Section 2: Watershed Characterization

This section summarizes the physical characteristics of the Credit River Watershed in terms of topography and drainage, soils, geomorphology, aquatic habitat and wetlands, and land use. Most watershed characteristics are documented in GIS coverages. Maps of some of these characteristics are included in this Plan where the visual image provides meaningful information.

Topography and Drainage

The Credit River is a post glacial stream originating near New Market, MN and draining north through farmland and developed land in the city of Savage (Figures 2-1 and 2-2). The Credit River drains an area of 59 square miles (15,360 hectares), emptying into the Minnesota River just north of State Highway 13 in the City of Savage.

The valley form of the Credit River is rooted in its post-glacial history. The Credit River drains through steep slopes at the edges of the Minnesota River valley, but the steep slopes defining the edges of Bloomington and Eden Prairie to the north and Savage and Shakopee to the south, were not formed by the erosion of the Minnesota River. As the Des Moines lobe of glacial ice retreated around 10,000 years ago, it left behind moraine and till deposits many feet thick across Minnesota. Behind the southernmost terminal moraine, Glacial Lake Agassiz covered a large region from the Brownsville area north to central Manitoba. As the lake overtopped the southern moraine, flowing water (Glacial River Warren) cut down into the deposited glacial sediments and carved out the valley now occupied by the Minnesota River. Smaller drainages began to develop after River Warren subsided, and those tributaries to the Minnesota River began to erode the valley walls left behind by the glacial river. The Credit River is one of these drainages, and steep valley walls are typical in the middle section of the Credit, where the channel has cut down into the old glacial river terrace.

There is little variation in topography through much of the Credit River watershed. The topographic features that are present are primarily glacial in origin, such as moraines, eskers, kames, and kettle ponds. Kettle ponds are the main feature that has resulted in the occurrence of

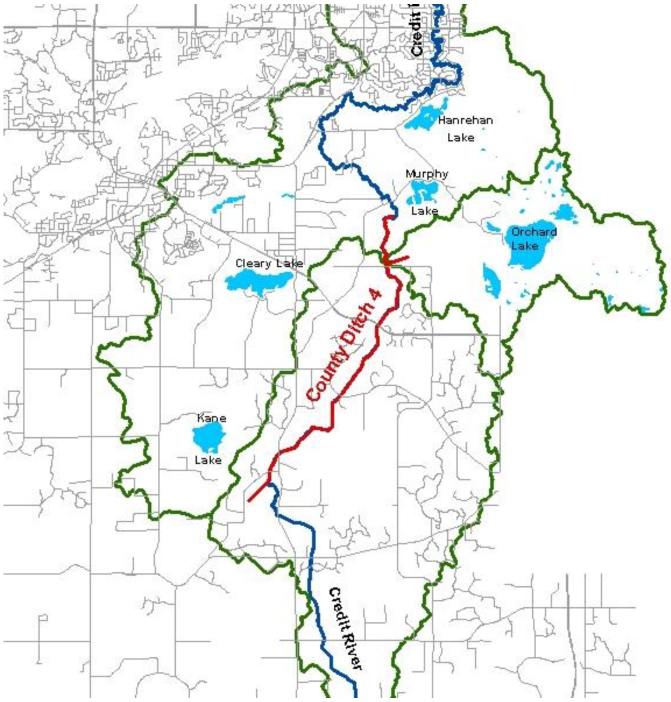

Figure 2-1. County Ditch 4 location along main stem of Credit River

landlocked bodies of water. There are many small ponds in the Credit River watershed that have no overland outlet and are dependent on precipitation to maintain their form and function.

County Ditch 4 was established in 1914 which starts just south of C.R. 75 near Murphy Lake and ends at Flag Trail, it spans a 6 mile stretch of the river covering a large portion of the main stem of the river (Figure 2-1). The most recent maintenance activity on the ditch was in 2008 when 1,800 feet of the ditch was cleaned out. The cleanout matched the 1984 and 1914 original depth.

Approximately 3,800 acres of the Credit watershed are located in Dakota County. The Orchard Lake subwatershed is approximately 2,400 acres, this area is mostly developed and consists primarily of residential areas. Water quality sampling results through the CAMP program show that the lake water has improved over the last few years and should not be contributing a large pollutant load to the river.

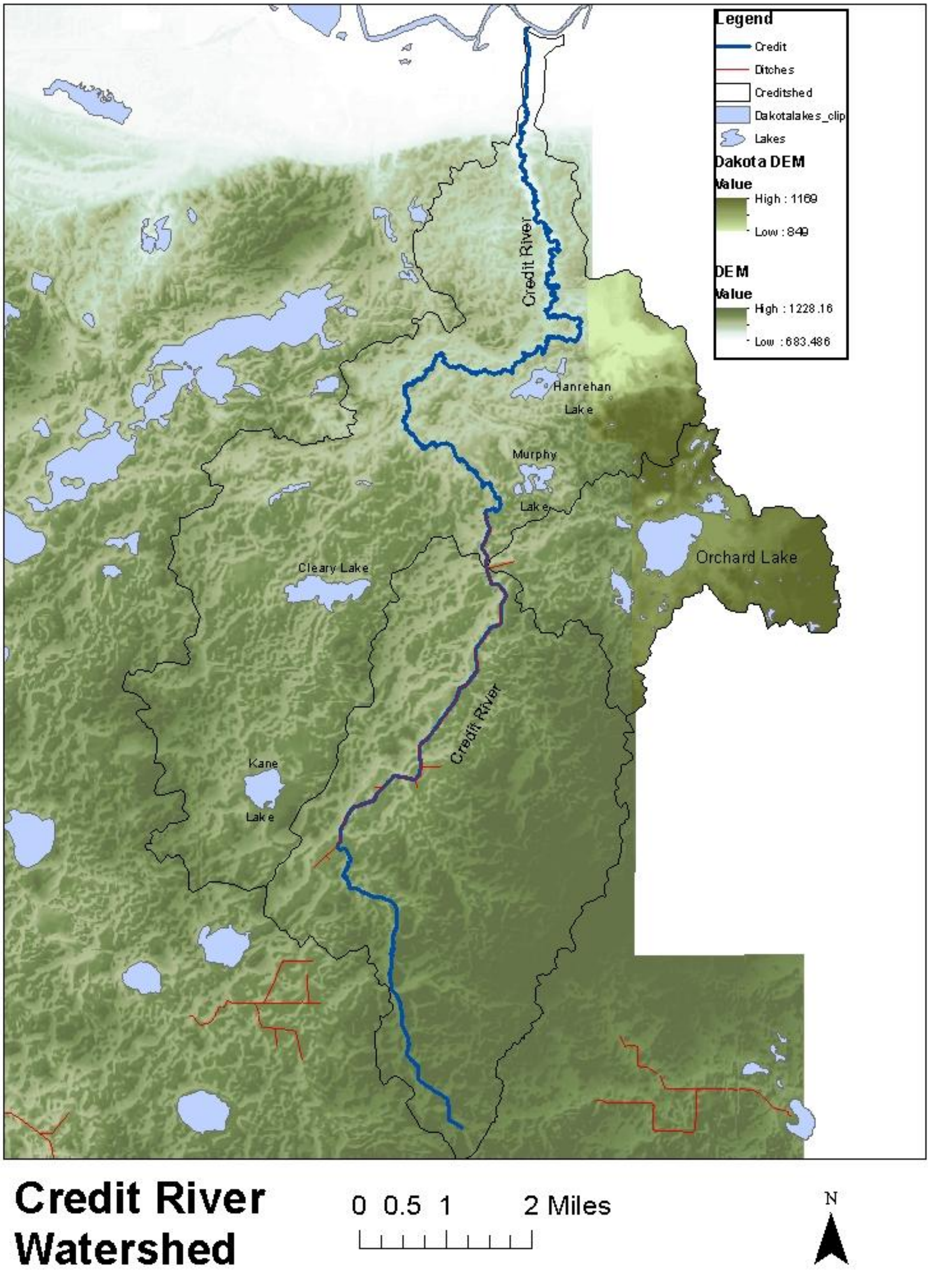

Figure 2-2. Credit River Watershed Topography & Drainage

Channels in the Credit River watershed are low-gradient for much of their lengths (Figure 2-3). The only sections with distinctly higher gradients are when the main stem is flowing through the steep bluffs of the old glacial river terrace discussed earlier. This occurs from the headwaters to approximately 18 miles downstream, the elevation of the channel decreases 250 feet. In the final 4 miles to the Minnesota River, the channel elevation drops an additional 175 feet. Most of the decrease in elevation in the first 18 miles occurs within three, 1 to 2-mile steeper sections, surrounded by a cumulative 12 miles of relatively low-gradient channel (Figure 2-3).

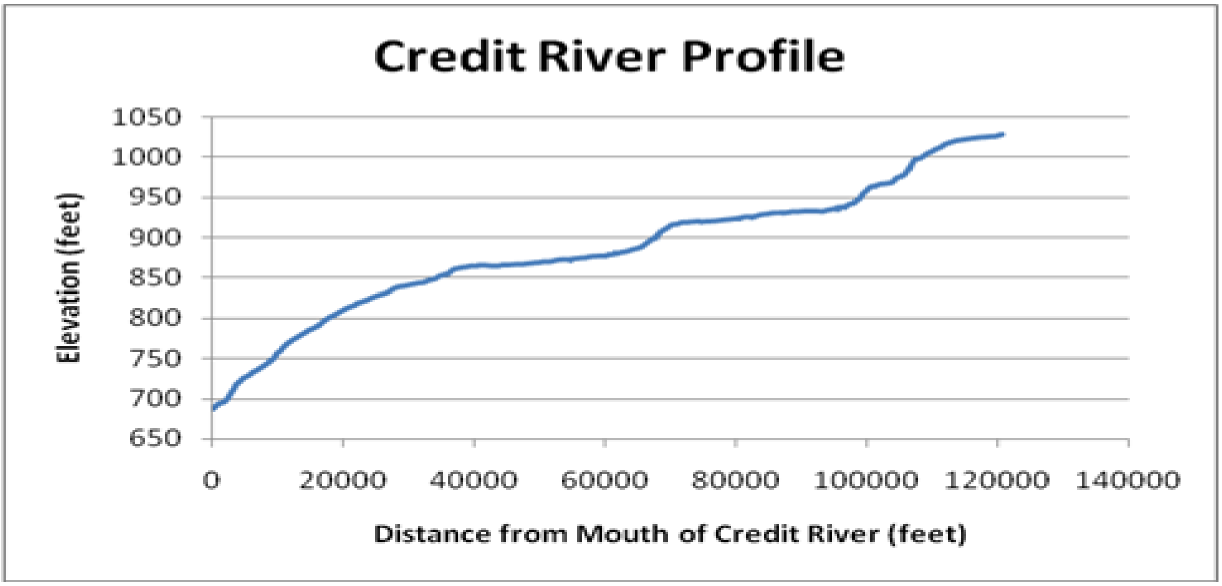

Figure 2-3. Credit River Profile (The profile is extracted from the HEC-RAS model created for the Credit River DFIRM study by Tetra Tech, dated February, 2010. Survey work to complete the model was completed in 2006).

The low-gradient sections of channel are located in wide, flat alluvial valleys; if these channels have not been straightened and ditched into agricultural channels, they are often in the form of wetland channels. The Credit River has eroded a narrow alluvial valley through the bluff near the Minnesota River with steep valley walls that rise more than 75 feet in some areas.

Geology and Soils

The bedrock in Credit River watershed is comprised primarily of Lower Ordovician crystalline dolostone, sandstone, and shale of the Prairie du Chien Group (Runkel and Mossler, 2006). Surficially, Scott County is dominated by glacial till, except along the Minnesota River, which is composed of alluvium and terrace deposits (Lusardi, 2006). The abundance of glacial till, a material with low permeability because of the silts and clays that fill in the spaces between the larger grains, provides a layer of protection for the county's aquifers that lie in the sedimentary rock below. The soils along the Credit River are composed primarily of silt, with some sand, clay and loam intermixed. The predominance of silt is due to the glacial activity during the Pleistocene Epoch that ended approximately 10,000 years ago. Glacial lobes from the northeast and northwest carried sand and clay-based drift from Lake Superior, northwestern Minnesota, northeastern North Dakota, and Manitoba, and deposited it in southern Minnesota, including throughout Scott County.

Credit River watershed has large amounts of highly erodible land (HEL). The headwaters area (subwatershed C68) holds the larger concentration of HEL and cultivated HEL (Figure 2-4). Table 2-1 below tabulates the acres in HEL by subwatershed as well as the amount cultivated. Examination of Table 2-1 and Figure 2-4 shows that most of the HEL is in stable condition as vegetated urban, rural residential land or regional parkland. As discussed in more detail in the subsection on land use (page 2-19), two large regional parks (Cleary Lake and Murphy Hanrehan), are located in the Credit River watershed.

Table 2-1. Highly Erodible Land (HEL) by Subwatershed

		HEL		Cultivated HEL	
Subwatersheds	**Acres in Subwatershed**	**Acres HEL**	**% of Subwatershed**	**Acres Cultivated**	**% of Subwatershed**
Lower Credit	5228	2617	50%	0	0
154 (Cleary)	13033	3081	24%	478	4%
Orchard Lake	3411	1597	47%	87	3%
C68 (Upper Credit)	6351	4931	78%	1075	17%

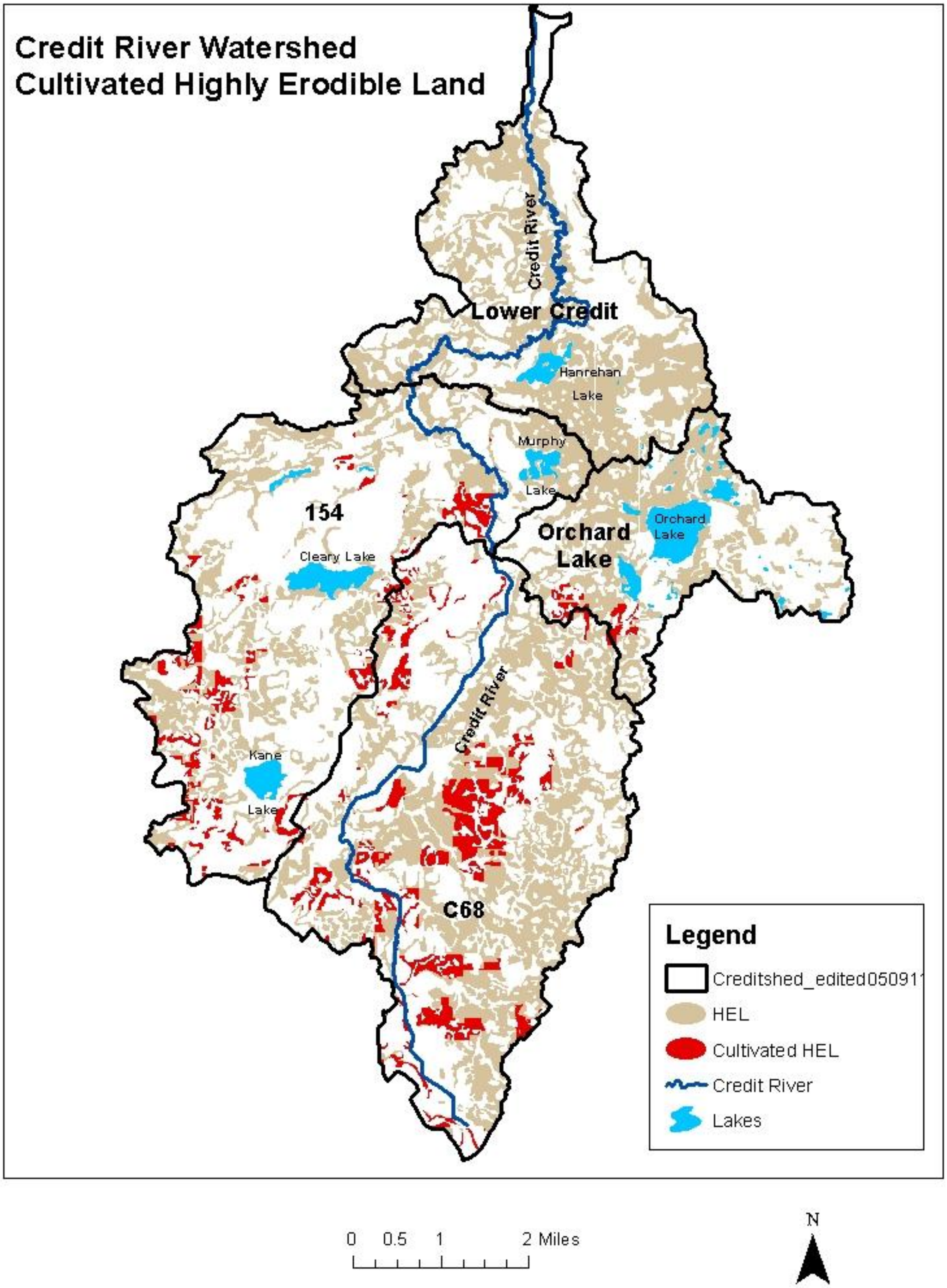

Figure 2-4. Cultivated Highly Erodible Land (Cultivated Land Source: Minnesota Agricultural Statistics, 2005)

Geomorphology

Scott WMO contracted with Inter-Fluve, Inc. to complete a Fluvial Geomorphic Assessment as part of this project. The assessment was completed since inventories conducted in 2005 and 2006 showed there was streambank erosion along the Credit River. Knowing streams are dynamic systems, it was necessary to find out where the streams were in their evolution to determine where to target corrections, and where to leave the stream to its own evolutionary processes. This section provides a summary of the Inter-Fluve report. Greater detail can be found in the attached report (Appendix C). The summary provides an overview of the principles behind fluvial geomorphology processes, and then provides a brief summary of Credit River reaches and its major tributaries.

Stable stream systems are in a delicate balance between the processes of erosion and deposition. Streams are continually moving sediment eroded from the bed and banks in high velocity areas such as the outside of meander bends and around logs and other stream features. In the slow water at the inside of meander bends or in slack water pools, some of this material is deposited. This process of erosion and deposition results in the migration of rivers within their floodplains. The process by which streams meander slowly within the confines of a floodplain is called *dynamic equilibrium* and refers mainly to this balance of sediment erosion and deposition. Streams typically have reaches that fall along the continuum of degradation (eroding) to aggradation (depositing) at any one time in the scale of channel evolution. The location and character of these individual reaches changes over time. When a stream channel is in equilibrium, it may move across the floodplain, erode and deposit sediment, but general planform geometry, cross-sectional shape, and slope remain relatively constant over human lifetimes (Figure 2-5).

Figure 2-5: Erosion along a cut bank and deposition on a point bar on Sand Creek

Many factors can influence this equilibrium by altering the input of sediment and the quantity and timing of runoff. These factors include soil types, rooted vegetation that holds soil in place, flashy flows that erode banks, large rainfall events, or increased sediment pollution that deposits sand or other fine sediment in the channel. When a channel loses its equilibrium due to changes in flood power and sediment load, it can in turn lose essential habitat features. The fundamental channel shaping variables in balance are slope, discharge (amount of water flow per time), sediment load and sediment size. The balance between the amount/size of sediment and slope/discharge is manifested in complex drainage networks of streams with a specific channel area and slope. Any change in one of the variables can upset this balance, resulting in either aggradation or degradation of the channel.

For example, given that the primary function of streams and rivers is to transport water and sediment downstream, changes in land use that affect the timing of runoff can affect sediment transport. Clearing of watershed forests, row crop agriculture and urban development cause storm water to reach the stream channel faster, and increase the peak discharge in the stream. Geomorphically, an increase in stream discharge might result in an increase in channel incision or lateral bank erosion, and hence, the amount of sediment being transported downstream. These changes may also result in changes to channel slope. The stream's evolution will persist until it reaches a new dynamic equilibrium between the channel shape, slope, and pattern (Schumm 1984, Leopold et al. 1964).

In a comprehensive geomorphic assessment, the physical attributes of the stream channel are measured to determine its geomorphic stability and the processes and factors responsible for that instability. Parameters typically measured include channel planform and profile, cross-section geometry, slope, watershed land use, riparian vegetation, soils, and channel erosion.

The Credit River is in remarkably good geomorphic condition for a stream near a major urban center with expanding development and a headwater area dominated by row crop agriculture. The following provides a reach by reach summary of the conditions observed in the river. Figure 2-6 shows the locations of the reaches.

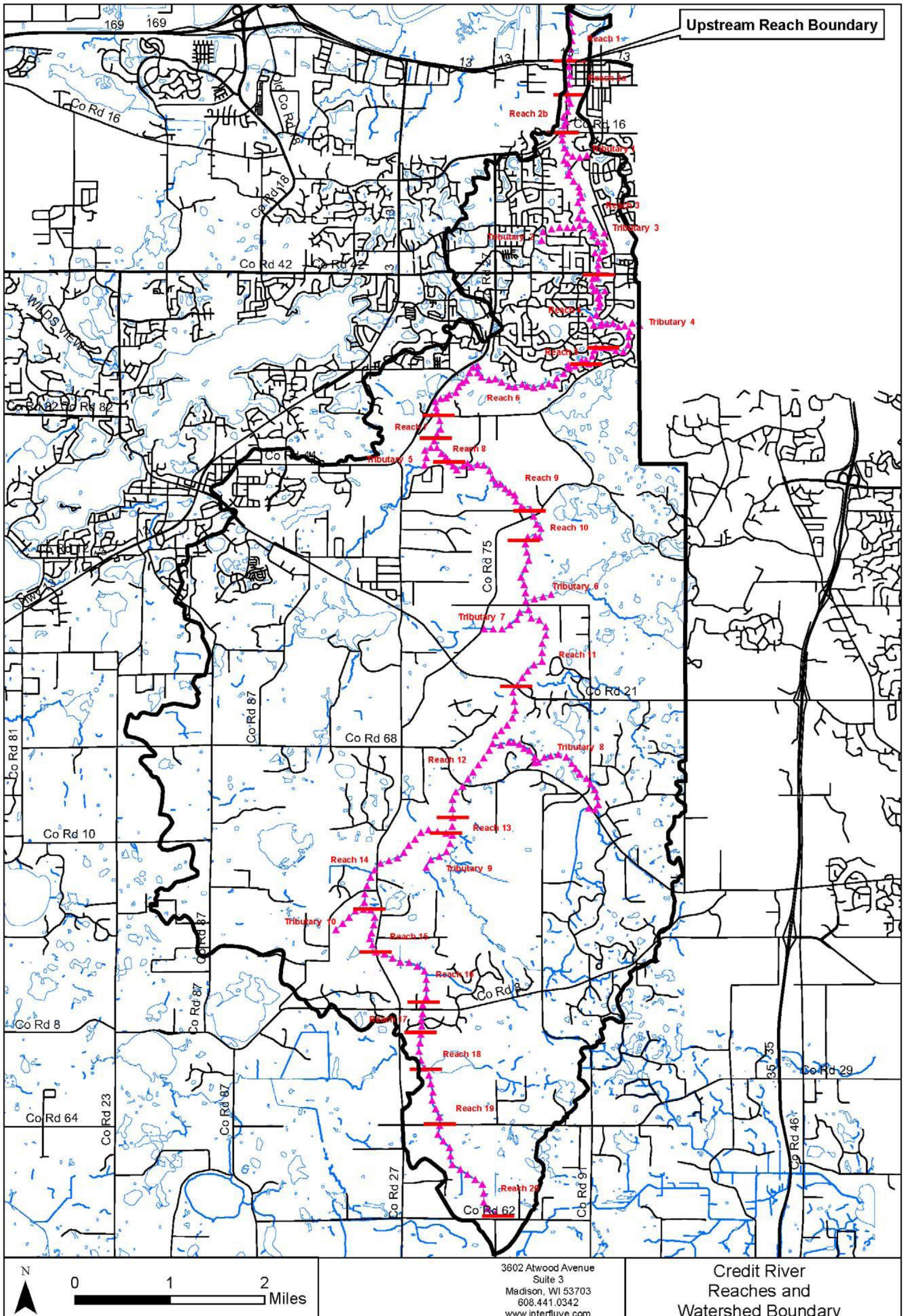

Figure 4: Credit River watershed (black polygon) and reach boundaries (red horizontal lines). Pink triangles indicate 500-ft increments along the channel centerline. Scott County provided the channel, road, and watershed layers; some of the smaller tributaries were not included in these layers.

Figure 2-6. Reach Designations for the Credit River

Reach 1

This is a straightened reach with high levee walls on both banks. The original channel meandered northeast at approximately station 2200, but this is completely cut off and the current channel flows north to the Minnesota River with few meanders and little habitat. The channel is wide, and there are narrow active floodplains with ~50 year old cottonwood trees. The gradient is controlled by bedrock. This appears to be a typical urban channel that has been completely altered in the past, but has since recovered somewhat so that there are active floodplains and the flows are able to mobilize sediment, but has little habitat value because of lack of channel complexity.

Reach 2a

This is a fairly straight, urban channel with limestone bedrock outcropping in the bed of the channel in a few locations. Though it may have been straightened historically, it also might be a naturally straight river due to the steep gradient in this area. Minnows, chub, and crayfish were observed, indicating that there is some reasonable habitat with protected undercut areas caused by bedrock and shade from some overhanging vegetation.

Reach 2b

This is a stable, meandering, reach with fairly good habitat. There is channel complexity with gravel bars, sandy pools, cut banks, and meanders. Though there are dense residential neighborhoods nearby and multiple road crossings, the actual riparian corridor is wooded and mostly free of development, likely due to the steep bluffs on either side of the channel. This has resulted in good habitat conditions with abundant fish and invertebrate species present.

Reach 3

This is a stable, meandering, reach with fairly good habitat. There is channel complexity with gravel bars, sandy pools, cut banks, and meanders. The riparian corridor is wooded and mostly free of development. Hidden Valley Park is located within this reach.

Reach 4

This is a very sinuous reach with good channel complexity and good available aquatic habitat. The riparian corridor is fairly wide with an active floodplain and diverse canopy in many areas, though this corridor is sandwiched between extremely dense residential neighborhoods and developments. Most of the building is on top of the bluff, but those landowners that have built near the stream have generally cleared the natural vegetation and installed riprap to stabilize their banks. Other than these alterations, as well as the occasional small stone dam built by landowners or children, this reach is in pretty good shape. There is a good diversity of aquatic plant and animal species.

Reach 5

This reach is similar to Reach 4 with a sinuous channel maintaining geomorphic and habitat complexity. However, this shorter reach is even more natural with less riprap and less landowner interference, and it maintains greater diversity and abundance of vegetation on the floodplain.

Reach 6

This is a wetland reach, narrow channel, with well-defined and vertical banks, mostly sand bed, few riffles, and little woody debris. This wetland reach is meandering and contains many side channels.

Reach 7 & 8

This is a similar wetland reach to Reach 6, except the valley is narrower and there are trees closer to the channel in some locations. The wetland is narrower, but the dominant vegetation cover is still reed canary grass. There is turf grass managed up to the edge of the channel in a couple of locations.

Reach 9

This is a very sinuous, meandering reach that changes from a wooded reach, to a wide wetland reach, to a narrow valley that is neither wetland nor wooded. There is good channel complexity and a range in percent canopy cover, thus offering a wide range in habitat structure.

Reach 10

A wooded meandering reach with a high degree of canopy cover composed of a diverse number of species. The riparian corridor is relatively wide and the floodplains appear to be active. This channel is in good shape, though dry in most areas during the summer.

Reach 11

This is a straightened, channelized ditch through agriculture fields or through forested corridors surrounded by agriculture fields. High banks about 15 feet high bound both sides of the channel, but the river has constructed very narrow floodplains about 3-4 feet above the bed. This is a homogenous reach, geomorphically, with multiple beaver dams creating the only bit of channel complexity and habitat diversity.

Reach 12

This entire reach is channelized and ditched through a wetland and agriculture fields. There is little good quality aquatic habitat, no channel complexity, and little canopy cover. The railroad berm at station 81500 divides the wetland, forcing all flows through the narrow opening at this location. There is much potential for restoration here, as there is no development in the wetlands, there is room to create a meandering channel similar to the wetland channels downstream.

Reach 13

There is no channel here, only open pond in the middle of a reed canary grass wetland.

Reach 14

This entire reach is a straightened ditch. The channel flows through wetland through the entire reach except a 2,100 foot stretch west of Texas Avenue and south of 196th Street East, where it flows through a slightly forested area surrounded by fields and houses. As with other ditched channels, there is no channel complexity, little canopy cover, and no quality aquatic habitat.

Reach 15

This is a more natural reach than the ditches upstream and downstream, but channel movement is restricted by the road and agriculture fields on either side. Also, there are many private bridges and structures on the channel that restrict fish movement. There is better habitat available in this reach, however, unless species stay in this short reach, there is little chance of survival on either end.

Reach 16

The channel is a constructed ditch through agriculture fields. It has little to no habitat quality.

Reach 17

This is a short reach that is slightly more sinuous and shaded than the reaches on either end. There are new developments bounding both banks, and though there is slightly better habitat with increased channel complexity, this is a pretty disturbed reach also with multiple fish passage barriers.

Reach 18, 19 & 20

The channel is a constructed ditch through agriculture fields. Habitat quality is poor.

Aquatic Habitat and Wetlands

Historically, the Credit River meandered through wetlands and oak savanna (mixture of prairie and forest). Where forest occurred, it provided abundant aquatic habitat with shade cover and woody debris in the form of trunks, large branches and root masses. Large woody debris, as it is commonly known, provides channel complexity as log jams develop, which cause sediment deposition within, and upstream of, the log jam and also cause scouring downstream of the log jam. Log jams can cause the channel to change its course by eroding cut banks or directing flow onto the floodplains, which causes new channels to form. This channel complexity creates habitat complexity that allows a high diversity of macroinvertebrate and fish species to survive. Since most of the forests were eliminated in the late 1800s, many channels have become more stable and less complex, resulting in decreased habitat complexity and decreased biotic diversity. Additionally, the shade provided by forests is no longer available, likely increasing water temperatures and reducing the amount of protection from aerial predators. In some reaches of the Credit River, particularly in the steep reaches near the confluence with the Minnesota River where building could not occur because of the steep valley walls, there are still trees covering the hillsides and floodplains that provide shade and woody debris. However, this is a relatively short reach with no upstream woody

Figure 2-7. A section of the Credit River was first characterized as a wetland channel in 1855, this section later turned into farmland and was essentially dry by 1937. Since then, it has turned back into a wetland that is dominated by reed canary grass.

debris source. Wood that does reach the channel is typically too small to remain in place for very long, and is washed downstream during floods.

The 1855 platmaps indicate that the Credit River channel is sinuous through some of the wetland regions and non-existent in others, indicating that water flowed diffusely through some wetland areas rather than along a distinct channel. Though it can be assumed that these maps do not precisely indicate the planform of the channel, it is likely that sinuous channels were present in some wetlands and not in others. One difference that was observed in the 1937 photographs was the absence of wetlands that appeared to be present on the 1855 platmaps and that are currently present along Credit River (Figure 2-7). The drought that occurred during the 1930s caused many of these wetlands to diminish or disappear and created more potential farmland. The active crop rows visible in the 1937 photographs are still visible within the wetland on the 2003 aerial photographs, but these areas are no longer actively farmed and are generally dominated by reed canary grass (Figure 2-7).

To determine habitat quality in Credit River, Inter-Fluve collected data in a Stream Visual Assessment Protocol (SVAP) form. The SVAP form, developed by the Natural Resource Conservation Service (NRCS). This protocol provides an assessment based primarily on physical conditions within the assessment area such as channel condition, hydrologic alteration, the riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, invertebrate habitat, canopy cover, riffle embeddedness, and observed macroinvertebrates. It may not detect some resource problems caused by factors located beyond the area being assessed. The use of higher tier methods is required to more fully assess the ecological condition and to detect problems originating elsewhere in the watershed. Table 2-2 shows how the SVAP score relate to the overall health of the stream. Figure 2-8 graphically displays the results.

Table 2-2. Stream Visual Assessment Protocol Scoring

SVAP	
Score	**Stream Health Rating**
<6	Poor
6.1-7.4	Fair
7.5-8.9	Good
>9.0	Excellent

Conditions are fair throughout the upper watershed with a small section just south of County Road 68 where conditions are poor because the stream is channelized through a small wetland. Stream habitat is good from approximately 165th Street East to just west of Cedarwood Road. Stream habitat then scores excellent from approximately one mile south of 154th Street West to Highway 13 in Savage when it rates good to its confluence with the Minnesota River.

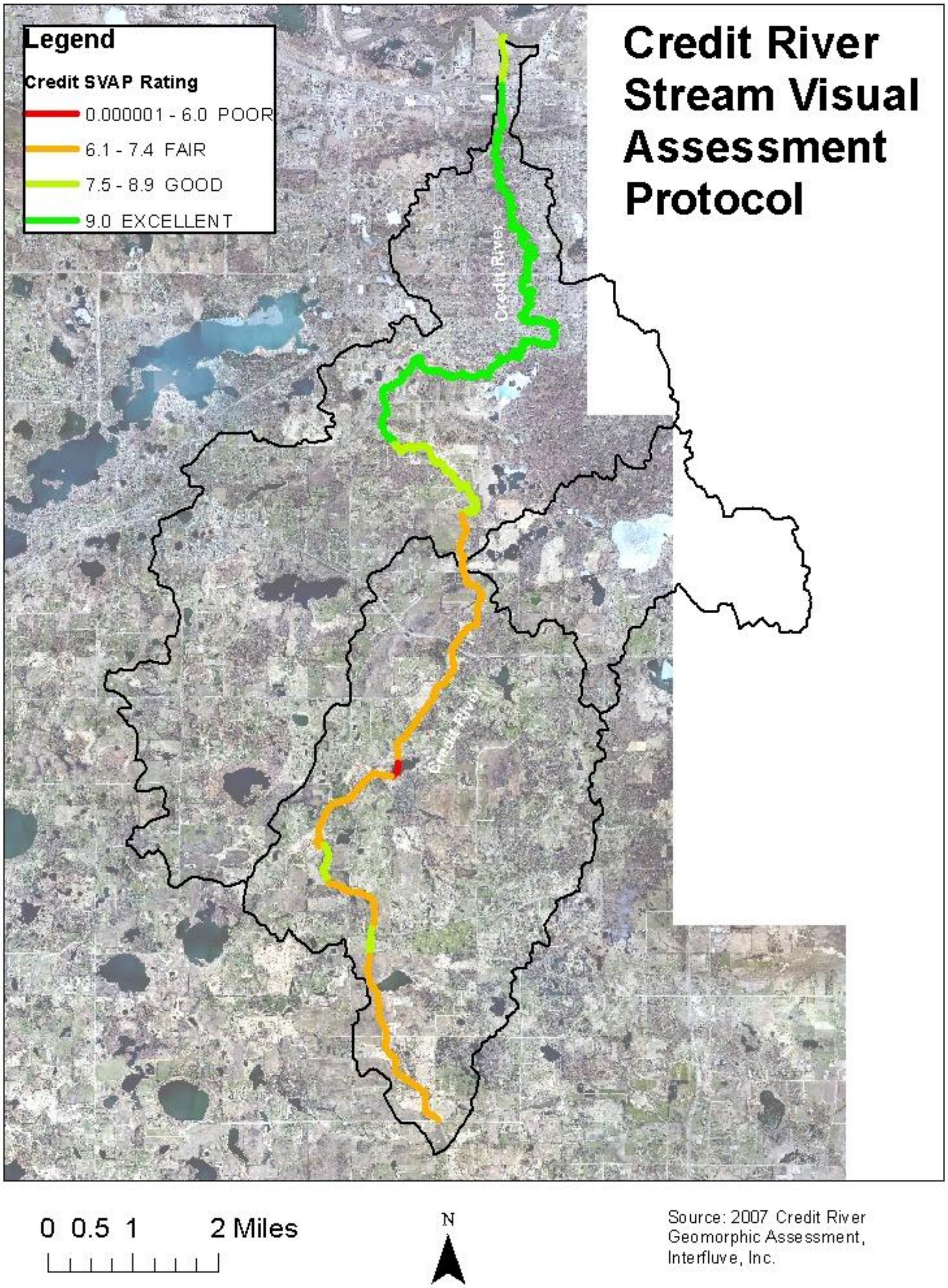

Figure 2-8: Stream Visual Assessment Ratings for Credit River

Land Use

Land use information is presented for historic, current, and future conditions.

Historic Conditions. Hardwood forests and wetlands dominated the Credit River watershed prior to the logging that began shortly after settlement in the 1850s. Today, only scattered remnants remain of what was the Big Woods and oak openings and barrens ecosystems, an expansive maple-basswood forest that covered 3,400 miles east of central Minnesota and stretching to Southern Illinois. The largest remaining tracts of Big Woods near the Credit River watershed are the Cannon River Wilderness Park (1,100 acres), Seven Mile Woods (700 acres), and Nerstrand Big Woods (1,300 acres), all in Rice County. Some remnant Big Woods and oak barren tracts are present in Credit River watershed in Murphy Hanrehan Park Reserve, and Cleary Lake Regional Park.

Most of the arable land within Scott County was converted to farmland starting approximately 150 years ago; to create this farmland many of the smaller rivers and streams were straightened and ditched and most of the wetlands were drained. Settlement began after two treaties were signed with the Dakota Indians in 1851 and 1853. As settlers arrived, the hardwood forests that dominated the region were removed to make room for crops.

The earliest survey of the region was conducted in the early 1850s and published in 1855. These platmaps indicate that the Credit River channel maintained a high degree of sinuosity from the headwaters to the mouth (Figure 2-7); additionally, the map indicates that low-gradient wetland channels were likely the predominant channel form from the present-day County Road 68 crossing upstream to the 230th St. E. crossing (the river does not continue upstream of this location on the 1855 maps). The straightened ditches that characterize many of the reaches higher in the watershed were created between 1855 and 1937. The 1937 series of aerial photographs indicate that the channel planform looks much the same in 1937 as it does today.

Current Conditions. Scott County experienced a housing boom in the early 2000s. From May 2001 through 2006, the County approved nearly 1,000 lots and issued 1,200 building permits for new homes in the unincorporated area. The northeastern portion of Scott County absorbed the bulk of this recent growth. In 1998 and 1999 the City of Savage and Credit River Township combined had over 1,000 new construction building permits. A reduction in construction activity is demonstrated by the fact that over the course of 2008 and 2009 this number has dropped to 151. Current Land Use is summarized in Table 2-3 and Figure 2-9.

There are two regional parks within the Credit River watershed: Murphy-Hanrehan Park Reserve, and Cleary Lake Regional Park which are managed by Three Rivers Park District. Murphy-Hanrehan Park Reserve is a 2,535-acre facility located in the northeast part of County with the Credit River flowing through the western portion of the park reserve. There are three lakes within the park, the largest being Hanrehan Lake. Cleary Lake Regional Park is a 1,048-acre natural area located just southwest of Murphy-Hanrehan, with Cleary Lake at 137 acres, being the central feature.

Table 2-3. 2002 Land Use for SWAT Model Calibration

Land Use	Area (Acre)	Percentage
Ag.	8240	27 %
Urban	9120	30 %
Forest	6780	22 %
Pasture	2120	7 %
Water	940	3 %
Wetland	3240	11 %
Others (Sand Mining)	180	1 %
Total	30620	

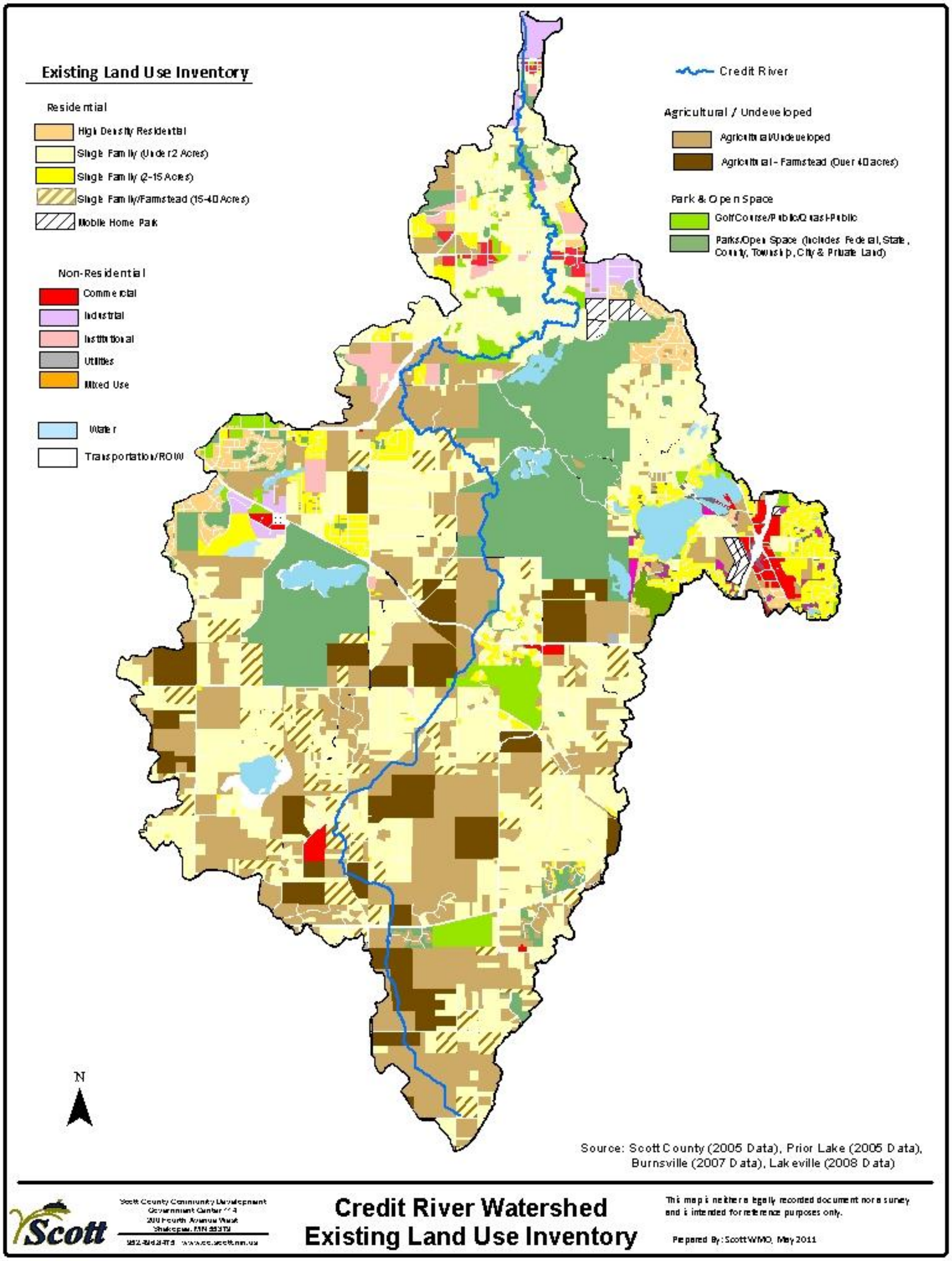

Figure 2-9: Existing Land Use in Scott County

Future Conditions. Planned future development in the Scott County 2030 Comprehensive Plan Update (Figure 2-10) guides roughly three-quarters of the county for ultimate urban development; with the remaining one-quarter (or 73 square miles) designated for rural development as the end land use. The 73-square mile area is the largest pocket in the seven-county Twin Cities region that the Metropolitan Council has formally recognized as an area that will unlikely ever be served by public sewer and water services, therefore, will unlikely ever have the potential to develop at the urban densities. The rural residential growth (i.e., 2.5 acre lots) areas are the southern portion of Credit River Township and west, covering part of Spring Lake Township and an area north of Elko New Market. Urban expansion in these areas is to be held at current densities, or a 1 in 40 acres, until sanitary sewer is provided or areas are annexed. In general the future land use in the Credit River Watershed is guided for urban in the lower (i.e., downstream, northern) portions, is guided for urban expansion in the central portions, and is guided for rural residential in the upper (i.e., upstream, southern) portions of the watershed.

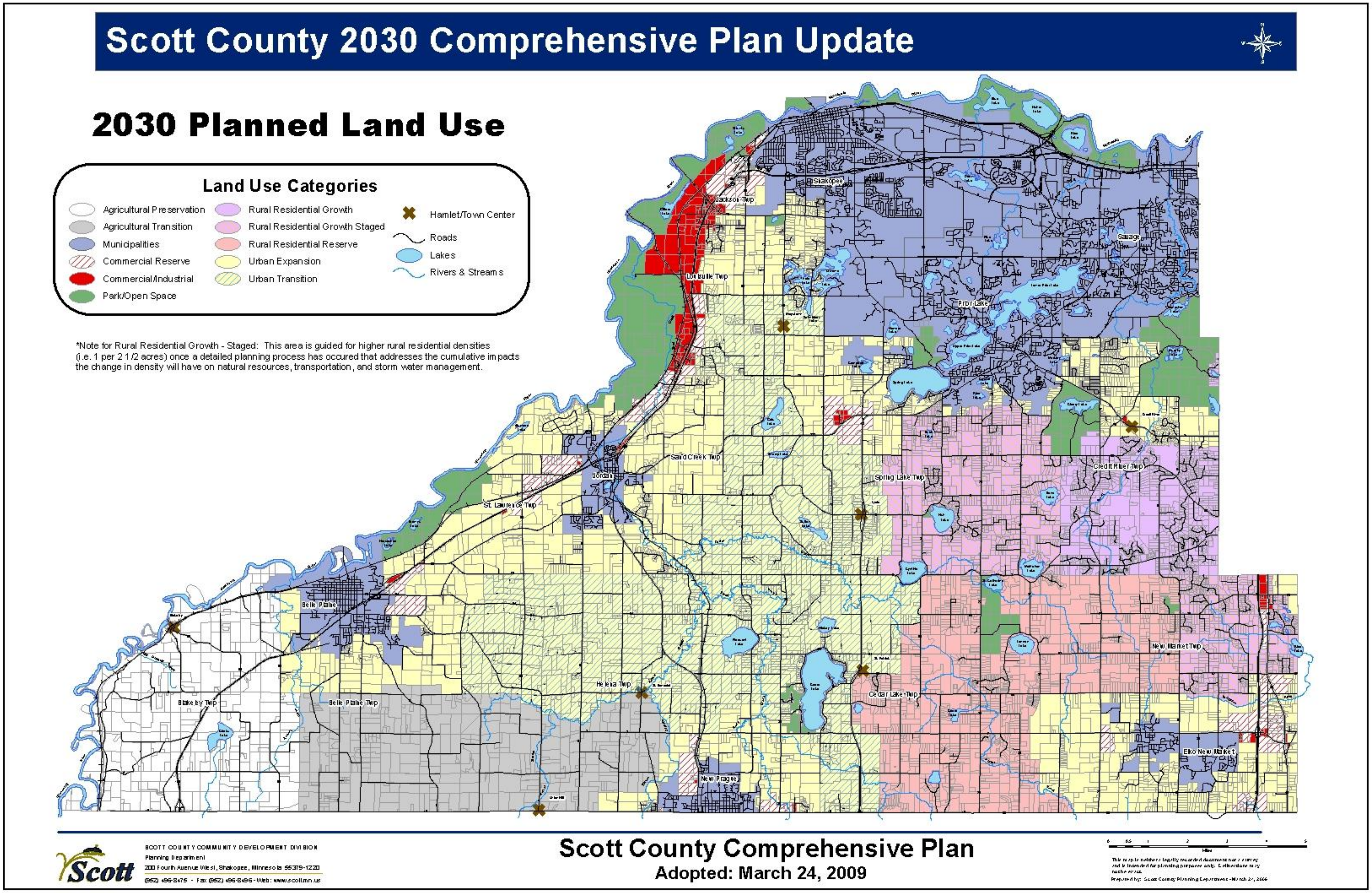

Figure 2-10. 2030 Comprehensive Plan