

Chapter 2 – Watershed Characteristics



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2.0 WATERSHED CHARACTERISTICS

OBJECTIVES

- What are the features of the surrounding landscape?
- What effect does hydrology and soil type have on the Watershed?
- What natural resources does the Watershed provide?
- How is land within the Watershed being used?

2.1 CULTURAL HISTORY

The Lower Grand River Watershed (LGRW or Watershed), home to the mound-building Hopewell Indian Tribe and later to the European settlers, is a region rich in cultural history and natural resources. Native Americans and European settlers alike depended on the Grand River for food, transportation, and recreation. In 1826, a trading post was established along the Grand River by a French trader named Louis Campau. The easiest way of communicating during this time was through the Grand River; chiefly by the use of Indian canoes.

Steamboats traversed the Grand River from Grand Haven all the way to Lyons from the 1830s to the 1870s. *The Grand River Times* described the Grand River in 1837 as “one of the most important and delightful (rivers) to be found in the country” with “clear, silver-like water winding its way through a romantic valley.”

Industrialization in the nineteenth century impacted the Grand River greatly. In 1889, Everette Fitch described the damaging effects on the Grand River. She wrote, “The channel was, as usual, covered with a green odiferous scum, mixed with oil from the gas works.” The Grand River was greatly abused by water-powered, river-dependant industries; large increases in population; stripping of the forests; and discharges of chemical and sewage wastes.

By the mid 1960s, the Grand River needed a massive cleanup effort. The Michigan Grand River Watershed Council, authorized by Governor Romney in 1966, spearheaded most of the river cleanup efforts. The council studied navigation, flood prevention, fish and wildlife, recreation, and water quality. Using funds from the 1968 Clean Water Bond, many municipal wastewater treatment plants were able to upgrade technologies, and volunteers had supplies they needed to clean up trash and debris and plant trees along the river’s banks.

By the end of the 1960s, water quality had improved to the point that recreationists were once again looking to the Grand River for waterskiing, boating, fishing, and swimming opportunities.

An ambitious project called the Grand River Salmon Plan began in 1977, and brought salmon and other sport fish all the way to the state capitol by constructing a series of fish ladders over the six dams that obstructed fish passage upstream of Grand Rapids.

In the 1990s, the City of Grand Rapids began a massive undertaking of removing combined sewers. The combined sewers delivered both sanitary and storm water to the City of Grand Rapids’ Wastewater



Treatment Plant. During periods of heavy rainfall, the sewers would overflow into the Grand River. Occasionally, this would result in bacteria counts that warranted beach closures downstream. Over the last 5 years, the City of Grand Rapids has removed 95% of the combined sewer overflows. Similar projects are taking place upstream in the Cities of Lansing and Jackson.

2.2 GEOGRAPHIC SCOPE AND BOUNDARIES

The LGRW encompasses 1,861,468 acres (2,909 square miles) and encompasses large portions of Ottawa, Muskegon, Kent, Montcalm, Ionia, Barry, and Eaton Counties. Counties with very small portions in the Watershed include: Newaygo, Allegan, and Mecosta Counties as shown in Figure 2.1. The Lower Grand River (LGR) is located in central Michigan and originates below the Looking Glass River confluence, near the City of Portland, flowing northwest to its convergence with Lake Michigan. The main branch of the LGR is 51 miles long, and the major tributaries flow for a total of 209 miles. In addition to the many subwatersheds with direct drainage to the Grand River, the Watershed includes three major subwatersheds: Thornapple River Watershed, Flat River Watershed, and Rogue River Watershed. These major subwatersheds include 31 smaller Subwatershed management units. The major subwatersheds and the 31 Subwatershed management units are shown in Figure 2.2 and their areas are provided in Tables 2.1a and 2.1b. Watershed boundary data was from Michigan Center for Geographic Information (MCGI) framework Watershed boundaries. The MCGI framework Watershed boundaries were combined to define a more recognizable local creek or river system, defining larger units so that data could be summarized at that geographic level instead of to over 100 tiny subwatersheds (original number of subwatersheds in LGRW using MCGI data). The Watershed contains two urban areas: the Grand Rapids Metropolitan area and the Muskegon Metropolitan area, which includes the Grand Haven, Tri-cities areas.

Table 2.1a – Subwatershed Management Units in Major Subwatersheds

(Source: GVSU, AWRI, 2008 for use in LLWFA)

Major Subwatershed: Thornapple River

Subwatershed Management Unit	Acres
Cedar Creek	29,624
Coldwater River	120,739
Fall Creek	15,870
Glass Creek	23,511
High Bank Creek	21,810
Lower Thornapple River	126,293
Mud Creek	38,600
Upper Thornapple River	166,535
Total:	542,982

Major Subwatershed: Flat River

Subwatershed Management Unit	Acres
Coopers, Clear, and Black Creeks	65,401
Dickerson Creek	48,388
Lower Flat River	78,873
Upper Flat River	138,115
Wabasis and Beaver Dam Creek	30,124
Total:	360,901

Major Subwatershed: Lower Grand River

Subwatershed Management Unit	Acres
Bass River	32,020
Bear Creek	20,332
Bellemy Creek	20,648
Buck Creek	32,392
Crockery Creek	102,318
Deer Creek	22,374
Direct Drainage to Lower Grand River	275,237
Indian Mill Creek	10,979
Lake Creek	18,172
Libhart Creek	35,176
Mill Creek	12,955
Plaster Creek	36,448
Prairie Creek	65,534
Rush Creek	38,041
Sand Creek	35,085
Spring Lake/Norris Creek	32,383
Total:	790,094

Major Subwatershed: Rogue River

Subwatershed Management Unit	Acres
Lower Rogue River	93,534
Upper Rogue River	73,988
Total:	167,522

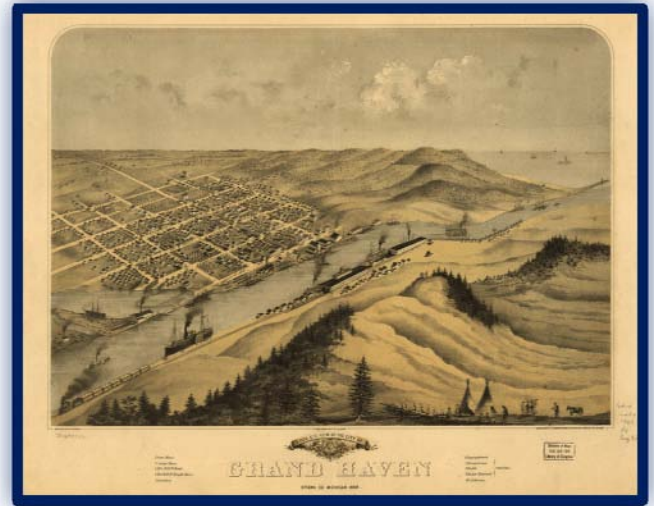
Table 2.1b – Acreages of Subwatershed Management Units*(Source: GVSU-AWRI, 2008 for use in LLWFA)*

ID	Subwatershed Management Units	Acres	Square Miles
1	Bass River	32,020	50
2	Bear Creek	20,332	32
3	Bellemy Creek	20,648	32
4	Buck Creek	32,392	51
5	Cedar Creek	29,624	46
6	Coldwater River	120,739	189
7	Coopers, Clear, and Black Creeks	65,401	102
8	Crockery Creek	102,318	160
9	Deer Creek	22,374	35
10	Dickerson Creek	48,388	76
11	Direct Drainage to Lower Grand River	275,237	430
12	Fall Creek	15,870	25
13	Glass Creek	23,511	37
14	High Bank Creek	21,810	34
15	Indian Mill Creek	10,979	17
16	Lake Creek	18,172	28
17	Libhart Creek	35,176	55
18	Lower Flat River	78,873	123
19	Lower Rogue River	93,534	146
20	Lower Thornapple River	126,293	197
21	Mill Creek	12,955	20
22	Mud Creek	38,600	60
23	Plaster Creek	36,448	57
24	Prairie Creek	65,534	102
25	Rush Creek	38,041	59
26	Sand Creek	35,085	55
27	Spring Lake / Norris Creek	32,383	51
28	Upper Flat River	138,115	216
29	Upper Rogue River	73,988	116
30	Upper Thornapple River	166,535	260
31	Wabasis and Beaver Dam Creek	30,124	47
	Total:	1,861,499	2,908

2.3 GEOLOGY AND TOPOGRAPHY

The bedrock formations of the Watershed consist primarily of shale, sandstone, limestone, and gypsum. These formations formed from sediments that were deposited from 345 to 370 million years ago, in seas which occupied a depression known as the Michigan basin. Another sea occupied central Michigan from 135 to 181 million years ago and deposited red muds, gypsum, and fine sands. A remnant of this formation occurs in the central part of the Watershed. The Pleistocene epoch began about 1 million years ago. At least four major glaciers advanced and retreated over Michigan during the Pleistocene epoch. As the last glacier retreated, the load of earthen materials incorporated in the ice was deposited, forming several types of glacial features (till plains, moraines, outwash, lake plains, and spillways). The thickness of the glacial drift overlying bedrock varies from 0 feet (in western Kent County) to more than 500 feet (at the northern end of the basin).

The topography within the LGRW (Figure 2.3) is influenced by glacial deposition of sediment and the effect of water deposition and drainage over time. Watershed topography is undulating and dissected by water courses with occasional small plains studded with bogs and small lakes. The elevations in the Watershed range from 780 feet, at the most eastern edge of the Watershed, to 571 feet at its confluence with Lake Michigan at the City of Grand Haven.



The LGR sub-basin ranges from fairly rugged topography in the entrenched main stream of the Grand River (in the Grand Rapids area) to a low, flat plains area along the lower reaches of the river toward Grand Haven. Many of the tributary streams in this area flow through steep, walled valleys where they join the entrenched valley of the Grand River. The streams are commonly 20 or more feet below the surrounding uplands (Grand River Basin Coordinating Committee, 1972).

2.4 SOILS

The debris deposited by the glaciers forms the parent material for the soils throughout the Watershed. The almost infinite variety of combinations of mineral materials located in many conditions of topography and climate have resulted in a great number of soil types of varying fertility. Sandy and loamy soils are common throughout the basin.

Hydrologic Soil Groups

Hydrologic soil groups are a classification system that describes the soil's storm water runoff-producing characteristics. The chief characteristic is the inherent capacity of soil to permit infiltration when bare of vegetation. Figure 2.4 illustrates the hydrologic soils groups within the Watershed. A description of the hydrologic soils groups is found in Table 2.2; and the total acres and percent of area represented for each hydrologic soil group in the Watershed are shown in Table 2.3.

Table 2.2 – Hydrologic Soil Groups

(Source: SCS Soil Survey)

Hydrologic Soil Group	Definition
A	High Infiltration (low runoff potential, high rate of water transmission, well drained to excessively drained sands or gravely sands)
B	Medium Infiltration (moderate rate of water transmission, moderately well to well drained, moderately fine to medium coarse texture)
C	Low Infiltration (slow rate of water transmission, has layer that impedes downward movement of water, moderately fine to fine texture)
D	Very Low Infiltration (high runoff potential, very slow rate of water transmission, clays with high shrink/swell potential, permanent high water table, clay pan or clay layer at or near surface, shallow over nearly impervious material)

Table 2.3 – Acreages of Hydrology Soils Groups*(Source: SSURGO soils, USDA NRCS. Obtained from the NRCS Data Gateway)*

Subwatershed Management Unit	Hydrologic Soil Group Area (%)							Total Acres
	A	A/D	B	B/D	C	C/D	D	
Bass River	26%	14%	10%	9%	31%	0%	9%	32,020
Bear Creek	42%	10%	37%	5%	3%	0%	1%	20,332
Bellemy Creek	5%	7%	47%	11%	26%	0%	3%	20,648
Buck Creek	20%	7%	23%	4%	19%	0%	0%	32,392
Cedar Creek	40%	10%	22%	7%	13%	0%	4%	29,623
Coldwater River	8%	7%	40%	18%	24%	0%	1%	120,737
Coopers, Clear, and Black Creeks	31%	13%	39%	9%	2%	0%	3%	65,400
Crockery Creek	19%	11%	19%	13%	24%	3%	10%	102,316
Deer Creek	12%	2%	22%	12%	12%	1%	39%	22,374
Dickerson Creek	37%	22%	32%	4%	2%	0%	0%	48,387
Direct Drainage to Lower Grand River	21%	4%	33%	10%	14%	1%	2%	275,232
Fall Creek	45%	6%	19%	5%	11%	0%	6%	15,870
Glass Creek	53%	11%	21%	2%	5%	0%	4%	23,511
High Bank Creek	32%	9%	18%	15%	19%	0%	3%	21,809
Indian Mill Creek	13%	3%	42%	6%	14%	0%	0%	10,979
Lake Creek	8%	8%	58%	15%	8%	0%	0%	18,172
Libhart Creek	2%	5%	37%	39%	15%	1%	0%	35,175
Lower Flat River	23%	9%	50%	6%	6%	0%	1%	78,872
Lower Rogue River	32%	8%	41%	5%	8%	0%	1%	93,532
Lower Thornapple River	34%	6%	28%	7%	19%	1%	1%	126,290
Mill Creek	20%	4%	36%	6%	26%	1%	6%	12,955
Mud Creek	5%	6%	23%	23%	43%	0%	0%	38,600
Plaster Creek	6%	2%	4%	4%	45%	4%	0%	36,447
Prairie Creek	11%	13%	34%	9%	26%	1%	4%	65,533
Rush Creek	19%	6%	25%	11%	29%	1%	5%	38,040
Sand Creek	10%	5%	19%	14%	23%	2%	26%	35,084
Spring Lake / Norris Creek	32%	20%	22%	0%	11%	3%	3%	32,383
Upper Flat River	38%	13%	38%	6%	0%	0%	0%	138,113
Upper Rogue River	34%	18%	31%	8%	7%	0%	1%	73,987
Upper Thornapple River	4%	5%	45%	18%	26%	0%	0%	166,532
Wabasis and Beaver Dam Creek	32%	12%	46%	3%	2%	0%	1%	30,123
Total:								1,861,468
Percent in LGRW	22	9	33	10	16	1	3	

Hydric soil is soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soil is an indicator of the current or historic presence of wetlands. Many wetlands are protected under federal, state, and local regulations.

Hydric soil is often high in organic matter, making it nutrient-rich and productive when drained for agricultural purposes. This explains why, historically, so many wetlands were drained in Michigan. Due to its naturally high water table, hydric soil is generally poorly suited for development, especially for septic fields. Such soils are, therefore, potential locations for successful wetland restoration projects.

Figure 2.5 indicates the location of hydric soil within the Watershed, as indicated in Soil Survey of Ottawa, Muskegon, Kent, Montcalm, Ionia, Barry, and Eaton Counties, Michigan.

Soils Relationship to Development

Development often occurs in soils which are highly permeable, and therefore reduces overall permeability on an urbanizing landscape. This can generate more runoff and impact hydrology and water quality. Low Impact Development (LID) is rapidly becoming the mainstream technique for storm water management. The purpose of LID is to mimic nature by managing rainfall using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source. Many LID techniques rely on infiltrating storm water and runoff; therefore, it is important to consider soil properties, as well as geology, when implementing LID (Southeast Michigan Council of Governments [SEMCOG], 2008). LID is an extremely beneficial management technique for treating storm water in urbanizing areas of the Watershed.

Soils Relationship to Prime Farmland

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) defines prime farmland as land with the best combination of physical and chemical characteristics for producing crops. This land must be available for agricultural use in order to receive a prime farmland designation. Prime farmland has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner, if it is treated and managed according to acceptable farming practices. Prime farmland soils may include those that are productive if artificially drained or managed to prevent flooding. Approximately 74% of the land in the Watershed is considered to be prime farmland, under this definition; but the placement of the farms and resulting impact from those farms has increased the potential for Nonpoint Source (NPS) pollution in the Watershed.

Soils Relationship to Erosion

The rate storm water infiltrates through soil has important implications with regard to storm water management. When infiltration occurs slowly, precipitation tends to flow over the ground surface during intense rain events and quickly enter storm sewers, ditches, creeks, and other water bodies. Water flows with higher energy, resulting in erosion, flooding, and impaired water quality.



There are three types of waterborne erosion: sheet, rill, and gully. Sheet erosion occurs when rainfall hits the ground and runs across its surface in a large sheet, picking up loose soil particles. Little to none of the water infiltrates. Rill erosion occurs when precipitation cuts small drainage pathways into the surface of the land, giving the precipitation little time to infiltrate. Gully erosion occurs when rills become much larger and deeper. Rills can be easily obliterated by normal tillage practices, whereas gullies cannot. Soil erosion susceptibility is greatest for loose soils on steep slopes. This Watershed has many soils that are susceptible to all three types of erosion.

2.5 HYDROLOGY

The LGR flows 260 miles and drains 2,909 square miles. The Watershed is characterized by poor natural drainage, resulting in numerous lakes, swamps, and artificial drains as shown in Figure 2.6.

The LGR includes three major tributaries that flow into the Grand River: the Thornapple River, the Flat River, and the Rogue River. The Thornapple River flows 78 miles northward and drains 848 square miles. It enters the Grand River between the Cities of Lowell and Grand Rapids. The Flat River is 70 miles long and drains 564 square miles in the northeast portion of the Watershed, entering the Grand River after passing through the City of Lowell. The Rogue River is 50 miles long and drains 262 square miles in the northwest portion of the Watershed, entering the Grand River north of the City of Grand Rapids (Grand River Basin Coordinating Committee, 1972).

Steamboat operators and log driving companies dredged the river and constructed pilings for log sorting pens in the 1800s. The Army Corps of Engineers constructed numerous wing dams, river training walls, and other navigation channel structures in the late 1800s and early 1900s. The City of Grand Rapids built major floodwalls before World War I and obtained Works Progress Administration (WPA) funds to work on flood protection and river beautification during the 1930s. In addition, significant sections of the Grand River bed and adjacent floodplain have been filled within the City of Grand Rapids.

An extensive system of county drains is located throughout the LGRW. Agricultural drains hasten storm water drainage from cultivated fields and other areas, reducing the frequency of flooding in these areas. However, rapidly flowing water is more likely to erode streambeds and carry sediment to the Grand River and its adjacent floodplain. Fields drained with tiles also create a hazard for surface water contamination from pesticides, fertilizer, and *E. coli*.

Precipitation and Climate

The LGRW enjoys a moderate continental climate and annually experiences 155 frost-free growing days. Air masses originate from the Gulf of Mexico, northern Canada, and the north Pacific. The presence of Lake Michigan has a slight moderating effect on annual temperatures and results in increased snowfall along the coast. Mean January temperature in the LGRW is approximately 23°F; the mean July temperature is approximately 71°F. The average rainfall throughout the LGRW is approximately 32 inches. Annual snowfall ranges from 80 inches along Lake Michigan to 40 inches along the eastern edge of the Watershed (Bieneman, 1999).

Surface Water

The Watershed has an extensive network of streams, creeks, constructed drainageways, and inland lakes as shown in Appendix 2.1. The named streams and tributaries for each Subwatershed Management Unit are listed in Tables 2.4 through 2.7.

LGRW Direct Drainage

The 2005 Report by Rockafellow (MI/DEQ/WB-05/097) indicated that the physical habitat and macroinvertebrate community of the LGR main stem were not evaluated due to the size and depth of the Grand River in the lower reaches. However, several water samples were collected and analyzed for multiple parameters to aid in the development of water quality-based effluent limits (WQBELs) for facilities that discharge to the LGR. No exceedances of the Michigan Water Quality Standards were documented during this survey of the LGR.

A qualitative macroinvertebrate sampling study was completed for sites in the Lower Grand River in 2009. Out of 35 stations sampled, only the North Branch of Crockery Creek was rated poor. All others were ranked acceptable; with the exception of Prairie Creek, which earned an excellent rating at one location.



More information can be found at the following website once the report is available:
http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-54941--,00.html

Table 2.4 – Streams in the Lower Grand River Watershed Direct Drainage (Not Found in Any Other Major Subwatershed)

Subwatershed Management Unit	Stream Name
Bass River	Bass Creek, Bass River, Bear Creek, Grand River, Little Bass Creek, Unnamed Tributaries
Bear Creek	Armstrong Creek, Bear Creek, Stout Creek, Unnamed Tributaries, Waddell Creek
Bellemy Creek	Bellamy Creek, Spring Brook, Unnamed Tributaries
Buck Creek	Buck Creek, Pine Hill Creek, Sharps Creek, Unnamed Tributaries
Crockery Creek	BR J Smith Drain, Brandy Creek, Canada Drain, Crockery Creek, Indian Run, Lawrence Drain, North Branch Crockery Creek, Rio Grande Creek, Sanford Drain, Smith Drain, Unnamed Tributaries
Deer Creek	Deer Creek, Grand River, Unnamed Tributaries
Direct Drainage to Lower Grand River	Bellamy Creek, Black Creek, Bruce Bayou, Buck Creek, Crooked Creek, De Young Swamp, Dermo Bayou, Egypt Creek, Flat River, Floodway, Goose Creek, Grand River, Grand River Basin, Honey Creek, Indian Channel, John Ball Lake, Lamberton Creek, Lee Creek, Libhart Creek, Lloyd Bayou, Millhouse Bayou, Ottawa Creek, Peacock Creek, Pine Creek, Pottawattomie Bayou, Red Creek, Scotch Creek, Scott Creek, Sessions Creek, Stearns Bayou, Sunny Creek, Tibbets Creek, Timberlin Creek, Toles Creek, Unnamed Tributaries
Indian Mill Creek	Brandy Wine Creek, Grand River, Indian Creek, Indian Mill Creek, Unnamed Tributaries
Lake Creek	Lake Creek, Little Creek, Unnamed Tributaries
Libhart Creek	Libhart Creek, Little Libhart Creek, Taylor Creek, Unnamed Tributaries, West Branch Knoll and Kneale Drain
Mill Creek	Grand River, Mill Creek, Strawberry Creek, Unnamed Tributaries
Plaster Creek	Little Plaster Creek, Plaster Creek, Unnamed Tributaries, Whisky Creek
Prairie Creek	Bacon Creek, Grand River, Prairie Creek, Unnamed Tributaries
Rush Creek	Dora Byron Drain, East Branch Creek, East Branch Rush Creek, Grand River, Rush Creek, Unnamed Tributaries
Sand Creek	Alpine Drain, Inter County Drain, Sand Creek, Unnamed Tributaries
Spring Lake/Norris Creek	Norris Creek, Rhymer Creek, Stevens Creek, Unnamed Tributaries, Vincent Creek, Willow Hill Creek

Thornapple River Subwatershed

The Thornapple River Subwatershed is the largest tributary to the LGR. The Thornapple River flows 78 miles from its headwaters in Eaton Rapids Township to its confluence with the Grand River near the Village of Ada. Some portions of the Thornapple River have been channelized or dredged, resulting in a loss of habitat for sport fish. However, several tributaries including Quaker Brook, Coldwater River, and High Bank Creek are cold water streams.

The Thornapple River is moderately impaired by agricultural runoff, channel modification, and to some degree, wastewater treatment plant discharges. While these impairments are evident, the overall habitat and water quality has been rated as “good” by the Michigan Department of Natural Resources and Environment (MDNRE). Priority concerns resulting from these impairments are groundwater and fisheries habitat protection. Tributaries and the main channel itself are recovering from historic dredging activities and are providing excellent substrate for macroinvertebrates and fish spawning. Many of these tributaries, with continued improvements, will provide valuable opportunities for fishing and wildlife viewing.

Table 2.5 – Streams in Thornapple River Subwatershed

Subwatershed Management Unit	Stream Name
Cedar Creek	Cedar Creek, Kellie Creek, North Branch Cedar Creek, Unnamed Tributaries
Coldwater River	Bear Creek, Burd Drain, Coldwater River, Duck/Black Creek, Kilgus Branch, Kilgus Branch Stream, Little Thornapple River, Messer Brook, Peddler Lake Drain, Pratt Lake Creek, Tupper Creek, Tyler/Bear Creek, Unnamed Tributaries, Woodland Creek
Fall Creek	Fall Creek, Unnamed Tributaries
Glass Creek	Glass Creek, Unnamed Tributaries
High Bank Creek	High Bank Creek, Mud Creek, Unnamed Tributaries
Lower Thornapple River	Bassett Creek, Butler Creek, Duncan Creek, Glass Creek, Grand River, High Bank Creek, Hill Creek, Thornapple River, Turner Creek, Unnamed Tributaries
Mud Creek	Doolin Drain, Hagar Creek, Mud Creek, Unnamed Tributaries
Upper Thornapple River	Allen and Crane Drain, Baker Drain, Bundige and Wilcox Drain, Burkhead Drain, Butternut Creek, Carmen Drain, Church Drain, Cole Wright Helms Drain, Darken and Boyer Drain, Densmore Perkins Fish Creek Drain, Fast and Bodell Drain, Garvey Drain, Gruesbeck Drain, Haner Creek, Hayon Creek, King Drain, Lacey Creek, Little Thornapple River, Milbourn and Garvey Drain, Morfey Brook, Munton Drain, Palmiter and Phelps Drain, Quaker Brook, Scipio Creek, Shanty Brook, Sharp Drain, Thornapple and Old Maid Drain, Thornapple Drain, Thornapple River, Thornapple-ext Drain, Unnamed Tributaries

Flat River Subwatershed

The Flat River Subwatershed flows 70 miles from the southeast corner of Mecosta County, in the Six Lakes area, through Montcalm and Ionia Counties and enters the Grand River in the City of Lowell, in eastern Kent County. Fifty percent of the Flat River Subwatershed is used for agriculture. The Flat River is described as the most scenic river in the southern Lower Peninsula. The Flat River Subwatershed is an excellent small-mouth bass fishery. The MDNRE designated the Flat River as a Natural River under the Natural Rivers Act of 1970.

The townships along the Flat River decided that local interests would be able to provide the most protection for the Flat River and its scenic values. Six of the nine townships along the segments of the Flat River that were designated Natural River areas adopted ordinances which include a zoning overlay zone that controls how development can impact the Flat River's water quality, habitat, and scenic views. The other three townships are using the Natural River Plan that was drafted by the MDNRE to help protect the Flat River.

The Flat River offers a number of opportunities for public recreation. Along the Flat River's 70 miles of scenic natural beauty, visitors can find many acres of naturally vegetated wetlands and hardwood forests. There are five dams that must be portaged between the Six Lakes area and the mouth of the Flat River in the City of Lowell. Along the way, canoeists will see two of Michigan's four remaining wood covered bridges. Approximately 7% of the shoreline along the Flat River is owned by the MDNRE as State Game Areas.

Table 2.6 – Streams in Flat River Subwatershed

Subwatershed Management Unit	Stream Name
Coopers, Clear, and Black Creeks	Black Creek, Butternut Creek, Clear Creek, Coopers Creek, Unnamed Tributaries
Dickerson Creek	Dickerson Creek, Unnamed Tributaries
Upper Flat River	Flat River, Page Creek, Power Canal, Seely Creek, Toles Creek, Unnamed Tributaries, Flat River, Stony Creek, Townline Creek, Unnamed Tributaries, Wabasis Creek
Lower Flat River	Dickerson Creek, Flat River, Page Creek, Power Canal, Seely Creek, Toles Creek, Unnamed Tributaries
Wabasis and Beaver Dam Creek	Beaver Dam Creek, Unnamed Tributaries, Wabasis Creek, Wabasis Road

Rogue River Subwatershed

The Rogue River Subwatershed is located mostly in Kent and Newaygo Counties. At one time it received discharges from agriculture, landfills, and industry that turned the Rogue River into a virtually fishless habitat. Today, these discharges have been largely controlled, and the Rogue River has since returned to a top-class trout stream.

Water quality in the Rogue River is partially protected under the Natural Rivers Act of 1970. Approximately half of the Rogue River Subwatershed's 180 miles of streams are designated as a Natural River. This designation creates an overlay district around the designated stream segments where development must preserve water quality, wildlife and aquatic life habitat, and scenic views.

Prior to settlement, the Rogue River Subwatershed was mostly covered in white pine forests. Today, the majority of the Rogue River Subwatershed is used for agricultural purposes. The lower portion of the Rogue River Subwatershed is mostly residential and urban. Residential development is the fastest expanding land use and threatens water quality with NPS pollution.

The majority of flow in the Rogue River comes from groundwater sources. This characteristic is what accounts for the cool/coldwater fisheries.

Table 2.7 – Streams in Rogue River Subwatershed

Subwatershed Management Unit	Stream Name
Lower Rogue River	Ball Creek, Barkley Creek, Becker Creek, Cedar Creek, Duke Creek, Grand River, Little Cedar Creek, Nash Creek, Rogue River, Rum Creek, Shaw Creek, Stegman Creek, Unnamed Tributaries
Upper Rogue River	Barber Creek, Duke Creek, Forest Creek, Frost Creek, Geers Drain, Hickory Creek, Hillbrand Drain, Lockwood Drain, Post Creek, Ransom Creek, Rogue River, Spring Creek, Unnamed Tributaries, Walter Creek, White Creek

High Flows

The MDNRE Land and Water Management Division estimated the flooding frequency discharges for the Grand River at locations indicated in Table 2.8. The discharge, measured in cubic feet per second (cfs) are the predictions of the chance of storm events to occur within a certain number of years.

Table 2.8 – Flow Rates by Storm Event Predictions for the LGR*(Source: MDNRE, Land and Water Management Division)*

County	Location	Date of Measurement	Drainage Area (mi ²)	Discharge Frequencies (% chance)	Flow Rate (cfs)
Ionia	I-96	11/05/2001	1,401.11	10-year (10%)	12,000
				50-year (2%)	19,000
				100-year (1%)	22,000
Ionia	Lyons Dam	2/27/2008	1,752.89	10-year (10%)	15,000
				50-year (2%)	23,000
				100-year (1%)	37,000
Kent	At Islands (Lowell)	2/19/2002	3,620.00	10-year (10%)	25,000
				50-year (2%)	37,000
				100-year (1%)	42,000
Kent	3,700 feet upstream of M-44	11/02/2001	4,550.41	10-year (10%)	31,000
				50-year (2%)	45,000
				100-year (1%)	51,000
Ottawa	Upstream of Crockery Creek	8/15/2000	5,296.42	10-year (10%)	35,000
				50-year (2%)	52,000
				100-year (1%)	59,000
Ottawa	US-31	10/30/2002	5,570.00	10-year (10%)	37,000
				50-year (2%)	53,000
				100-year (1%)	61,000

mi² square miles

cfs cubic feet per second

Information for Table 2.8 was extracted from the MDNRE Flood Flow Discharge Database found at <http://www.deq.state.mi.us/flow/> on February 11, 2010.

Increased drainage in certain areas can result in excessive flows in receiving streams. This excessive flow can be exhibited by higher peak flows, longer peak flow periods, or both. The results of these excess flows are increased streambank erosion, increased streambed scouring, sediment re-suspension, habitat destruction, and decreased diversity and number of fish and aquatic organisms.

Relative to those that maintain a steadier flow, streams that rise and fall quickly during a storm are considered flashy. Streams become flashy when there is an increase in runoff from the surface which enters the streams, such is the case where increased impervious area in a Watershed creates increased surface runoff to the streams. Based on the study completed by the MDNRE (Fongers, 2008) on the flashiness index of the LGR and its tributaries, it appears that the flashiness index for the Red Cedar River and the Thornapple River is increasing over time, at the locations near the gage station in East Lansing (gage data from 2004) and near Caledonia (gage data from 1994), Michigan, respectively. An increase in flashiness, often due to changing land use, is a common cause of stream channel instability and channel erosion. The MDNRE study indicated that large-scale solutions, for example, regional storm water management practices or LID retrofits, may be needed to help reduce the flashiness and stabilize the river flows.

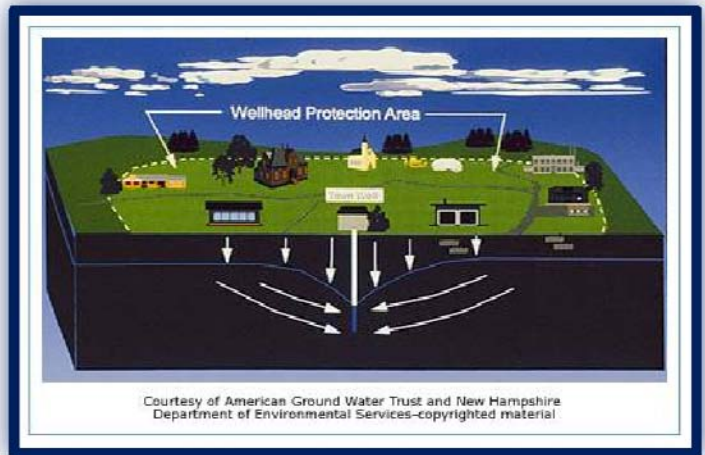
Groundwater (Recharge Areas) and Wellhead Protection

Groundwater is a crucial part of the Watershed. While this project deals mostly with surface water and the problems associated with NPS pollution, groundwater and surface water are intimately connected, and will have great influence on each other. Groundwater and surface water interact in areas known as recharge or discharge zones. The LGR has both recharge and discharge areas. Groundwater recharge areas are critical to protecting drinking water sources and maintaining high quality streams.

In areas where groundwater is used as the municipal drinking water supply, a critical area that contributes water to the municipal water supply well is called a wellhead protection area. Wellhead protection plans involve activities and management practices for protecting public groundwater supply systems from contamination, which limits the types and feasibility of infiltration practices. Table 2.9 identifies the municipalities within the Watershed having designated wellhead protection areas to protect groundwater recharge areas. These areas are illustrated in Figure 2.7.

Dams

Dams have potential to drastically affect the ecological and physical conditions of riverine systems. The physical characteristics of rivers downstream of a dam are often substantially different from physical characteristics of the rivers upstream of a dam where they enter an impoundment. Normal high and low water conditions within the riverine system are normally altered by dams, resulting in changes in stream channel, fisheries, and other aquatic habitats. In addition, dams limit the normal movement of fish and other aquatic organisms along a river's length.



Significant alterations have been made to the Grand River and its tributaries since the 1800s. The first dam built across the Grand River, in Grand Rapids, was completed in 1849 and rebuilt in 1866. Today, approximately 129 dams or impoundments are located in the Grand River Watershed to control water levels and/or to generate power (GLIN, 2008). The dams are noted on Figure 2.8. A complete list of dams and their locations can be found in Appendix 2.1. The Sixth Street dam, in downtown Grand Rapids, was constructed in 1910 to control water levels. A pool-and-weir type fishway (the "fish ladder") was constructed adjacent to the dam in 1975 to allow salmon to migrate upstream (Huggler, 1990). More "fish ladders" followed at the Lyons, Webber, Portland, Grand Ledge, and North Lansing dams. This project, called the Grand River Salmon Plan, allowed unrestricted fish passage from Lake Michigan to the City of Lansing.

Table 2.9 – Wellhead Protection Areas

(Source: MDEQ, <http://gwwmap.rsgis.msu.edu/>)

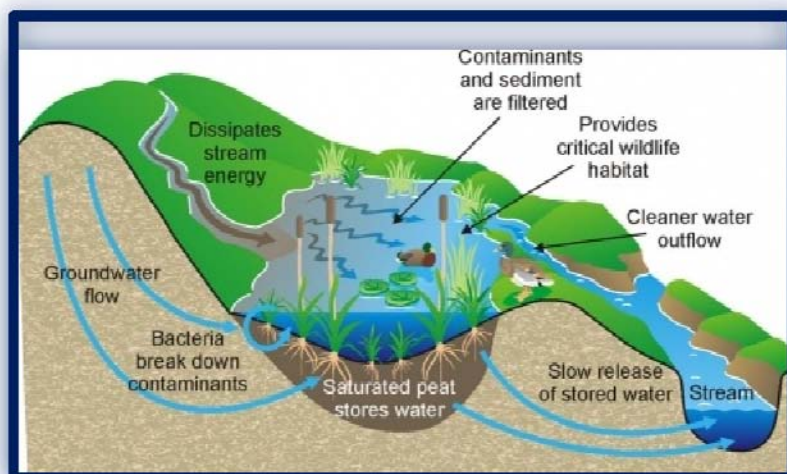
Community	County	Type
Hastings Township	Barry	Source Water Protection Area
Thornapple Township	Barry	Wellhead Protection Area
Irving Township	Barry	Wellhead Protection Area
Vermontville Township	Eaton	Wellhead Protection Area
Castleton Township	Eaton	Wellhead Protection Area
Oneida Township	Eaton	Wellhead Protection Area
Lyons Township	Ionia	Source Water Protection Area
Boston Township	Ionia	Wellhead Protection Area
Odessa Township	Ionia	Wellhead Protection Area
Orange Township	Ionia	Wellhead Protection Area
Ronald Township	Ionia	Wellhead Protection Area
Lyons Township	Ionia	Source Water Protection Area
Portland	Ionia	Wellhead Protection Area
Rockford	Kent	Wellhead Protection Area
Plainfield Township	Kent	Wellhead Protection Area
Sparta Township	Kent	Wellhead Protection Area
Cannon Township	Kent	Wellhead Protection Area
Cedar Springs	Kent	Wellhead Protection Area
Grattan Township	Kent	Wellhead Protection Area
Vergennes Township	Kent	Wellhead Protection Area
Greenville	Montcalm	Wellhead Protection Area
Home Township	Montcalm	Wellhead Protection Area
Home Township	Montcalm	Source Water Protection Area
Otisco Township	Montcalm	Wellhead Protection Area
Ravenna Township	Muskegon	Source Water Protection Area
Grant Township	Newaygo	Wellhead Protection Area

Note: Wellhead protection areas listed are either partially or entirely located in the Lower Grand River Watershed.

2.6 NATURAL RESOURCES

Wetlands

Wetlands are a critical component to Watershed health, as they improve water quality by trapping pollutants and serving as natural detention areas. The Watershed is home to numerous types of wetlands, a majority of which are classified as palustrine by the National Wetland Inventory. Palustrine wetlands are associated with streams, creeks, swales, or are separate wetland features in the landscape. Other types of wetlands in the Watershed are riverine, associated with river systems, and lacustrine, associated with or adjacent to lakes. Wetlands in the Watershed range



from forested wetlands with red and silver maple and sycamore, to emergent vegetation such as cattail marshes. Many shrub-scrub wetlands are also present. Figure 2.9 is a map of the approximate vegetation in the 1800s. According to the MDNRE, approximately 170,000 acres of wetlands (42%) have been drained/lost since the 1800s.

Figure 2.10 is a map of Wetland Restoration Potential created by the MDNRE. The map shows hydric soils, circa 1800 wetlands, and existing wetlands. The overlapping areas of the hydric soils and circa 1800 wetland areas indicate areas with a high potential for wetland restoration. The MDNRE has completed a Landscape Level Wetland Functional Assessment (LLWFA) of existing and historically lost wetlands for various watersheds around the state and has a long-term goal to complete LLWFA for the entire state. Additional information about the MDNRE LLWFA report can be found in Section 3.3.6. A complete LLWFA report is found in Appendix 3.5.



Wetlands are invaluable for a variety of water quality functions they naturally perform. These include, but are not limited, to the following:

- **Denitrification:** Studies show that in certain instances, wetlands can remove from 70 to 90 percent of nitrates. One study in the southeastern U.S. projected a 20-fold increase in nitrogen loadings to streams, as a result of a total conversion to adjacent bottomland hardwood forested wetlands to cropland.
- **Trapping sediments** can keep large amounts of phosphorous from entering adjacent rivers and reduces sedimentation.
- **Flood control:** Studies in the Midwest show floodwater flows can be reduced by 80 percent in watersheds with wetlands, as opposed to those without them.
- **Groundwater Recharge:** Returning water to underground aquifers is known as "groundwater recharge." Much of the water in a wetland used for recharge would have been deposited there during wet periods, so the wetland would not only stem flooding by retaining water, but by having that water available to recharge groundwater (information from North Carolina State University webpage).

A major function of wetlands is the preservation of water quality. Wetlands are similar to living filters. They trap pollutants such as nutrients and sediments, which can impair/impact the designated/desired uses of total and partial body contact, public water supply, and warmwater fishery. Wetlands also act as natural detention areas by storing flood waters and releasing them slowly, which reduces peaks flows and protects downstream property owners from flooding. The State of Michigan has set a goal of 10% wetland restoration, which will be used as a basis for setting the goal for this Watershed.

According to the MDNRE website (www.michigan.gov/wetlands), Michigan received authorization from the federal government in 1984 to administer Section 404 of the federal Clean Water Act in most areas of the state. A state-administered 404 program must be consistent with the requirements of the federal Clean Water Act and associated regulations set forth in the Section 404(b) (1) guideline. In other states, where an applicant must apply to the U.S. Corps of Engineers and a state agency for wetland permits, applicants in Michigan generally submit only one wetland permit application to the MDNRE. Currently, wetlands are regulated at the State under Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Part 303).

Part 303 indicates that a wetland is regulated if it is any of the following:

- Connected to one of the Great Lakes or Lake St. Clair.
- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river, or stream.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, but are more than 5 acres in size.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the MDNRE has determined that these wetlands are essential to the preservation of the State's natural resources and has notified the property owner webpage).

The law requires that persons planning to conduct certain activities in regulated wetlands apply for and receive a permit from the State before beginning the activity. In accordance with Part 303, a local unit of government can also regulate wetlands by ordinance, in addition to state regulation, if certain criteria are met.

The Communities of Cannon Township, Grattan Township, and Spring Lake Township have wetland ordinances, but the majority of communities do not offer wetland protection at the local level.

Fish and Wildlife

A diversity of aquatic and terrestrial habitat types are found throughout the Watershed that harbors various amphibian, reptile, avian, mammal, and fish species. Many of these species are important from a recreational and economical perspective. Well-organized conservation and outdoor sporting groups exist throughout the Watershed, such as Ducks Unlimited, Pheasants Forever, Trout Unlimited, Michigan United Conservation Clubs, to protect and enhance habitat for animals such as whitetail deer, wild turkeys, pheasants, grouse and many species of fish. Many nontarget species are also likely to benefit from these efforts.

Coldwater Fishery

The State of Michigan designates certain coldwater streams as trout streams under provisions of Fisheries Order 210.10 (http://www.michigan.gov/documents/dnr/FO_210.10_317504_7.pdf). Designated trout streams take water temperature, habitat, fish population, structure, and other factors into consideration, and are protected through restrictive fishing regulations and discharge guidelines.

Figure 2.11 identifies the designated trout streams. Table 2.10 lists the stream miles in the management units that are designated trout streams.

Table 2.10 – Designated Trout Streams

(Source: DNR-DFI 101 FO-210.08. Obtained from the Michigan Center for Geographic Information, 2010)

Subwatershed Management Unit	Designated Trout Stream Miles	Total Stream Miles	Designated Trout Stream Miles (%)
Bass River	1.7	102.5	2%
Bear Creek	10.7	48.4	22%
Bellemy Creek	11.6	55.3	21%
Buck Creek	15.6	82.9	19%
Cedar Creek	6.5	44.7	15%
Coldwater River	26.1	244.7	11%
Coopers, Clear, and Black Creeks	1.3	118.0	1%
Crockery Creek	29.0	300.3	10%
Deer Creek	1.5	64.5	2%
Dickerson Creek	10.8	102.2	11%
Direct Drainage to LGR	72.8	820.0	9%
Fall Creek	0.0	20.1	0%
Glass Creek	6.5	37.8	17%
High Bank Creek	2.4	34.4	7%
Indian Mill Creek	5.4	27.4	20%
Lake Creek	9.2	43.1	21%
Libhart Creek	0.0	85.1	0%
Lower Flat River	3.9	190.6	2%
Lower Rogue River	38.5	226.7	17%
Lower Thornapple River	7.0	345.5	2%
Mill Creek	7.6	34.8	22%
Mud Creek	0.0	69.2	0%
Page Creek	4.1	4.1	100%
Plaster Creek	0.0	92.2	0%
Prairie Creek*	25.9	144.4	18%
Rush Creek	0.0	112.3	0%
Sand Creek	19.4	84.6	23%
Spring Lake/Norris Creek	9.4	61.8	15%
Upper Flat River	1.8	248.2	1%
Upper Rogue River	24.4	167.6	15%
Upper Thornapple River	8.1	401.1	2%
Wabasis and Beaver Dam Creek	0.0	47.0	0%
Total:	357.1	4,457	8%

*Note: Prairie Creek has been identified as high priority breeding ground for trout (Source: MDNRE, 2010)

Exotic and Invasive Species

Exotic species are defined as those that have been introduced from another geographic region to an area outside its natural range, while invasive species are those that heavily colonize or take over a particular habitat. Many invasive species exist in the LGRW, as indicated in the following table.



Table 2.11 – Invasive Species

(Source: USGS, Michigan Natural Features Inventory)

	Scientific Name	Common Name
Trees	<i>Elaeagnus angustifolia</i>	Russian Olive
	<i>Elaeagnus umbellata</i>	Autumn Olive
	<i>Robinia pseudoacacia</i>	Black Locust
	<i>Salix fragilis</i>	Crack willow
Shrubs	<i>Berberis thunbergii</i>	Japanese Barberry
	<i>Ligustrum vulgare</i>	Privet
	<i>Lonicera maackii</i>	Amur Honeysuckle
	<i>Lonicera morrowii</i>	Morrow's Honeysuckle
	<i>Lonicera tatarica</i>	Tartarian Honeysuckle
	<i>Lonicera xbella</i>	Bell's Honeysuckle
	<i>Rhamnus cathartica</i>	Common Buckthorn
	<i>Rhamnus frangula</i>	Glossy Buckthorn
	<i>Rosa multiflora</i>	Multiflora Rose
Woody Vines	<i>Lonicera japonica</i>	Japanese Honeysuckle
	<i>Toxicodendron radicans</i>	Poison Ivy
Herbaceous Plants	<i>Agrostis gigantea</i>	Redtop
	<i>Alliaria petiolata</i>	Garlic Mustard
	<i>Cardamine impatiens</i>	Narrow-leaved Bitter-cress
	<i>Centaurea maculosa</i>	Spotted Knapweed
	<i>Cirsium arvense</i>	Canada Thistle
	<i>Cirsium palustre</i>	European Swamp Thistle
	<i>Echinochloa crusgalli</i>	Barnyard grass
	<i>Epilobium hirsutum</i>	Great hairy willow herb
	<i>Euphorbia esula</i>	Leafy Spurge
	<i>Hesperis matronalis</i>	Dame's Rocket
	<i>Lysimachia nummularia</i>	Moneywort
	<i>Lythrum salicaria</i>	Purple Loosestrife
	<i>Melilotus alba</i>	White Sweet Clover
	<i>Melilotus officinalis</i>	Yellow Sweet Clover
	<i>Nasturtium officinale</i>	Water-cress
	<i>Pastinaca sativa</i>	Wild Parsnip
	<i>Phalaris arundinacea</i>	Reed Canarygrass
	<i>Phragmites australis</i>	Giant Reed
	<i>Polygonum cuspidatum</i>	Japanese Knotweed
	<i>Polygonum persicaria</i>	Lady's Thumb
	<i>Polygonum sachalinense</i>	Giant Knotweed
	<i>Rumex obtusifolius</i>	Bitter dock
	<i>Solanum dulcamara</i>	Bittersweet nightshade
	<i>Sonchus arvensis</i>	Field sow thistle
	<i>Typha angustifolia</i>	Narrow-leaved Cat-tail
	<i>Vincetoxicum spp.</i>	Swallow-worts

Table 2.11 – Invasive Species

(Source: USGS, Michigan Natural Features Inventory)

	Scientific Name	Common Name
Aquatic Plants	<i>Myriophyllum spicatum</i>	Eurasian Water Milfoil
	<i>Potamogeton crispus</i>	Curly Pondweed
Fish	<i>Cyprinus carpio</i>	Common Carp
	<i>Neogobius melanostomus</i>	Round goby
	<i>Petromyzon marinus</i>	Sea lamprey
	<i>Morone americana</i>	White perch
	<i>Gymnocephalus cernuus</i>	Eurasian ruffe
	<i>Alosa pseudoharengus</i>	Alewife
Crustaceans	<i>Orconectes rusticus</i>	Rusty crayfish
	<i>Bythotrephes cederstroemi</i>	Spiny water flea
Mollusks	<i>Dreissena polymorpha</i>	Zebra mussel
	<i>Dreissena rostriformis bugensis</i>	Quagga mussel
	<i>Bithynia tentaculata</i>	Mud bithynia, faucet snail

Protected Species

Michigan has a number of significant natural features located across the state. These natural features can provide public benefits that may include bird watching, hunting, fishing, camping, hiking, off-roading, and water sports. However, these areas also include critical habitat for different species of plants, mammal, amphibians, reptiles, birds, fish, and macroinvertebrates.

The MDNRE provides information on threatened and endangered plants and animals in Michigan. This work is coordinated by the Michigan Natural Features Inventory (MNFI). Results of the MNFI (<http://web4.msue.msu.edu/mnfi/>) data indicate that nine species in the Watershed are endangered, and there are many of special concern, threatened, or extirpated. The categories used to describe these species and a complete list of threatened, endangered, and state special concern species previously documented in the LGRW can be found in Appendix 2.2.

Endangered species are in danger of extinction and are protected by law; they may not be killed, harassed, handled, or possessed without a permit. A threatened species is any species that is likely to become an endangered species within the foreseeable future. Both endangered and threatened species are protected under Michigan's Endangered Species Act (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act).

Special concern species are not protected under the Endangered Species Act. These species are of concern due to declining or relict populations in the state. If these species continue to decline, they would be recommended for threatened or endangered status. It is important to maintain self-sustaining populations of special concern species in order to prevent them from becoming endangered or threatened species in the future. Tables 2.12a and 2.12b list the endangered species.

Table 2.12a – Endangered Animal Species in LGRW*(Source: Michigan Natural Features Inventory)*

Subwatershed Management Unit	Common Name	Type of Animal
Bear Creek	Pugnose shiner	Fish
Cedar Creek	Henslow's sparrow	Bird
Coldwater River	Henslow's sparrow	Bird
Coopers, Clear, and Black Creeks	Henslow's sparrow	Bird
	Pugnose shiner	Fish
Dickerson Creek	Regal fritillary	Butterfly
Direct Drainage to Lower Grand River	Henslow's sparrow	Bird
	Snuffbox	Mussel
	Peregrine falcon	Bird
Glass Creek	Henslow's sparrow	Bird
	Pugnose shiner	Fish
High Bank Creek	King rail	Bird
Lower Flat River	Pugnose shiner	Fish
Lower Rogue River	King rail	Bird
Lower Thornapple River	Henslow's sparrow	Bird
	Three-staff underwing	Moth
	Mitchell's satyr	Butterfly
Mill Creek	Snuffbox	Mussel
Mud Creek	King rail	Bird
Plaster Creek	Snuffbox	Mussel
Upper Flat River	Henslow's sparrow	Bird
Upper Thornapple River	Henslow's sparrow	Bird
	Indiana bat	Bat
	King rail	Bird

The MNFI notes a wide variety of habitats that support the listed species. These include forests (mesic southern, mesic northern, dry mesic, and southern floodplain), prairie (dry sand, hillside, wet, and wet-mesic), wetlands (bog, southern swamp, emergent marsh, Great Lakes marsh, inter-dunal, hardwood-conifer swamp, prairie fen, and coastal plain marsh), Great Lakes barrens, and open dunes.

Sensitive Areas

Critical and unique habitat for fish and wildlife within the Watershed are provided in the wetland areas and in the river corridor areas located in the Watershed. The wetland areas provide habitat for waterfowl, reptiles, mammals, amphibians, insects, and birds. The forested areas along the watercourses and drainageways provide shade to the watercourses, resulting in cooler water and improved water quality, habitat for various birds and mammal species and provide migration corridors for wildlife species.

Table 2.12b – Endangered Plant Species in LGRW

(Source: Michigan Natural Features Inventory)

Subwatershed Management Unit	Common Name
Bear Creek	Virginia bluebells
	Orange- or yellow-fringed orchid
Buck Creek	Virginia bluebells
Coldwater River	Kitten-tails
	Virginia bluebells
	Orange- or yellow-fringed orchid
Direct Drainage to Lower Grand River	Kitten-tails
	Side-oats grama grass
	White gentian
	Downy gentian
	Virginia bluebells
	Orange- or yellow-fringed orchid
	Mermaid-weed
	Three-square bulrush
Indian Mill Creek	Virginia bluebells
Lake Creek	Kitten-tails
Lower Flat River	Kitten-tails
	Virginia bluebells
	Orange- or yellow-fringed orchid
Lower Rogue River	Kitten-tails
	Orange- or yellow-fringed orchid
Lower Thornapple River	Kitten-tails
	Side-oats grama grass
	American chestnut
	Virginia bluebells
	Orange- or yellow-fringed orchid
Plaster Creek	Spotted pondweed
	Virginia bluebells
Sand Creek	Virginia bluebells
Upper Rogue River	Orange- or yellow-fringed orchid
Upper Thornapple River	Virginia bluebells
	Prairie white-fringed orchid
Wabasis and Beaver Dam Creek	Orange- or yellow-fringed orchid

Dedicated/Protected Lands

The Watershed has protected lands in the form of state, county, township, city, and village parks. Approximately 44,396 acres of State Game Area are currently protected in the Watershed. Some private land has also been protected, including efforts by local land trusts, and other private acquisitions. Lands in the Watershed are also enrolled in the PA-116 program, a State program to protect farmland from development for a specified number of years. Figure 2.12 is a map showing the prime farmlands in the Watershed which are available for Purchase of Development Rights (PDR) through the Michigan Farmland Preservation Program. Figure 2.13 illustrates the government and protected lands in the Watershed.

The PDR program is a voluntary program, where a land trust, or some other agency usually linked to local government, makes an offer to a landowner to buy the development rights on the parcel. Once an agreement is made, a permanent deed restriction is placed on the property which restricts the type of activities that may take place on the land in perpetuity. In this way, a legally binding guarantee is achieved to ensure that the parcel will remain agricultural or as open (green) space forever. The deed

restriction may also be referred to as a conservation easement. This is an excellent step toward more permanent land protection measures.

The Wetlands Reserve Program (WRP) is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection beyond that which can be obtained through any other USDA program.



Additional land protection programs are discussed in Chapter 6.

Natural Rivers

The State has designated the Rogue River and the Flat River as Natural Rivers under the Part 305, Natural Rivers, of the Natural Resources and Environmental Protection Act 451 of 1994. The State designates a river or portion of a river as a natural river area for the purpose of preserving and enhancing its values for water conservation, its free flowing condition, and its fish, wildlife, boating, scenic, aesthetic, floodplain, ecologic, historic, and recreational values and uses. As stated on the MDNRE website, (http://www.michigan.gov/dnr/0,1607,7-153-30301_31431_31442---,00.html), the Natural Rivers Program is an effective management tool, due to the development standards and their influence on private as well as public lands. All lands, public and private, within the Natural River district, which includes 400 feet on either side of a designated river, are included in the designation, creating a seamless corridor of protected land. Also, local units of government are able to adopt Natural River zoning standards to become the Program administrators on private lands within their jurisdiction.

2.7 LAND USE AND LAND COVER

Open Space

Open space for this Watershed includes wetlands, forests, croplands, rangeland, and open waters and streams. The Lower Grand River Watershed has approximately 90 percent open space distributed throughout the Watershed. Urbanized areas are located in the midwest and mid-sections of the Watershed, with the City of Grand Rapids being the largest, and make up 10 percent of the basin. The major land use within the Watershed is agriculture, which comprises approximately 51 percent of the Watershed. Figure 2.13 shows the natural connections in the Watershed, while Figure 2.14 depicts the current land use in the Watershed in 2006. Table 2.13 below depicts land use characteristics of each of the 31 Subwatershed Management Units.



Figure 2.13 shows the natural connections in the Watershed, while Figure 2.14 depicts the current land use in the Watershed in 2006. Table 2.13 below depicts land use characteristics of each of the 31 Subwatershed Management Units.

Agricultural Lands

Currently, most of the land not covered by residences, urban centers, and forests is cultivated. Primary agricultural products include fruit, dairy products, potatoes, poultry, and vegetables through truck gardening (cucumbers, onions, mint, and celery). Kent and Ottawa Counties are the most significant counties within the LGRW in terms of value of agricultural products. Ottawa County is the highest producing agricultural county in the State of Michigan (West Michigan Strategic Alliance, 2002). However, urbanization is impacting agricultural land, resulting in significant yearly loss of farmland to residential and commercial development.



Livestock operations within the Watershed range in size. Beef cattle, dairy cows, hogs, and sheep are some of the livestock raised in the Watershed.

Table 2.13 – Land Use by Subwatershed

(Source: NOAA (National Oceanographic and Atmospheric Administration) CSC (Coastal Services Center)/Coastal Change Analysis Program (C-CAP), 20060519, NOAA C-CAP Land Cover and Change Data, Charleston, SC. 2006.)

Subwatershed Management Unit	Agriculture (acres)	Forest (acres)	Lakes (acres)	Open Land (acres)	Urban (acres)	Wetland (acres)
Bass River	20,297	4,986	134	1,216	2,364	2,997
Bear Creek	6,795	7,292	464	684	2,486	2,610
Bellemy Creek	15,823	2,306	29	286	312	1,893
Buck Creek	5,835	3,546	58	1,131	20,604	1,203
Cedar Creek	12,720	9,613	1,206	1,072	495	4,502
Coldwater River	88,956	16,516	1,202	1,915	3,047	9,103
Coopers, Clear, and Black Creeks	34,018	12,118	2,009	2,240	2,830	12,164
Crockery Creek	67,969	15,300	428	3,232	4,909	10,441
Deer Creek	17,778	944	68	385	1,844	1,355
Dickerson Creek	26,710	7,920	1,023	1,299	1,162	10,252
Direct Drainage to Lower Grand River	90,255	72,677	10,625	11,412	64,409	25,797
Fall Creek	5,746	5,422	776	636	813	2,471
Glass Creek	6,771	10,874	811	1,114	307	3,626
High Bank Creek	12,515	4,652	786	615	442	2,769
Indian Mill Creek	4,246	1,348	9	269	4,717	390
Lake Creek	12,594	2,921	390	375	798	1,095
Libhart Creek	29,901	2,123	29	350	695	2,065
Lower Flat River	36,785	20,843	2,921	3,116	4,587	10,621
Lower Rogue River	39,614	22,124	1,450	3,629	17,554	9,163
Lower Thornapple River	53,907	36,968	3,033	4,235	17,197	10,913

Table 2.13 – Land Use by Subwatershed

(Source: NOAA (National Oceanographic and Atmospheric Administration) CSC (Coastal Services Center)/Coastal Change Analysis Program (C-CAP), 20060519, NOAA C-CAP Land Cover and Change Data, Charleston, SC. 2006.)

Subwatershed Management Unit	Agriculture (acres)	Forest (acres)	Lakes (acres)	Open Land (acres)	Urban (acres)	Wetland (acres)
Mill Creek	8,455	1,503	142	261	2,245	349
Mud Creek	28,954	4,295	361	527	674	3,767
Plaster Creek	6,167	3,724	55	734	23,622	2,146
Prairie Creek	45,031	7,569	341	1,047	1,339	10,156
Rush Creek	14,263	3,470	378	1,124	17,469	1,303
Sand Creek	22,396	4,029	100	779	4,996	2,783
Spring Lake / Norris Creek	5,647	13,851	1,204	3,083	4,809	3,752
Upper Flat River	69,602	28,078	2,989	9,418	7,781	20,140
Upper Rogue River	33,188	21,836	1,003	3,951	3,699	10,265
Upper Thornapple River	115,384	24,344	679	3,388	5,808	16,771
Wabasis and Beaver Dam Creek	13,469	8,516	1,108	1,611	1,236	4,183
Total:	951,791	381,710	35,812	65,133	225,252	201,047
Percent in Watershed:	51	21	2	3	12	11

2.8 POLITICAL BOUNDARIES

Community Profiles

The Watershed is contained within parts of Ottawa, Muskegon, Kent, Montcalm, Ionia, Barry, Eaton, Newaygo, Allegan, and Mecosta Counties. Located in West Michigan, the Watershed includes many larger communities which offer employment, shopping centers, and cultural activities. The LGRW contains two urban areas: the Grand Rapids Metropolitan area and the Muskegon Metropolitan area, which includes the Grand Haven, Tri-cities areas. Community profiles are described in greater detail in the Social Profile in Chapter 7.

Demographics

Major metropolitan areas account for 12 percent of the area in the Watershed. The City of Grand Rapids and the Tri-Cities area of Grand Haven, Ferrysburg, and Spring Lake are experiencing slight population growth as people are slowly moving back into urban centers. Although the population of the State of Michigan overall has declined, results of the 2010 U.S. Census should indicate the densities in urban areas are increasing. Figure 2.15 depicts total population in the Watershed. Table 2.14 illustrates 2000 U.S. Census information. Demographics of the Watershed are described in greater detail in the Social Profile in Chapter 7.

2.9 DEVELOPMENT TRENDS

The impact of this reversal of urban sprawl will be seen in a reduction of large-lot residential areas; less large shopping centers; and fewer new roads, parking lots, rooftops, and driveways that increase the LGRW's imperviousness. The urban areas will have challenges with this population growth. Aging infrastructure will be further stressed as it is needed to service more people. In addition, urban areas that own or operate a municipal separate storm sewer system (MS4) must comply with increased regulations to reduce impacts of storm water runoff. The National Pollutant Discharge Elimination System (NPDES) stormwater permits state requirements for addressing exceedances of water quality standards, provide

public education, find and eliminate illicit connections, provide construction site and post-construction stormwater controls, and conduct pollution prevention and good housekeeping measures on their properties. References to these regulations will be found throughout this document to assist the following communities that are required to have storm water permits:

- Kent County Administration and Drain Commissioner
- Kent County Road Commission
- Ottawa County Administration and Drain Commissioner
- Ottawa County Road Commission
- Allendale Charter Township
- Cascade Charter Township
- City of East Grand Rapids
- City of Ferrysburg
- Georgetown Charter Township
- City of Grand Haven
- City of Grand Rapids
- Grand Rapids Charter Township
- City of Grandville
- City of Hudsonville
- City of Kentwood
- Plainfield Charter Township
- City of Rockford
- Village of Sparta
- Village of Spring Lake
- City of Walker
- City of Wyoming

Table 2.14 – Population (2000 census)

Subwatershed Management Unit	Total Population (2000 Census)	Population Density (people/sq. mile)	Housing Density (houses/sq. mile)	% Area Within Watershed
Bass River	11,707	234.0	68.5	1.7%
Bear Creek	6,719	211.5	75.5	1.1%
Bellemy Creek	11,244	224.2	54.2	1.7%
Buck Creek	94,086	1,859.0	741.6	1.7%
Cedar Creek	3,554	76.8	35.2	1.6%
Coldwater River	14,298	75.8	28.6	6.5%
Coopers, Clear, and Black Creeks	9,256	90.6	37.0	3.5%
Crockery Creek	12,144	76.0	27.1	5.5%
Deer Creek	6,015	172.1	63.0	1.2%
Dickerson Creek	5,042	66.7	27.8	2.6%
Direct Drainage to Lower Grand River	291,053	706.1	280.3	14.2%
Fall Creek	4,524	182.5	76.0	0.9%
Glass Creek	2,582	70.3	28.9	1.3%
High Bank Creek	2,304	67.6	29.0	1.2%
Indian Mill Creek	13,671	796.9	320.0	0.6%
Lake Creek	3,041	107.1	43.8	1.0%
Libhart Creek	2,993	54.5	20.9	1.9%
Lower Flat River	16,735	135.8	52.5	4.2%
Lower Rogue River	45,543	311.6	112.9	5.0%
Lower Thornapple River	41,754	222.2	83.4	6.5%
Mill Creek	6,157	304.2	117.0	0.7%
Mud Creek	3,144	52.1	20.1	2.1%
Plaster Creek	115,497	2,028.1	776.5	2.0%
Prairie Creek	7,211	70.5	25.1	3.5%
Rush Creek	49,139	827.0	293.6	2.0%
Sand Creek	11,174	203.8	74.4	1.9%
Spring Lake/Norris Creek	15,177	299.9	122.8	1.7%
Upper Flat River	21,350	98.9	44.4	7.4%
Upper Rogue River	11,712	101.3	38.3	4.0%
Upper Thornapple River	26,533	98.4	38.0	9.3%
Wabasis and Beaver Dam Creek	5,976	126.9	48.4	1.6%
Total:	871,335			100.0%

