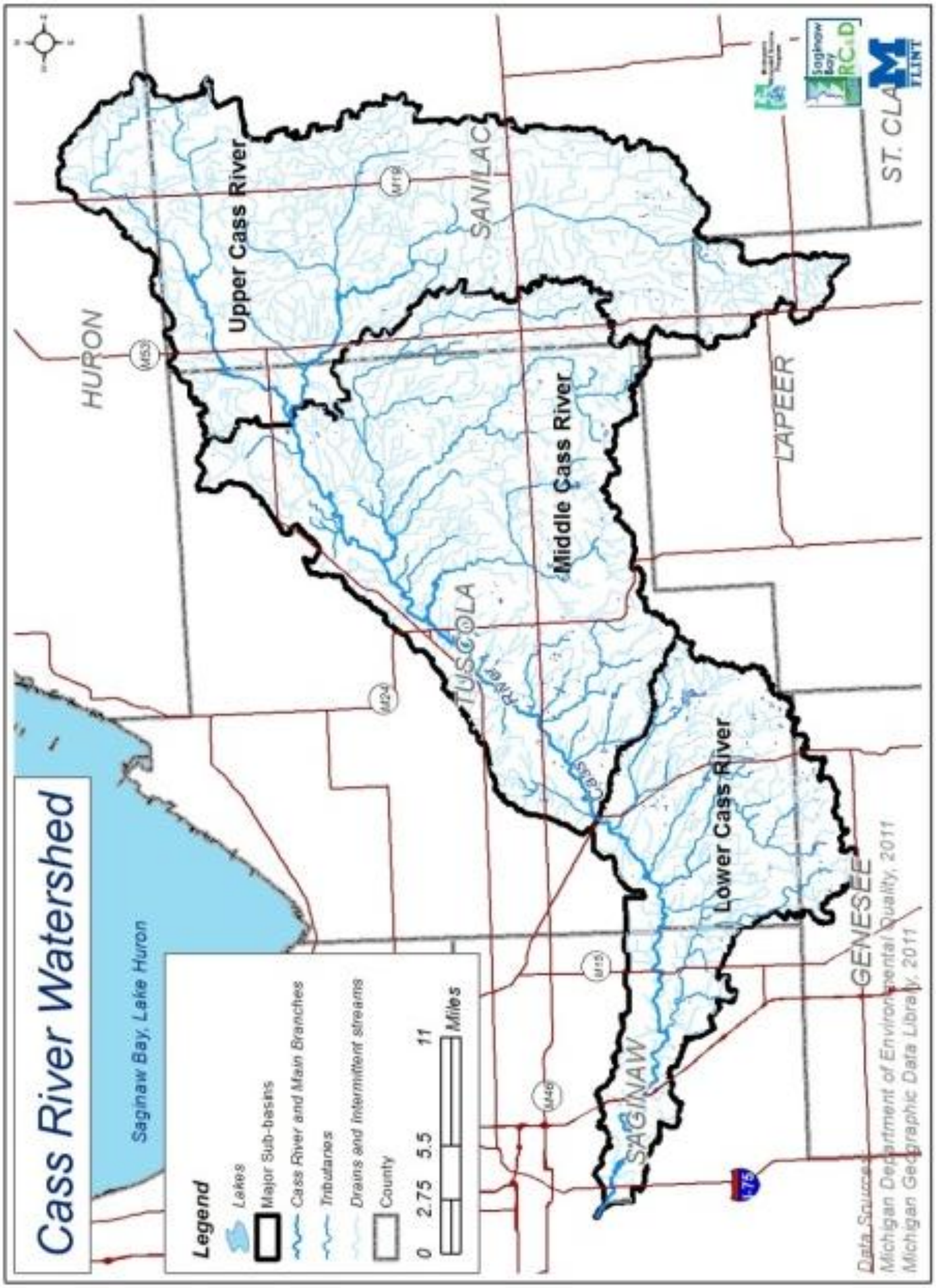
CHAPTER 2: WATERSHED CHARACTERISTICS

2.1 Geographic Scope and Boundaries

The Cass River Watershed lies within the eastern portion of the Lower Peninsula of Michigan and is 908 square miles in area. The streams and rivers in this watershed total 1,352 river miles, but only 352 linear miles are considered perennial (flow year round) (RC&D pg. 1). The South Branch Cass River forms out of swampland and farm fields in northern Lapeer County while the North Branch Cass River begins in southern Huron County. These two branches flow towards each other forming the Main Branch of the Cass River near Cass City. The Main Branch Cass River flows west through the cities of Caro, Vassar, and Frankenmuth into the Shiawassee National Wildlife Refuge. Cass River water eventually ends up in the Saginaw River and Bay, thenLake Huron.

Within the Cass River Watershed lie 3 major sub-basins – Upper Cass River, Middle Cass River, and Lower Cass River. Each of these sub-basins contains even smaller basins called sub-watersheds; in total the Cass River Watershed contains 25 sub-watersheds and each have unique characteristics. Of the three major sub-basins the Upper Cass and Middle Cass are about equal in area – occupying 39.7% and 39.9% of the watershed respectively. Map 2.1 shows the location of the Cass River Watershed within the 6 county region and 3 major sub-basins.

Map 2.1: Cass River Watershed Location



2.2 Topography

The topography of the Cass River Watershed, the shape of its surface, can be attributed to the most recent glacial period about 14,000-8,000 years ago. During this time, erosion and deposition occurred creating the landforms that are present in the Cass River Watershed today and aided in dictating the elevations of the watershed. The Cass River Watershed is its highest in the Huron County area, at 850 feet above sea level, and its lowest in the Saginaw region (where the Cass River meets the Saginaw River), at 580 feet above sea level. In this watershed the surface generally appears flat, with streams that tend to show a stream flow of less than one foot per second. In general, the watershed varies in width from 15 miles to 35 miles and reaches about 55 miles long (RC&D pg. 1).

The Cass River Watershed has a unique topography that influences the agriculture and other economic activity that takes place. The glacial erosion and deposition aided in creating current landforms and soil compositions. In the Cass River Watershed there are two Level III ecoregions as described by the Environmental Protection Agency (EPA). The first, the Southern Michigan/Northern Indiana Drift Plains, spans 834 miles of the watershed. The last 74 miles belong to the Huron/Erie Lake Plains ecoregion. Each of these ecoregions has unique characteristics that influence the land use and major industries that take place (RC&D pg. 2).

The first ecoregion, the Southern Michigan/Northern Indiana Drift Plains comprises about 92 percent of the watershed and is located in the eastern portion. This ecoregion is characterized by its soils, varying landforms, and broad till plains. The soils of this region have more drainage than the soils of the Huron and Erie Lake Plains region and are more nutrient-rich than the soils to the north of this ecoregion. This region's soils and landforms make for an agricultural industry that typically produces feed grain, soybeans, and livestock (Ecoregion Details: Southern).

The Huron/Erie Lake Plains ecoregion is located on the western side of the Cass River Watershed and makes up about 8 percent of the total watershed area. This region is dominated by broad, flat lands that are characteristically fertile. Originally this ecoregion's soil had very poor drainage, but there are now several man-made drains. The characteristically fertile soils of this ecoregion have led to high farming activity that mainly produces corn, soybeans, and livestock (Ecoregion Details: Huron).

2.3 Soils

The geology and soils of the Cass River Watershed affect hydrology, temperature regime, and the feasibility of certain Best Management Practice (BMP) installations. The types and location of soils often determine what managerial, structural or vegetative activities are feasible. For example, specific geologic landforms and soils contain highly permeable soils that are more suitable for the installation of BMPs that function to increase infiltration. Likewise some soils types are susceptible to extensive erosion if managed incorrectly and need to be planned for with particular strategies in mind. The soils in the Cass River Watershed can be described and understood through

1. drainage classifications,
2. the presence of hydric soils, and
3. the K-factor

Each of these categories describes a different aspect of soils and can aid us in discovering the BMPs for different areas of the Cass River Watershed and the watershed as a whole.

1. Drainage Classification

Drainage classification is determined by the frequency and interval in which wet periods, with the same conditions that the soil originally formed, occur. Drainage classifications aid us in determining the drainage capability, and therefore the saturation, of the soil at hand. In the case of the Cass River Watershed, the soils are heavy and often very saturated due to the poor or very poor classification of the drainage in the Cass River Watershed (RC&D pg. 7). Soils with poor or very poor drainage classifications often require artificial drainage to be suitable for crop production. Due to this, there are many artificial drains in the Cass River Watershed. After the crop fields in the Cass River Watershed are drained and tiled the resulting soil is perfect for agriculture (RC&D pg. 7).

2. Hydric Soils

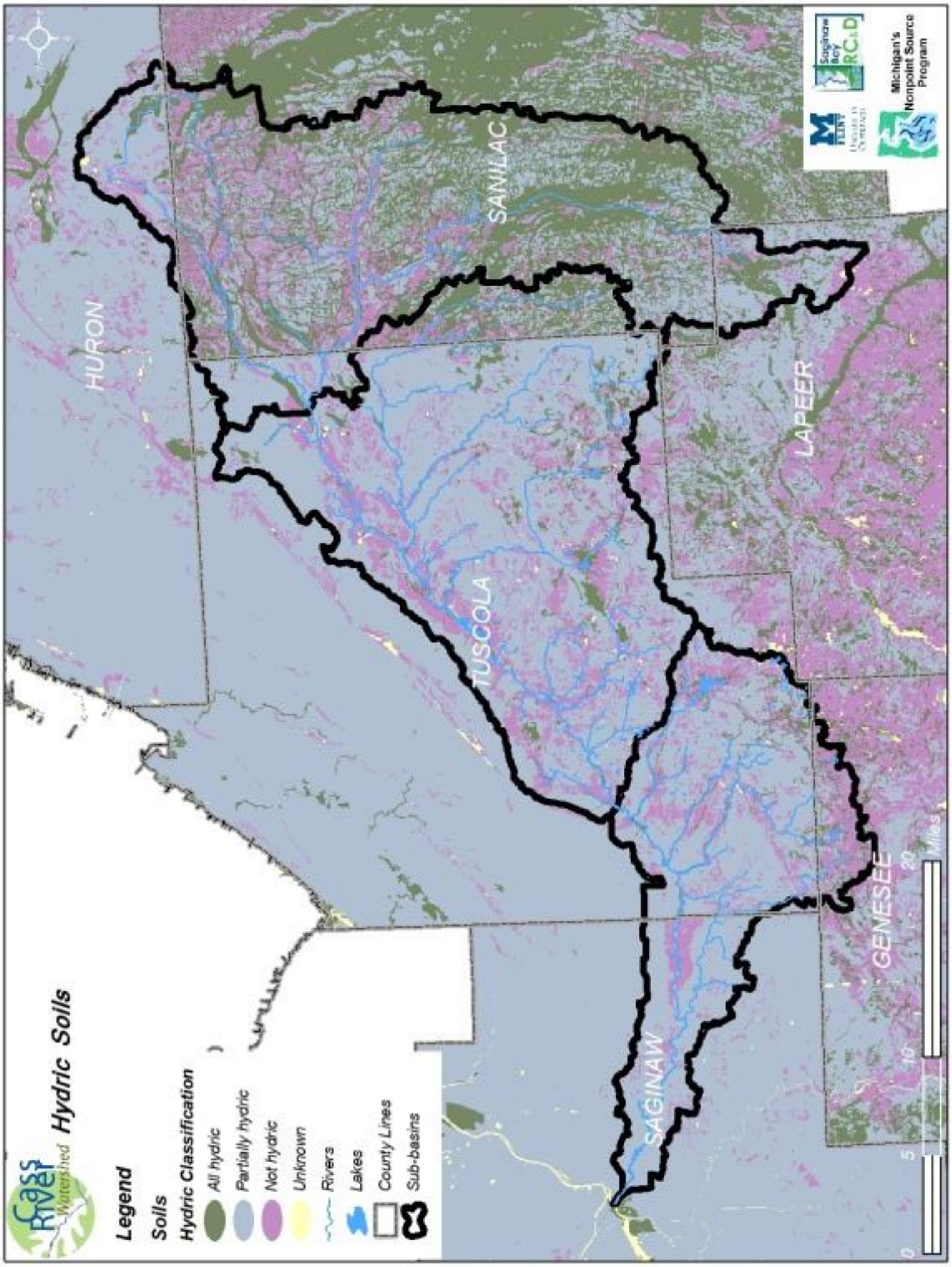
Hydric soils are formed when flooding, ponding, or saturation occurs for a prolonged period of time and creates an anaerobic (without oxygen) environment for the top portion of the soil. Soils that are hydric are often home to hydrophytic vegetation. This is because hydrophytic plants are adapted to living in aquatic environments or soils that are saturated for prolonged periods of time. This soil characteristic is important to determine because hydric soils are one of the criteria that must be present for a piece of land to be considered a wetland. Hydric soils are shown in Map 2.2.

3. K- Factor

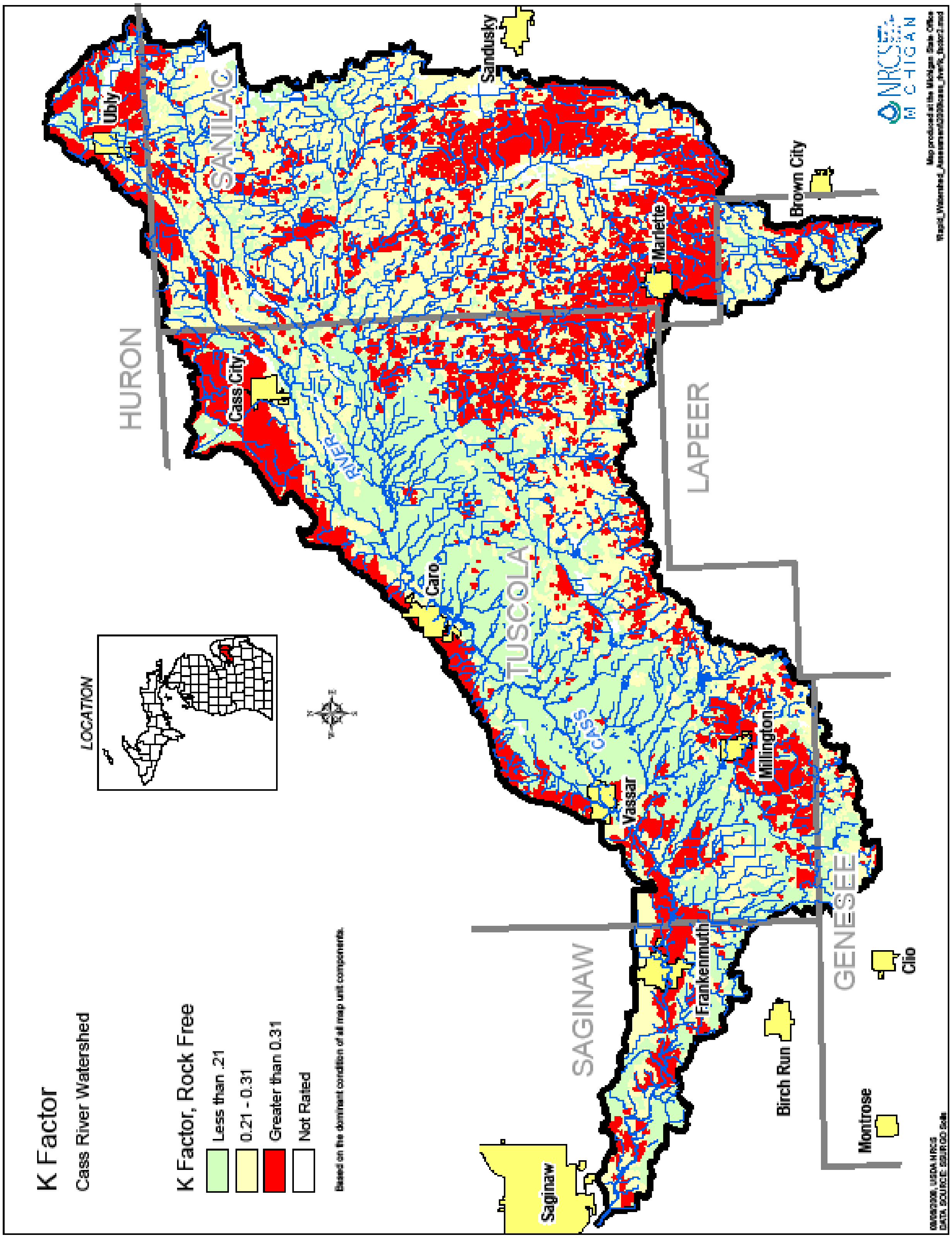
A significant indicator of the soils that are in the Cass River Watershed is the K-factor. The K-factor determines a soil's susceptibility to sheet and rill erosion. Not only does this indicator provide us valuable insight into one aspect of erosion, but it is one of six factors that are used in the Revised Universal Soil Loss Equation. In the equation, the K-factor predicts the annual rate of soil loss due to sheet and rill erosion per year; it is measured in tons per acre per year (RC&D pg. 9). K-factor values are shown in Map 2.3.

To determine the K-factor the percentage of silt, sand, and organic matter are measured. These percentages are combined with the soil structure and saturated hydraulic conductivity, also known as Ksat, to produce an estimate prediction. The K-factor is typically between .02 and .64. A higher value of the K-factor indicates that there is increased susceptibility to erosion. In Map 2.3 the K-factors were grouped into three categories to aid in the visualization of the erosion potential for the Cass River Watershed and to better determine the acreages and percentage that each group covers (RC&D pg. 9). Areas with high K-factor values are targeted in the implementation plans (Chapters 7-9) for erosion control practices.

Map 2.2: Cass River Watershed Soils - Hydric



Map 2.3: Cass River Watershed Soils - K Factor

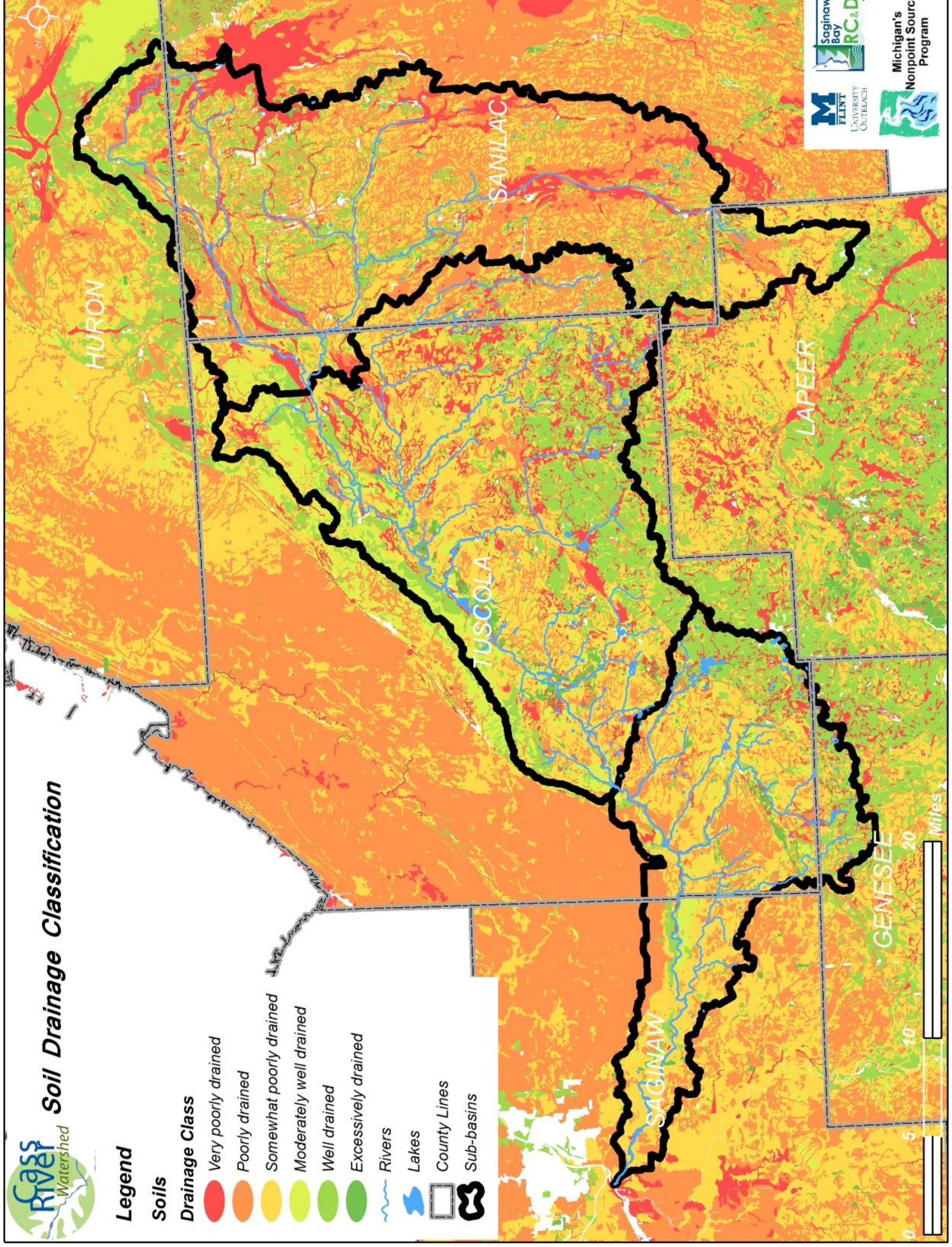


Septic Limitations

Given the amount of concern and documented issues with bacteria in the watershed, it was pertinent to include an analysis of where soils are limited for septic tank absorption fields. Soils are evaluated from 24-60 inches below the surface and are rated based on absorption of the effluent, construction and maintenance of the system. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The ratings were derived from the following properties that affect absorption of septic effluent: saturated hydraulic conductivity (Ksat), depth to water table, ponding, depth to bedrock or a cemented pan, and flooding (U.S.G.S.). The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use.

> The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected. Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00). Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines. In these soils the absorption field may not adequately filter the effluent, particularly when the system is new. As a result, the ground water may become contaminated.
>
> USDA-NRCS, 2006

Figure 2.4 Soil Limitations for Septic Effluent



2.4 Hydrology

Hydrology is the study of the movement, distribution, and quality of water on Earth. To understand the hydrology of the Cass River Watershed one needs to know where and how water moves through the watershed. A watershed is the total area in which water drains into one main body of water, in this case the main body is the Cass River. One of the main aspects of how water moves through the watershed is through the drainage system – the pattern that the lakes, river, and streams in the watershed make. Reviewing information about the volume and rate at which water travels through the system before, during and after rain events can help us understand how the hydrology of the Cass River Watershed affects water quality.

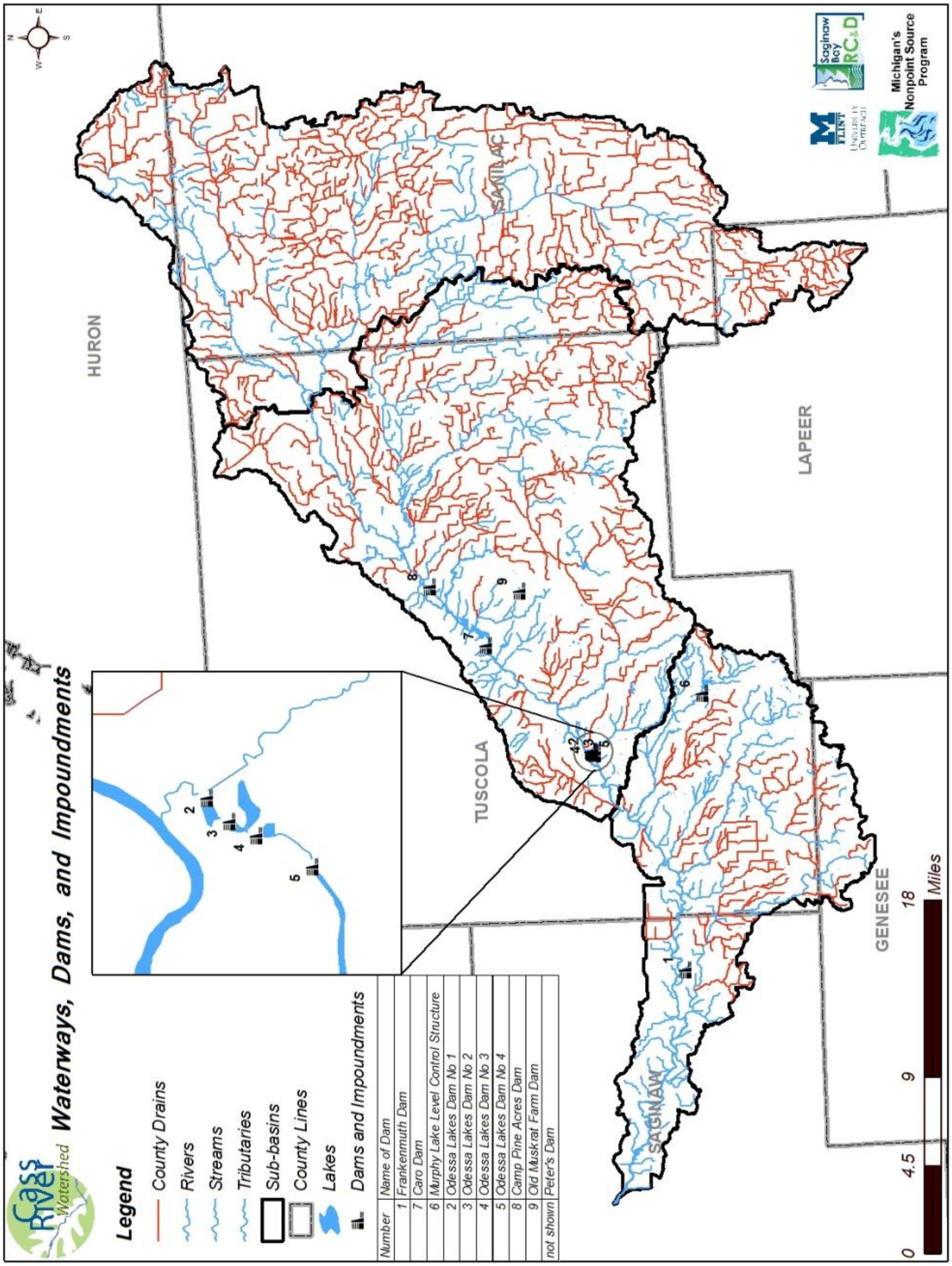
Streams receive water in two general ways including overland flow, also known as runoff, from the earth's surface and from base flow –the infiltration that seeps directly into the stream channel via groundwater. Land use changes in a watershed redistribute the amount of water that is delivered to the stream by these two processes. In most cases human interactions tend to increase the amount of water entering the stream from direct runoff while reducing the water available for base flow. This change in the hydrology is measured by two variables: the coefficient of runoff (the amount), and the concentration time (the speed). Landscape changes including land clearing, deforestation and the introduction of impervious surfaces increase the coefficient of runoff. Concentration time is shortened by activities such as installing ditches, constructing storm sewers and removing wetlands.

The increases in runoff and concentration times, the time it takes rainwater to reach the stream channel, associated with land use changes and channel alterations results in significant impacts on water quality. Changes in these two variables directly impact the aquatic habitats of the stream system. In addition they affect the magnitude and frequency of flooding events, increase erosion and the delivery of non-point source pollutants to the stream. The reduction in base flow negatively impacts the stream by reducing the water available for human and animal uses.

There are several factors in the Cass River Watershed that contribute to changes in runoff and concentration time. The impact of these changed variables can be seen mainly in the headwaters of the watershed. Here the streams are relatively unstable due to the installation and maintenance of ditches and dikes. Ditches are man-made depressions in the Earth's surfaces that are meant to hold and channel water. Often times, ditches are used as surface drains for flooded fields and lands. This is true for the Cass River Watershed. On the other hand, dikes are natural or artificially made slopes that serve to regulate water levels. These can often be in association with ditches and typically run parallel to the edge of a river or stream. The presence of ditches and dikes in the watershed alter the runoff and concentration time. This causes local streams to react to rain events and snowmelt in a short time. This correlation logically relates the stability of the headwaters, which have a large number of ditches and dikes, to the level of stability that they have. On the other hand, the concentration time for the main branch is not altered as significantly, and remains stable most of the time.

The presence of ditches is very prominent in the Cass River Watershed due to the high level of agriculture and the poorly drained soils in the watershed. Therefore, for the lands to be available for agriculture there must typically be the presence of artificial drainage. In fact, the Cass River Watershed is home to 269 drains in all. The most prominent type of drains are surface drains or ditches. The drains in this watershed are often very old and used to drain miles of agricultural lands. This not only makes large contributions to the concentration time of the waters, but adds to the pollution in the waters as well. The agricultural runoff (sediment) that finds its way into these drains is often lead straight to the Cass River tributaries. This leads to an increase in the non-point source pollution in the river and often times the nutrient and sediment levels. There are also numerous private field tiles in place throughout the watershed that undoubtedly alter the flow of water in the watershed. Removal of field tiles is often considered an option when wetland restoration is feasible and desirable.

Map 2.4: Waterways, Drains, and Impoundments



Not only do the drains in the watershed modify hydrology, but the presence of dams does as well. Dams are often used as a means of water retention, distribution management, and flood control. On the Cass River there are nine dams. The two largest are the Frankenmuth Dam and the Caro Dam. These dams pose some potential problems including fish passage and sediment distribution. Fish passage is important to the spawning habits of several species of fish, some of those located in the Cass River. Recently, the Frankenmuth Dam will be adding a rock rapid fish passage that will extend the accessible walleye and sturgeon spawning habitats, reconnecting 73 miles of stream. Dams can also cause sediment distribution problems because they create a break in the sediment flow. Sediments behind the dam build up while there is a decrease in sediments downstream of the dam. This can change turbidity and temperature of the waters causing a change in the environment for aquatic species. As of 2012 the City of Vassar is securing funding to fully remove the Vassar dam from the Cass River to restore recreational opportunities, fish passage during low water and downstream sediment transport. The Caro Dam is the largest dam on the Cass River, and is privately owned. Several locals would like to see the Caro Dam removed while others enjoy the recreation the impoundment (lake) provides. In the interim a canoe portage is being discussed to allow paddlers in canoes and kayaks to traverse around the dam safely.

The impact of dams on flow can be seen in the following graphs detailing USGS stream gauges at three locations in the Cass River. The USGS maintains stream gauges at three locations along the mainstem Cass River in Frankenmuth, Cass City, and Wahjamega shown in Figures 2.1-2.3. Figure 2.1 at Frankenmuth illustrates a lower spread between low flow and high flow volumes, illustrating the role dams play in regulating stream flow during dry and wet weather periods. The three graphs also show the Cass River's flow in relation to precipitation. For example, there was a period of extensive dry weather starting in the year 1960, and a period of extensive wet weather in the early 1980's.

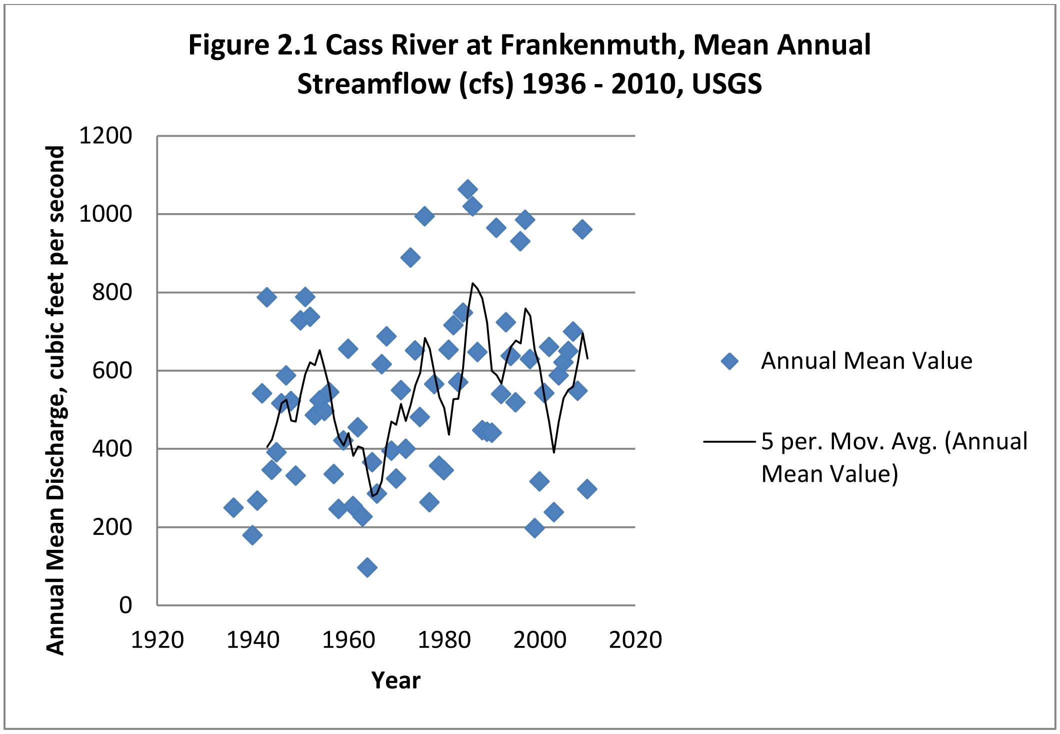


Figure 2.1 Caption: Streamflow data is presented in cubic feet per second (cfs) and is available from the USGS in Frankenmuth from 1936 – 2011. Daily discharge statistics show a minimum flow of 54 cfs in 1941 and a maximum flow of 2,110 cfs in 1996. The mean (average) flow is 305 cfs for the Cass River in Frankenmuth (USGS).

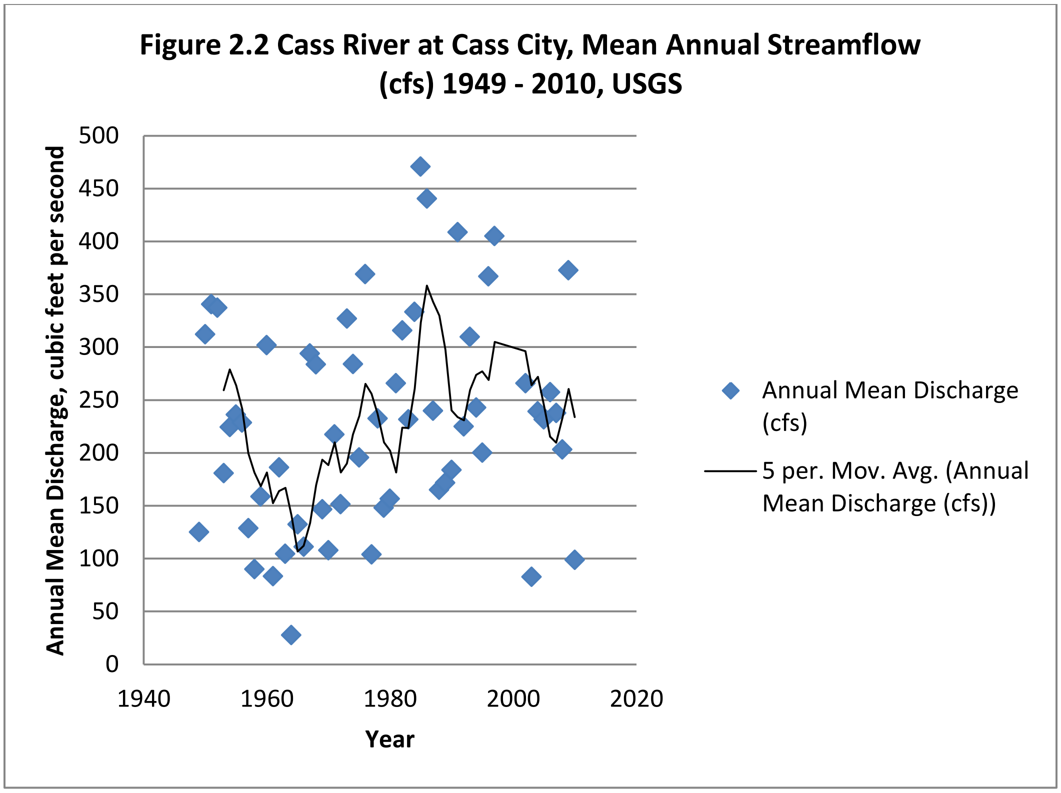


Figure 2.2 Caption: Streamflow data is presented in cubic feet per second (cfs) and is available from the USGS in Cass City from 1949 – 2011. Daily discharge statistics show a minimum flow of 6.6 cfs in 1949 and a maximum flow of 1,060 cfs in 1962. The mean (average) flow at this location is 106 cfs. This USGS gauge will presumably be discontinued in October 2011 due to lack of funding support and partners.

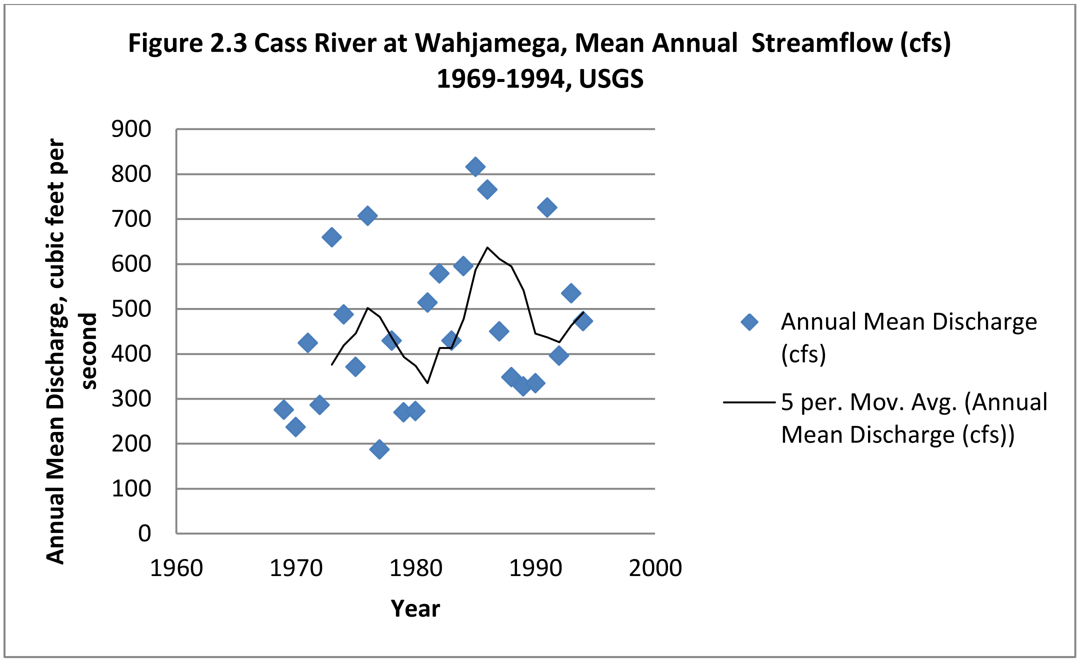


Figure 2.3 Caption: Streamflow data is presented in cubic feet per second (cfs) and is available from the USGS in Wahjamega from 1969 – 1994. Daily discharge statistics are not available for this site from the USGS website.

2.5 Land Use and Cover

The type and intensity of the watershed's land use and cover can indicate the amount of nonpoint source pollution added to the Cass River if no preventative measures are in place. This is why understanding land use is important to a Watershed Management Plan; it helps to find trends between land use and water quality degradation so that action can be taken. The increase in human development in the Cass River Watershed is causing an increase in demand for natural resources. The Cass River is currently being used for industrial water supply, agriculture production, navigation, and warm water fishing. In order to accommodate the increase in human activity forests, riparian land, and open spaces are being changed into homes, roads, and spaces for commercial use (RC&D pg. 2).

Determining the land use and cover in the Cass River Watershed was done using an existing dataset from the National Oceanic and Atmospheric Association's Coastal Change Analysis Program (C-CAP). The C-CAP dataset is updated every five years and is derived from satellite imagery. The most recent data used was from 2010. There are 18 different classifications found in the Cass River Watershed. Each of the classifications is described in appendix E.

To determine the land use and cover according to these classifications the watershed was examined on the sub-watershed level – there are 25 sub-watersheds and 3 sub-basins in the Cass River Watershed. **There are two dominant land uses in the Cass River Watershed – agricultural and natural**. Agricultural land use includes cultivated crops, pastures, and hay. These uses account for about 59.3 percent of the total watershed. Natural land use includes many uses or covers such as Evergreen Forest, Palustrine Forested Wetlands, Mixed Forests, Palustrine Emergent Wetlands, Deciduous Forests, and Palustrine Scrub/Shrub Wetlands. Natural land use makes up about 36.5 percent of the total watershed. While these percentages are for the total watershed, looking at sub-basin breakdowns and sub-watershed breakdowns we can see many different variations of land use breakdowns.

At the sub-basin level the average land use or cover is much different than at the watershed level. The Upper Cass River is predominantly made of agricultural land use, at about 71.2 percent. This sub-basin's natural land use accounts for about 26.6 percent of the watershed; it is much more agricultural than looking at the watershed as a whole. This tells us that a large portion of the Cass River Watershed's agriculture takes place in the Upper Cass River. In the Middle Cass River it can be seen that the land use and cover is fairly evenly distributed between agricultural and natural land use. The approximate percentage of this sub-basin's agricultural land use is 49.3 percent; at the same time, its approximate percentage of natural land use is 46.6 percent. The Lower Cass River reflects the average land use of the entire watershed. This sub-basin's agricultural land use is about 54.4 percent and its natural land use is about 37.8 percent.

By looking at the land use data we can separate the sub-watersheds that have a dominant natural land use from those with a dominant agricultural land use. This data will aid us in distinguishing which dominant land use is associated with impaired waterways as listed by the MDEQ. This information can then be used to determine ways to improve the impaired waterways.

Six of the 25 sub-watersheds are dominated by natural land use. Most of which are located in the Middle Cass River. One of the sub-watersheds in the Cass River Watershed is dominated equally by both agricultural and natural land uses. Finally, there are 18 sub-watersheds that are dominated by agricultural land use; half of these, nine, are located in the Upper Cass River sub-basin.

Of the dominant agricultural land use, there are a few that are extremely dominated by agriculture. There are a total of five sub-watersheds that have 80 percent or higher agricultural land use. Four of them are located in the Upper Cass River. They are: Duff Creek – Cass River, Gerstenberger Drain South Branch – Cass River, Spring Drain South Branch – Cass River, and Stony Creek South Branch – Cass River. The fifth sub-watershed is in the Middle Cass River and is Clark Drain North Branch White Creek – Cass River. In addition there are two sub-watersheds that are more than 60 percent natural land use; they are: Scott Drain – Cass River, and White Creek – Cass River.

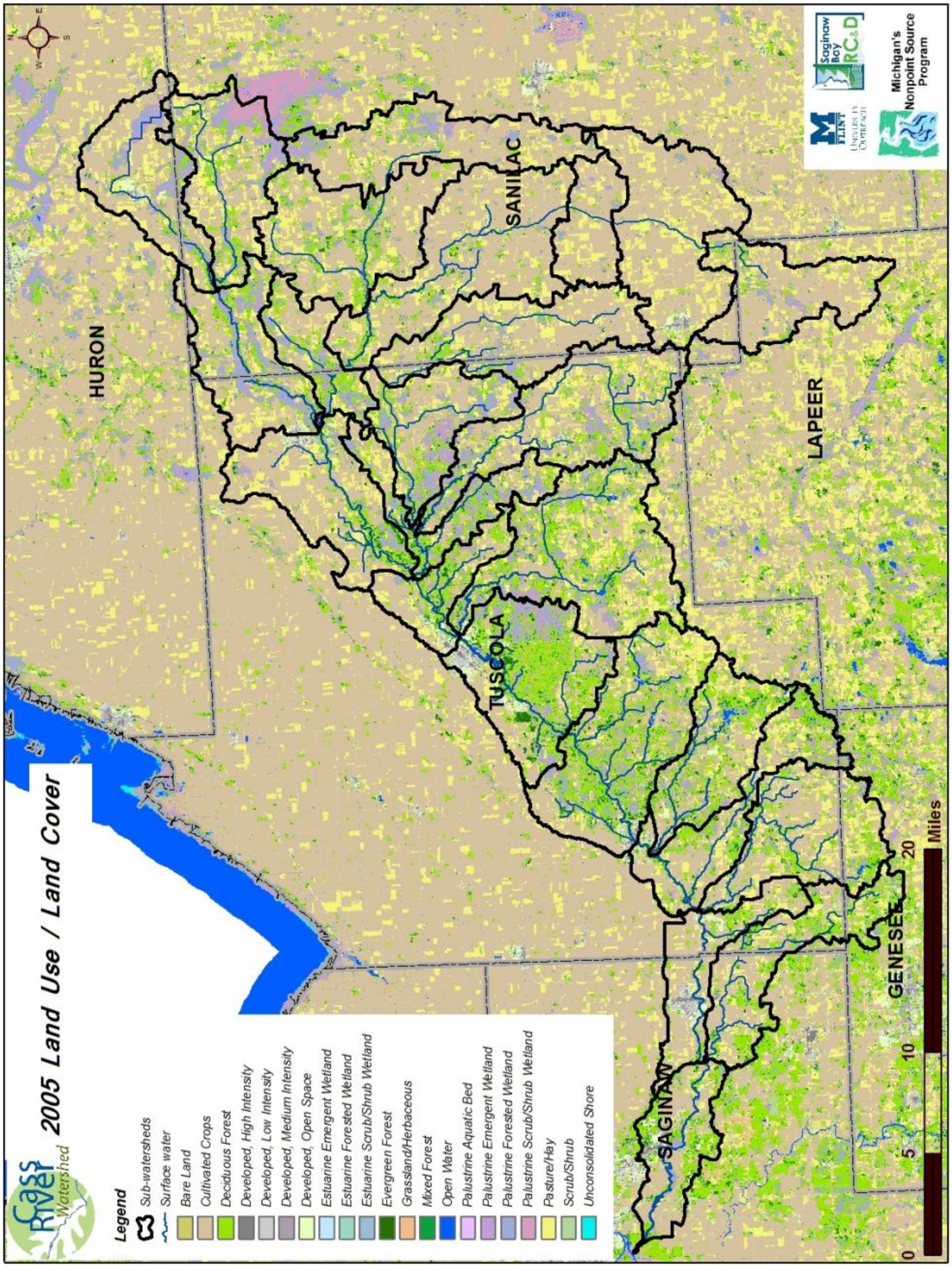
The following data tables break down the land use according to dominantly agricultural, dominantly natural, and equally distributed.

Table 2.2: Dominant Land Use by Sub-watershed

Agricultural Dominant				
Sub-Basin	HUC Code	Name	Agricultural Percent	Natural Percent
Lower	040802050306	Cass River	46	41
Lower	040802050305	Cole Creek - Cass River	66	18
Lower	040802050304	Dead Creek - Cass River	57	39
Lower	040802050303	Millington Creek - Cass River	53	43
Lower	040802050302	Perry Creek - Cass River	65	31
Middle	040802050207	Butternut Creek - Cass River	47	46
Middle	040802050205	Cedar Run White Creek - Cass River	69	26
Middle	040802050203	South Branch White Creek - Cass River	56	41
Middle	040802050201	Clark Drain North Branch White Creek - Cass River	81	18
Upper	040802050109	North Branch - Cass River	54	44
Upper	040802050108	Tyre Drain North Branch - Cass River	67	29
Upper	040802050107	South Fork - Cass River	54	45
Upper	040802050106	Stony Creek South Branch - Cass River	83	15
Upper	040802050105	Middle Branch - Cass River	72	28
Upper	040802050104	Hartel Drain Middle Branch - Cass River	73	27
Upper	040802050103	Gerstenberger Drain South Branch - Cass River	90	8
Upper	040802050102	Duff Creek - Cass River	90	5
Upper	040802050101	Spring Drain South Branch - Cass River	80	16
Natural Dominant				
Sub-Basin	HUC Code	Name	Agricultural Percent	Natural Percent
Lower	040802050301	Goodings Creek - Cass River	40	55
Middle	040802050209	Moore Drain White Creek - Cass River	37	57
Middle	040802050208	Scott Drain White Creek - Cass River	24	66
Middle	040802050206	Sucker Creek - Cass River	45	52
Middle	040802050204	White Creek - Cass River	37	63
Middle	040802050202	North Branch White Creek - Cass River	48	50

Equally Dominant				
Sub-Basin	HUC Code	Name	Agricultural Percent	Natural Percent
Upper	040802050110	South Branch - Cass River	49	49

Map 2.7: Land Use



2.6 Political Landscape

Determining the political landscape of the Cass River Watershed is an important step toward enacting a Watershed Management Plan. The political landscape of a watershed is the layers of government and governing bodies that have an influence on the water management practices, other land practices, and community involvement that occur in the watershed. Understanding and involving each layer and group in the WMP is imperative because it creates a cohesive environment in which tasks are achieved. In the Cass River Watershed the layers of government involved range from the federal and state level to counties, townships, cities, and villages. Below is a list and description of what each layer of government involved in the Cass River Watershed does.

Township/City/Village – This is the most local level of government involved in the Cass River Watershed. At this level land use planning occurs and bonds are passed. There are a total of 39 townships, three cities, and six villages.

Townships in the Cass River Watershed include: Almer, Arbela, Argyle, Austin, Bingham, Birch Run, Bridgeport, Burnside, Custer, Dayton, Denmark, Elkland, Ellington, Elmer, Elmwood, Evergreen, Forest, Frankenmuth, Flynn, Fremont, Greenleaf, James, Juniata, Kingston, Koylton, Lakefield, Lamotte, Marlette, Millington, Minden, Moore, Novesta, Paris, Thetford, Tuscola, Vassar, Watertown, Wells, Wheatland.

Cities in the Cass River Watershed include: Frankenmuth, Marlette and Vassar.

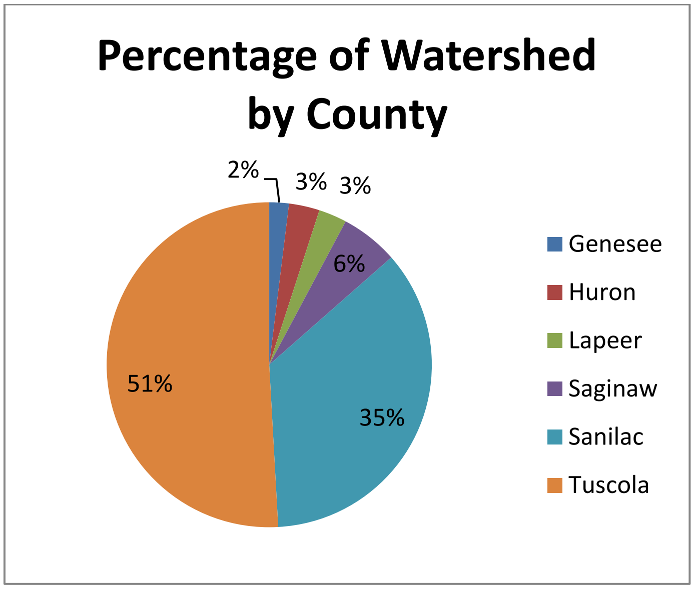
Villages in the Cass River Watershed include: Cass City, Caro, Kingston, Mayville, Millington, and Ubly.

County – The next level of government involved is the county level. At the county level there are a number of branches that need to be involved in a WMP. For our purposes we will need to involve each county's drain commissioner, heath department, road commission, and the local conservation districts.

The purpose of the drain commissioners is to monitor and manage all established drains, and to run the legal proceeding and hearings for drains, dams, dikes, levies, water and sewage projects, lake level control structures, and pumping stations. The health departments monitor bacteria levels at public swimming beaches, which are an important indicator of waters quality and is involved in determining the designated uses. They are also involved in permitting and inspection of septic systems, sewer management, and public health overall – including public education. The road commission is involved in regulating culverts and road-related ditches. They have standards in which must be met to ensure that water can pass road crossings adequately. In addition, the road commission regulates road salting and grading which can contribute to pollution problems.

Counties in the Cass River Watershed include: Genesee, Huron, Lapeer, Saginaw, Sanilac, and Tuscola. Figure 2.5 shows the percentage of the watershed in each county. By area, Tuscola and Sanilac, are the most influential counties in the watershed comprising 51% and 35% total watershed area (respectively).

Figure 2.5: Cass River Watershed Percent Area by County



Each county has a local conservation district, also known as Soil and Water Conservation Districts. These were originally Michigan state government, but now receive limited state funding. These districts work to aid residents in managing their natural resources and educate citizens about valuable conservation practices. This is important because education plays a key role in implementing a watershed management plan. Conservation Districts are typically housed in offices with federal agencies including the United States Department of Agriculture, Natural Resource Conservation Service that administer federal Farm Bill programs.

In addition to the road commissions, drain commissioners, and health departments from each county, there are national farm organizations that have local offices in each county. The Farm Service Agency, one of the farm organizations, has county level offices that monitor and regulate farm practices. A second agency, which is optional is the Farm Bureau, they encourage better management practices and aid farmers with farm plans. Both agencies have county level offices, and then grow to the state and eventually the national level.

To achieve our goals of improving water quality in the Cass River Watershed the unity and involvement of each level of government is needed. Knowing such details allows us to involve the governing bodies in the process of developing the Cass River Watershed Management Plan. This allows the different levels of government to become invested in the project and support implementation.

2.7 Designated Uses

A stream or site in the watershed is listed as impaired if it is failing to meet one or several designated uses as defined by the State of Michigan. Designated uses include:

- **Agriculture** – Irrigation water for crops or water for livestock
- **Public Water Supply** – Surface water for drinking water at a designated point of intake (not to confuse with well water and aquifers)
- **Wildlife and Other Indigenous Aquatic Life** –Aquatic life and wildlife can thrive and reproduce. (Comment: Minimum Flows and levels should be maintained in order to sustain environmental conditions and wildlife throughout the year. (Water balance)
- **Total and Partial Body Contact** – Recreational (swimming, fishing, boating) all waters protected for recreation shall not exceed specific levels of E.coli from May to October.
- **Navigation** – Water is navigable by watercraft remaining free of obstructions and pollutants that may impede boat function
- **Warm Water Fishery** – Water supports warm water fish species including reproduction and sustainability,
- **Industrial** – Water is usable by industry and able to pass through intakes
- **Cold Water Fishery** - Water supports cold water fish species reproduction that can thrive and reproduce

Designated use impairments are discussed for each sub-basin (upper, middle, lower) in chapters 7, 8, and 9 respectively.