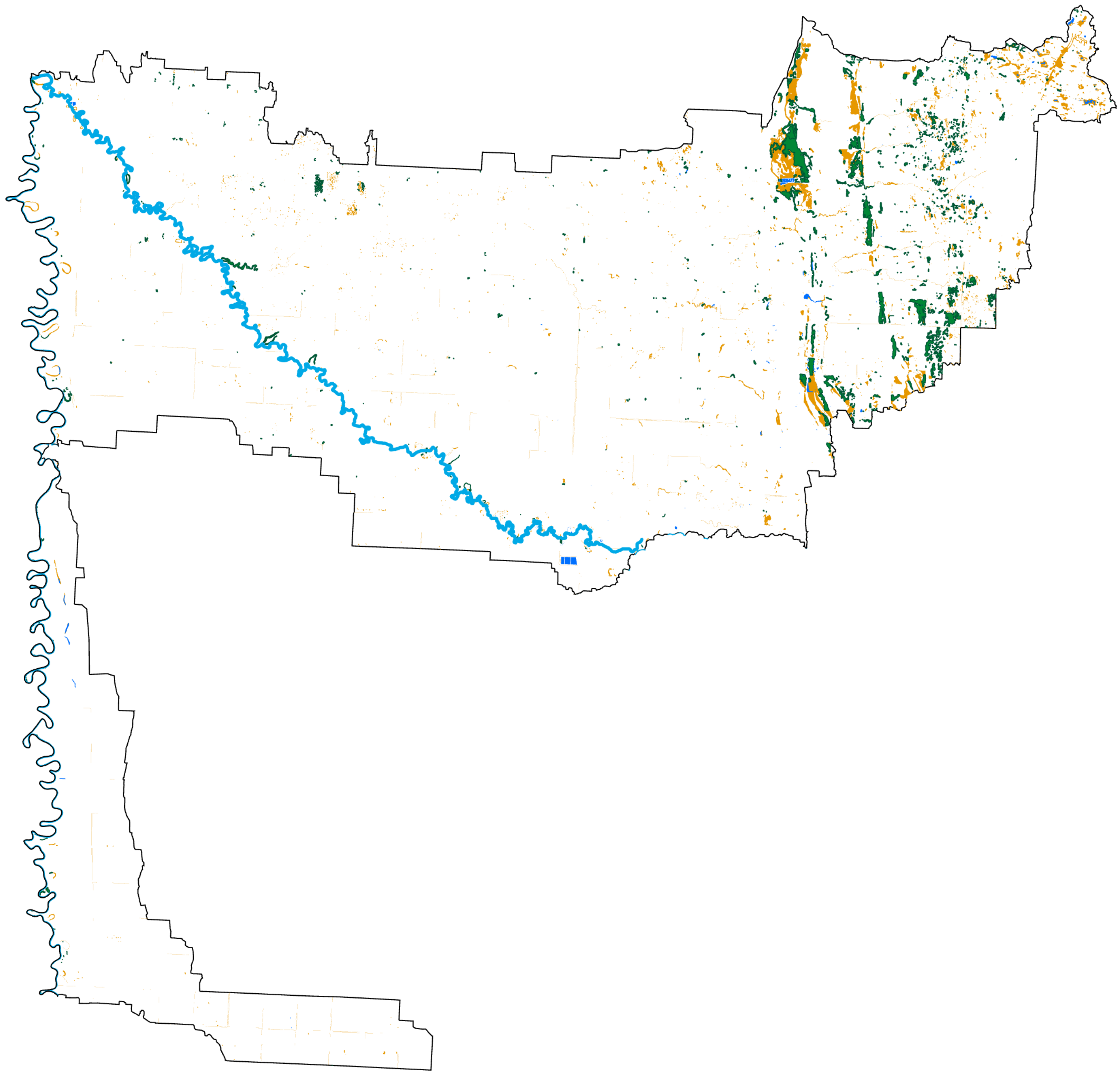
BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Buffalo River -

Legend: City Watershed River Lake

N
Miles
0 2 4 8

Figure A6: National Wetland Inventory



Wetland Type

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond

BOARD OF WATER AND SOIL RESOURCES

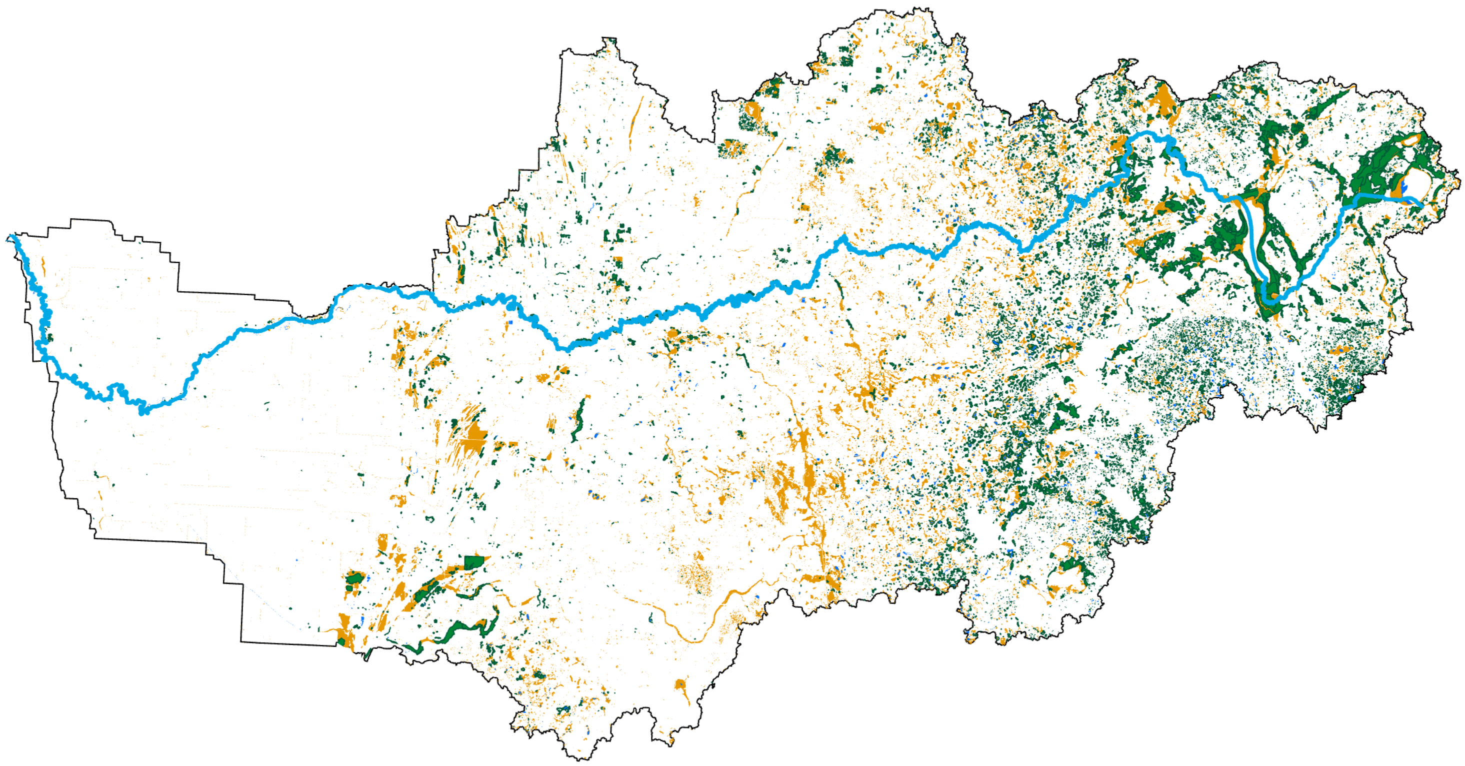
Upper Red River Watershed
Wetland Restoration Planning Study
- Marsh River -

Legend: City, Watershed, River, Lake

N

Miles
0 1 2 4

Figure A7: National Wetland Inventory



Wetland Type

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond

BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Wild Rice River -

Legend: City Watershed River Lake

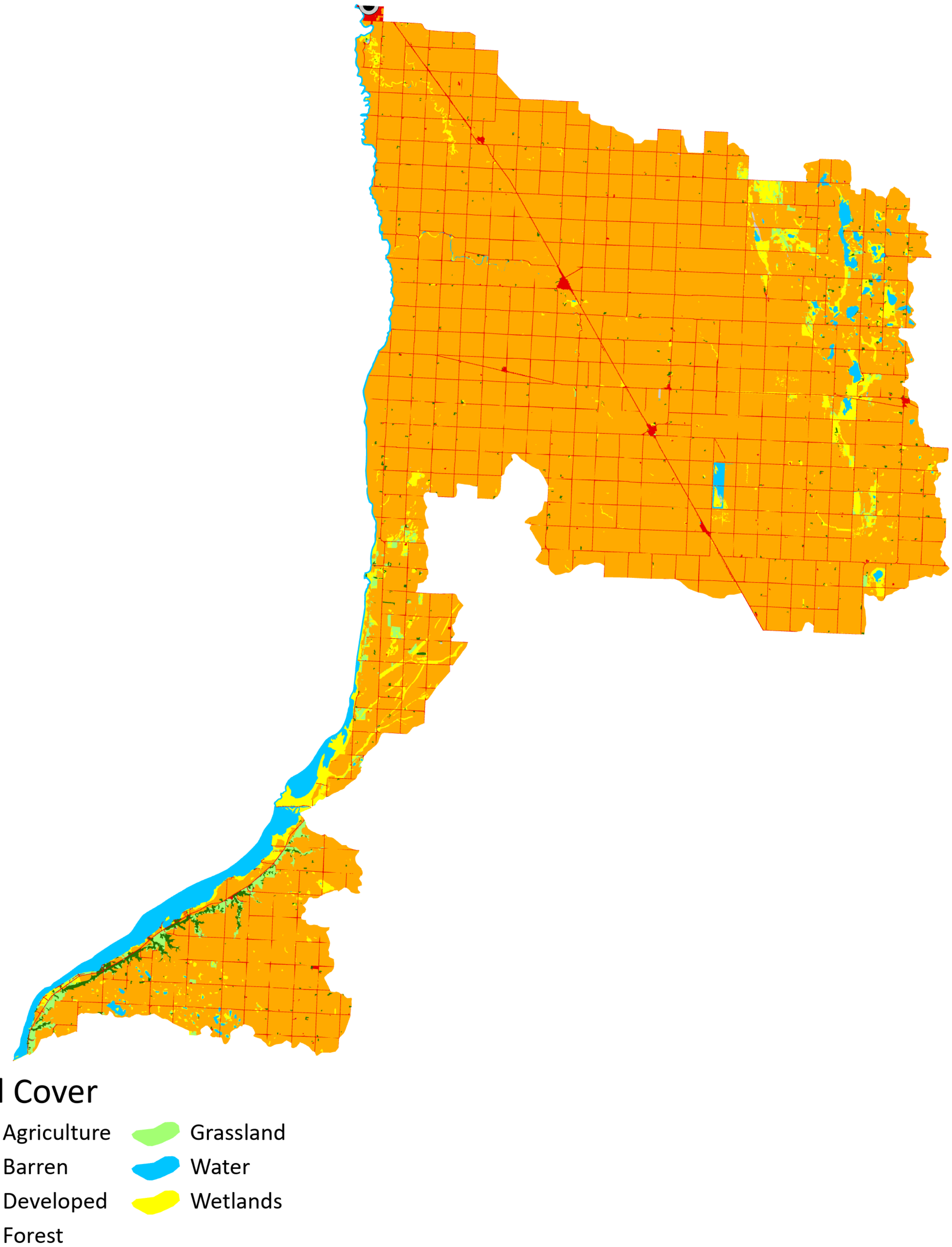
N

Miles
0 2.25 4.5 9

Appendix B

Land Cover Maps

Figure B1: Land Cover (2016)



Upper Red River Watershed
Wetland Restoration Planning Study
- Bois de Sioux River -

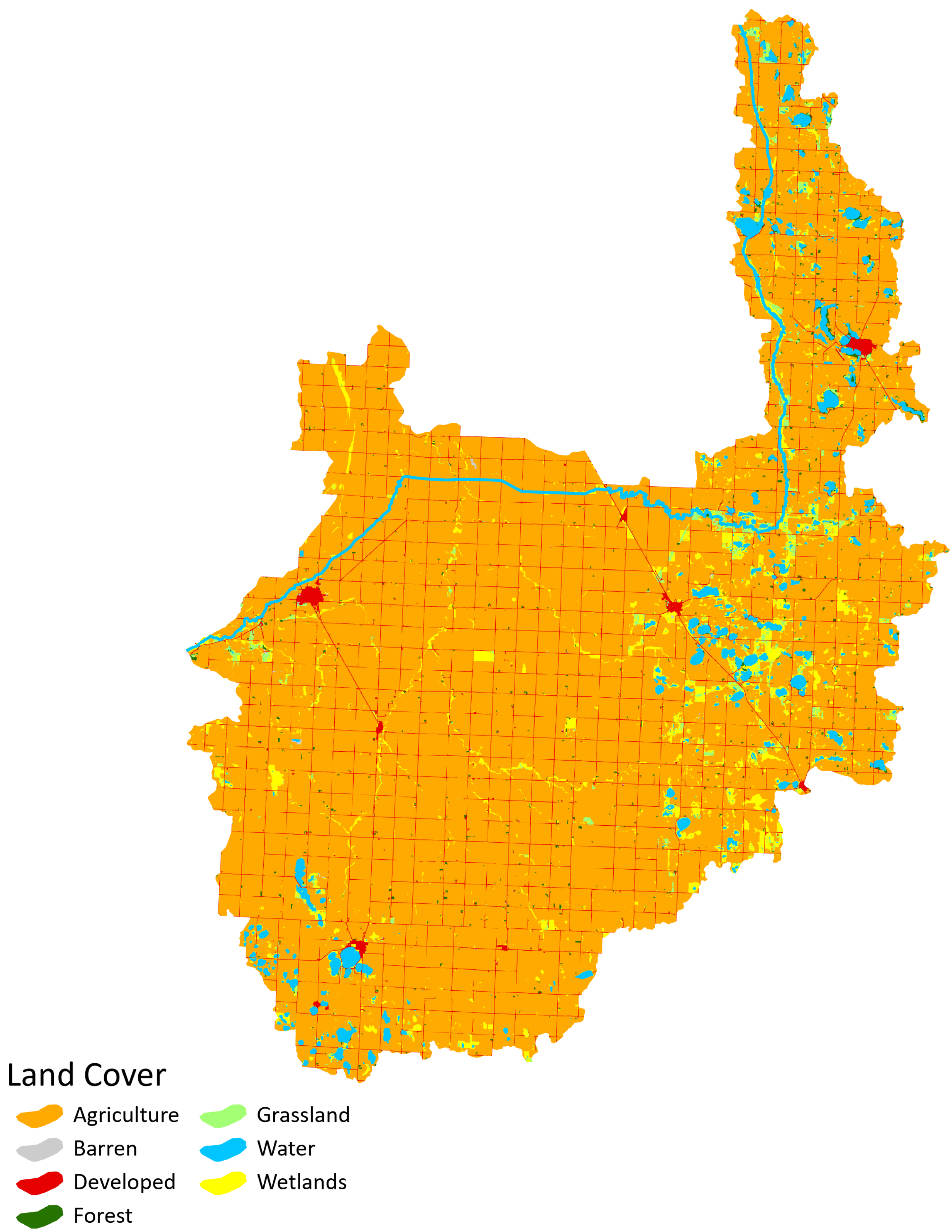
Legend: City Watershed River Lake

N

Miles
0 1.5 3 6

BOARD OF WATER AND SOIL RESOURCES

Figure B2: Land Cover (2016)

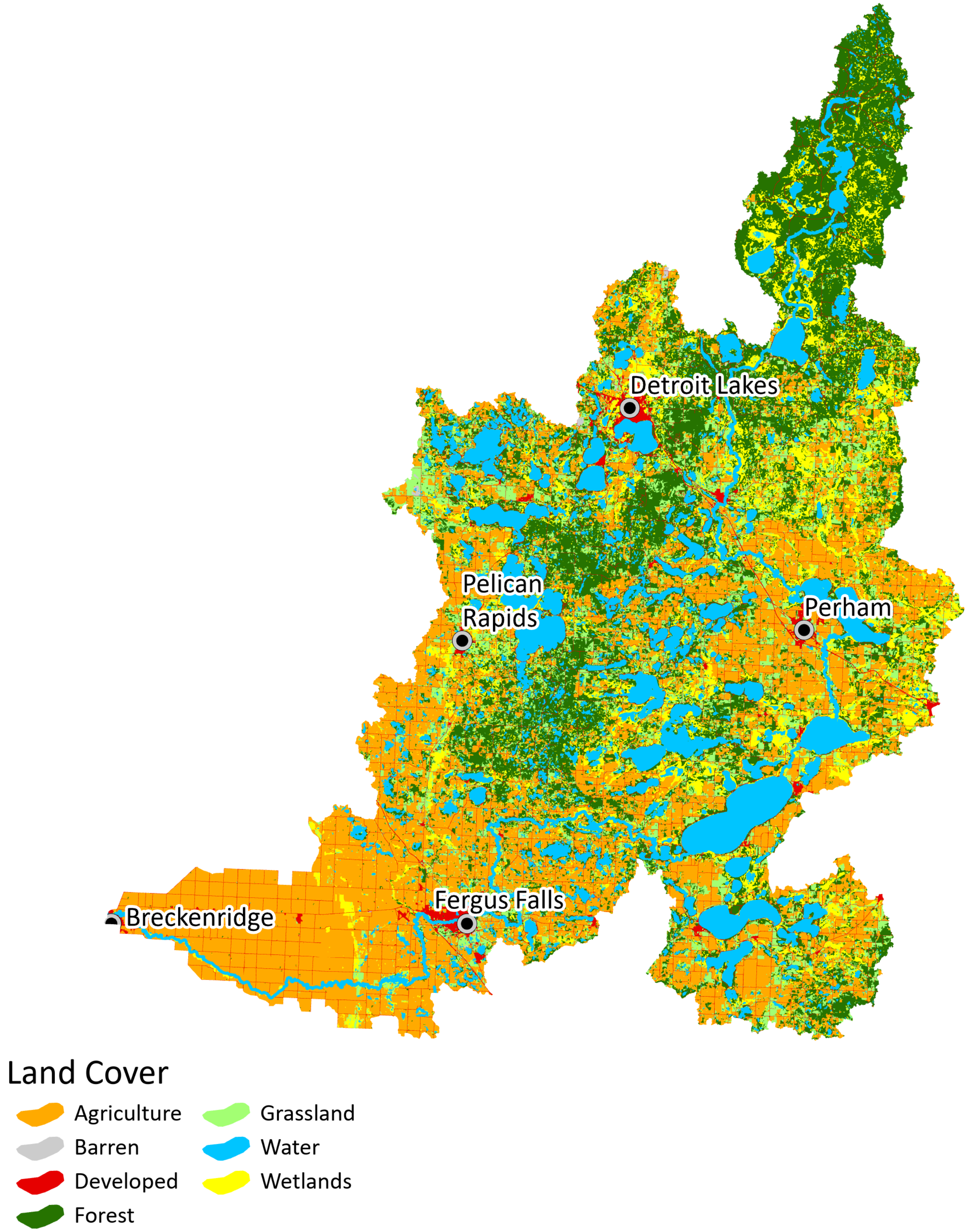


Upper Red River Watershed
Wetland Restoration Planning Study
- Mustinka River -

Legend: City Watershed River Lake

N
Miles
0 1.5 3 6

Figure B3: Land Cover (2016)



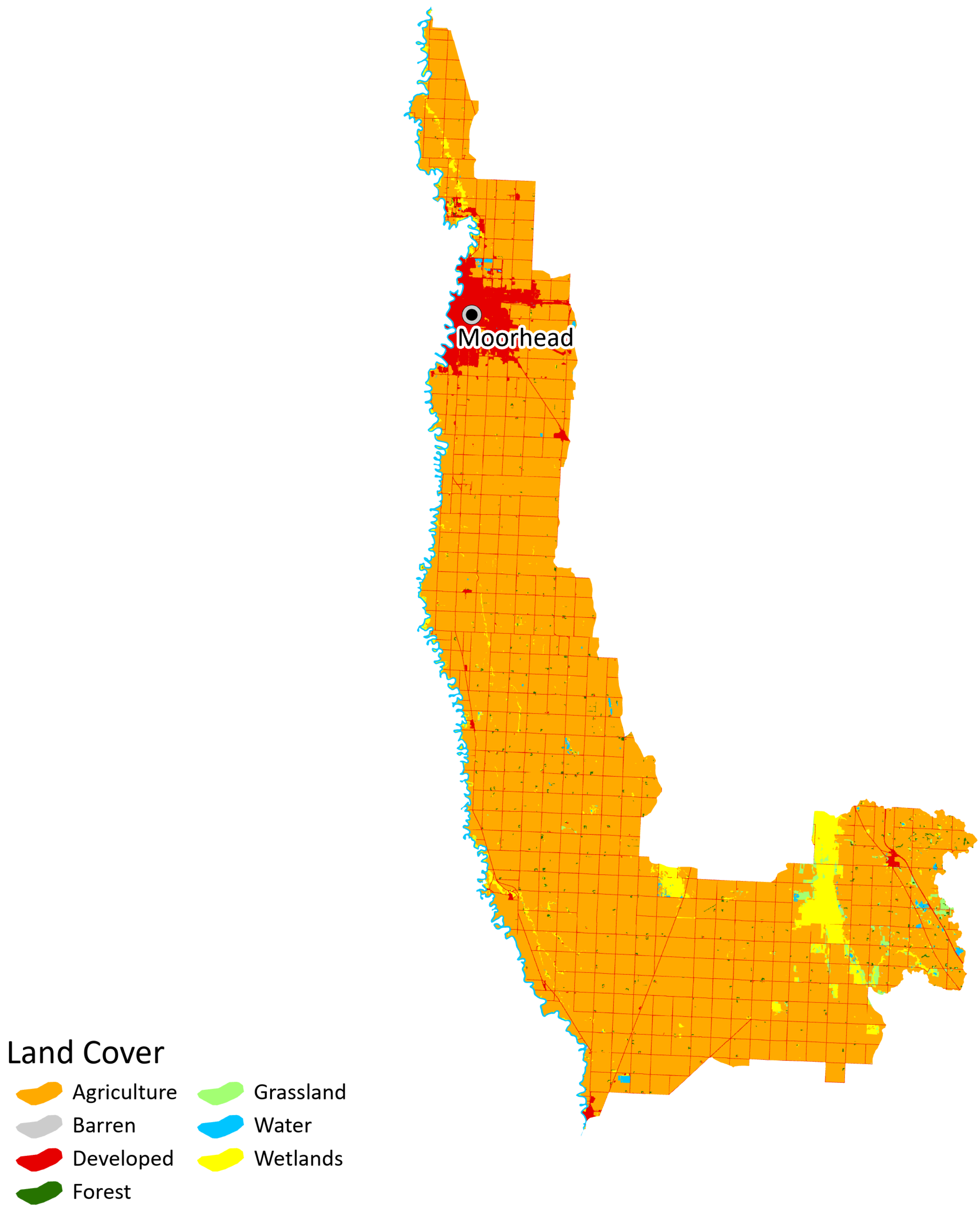
BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Otter Tail River -

Legend: City, Watershed, River, Lake

N
Miles
0 2.5 5 10

Figure B4: Land Cover (2016)



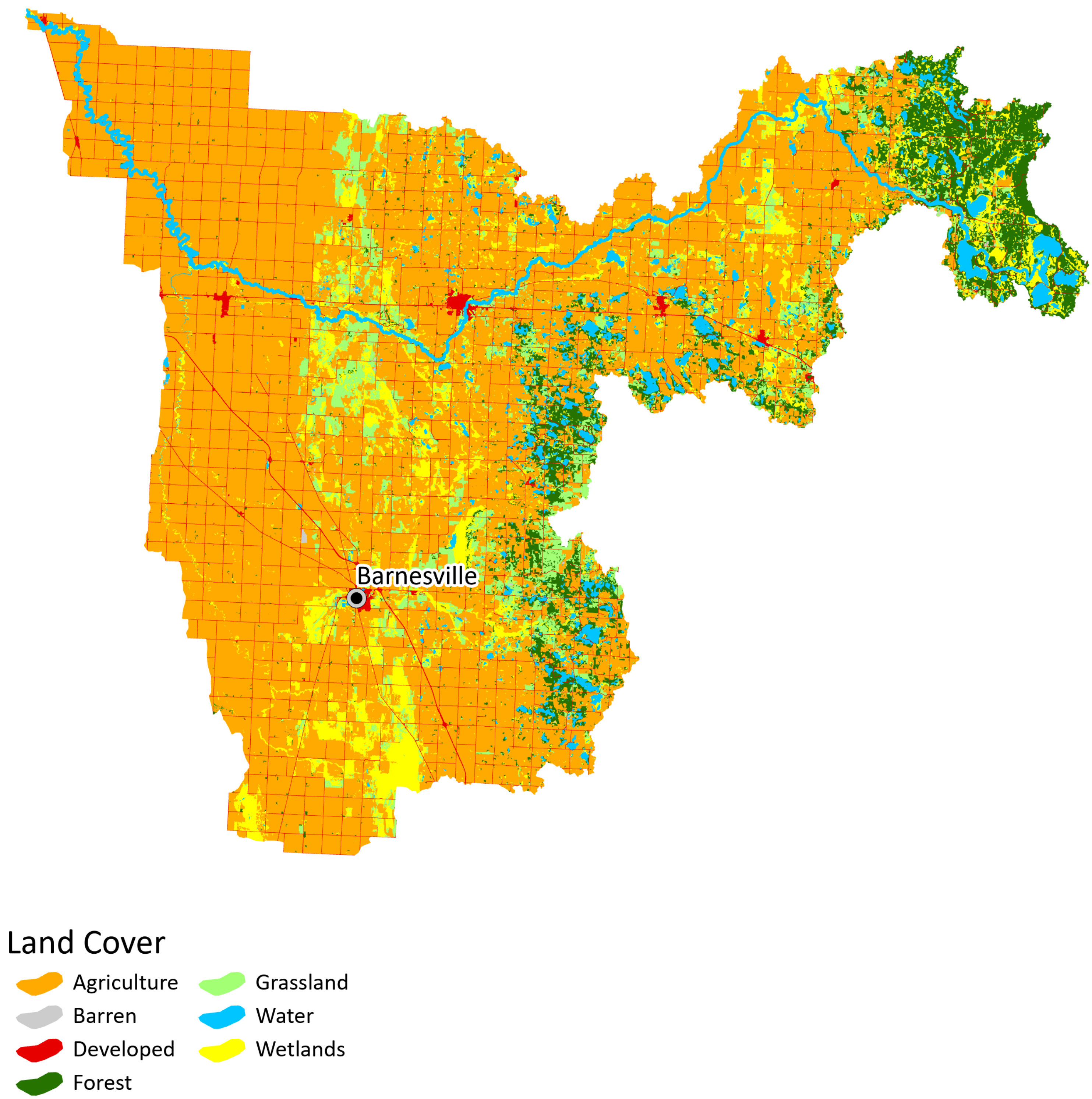
BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Upper Red River -

Legend: City Watershed River Lake

N
Miles
0 1.75 3.5 7

Figure B5: Land Cover (2016)



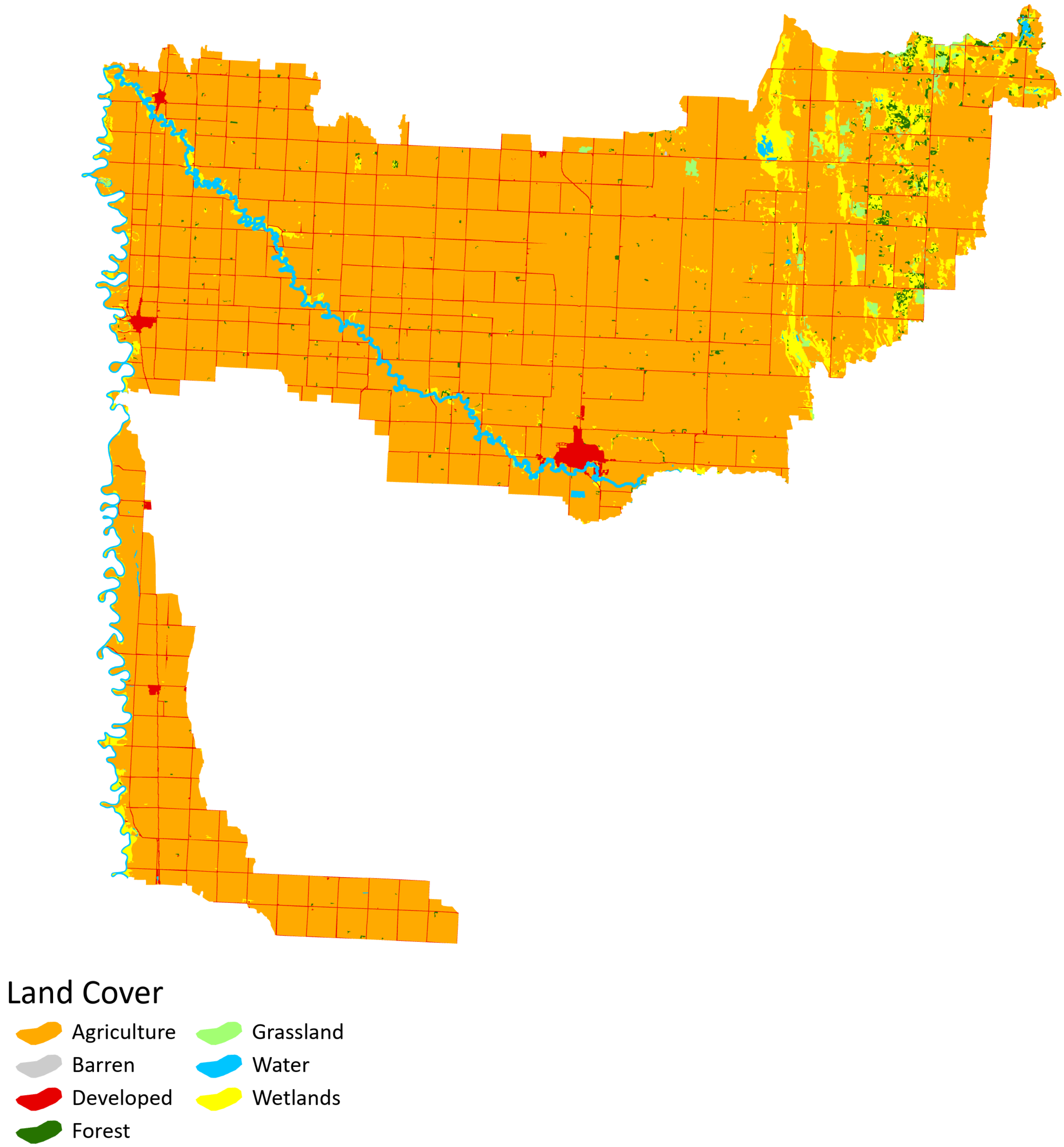
Upper Red River Watershed
Wetland Restoration Planning Study
- Buffalo River -

Legend: City Watershed River Lake

BOARD OF WATER AND SOIL RESOURCES

N
Miles
0 2 4 8

Figure B6: Land Cover (2016)



Upper Red River Watershed
Wetland Restoration Planning Study
- Marsh River -

Legend: City Watershed River Lake

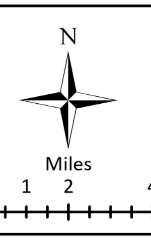
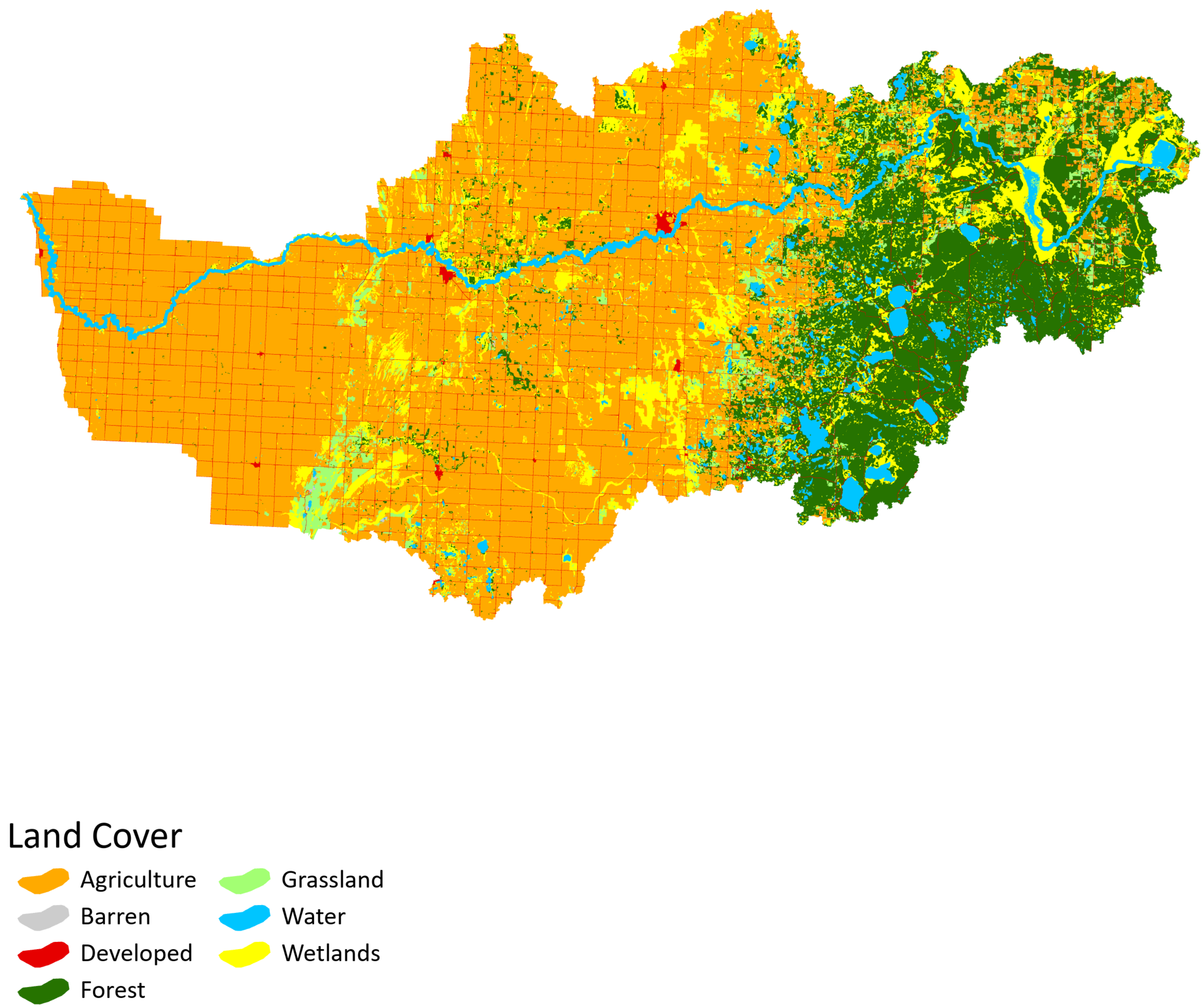
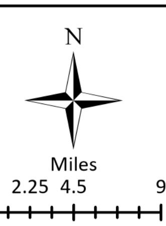


Figure B7: Land Cover (2016)



Upper Red River Watershed
Wetland Restoration Planning Study
- Wild Rice River -

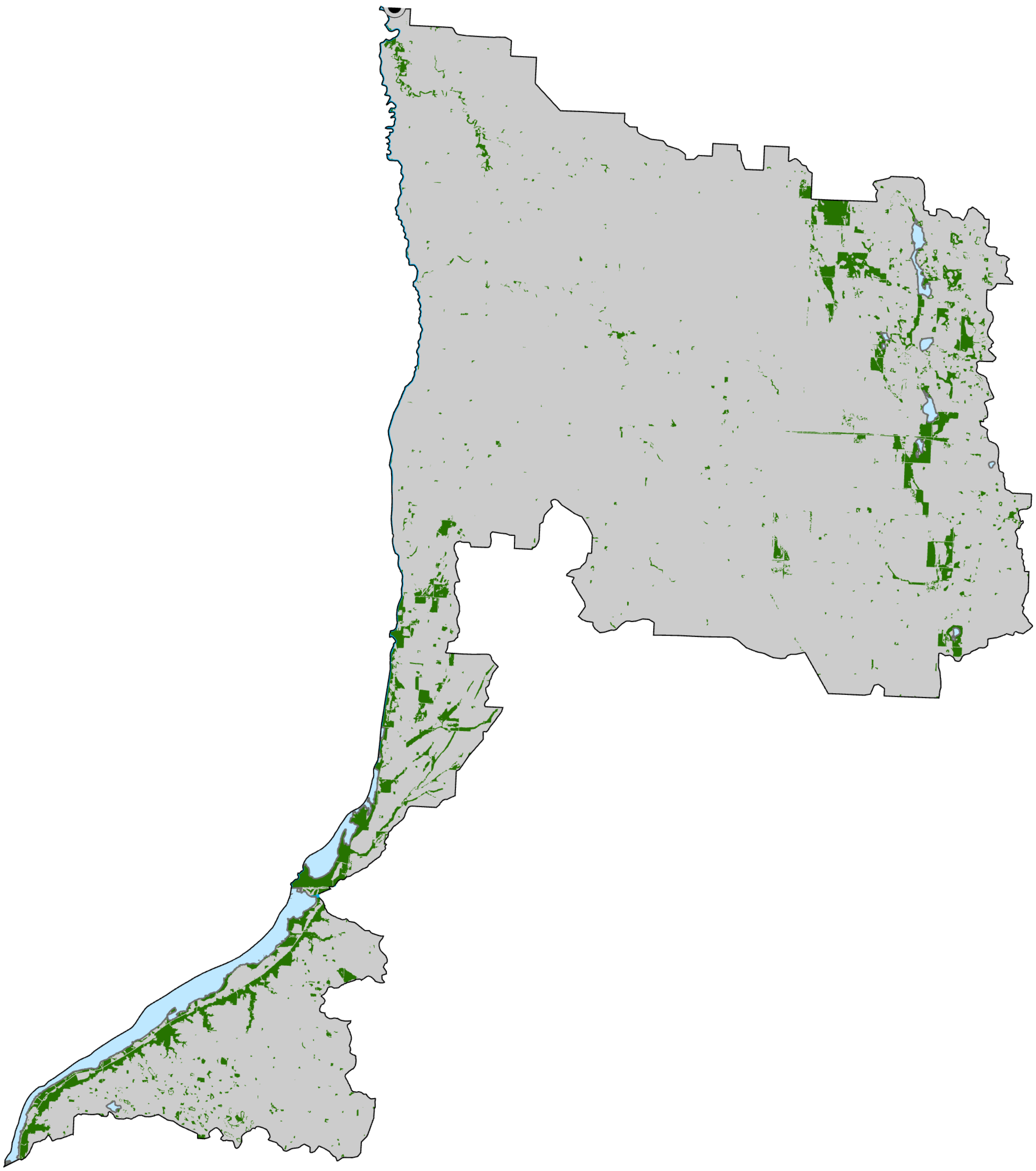
Legend: City Watershed River Lake



Appendix C

Perennial Cover Maps

Figure C1: Perennial Cover



Perennial Cover

- Yes
- No

BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Bois de Sioux River -

Legend: City, Watershed, River, Lake

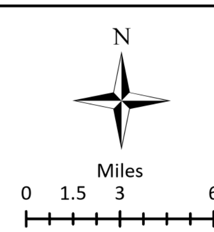
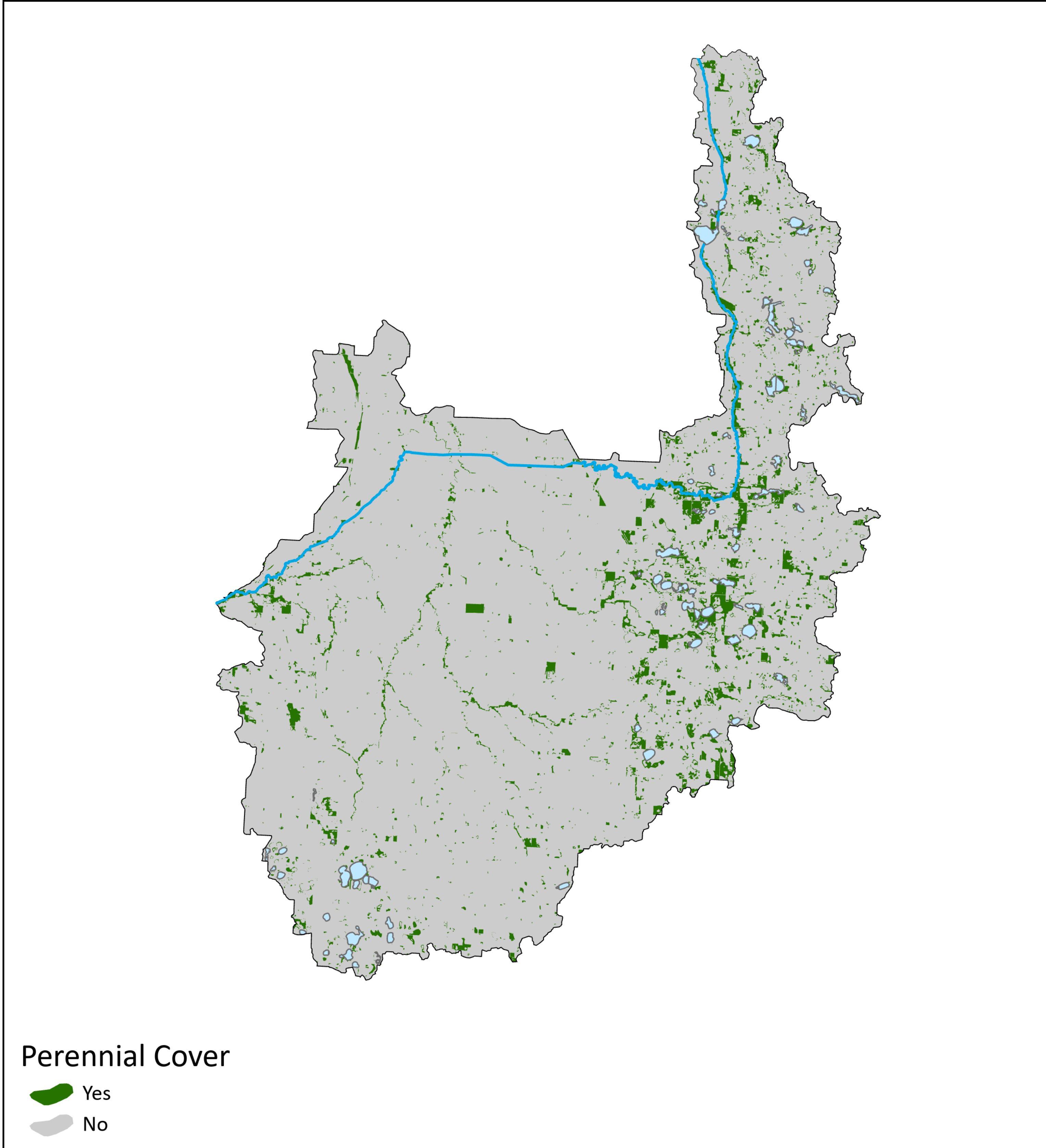


Figure C2: Perennial Cover

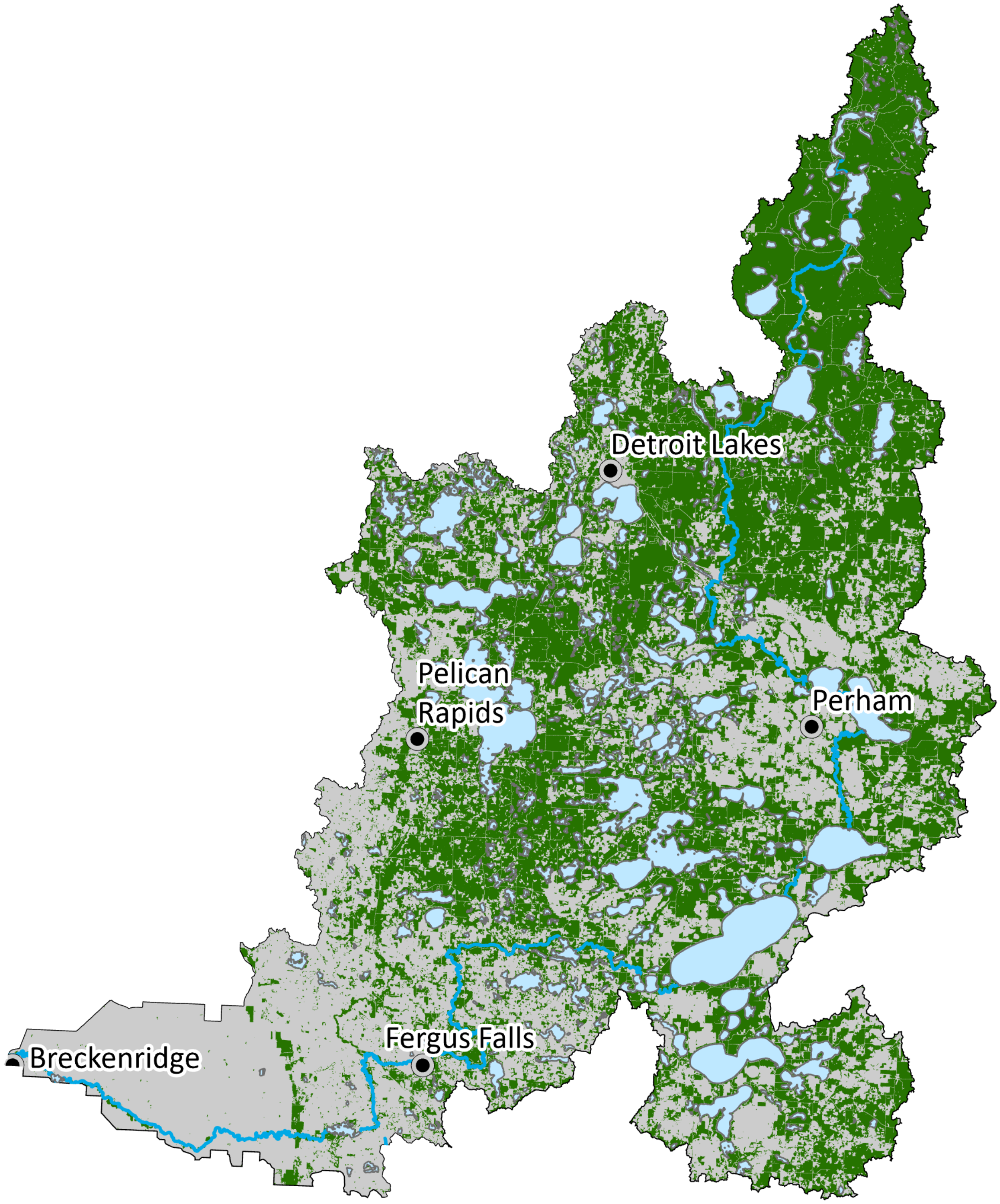


BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Mustinka River -

Legend: City Watershed River Lake

Figure C3 Perennial Cover



Perennial Cover

Yes

No

BOARD OF WATER AND SOIL RESOURCES

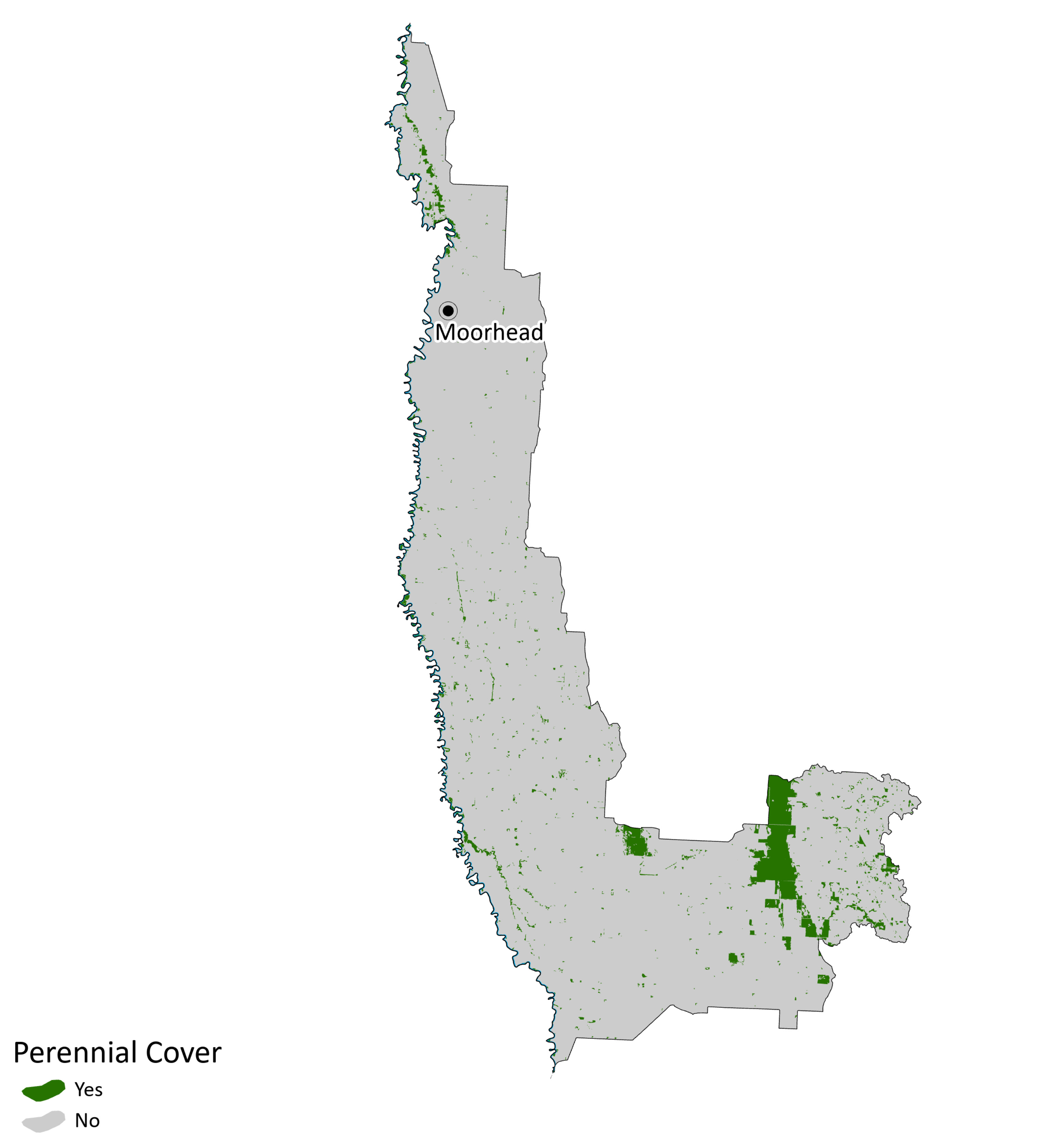
Upper Red River Watershed
Wetland Restoration Planning Study
- Otter Tail River -

Legend: City Watershed River Lake

N

Miles
0 2.5 5 10

Figure C4: Perennial Cover

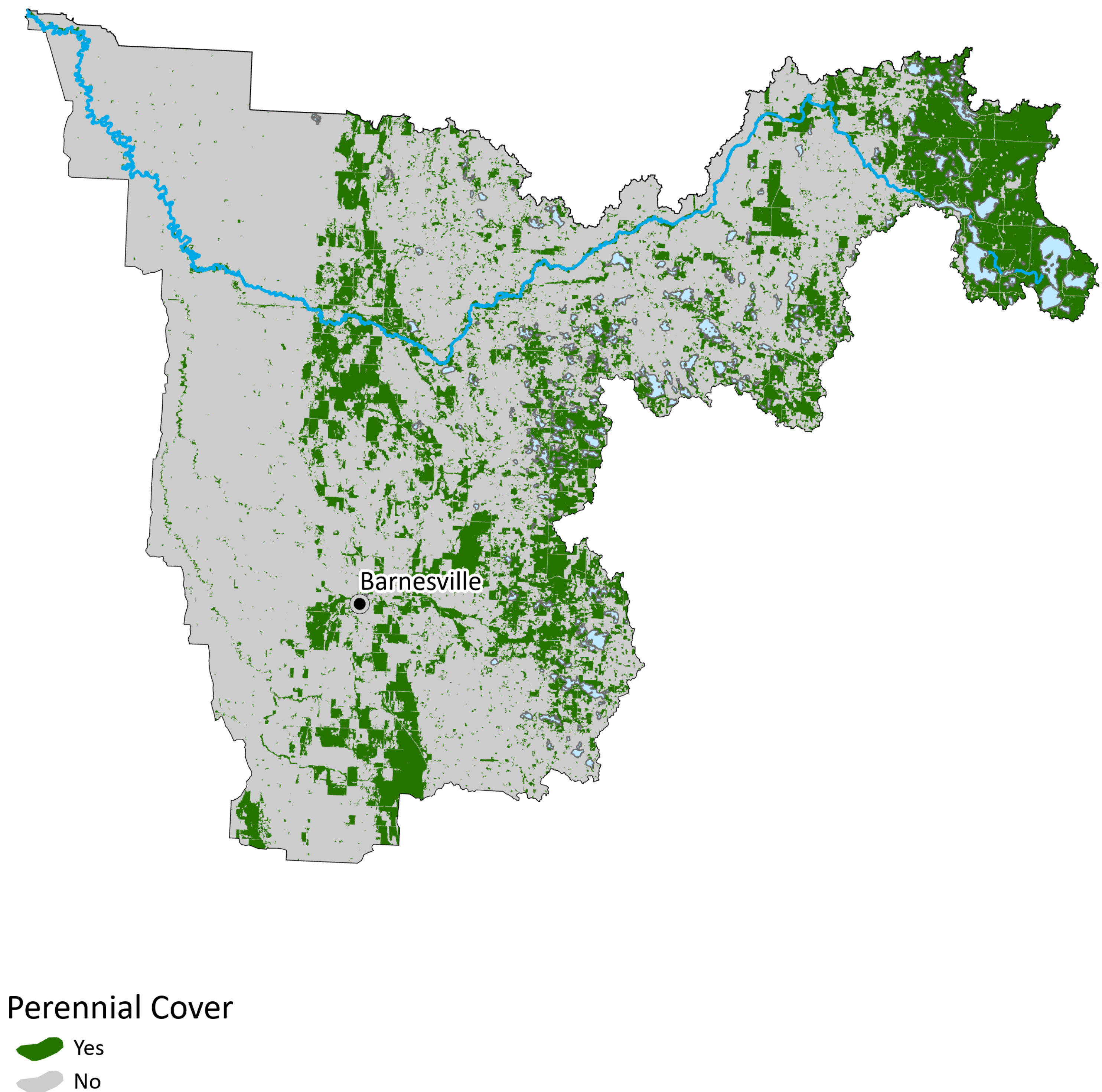


Upper Red River Watershed
Wetland Restoration Planning Study
- Upper Red River -

Legend: City Watershed River Lake

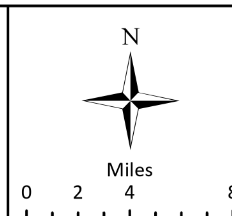
BOARD OF WATER AND SOIL RESOURCES

Figure C5: Perennial Cover



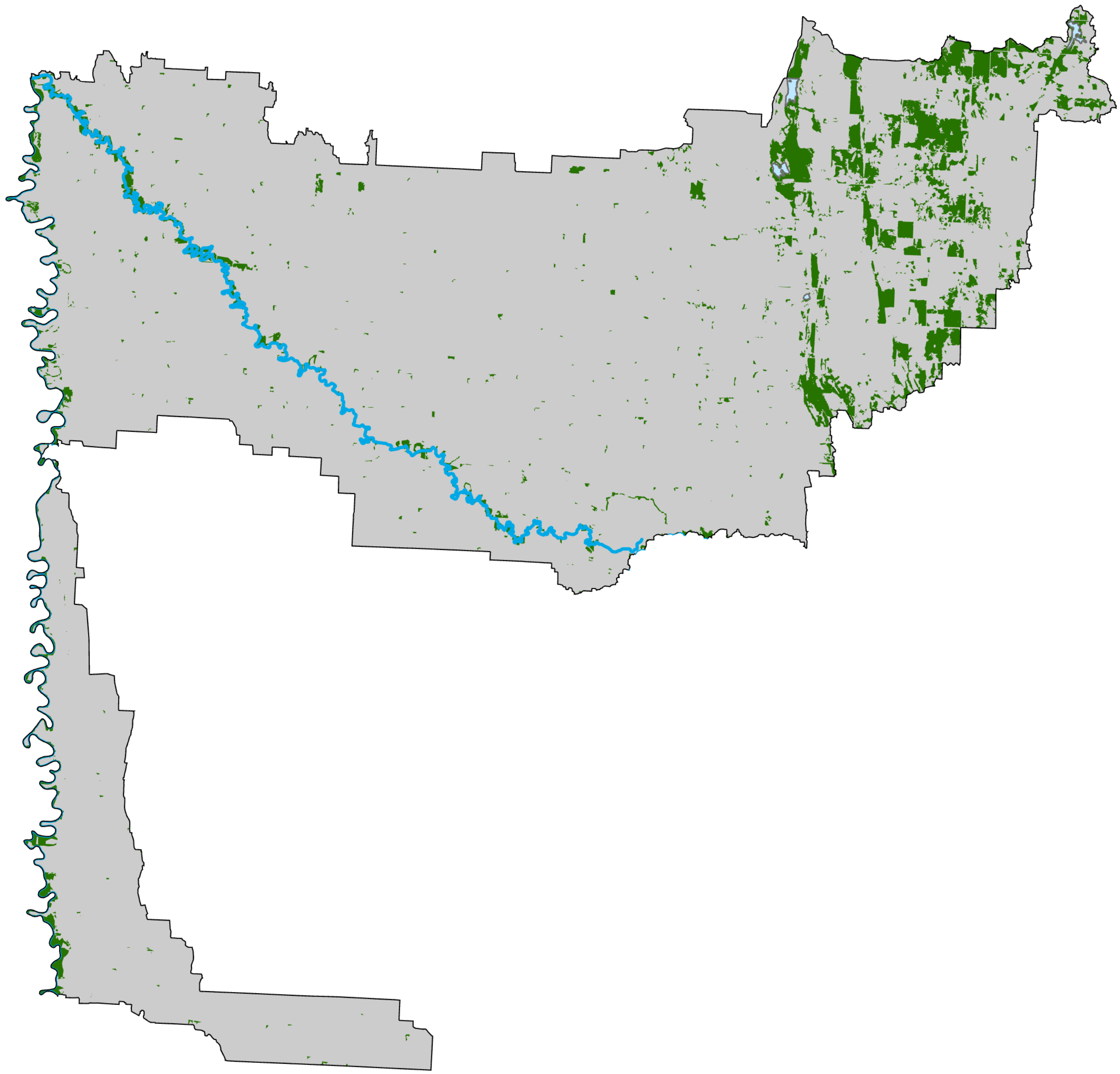
BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Buffalo River -



Legend: City Watershed River Lake

Figure C6: Perennial Cover



Perennial Cover

- Yes
- No

BOARD OF WATER AND SOIL RESOURCES

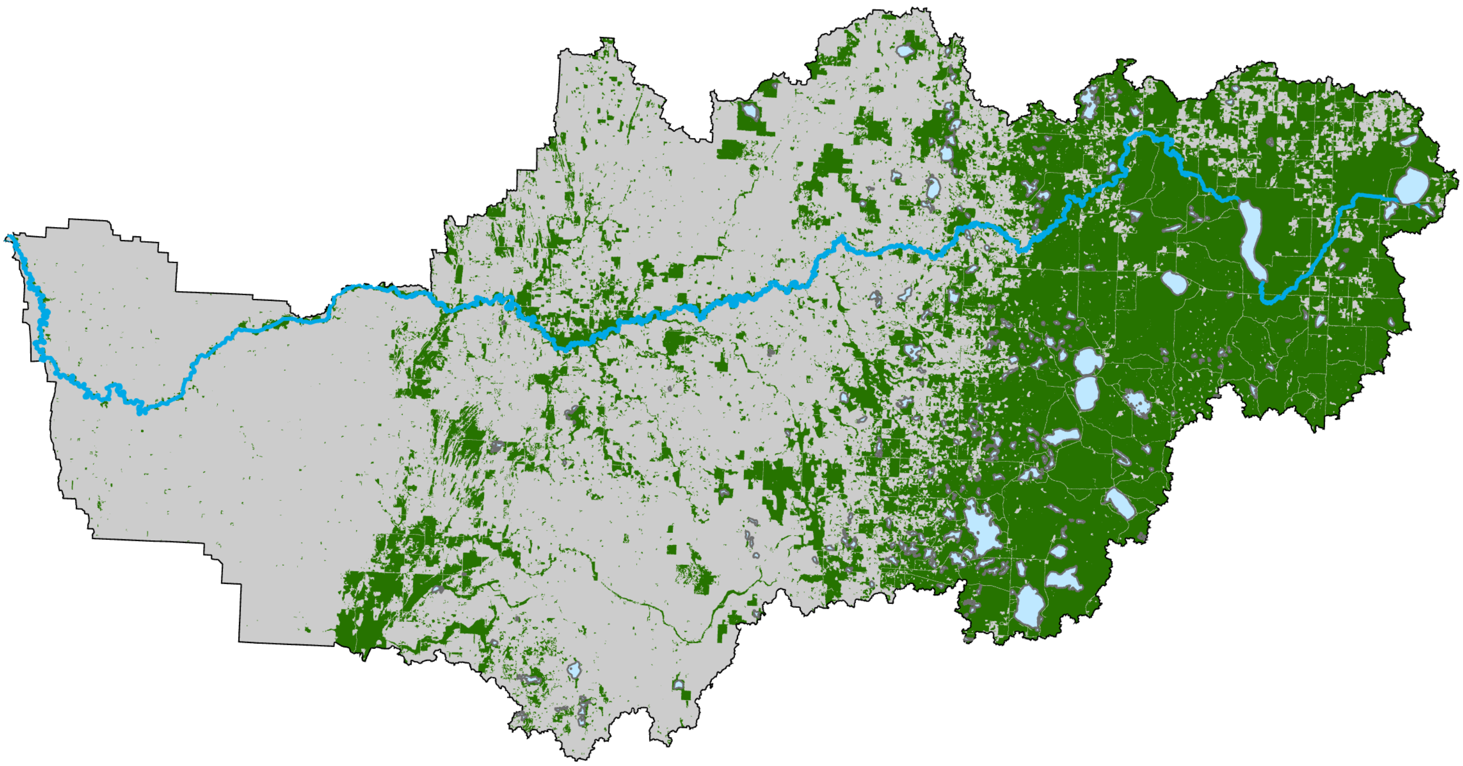
Upper Red River Watershed
Wetland Restoration Planning Study
- Marsh River -

Legend: City Watershed River Lake

N

Miles
0 1 2 4

Figure C7: Perennial Cover



Perennial Cover

Yes

No

Upper Red River Watershed
Wetland Restoration Planning Study
- Wild Rice River -

Legend: City Watershed River Lake

BOARD OF WATER AND SOIL RESOURCES

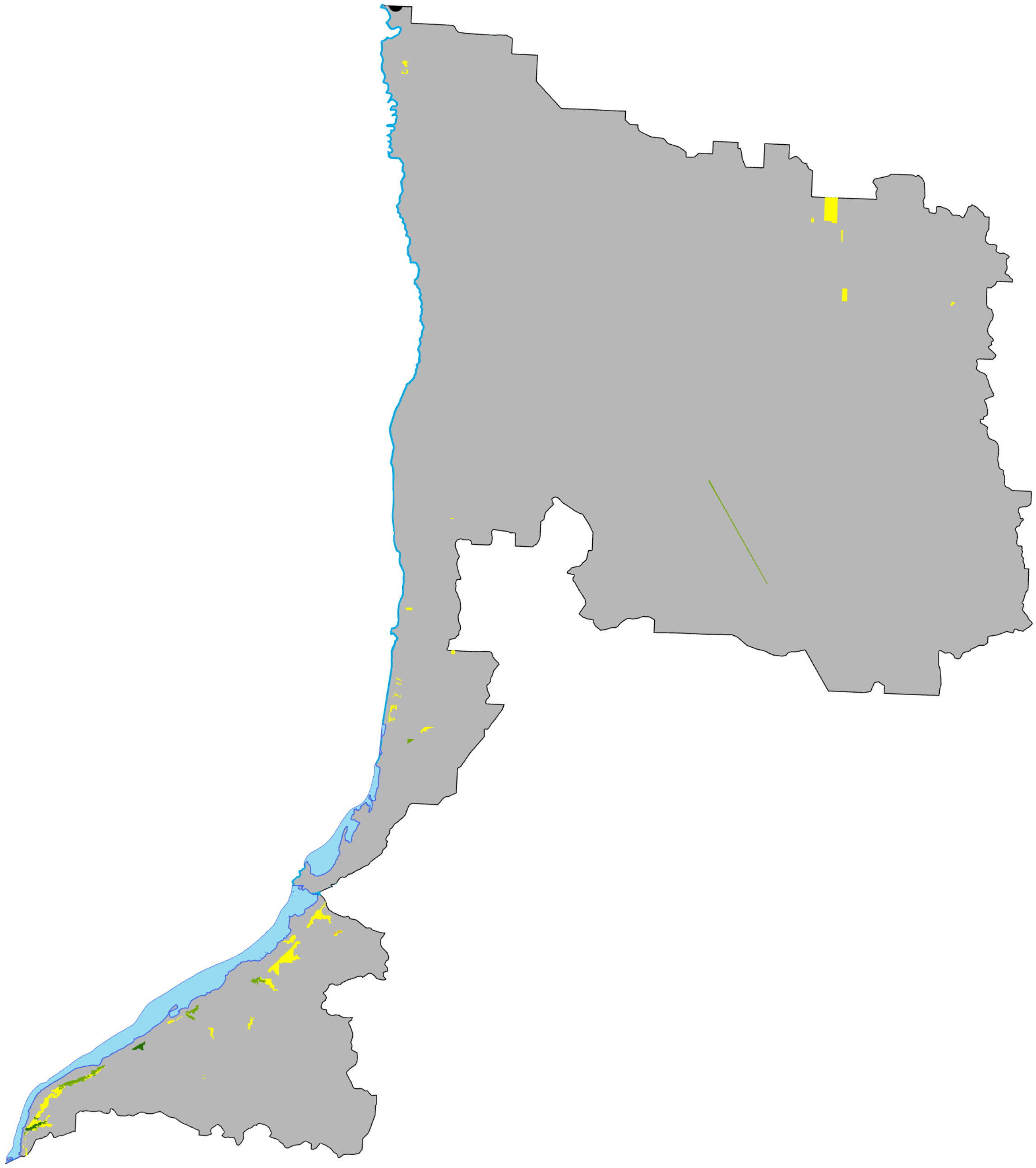
N

Miles
0 2.5 5 10

Appendix D

Native Plant Communities

Figure D1: Native Plant Communities



Plant Community Status

- S1 - Critically Imperiled
- S1 or S2 or S3 - Between Critically Imperiled and Vulnerable to Extirpation
- S1S2 - Between Critically Imperiled and Imperiled
- S2 - Imperiled
- S2S3 - Between Imperiled and Vulnerable to Extirpation
- S3 - Vulnerable to Extirpation
- S3S4 - Between Vulnerable to Extirpation and Apparently Secure

BOARD OF WATER AND SOIL RESOURCES

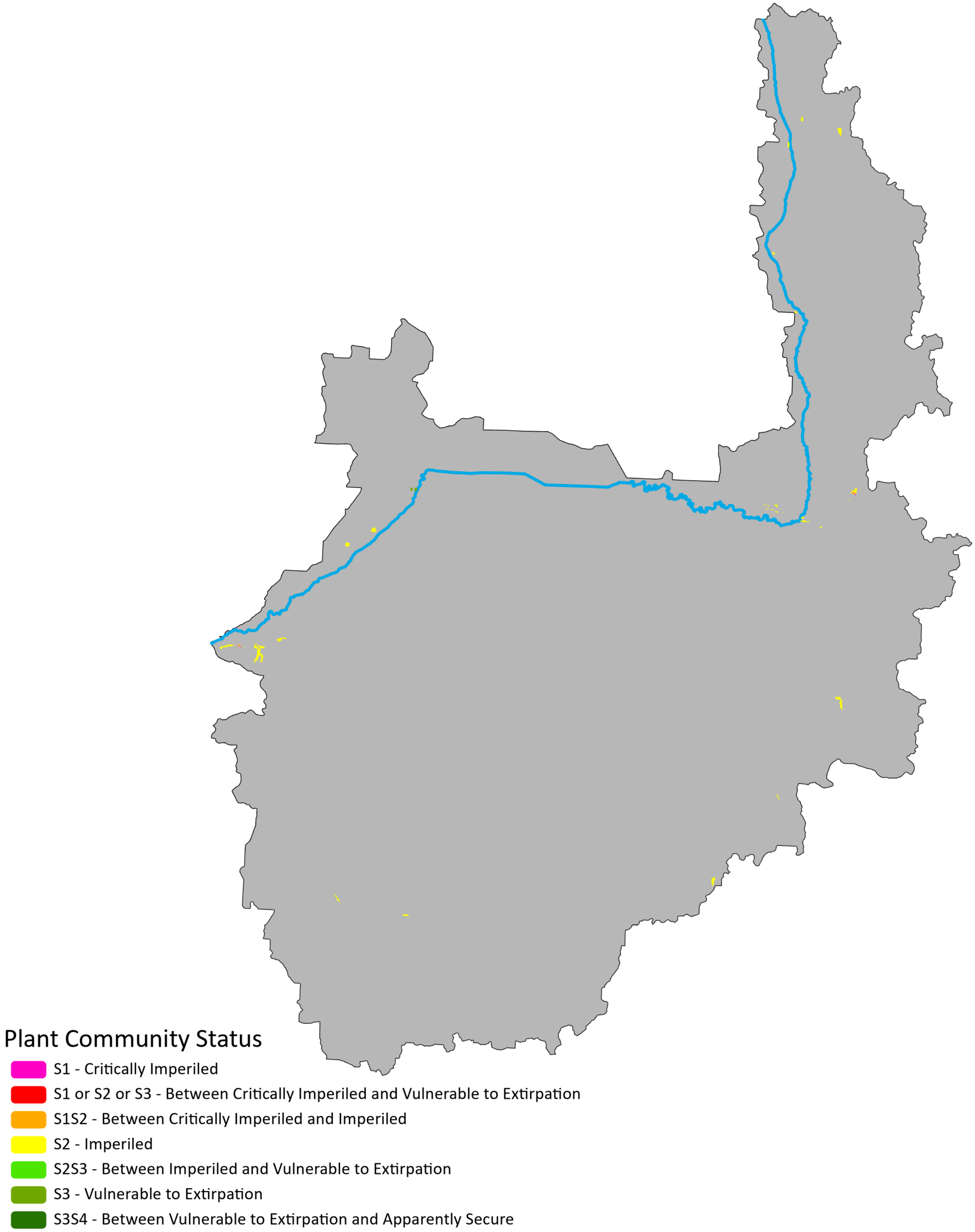
Upper Red River Watershed
Wetland Restoration Planning Study
- Bois de Sioux River -

Legend: City | Watershed | River | Lake

N

Miles
0 1.5 3 6

Figure D2: Native Plant Communities



BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Mustinka River -

Legend: City Watershed River Lake

N

Miles
0 1.5 3 6

Figure D3: Native Plant Communities

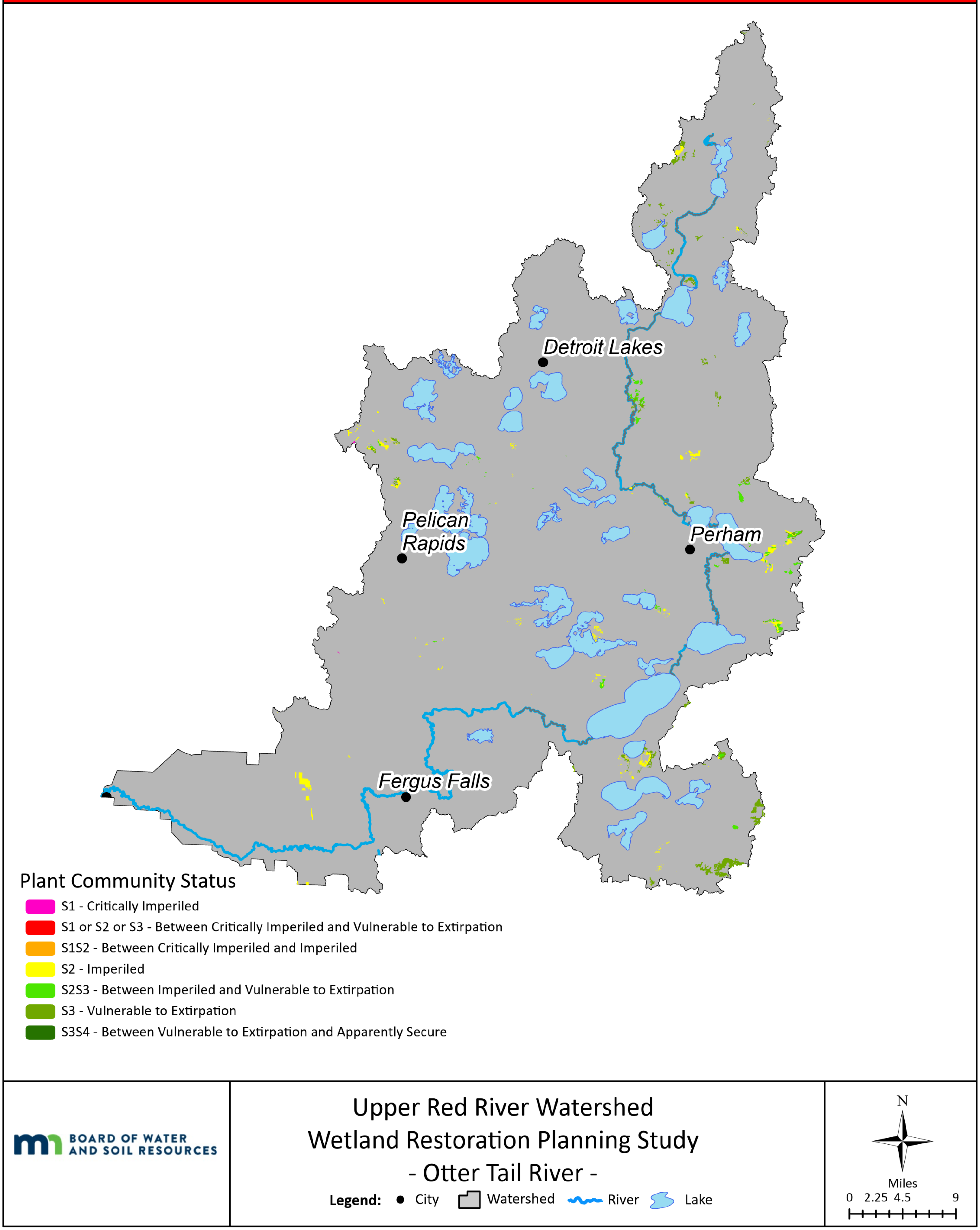
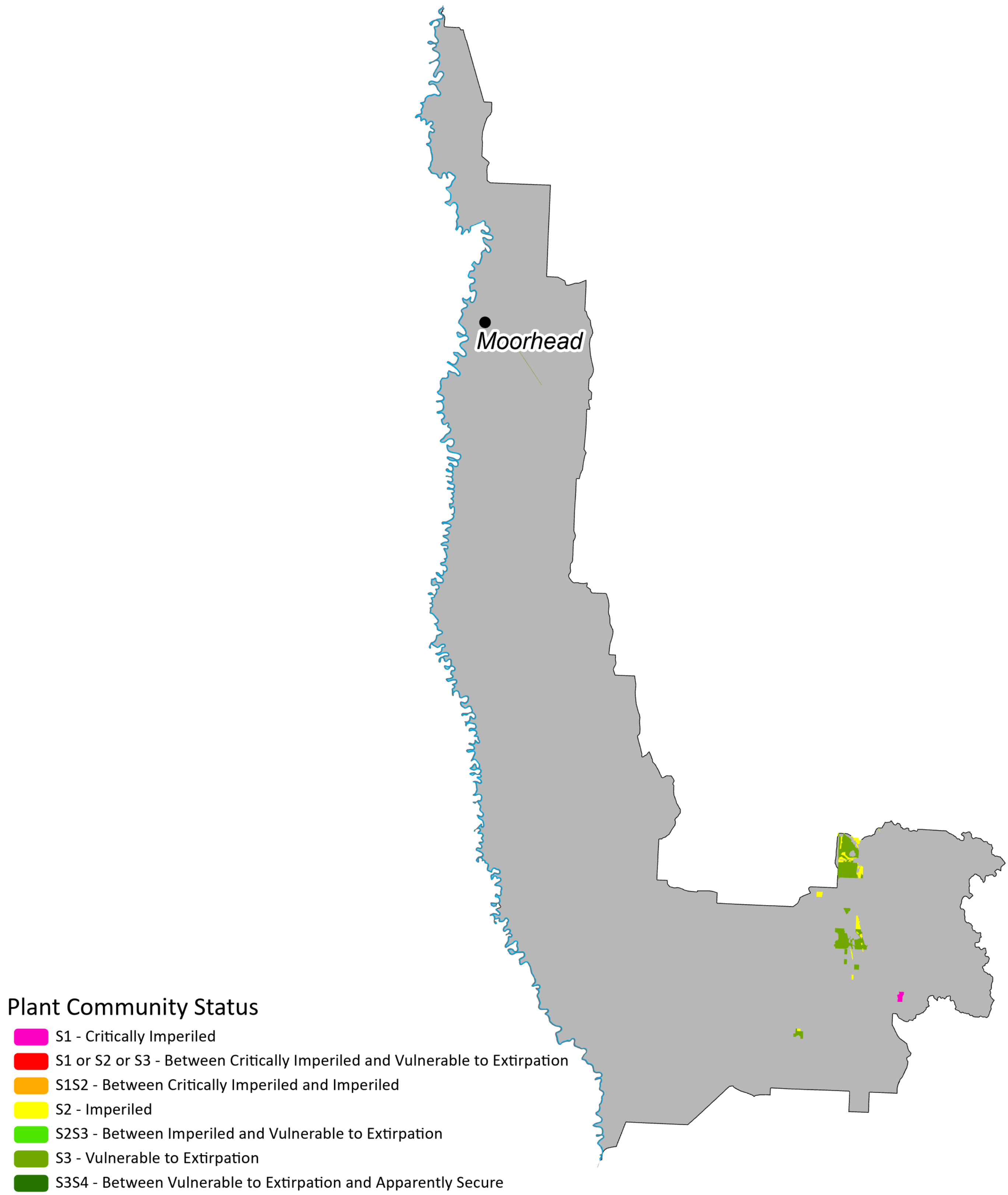


Figure D4: Native Plant Communities



BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Upper Red River -

Legend: City, Watershed, River, Lake

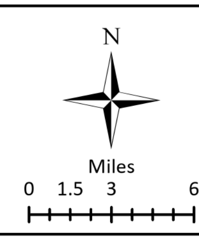
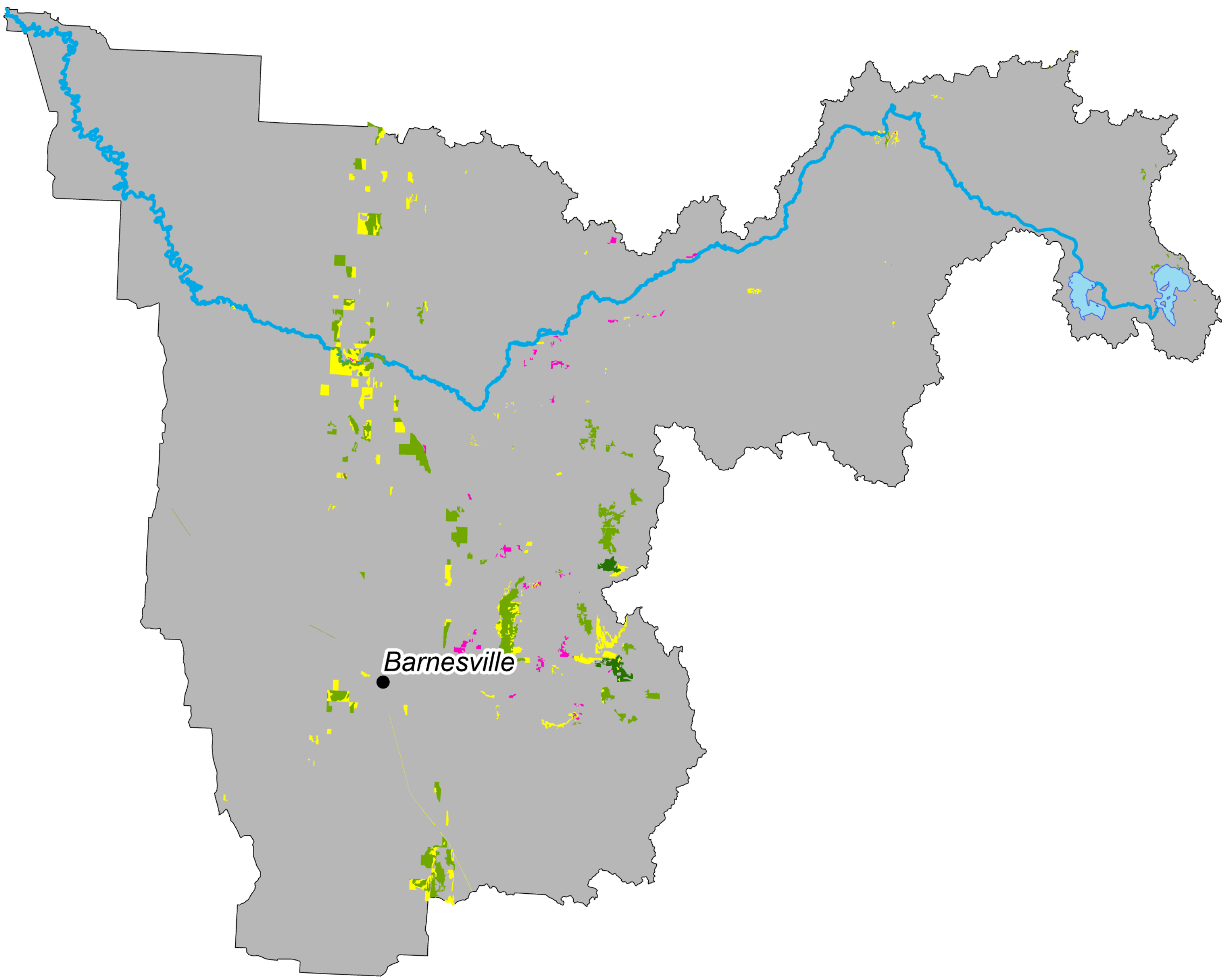


Figure D5: Native Plant Communities



Plant Community Status

- S1 - Critically Imperiled
- S1 or S2 or S3 - Between Critically Imperiled and Vulnerable to Extirpation
- S1S2 - Between Critically Imperiled and Imperiled
- S2 - Imperiled
- S2S3 - Between Imperiled and Vulnerable to Extirpation
- S3 - Vulnerable to Extirpation
- S3S4 - Between Vulnerable to Extirpation and Apparently Secure

BOARD OF WATER AND SOIL RESOURCES

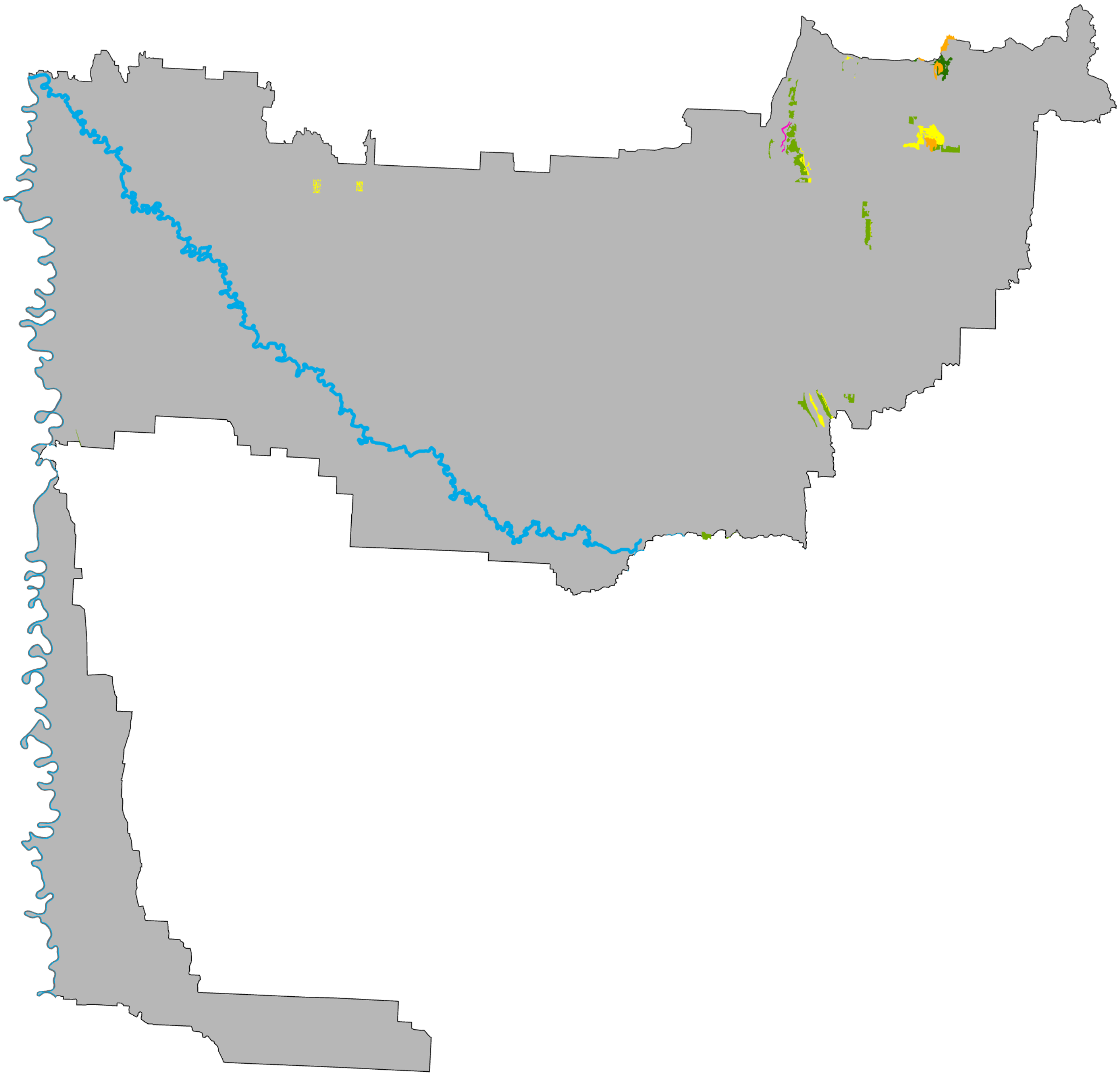
Upper Red River Watershed
Wetland Restoration Planning Study
- Buffalo River -

Legend: City Watershed River Lake

N

Miles
0 1.75 3.5 7

Figure D6: Native Plant Communities



Plant Community Status

- S1 - Critically Imperiled
- S1 or S2 or S3 - Between Critically Imperiled and Vulnerable to Extirpation
- S1S2 - Between Critically Imperiled and Imperiled
- S2 - Imperiled
- S2S3 - Between Imperiled and Vulnerable to Extirpation
- S3 - Vulnerable to Extirpation
- S3S4 - Between Vulnerable to Extirpation and Apparently Secure

BOARD OF WATER AND SOIL RESOURCES

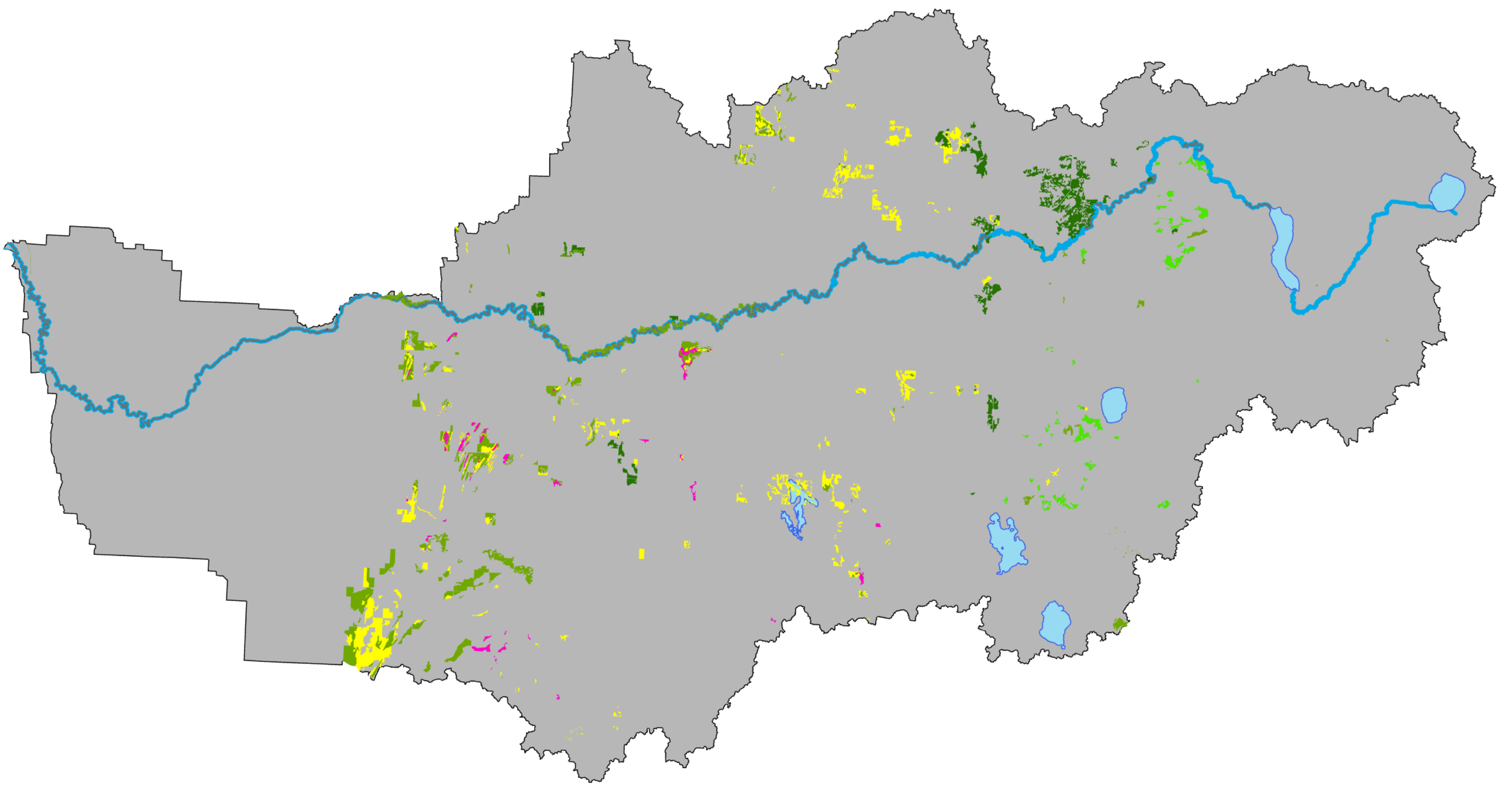
Upper Red River Watershed
Wetland Restoration Planning Study
- Marsh River -

Legend: City Watershed River Lake

N

Miles
0 1 2 4

Figure D7: Native Plant Communities



Plant Community Status

- S1 - Critically Imperiled
- S1 or S2 or S3 - Between Critically Imperiled and Vulnerable to Extirpation
- S1S2 - Between Critically Imperiled and Imperiled
- S2 - Imperiled
- S2S3 - Between Imperiled and Vulnerable to Extirpation
- S3 - Vulnerable to Extirpation
- S3S4 - Between Vulnerable to Extirpation and Apparently Secure

BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Wild Rice River -

Legend: City, Watershed, River, Lake

N

Miles
0 2.25 4.5 9

Appendix E

Impoundments

Figure E1: Minnesota Dams (2014)

Dam Inventory

Rivers and Streams

Dam

BOARD OF WATER AND SOIL RESOURCES

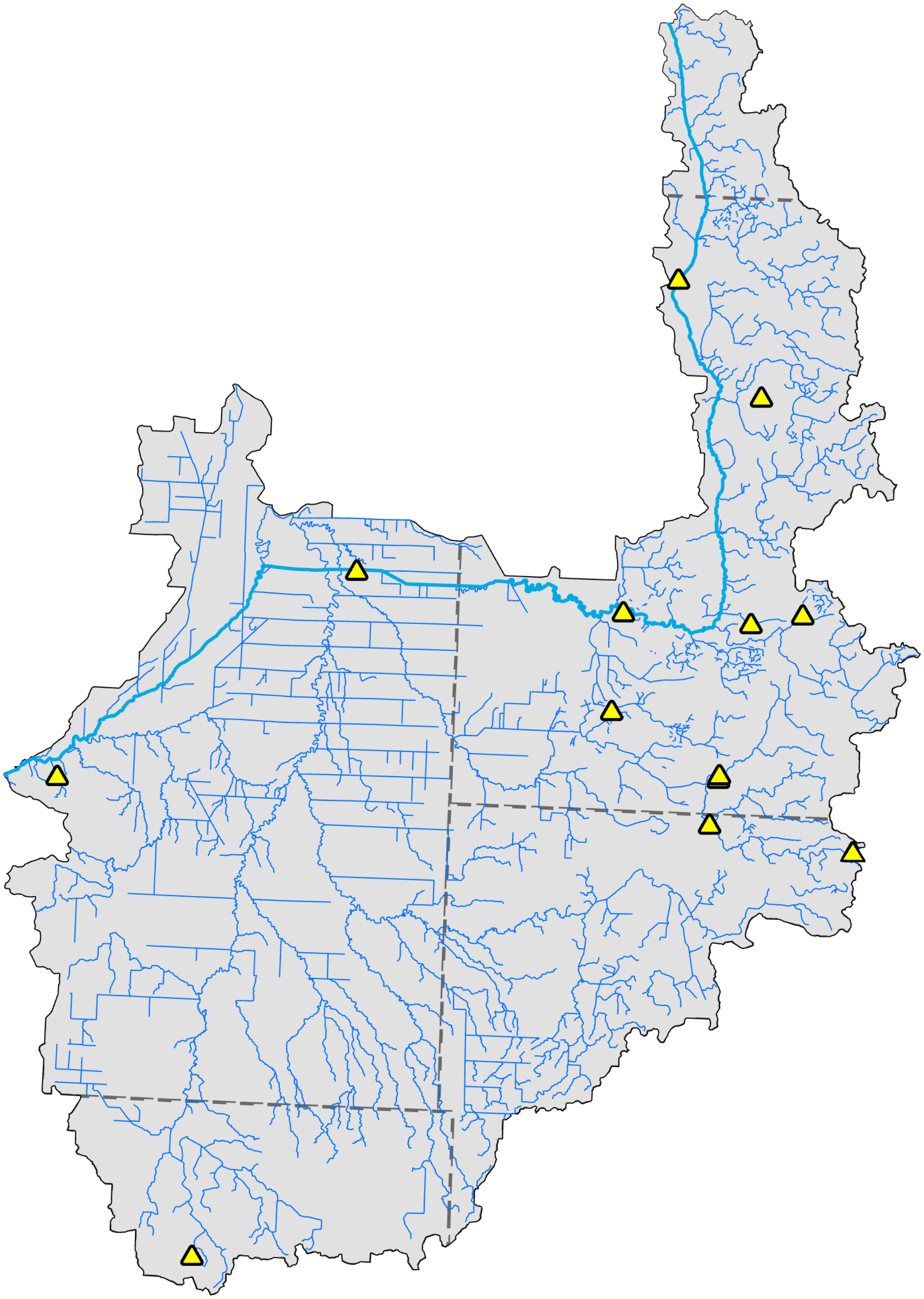
Upper Red River Watershed
Wetland Restoration Planning Study
- Bois de Sioux River -

Legend: City County River Lake

N

Miles
0 1.25 2.5 5

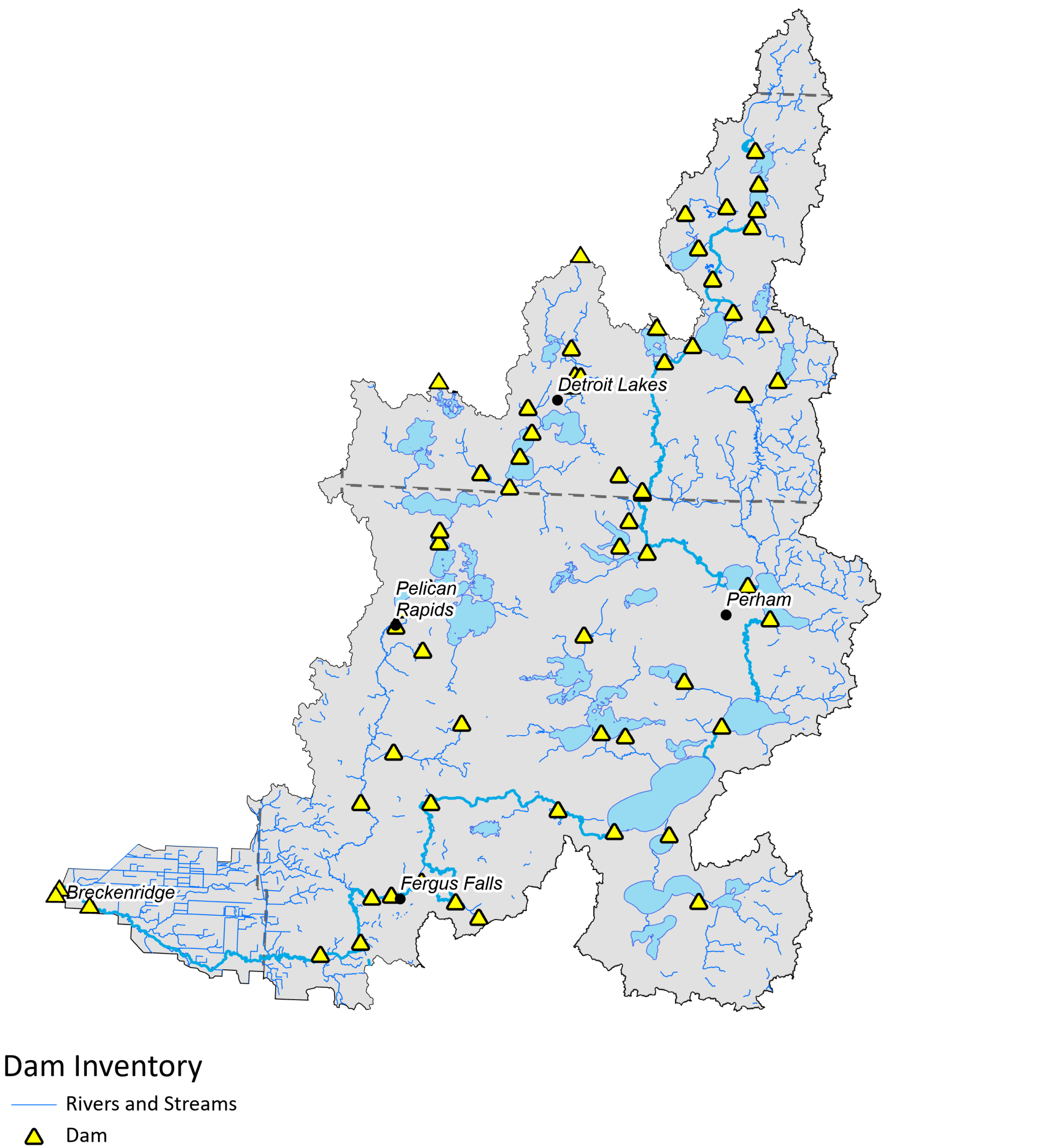
Figure E2: Minnesota Dams (2014)



Upper Red River Watershed
Wetland Restoration Planning Study
- Mustinka River -

Legend: City County River Lake

Figure E3: Minnesota Dams (2014)



BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Otter Tail River -

Legend: City County River Lake

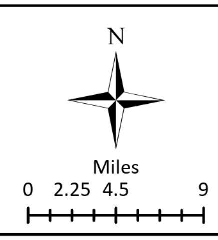
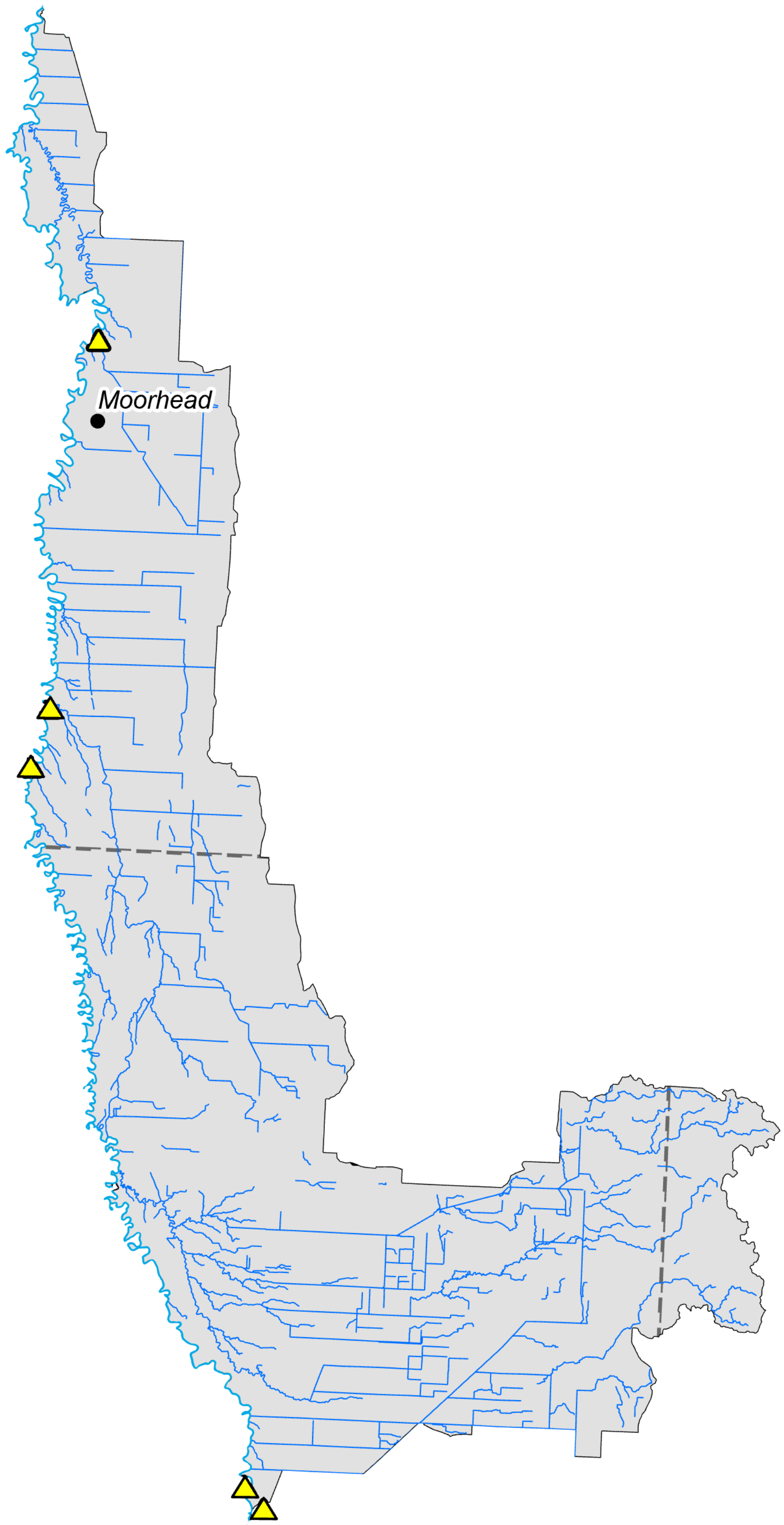


Figure E4: Minnesota Dams (2014)



Dam Inventory

Rivers and Streams

Dam

BOARD OF WATER AND SOIL RESOURCES

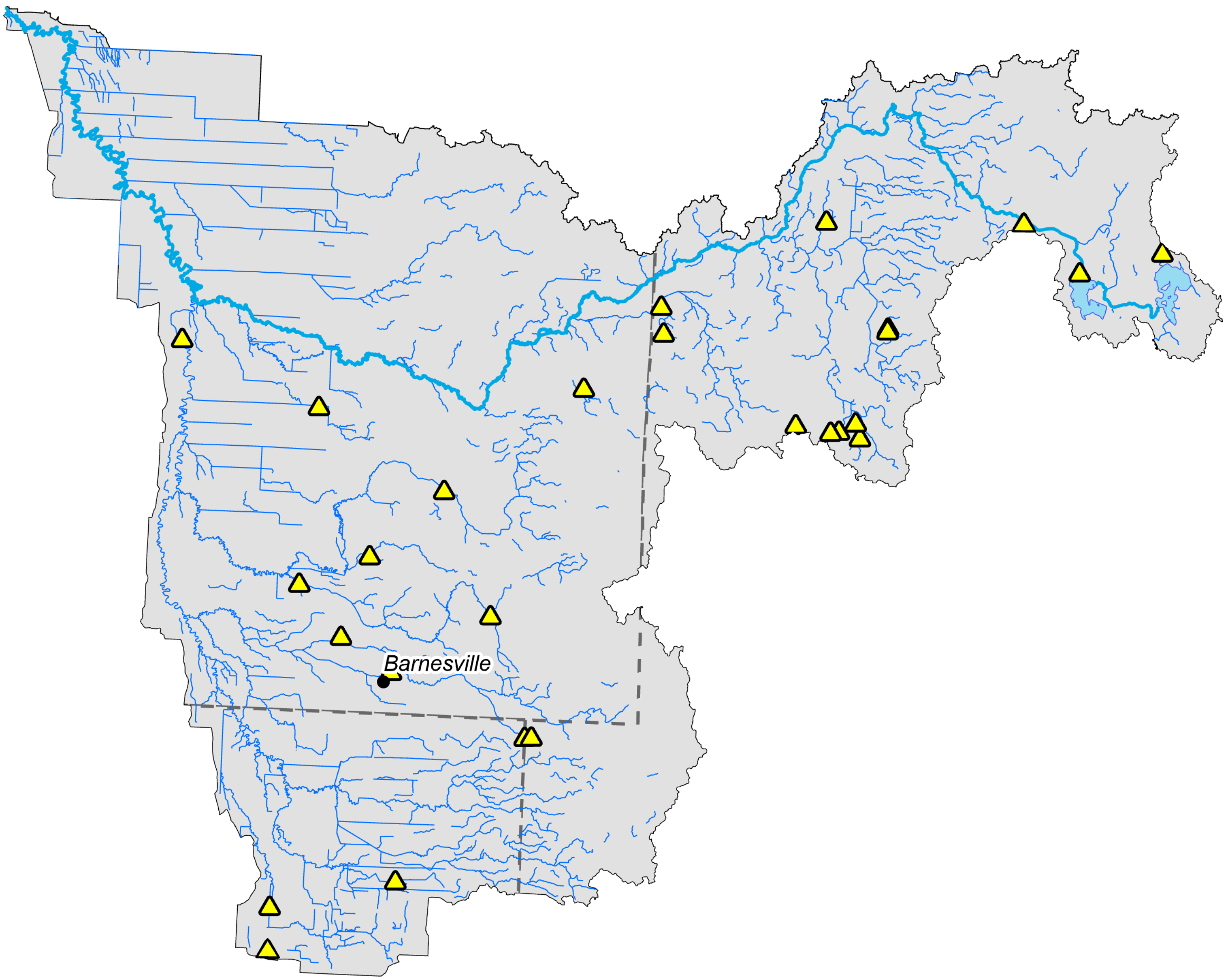
Upper Red River Watershed
Wetland Restoration Planning Study
- Upper Red River -

Legend: City County River Lake

N

Miles
0 1.5 3 6

Figure E5: Minnesota Dams (2014)



Dam Inventory

- Rivers and Streams
- Dam

BOARD OF WATER AND SOIL RESOURCES

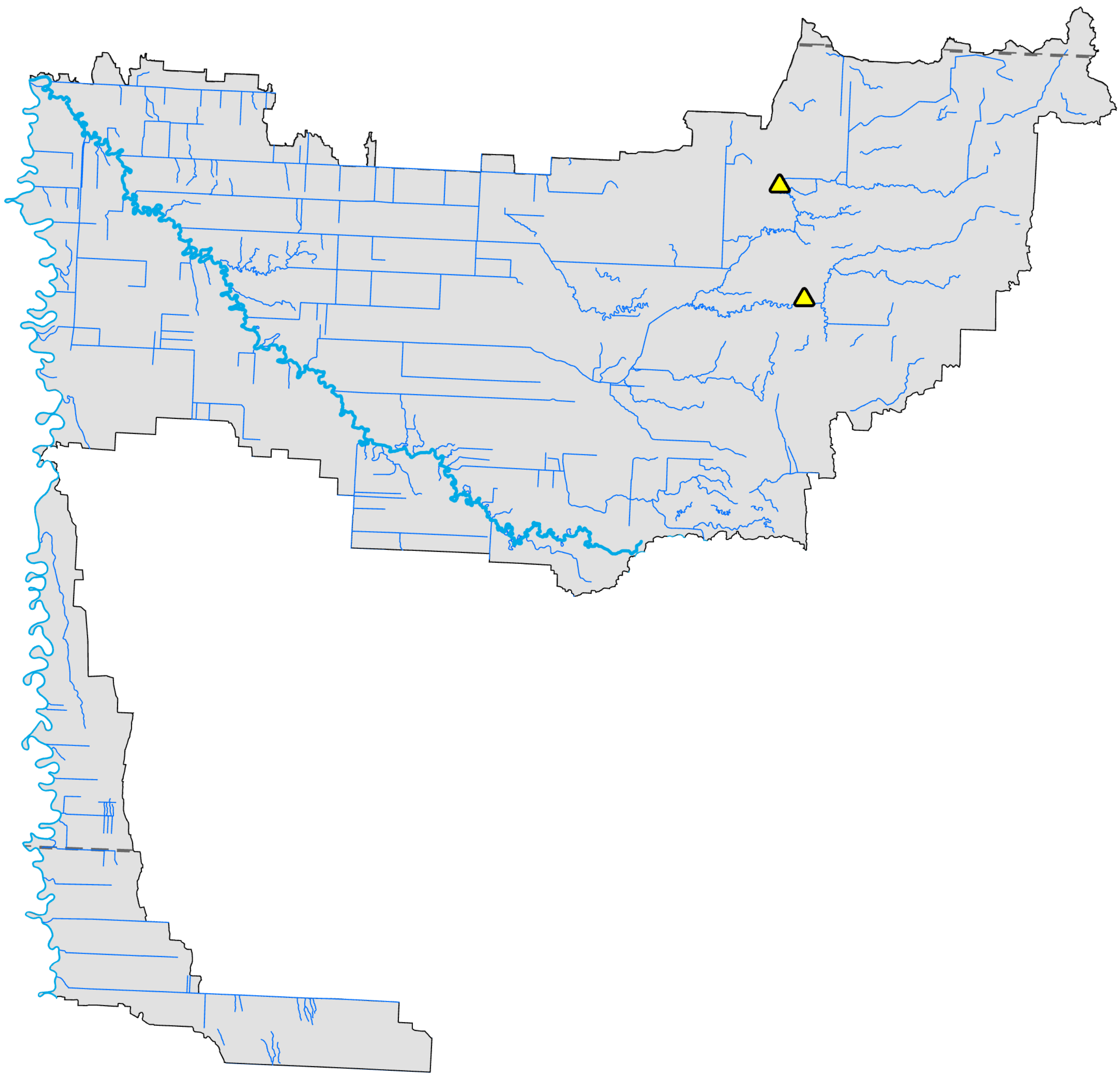
Upper Red River Watershed
Wetland Restoration Planning Study
- Buffalo River -

Legend: City County River Lake

N

Miles
0 1.5 3 6

Figure E6: Minnesota Dams (2014)



Dam Inventory

Rivers and Streams

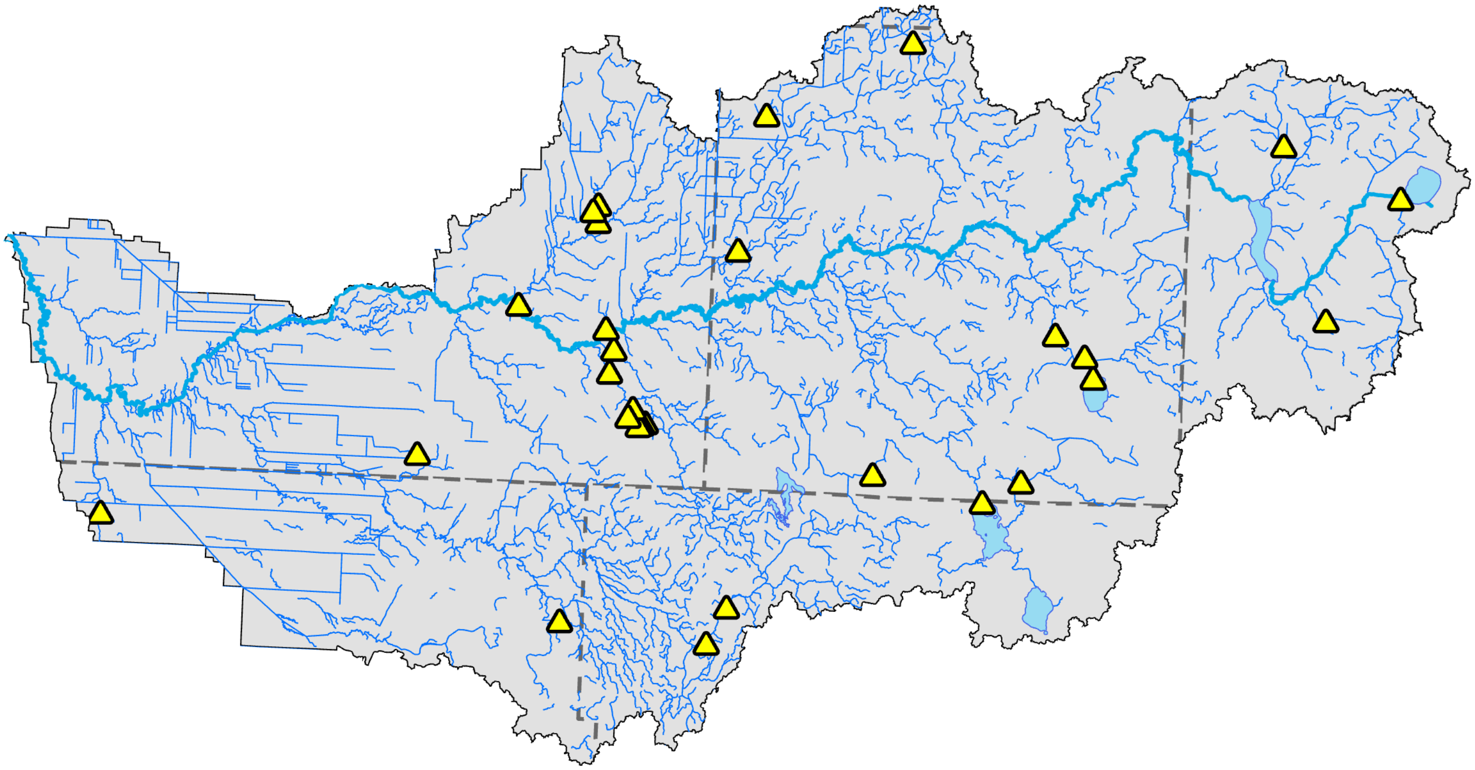
Dam

BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Marsh River -

Legend: City County River Lake

Figure E7: Minnesota Dams (2014)



Dam Inventory

Rivers and Streams

Dam

BOARD OF WATER AND SOIL RESOURCES

Upper Red River Watershed
Wetland Restoration Planning Study
- Wild Rice River -

Legend: City County River Lake

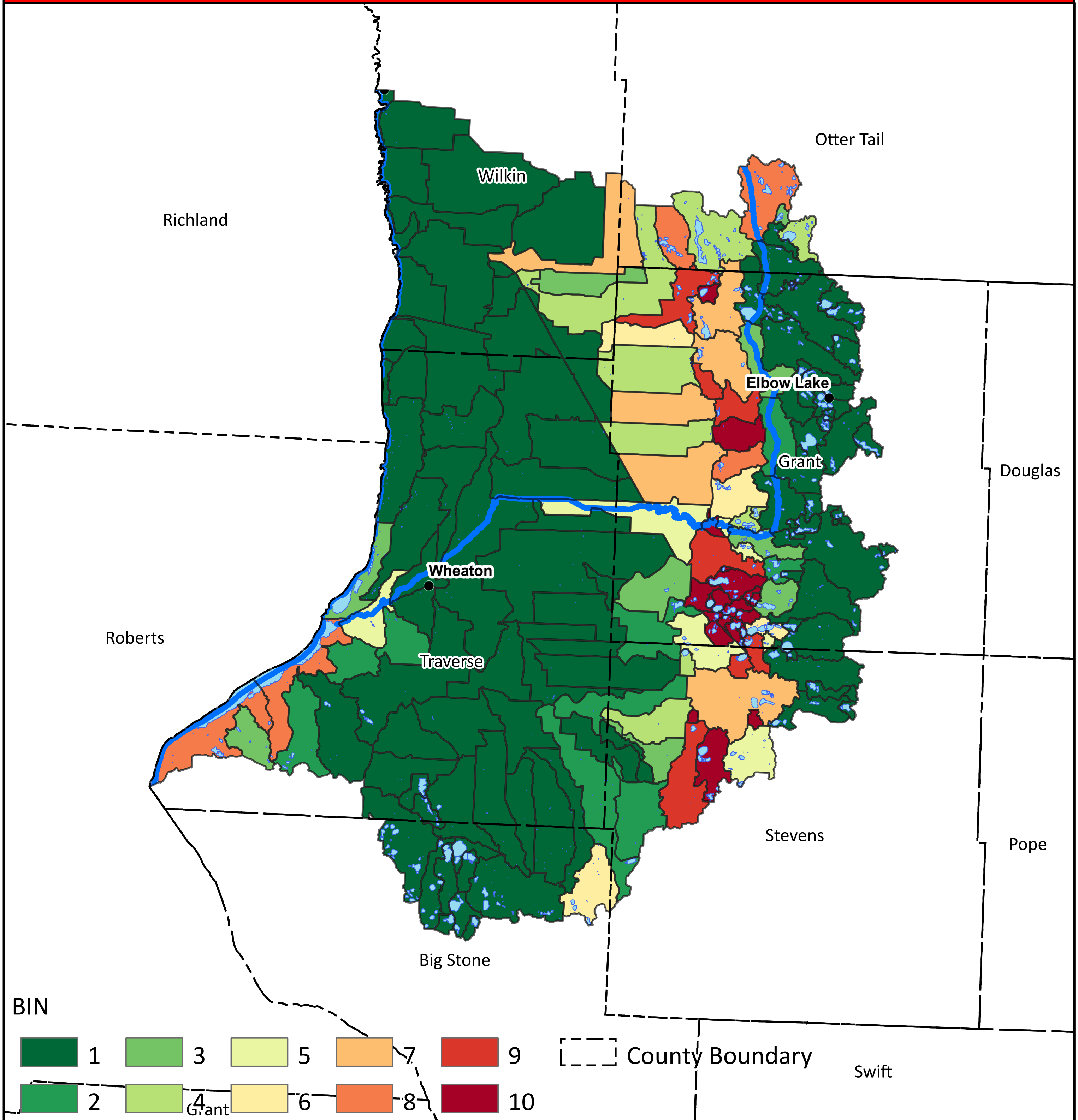
N

Miles
0 2.25 4.5 9

Appendix F

Unweighted Catchments

Figure F1: Unweighted Catchment Prioritization



Upper Red River Watershed
Wetland Restoration Planning Study
- Bois de Sioux - Mustinka -

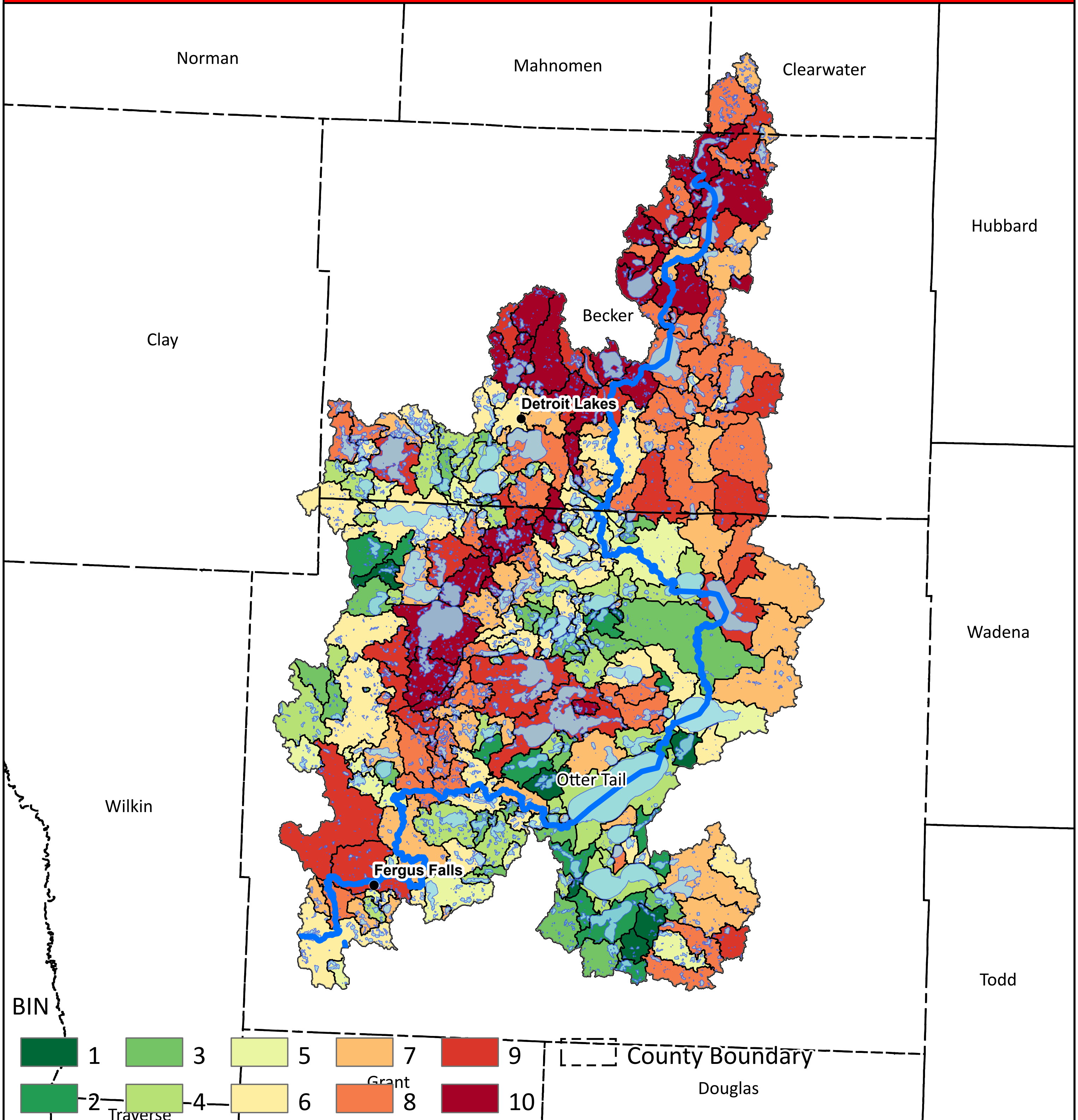
River Lake

N

Miles
0 2.25 4.5 9

BOARD OF WATER AND SOIL RESOURCES

Figure F2: Unweighted Catchment Prioritization



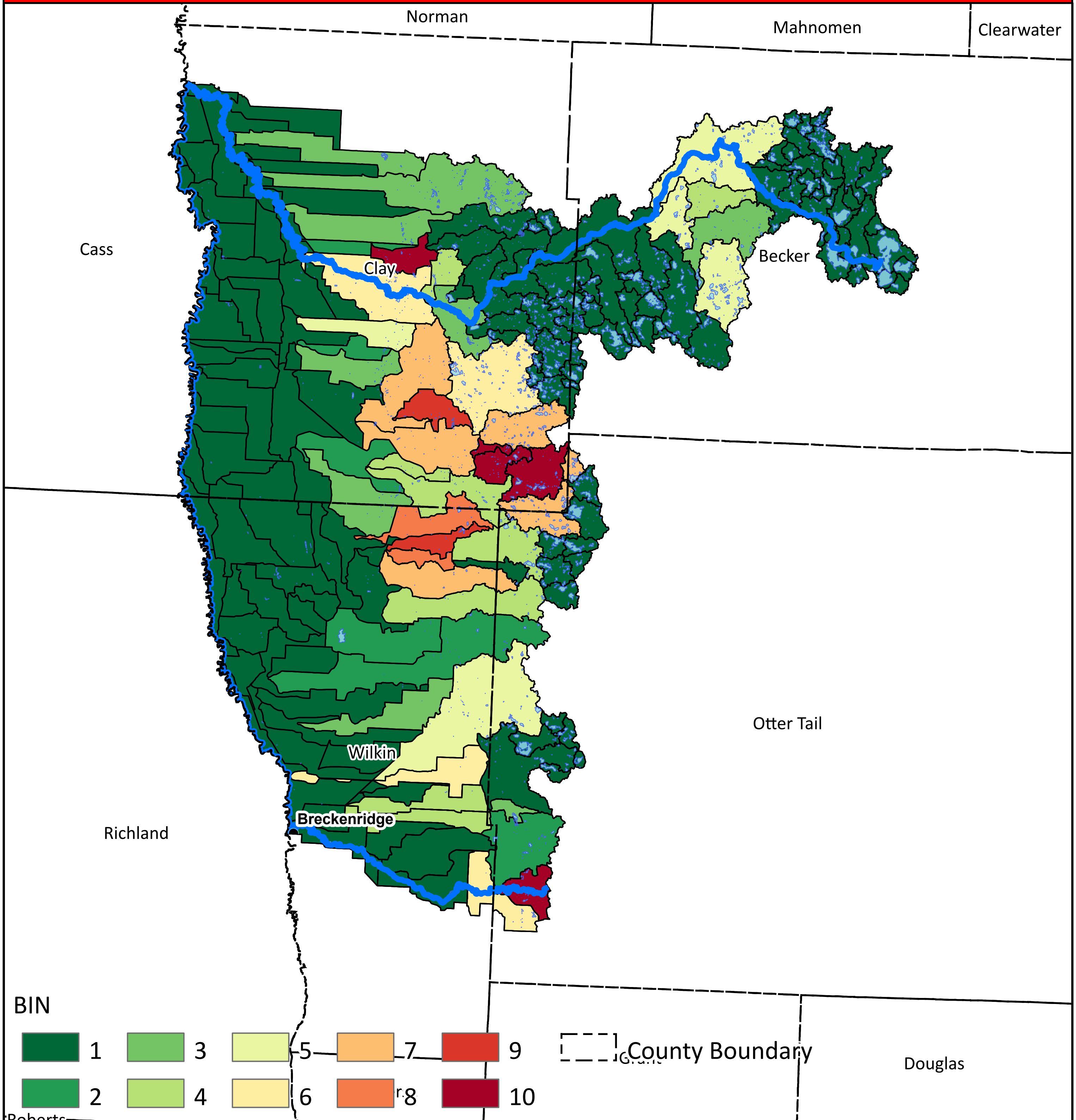
Upper Red River Wetland Restoration Planning Study - Upper Otter Tail River -

River
Lake

N
Miles
0 2.75 5.5 11

BOARD OF WATER AND SOIL RESOURCES

Figure F3: Unweighted Catchment Prioritization



Upper Red River Watershed
Wetland Restoration Planning Study
- Buffalo - Red River -

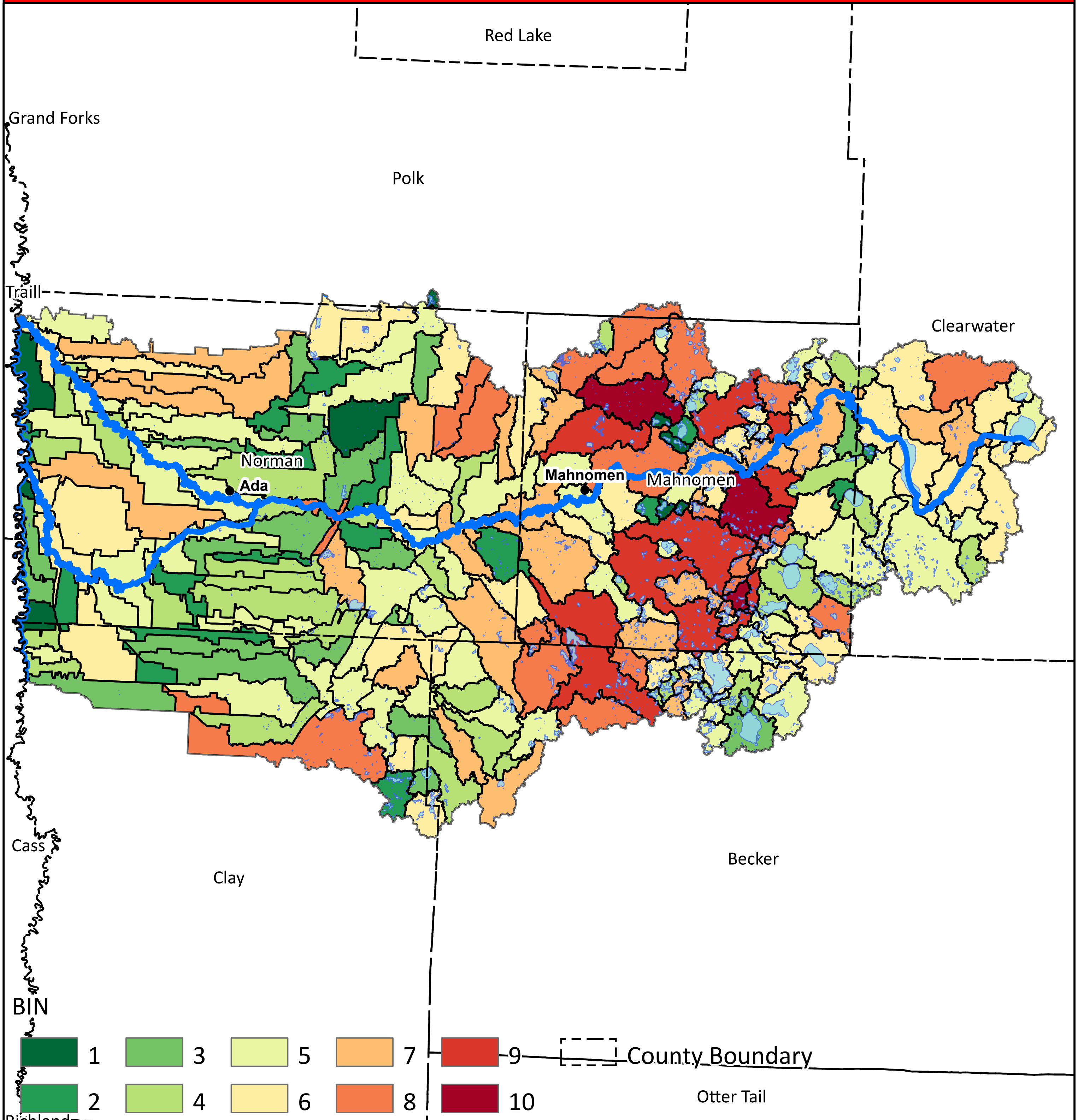
Lake River

N

Miles
0 2.75 5.5 11

BOARD OF WATER AND SOIL RESOURCES

Figure F4: Unweighted Catchment Prioritization



Upper Red River Wetland Restoration Planning Study
- Wild Rice Marsh River -

River
Lake

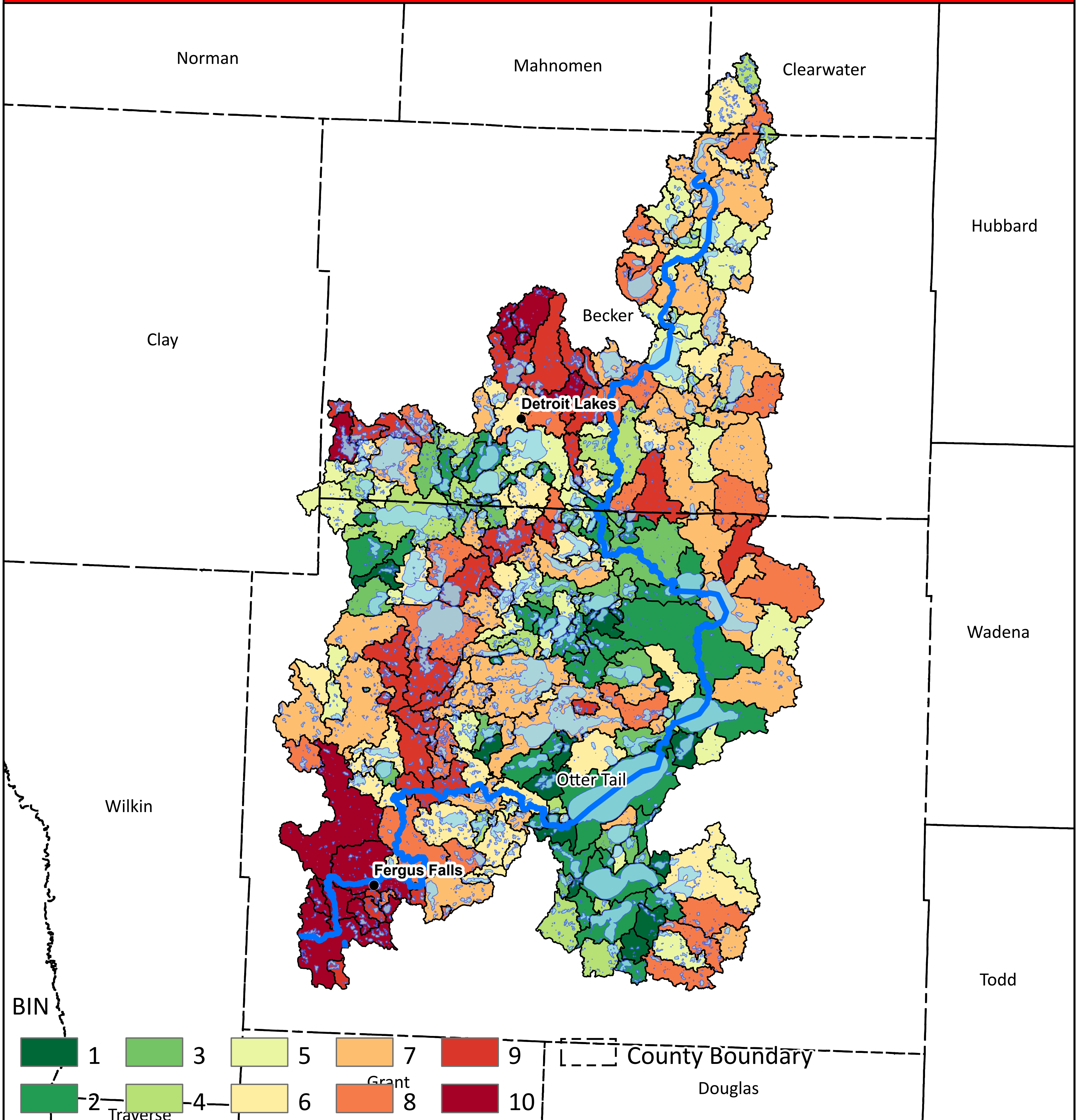
N
Miles
0 2.5 5 10

BOARD OF WATER AND SOIL RESOURCES

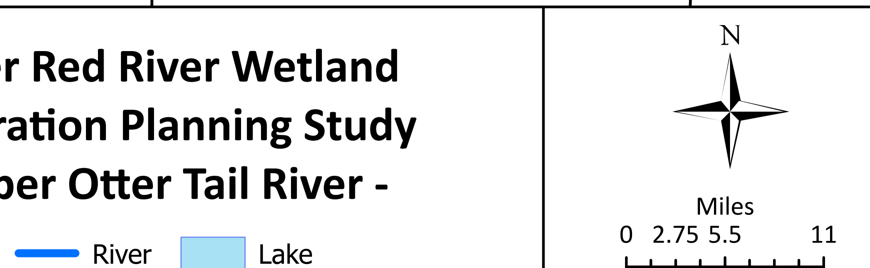
Appendix G

Weighted Catchments

Figure G1: Weighted Catchment Prioritization

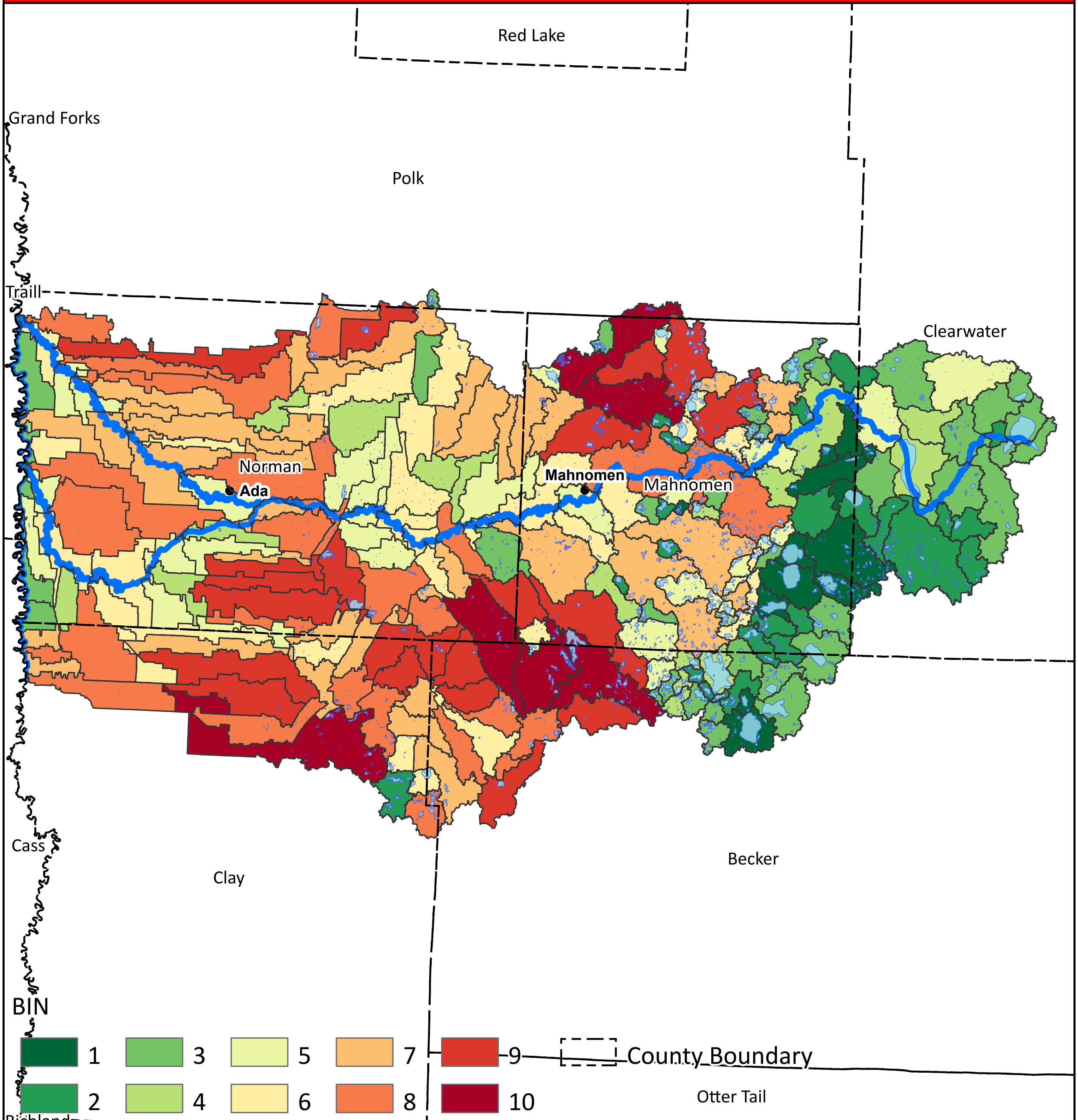


Upper Red River Wetland Restoration Planning Study
- Upper Otter Tail River -



BOARD OF WATER AND SOIL RESOURCES

Figure G2: Weighted Catchment Prioritization



BOARD OF WATER AND SOIL RESOURCES

Upper Red River Wetland Restoration Planning Study - Wild Rice Marsh River -