

Section 3: Watershed Resource Inventory and Assessment

Section 3.1 Introduction

An understanding of the unique features and natural processes associated with the Madigan Creek watershed, as well as the current and potential future condition, is critical to developing an effective watershed-based plan. This watershed inventory and assessment organizes, summarizes, and presents available watershed data in a manner that clearly communicates the issues and processes that are occurring in the watershed so that stakeholders living the Madigan Creek watershed can make informed decisions about the watershed's future. The inventory and analysis identifies the causes and sources of watershed degradation and provides the basis for recommending both programmatic and site specific actions intended to improve the watershed, which are found in [Chapter 5](#).

As part of the preparation of the Watershed Resource Inventory and Assessment, WCWIPSC collected and reviewed available watershed data, conducted an investigation of stream reaches in the field, and gathered input from watershed stakeholders. Examples of information investigated includes water quality, streambank erosion, soils, wetlands, flood damage areas, the detention and drainage system, population, and current and future land use.

Geographic Information System (GIS) software was used to compile, analyze, and display this detailed information in graphical and map format so that stakeholders can easily understand the condition and location of watershed resources. The amounts of different pollutants that are expected from various land uses to enter Madigan Creek was also investigated.

This chapter presents the results of the inventory and analysis in a series of maps, tables, graphs, and narrative format. A summary of the watershed assessment is included at the end of the chapter.

3.2 Watershed Setting

The Madigan Creek watershed is located in the south-central Winnebago County in northern Illinois (Figure 3-1). The watershed drains approximately 6.21 square miles (3,973 acres) of land into the Kishwaukee River. From the confluence with Madigan Creek, the Kishwaukee River flows westward through Rockford before joining the Rock River. The Rock River flows southwestly direction before joining the Mississippi River in the Quad Cities area (Moline, Illinois; Rock Island, Illinois, Davenport, Iowa; and Bettendorf, Iowa).

3.3 Water Resources

In addition to the mainstem of Madigan Creek, 3 unnamed major tributaries makeup the Madigan Creek system. Collectively, there are 20.31 stream miles in the Madigan Creek watershed of which 4.42 miles are attributed to the mainstem of Madigan Creek. Available data indicates that 25.65 acres of wetlands are located within the Madigan Creek watershed. With the exception of the Cherry Valley Regional Storm Water Detention Facilities near the

confluence of Madigan Creek and the Kishwaukee River, there are no major impoundments on Madigan Creek or its tributaries.

3.4 Geology/Topography

During the Pleistocene Era or “Ice Age” advancing and receding glaciers covered much of North America. The Illinoian glacier extended to southern Illinois between 300,000 and 125,000 years ago. It is the Illinoian glacier that is responsible for the flat, farm-rich areas in the southern half of the state. The northeastern portion of Illinois including the watershed area was also covered by the most recent glacial event known as the Wisconsinan. The Wisconsinan began approximately 70,000 years ago and ended around 14,000 years ago. It was during this time that the temperatures began to rise and the ice retreated to form a landscape similar to the Alaskan tundra. As the temperatures began to rise, the tundra was replaced by cool moist deciduous forests, and eventually oak-hickory forests and prairies. The final retreat of the Lake Michigan lobe of the Wisconsin glacier is responsible for the formation of the Great Lakes and the landscape of the watershed. This landscape contains moraines, flood plains, bogs, outwash plains, lake plains, beaches, stream terraces, kames, ridges, and kettle holes (wetlands, ponds, and lakes).

Topography refers to the elevations of landscape that describes the configuration of its surface. Topography is an essential tool in the watershed planning process because topography defines the boundaries of the Madigan Creek watershed. For this watershed-based plan, the Online Watershed Delineation (HYMAPS-OWL) tool, created by Department of Agriculture and Biological Engineering at Purdue University was used to create the initial subwatershed boundaries. The subwatershed (also referred to as subbasin) boundaries generated by HYMAPS-OWL were then cross referenced with boundaries obtained by inputting 2-foot topography into the GIS-based model, Arc Hydro. This combined data generated a Digital Elevation Model (DEM) that was used to delineate and refine the watershed and subwatershed boundaries for Madigan Creek. Inconsistency in the two model’s delineations was altered to reflect real-world conditions and more accurately depict the hydrologic boundaries. Most of these inconsistencies occurred in areas divided by roadways that were not accounted for in the model. Figure 3-2 depicts the DEM and boundary of Madigan Creek.

The Madigan Creek watershed generally drains from north to south to the Kishwaukee River. The highest point in the watershed (850 feet) is located north of State Street. The lowest point in the watershed (750 feet) is located near the creek’s confluence with the Kishwaukee River. The difference in the highest and lowest points reflects a 100-foot change in elevation as you traverse from the northern to the southern section of the watershed.

3.5 Climate and Precipitation

3.5.1 Climate

Illinois is situated midway between the Continental Divide and the Atlantic Ocean and is often times underneath the polar jet-stream. The polar jet-stream is a focal point for movement between cold polar air masses from the north moving southward and warmer, tropical air from the south moving northward. The convergence of polar and tropical air

causes Illinois to have a humid continental climate with hot humid summers and cool to cold winters with short frequent fluctuations in wind direction, cloudiness, humidity, and temperature.

Data collected in Rockford, Illinois best represents the overall climate and weather patterns experienced in the watershed. The average annual temperature for Rockford, Illinois is 47.7°F. The winter months (December – February) are cold with an average temperature of 21.7°F with the lowest temperature on record of -27°F recorded on January 10, 1982. There is an average of 144 annual days below freezing. The summer months are hot and humid with an average temperature of 71°F. The highest temperature on record for Rockford, Illinois is 112°F recorded on July 14, 1936.

3.5.2 Precipitation

Average yearly precipitation for Illinois varies from just over 48 inches at the southern tip of the state to just under 32 inches in the northern portion of the state. May and June are the wettest months of the year. Flooding is the most damaging weather hazard within the state. Increased warming within urban heat islands leads to an increase in rainfall downwind of cities. Lake Michigan leads to an increase in winter precipitation along its south shore due to lake effect snow forming over the relatively warm lakes. Normal annual snowfall exceeds 38 inches in Chicago, and the southern portion of the state normally receives less than 14 inches. Storms exceeding the normal winter value are possible within one day. In summer, the relatively cooler lake leads to a more stable atmosphere near the lake shore, reducing rainfall potential. Illinois averages around 50 days of thunderstorm activity a year which put it somewhat above average for number of thunderstorm days for the United States. Illinois is also vulnerable to tornadoes with an average of 35 occurring annually.

The average annual rainfall for Rockford, Illinois is 36 inches. Average snowfall for the area is 39 inches. The most rainfall received in one year occurred in 2008 when more than 51 inches of rain fell. The snowiest winter in the history of the city was the winter of 1978-1979, when 75 inches of snow fell. The one-day maximum precipitation (3.45 inches) occurred on September 26, 2011.

3.6 Soils

Deposits left during by the Lake Michigan lobe of the Wisconsin glacier are the raw materials of the soils currently found in the Madigan Creek watershed. A combination of biological, physical, and chemical variables such as climate, drainage patterns, vegetation, and topography have all interacted together to form the soils found today. Soils are identified by a name associated with each series or class of soils with similar characteristics. A soil series is commonly derived from a town or landmark in or near the areas where the soil series was first identified, although sometimes naming conventions vary by county. Soil series are differentiated based on the amounts and size of particles making up the soil, water-holding capacity, the slopes where they are located, permeability characteristics, and organic content.

Table 3-1 lists the dominant soil series located within the watershed.

Table 3-1 Soil Series in the Madigan Creek Watershed

Soil Series	Hydric	Highly Erodible	Hydrologic Soil Group	Acres	% of Watershed
Plano	No	Potential	B	568.07	14.30%
Greenbush	No	Potential	B	540.43	13.61%
Olge	No	Potential	B	510.45	12.86%
Atterberry	No	No	B	307.21	7.73%
Argyle	No	Potential	B	211.82	5.33%
Fayette	No	Potential	B	192.20	4.84%
Kidder	No	Yes	B	151.41	3.81%
Flagg	No	Yes	B	133.43	3.36%
Muscatune	No	No	B	125.41	3.16%
Comfrey	Yes	No	B/D	105.51	2.66%
Kane	No	No	B	96.82	2.44%
Grellton	No	No	B	90.37	2.28%
Elco	No	Potential	B	83.14	2.09%
Lahoguess	No	No	B	82.68	2.08%
Virgil	No	No	B	73.73	1.86%
Troxel	No	No	B	57.32	1.44%
Jasper	No	No	B	49.13	1.24%
Stronghurst	No	No	B	48.11	1.21%
Pecatonica	No	Yes	B	46.75	1.18%
Winnebago	No	Yes	B	43.75	1.10%
Waupecan	No	No	B	40.90	1.03%
St Charles	No	Potential	B	39.16	0.99%
Sable	Yes	No	B/D	36.92	0.93%
Martinsville	No	Potential	B	31.03	0.78%
McHenry	No	Yes	B	29.68	0.75%
Hitt	No	Potential	A	27.25	0.69%
Rozetta	No	No	B	25.57	0.64%
Orthents	No	Potential	C	23.73	0.60%
Assumption	No	Potential	B	21.05	0.53%
Pits, Quarry	No	No	N/A	20.86	0.53%
Kendall	No	No	B/D	20.57	0.52%
Non-Dominant Soil Types	N/A	N/A	N/A	137.54	3.46%

There are 37 soil series found in the Madigan Creek watershed. Of these 37, 31 are considerate dominant soil types (greater than 0.5% of the watershed). The remaining 14 soils have been classified as “non-dominant soils”. The “non-dominant soils cover 3.46% f the Madigan Creek watershed.

Plano is the predominant soil type in the watershed, covering 568.07 acres or approximately 14.30% of the watershed. Greenbush soils are the next most dominant soil series covering approximately 13.61% or 540.43 acres of the watershed. The majority of the soils located in the watershed are well drained, non-hydric soils. Native plant communities in the watershed were likely comprised of prairie grasses and widely spaced trees including oaks and hickories.

3.6.1 Hydric Soils

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that are formed under conditions of saturation, flooding, or ponding and retain moisture long enough during the growing season to develop anaerobic (oxygen-deprived) conditions in the soil layers closest to the surface. Hydric soils are important because they indicate the presence of existing or historical wetlands and digressional areas. Thus areas of hydric soils may be suitable for wetland restoration. Often, drain tiles are found in areas of hydric soils but because the tiles are draining water away from the area, wetlands that were once present are no longer present. By breaking these tiles and restoring the natural flow of water to these areas, wetland hydrology can potentially be restored and with a properly designed excavation, planting and management plan, a high quality wetland can be established. Table 3-2 identified the percent coverage of hydric soils in the watershed and Figure 3-3 displays the coverage of hydric soils. Hydric soils comprise 142.47 acres or 3.59% of the Madigan Creek watershed and hydric soil inclusions comprise 790.46 acres or 19.89% of the watershed. The remaining 3040.3 acres (76.52%) are non-hydric soils. The hydric soils are primarily located along Madigan Creek. The hydric inclusion soils are located along Madigan Creek and in the southeast corner and northern portion of the watershed.

Table 3-2 Percent Coverage of hydric and non-hydric soils in the Madigan Creek Watershed

Soil	Total area (acres)	Percentage of Watershed
Non-Hydric Soils	3040.3	76.52%
Hydric Soils	142.44	3.59%
Hydric Inclusion Soils	790.46	19.89%
Total	3973.23	100%

3.6.2 Soil Erodibility

Soil erosion and sedimentation are significant causes of degraded water quality in Illinois. Soil erosion is the process in which soil is detached and moved by flowing water, wave action or wind. Through erosion, sediment is transported from its original location and deposited in a new location such as a stream, river, lake, or other ground surface. This deposition process is commonly referred to as sedimentation. The movement of eroded soils into streams, rivers, and lakes affects water quality chemically, biologically, and physically. Damage from sediment can be expensive both environmentally and economically. Over time, sediment deposits can blanket rock, cobble, and sandy substrate needed by fish and macroinvertebrates for habitat, food, and reproduction; reduce useful storage volumes in ponds, reservoirs, and lakes; and increase the need for costly water filtration systems for municipal drinking water supplies. Often times, the impacts of erosion and sedimentation are additive and the effects and costs of the sedimentation can be severe, both for those immediately affected and for those who must mitigate subsequent problems.

A map identifying the highly erodible soils in the watershed was created (Figure 3-4) by selecting soils that have been classified as highly erodible by the Natural Resource Conservation Service (NRCS). It is important to map the highly erodible soils because they represent those areas that have the highest potential to degrade water quality. As identified in Table 3-3, 8.29% (329.3 acres) of the soils within the watershed are highly erodible.

Table 3-3: Highly erodible soils in the Madigan Creek Watershed

Soil Name	Soil Code	Acres	Percent of Watershed
Kidder	361D2	151.41	3.81%
Flagg	419C2	41.63	1.05%
Pecatonica	21C2	37.51	0.94%
Winnebago	728C2, 728D2	27.94	0.70%
McHenry	310D2	17.31	0.44%
Whalen & New Glarus	561C2, 561D2	15.67	0.39%
Ringwood	297D2	10.39	0.26%
Griswold	363D2	8.89	0.22%
Oscos	86C2	7.51	0.19%
Westville	22C2	7.29	0.18%
Rockton & Dodgeville	566C2	3.75	0.09%

3.6.3 Hydrologic Soil Groups

The permeability and surface runoff potential of the soils in the United States have been classified by the NRCS into Hydrologic Soil Groups (HSGs). HSGs are based on a soil's infiltration and transmission (or permeability) rates and are used by engineers to estimate runoff curve numbers. Runoff curve numbers are an estimate of runoff potential of different soil types with different land covers. The curve numbers allow engineers to estimate the approximate amount of direct runoff from a rainfall event in a particular area and design new development in that area in a way which stormwater runoff is controlled. HSGs are classified into four primary categories: A, B, C, and D, and three dual classes, A/D, B/D, and C/D.

- Group A is comprised of the most permeable soil types and have the lowest runoff potential. These soils consist of mainly deep, well drained to excessively drained sands or gravelly sands. Group A soils have a high rate of water transmission.
- Group B soils have a moderate infiltration rates and are moderately deep, moderately well drained or well drained with fine texture to moderately coarse texture (silt and sand). Group B soils have a moderate rate of water transmission.
- Group C soils have slow infiltration rates because of a fine texture soil layer comprised of silt and clay that impedes the downward migration of water. Group C soils have a slow rate of water transmission.
- Group D soils have the slowest infiltration rates and a high runoff potential. These soils are typically clay and exhibit very slow rates of water transmission.
- Dual hydrologic groups (A/D, B/D, and C/D) are classified differently. The first letter represents the HSGs for the artificially drained soils in the area. The second letter represents the HSGs for the undrained, natural conditions. Only soils that are rate D in the natural conditions are assigned to dual classes.

The location of Group A and Group B soils within a watershed is imperative to a watershed planning process. Many of the BMPs included in watershed plans are infiltration BMPs including rain gardens, bioswales, and infiltration basins. Table 3-4 summarizes the HSGs and their corresponding attributes. Figure 3-5 depicts the location of each HSG within the watershed while Table 3-5 summarizes the acreage and percent of the watershed for each HSG. 93.28% of the soils in the Madigan Creek watershed as Group B with 4.37% classified

as Group B/D. The remaining 2.35% of soils are comprised of Group A, C, C/D, and unclassified soils. There are no Group A/D or D soils in the Madigan Creek watershed.

Table 3-4: Hydrologic Soil Groups and their corresponding attributes in the Madigan Creek watershed

HSG	Soil Texture	Drainage Description	Runoff Potential	Infiltration Rate	Transmission Rate
A	Sand, loamy sand, or sandy loam	Well to excessively well drained	Low	High	High
A/D	Sand or silt loam to clay	Well drained to poorly drained	High to Low	High to Very Low	High to Very Low
B	Silt loam or loam	Moderately well to well drained	Moderate	Moderate	Moderate
B/D	Silt loam, silty clay loam, clay	Moderately well to poorly drained	Moderate to Low	Moderate to Low	Moderate to Very Low
C	Sandy clay loam	Somewhat poorly drained	High	Low	Low
C/D	Sandy clay loam, silty clay loam, clay	Somewhat poorly drained to poorly drained	High	Low to Very Low	Low to Very Low
D	Clay loam, silty clay loam, sandy clay loam, silty clay, clay	Poorly drained	High	Very Low	Very Low

Table 3-5: Hydrologic Soil Groups including acreage and percent of watershed

HSG	Total Acreage	Percent of Watershed
A	27.25	0.69%
A/D	0	0%
B	3705.23	93.28%
B/D	173.77	4.37%
C	23.73	0.60%
C/D	14.65	0.37%
D	0	0%
Unclassified	28.60	0.69%

As noted above, Madigan Creek is comprised mainly of Type B soils. Type B soils are soils with moderately low runoff potential when thoroughly wet. Water is typically transmitted through these soils without impediment. Type B soils typically have less than 20 percent clay, and between 50 and 90 percent loamy sand or sandy loam textures. These soils have moderately fine to moderately course textures. The predominance of these Type B soils in the Madigan Creek watershed should facilitate infiltration in pervious areas.

3.7 Watershed Jurisdictions

One county, two municipalities and 2 townships comprise the Madigan Creek watershed (Table 3-6, Figure 3-6). The watershed is located completely in Winnebago County and the City of Rockford (2018.6 acres/50.81%) is the municipality that occupies the largest portion of the watershed. The Village of Cherry Valley (1001.43 acres/25.2%) is also located within the watershed. All remaining land in the watershed (953.19 acres/23.99%) is

Unincorporated and under the jurisdiction of the Rockford and Cherry Valley Townships. Additional entities with jurisdiction in the watershed include:

1. Winnebago County Board Districts (District 8, 11, and 15)
2. Rockford Park District
3. Winnebago County Soil and Water Conservation District
4. Illinois State Representative District (District 67, 68, 69)
5. Illinois State Senatorial District (District 34, 35)
6. US Congressional District (District 16)

Table 3-6: County, municipal, and township jurisdictions in the Madigan Creek Watershed

Jurisdiction	Acres	Percent of Watershed
Winnebago County	3973.23	100%
Municipalities		
Cherry Valley	1001.43	25.2%
Rockford	2018.6	50.81%
Unincorporated Areas	953.19	23.99%
Townships		
Cherry Valley	624	16.2%
Rockford	3332	83.8%
Rockford Park District	120.05	3.02%
Winnebago County Soil and Water Conservation District	3973.23	100%
County Board of Directors		
District 8	1715	43.15%
District 11	1794	45.14%
District 15	465	11.7%
Congressional District		
US House District 16	3973.23	100%
State Senate		
District 34	43	1%
District 35	3930	99%
State Assembly		
District 67	14	0.35%
District 68	3774	95.0%
District 69	185	4.65%

One Watershed: Multiple Decision Makers

As watershed boundaries do not typically follow political boundaries, one of the greatest challenges faced during watershed planning and implementing a watershed plan is that watersheds typically include multiple jurisdictions that have varying interests, resources, and responsibility. Actions by one jurisdiction in the watershed impact others in watershed both negatively and positively. By actively working together, jurisdictions within the watershed can ensure that that goals, objectives, and projects outlined in the watershed plan are considered in each of the jurisdiction’s decision making process on policies, projects, and programs.

As part of the watershed planning process, the Winnebago County Watershed Plan Steering Committee (WCWPSC) was formed. WCWPSC has been successful in bringing together representatives from the county, municipalities, townships, the Rockford Park District, and Winnebago County Soil and Water Conservation District. Additionally, the WCWPSC includes watershed residents and members of the Kishwaukee River Ecosystem Partnership (KREP). Ensuring that the WCWPSC or a similar watershed council continues to be active after the watershed planning process is complete is a necessity to provide a venue for communication, coordination, and collaboration between the multiple watershed jurisdictions and ensure the implementation of the watershed plan.

3.8 Watershed Demographics

The Rockford Metropolitan Agency for Planning (RMAP) is the designated Metropolitan Planning Organization (MPO) for the Rockford region. Under Federal law urbanized areas with populations exceeding 50,000 are required to have an organization that plans and coordinates decision regarding the area’s transportation systems. RMAP is governed by a Cooperative Agreement that has been adopted by the Cities of Rockford, Belvidere and Loves Park, the Village of Machesney Park, the Counties of Boone and Winnebago and the Illinois Department of Transportation.

Planning for transportation, land use and environmental issues were traditionally undertaken separately by various agencies within an urban area. This separation made it difficult to understand the connection among various subjects and how changes in one area may affect another. Over the past several decades, an integrated approach to transportation planning has evolved to create a system that incorporates environmental, economic development and community goals.

According to RMAP’s 2040 forecasts for population, number of households and employment, the Madigan Creek is expected to experience growth (Tables 3-7 to 3-9). Growth within the watershed has the potential to impact watershed conditions through changes in land use.

Table 3-7: RMAP 2000 to 2040 Population Forecast Data for the Madigan Creek Watershed

Population	2000	2040	Change	% Change
Madigan Creek	14,782	19,269	4,487	30.35

Table 3-8: RMAP 2000 to 2040 Household Forecast Data for the Madigan Creek Watershed

Households	2000	2040	Change	% Change
Madigan Creek	6,317	7,826	1,509	23.89

Table 3-9: RMAP 2000 to 2040 Employment Forecast Data for the Madigan Creek Watershed

Employment	2000	2040	Change	% Change
Madigan Creek	12,576	18,458	5,882	46.77

It should be noted that the population and household data were obtained from the 2010 Decennial Census and are based on block group census geography. As such, the boundaries extend beyond the natural watershed boundaries, potentially leading to inflated estimates for each watershed. The total for each block group that intersected with the watershed was included. Additionally, the employment data came from the U.S. Census Bureau 2010 Longitudinal Employer-Household Dynamics (LEHD). This data follows TAZ (Traffic Analysis Zone) geography, which again extends beyond the natural watershed boundaries, producing inflated estimates for each watershed.

Using 2000 base year data, RMAP was able to use our Travel Demand Model (TDM) to forecast these figures out to 2040. For the TDM, RMAP uses PTV software to project current and future travel volumes for the region’s roadways. The model uses demographic and land-use forecasts as a major source of data input for the model. The study area is divided into Transportation Analysis Zones (TAZs) for the purpose of the modeling effort, utilizing trip generation, trip distribution and trip assignment to execute the modeling process. Modeling begins with historic and current data inputs such as current traffic, population, employment and land use, and ties in predictions of future land use to determine how the population, dwelling units (households) and employment will be distributed in the study area. The model runs on the assumption that each land use classification will produce or attract a certain amount of vehicle trips. The model is based on the most recent Census data available for TAZs, Woods and Poole state profile data for regional demographics and economics, as well as employment data from the Illinois Department of Employment Security. The data is projected out to 2040 using employment and dwelling unit data based upon the adopted land use plans of all the local and county jurisdictions.

3.9 Land Use

Land use and cover refer to the type of use assigned to a parcel, such as residential or commercial, and the type of surface coverage found on a parcel, such as forest and grassland, respectively. This information is necessary for understanding the impact of current and future land use on watershed resources and the restoration potential.

3.9.1 Historical Land Use

1972 Land Use data for the Madigan Creek watershed was obtained from the United States Geological Survey (USGS) GIRAS Land Use and Land Cover database. USGS GIRAS Land Use and Land Cover for the Madigan Creek watershed is summarized in Table 3-10 and depicted in Figure 3-7.

Table 3-10 Geological Survey (USGS) GIRAS Land Use and Land Cover for the Madigan Creek Watershed

USGS GIRAS Land Use and Land Cover Type	Acres	Percent of Watershed
Residential	1,050.29	28.36%
Commercial and Services	143.26	3.87%
Transportation, Communications, and Utilities	65.30	1.76%
Other Urban Built-up	133.51	3.60%
Cropland and Pasture Lands	2,009.06	54.24%

Deciduous Forest Lands	63.01	1.70%
Strip Mines	40.77	1.10%
Transitional Areas	198.71	5.36%

Definitions of each land use/cover types listed in Figure 3-7 and Table 10 are as follows:

Residential: Land cover than contains residential areas ranging from high density to low density.

Commercial and Services: Land cover that contains commercial areas used predominately for the sale of products and services. Includes such land uses are urban business districts, shopping centers, commercial strip developments, junkyards, resorts, etc. Institutional land uses just as educational, religious, health, correctional and military facilities are also included in this land use.

Transportation, Communications and Utilities: Land cover that includes roads, railways, airports, seaports, and major lake ports.

Other Urban or Built-Up Land: Land cover consisting of golf driving ranges, zoos, urban parks, cemeteries, waste sumps, water-control structures and spillways, golf courses, and ski areas.

Cropland and Pasture: Land cover consisting of agricultural land used for harvest and pasture.

Deciduous Forest: Land cover consisting of all forested areas having a predominance of trees that lose their leaves at the beginning of the forest system or at the beginning of a dry season.

Mines: Land cover consisting of extractive mining activities with a significant surface expression.

Transitional Areas: Land cover in areas that are in transition from one land use activity to another.

3.9.2 Existing Land Use

Existing land use data was not readily available for the Madigan Creek watershed. In order generate this data, zoning information provided by the county was overlayed with the 2000 aerial photograph as a means of generating existing land use data. Existing Land Use and Land Cover for the Madigan Creek watershed is summarized in Table 3-11 and depicted in Figure 3-8.

Table 3-11 Existing Land Use and Land Cover for the Madigan Creek Watershed

USGS GIRAS Land Use and Land Cover Type	Acres	Percent of Watershed
Agriculture	270.62	6.81%
Commercial	910.80	22.92%
Other	15.51	0.39%
Publicly Owned Land/Parks/Rec. Areas	212.99	5.36%
Residential	1718.34	43.25%

Right-of-Way	764.14	19.23%
Industrial	80.82	2.03%

Definitions of each land use/cover types listed in Figure 3-8 and Table 3-11 are as follows:

Agriculture: Land cover consisting of agricultural land used for harvest and pasture.

Commercial: Land cover that contains commercial areas used predominately for the sale of products and services. Includes such land uses are urban business districts, shopping centers, commercial strip developments, junkyards, resorts, etc.

Other: Land cover consisting of extractive mining activities with a significant surface expression.

Publically Owned/Land/Parks: Land cover consisting of parks, golf courses, nature preserves, playgrounds and athletic fields when associated with another open space activity. Institutional land uses just as educational, religious, health, correctional and military facilities are also included in this land use.

Residential: Land cover than contains residential areas ranging from high density to low density.

Right of Way (ROW): Land cover that includes roads, railways, airports, seaports, and major lake ports.

Industrial: Land cover consisting of manufacturing and processing, warehousing and distribution centers, wholesale facilities, and industrial parks.

3.9.3 Future Land Use

Through land use decisions and development standards and controls, Cherry Valley, Rockford, and Winnebago County have the majority of the land use discretion to determine the future of the watershed. Without proper attention to development location and design, future impacts to watershed could include increased flooding and streambank erosion and the degradation of water quality, and aquatic habitat.

Much of what is currently agriculture, or other is expected to be converted to urban land uses. As detailed in Table 3-11, approximately 7% of the watershed may be available for additional development in the future. Based on the location of these areas, it is likely that these lands will be converted into residential and commercial uses. Land use conversion from primarily open to a residential and commercial uses will increase the impervious cover of the watershed, which will also have a significant impact on flooding, water quality, and other watershed resources. To help reduce the negative impact of additional impervious surfaces, best management practices should be integrated into development designs wherever possible. Conservation development, practices that attempts to preserve the natural drainage and infiltration capacity of the developed landscape, is another very effective way to reduce the negative effects of land use changes and increased impervious areas.

3.10 Cultural Resources

Cultural resources are sites, structures, buildings, landscapes, districts, and objects that are significant in history, prehistory, archeology, architecture, engineering, and/or culture. Knowing the culture resources of a watershed provides information on changes that occurred in the landscape and help define information related to historical vegetative communities, climate changes, wildlife populations, and historic uses of the land. All of which could be useful during the watershed planning process. Additionally, as cultural resources provide learning opportunities for the public, the preservation and protection of the cultural resources located in the watershed from development and damage is an important objective of watershed planning.

In 1966, the National Historic Preservation Act was passed to manage and protect cultural resources by requiring Federal and State agencies to establish historic preservation programs to identify, evaluate, and protect important sites under their jurisdiction. The National Park Service administers the National Register of Historic Places as part of the requirements of the National Historic Preservation Act. Properties in the Register include districts, sites, buildings, structures, and objects that are significant in American history, archeology, architecture, engineering, and culture. The National Register sites have been nominated by governments, organizations, and individuals according to defined, uniform set of standards. According to the National Register of Historical Places, there are no National Register for Historic Places listed for the Madigan Creek watershed.

In Illinois, the Illinois Historical Preservation Agency (IHPA) preserved and protects public and private historical properties and library collections. The IHPA Historic Architecture and Archeological Resource Geographic Information System (HAAGIS) (<http://gis.hpa.state.il.us/hargis/>) was utilized to locate and identify the historical properties in the Madigan Creek database. There are no sites within the Madigan Creek watershed identified on the HAAGIS site as historic site.

3.12 Transportation

Approximately 20% of the Madigan Creek watershed is right-of-way for roads, trails, and railroads. The impact of streets and highways on the watershed, particularly water quality, is significant. Table 3-12 lists a number of water quality pollutants and their sources, all of which are associated with the transportation system. Rain water flowing over the surface of our streets can carry these pollutants into our wetlands and stream, where they can accumulate and impair the quality of these resources for aquatic life.

Table 3-12 Transportation Related Pollutants

Pollutant	Primary Sources
Particulates	Pavement wear, atmosphere, vehicles
Nutrients including nitrogen and phosphorus	Atmosphere, fertilizer application
Lead	Tire wear, exhaust
Zinc	Tire wear, motor oil and grease
Iron	Rust, steel highway structures, engine parts
Copper	Metal plating, break lining wear, engine parts, bearing and bushing

	wear, fungicides and pesticides
Cadmium	Tire wear, insecticides
Chromium	Metal plating, engine parts, break lining wear
Nickel	Diesel fuel, gasoline, oils, metal plating, break lining wear, asphalt paving
Manganese	Engine parts
Cyanide	Anticake compound used in deicing salts
Sodium, Calcium, Chloride	Deicing salts
Sulphate	Fuel, deicing salts
Petroleum	Spills and leaks of motor oils, antifreeze and hydraulic fluids, asphalt surface leachate

3.12.1 Existing Transportation Network

Two interstates are located in or immediately adjacent to the Madigan Creek watershed. Interstate 90 borders the Madigan Creek watershed to the east. Interstate 39 is located in the southeast corner of the watershed near within Cherry Valley. In addition to the interstates, several secondary roads traverse the Madigan Creek watershed: State Street, Newburg Road, Charles Street, Harrison Avenue, Milford Road, and Perryville Road. State Street is located in the north portion of the watershed and generally run from east to west. Many commercial properties are situated along State Street. State Street provides access to Interstate 90 just east of the watershed boundary. Newburg Road also running east to west is located in the central part of the watershed. Residential properties are primarily situated along Newburg Road. Harrison Avenue and Charles Street are located on the southern portion of the Madigan Creek watershed. Charles Street runs on a slight west to east diagonal and eventually terminates at Harrison Avenue just west of the CherryVale Mall. Harrison Avenue also runs east to west and provides access to Interstate 39 via a cloverleaf interchange southeast of the CherryVale Mall. Mulford Road and Perryville Road are the major north to south secondary roads in the watershed. Mulford Road is located in the western portion of the watershed with Perryville located in the eastern part. Figure 3-9 depicts the watershed transportation network.

There is one rail line operated by the Canadian National Railway Company is located in the southeast portion of the Madigan Creek watershed.

3.12.2 Proposed Transportation Projects

There are no significant road constructions or road widening projects proposed in the Madigan Creek watershed. As such, no changes to the existing transportation network are presumed to occur in the watershed.

3.13 Natural Resources

This section of the plan describes the natural areas within the Madigan Creek watershed, including natural areas, parks, recreational trails plant and animal species concerns, wetlands, and groundwater.

3.13.1 Natural Areas

Historically, there was a portion of one Winnebago County Natural Areas Inventory (NAI) site located in the Madigan Creek watershed: Harrison Woods. Approximately 1.9 acres of

Harrison Woods were located in the southwest portion of the watershed near the intersection of Harrison Avenue and Stowmarket Avenue. Historically, this area was comprised of undisturbed native upland woods including white oaks, sugar maples, and walnuts. However, this area was developed in 2006 and is now comprised commercial and residential properties. It should be noted that a very small remnant of the native upland forest are located between the commercial and residential properties but are considered be of low ecological significance. Figure 3-10 depicts the historical location of Harrison Woods.

There are no Illinois NAI sites in the Madigan Creek watershed.

3.13.2 Recreational Parks

The Rockford Park District manages 7 recreational parks located entirely or partially within the Madigan Creek watershed. Additionally, one privately owned facility, the Midway Village and Museum Center is partially located in the watershed. Each of these facilities and a description of their amenities is include in Table 3-13 and depicted on Figure 3-11.

Table 3-13: Natural Areas and Recreational Parks in the Madigan Creek watershed

Park Name	Address	Total Acreage	Acreage in Watershed	Natural Areas	Playground	Tennis Court	Ball Diamond	Basketball Court	Soccer Field
Gregory School Park	4820 Carol Ct, Rockford, IL	7.13	0.62		✓	✓	✓		
Magic Waters	7820 N Cherryvale Blvd, Cherry Valley, IL	37.3	37.3	Facility is a water park					
Mariposa Park	2175 Arnold Ave., Rockford, IL	6.05	5.62		✓	✓	✓	✓	✓
Midway Village and Museum Center	6799 Guilford Road, Rockford, IL	137	6.82	✓					
Southeast Community Park	3151 Perryville Road, Rockford, IL	77.92	58.55	✓					✓
Swanson Park	2780 Swanson Parkway, Rockford, IL	6.15	6.15	✓					
Vandercook School Park	5929 Darlene Drive, Rockford, IL	8.42	4.99		✓	✓	✓	✓	

3.13.3 Pedestrian Trails

There are three pedestrian/recreational trails located in the Madigan Creek watershed: Perryville Path, Charles Street Community Path and the Cherry Valley Pedestrian Path. The Perryville Path is located in the northern portion of the watershed. The Perryville Path runs

nearly 7 miles (of which 0.5 miles is located in the watershed) and connects the communities of Loves Park and Rockford. The asphalt paved trails begins in Rock Cut State Park and continues south along Perryville Road through residential, commercial and business areas ending just south of Midway Village and Museum Center in the Madigan Creek watershed near the intersection of Perryville Road and Angus Drive. Future plans for the Perryville Path include extending the path along Perryville Road or Bell School Road to the CherryVale Mall.

The Charles Street Community Path is located in the southern portion of the watershed along Charles Street. This 2.6 mile asphalt-paved path begins at the intersection of Charles Street and Quentin Street near Alpine Park and terminates in the watershed at the intersection of Charles Street and Perryville Road near the CherryVale Mall. The Charles Street Community Path also provides access to AC Thompson Elementary School. Approximately 0.86 miles of the Charles Street Community Path is located within the Madigan Creek watershed. According to the Greenway Plan prepared by RMAP, there are plans to extend the St. Charles Path to connect with the Perryville Path and the Cherry Valley Path.

The Cherry Valley Pedestrian Path is located in the southeast corner of the Madigan Creek watershed. This 1.43-mile long asphalt-path is located in Southeast Community Park and Swanson Park and runs between Swanson Parkway and Valley Woods Drive. The path offers a scenic route through wooded areas and by the three ponds located within Swanson Park. The entire length of the Cherry Valley Pedestrian Path is located within the Madigan Creek watershed. As mentioned above, the Greenway Plan prepared by RMAP proposed to extend the Cherry Valley Pedestrian Path to the Perryville Path and St. Charles Path. Additional expansions to the Cherry Valley Pedestrian Path also include extending the path to Bauman Park to the southeast and to the Espenscheid Forest Preserve to the south.

Figure 3-12 shows the location of each of the pedestrian trails located in the Madigan Creek watershed.

3.13.4 Threatened and Endangered Species

The Illinois Endangered Species Protection Board was created by the passage of the Endangered Species Protection Act in 1972 and determines which plant and animal species are threatened or endangered (T&E) in the state. The Illinois Endangered Species Protection Board also advises the Illinois Department of Natural Resources (IDNR) on means of conserving those species. State listed T&E species are designated “endangered” if a species is in danger of extinction as a “breeding” species and is considered “threatened” if the species includes any which is likely to become an endangered species within the foreseeable future. The Illinois Endangered Species Protection Board’s Natural Heritage Database October 2012 Endangered and Threatened Species List identifies 54 T&E species in Winnebago County. A more refined of the Madigan Creek watershed search using the IDNR’s Ecological Compliance Assessment Tool (EcoCat) identified 3 species located in the vicinity of the watershed (Table 3-12). Additionally, the US Fish and Wildlife Service has identified the 3 Federally listed T&E species in Winnebago County (Table 3-13)

Table 3-14: State T&E Species Identified in the Vicinity of the Madigan Creek watershed

Common Name	Scientific Name	State Protection	# of occurrences	Last Observed
Blandings Turtle	<i>Emydoidea blandingii</i>	Endangered	5	08-07-2012
Gravel Chub	<i>Erimystax x-punctatus</i>	Threatened	9	06-06-2012
Black Sandshell	<i>Ligumia recta</i>	Threatened	8	06-06-2012

Table 3-15: Federal T&E Species Identified in Winnebago County

Common Name	Scientific Name	Federal Protection
Prairie bush-clover	<i>Lespedeza leptostachya</i>	Threatened
Indiana bat	<i>Myotis sodalis</i>	Endangered
Eastern prairie fringed orchid	<i>Platanthera leucophaea</i>	Threatened

Based on a review of the critical habitat requirements for each of the state and federal T&E species there is very low potential that the species are currently present within the Madigan Creek watershed.

3.13.5 Wetlands

Wetlands, once prevalent within Illinois, have continued to decline in area and quality. Wetlands are of interest to watershed studies of this sort due to the benefits they provide. Wetlands do more for water quality improvement and flood damage reductions than any other natural resource within a watershed. Wetlands provide a multitude of ecological, economic and social benefits. They provide habitat for fish, wildlife and a variety of plants. Wetlands are also important landscape features because they hold and slowly release flood water and snow melt, recharge groundwater, recycle nutrients, and provide recreation and wildlife viewing opportunities for residents.

The National Wetlands Inventory (NWI) was established by the US Fish and Wildlife Service (FWS) to conduct a nationwide inventory of U.S. wetlands to provide biologists and others with information on the distribution and type of wetlands to aid in conservation efforts. The NWI maps are prepared from the analysis of high altitude imagery, vegetation, visible hydrology, and geography. Infield inspections and wetland delineations are not utilized in the preparation of the NWI maps. Additionally, certain wetland habitats are not included on their maps due to limitations of aerial reconnaissance to properly identify these habitats as wetlands. According the NWI map, there are 25.64 acres of wetland (0.65% of the watershed). As can be seen from Figure 3-13, the majority of the NWI wetlands in the Madigan Creek watershed have been impacted by development.

In order to protection wetlands, projects and other activity should be designed to avoid and minimize any disturbance to the wetland, stream, or other aquatic area. However, if there is an unavoidable impact or disturbance to a wetland or stream, a Clean Water Act Section 404 permit must be obtained from the US Army Corps of Engineers (USACE). The USASE has jurisdiction over waters of the United States (WOUS) including connected wetlands and navigable streams and rivers. For wetlands and WOUS in the Madigan Creek watershed, the ACOE Rock Island District is the responsible entity for permitting any activities that impact jurisdictional wetlands and WOUS. The Rock Island permit program includes a series of regional permits (RP) for various activities such as bank stabilization, flood damage control and road crossings. Activities outside the RP categories are required to obtain an individual

permit (IP). The USACE permits must be applied for and issued before any wetland or WOUS disturbance or impacts occur.

3.13.6 Potential Wetland Restoration Sites

Wetland restoration and creation could be beneficial to the Madigan Creek watershed. By restoring the environmental functions of impacted wetlands or creating new wetlands in suitable areas, wetland restoration and wetland creation could potentially reduce flood volumes and rates, increase plant and animal diversity, and improve water quality conditions. Potential restoration sites were identified using a Geographic Information System (GIS) exercise. As part of this exercise, specific criteria essential for the restoration of a functional and beneficial wetland were utilized and included:

- Site contains NWI wetland
- Site contains at least 2.5 acres of hydric soils
- Site is located on an parcel containing no or very few structures

The GIS analysis revealed one location that could potentially be suitable for wetland creation/restoration – a 14.20 acre parcel located east of the Arlington Memorial Park and Cemetery. It should be noted that residential homes are located on portions of this property.

3.13.7 Drinking and Groundwater Wells

Aquifers in the glacial drift (sand and gravel) of the Quaternary age (less than 75,000 year old) and the carbonate deposits (dolomite and limestone) of the Platteville and Galena Group of Ordovician age (about 450 million years old) are the major sources of groundwater in the watershed. These glacial drift and Galena-Platteville aquifers are considered to be extremely susceptible to contamination as the aquifer is near the land surface, typically at a depth of less than 50 feet, and the soils compose and overlie the aquifers have relatively high hydraulic conductivity of at least 1 foot per day. According to the US Geological Survey (USGS), Winnebago County is considered to have the greatest potential for ground-water contamination in Illinois.

Residents in the Madigan Creek watershed utilize groundwater for a variety of purposes including drinking water, irrigation, and industrial process water. Both the City of Rockford and Cherry Valley use groundwater as their source of drinking water. While under natural undisturbed conditions, groundwater in the Madigan Creek watershed is of high quality and meets the drinking and groundwater standards set for different contaminants by the Illinois Pollution Control Board. Due to the nature of the aquifers in the region, impacts associated with urbanization have the potential to negatively impact drinking and groundwater. Potential sources for contamination associated with urbanization include septic system effluent, oil, gasoline, animal wastes, industrial effluent, paint, solvents, road salt, and lawn and household chemicals.

In order to protect groundwater in Illinois in 1987, the General Assembly passed the Illinois Groundwater Protection Act (IGPA). The IGPA emphasizes the comprehensive management of groundwater resources by requiring the implementation of practices and policies to protect groundwater. These include setting groundwater protection policies such

as setback zones; assessing the quality and quantity of groundwater resources being utilized; and establishing groundwater standards.

Illinois State Geological Survey Well Database

According to the Illinois State Geological Survey (ISGS) database, there have been 505 wells installed in the Madigan Creek watershed. Table 3-16 depicts the quantity and type of each well and Figure 3-14 illustrated the location of each well in the watershed. The ISGS database contains information on wells that was supplied to the agency and has not been feel verified.

Table 3-16: ISGS Wells in the Madigan Creek Watershed

ISGS Well Type	Number of Wells in Watershed
Water Well Monitoring Well	0
Water Well	498
Temporarily Abandoned	0
Engineering Test	6
Dry and Abandoned Well	0
Other Well	1

Illinois Department of Health Well Database

According to the Illinois Department of Health (IDH), there are 18 community and non-community wells in the Madigan Creek watershed. Of the 18 IDH wells, 12 are community wells and 6 are non-community wells. Community wells are public wells that serve residents year round. A public well is defined as well with more than 15 service connections or any well that serves 25 people for at least 60 days per year. A non-community well is public wells that serve nonresidents such as at a restaurant, motel, school, or camp ground. Owners of the community and non-community wells are subject to the requirements of the Safe Drinking Water Act (SWDA) and are responsible for meeting all of the requirements outlined in the Act including conduction drinking water sampling, maintenance of the system and reporting to IDH. Table 3-17 depicts the owner and type of each well and Figure 3-15 illustrated the location of each well in the watershed.

Table 3-17: Community and Non-Community Wells in the Madigan Creek Watershed

Owner	Well Type	Number of Wells Owned
Brian Green Apartments	Community	1
Cherry Valley Easy Apartments	Community	2
Cherry Valley (Village of)	Community	3
Cherry View Apartments	Community	1
Newburgh Landowners Water Association	Community	2
Rockford (City of)	Community	1
Utl Inc/Coventry Hills Uti Inc.	Community	1
Wildwood Utility Company	Community	1
Alvarex Mexican Restaurant	Non-Community	1
Franchesco’s Restaurant	Non-Community	1
Mobil Gas Station	Non-Community	1
Muslim Community Center	Non-Community	1
Oakview Diesel	Non-Community	1
St. Rite’s School	Non-Community	1

3.13.8 Agricultural Best Management Practices

Various programs sponsored by the Natural Resource Conservation Service (NRCS) and Farm Service Agency Wetlands Reserve Program (WRP), Grasslands Reserve Program (GRP), Wildlife Habitat Incentives Program (WHIP), Environmental Quality Incentives Program (EQIP), Conservation Reserve Enhancement Program (CREP), and Conservation Reserve Program (CRP) promote and fund the construction of agricultural BMPs on farmland. Currently there are no agricultural BMPs sponsored by these programs located within the watershed.

3.14 Natural Drainage System

This section describes the conditions and characteristics of the natural drainage system of the Madigan Creek watershed.

3.14.1 Stream Flow

There are no USGS gauging stations on Madigan Creek or within the Madigan Creek watershed. Readily available flow data for the Madigan Creek watershed is limited to calculated flood flows published in the Flood Insurance Survey for Winnebago County and Incorporated Areas (Table 3-18). It should be noted that these flows were based on analysis performed in 1976 and likely do not reflect current watershed conditions.

Tables 3-18: Flood Insurance Study Flows (1976)

Cross Section Location	50-year Flow		100-year Flow	
	Flow (cfs)	Flow cfs/acre	Flow (cfs)	Flow cfs/acre
At Charles Street	920	0.369	1139	0.456

3.14.2 Watershed Hydrology and Hydraulics

Hydrology and hydraulics are commonly used terms to describe the effects of precipitation, runoff, and evaporation on the flow of water in streams and rivers and on adjacent land surfaces. The basis for hydrology and hydraulics studies typically start with an understanding of how topography delineates the land into watershed and subwatersheds. As discussed in the Topography section of this reports, the Online Watershed Delineation (HYMAPS-OWL) tool, created by Department of Agriculture and Biological Engineering at Purdue University was used to create the initial subwatershed boundaries. The subwatershed boundaries generated by HYMAPS-OWL were then cross referenced with boundaries obtained by inputting 2-foot topography into the GIS-based model, Arc Hydro. This combined data generated a Digital Elevation Model (DEM) that was used to delineate and refine the watershed and subwatershed boundaries for Madigan Creek. Inconsistency in the two model's delineations was altered to reflect real-world conditions and more accurately depict the hydrologic boundaries. Most of these inconsistencies occurred in areas divided by roadways that were not accounted for in the model.

The Madigan Creek watershed drains 6.21 square miles. Broad assessment of conditions such as soils, wetlands, and water quality are often evaluated at a watershed level and provide great information of the overall condition of the watershed. However, a more detailed look at smaller drainage areas or subwatershed will often be helpful in finding

specific problem areas. The Madigan Creek contains 23 subwatersheds (Table 3-19). Figure 3-2 depicts the location of each of the subwatershed within the Madigan Creek watershed.

Table 3-19: Subwatersheds in the Madigan Creek Watershed

Subwatershed	Total Acres	Percent of Watershed
1	176.17	4.43%
2	188.76	4.75%
3	463.82	11.67%
4	415.16	10.45%
5	243.04	6.12%
6	417.26	10.50%
7	145.77	3.67%
8	10.81	0.27%
9	59.10	1.49%
10	71.78	1.81%
11	139.62	3.51%
12	284.73	7.17%
13	190.17	4.79%
14	216.82	5.46%
15	252.13	6.35%
16	39.07	0.98%
17	229.18	5.77%
18	16.13	0.41%
19	103.17	2.60%
20	131.55	3.31%
21	56.52	1.42%
22	122.47	3.08%

3.14.3 Flow Paths

The Madigan Creek watershed is drained by the mainstem of Madigan Creek and 3 main tributaries. Madigan Creek is 4.42 miles in length. The mainstem of Madigan Creek has its headwaters in the vicinity of State Street and Bell School Road in a heavy developed commercial area. The headwaters have been significantly modified from its historical location by this development including placing the creek into a municipal storm sewer system and relocating the channel around the commercial development. From the commercial area situated along State Street and Bell School Road, Madigan Creek crosses Mill Road and flows southward through a residential area. Through this residential area, Madigan Creek follows along Cerasus Drive and Montmorency Drive before crossing Newburg Road.

Just south of Newburg Road, an unnamed tributary (Tributary #1) joins Madigan Creek. From this point, Madigan Creek runs in a southerly direction through a residential area along Valencia Drive. A series of large on-line wetland bottom detention basins associated with the commercial development along Perryville Road are located on this segment of Madigan Creek. Just north of the on-line detention basins, Tributary #2 joins Madigan Creek.

From its confluence with Tributary #2, Madigan Creek flows to the southeast through a commercial area crossing Perryville and Charles Roads. The segment of Madigan Creek located between Charles Road and Harrison Avenue is lined with concrete revetment mat.

From Harrison Avenue, Madigan Creek continues to flow to southeast to Vandiver Road. Just south of Vandiver Road, an on-line regional compensatory storage basin has been constructed on the creek commonly referred to as the upper pond in Southeast Community Park. Tributary #3 is also tributary to the upper pond. From the upper pond, Madigan Creek flows southeasterly into another on-line regional compensatory storage basin known as the lower pond before flowing under Interstate 39 and the Canadian National Railroad before its confluence with the Kishwaukee River. More information on these basins is available in Section 3.16.4.

Tributary #1 has its headwaters in the north central portion of the watershed near the intersection of Trainer Road and Fincham Drive. There have been significant modifications to the hydrology of Tributary #1. The headwaters of Tributary #1 are a stream with an undefined channel flowing southwest towards Mulford Road though an undeveloped parcel. The original flowpath of Tributary #1 flows west/southwest from Mulford Road to near Woodbine Drive and Gordon Avenue where it merged with another small tributary. However, in the 1970s, Tributary #1 from Mulford Road to Woodbine Drive/Gordon Avenue was placed in a culvert and the flows redirected towards the south along Mulford Road. The culvert runs south to Van Matre Heathsouth Rehab Hospital before turning east near Laurel Cherry Drive. From this point, the culvert turns south again and daylight at Fox Basin Road/Conrad Road. A large concrete energy dissipating structure is located at the outfall of the culvert. It should be noted that flow path of the culvert is approximate as the original construction plans were not available for this review. The energy dissipating structure discharges into a Tributary #1 which is concrete lined.

Tributary #1 remains surface water at Woodbine Drive/Gordon Avenue. From this location, Tributary #1 flow south/southeast under Newburg Road. Just south of Newburg Road, a small tributary meets Tributary #1 and continued to flow east. From approximately just east of Greenleaf Way to Mulford Road, the channel of Tributary #1 is concrete lined. At the intersection of Mulford Road and Newburg Road, the creek crosses to the north side of Newburg Road and flows east towards Perryville Road. The segment from Newburg Road to Stoney Creek Way is also concrete lined and the outfall discussed above discharges to this segment of Tributary #1. From this point, Tributary #1 flows in an open channel through a residential area in an easterly direction and meets it confluence with Madigan Creek just south of the intersection of Perryville Road and Newburg Road.

The headwaters of Tributary #2 are located in Arlington Memorial Park Cemetery. From the cemetery, Tributary #2 flows easterly towards Mulford Road. After crossing Milford Road, the tributary continues to flow easterly towards though a forested area and then through a residential subdivision before its confluence with Madigan Creek.

The headwaters of Tributary #3 are located near the intersection of Mulford Road and Columbine Drive. From this point, Tributary #3 flows in an open channel along Columbine Drive to the south/southeast through a residential area before crossing Harrison Avenue. From Harrison, the tributary flows in an easterly direction towards Panorama Drive. After crossing Panorama Drive, the creek becomes concrete lined as the creek flows into Southeast Community Park. However, once inside the park, the creek then begins to flow in an open channel and parallels the Cherry Valley Path until its confluence with Madigan Creek at the upper pond. Just west of Perryville Road, an online compensatory storage basin

referred to as the Cherry Valley Phase I detention basin is located on Tributary #3. More information on this basin is available in Section 3.16.4.

3.14.4 Channel Conditions

Urban development in the watershed is reducing the amount of land available for the natural infiltration of rainfall into the ground, where it can be intercepted and absorbed by vegetation or stored in depressional areas, wetlands and floodplains of the watershed. With increasing amounts of impervious surface and an extensive network of storm sewers that convey the increased volume of runoff to the stream channel faster, a stream channel experiences what is called "flashy" hydrology. A "flashy" hydrology means that the water level in the stream rises very quickly during a storm and falls quickly afterward. Since less water is infiltrating into the ground and constantly seeping out and creating a steady base flow within the stream, low flows are considerably lower. Likewise, because less water is absorbed by the ground and more water is flowing into the streams, high flows are considerably higher. High flows can result in damage to property of watershed residents, erosion, flooding, and pollution. Decreased or low flows degrade aquatic habitat because low flows have low levels of dissolved oxygen necessary for aquatic animals and because, in extreme cases, the stream can dry up completely for periods of time.

A number of factors were inventoried to better describe the condition of the Madigan Creek Watershed. The degree of hydromodification and channelization, are both measures of the health and condition of a river or stream.

Hydromodification

Hydromodification is a term that is used to describe human induced activities that change the dynamics of surface or subsurface flow. Historically, the most prevalent form of hydromodification was the channelization of streams to increase agricultural production. Early settlers of the Midwest quickly realized that the soils found under wetlands and wet prairies were ideal for crop production once the water was removed. In order to "dry" the wetlands and the wet prairies, systems of sub-surface drainage tiles were installed in order to re-route the groundwater away from the wetlands and wet prairies and discharged in to surface waters. Given that the drain tiles were drained by gravity flow, the receiving surface water needed to be a lower elevation than the tile. As such, naturalized stream channels were often excavated to a deeper depth and straightened to facilitate quicker drainage of the fields. Once the water was removed, these areas could be put into successful agricultural production. This creation of agricultural land was at the cost of the loss of wetlands, wet prairies, and riparian habitat. Hydromodification attributed to the installation of drain tiles is not prevalent in the Madigan Creek watershed.

In the Madigan Creek watershed, hydromodification attributed to urbanization is prevalent. The process of urbanization affects streams by altering watershed hydrology and sediment-transport patterns. Development increases the amount of impervious surfaces (parking lots, rooftops, highly compacted ground, etc) on formerly undeveloped landscapes. This reduces the capacity of the remaining pervious surfaces to capture, filter rainfall, and allow the rainfall to infiltrate into the ground. As a result, a larger percentage of rainfall becomes runoff during any given storm. Subsequently, runoff reaches stream channels much more quickly, and peak discharge rates are higher than before development for the same size rainfall event.

The short-term impact result of this type of hydromodification is localized, overbank flooding. Over the long term, hydromodification will cause the stream channel to expand as a means of handling the higher flows. As the stream channel expands, the banks will erode and the bottom will become deeper. This deepening of the stream channel is called incision. The process of stream bank erosion and channel incision causes a significant amount of sediment to be generated within the stream and carried through the watershed and into the stream's receiving water. Channel incision also leads to a disconnect between the stream and its floodplain. Once separated, high flows that were once stored in the floodplain and slowly released back into the stream are forced to remain in the channel. These "trapped" flows have high velocities leading to additional streambank erosion and incision of the stream channel. It becomes a vicious pattern where with each rainfall event; the creek continues to erode adding additional sediments to the watershed and further preventing the creek to access the floodplain.

Hydromodification attributed to urbanization is prevalent throughout the Madigan Creek watershed and is the most significant cause of water quality degradation in the watershed. Figure 3-16 depicts significant hydromodification impacts in the Madigan Creek watershed.

Channelization

Channelization is the practice of dredging and straightening stream channels to increase flow rates and carrying capacities. In some cases, the stream channel will be paved with concrete during channelization. Traditionally, channelization was done to move as much water as possible away from an area in a short period of time and prevent flooding. However, there are problems resulting from channelization. Channelization is detrimental for the health of streams and rivers through the elimination of suitable instream habitat for fish and wildlife and the creation of excessive flows in the stream leading to hydromodification both within and downstream of the channelized areas.

Figure 3-17 depicts the location of severe channelization in the Madigan Creek watershed. The figure also denoted which portions of the surface waters are concrete-line and lined with concrete revetment mat.

3.14.5 Hydraulic Structures

Hydraulic structures are categorized as bridges, culverts, levees, weirs, dams, fencing and any other human made structures located in or over the stream channel. The location and condition of hydraulic structures is a valuable piece of information as hydraulic structures may act as possible constrictions in conveying river flow, increase the potential for backwater flooding problems, and impede the movement of fish and other aquatic species up and down the stream.

As part of the watershed planning process, 22 hydraulic structures were surveyed in the Madigan Creek watershed (Table 3-20 and Figure 3-18).

Table 3-18: Hydraulic Structures Surveyed in the Madigan Creek Watershed

Structure No.	Type	Opening	Length	Slope
1	CMP H. Ellipt.	36" Equiv. Diameter	36'	0.20%
2	RCP	24" Dia.	215'	0.25%
3	RC Box	6.5' x 6'	130'	0.40%
4	CMP Arch	106" x 73"	61'	1.21%
5	CMP Arch	106" x 73"	101'	0.92%
6	CMP	2 @ 72" Dia.	61'	0.45%
7	RC Box	1 @ 10' x 4' 1 @ 6' x 4'	97'	0.18%
8	RC Box	1 @ 10' x 4' 1 @ 6' x 4'	102'	0.15%
9	RC Box	1 @ 10' x 4' 1 @ 6' x 4'	88'	0.34%
10	RC Box	10' x 3.5'	38'	0.00%
11	CMP	48" Dia.	75'	0.53%
12	RC Box	13' x 4.5'	119'	0.40%
13	RC Box	11' x 8'	227'	0.59%
14	RC Box	2 @ 12' x 5'	72'	0.00%
15 (101-5111)	RC Box	2 @ 12' x 5'	562'	0.42%
16 (101-2017)	RC Box	3 @ 8' x 6'	112'	0.53%
17 (101-2018)	RC Box	3 @ 8' x 6'	200' (W cell) 195' (center) 190' (E cell)	0.34%
18 (101-2026)	RC Box	2 @ 10' x 7.5'	46'	1.00%
19	RC Box	2 @ 12' x 10'	241'	0.59%
20	RC Box	3 @ 8' x 7'	76'	0.51%
21	Railroad Bridge			
22 (101-5146)	RC Box	2 @ 13.5' x 12.5'	62'	0.16%

With the exception of the railroad crossing, all of the hydraulic structures surveyed were in-stream culverts under road crossings. Culverts are metal, plastic, or concrete pipes that transport water, most commonly used under roadways or driveways. Culverts may be round, oval, rectangular, or other shapes, and they can be open or closed on the bottom. A number of these within the watershed are exhibiting clogging, wear and tear, erosion, and near failure in some locations.

Dams can serve as potential barriers to the movement and dispersal of aquatic organisms such as fish and may limit available habitat for breeding and feeding. Two Class III dams are located in the Madigan Creek watershed. These dams are discussed in more detail in Section 3.16.4.

3.14.6 Instream and Riparian Habitat Assessment

Water quality criteria were originally published as guidance under Section 304(a) of the Clean Water Act to allow states to derive site-specific water quality criteria for the protection of stream health. In addition, to these water quality guidance criteria, the US EPA established guidance, *Water Body Survey and Assessment Guidance for Conducting Use Attainability Analysis*, to determine if a surface water is meeting its established criteria. The US EPA has updated this guidance and published the *Rapid Bioassessment Protocol (RBP) for Stream and Rivers*. The RBP includes methods for conducting cost effective biological assessments of stream and rivers including sampling methods for periphyton, benthic macroinvertebrates, fish, and habitat. During the Madigan Creek watershed stream walk in July 2011, the RFB methodologies were utilized to evaluate habitat conditions at 19 sites within the watershed (Figure 3-19).

The RBP scoring assessment was used to estimate the habitat quality and conditions at each of the 19 sites on Madigan Creek. The following is a list of the physical, water quality, and habitat parameters evaluated at each site:

- **Physical Parameters**
 - Predominate surrounding land use
 - Local watershed nonpoint source pollution
 - Stream depth and width
 - Dams
 - Channelization
 - Canopy Cover
 - Sediment odors
 - Sediment oils
 - Substrate texture
 - Aesthetics
- **Water Quality Parameters**
 - Water odors
 - Surface odors
 - Turbidity
 - Stream type and state class
- **Habitat Parameters**
 - Substrate cover for aquatic organisms
 - Embeddedness
 - Flow
 - Channel alteration
 - Bottom scour/deposition
 - Run/bend ratio
 - Bank stability
 - Bank vegetation

- Streamside cover
- Undercut banks
- Bank slope

The results of the Habitat RFB are presented in Tables 3-21 to 3-28. Field data sheets are included in Appendix XX.

Table 3-21: Madigan Creek RBP Physical Characteristic - Instream Features

Station	Instream Features							Channelized?	Dam Present?
	Est. Stream Width	Est. Stream Depth	Canopy Cover	Proportion of Reach Represented by Stream Morphology Types					
				Riffle	Pool	Run			
1	6 ft	0.8 ft	Partly Shaded			100%	Yes	No	
2	30 ft	1 ft	Partly Open			100%	Yes	No	
3	10 ft	1.33 ft	Partly Open			100%	Moderate	No	
4	13 ft	0.8 ft	Partly Open			100%	Yes	No	
5	5 ft	0.7 ft	Partly Open			100%	Yes	No	
6	10.5 ft	0.3 ft	Partly Open			100%	Moderate	No	
7	12.15 ft	0.6 ft	Partly Open			100%	Yes	No	
8	6 ft	0.65 ft	Partly Open			100%	Yes	No	
9	8 ft	0.2 ft	Partly Shaded			100%	Yes	No	
10	20 ft	1 ft	Partly Open	50%	50%		Yes	No	
11	5 ft	Dry	Partly Open			100%	Yes	No	
12	*	*	Partly Open			100%	Yes	No	
13	15 ft	Dry	Partly Open			100%	Yes	No	
14	30 ft	2 ft	Partly Shaded	50%	50%		No	No	
15	6 ft	Dry	Shaded			100%	Yes	No	
16	6 ft	Dry	Shaded			100%	Yes	No	
17	**	Dry	Partly Shaded			100%	No	No	
18	*	Dry	Partly Open			100%	Yes	No	
19	6 ft	Dry	Shaded			100%	Yes	No	

* Online detention

** Undefined Channel

Table 3-22: Madigan Creek RBP Madigan Creek RBP Physical Characteristic -Watershed Features and Riparian Habitat

Station	Watershed Features			Riparian Vegetation	
	Predominant Surrounding Land Use	Local Watershed NPS Pollution	Local Watershed Erosion	Dominant Type	Dominant Species
1	Commercial	Obvious sources	None	Grasses/Herbaceous	Natives
2	Commercial	Obvious sources	None	Grasses/Herbaceous	
3	Commercial/Residential	Obvious sources	None	Shrubs/Grasses/Herbaceous	Natives
4	Residential	Obvious sources	Heavy	Trees/Herbaceous	
5	Residential	Obvious sources	None	Grasses	
6	Residential	Obvious sources	Heavy	Trees/Grasses	
7	Commercial	Some potential sources	Heavy	Trees/Herbaceous	
8	Residential	Some potential sources	Heavy	Grasses	Turf
9	Residential	Obvious sources	Heavy	Trees/Shrubs	
10	Commercial	Obvious sources	Heavy	Trees	
11	Commercial/Residential	Some potential sources	None	Grasses	
12	Commercial/Residential	Some potential sources	None	Grasses	Reed, teasel
13	Commercial	Some potential sources	None	Trees/Grasses	
14	Forest/Residential	Obvious sources	Moderate	Grasses	
15	Forest	Some potential sources	None	Trees	
16	Forest	Some potential sources	None	Trees	
17	Residential	Some potential sources	None	Trees	
18	Residential	Obvious sources	None	Grasses	Turf
19	Forest	Some potential sources	Moderate	Trees	

Table 3-23: Madigan Creek RBP Physical Characteristic – Substrate Components

Station	Inorganic Substrate Components							Organic Substrate Components		
	Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Clay	Detritus	Muck-Mud	Marl
1	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	75%	0%	25%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
4	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
6	0%	0%	0%	75%	25%	0%	0%	0%	0%	0%
7	0%	0%	0%	25%	75%	0%	0%	0%	0%	0%
8	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
9	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
10	0%	0%	25%	50%	25%	0%	0%	0%	0%	0%
11	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
12	0%	0%	0%	50%	0%	50%	0%	0%	0%	0%
13	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
14	0%	0%	25%	50%	25%	0%	0%	0%	0%	0%
15	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
16	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
17	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
18	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
19	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%

Table 3-24: Madigan Creek Watershed RBP Habitat Assessment Results

Station	Stream Type	Epifaunal Substrate/Available Cover	Pool Substrate Characterization	Pool Variability	Sediment Deposition	Channel Flow Status	Channel Alteration	Channel Sinuosity	Bank Stability		Vegetative Protection		Riparian Vegetative Zone		Total Score
									Left	Right	Left	Right	Left	Right	
1	Perennial	9	4	1	20	2	19	1	9	9	4	4	0	0	82
2	Intermittent	9	7	0	7	1	6	0	10	10	9	9	6	1	75
3	Intermittent	13	1	0	20	1	10	2	10	10	9	9	7	7	99
4	Perennial	9	17	1	20	1	7	0	0	0	0	0	0	0	55
5	Intermittent	7	16	0	20	1	8	0	7	7	6	6	0	0	78
6	Intermittent	7	6	0	19	1	6	0	0	0	1	1	0	0	41
7	Intermittent	10	11	7	7	1	11	4	3	3	2	2	0	0	61
8	Intermittent	9	6	1	20	1	6	1	4	4	2	2	0	0	56
9	Intermittent	3	8	1	20	1	7	1	2	2	1	1	0	0	47
10	Intermittent	5	7	8	15	7	7	3	2	2	2	2	0	0	60
11	Intermittent	1	1	1	20	2	6	1	8	8	6	6	0	0	60
12	Intermittent	6	6	1	1	2	5	1	9	9	8	8	5	5	66
13	Intermittent	1	8	1	19	2	6	1	8	8	7	7	0	0	68
14	Perennial	13	9	13	14	9	14	13	6	6	6	6	1	1	111
15	Intermittent	3	6	0	19	0	16	14	0	0	0	0	4	3	65
16	Intermittent	3	6	0	19	0	16	14	0	0	0	0	4	3	65
17	Intermittent	2	6	0	20	0	16	0	0	0	0	0	2	2	48
18	Intermittent	0	0	0	20	0	0	0	10	10	0	0	0	0	40
19	Intermittent	15	6	0	20	0	6	0	0	0	0	0	4	3	39

Table 3-25: Madigan Creek RBP Physical Characteristic – Water Quality and Soil Conditions

Station	Water Quality			Sediment			
	Water Odors	Water Surface Oils	Turbidity	Odors	Deposits	Oils	Black Rock Undersides?
1	Normal/None	None	Slightly turbid	Normal	None	Absent	No
2	Normal/None	None	Slightly turbid	Normal	None	Absent	No
3	Normal/None	None	Turbid	Normal	None	Absent	No
4	Normal/None	None	Slightly turbid	Normal	None	Absent	No
5	Normal/None	None	Slightly turbid	Normal	None	Absent	No
6	Normal/None	None	Clear	Normal	None	Absent	No
7	Normal/None	None	Slightly turbid	Normal	None	Absent	No
8	Normal/None	None	Turbid	Normal	None	Absent	No
9	Normal/None	None	Turbid	Normal	None	Absent	No
10	Normal/None	None	Slightly turbid	Normal	None	Absent	No
11	Dry	Dry	Dry	Normal	None	Absent	No
12	Normal/None	None	Slightly turbid	Normal	None	Absent	No
13	Fishy	None	Slightly turbid	Normal	None	Absent	No
14	Normal/None	None	Slightly turbid	Normal	Sand	Absent	No
15	Dry	Dry	Dry	Normal	None	Absent	No
16	Dry	Dry	Dry	Normal	None	Absent	No
17	Fishy	None	Slightly turbid	Normal	None	Absent	No
18	Dry	Dry	Dry	Normal	None	Absent	No
19	Dry	Dry	Dry	Normal	None	Absent	No

Each of the habitat parameters listed in Table 3-26 were visually evaluated and assigned a conditions number using the scale in Table 3-27. The habitat parameter evaluation criterion is detailed on the Field Sheets included in Appendix XX. For the purposes of the watershed plan, a Cumulative Habitat Condition Category and Scale was developed in order to assign each sampled site a habitat category from poor to optimal (Table 3-28).

Table 3-26: RBP Madigan Creek Watershed RBP Habitat Condition Category and Scale

Condition Category			
Poor	Marginal	Suboptimal	Optimal
0-5	6-10	11-15	16-20

*Bank Stability, Vegetative Protection, and Riparian Vegetative Zone Width are scored for each bank using a scale of 1-10 and then summed for a score between 1-20.

Table 3-27: RBP Madigan Creek Watershed Cumulative Habitat Condition Category and Scale

Condition Category			
Poor	Marginal	Suboptimal	Optimal
0-50	50-110	100-150	150-200

Based on the cumulative habitat condition scale outline in Table 3-27, 5 sites within the Madigan Creek watershed are categorized as poor, 13 are marginal and 1 is suboptimal. No sites were identified as having optimal habitat conditions (Table 3-28).

Table 3-28: Habitat Condition Scores for Madigan Creek Watershed

Site	Cumulative Score	Condition Category
1	82	Marginal
2	75	Marginal
3	99	Marginal
4	55	Marginal
5	78	Marginal
6	41	Poor
7	61	Marginal
8	56	Marginal
9	47	Poor
10	60	Marginal
11	60	Marginal
12	66	Marginal
13	68	Marginal
14	111	Suboptimal
15	65	Marginal
16	65	Marginal
17	48	Poor
18	40	Poor
19	39	Poor

Benthic Monitoring

RiverWatch volunteers conducted a macroinvertebrate survey on Madigan Creek near its confluence with the Kishwaukee River at the Mill Road Bridge on 06/30/2011. Macroinvertebrates are small animals that do not have a backbone and can be seen with the naked eye. Macroinvertebrates include animals such as insects, crustaceans, mollusks, arachnids, and annelids. As macroinvertebrates live in water for all or part of their lives, their survival is related to water quality. These animals are sensitive to different chemical and physical conditions in the water such as increased water pollution or changes in water flow. As such, the richness of macroinvertebrate community composition in a stream or river can be used to provide an estimate of stream health.

After collecting the macroinvertebrates, the volunteers calculated a Macroinvertebrate Biotic Index (MBI). The MBI is designed to rate water quality using the pollution tolerance of macroinvertebrates and is an estimate of the degree and extent of organic pollution and disturbance in the stream. The MBI is a modification of the Hilsenhoff Biotic Index (HBI) first used in Wisconsin streams. Following data collection, the macroinvertebrates are

identified and given a predetermined pollution tolerance rating. The MBI is calculated by taking the average of tolerance ratings weight by the number of individuals in the sample. MBI scores of less than 4.35 represent excellent water quality while scores greater than 6.26 indicate poor water quality.

As the sampling site is just upstream of Madigan Creek's confluence with the Kishwaukee River, the site provides a "snapshot" of water quality for the entire watershed. The results of the macroinvertebrate sampling resulted in a MBI of 6.87 or poor water quality. No macroinvertebrates of special interest such as native mussels were observed. Although the MBI indicated poor water quality, it was noted that numerous frogs, tadpoles, and fish were present in the creek at the time of the sampling.

With the exception of the one RiverWatch sample noted above, no additional biological data is known to exist for the Madigan Creek watershed.

3.15 Water Quality

Water quality is impacted by pollutants from a number of point and non-point sources. Point sources are discharges from a single source such as a pipe conveying wastewater from a wastewater treatment facility into the stream. Nonpoint sources contribute pollutants to the water system from across the landscape including runoff from yards, rooftops, roads, parking lots, and other urban and nonurban surfaces. During storms, pollutants on the landscape are washed from the ground and impervious surfaces into storm sewers and roadside drainage ditches, and ultimately into the Madigan Creek stream system. Physical changes in the watershed, such as hydromodification, channelization and the loss of riparian vegetation and wetlands, also impact water quality and aquatic habitat.

The causes and sources of water quality problems in the Madigan Creek watershed are urban in nature. These problems are the result of many years of modification of the watershed landscape as it changed from natural to agricultural to urban. These changes have included modification of the stream channel, floodplain, and wetlands. Other changes are the result of the increased watershed impervious cover that has led to an increase in the volume and rate of runoff in the watershed. The increased quantity of runoff has caused problems such as excessive stream bank erosion and the deepening of the stream channel due to channel erosion. In addition to increasing surface runoff, impervious surfaces reduce the amount of rainwater that infiltrates into the ground to recharge groundwater sources.

3.15.1 State of Illinois Reporting

Surface water quality monitoring is used by limnologists and scientists to evaluate the ecological health of waterbody. The overall objective for water quality sampling is to assess the existing conditions of a stream, river or lake in an attempt to restore or maintain the chemical, physical, and biological integrity of the monitored surface water. In Illinois, the IEPA utilizes water quality monitoring data as its major source of information for the IEPA Section 305(b) and Section 303(d) List integrated report. Section 303(b) of the Federal Clean Water Act required each state to submit to the USEPA a biannual report of the quality of the state's surface and groundwater resources. The 305(b) report includes a detailed description of the how Illinois assesses water quality and whether the assessed waters meet

or do not meet “Designated Uses”. When a waterbody is determined to be impaired, IL must list the potential reasons for the impairment in the Section 303(d) impaired waters list.

Section 303(d) of the Clean Water Act requires Illinois to submit to the USEPA a list of waterbodies with impaired uses, the pollutant causing the impairment, and a priority ranking for the development of Total Maximum Daily Loads (TMDLs). The establishment of the TMDL sets the pollution reduction goal to improve the impaired waters. Historically, the 305(b) list and the 303(d) list were submitted to the USEPA as separate documents, however, since 2006, the reports have been integrated into a single report.

The surface water assessments included in the 2012 Illinois Integrated Water Quality Report and Section 303(d) List are based on data obtained through chemical, physical, and biological sampling. These assessments help protect “Designated Uses” by setting water quality standards that will protect the designated uses. In Illinois, the “designated uses” for surface waters include: aquatic life, indigenous aquatic life, fish consumption, primary contact, secondary contact, water supply and aesthetic quality. For each “designated use” it is determined if a waterbody is either “fully supporting” or “not supporting” the use based on the available data. Any waters that are determined to be not supporting a designated use as considered impaired. Additionally, the USEPA required that the assessed waters be placed into categories based on their attainment (Table 3-29). Category 5 waters comprise the Illinois 303 (d) list. The 303(d) listed waters are prioritized by the IEPA and TMDLs are prepared for waters in the order of priority (highest to lowest).

Table 3-29: Categorization of 303(d) Listed Waters

Category	Sub-Category	Description
1		All designated uses are assessed as fully supporting and no use is threatened (Note- Illinois does not assess any waters as threatened).
2		Available data and/or information indicate that some but not all designated uses are supported
3		Insufficient data and/or information to make a use support determine for any use
4		Waterbodies contain at least one impaired use but TMDL is not required. Category 4 is subdivided as listed below based on the reason a TMDL is not required.
	a	TMDL has been approved or established by the USEPA.
	b	Technology based effluent limitations required by the Clean Water Act, more stringent effluent limits required by the state, local, or federal authority, or other pollution control requirements required by state, local or federal authority are stringent enough to implement applicable water quality standards within a reasonable period of time
	c	Failure to meet the applicable water quality standards is not caused but a pollutant but other types of pollution (such as aquatic life impairment due to habitat degradation)
5		Available data and/or information indicate that at least one designated use is impaired and a TMDL is required.

No waters in the Madigan Creek watershed are assessed by the IEPA and therefore, no streams in the Madigan Creek watershed are listed on the 2012 303(d) list as impaired.

3.15.2 Available Chemical and Physical Water Quality Monitoring

Typically, chemical and physical water quality monitoring includes the collection of water quality samples that are analyzed for the following parameters:

- Temperature
- pH
- Dissolved oxygen (DO)
- Conductivity
- Total suspended solids (TSS)
- Total dissolved solids (TDS)
- Metals including cadmium, chromium, copper, iron, lead, manganese, mercury, silver, and zinc
- Nitrogen including nitrite, nitrate, and total nitrogen
- Phosphorus including dissolved phosphorus and total phosphorus
- Bacteria
- Chlorides

There is no known water quality data available for Madigan Creek collected by any local, state, or Federal agency. As such as part of the stream walk conducted in the watershed on July 11, 2011, temperature, conductivity, dissolved oxygen, and pH were collected at 6 sites within the watershed. A visual description of turbidity was also noted. The data collected is summarized in Table 3-30. The monitored sites are shown in Figure 3-19.

Table 3-30 Water Quality Data for the Madigan Creek watershed

Site	Temperature (°C)	Conductivity	Dissolved Oxygen (mg/L)	pH	Turbidity
1	23.3	330	5.06	7.57	Slight
3	24.6	346	5.96	7.55	Turbid
4	24.9	349	6.28	7.62	Slight
5	25.4	345	6.52	7.61	Slight
6	24.5	346	7.06	7.62	Clear
8	27.1	952	6.33	7.71	Turbid

Water quality data was not collected at the other sites visited on the stream walk due to insufficient flows in Madigan Creek at the time of the sampling.

Temperature

Water temperatures fluctuated with daily air temperatures as well as with seasonal changes, i.e., water temperatures are higher in summer and cooler in spring and fall. Maximum water temperatures over 20°C may preclude most numerous fish from using these streams for habitat.

Conductivity

Specific conductivity indirectly measures the concentration of chemical ions or dissolved salts in the water, and may be an indicator of salt as a pollutant. The more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. High chloride concentrations following salt applications for snow melting in winter can led to high

conductivity readings, as can the leaching of effluent from a sanitary sewer line into a stream. Low water levels tend to increase concentrations of ions in the water column, while rain events tended to temporarily flush ions out of the stream system.

Dissolved Oxygen

Algae and aquatic plants in the creek elevate dissolved oxygen (DO) concentrations during the day (due to photosynthesis) and lower DO concentrations at night (due to respiration). Low DO conditions typically exist in mid to late summer when air and water temperatures are high and water levels are low. DO concentrations below the Illinois Environmental Protection Agency standard of 5.0 mg/L can stress many fish species, and concentrations below 1.0 mg/L (hypoxic conditions) can be detrimental to aquatic life.

pH

Normal pH (a measure of hydrogen ions in the water) values in streams should range from 6.5 to 8.5, good conditions for aquatic life.

Turbidity

Turbidity, a measurement of the 'cloudiness' of water, is caused by suspended particles, or TSS (total suspended solids), and may indicate erosion or sedimentation problems. Turbidity tends to increase after rain events when runoff carries particles into the stream, when high flows erode streambanks and/or the streambed, and when the increased volume of water in the channel stirs the sediment in the bottom of the channel.

3.15.3 IEPA Permit Programs

The Illinois Environmental Protection Agency (IEPA) Bureau of Water regulates wastewater discharges through the implementation of the National Pollution Discharge Elimination System (NPDES) program. This program was initiated under the Clean Water Act to reduce pollution to surface waters and required permits be issued for the discharge of: 1) treated municipal effluent; 2) treated industrial effluent; and 3) stormwater from separate storm sewer systems (MS4's) and construction sites.

NPDES Point Source Discharges for Municipal and Industrial Effluent

Point sources of pollution are discharges from a single source such as a pipe conveying wastewater from an industrial process or a wastewater treatment facility into the stream. There are no municipal wastewater treatment plants discharging to the Madigan Creek watershed. There is one NPDES point source industrial permit issued by the Creek watershed: Rockford Sand and Gravel, a crushed and broken limestone quarry, located at 5155 West Charles Street, Loves Park, and Winnebago County, Illinois. The NPDES permit number for this facility is ILG840122 and the facility is permitted to discharge total suspended solids (TSS) into an unnamed tributary of Madigan Creek at one discharge location. The permit also requires Rockford Sand and Gravel to monitor for pH, TSS, flow, and offensive conditions. The quarry also has an air quality permit (ID 201808ACR) for the release of particulates into the air.

NPDES Stormwater Regulations

Stormwater runoff is a major source of pollution to the Madigan Creek watershed. Stormwater runoff includes rainwater and snow melt that flows off the land into storm

sewers or directly into lakes, rivers, or streams. Stormwater runoff can carry a wide range of pollutants including sediment, nutrients, metals, chlorides, and petroleum. Additionally, as the runoff flows over land, it can lead to increased erosion of exposed soils, especially on construction sites.

In order to reduce the impacts of stormwater on our rivers, streams and lakes, Illinois has been implementing stormwater regulations since 1990 through the NPDES program. The regulations have been implemented in two phases: Phase I and Phase II. Phase I began in 1990 and required large and medium-size city with populations over 100,000 to obtain an NPDES permit coverage for their municipal separate storm sewer system (MS4). Phase I also required NPDES permits for ten industrial uses and for construction sites disturbing 5 acres or more of land.

The NPDES Phase II program began in 2003 and was an update to the 1990 Phase I program. The Phase II program expanded the program by including additional MS4 categories, providing a “no exposure” exemption to certain industrial facilities if activities are protected by a storm-resistant shelter to prevent the exposure of runoff and material from leaving the facility, and decreasing the threshold for a construction site permit to 1 acre or more of land disturbing activity.

MS4 Permits

The City of Rockford was considered an MS4 under the Phase I regulations (IEPA Permit Number ILS000001). With the implementation of the Phase II regulations in 2003, the following governmental entities with the Madigan Creek watershed were designated as MS4 communities: Cherry Valley; Cherry Valley Township; Rockford Township; and Winnebago County. The Phase II communities all operate under a General Permit for Discharges from Small MS4s (IEPA Permit Number ILR40).

Both the City of Rockford and the Phase II communities are required to complete a series of Best Management Practices (BMPs) including 1) Develop a stormwater management program consisting of BMPs and measurable goals for at least 6 control measures: 1) public education and outreach on stormwater impacts; 2) public involvement; 3) illicit discharge detection and elimination; 4) construction site stormwater runoff control; 5) post-construction stormwater runoff control in new developments; and 6) pollution prevention/good housekeeping for municipal operations. In addition to the 6 control measures, the MS4s must also submit a Notice of Intent (NOI) and an annual report of activities related to the permit to the IEPA.

Construction Permits

As discussed above, NPDES Phase II Stormwater Regulations were implemented by the IEPA in 2003 to address potential erosion from construction including commercial, residential, road building, and demolition sites in the state that disturb more than one acre of land. Land disturbance is defined as exposing soil during clearing, grading, or excavation. The regulations specifically require the operator (person with operational control of the day to day construction activities) of the property to ensure compliance with the permit conditions outlined in the Illinois Construction Site General Permit (ILR10). These requirements include submitting a Notice of Intent (NOI) to begin construction, create a Stormwater Pollution Prevent Plan (SWPPP) to control erosion during construction, and

submit a Notice of Termination (NOT) when the site is permanently stabilized. The regulations also require that the construction site be inspected every 7 days and after every 0.5-inch or greater rainfall event or equivalent snowfall by a qualified inspector. During the weekly inspection, the sites are existing soil erosion and sediment control (SESC) practices are inspected for needed repairs. Additionally, the inspections are used to identify additional potential sources of erosion and sedimentation and make recommendations for additional SESC control practices. If construction activities result in an off-site discharge of sediment bearing waters, the operator is required to submit a Incident of Non-compliance (ION) to the IEPA and provide a plan to prevent further releases of sediment. As of January 2013, there are two active ILR10s issued for the Madigan Creek watershed and are detailed in Table 3-31.

Table 3-31: ILR10 Permits in the Madigan Creek watershed

Permit Number	Operator	Address	Description of Activity
ILR10Q792	555 Partnership	Anjali Perryville Subdivision, 555 S Perryville Road, Rockford, IL	Office building demolition and construction of new office building (3.9 acres of disturbance)
ILR105804	John Slack	Hampton Crossing, Mulford and Newburg Roads, Rockford, IL	Construction of residential subdivision (40 acres of disturbance)

Winnebago County, the City of Rockford, and the Village of Cherry Valley also have soil erosion and sediment control ordinances that are aimed at reducing the potential for sediment from construction activities for negatively impacting the Madigan Creek watershed.

3.15.3 Nonpoint Source Pollution

When rain flows across the landscape, pollutants such as oil and grease, road salt, eroding soil and sediment, metals, bacteria from pet wastes, and excess nutrients (nitrogen and phosphorus) from fertilizers are washed from streets, buildings, parking lots, construction sites, lawns and golf courses into the streams. This kind of pollution is called nonpoint source pollution, because it comes from the entire watershed rather than a single point, plant, or facility. These pollutants accumulate as the water flows downstream and eventually begin to degrade the quality of Madigan Creek for aquatic life, as well as for human uses such as fishing, wading, and bird watching. In this way, every small bit of pollution adds up to a very large problem.

In addition to chemicals and other substances picked up from the landscape, non point source pollution includes other measures such as temperature, acidity, and the amount of oxygen in the water. Aquatic organism, including fish and benthic macroinvertebrates that are critical links in the food chain, need oxygen that is dissolved in the water to breathe. Low flows and nonpoint source pollution can cause the dissolved oxygen levels in the water to fall below healthy levels. When this happens, some plants and animals will die, in some cases causing fish kills, and others will leave that location to try to find cleaner water.

Water temperature can also cause problems. Many fish and other aquatic animals require cool or cold flowing water to survive. As rainwater flows across urban surfaces and through the sewer system, these surfaces warm the water causing the overall temperature of the

receiving stream to be too warm for many aquatic plants and animals. This water can also be either more acidic (low pH) or more alkaline (high pH) than is healthy for these organisms to survive. Additional potential source of pollution, in addition to the list of potential sources mentioned above are the sanitary sewer system and septic systems.

Sanitary Sewer System

The Rock River Water Reclamation District (RRWRD) wastewater treatment facility discharges treated wastewater the Rock River outside of the Madigan Creek watershed. This discharge is a point source of pollution covered by the NPDES point source permitting process discussed in Section 3.11. However, non-point source pollution also can be traced to issues (cross connections with the storm sewer system, leakage into or out of the sanitary sewer system, overflows of the sanitary sewer system due to stormwater infiltration or combined sewers) within the sanitary or sewer system. The following are known about the RRWRD's system:

- No known cross connections exist between the RRWRD sanitary system and the storm sewer system within the Madigan Creek watershed that could result in sanitary discharge into the storm sewers.
- There are no combined sewers within these watersheds
- There are no RRWRD overflow structures discharging into the waters of the watershed.

Septic Systems

Septic systems have the potential to discharge nutrients (phosphorus and nitrogen) and bacteria and virus in to the surface and groundwater of the Madigan Creek watershed. When properly designed and maintained, the quantity of pollution discharge from the septic systems is limited. However, failing septic systems have the potential to be a significant cause of surface water and groundwater quality degradation. Several areas in the Madigan Creek watershed are serviced by septic systems. These areas include the neighborhood bound to the north by Mill Road, the south by Newburg Road, Perryville to the west, and Bell School Road to the east and the neighborhood located north of Harrison Avenue, south of St Charles Road, east of Mulford Road and west of Perryville Road is also serviced by septic systems. Areas not serviced by sanitary sewer are assumed to be on septic systems.

Nonpoint Point Source Pollutant Load Analysis

As a means of quantifying non-point source pollution loading in the watershed, a Pollutant Loading (PLOAD) application model for the Madigan Creek watershed was developed. PLOAD is an extension of the comprehensive modeling tools in the Environmental Protection Agency's (EPA) Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) model. PLOAD is a GIS-based model that estimates nonpoint-source and point-source loadings on an annual average basis for small urban watersheds.

Hey has selected PLOAD as the nutrient loading modeling application that is the most appropriate for the Madigan Creek watershed for the following reasons:

Transferability

PLOAD was designed to be utilized in a wide range of applications and uses including NPDES stormwater permitting, watershed management, watershed planning, and lake/reservoir protection projects. PLOAD is applicable for

both small urban and rural watersheds of any size. The model inputs include GIS coverages of land use, subbasin boundaries, and BMP locations along with look-up tables for pollutant event mean concentrations (EMCs), imperviousness and BMP removal efficiencies.

Additionally, as PLOAD is an extension of the BASINS model, the model can be downloaded for free from the IEPA on the BASINS homepage. As such it is not cost prohibitive for even the smallest watershed planning organizations.

Applicability

PLOAD has the ability to estimate the importance of pollution contributions from multiple land uses and many individual sources in a watershed. Thus, it can be used to target important areas of pollution generation and identify areas best suited for controls within a watershed. Once these “hot spots” are identified, PLOAD can then be utilized to evaluate the effectiveness that various types and locations of BMPs within the “hot spots” would have on pollutant loading.

PLOAD also has the ability to assess seasonal or inter-annual variability of nonpoint-source pollution and to assess long-term water quality trends. It can also be used to address land use patterns and landscape configurations in the watershed. This allows for the user to evaluate changes in pollutant loading that may occur as the result of future, predicted land use conditions.

Ease of Use

PLOAD has a user-friendly interface. Starting a new project within the BASINS platform involves an easy to follow step-by-step process. Once a project is started in BASINS, the gathering of background data necessary to run the PLOAD model can begin. After the initial background data is loaded into the model (land use, elevation and hydrology information, watershed boundaries, etc.) the PLOAD model plug-in can be utilized. The PLOAD model plug-in incorporates another step-by-step process where land use, precipitation, event mean concentration, BMPs, point sources, and bank erosion can either be referenced to BASINS or inserted manually where applicable for the particular project or area being analyzed. Manual insertion of the data is clearly detailed within the software instructions.

After modeling is complete, PLOAD gives its user the ability to generate out-puts as user-defined formats. This enables

the user to tailor the output data they need. If so desired, the user can view the data from BASINS and PLOAD in ArcGIS if that software is installed on the computer being utilized.

Customizable

PLOAD’s organization and structure facilitates modification and customization. By using look-up tables for EMCs, imperviousness terrain factor, and BMP removal efficiencies, PLOAD gives the user the opportunity to integrate site and region specific data on loading and removal rates into the model. This allows for a more refined calculation of loading and reduction rates.

Pollutants evaluated using PLOAD included

- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Total Phosphorus (TP)
- Total Nitrogen (TN)
- Nitrate-Nitrite (NO3-NO2)
- Total Kjeldahl Nitrogen (TKN)
- Lead
- Copper
- Cadmium
- Chromium
- Nickel
- Zinc

The model estimated pollutant loading of each pollutant from each subbasin. The modeled values were compared to the Illinois Environmental Protection Agency (IEPA) Water Quality Standards for General Use, Secondary Contact, and Aquatic Life. The IEPA Water Quality Standards used for this assessment are included in Table 3-32.

Table 3-32: IEPA Water Quality Standards

Pollutant	IEPA Standards
TSS	750 ppm
TDS	1,500 mg/L
BOD	5.0 mg/L
COD	30 mg/L
Total Phosphorus*	0.05 mg/L
Total Nitrogen (TN)	15 mg/L
Nitrate – Nitrite (NO3-NO2)	Not applicable
Total Kjeldahl Nitrogen (TKN)	10 mg/L
Lead (Pb)	0.1 mg/L
Copper (Cu)	1.0 mg/L
Cadmium (Cd)	0.15 mg/L
Chromium (Cr)	0.3 mg/L

Nickel (Ni)	1.0 mg/L
Zinc (Zn)	1.0 mg/L

* Applicable only to lakes/reservoirs and streams at its confluence with a lake/reservoir

Four pollutants in particular (TSS, TP, COD, and BOD) are considered as pollution indicators for this watershed. TSS and TP are typical indicators of high urban pollutant loadings. TSS can lead to excessive sedimentation in stream reaches and ultimately cover and impair instream habitat. TP can lead to excessive productivity levels of aquatic plants in slow moving reaches and in wetlands. This can then lead to low DO levels as the plant material decays. Low DO levels make the stream uninhabitable for some species of aquatic life. Since COD and BOD represent oxygen demanding substances they were included in the list of indicator pollutants for this watershed.

The pollutant loading results were used to identify and prioritize subbasins by their respective degree of pollutant loading. Table 4-33 details the pollution loading estimates from each subwatershed on a concentration basis (mg/L). Table 4-34 includes pollutant load calculations in pounds per acre per year.

The loading calculations were used to establish a ranking system for each of the modeled pollutants in order to identify priority watersheds. The rankings included “High” for those pollutants that exceeded the IEPA standard, “Medium” for those pollutants that were under the IEPA standard but at least half their value, and “Low” for those pollutants that were less than half of the IEPA standard. Table 3-35 lists the IEPA standards by pollutant and those subwatersheds exhibiting High, Medium, and Low levels for each pollutant.

Table 3-33: Estimated Pollutant Loading by Subwatershed in the Madigan Creek watershed (mg/L)

Subbasin	Acres	TSS	TDS	BOD	COD	TP	TN	NO3	NO3-NO2	TKN	Pb	Cu	Cd	Cr	Ni	Zn
1	176.17	206.9945	92.09	15.87	66.50	0.50	2.38	0.20	0.70	1.79	0.03266	0.03659	0.00495	0.00792	0.00792	0.133
2	188.76	178.1444	92.00	16.00	67.00	0.50	2.40	0.20	0.70	1.80	0.03300	0.03700	0.00500	0.00800	0.00800	0.134
3	463.82	197.9109	92.03	15.97	66.87	0.50	2.40	0.20	0.70	1.80	0.03291	0.03689	0.00499	0.00798	0.00798	0.134
4	415.16	199.5129	92.00	16.00	67.00	0.50	2.40	0.20	0.70	1.80	0.03300	0.03700	0.00500	0.00800	0.00800	0.134
5	243.04	208.5423	92.02	15.98	66.91	0.50	2.40	0.20	0.70	1.80	0.03294	0.03693	0.00499	0.00799	0.00799	0.134
6	417.26	233.0523	92.01	15.98	66.94	0.50	2.40	0.20	0.70	1.80	0.03296	0.03695	0.00499	0.00799	0.00799	0.134
7	145.77	235.2836	92.00	16.00	67.00	0.50	2.40	0.20	0.70	1.80	0.03300	0.03700	0.00500	0.00800	0.00800	0.134
8	10.81	176.3355	92.00	16.00	67.00	0.50	2.40	0.20	0.70	1.80	0.03300	0.03700	0.00500	0.00800	0.00800	0.134
9	59.10	219.6009	92.00	16.00	67.00	0.50	2.40	0.20	0.70	1.80	0.03300	0.03700	0.00500	0.00800	0.00800	0.134
10	71.78	249.7145	92.16	15.78	66.18	0.49	2.37	0.20	0.70	1.78	0.03243	0.03631	0.00492	0.00786	0.00786	0.132
11	139.62	263.3019	92.06	15.92	66.70	0.50	2.39	0.20	0.70	1.79	0.03280	0.03675	0.00497	0.00795	0.00795	0.133
12	284.73	179.5718	92.01	15.99	66.97	0.50	2.40	0.20	0.70	1.80	0.03298	0.03698	0.00500	0.00800	0.00800	0.134
13	190.17	253.0666	92.35	15.52	65.17	0.49	2.34	0.20	0.69	1.75	0.03174	0.03547	0.00483	0.00769	0.00769	0.129
14	216.82	201.6106	92.00	16.00	67.00	0.50	2.40	0.20	0.70	1.80	0.03300	0.03700	0.00500	0.00800	0.00800	0.134
15	252.13	206.3948	92.01	15.98	66.94	0.50	2.40	0.20	0.70	1.80	0.03296	0.03695	0.00499	0.00799	0.00799	0.134
16	39.07	191.5601	92.14	15.81	66.27	0.49	2.38	0.20	0.70	1.78	0.03250	0.03639	0.00493	0.00788	0.00788	0.132
17	229.18	318.0372	93.37	14.12	59.81	0.45	2.16	0.18	0.67	1.61	0.02803	0.03100	0.00431	0.00680	0.00680	0.114
18	16.13	398.0601	92.65	15.11	63.61	0.48	2.29	0.19	0.68	1.71	0.03066	0.03417	0.00468	0.00743	0.00743	0.125
19	103.17	224.6276	92.00	16.00	67.00	0.50	2.40	0.20	0.70	1.80	0.03300	0.03700	0.00500	0.00800	0.00800	0.134
20	131.55	215.6327	92.22	15.70	65.86	0.49	2.36	0.20	0.69	1.77	0.03221	0.03605	0.00489	0.00781	0.00781	0.131
21	56.52	289.4135	93.27	14.25	60.33	0.45	2.18	0.18	0.67	1.63	0.02839	0.03144	0.00436	0.00689	0.00689	0.116
22	122.47	323.0602	93.50	13.94	59.12	0.44	2.14	0.18	0.66	1.59	0.02756	0.03043	0.00425	0.00669	0.00669	0.113

Table 3-34: Estimated Pollutant Loading by Subwatershed in the Madigan Creek watershed (lbs/acre/year)

Subbasin	Acres	TSS	TDS	BOD	COD	TP	TN	NO3	NO3-NO2	TKN	Pb	Cu	Cd	Cr	Ni	Zn
1	176.17	857.30	381.43	65.73	275.43	2.06	9.87	0.82	2.89	7.40	0.135	0.152	0.021	0.033	0.033	0.55
2	188.76	1046.79	540.60	94.02	393.70	2.94	14.10	1.18	4.11	10.58	0.194	0.217	0.029	0.047	0.047	0.79
3	463.82	904.11	420.40	72.93	305.47	2.28	10.94	0.91	3.19	8.21	0.150	0.169	0.023	0.036	0.036	0.61
4	415.16	895.58	412.97	71.82	300.75	2.24	10.77	0.90	3.14	8.08	0.148	0.166	0.022	0.036	0.036	0.60
5	243.04	851.04	375.51	65.20	273.06	2.04	9.78	0.82	2.85	7.34	0.134	0.151	0.020	0.033	0.033	0.55
6	417.26	763.21	301.32	52.35	219.22	1.64	7.85	0.65	2.29	5.89	0.108	0.121	0.016	0.026	0.026	0.44
7	145.77	756.99	296.00	51.48	215.56	1.61	7.72	0.64	2.25	5.79	0.106	0.119	0.016	0.026	0.026	0.43
8	10.81	1064.02	555.13	96.55	404.28	3.02	14.48	1.21	4.22	10.86	0.199	0.223	0.030	0.048	0.048	0.81
9	59.10	806.73	337.97	58.78	246.13	1.84	8.82	0.73	2.57	6.61	0.121	0.136	0.018	0.029	0.029	0.49
10	71.78	720.12	265.76	45.52	190.83	1.42	6.84	0.57	2.01	5.13	0.094	0.105	0.014	0.023	0.023	0.38
11	139.62	693.03	242.30	41.91	175.57	1.31	6.29	0.52	1.84	4.72	0.086	0.097	0.013	0.021	0.021	0.35
12	284.73	1033.75	529.65	92.06	385.53	2.88	13.81	1.15	4.03	10.36	0.190	0.213	0.029	0.046	0.046	0.77
13	190.17	711.75	259.73	43.65	183.29	1.37	6.58	0.55	1.94	4.93	0.089	0.100	0.014	0.022	0.022	0.36
14	216.82	884.51	403.62	70.20	293.94	2.19	10.53	0.88	3.07	7.90	0.145	0.162	0.022	0.035	0.035	0.59
15	252.13	860.89	383.79	66.67	279.22	2.08	10.00	0.83	2.92	7.50	0.137	0.154	0.021	0.033	0.033	0.56
16	39.07	940.94	452.58	77.65	325.53	2.43	11.67	0.97	3.42	8.75	0.160	0.179	0.024	0.039	0.039	0.65
17	229.18	613.63	180.15	27.24	115.39	0.87	4.17	0.35	1.28	3.11	0.054	0.060	0.008	0.013	0.013	0.22
18	16.13	558.17	129.91	21.19	89.19	0.67	3.21	0.27	0.96	2.40	0.043	0.048	0.007	0.010	0.010	0.17
19	103.17	789.31	323.28	56.22	235.43	1.76	8.43	0.70	2.46	6.32	0.116	0.130	0.018	0.028	0.028	0.47
20	131.55	819.75	350.57	59.69	250.36	1.87	8.98	0.75	2.64	6.73	0.122	0.137	0.019	0.030	0.030	0.50
21	56.52	646.67	208.41	31.85	134.80	1.01	4.87	0.41	1.49	3.63	0.063	0.070	0.010	0.015	0.015	0.26
22	122.47	608.39	176.08	26.25	111.34	0.84	4.03	0.34	1.25	3.00	0.052	0.057	0.008	0.013	0.013	0.21

Table 3-35

Pollutant	IEPA Standard (mg/L)	High	Medium	Low
TSS	750ppm	None	None	All
TDS	1,500 mg/L	None	None	All
BOD	5.0 mg/L	All	None	None
COD	30 mg/L	All	None	
Total Phosphorus	0.05 mg/L	All	None	None
Total Nitrogen (TN)	15 mg/L	None	None	All
Total Kjeldahl Nitrogen (TKN)	10 mg/L	None	None	All
Lead (Pb)	0.1 mg/L	None	None	All
Copper (Cu)	1.0 mg/L	None	None	All
Cadmium (Cd)	0.15 mg/L	None	None	All
Chromium (Cr)	0.3 mg/L	None	None	All
Nickel (Ni)	1.0 mg/L	None	None	All
Zinc (Zn)	1.0 mg/L	None	None	All

3.15.4 Summary of Water Quality Assessment

The conclusions drawn and management strategies recommended in this report are the best possible, given the extremely limited water quality data in this watershed. However, typical urban watershed problems as well as site specific issues have been identified. The primary issues with respect to water quality, including those that relate to instream and riparian habitat, are discussed below.

Total Suspended Solids

Although the nutrient modeling did not identify Total Suspended Solids (TSS) as a major source of impairment, the habitat assessment and stakeholder input has identified TSS as an major issue in the watershed. The primary impact of high suspended solids concentrations in streams occurs when these solids settle in depositional areas of the stream system and cover the more desirable gravel substrates. Excessive levels of particulate material also create difficult conditions for gill breathing fish and some of their food sources, including macroinvertebrate organisms.

The sources of TSS appear to be streambank erosion (due to hydrologic instability) with contributions from urban runoff over impervious surfaces. Suspended solids can be transported to the streams and lakes, even from remote areas of the watershed, via storm sewers and roadside ditches.

Increases in impervious cover combined with introduction of stormwater drainage systems and loss of wetlands has lead to significant changes in watershed hydrology (flow alterations and hydromodification). This has in turn led to increased streambank and streambed erosion and degradation of instream habitat in many reaches.

As the remaining vacant land of the watershed develops, as is projected, construction site runoff will be a potential growing source of sediment if soil erosion and sediment control practices are not properly designed, installed, and maintained.

Habitat

There are very limited high quality habitat features such as instream habitat and relatively natural floodplains in the Madigan Creek watershed. As such, biological communities are of poor quality with limited diversity. The lack of instream features, intermittent hydrologic connection with the Kishwaukee River, the flashy hydrology of the streams due to urban development within the watershed, periods of very low flow, and low dissolved oxygen conditions in the summer months all contribute to the impacts to the biological community of the creek. Additional biological sampling should be conducted in a variety of locations to establish a baseline from which improvement or degradation can be assessed.

Additionally, there has been significant encroachment by urban uses into the stream corridor and loss of riparian habitat. These encroachments can be locations of yard waste dumping as well as sheet drainage of fertilizers and pesticides into the stream. These encroachments can also disrupt wildlife corridors.

Nutrients

Urban runoff is the likely contributor of high nutrient loads, particularly phosphorous, to the stream systems. Stream or streambank dumping of yard waste, grass clippings, and leaves collected in the fall can also contribute significant nutrient loading to the stream.

Total Dissolved Solids

Dissolved solids (TDS) include substances such as salts. One of the most problematic dissolved solids in urban watersheds is sodium chloride, used as road deicing material. Road salt can occur at toxic levels in the water column at intermittent times when the weather conditions demand its use. Sodium chloride is not removed by BMPs and is conservative (does not decompose or readily change form), and can cause spikes in the water column, typically detected as increased conductivity. Salinity and chlorides were measured within the stream by collecting data on the conductivity levels in the stream, which indicated slightly elevated conductivity readings. It should be noted that these conductivity readings were taken in the summer when levels of dissolved solids are most likely at their lowest in the stream. It is expected that high concentrations would be present during the winter months due to the application of road salt.

3.16 Floodplain and Flood Hazard Areas

This section of the plan includes information on the FEMA floodplain as well as areas of known flooding within the Madigan Creek watershed.

3.16.1 Floodplain

Floodplains along stream and river corridors provide a variety of benefits including aesthetic value, flood storage, water quality, and plant and wildlife habitat. However, the most important function is the capacity of the floodplain to hold water during significant rainfall events to minimize flooding. Flood hazard areas are identified on the Flood Insurance Rate Map (FIRMs) and are categorized as a Special Flood Hazard Areas (SFHA). SFHAs are defined as the area that will be inundated by a flood event having a 1-percent chance of

being equaled or exceeded in any given year. This 1-percent annual chance flood is commonly referred to as the base flood or 100-year flood. It should be noted that the 100-year flood can and do occur more frequently than every 100 years. SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30.

There are approximately 44.32 acres of 100-year floodplain with in Madigan Creek watershed (Table 3-36 and Figure 3-21). The Madigan Creek floodplain is classified as Zone A and Zone AE. Zone AE areas are subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply. Mandatory flood insurance purchase requirements and floodplain management standards apply for all structures located in Zone AE. The Zone AE areas in Madigan Creek are located along Madigan Creek from approximately Rolling Hedge Lane to its confluence with the Kishwaukee River.

Zone A Areas are subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown for Zone A areas. Mandatory flood insurance purchase requirements and floodplain management standards apply for all structures located in Zone A. The Zone A areas are located along Madigan Creek near Valencia Drive south of Calimar Drive, along a Madigan Creek tributary #3 in Southeast Community Park, and along a Madigan Creek tributary #2 near Meadowlark Lane and Newburg Road to Woodcreek Bend road.

Table 3-36: Floodplain in the Madigan Creek watershed

SFHA	Acreage	% of Watershed
AE	26.54	0.67%
A	17.78	0.45%

Structures appear to be located in the mapped floodplain near the intersection of Newburg Road and Mulford Road (Figure 3-21).

Records maintained by the Federal Emergency Management Agency (FEMA) indicate that no letters of map revision (LOMRs) have been issued for development projects in the Madigan Creek watershed in the last 30 years.

3.16.2 Flooding and Drainage Problems

Over the past years the Madigan Creek watershed has recorded some of its worst flooding to date. Five inches of rain fell on September 4, 2006 leading to damage of hundreds homes. Less than a year later on August 7, 2007, the watershed was again hit by rain when 5–7 inches of rain fell. Many streets, including major thoroughfares were flooded. Following the 2007 storm, the Governor of Illinois declared Rockford and Winnebago County a state disaster area. Debris removal, law enforcement, damage assessment, and other duties were offered by the governor.

In addition to these flooding events caused by significant rainfalls, the Madigan Creek watershed experiences flood and drainage problems following much smaller rainfall events. Several different types of flooding that occurs in the watershed includes:

- Overbank flooding from a waterway
- Local drainage problems (shallow flooding on roads, yards and sometimes buildings) often due to development in a drainage way, inadequately maintained drainage ditches, undersized storm sewers, and storm sewers .
- Depressional flooding in areas where water ponds in a natural depression in the landscape and there is no natural outlet for runoff. May be caused by failed or sewer or adjacent or surrounding development causing increased runoff into the depressional area.
- Sanitary sewer backups may occur, flooding basements, when stormwater infiltrates into the sanitary sewer pipes, leaky manholes, or inappropriate connections to the sanitary lines.

In 2009, the City of Rockford prepares a Citywide Stormwater Management/Flood Control Assessment of the portions of the Madigan Creek watershed located within its city limits. The Citywide Stormwater Management/Flood Control Assessment identified 7 stormwater/flood control issues in the Rockford portion of the watershed. This list was presented to the Winnebago County Watershed Planning Steering Committee and other watershed stakeholders during the watershed planning process and was expanded.

Table 3-37 and Figure 3-22 lists all of the flooding and drainage problems identified during the watershed planning process.

Table 3-37: Flooding and Drainage Problems in the Madigan Creek watershed

Location	Problem Description	Over-bank Flooding	Major Surface Flooding	Localized Flooding	Roadway Overtopping	Pipe Surcharge	Culvert Scour	Water Quality Impacts	Streambank Erosion
Rockford, IL									
Tulip Lane	Area residents west of Tulip Lane report the occurrence of backyard flooding			✓					
Argus Drive and Sundae Drive	Area experiences street flooding with depths of up to 4-feet during small frequent storms			✓					
Stoney Creek Way and Madigan Creek	Occurrence of nuisance flooding due to undersized culverts			✓					
Wood Creek Bend and Madigan Creek	Area residents report flooding along driveways. Storm sewer needs to be upsized.			✓					
Trainer Road and	The 78-inch culvert is in need of						✓		

Location	Problem Description	Over-bank Flooding	Major Surface Flooding	Localized Flooding	Roadway Overtopping	Pipe Surchage	Culvert Scour	Water Quality Impacts	Streambank Erosion
Madigan Creek	maintenance. Crossing does not have a headwall and side slopes are eroded.								
Trainer Road south of Forest Plaza	Roadside vegetated ditch needs maintenance			✓					
Trainer Road at Grassridge Road	Area residents note the presence of streambank erosion.								✓
Trainer Road at Rolling Hedge Lane	Area residents report that debris clogs roadside swale culvert.			✓					
Near Grassridge Road and tributary to Madigan Creek	Area residents report a bridge has been constructed over the creek. This bridge restricts flow and causes water backup.			✓					
Residences along Grassridge Road	Structures (sheds, gazebos, etc) have been constructed in detention basins.			✓					
Quarry SW of Charles Street and Mulford Road	Current owner would like to deepen quarry and increase discharge to Madigan Creek tributary							✓	✓
Arlington Cemetery and tributary to Madigan Creek	Area residents report that combined flows from Charles St, Mulford St, and the Maplewood Subdivision have caused increased flows in the creek channel.							✓	✓
NE of Brady Lane and Stone Bridge Crossing	Subdivision would like to construct bridge for additional road access			✓					
North of Newberg Road and Madigan Creek	Area residents report loss of storage volume in detention basin			✓				✓	
Newburg Road and Mulford Road	Area residents report increased flows in the tributary to Madigan Creek. Increases flows were noted at about the time the condos at the intersection were constructed				✓				✓
Newburg Road and Woodcreek Bend	Area residents report that debris clogs roadside swale culvert.			✓					
Newburg Road and Avalon Drive	Area residents note the presence of streambank erosion. Culvert may also be undersized. Scour is observed below the culvert.			✓			✓	✓	
Woodcreek Bend and Willowick Lane	A resident has constructed a berm that is redirecting flows			✓					
Woodcreek Bend along tributary Madigan Creek	Residents report that flow is restricted in the channel due to debris accumulation at culverts.			✓				✓	

Location	Problem Description	Over-bank Flooding	Major Surface Flooding	Localized Flooding	Roadway Overtopping	Pipe Surcharge	Culvert Scour	Water Quality Impacts	Streambank Erosion
Newburg Road and Valencia Drive	ComEd electrical box is located on creek bank. Box is submerged during heavy rain events.			✓					
Newburg Road and Perryville Road	Area residents report insufficient detention associated with road widening activities			✓					
Chatsworth Drive and tributary to Madigan Creek	Area residents report basement flooding and roadway overtopping.			✓	✓				
Rock Creek Church on Harrison Avenue	Area residents report that debris clogs roadside swale culvert. Erosion is also noted in the drainage swale in the Swanson Park Condos.			✓					
Harrison Avenue and Mulford Road	Area residents report existing detention basin is undersized.			✓	✓				
Waterford Drive and Cerasus Drive	Area residents report an undersized culvert.			✓	✓				✓
Waterford Drive and Bell School Road	Area residents report undersized detention basin.			✓					
Black Cherry Drive and Madigan Creek	Streambank erosion has exposed electrical lines.								✓
Cerasus Drive from Mill Road to Laurel Cherry Drive along Madigan Creek	Significant streambank erosion observed. Also significant amount of trash observed in stream.							✓	✓
Montmorency Drive from Laurel Cherry Drive to Chokecherry Drive and Temple Circle along Madigan Creek	Significant streambank erosion observed.							✓	✓
North side of Chatsworth Drive	Area residents report high flows in roadside ditches following storm events. In large events, water overflows from the ditches.			✓	✓				
Swanson Parkway and Harrison	A resident has constructed a berm that is redirecting flows			✓					
Cherry Valley									
Valencia Drive and Rolling Hedge Lane	Area residents report that the roadside vegetated ditch needs maintenance			✓					
Tributary between Kensington Place and Panorama Road	Area residents note debris in creek restricts flows.			✓				✓	
Valencia Drive and	Area residents report insufficient			✓					✓

Location	Problem Description	Over-bank Flooding	Major Surface Flooding	Localized Flooding	Roadway Overtopping	Pipe Surcharge	Culvert Scour	Water Quality Impacts	Streambank Erosion
Hedgewood Road	detention.								
Mike's Place and Madigan Creek	Area residents report debris and trash in creek.						✓		
Madigan Creek and railroad trestle	Significant streambank erosion observed.							✓	

3.16.3 Constructed Drainage System

As development occurred in the Madigan Creek watershed, the natural drainage system in the watershed was altered. Early construction of residential, commercial, industrial and roads were built without detention basins or other stormwater management practices. With the intent of removing stormwater runoff as quick as possible, this early development utilized storm sewer systems and ditches to quickly transport the water into Madigan Creek and its tributaries. Without detention, after each rainfall stormwater was quickly delivered to the surface waters resulting in increased flows in the stream channels. These frequent, intense flows lead to channel hydromodification including stream bank erosion and channel incision. See Section 3.14.4 for more information on hydromodification.

More recently city engineers and decision makers have realized the benefits of storing stormwater in detention facilities that are designed to capture runoff from an impervious area and slowly releases the water over a given amount of time. Winnebago County (Article IV Surface Water Management), the City of Rockford (Part II Chapter 109), and the Village of Cherry Valley (Article IV Stormwater Detention) all have stormwater management and detention requirements. Winnebago County and the City of Rockford have also adopted technical regulations/requirements in regards to surface water management.

All three stormwater management ordinances state that the maximum controlled stormwater runoff releases rate from shall not exceed the natural safe stormwater drainage capacity of the downstream system or 0.2 cubic feet per second (cfs) per acre. The ordinances allow for the use of the following stormwater storage methods in order to ensure a release rate of 0.2 cfs/acre is met: dry bottom basins, wet bottom basins, paved stormwater storage areas, rooftop storage areas, automobile parking stormwater storage areas, and underground stormwater storage areas.

Detention Basins – dry bottom and wet bottom

Detention basins or detention ponds are stormwater management facilities that are constructed on or adjacent to rivers, streams, or lakes that are designed to storm rainfall in order to protect against flooding and protect downstream channels from hydromodification. Detention facilities that are constructed on a river or stream are commonly referred to as “on-line” basins. On-line basins are not recommended and are commonly prohibited under a variety of stormwater regulations. Detention basins that are not on-line and typically

constructed in low areas relative to development and either discharge directly to a surface water or discharge to surface water through a stormwater sewer network. Detention basins are commonly referred to as dry bottom or wet bottom.

Dry bottom basins typically hold water for short periods of time following rain events. They are commonly lined with manicured turf grass. While dry detention basins may slow water from reaching creeks and rivers, their short residence time does not promote groundwater infiltration or provide significant water quality benefits. Structures such as gazebos and storage sheds should not be located in dry bottom basins.

Wet bottom basins are designed to permanently retain some volume of water at all times. The amount of water is determined by the elevation of the outlet pipe of the basin. The sideslopes of wet bottom basins can be planted with both turf grass or native grasses. Often wet bottom basins planted with turf grass will experience bank erosion resulting in the placement of riprap near the toe of slope as a measure to slow the erosion. While turf grass detention basins do promote the infiltration of stormwater, they do not provide significant water quality benefits.

Wet detention basins planted with native vegetation are commonly referred to as naturalized detention basins. Naturalized detention basins are designed to be wet bottom with side slopes and an emergent zone that is planted with native plants, flowers, and shrubs. In addition to providing stormwater management, naturalized detention basins promote groundwater infiltration and provide water quality benefits and wildlife habitat.

The City of Rockford has conducted an overview survey of detention basins within the Rockford portion of the Madigan Creek watershed. According to the survey there are 55 detention basins located within the watershed. The basins, their approximate locations, and any description of the basin's configuration/landscape supplied by the City are included in Table 3-38. Figure 3-23 depicts the location of the detention basins in the watershed.

Table 3-38: Detention Basins in the Madigan Creek Watershed

Basin ID #	Location	Basin Configuration
249	Settlement Way and Old Colony Bend	mowed grass
250	E. State & Perryville NEX (Lowes)	mowed grass
251	Bell School and E State	
266	Perryville and Argus NW	
57	E State and Puri Pkwy	low grass area
58	E State and Puri Pkwy	low grass area
64	Joyce and Garret	low grass area,
65	Argus and Buckley	cattails
66	Argus and Buckley	
67	Argus and Buckley	
68	Argus and Buckley	low grass area
69	SUNDAE AND STATE	mowed grass
70	Argus and Bell School	parking lot of Red Roof Inn
71	Bell School and E State	Country Kitchen parking lot
72	Coliseum and Amphitheater	newly seeded grass
73	Colosseum and Tulip	wooded
74	Tulip and Meander	mowed grass

Basin ID #	Location	Basin Configuration
75	Fox Chase and Centennial	mowed grass
76	Meander and Tulip	low grass area with standing water
77	Meander and McKnight	mowed grass
78	McKnight Circle	mowed grass
82	Walton and Doss	low grass basin, with mowed on sideslopes and a small amount of standing water
83	E State around Perryville	cattails
84	Stalter and Deane	unmowed grass
85	Stalter and Mill	cattails
86	Mill and Perryville	mowed grass
87	White Chapel and Highgrove	
88	Fincham and Mid America	unmowed grass
89	Trainer and Fincham	unmowed grass
90	Southfield and Britannia	mowed grass
92	Laurel Cherry Dr and Anee Dr	mowed grass
93	Timberline Ln and Revere Ridge	mowed grass
94	Timberline Ln and Trainer Rd	unmowed grass
95	Newburg Rd and Perryville Rd	low, well kept grass area,
96	End of Creekwood Circle	low, well kept grass area
97	Stony Creek Way and Fox Basin Rd	low, unkept grass area
98	Wood Creek Bend	low, unkept grass area with standing water
99	On Woodcreek	grassy march
100	Highridge Rd and Grassridge Rd	low, well kept area with small creek
101	Old Oaks Ct and Grassridge Rd	well kept low grass area
102	End of Sulkey Ln	low grass area,
103	Carriage Green Way	low grass area with erosion along hillside and standing water
104	Mulford and Phaeton Dr	low, well kept grass area
105	Along Mulford	grass bottom with cement drainageways connecting outfalls
106	Elaine Dr and Mulford	low grass area, well kept
107	Mulford and Elaine Dr	wet pond
203	Wellingham Circle	riprap
212	Ware and Colosseum	
219	Argus and Amphitheater	mowed grass
223	Harrison and Stowmarket	unmowed grass
225	Stoney Creek and Newburg	
226	Argus near Sunderland Furniture	
268	NW Mulford & Harrison	
N/A	west of Best Buy	
N/A	Woodcreek Bend East	small creek channel

Paved Stormwater Storage Areas

Paved stormwater storage areas are similar to detention basin except that instead of turf grass or native grasses, the basins are paved, typically with concrete. Paved stormwater storage areas prohibit groundwater infiltration and provide no water quality or habitat benefits.

Rooftop Storage Areas

Rooftop storage areas are essentially specialized detention basins used to reduce the peak discharge from rooftops. In a rooftop storage area, all rainfall that falls on a building's roof is stored on the roof and slowly released into the storm sewer system or surface waters. The

water is stored on the roof through the use of small weirs located within the roof drains that capture the rainfall and slowly releases it. Rooftop storage areas are traditionally used in high density areas where traditional means of stormwater detention such as ponds are not practical. Rooftop storage areas can be installed at the time of construction or retrofitted onto existing building as long as certain design conditions such as the use of a water proof membrane and ensuring that the roof can handle the additional weight are met.

Automobile Parking Stormwater Storage Areas

Automobile parking stormwater storage areas include the temporary surface storage of stormwater in remote, used areas of parking lots. In this practice, stormwater is temporarily stored on the surface of a parking lot immediately following a storm event prior to be slowly drained into the storm sewer system or other onsite detention facility. Automobile parking stormwater storage areas do not promote groundwater infiltration or provide water quality or habitat benefits. In fact, automobile parking stormwater storage areas may increase pollution loading into a stream or river as parking lots runoff can contain metals, oils, grease, and other water quality contaminants.

Underground Stormwater Storage Areas

Underground stormwater storage areas are a structural practice used to control the flow of stormwater. With underground storage areas, stormwater is stored under the ground in pre-fabricated containers and discharged over time. The systems are typically installed beneath parking lots, streets and parks where there is not enough allowable space for a traditional detention basin. Underground stormwater storage areas prohibit groundwater infiltration and provide no water quality or habitat benefits.

In addition to the construction of detention facilities, the installation of storm sewer systems has also changed the natural drainage pathways of the Madigan Creek watershed. Storm sewer systems collect water from residential, commercial, and industrial areas and roads and transport the stormwater to directly to surface waters or to detention facilities prior discharging to surface waters. Storm sewer systems are not just underground pipes as constructed drainage swales are also commonly utilized in storm sewer systems. In some cases, surface waters such as creek and rivers are re-routed into storm pipes in order to accommodate development. As discussed in the Flow Path discussion above, numerous areas of the watershed have been impacted by the construction of storm sewer systems. Figure 3-24 depicts locations where Madigan Creek and its tributaries have been redirected into the storm sewer system.

The City of Rockford has conducted a survey of storm sewer outfalls within the Rockford portion of the Madigan Creek watershed. According to the survey there are 34 stormwater sewer outfalls located within the watershed. The outfalls, their approximate locations, and any description supplied by the City are included in Table 3-39. Figure 3-25 depicts the location of the storm sewer outfalls in the watershed.

Table 3-39 Storm sewer Outfalls in the Madigan Creek Watershed

Outfall ID#	Outfall Size (inch)	Material	Description of the End of Pipe
23	24	PCC	elliptical beginning of channel
24	15	PCC	flared end section from detention

Outfall ID#	Outfall Size (inch)	Material	Description of the End of Pipe
25	36	PCC	flat drain from parking lot
26	18	PCC	pipe at box culvert
27	18	PCC	pipe in box culvert
28	15	PCC	flared end section
29	15	PCC	flared end section
30	30	PCC	flared end section
31		Concrete	concrete channel
32	30	PCC	flared end section
33	36	PCC	flat drain
34	12	CPP	flared end section
36	15	PCC	flared end section
35	15	PCC	flared end section
37	12	CPP	pipe
38	15	CMP	2 pipes
39	24	PCC	elliptical pipe at box culvert
40	12	PCC	pipe
41	12	CPP	pipe from UPS store
42	12	CPP	pipe from Quality Inn
43	18	PCC	flared end section
44	8	PVC	pipe from Quality Inn
45	24	PVC	flared end section from detention
46			pipe intake
47	30	CPP	2 pipes in conc. headwall
48	48	PCC	flared end section with grate
50	36	PCC	flared end section
51	48	PCC	pipe
52	78	PCC	culvert
53	36	PCC	3 pipes
N/A	30	PVC	flared end section
N/A		PCC	buried under silt
N/A	5 foot	CMP	4 pipes from under hotel
55	18 & 54	PCC	flared end section

3.16.4 Regional Compensatory Storage Facilities

Three regional compensatory storage facilities are located within the Madigan Creek watershed: the Cherry Valley Detention Pond, the upper pond and the lower pond. All of the facilities are located in the southeast corner of the watershed in Southeast Community Park. The Cherry Valley Detention Pond was constructed in the Summer of 1991 and has a storage volume of 14 acre-feet. The Cherry Valley Detention Pond has not been dredged to date.

The upper and lower ponds were constructed in the Fall of 1992. The storage volume of the upper and lower ponds are included in Table 3-40. The upper pond was dredged in 2001 and approximately 8,200 cubic yards of sediment were dredged from the pond. The lower pond was dredged in 2006 and approximately 12,350 cubic yards of sediment were dredged from the pond. Both the upper and lower pond have a Class III dam. Class III dams are dams for which a failure has a low probability for loss of life or substantial economic loss.

Table 3-40: Storage Volumes of the Upper and Lower Ponds

Pond	Pond Volume (Acre-Feet)
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	No flow	Low Flow	100-Year
Upper	2.98	6.00	14.54
Lower	15.55	20.88	47.52

3.17 Impervious Area Analysis

An Impervious Area Analysis was used to help understand how stream quality relates to the subwatershed area that drains to a particular stream reach. This analysis uses the subbasins described in Section 3.14.2 and illustrated in Figure 3-2. The Impervious Area Analysis utilized based on the well-established belief that as the percentage of watershed imperviousness increases with increasing urbanization, the quality of physical, chemical, and biological conditions of streams within the watershed decreases.

The objective of this analysis is to determine whether a subwatershed supports or does not support healthy stream conditions by calculating the percentage of impervious cover within all subbasins that drain to a particular stream reach. Each subbasin is then assigned a subwatershed support level based on its percentage of impervious cover according to Table 3-41.

Table 3-41 Impervious Area Analysis Criteria

Subwatershed Support Level	Percent Imperviousness
Supporting	0 to 10%
Impacted	11 to 25%
Non-Supporting	25% or more

Table 3-42 Impervious Area Analysis Results

Subwatershed	Percent Impervious	Support Level
1	50.52%	Non-Supporting
2	74.46%	Non-Supporting
3	56.56%	Non-Supporting
4	55.57%	Non-Supporting
5	49.96%	Non-Supporting
6	39.01%	Non-Supporting
7	38.25%	Non-Supporting
8	76.61%	Non-Supporting
9	44.47%	Non-Supporting
10	33.35%	Non-Supporting
11	30.16%	Non-Supporting
12	72.81%	Non-Supporting
13	32.08%	Non-Supporting
14	54.18%	Non-Supporting
15	52.02%	Non-Supporting
16	60.78%	Non-Supporting
17	18.58%	Impacted
18	12.81%	Impacted
19	42.40%	Non-Supporting
20	45.54%	Non-Supporting
21	22.58%	Impacted

22	17.81%	Impacted
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Of the 22 subwatershed in Madigan Creek, four subwatershed have impervious areas less than 25% and are considered impacted. (Table 3-42) The remaining 18 subwatershed are considered to be non-supporting due to their high impervious area. No subwatersheds in the Madigan Creek watershed are considered supporting. The results of the Impervious Analysis are depicted in Figure 3-26.

In order to generate specific recommendations for addressing the results of this analysis, the subwatershed identifies as “impacted” and subwatershed with impervious higher than 50% require the most immediate attention. For these “impacted” subwatersheds, it is important that future development use conservation design and low impact development practices to reduce the amount and impact of impervious surfaces and to help filter and infiltrate stormwater runoff onsite. For those watershed with impervious area higher than 50%, BMPs need to be implemented in order to reduce the amount of impervious area. These Critical Areas are discussed in the next section, and recommendations for improving conditions within these areas are detailed in Chapter 5.

3.18 Critical Areas

The intent of identifying Critical Areas is to focus watershed improvement efforts on areas where impairments are concentrated or relatively worse than in other areas of the watershed. Restoration, prevention, and remediation efforts in these Critical Areas are expected to achieve a greater impact than in less critical parts of the watersheds. The Critical Area analysis identified two different types of Critical Areas: Critical Subbasins and Critical Reaches, as described below. These results, and recommendations for watershed improvement, have been incorporated into the watershed Action Plan.

3.18.1 Critical Subbasins

Critical Subbasins are those that have particularly strong impact on watershed resources and water quality due to the type and extent of current and planned development. These subbasins will require action to reduce the impact of existing impervious surfaces. Critical Subbasins are listed in Table 3-43 and shown on Figure 3-37 and include the following:

- Subwatersheds identifies as “impacted” by the impervious analysis. These subbasins are considered critical as there is potential conversion of land to higher impervious land uses that would lead to the future degradation of water quality and natural resources.
- Subwatershed with impervious higher than 50% by the impervious analysis. These subbasins are considered critical due to the negative impacts being observed in the watershed associated with the high impervious area include hydromodification, flooding, and streambank erosion.

Subwatershed	Acres	% Impervious
1	176.17	50.52%
2	188.76	74.46%
3	463.82	56.56%
4	415.16	55.57%
8	10.81	76.61%

14	216.82	54.18%
15	252.13	52.02%
16	39.07	60.78%
17	229.18	18.58%
18	16.13	12.81%
21	56.52	22.58%
22	122.47	17.81%

3.18.2 Critical Reaches

Critical Reaches are those that have been impacted due to significant streambank erosion problems and to low habitat quality. These reaches will require restoration of the channel and riparian areas, which will help improve water quality. Critical Reaches are shown on Figure 3-38 include the following:

- Madigan Creek from Waterford Drive to Newberg Road (streambank erosion)
- Madigan Creek from Camilar Road to Hedgewood Road (streambank erosion and hydromodification)
- Madigan Creek Tributary #1 from Mulford Road to Trainer Road (hydromodification)
- Madigan Creek Tributary #2 from Grassridge Drive to the confluence with Madigan Creek (hydromodification)
- Madigan Creek Tributary #3 from Perryville Road to the confluence with Madigan Creek (undeveloped floodplain)

3.19 Summary and Conclusions

The Madigan Creek watershed resource inventory and assessment provides important insight into the issues and problems in the watershed and the opportunities available for preserving and improving watershed resources. The vast majority of the impacts and impairments to watershed resources identified are the direct result of years of modification of the stream and surrounding lands as land use in the watershed changed from undeveloped to agriculture to urban. The impacts of this changing landscape on watershed resources are summarized here and actions for addressing these impacts are included in the Action Plan in Chapter 5.

It is important to identify potential causes and sources of impairment in the watershed so that preventive and restorative measures can be planned and implemented. The issues, causes and sources identified below and in Table 3-XX are based on the best professional judgment based on the watershed inventory assessment and input from the watershed stakeholders. Thus, they should be considered as potential rather than confirmed until additional sampling and surveying can be done. Table 3-46 includes those impairments, causes, and sources that are most relevant to the Watershed-Based Plan nine element requirements of the US EPA. Nonetheless, although the table does not include all of the issues and problems identified below, they all have been addressed within the Action Plan included in Chapter 5.

Water Quality

The most important water quality issues that need to be addressed include the following:

- low dissolved oxygen concentrations due to low flow and the lack of adequate stream habitat features to help oxygenate the water;

- sedimentation of stream channels within low gradient reaches, that is the result of streambank erosion and runoff from the urban landscape; and
- elevated chloride levels resulting from application of salt for snow and ice control on roads, as well as other toxic substances in the water column from urban runoff from impervious surfaces including roads and highway

Watershed Hydrology

The most important issues related to watershed hydrology that need to be addressed include the following.

- flashy hydrology (higher high flows and lower low flows), which impact a number of other watershed resources;
- poor performing detention basins;
- unmaintained, undersize and/or damaged culverts and roadside conveyance systems restricting flow in the stream channels; and
- unmaintained, undersize and/or damaged storm sewers restricting flow and causing localized flooding.

Stream Channels

The most important issues related to stream channels that need to be addressed include the following:

- streambank erosion resulting from flashy hydrology, unstable streambanks, and stormwater discharges;
- stormwater discharges from residential and municipal stormwater management systems that cause erosion of the streambanks and stream channel;
- debris buildup and obstruction within the stream channel that is the result of streambank erosion and dislodged trees and vegetation;
- improperly designed, installed or maintained streambank and stream channel armoring (gabions, riprap, etc.) that is intended to control erosion but is contributing to erosion problems; and
- channelized and incised stream channels.

Riparian Corridors

The most important riparian corridor issues that need to be addressed include the following:

- lack of riparian vegetation as the existing turf grass that is present to the water or stream bank edge destabilizes streambanks and provides no water quality or riparian habitat benefits; and
- dumping of yard waste along the stream banks and in stream channels, which smothers ground level vegetation and adds organic matter and nutrients to the water.

Natural Areas and Wetlands

The most important issues related to watershed wetlands include the following:

- lack of management and restoration plans and action to preserve and restore native habitat;
- invasive species infestations that degrade natural habitat;
- lost wetland acreage; and
- impairment of natural hydrologic patterns that support healthy wetlands resulting from stormwater discharge.

Flooding

The most important flooding issues that need to be addressed include the following:

- risk of flood damage to structures located along the waterways;
- hydrologic modification causing high flows; and
- creation of detention and retention areas including wetlands and depressional storage.

Land Use

The most important land use issues that need to be addressed include the following:

- conversion of vacant, agricultural, or open land to urban uses, which increases impervious surface area and impacts water quality and runoff volume; and
- redevelopment of existing developed land to other land uses with greater impervious surface area and/or higher pollutant loading rates;

Table 3-46 Watershed Impairments, Causes and Sources

Impairment	Causes	Sources
Water Quality	Total suspended solids/sedimentation and siltation	In channel erosion caused by streambank modification and destabilization
		Urban runoff/storm sewers
		Construction sites
		Streets, highway and bridge runoff
Water Quality	Nutrients – phosphorus and nitrogen	Urban runoff/storm sewers
		Soil erosion
		Agricultural activities/golf courses
		Improper disposal of wastes (yard waste, pet waste, etc)
		Leaking septic systems
Water Quality	Low dissolved oxygen (elevated biological oxygen demand & chemical oxygen demand)	Flow alteration (low flow)
		Habitat modifications
		Urban runoff/storm sewers
		Improper disposal of wastes (yard waste, pet waste, etc)
Water Quality	Salinity/chlorides/total dissolved solids	Urban runoff/storm sewers
		Road salt storage and use
Habitat degradation	Hydromodification and flow alterations	Urban runoff/storm sewers
		Loss of riparian buffer
		Loss of floodplain, wetlands, and depressional storage
		Modification to stream flow regime
		Development
Habitat degradation	Lack of instream habitat	Habitat modifications
		Unstable streambanks
		Channelization
Habitat degradation	Loss of riparian buffer	Habitat modifications
		Development
		Inappropriate land management
		Unstable streambanks
Increased stream flows	Increased rate and volume or runoff	Habitat modifications
		Development
		Loss of floodplain, wetlands, and depressional storage

		Poorly functioning/undersized detention
Increased stream flows	Loss of floodplain, wetlands, and depression storage	Draining/filing of floodplain, wetlands, and depression storage
		Development
Flood damage	Past encroachment on floodplain	Past floodplain development
Flood damage	Undersize/improperly maintained infrastructure (storm sewers, culverts, detention, etc)	Development
		Lack of infrastructure maintenance