LPL-797

DODGE COUNTY
WATERWAY CLASSIFICATION SYSTEM

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1.0 INTRODUCTION

Dodge County (the County) completed a Lake Planning Grant Project in 2002 that included the preparation, disbursement, collection and evaluation of a survey questionnaire to determine the public opinion concerning existing and future development along the shorelines of the lakes, streams and rivers in the County, and to determine if there was support for a Waterway Classification. The results of this questionnaire indicated that a majority of the respondents were concerned about development along County shorelines and supported the preparation of a Waterway Classification project.

The surface waters of Dodge County are experiencing increased impacts due to land development, water quality issues, and user conflicts. Based on these trends, the County recognized the need to develop appropriate management and protection strategies. RSV Engineering, Inc., (RSV) prepared the Waterway Classification to inventory current levels of waterway sensitivity with respect to development. The goal of the waterway classification system was to provide the County with a method of categorizing or classifying each lake, river, and stream by their unique characteristics. Once the classification system is complete, modifications to the existing shoreland zoning regulation may be prepared by the County to provide varying degrees of protection to the waterbodies.

The classification of lakes was based on seven of the criteria developed by Bob Young of the Wisconsin Department of Natural Resources (WDNR). The criteria were applied to all lakes in Dodge County. Results of the criteria evaluation were used in a lake classification model developed by Mr. Young to categorize the selected lakes into three classes based on their sensitivity to future development. The first six criteria (Lake Sensitivity Classification Criteria) were used to develop a Total Lake Sensitivity Score. The Existing Development Criterion was used with the Total Lake Sensitivity Criteria to develop the final classification for each lake. This classification method is referred to as the Matrix Classification System. In this manner, a water resource's level of existing development is given the same importance or weight as its sensitivity to future development impacts in determining the final classification for new zoning standards.

The classification of rivers and streams was based on four criteria developed by WDNR to categorize rivers and streams into three classes based on their sensitivity to development. The first three criteria (River & Stream Sensitivity Classification Criteria) were used to develop a Total River & Stream Sensitivity Score. The Existing Development Criterion was used with the Total River & Stream Sensitivity Score to develop the final classification for each river and stream. This classification method is referred to as the Matrix Classification System. In this manner, a stream's level of existing development is given the same importance or weight as its sensitivity to future development impacts in determining the final classification for new zoning standards.

2.0 PROJECT GOAL

Dodge County has retained the professional consulting services of RSV to classify the waterways in Dodge County according to the Waterway Classification System. The goal of the waterway classification system was to provide the County with a method of categorizing or classifying each lake, river, and stream by their unique characteristics. Upon completion of the waterway classification, new zoning ordinances or modifications to existing ordinances can be prepared by the County to provide varying degrees of protection to the waterbodies.

As applied to lakes, the Waterway Classification System consists of categorizing each lake in the county according to seven criteria. These criteria are:

- Lake Surface Area
- Shoreline Development Factor
- Stratification Factor
- Lake Hydrologic Type
- Soil Erodability
- Septic Suitability
- Existing Development

The first six criteria (Lake Sensitivity Classification Criteria) were used to develop a Total Lake Sensitivity Score. The Existing Development Criterion was used with the Total Lake Sensitivity to develop the final classification for each lake. This classification method is referred to as the Matrix Classification System. A description of each classification criterion and its relative measure is included in Sections 3.0 and 4.0. The Lakes Matrix Classification System is discussed in detail in Section 5.0.

With respect to rivers and streams, the Waterway Classification System consists of categorizing each river and stream according to four criteria. The criteria chosen by the County for this classification are; Stream Order, Septic Suitability, Soil Erodability and Existing Development. A description of each classification criterion and its relative measure is included in Section 6.0. The River & Stream Matrix Classification System is discussed in detail in Section 7.0.

3.0 LAKE SENSITIVITY CLASSIFICATION CRITERIA

The Lake Sensitivity Classification System used six criteria to develop a Total Lake Sensitivity Score. Each lake was sub-classified according to value or unit of measure break points established for each criterion. RSV followed the classification criteria and associated break points requested by the County. The scoring of each criterion was based on a scale ranging from 1 - 4, with 1 representing least sensitive to development and 4 representing most sensitive to development.

The Total Lake Sensitivity Score was the sum of the scores for each of the six criteria. The County requested that RSV suggest relatively simple, conventional statistical measures to identify three classes of lakes (i.e., Less Sensitive, Moderately Sensitive, and More Sensitive) based on the distribution of Total Lake Sensitivity Scores. RSV suggested the first and third quartiles as defining the extreme values of the Moderately Sensitive classification. Total Lake Sensitivity Scores of the More Sensitive and Less Sensitive classifications would be above and below the Moderately Sensitive values, respectively. The first quartile of a distribution is a number below which 25 percent of a ranked (lowest to highest) distribution is found. The third quartile is a number below which 75 percent of a ranked distribution is found. Therefore, the values between the first and third quartile (interquartile range) represent the middle 50 percent of the distribution.

The description and scoring for each criterion in the lake sensitivity classification system are presented below. Each criterion and its respective scoring system were approved by Dodge County. The descriptions and scoring system are referenced to the WDNR Guidance Document entitled, Lake Classification For Shoreland Development Impacts (Young, 1998).

3.1 Lake Surface Area

Lake surface area is a physical measure of the waterbody. The unit of measure for this criterion is acres. Surface area is important in determining the amount of shoreline available for development and also provides a relative measure of size of the waterbodies in the County.

As a general rule, the smaller the waterbody, the more sensitive the waterbody is to shoreland development and human impacts. Human impacts in the form of point source and non-point source pollution are the most common forms of impacts due to shoreline development. The primary forms of impacts from shoreline development are increased nutrient loading from septic systems and chemical applications. Secondary impacts may include one or more of the following: deforestation, vegetation removal, soil disruption, soil erosion, habitat loss, and aesthetic degradation.

The criterion scoring of the lakes was based on relative lake size and distribution. Lakes that ranged in size from 1 to 249 acres were assigned a score of 4. Lakes that were 250 acres or larger were assigned a score of 2.

The surface area data (acreage) used for this criterion was taken from the WDNR Surface Water Resources of Dodge County ("SWR").

The criterion scoring was based on the amount of relatively small and medium sized lakes in the County. Approximately three quarters of the lakes included in the classification system are less than 100 acres. In contrast, only five lakes in the County are greater than 250 acres in size.

3.2 Shoreline Development Factor

Shoreline Development Factor ("SDF") is a method of assessing the degree of irregularity of a lake's shoreline compared to its surface area. The SDF is a ratio of the length of actual shoreline of the lake to the shoreline length of a lake that is perfectly circular and has the same surface area. For example, a perfectly circular lake would have an SDF of 1.00. The more irregular the lake shoreline is, the greater the ratio becomes.

The significance of the SDF is that the more irregular a lake shoreline is, the more shoreline development opportunities exist. Comparing two lakes of equal surface area but different SDFs, the lake with the lower SDF would be less likely to have excessive nutrient loading and runoff given an equal amount of development.

The SDF is a relative (or unitless) measure of the potential for shoreline development to cause negative impacts to the waterbody. Lakes with an SDF $\geq$ 3.00 are the most vulnerable to potential over-development and the resulting pollution associated with over-development.

The surface area and shoreline length data used for calculating the SDF were taken from the SWR.

The scoring system used for this criterion was based on recommendations by WDNR. A lake with an SDF of 1.00 to 1.49 was assigned a score of 1 because it is less vulnerable to over-development than a lake with an SDF >1.50. A lake with an SDF of 1.50 to 1.99 was assigned a score of 2. A lake with an SDF of 2.00 to 2.99 was assigned a score of 3, and a lake with an SDF > 3.00 was assigned a score of 4.

3.3 Phosphorus Sensitivity - Stratification Factor

Phosphorus sensitivity predicts a lake's sensitivity to increases in phosphorus concentration or loading. Phosphorus is the primary nutrient that is used by aquatic plants and algae to stimulate growth. Phosphorus loading tends to increase in proportion to increased shoreline development. Phosphorus sensitivity can be measured by examining two physical criteria; thermal stratification and flushing rate.

Thermal stratification is a temperature-dependent condition that prevents the mixing of the three layers within the deep basin of a lake. The upper or surface layer (epilimnion) is the warmest layer in summer and is the layer in which most plant life exists. The thermocline or metalimnion is the middle layer that acts as a buffer between the warmer surface layer and the cooler bottom layer. The thermocline is a relatively thin layer that exhibits a great temperature and density gradient. The bottom layer or hypolimnion is coolest and receives no mixing from wave or wind action.

The stratification factor is an estimate of the effect of excess phosphorus in the waterbody. Because of the stratification that occurs in deeper lakes, these lakes are more sensitive to the negative effects of phosphorus loading. The increased phosphorus concentrations result in decreased oxygen levels in the hypolimnion layer. When this condition exists, aquatic plant and animal life is limited or eliminated in the bottom layer. Deep lakes are more affected by this phenomenon than shallow lakes because wind and wave action continually mix the water column in the shallow lakes. In deep lakes, wind and wave action mix only the upper layer and the thermocline acts as a barrier because of the temperature and density gradient.

The Stratification Factor is calculated by dividing the maximum depth of a lake (plus 4.5) by the surface area of the lake. The calculation formula for this criterion is :

$$\textbf{Stratification Factor} = \frac{\text{Maximum Depth (ft)} + 4.5}{\text{Log Area (acres)}}$$

The Maximum Depth and Area values were taken from the SWR.

The scoring system used for this criterion is based on recommendations by WDNR. A lake with a stratification factor of 0 to 11.4 was assigned a score of 1. A lake with a stratification factor between 11.5 and 13.4 was assigned a score of 2. A lake with a stratification factor between 13.5 and 29.9 was assigned a score of 3. A lake with a stratification factor of > 30.0 was assigned a score of 4.

Reference: Lathrop, Richard C. and Richard A. Lillie. 1980. Thermal Stratification of Wisconsin Lakes. Trans. Wis. Acad. Sci., Arts, and Letters. 68:90-96.

3.4 Lake Hydrologic Type

The Lake Hydrologic Type criterion is based on the primary water source and characteristics of a lake. There are four hydrologic lake types; seepage lakes, drainage lakes, spring lakes, and drained lakes.

The following is a brief description of each hydrologic lake type and the significance of the lake type with respect to shoreline development.

Seepage Lakes

The primary source of water for seepage type lakes is rainfall or groundwater recharge. The watersheds of seepage lakes are generally small. Seepage lakes have no inlet or outlet.

The significance of these characteristics is:

- Because these lakes have no inlet or outlet, little flushing action is realized,
- If the lake stratifies, nutrient loading is magnified because of the low flushing rate, and
- Because the watersheds are generally small, these lakes are most sensitive to shoreline development and pollution.

Drained Lakes

Drained lakes are similar to seepage lakes except that watershed sizes are more variable and an outlet is present that allows limited flushing action. Drained lakes have a primary water source of rainfall or groundwater recharge as with seepage lakes. Generally the watersheds of these lakes are small and the flushing rate is relatively low. These lake types are the second most sensitive to nutrient loading from shoreline development.

Spring Lakes

Spring lakes have a primary water source of groundwater discharge and have high flow outlet streams. The flushing rates are generally high and stratification is reduced due to mixing caused by spring and outlet water movement. These lakes are relatively insensitive to nutrient loading associated with shoreline development.

Drainage Lakes

Drainage lakes have a primary water source that consists of overland flow from the watershed and influent from streams or rivers. The watershed areas of drainage lakes are generally large and the permanent inlet and outlet streams cause high flushing rates. Because of the high flushing rates, stratification is usually not a significant factor.

Drainage lakes are the least sensitive to shoreline development based on the primary water source and high flushing rates.

The hydrologic lake type data used for this criterion is included in the SWR.

The scoring system for this criterion was based on the sensitivity of each lake hydrologic type. Drainage lakes are assigned a score of 1. Spring lakes are assigned a score of 2. Drained lakes are assigned a score of 3, and seepage lakes are assigned a score of 4.

3.5 Soil Erodability

Soil erodability assesses the potential for shoreline development to cause erosion that will impact water quality and near shore aquatic habitat due to sediment and phosphorus loading. Lakes with a higher proportion of steeply sloped shorelines are more vulnerable to erosion and the resulting pollutants than lakes with a relatively flat landform surrounding the lake. Soil erodability was determined by the percentage of the lake's shoreline (within 300 feet of shore) that has a 12% or greater slope. This information was provided to RSV by the Dodge County GIS Department and included the soils data from the Natural Resources Conservation Service (NRCS).

The scoring system used for this criterion was based on an equal percentage of the ranges of values for the criterion among lakes in the County. The range of percentages of erodable soils for lakes was 0 to 37.4%. A lake with a soil erodability factor of 0 to 9.9 was assigned a score of 1. A lake with a soil erodability factor between 10 and 19.9 was assigned a score of 2. A lake with a soil erodability factor between 20 and 29.9 was assigned a score of 3. A lake with a soil erodability factor of > 30.0 was assigned a score of 4.

3.6 Septic Suitability

The septic suitability criterion is a measure of how suitable shoreland soils are for in-ground septic systems. Septic systems in unsuitable soils result in water quality impacts through the active transport of phosphorus-rich wastewater into the lake via groundwater or seepage. Lakes with a higher proportion of shorelands containing unsuitable soils are more vulnerable to water impacts than lakes with more suitable soils. Septic suitability was determined by the percentage of a lake's shoreline (within 300 feet of shore) that contain hydric soils by NRCS definition. These soils are typically saturated during the growing season and depth to groundwater was usually less than 2.5 feet. This information was provided to RSV by the Dodge County GIS Department and included the soils data from the NRCS.

The scoring system used for this criterion was based on equal percentage of the ranges of values for the criterion among lakes in the County. The range of percentages of septic suitability for lakes was 2.8 to 86.0%. A lake with a septic suitability factor of 0 to 24.9 was assigned a score of 1. A lake with a septic suitability factor between 25 and 49.9 was assigned a score of 2. A lake with a septic suitability factor between 50 and 74.9 was assigned a score of 3. A lake with a septic suitability factor of > 75 was assigned a score of 4.

Lake Sensitivity Total Score

Dodge County chose the first and third quartile breaks in the total lake sensitivity score for all the lakes evaluated. The first quartile of a distribution is a number below which 25 percent of a ranked (lowest to highest) distribution is found. The third quartile is a number below which 75 percent of a ranked distribution is found. Therefore, the values between the first and third quartile (interquartile range) represent the middle 50 percent of the distribution. The quartile breaks were established in terms of the total lake sensitivity score. Figure 1 on Page 9 provides graphical representation of the quartile breaks for the Lake Sensitivity Total Scores.

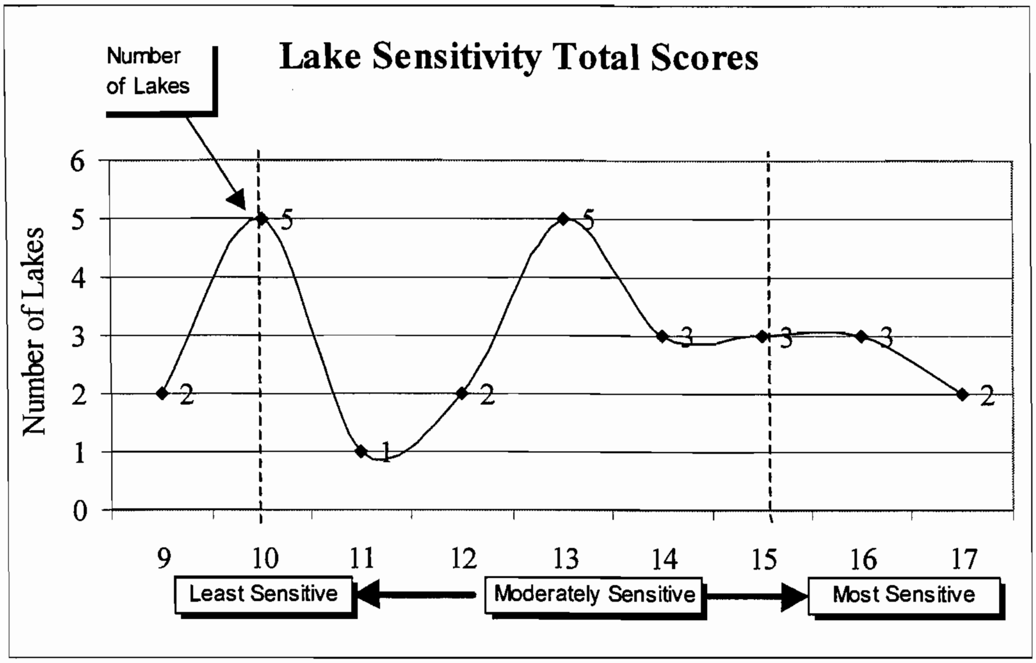

Figure 1. Graph of Lake Sensitivity Total Scores with 25th and 75th Quartile breaks.

Table 1 on Page 10 provides a listing of the lakes included in the classification and their respective scores for the six classification criteria and the total lake sensitivity score.

Table 1. Dodge County Waterway Classification, Lake Sensitivity Scores.

NAME	SA	SDF	SF	SS	SE	HYD	Total SENS
ALDERLY MILL POND	4	2	2	2	2	1	13
BEAVER DAM LAKE	2	4	1	1	1	1	10
CHUB LAKE	4	1	1	2	1	1	10
COLLINS LAKE	4	1	3	2	4	2	16
CRYSTAL LAKE	4	2	3	2	1	1	13
DANVILLE MILL POND	4	4	1	1	3	1	14
LAKE EMILY	2	1	1	1	2	3	10
FOX LAKE	2	3	1	1	1	1	9
KEKOSKEE MILL POND	4	3	1	1	1	1	11
LOMIRA MILL POND	4	1	4	1	1	3	14
LOST LAKE	2	1	1	2	1	3	10
LOWELL MILL POND	4	3	1	1	2	1	12
UPPER MAYVILLE POND	4	4	1	1	2	1	13
LOWER MAYVILLE POND	4	3	1	1	3	1	13
MUD LAKE	4	1	1	2	1	1	10
NEOSHO MILL POND	4	3	1	1	2	1	12
LAKE SINNISSIPPI	2	3	1	1	1	1	9
UNNAMED S 26 T9N R 13E	4	1	1	3	1	4	14
UNNAMED S 27 T9N R 13E	4	1	4	3	2	3	17
UNNAMED S 15 T9N R 14E	4	1	1	4	1	4	15
UNNAMED S 20 T9N R 15E	4	1	4	2	1	4	16
UNNAMED S 4 T9N R 17E	4	1	2	3	2	4	16
UNNAMED S 14 T9N R 17E	4	1	1	1	2	4	13
UNNAMED S 26 T10N R 13E	4	1	4	3	1	4	17
UNNAMED S 1 T11N R 14E	4	1	4	2	3	1	15
UNNAMED S 12 T11E R 16E	4	1	4	1	1	4	15

SA - Surface Area
SDF - Shoreline Development Factor
SF - Stratification Factor
SS - Septic Suitability
SE - Soil Erodability
HYD - Hydrologic Lake Type
Total SENS - Total Lake Sensitivity Score

4.0 EXISTING DEVELOPMENT CLASSIFICATION CRITERION

The Existing Development classification criterion was based on the current development status of the lake shoreline. The criterion was based on the average feet of shoreline per development. The development counts are based on any development structure within 300 feet of the Ordinary High Water Mark ("OHWM") as defined by WDNR.

The spatial limits of a positive count for existing development was mutually agreed upon by the County and RSV to be any development within 300 feet of the OHWM of each lake shoreline. The existing development counts were completed using the Dodge County Geographic Information System (GIS). These counts were expected to be the most up-to-date and accurate records of development within 300 feet of the OHWM of each lake.

The scoring system for the Existing Development criterion was chosen by the County based on breaks or feet per development limits. Using the County break methodology, a lake with an average of greater than 750 feet of shoreline per development was assigned a class of 1; or less developed. A lake with an average of between 200 and 749.9 feet of shoreline per development was assigned a class of 2; or moderately developed. A lake with an average of less than 200 feet of shoreline per development was assigned a class of 3; or more developed.

Table 2 on Page 12 provides a listing of the lakes and their respective Existing Development scores.

Table 2. Dodge County Waterway Classification, Lakes Existing Development Scores.

NAME	Existing Development Score
ALDERLY MILL POND	2
BEAVER DAM LAKE	2
CHUB LAKE	1
COLLINS LAKE	1
CRYSTAL LAKE	2
DANVILLE MILL POND	1
LAKE EMILY	2
FOX LAKE	3
KEKOSKEE MILL POND	2
LOMIRA MILL POND	3
LOST LAKE	1
LOWELL MILL POND	2
UPPER MAYVILLE POND	3
LOWER MAYVILLE POND	1
MUD LAKE	1
NEOSHO MILL POND	2
LAKE SINNISSIPPI	3
UNNAMED S 26 T9N R 13E	1
UNNAMED S 27 T9N R 13E	1
UNNAMED S 15 T9N R 14E	1
UNNAMED S 20 T9N R 15E	2
UNNAMED S 4 T9N R 17E	1
UNNAMED S 14 T9N R 17E	1
UNNAMED S 26 T10N R 13E	2
UNNAMED S 1 T11N R 14E	1
UNNAMED S 12 T11E R 16E	1

5.0 LAKES MATRIX CLASSIFICATION SYSTEM

Dodge County chose to incorporate the Existing Development criterion in a matrix classification system with the Total Lake Sensitivity classification for final classification. In this manner, a lake's level of existing development would be given the same importance or weight as its sensitivity to future development impacts in determining the final classification for new zoning standards.

The matrix classification system consisted of the following procedures.

1. Score lakes for Total Lake Sensitivity based on chosen criteria.
2. Choose classes of Total Lake Sensitivity from entire range (i.e., Class 1, 2, 3).
3. Determine level of Existing Development for each lake.
4. Choose classes of Existing Development from entire range (i.e., Class 1, 2, 3).
5. Combine Total Lake Sensitivity classes with Existing Development classes into matrix.
6. Establish final Lake Classification from matrix for development of zoning standards.

The matrix classification system shown below depicts the procedure used to determine the final classification. The lake sensitivity ranges from more sensitive to less sensitive and the existing development ranges from less developed to more developed. The Class 1, 2, 3 designations inside the matrix are the Final Lake Classification.

	EXISTING DEVELOPMENT		
LAKE SENSITIVITY	Less Developed		More Developed
More Sensitive	CLASS 1	CLASS 1	CLASS 2
	CLASS 1	CLASS 2	CLASS 3
Less Sensitive	CLASS 2	CLASS 3	CLASS 3

Class 1 = Most restrictive zoning standards.
Class 2 = Intermediate zoning standards.
Class 3 = Least restrictive zoning standards.

Table 3 on Page 14 presents the Final Lake Classification (Matrix Classification System).

Table 3. Dodge County Waterway Classification, Final Lake Matrix Classification.

Class 1 Lakes	Class 2 Lakes	Class 3 Lakes
COLLINS LAKE	ALDERLY MILL POND	BEAVER DAM LAKE
DANVILLE MILL POND	CHUB LAKE	LAKE EMILY
LOWER MAYVILLE POND	CRYSTAL LAKE	FOX LAKE
UNNAMED S 26 T9N R 13E	KEKOSKEE MILL POND	LOMIRA MILL POND
UNNAMED S 27 T9N R 13E	LOST LAKE	UPPER MAYVILLE POND
UNNAMED S 15 T9N R 14E	LOWELL MILL POND	LAKE SINNISSIPPI
UNNAMED S 20 T9N R 15E	MUD LAKE	
UNNAMED S 4 T9N R 17E	NEOSHO MILL POND	
UNNAMED S 14 T9N R 17E		
UNNAMED S 26 T10N R13E		
UNNAMED S 12 T11N R16E		
UNNAMED S 1 T11N R 14E		

A Dodge County map is included which shows the county boundaries, roads and waterbodies. The lakes are color coded for identification of final lake classification. Lakes colored red are classified as Class 1, lakes colored blue are Class 2, and lakes colored green are classified as Class 3.

6.0 RIVER AND STREAM CLASSIFICATION CRITERIA

The classification of rivers and streams ("streams") in the County is similar in scope to the lake classification in that different levels of protection are to be applied to each river and stream based on selected criterion scoring. The scoring system included four criteria; stream order, septic suitability, soil erodability and existing development.

Each stream was sub-classified according to value or unit of measure break points established for each criterion. RSV followed the classification criteria and associated break points requested by the County. The scoring of each criterion was based on a scale ranging from 1 - 4, with 1 representing least sensitive to development and 4 representing most sensitive to development.

The Total Stream Sensitivity Score was the sum of the scores for each of the three criteria. The County requested that RSV suggest relatively simple, conventional statistical measures to identify three classes of streams (i.e., Less Sensitive, Moderately Sensitive, and More Sensitive) based on the distribution of Total Stream Sensitivity Scores. RSV suggested the first and third quartiles as defining the extreme values of the Moderately Sensitive classification. Total Stream Sensitivity Scores of the More Sensitive and Less Sensitive classifications would be above and below the Moderately Sensitive values, respectively. The first quartile of a distribution is a number below which 25 percent of a ranked (lowest to highest) distribution is found. The third quartile is a number below which 75 percent of a ranked distribution is found. Therefore, the values between the first and third quartile (interquartile range) represents the middle 50 percent of the distribution.

The description and scoring for each criterion in the stream sensitivity classification system are presented below. Each criterion and its respective scoring system were approved by Dodge County. The descriptions and scoring system are referenced to the WDNR Guidance Document entitled, Lake Classification For Shoreland Development Impacts (Young, 1998).

6.1 Stream Order

Stream Order is one method of classifying streams based on their geomorphologic characteristics. A method of classifying the hierarchy of natural channels according to their position in the drainage system, referred to as stream order, permits comparison of the behavior of a river with others similarly situated. It is useful for developing and testing generalizations and predictions about river processes. Several modifications exist of the original stream-order system developed by Horton in 1945. In the most commonly cited and used system (Strahler, 1957), small headwater streams are designated Order I. Streams formed by the confluence of two Order I streams are referred to as Order II, and so on, with larger numbers indicating larger rivers with multiple tributary streams. This general methodology was used to apply a stream order value for the streams and rivers in Dodge County.

For classification purposes, all Order 1 or small streams were assigned a score of 4. Small streams are generally most sensitive to development due to their small size and capacity to attenuate pollutants.

All streams that are tributaries to lakes in the County were assigned a score of 3. Streams that flow into a lake are a source of pollutant discharge from a generally much larger watershed area than the subwatershed of the lake itself and therefore should be considered to be a more sensitive water resource.

Large streams or small rivers were assigned a score of 2. These streams are generally Order 2 or 3 streams. These larger streams and small rivers are less sensitive to development due to their increased volume and surface area.

Large rivers were assigned a score of 1. These larger rivers are less sensitive to development due to their increased volume and surface area.

6.2 Septic Suitability

The septic suitability criterion is a measure of how suitable streamside soils are for in-ground septic systems. Septic systems in unsuitable soils result in water quality impacts through the active transport of phosphorus-rich wastewater into the stream via groundwater or seepage. Streams with a higher proportion of streamside lands containing unsuitable soils are more vulnerable to water impacts than streams with more suitable soils. Septic suitability was determined by the percentage of a stream's shoreline (within 300 feet of shore) that contain hydric soils by NRCS definition. These soils are typically saturated during the growing season and depth to groundwater was usually less than 2.5 feet. This information was provided to RSV by the Dodge County GIS Department and included the soils data from the NRCS.

The scoring system used for this criterion was based on equal percentage of the ranges of values for the criterion for streams in the County. The range of percentages of septic suitability for streams was 6.8 to 83.0%. A stream with a septic suitability factor of 0 to 24.9 was assigned a score of 1. A stream with a septic suitability factor between 25 and 49.9 was assigned a score of 2. A stream with a septic suitability factor between 50 and 74.9 was assigned a score of 3. A stream with a septic suitability factor of > 75 was assigned a score of 4.

6.3 Soil Erodability

Soil erodability assesses the potential for shoreline development to cause erosion that will impact water quality and near shore aquatic habitat due to sediment and phosphorus loading. Streams with a higher proportion of steeply sloped shorelines are more vulnerable to erosion and the resulting pollutants than streams with a relatively flat landform surrounding the stream. Soil erodability was determined by the percentage of the stream's shoreline (within 300 feet of shore) that has a 12% or greater slope. This information was provided to RSV by the Dodge County GIS Department and included the soils data from the NRCS.

The scoring system used for this criterion was based on an equal percentage of the ranges of values for the criterion for streams in the County. The range of percentages of erodable soils for streams was 0 to 19.3%. A stream with a soil erodability factor of 0 to 4.9 was assigned a score of 1. A stream with a soil erodability factor between 5 and 9.9 was assigned a score of 2. A stream with a soil erodability factor between 10 and 14.9 was assigned a score of 3. A stream with a soil erodability factor of > 15 was assigned a score of 4.

Total Stream Sensitivity Score

Dodge County chose the first and third quartile breaks in the total stream sensitivity score for all the streams evaluated. The first quartile of a distribution was a number below which 25 percent of a ranked (lowest to highest) distribution is found. The third quartile was a number below which 75 percent of a ranked distribution is found. Therefore, the values between the first and third quartile (interquartile range) represents the middle 50 percent of the distribution. The quartile breaks were established in terms of the total stream sensitivity score. Figure 2 on Page 18 provides graphical representation of the quartile breaks for the Stream Sensitivity Total Scores.

Figure 2. Dodge County Waterbody Classification, Stream Sensitivity Total Scores.

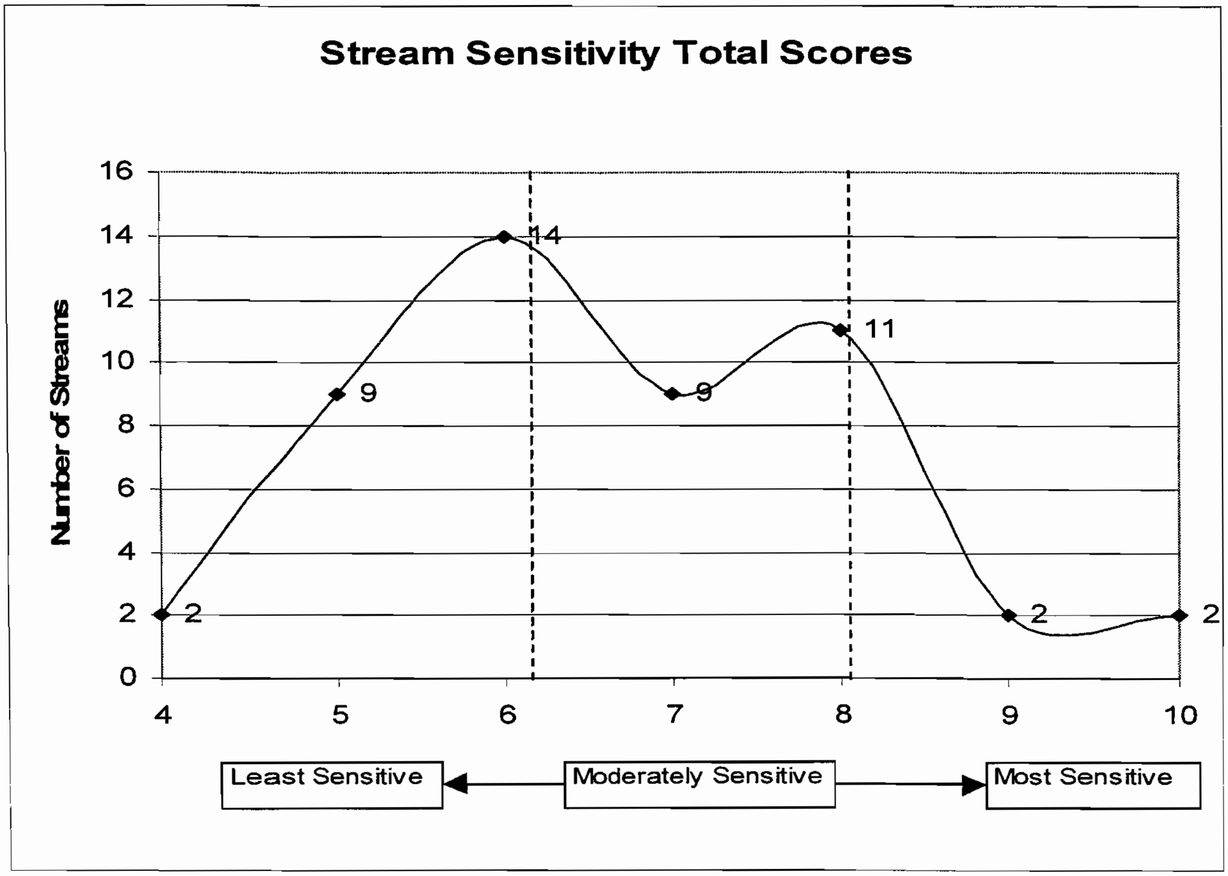

Table 4 on Pages 19 and 20 provide a listing of the streams included in the classification and their respective scores for the three classification criteria and the total stream sensitivity score.

Table 4. Dodge County Waterway Classification, Stream Sensitivity Scores.

Name	SO Score	SE Score	SS Score	Total SENS
Alto Creek	3	1	2	6
Ashippun River	2	3	2	7
Baker Creek	4	1	3	8
Beaver Creek	3	3	2	8
Beaver Dam River	1	1	3	5
Butler Creek	2	2	1	5
Calamus Creek	2	2	2	6
Casper Creek	2	1	3	6
Clyman Creek	4	4	2	10
Cold Spring Creek	2	1	3	6
Crawfish River	1	1	2	4
Crystal Creek	4	2	2	8
Davy Creek	2	1	4	7
Dawson Creek	2	3	2	7
Dead Creek	3	2	3	8
Drew Creek	3	1	2	6
Fink Creek	2	4	2	8
Gill Creek	2	2	1	5
Hepp Creek	2	4	2	8
Irish Creek	2	1	2	5
Kummel Creek (Lomira Creek)	2	2	2	6
Lau Creek	2	1	3	6
Lentz Creek	4	4	1	9
Libby Creek	2	1	3	6
Limestone Creek	4	1	2	7
Mill Creek (Fox Lake to BDL)	3	1	2	6
Milwaukee River (West Branch)	2	1	2	5
Mud Lake Creek	2	4	2	8
Mud Run Creek	2	3	2	7
Neda Creek	4	1	2	7
Nolan Creek	2	3	2	7
No Name Creek	2	1	3	6
Old Mill Creek (Chester)	2	1	1	4
Oliver Creek	4	3	2	9
Park Creek	4	2	2	8
Plum Creek	2	1	3	6
Pratt Creek	2	2	2	6
Rock River (Mainstem)	1	1	3	5
Rock River (East Branch)	1	1	3	5
Rock River (West Branch)	1	1	3	5
Rubicon River	2	3	2	7

Name	SO Score	SE Score	SS Score	Total SENS
Schultz Creek	4	1	1	6
Shaw Brook	2	2	2	6
Silver Creek	2	3	3	8
Spring Brook	2	1	2	5
Stony Creek	4	3	3	10
Waterloo Creek	2	2	4	8
Wildcat Creek	2	3	2	7
Woodland Creek	4	3	1	8

SO Score - Stream Order Score
SE Score - Soil Erodability Score
SS Score - Septic Suitability Score
Total SENS - Total Stream Sensitivity Score

6.4 Existing Development

The Existing Development classification criterion was based on the current development status of the stream shoreline. The criterion was based on the average feet of shoreline per development. The development counts are based on any development structure within 300 feet of the Ordinary High Water Mark ("OHWM") as defined by WDNR.

The spatial limits of a positive count for existing development was mutually agreed upon by the County and RSV to be any development within 300 feet of the OHWM of each stream shoreline. The existing development counts were completed using the Dodge County Geographic Information System (GIS). These counts were expected to be the most up-to-date and accurate records of development within 300 feet of the OHWM of each stream.

The scoring system for the Existing Development criterion which was chosen by the County based on breaks or feet per development limits. Using the County break methodology, a stream with an average of greater than 2,000 feet of shoreline per development was assigned a class of 1; or less developed. A stream with an average of between 1,000 and 1,999 feet of shoreline per development was assigned a class of 2; or moderately developed. A stream with an average of less than 1,000 feet of shoreline per development was assigned a class of 3; or more developed.

Table 5 on Page 21 provides a listing of the streams and their respective Existing Development scores.

Table 5. Dodge County Waterway Classification, Stream Existing Development Scores.

Stream Name	Existing Development Score
Alto Creek	1
Ashippun River	1
Baker Creek	1
Beaver Creek	2
Beaver Dam River	3
Butler Creek	2
Calamus Creek	1
Casper Creek	1
Clyman Creek	1
Cold Spring Creek	1
Crawfish River	3
Crystal Creek	3
Davy Creek	2
Dawson Creek	3
Dead Creek	1
Drew Creek	2
Fink Creek	2
Gill Creek	3
Hepp Creek	2
Irish Creek	3
Kummel Creek (Lomira Creek)	2
Lau Creek	1
Lentz Creek	2
Libby Creek	1
Limestone Creek	2
Mill Creek (Fox Lake to BDL)	3
Milwaukee River (West Branch)	2
Mud Lake Creek	3
Mud Run Creek	1
Neda Creek	3
Nolan Creek	1
No Name Creek	2
Old Mill Creek (Chester)	1
Oliver Creek	2
Park Creek	3
Plum Creek	1
Pratt Creek	2
Rock River (Mainstem)	2
Rock River (East Branch)	3
Rock River (West Branch)	1
Rubicon River	2
Schultz Creek	3
Shaw Brook	2
Silver Creek	1
Spring Brook	3
Stony Creek	3
Waterloo Creek	1
Wildcat Creek	3
Woodland Creek	3

7.0 RIVERS & STREAMS MATRIX CLASSIFICATION SYSTEM

Dodge County chose to incorporate the Existing Development criterion in a matrix classification system with the Total Rivers & Streams Sensitivity classification for final classification. In this manner, a stream's level of existing development would be given the same importance or weight as its sensitivity to future development impacts in determining the final classification for new zoning standards.

The matrix classification system consisted of the following procedures.

1. Score streams for Total Stream Sensitivity based on chosen criteria.
2. Choose classes of Total Stream Sensitivity from entire range (i.e., Class 1, 2, 3).
3. Determine level of Existing Development for each stream.
4. Choose classes of Existing Development from entire range (i.e., Class 1, 2, 3).
5. Combine Total Stream Sensitivity classes with Existing Development classes into matrix.
6. Establish Final Stream Classification from matrix for development of zoning standards.

The matrix classification system shown below depicts the procedure used to determine the final classification. The stream sensitivity ranges from more sensitive to less sensitive and the existing development ranges from less developed to more developed. The Class 1, 2, 3 designations inside the matrix are the Final River & Stream Classification.

	EXISTING DEVELOPMENT		
STREAM SENSITIVITY	Less Developed		More Developed
More Sensitive	CLASS 1	CLASS 1	CLASS 2
	CLASS 1	CLASS 2	CLASS 3
Less Sensitive	CLASS 2	CLASS 3	CLASS 3

Class 1 = Most restrictive zoning standards.
Class 2 = Intermediate zoning standards.
Class 3 = Least restrictive zoning standards.

Table 6 on Page 23 presents the Final River & Stream Classification (Matrix Classification System).

Table 6. Dodge County Waterway Classification, Final River & Stream Classification.

CLASS 1	CLASS 2	CLASS 3
Alto Creek	Beaver Creek	Beaver Dam River
Ashippun River	Davy Creek	Butler Creek
Baker Creek	Drew Creek	Crawfish River
Calamus Creek	Fink Creek	Crystal Creek
Casper Creek	Hepp Creek	Dawson Creek
Clyman Creek	Kummel Creek	Gill Creek
Cold Spring Creek	Limestone Creek	Irish Creek
Dead Creek	No Name Creek	Mill Creek (Fox Lake - BDL)
Lau Creek	Old Mill Creek (Chester)	Milwaukee River (West Br.)
Lentz Creek	Pratt Creek	Mud Lake Creek
Libby Creek	Rock River (West Br.)	Neda Creek
Mud Run Creek	Rubicon River	Park Creek
Nolan Creek	Shaw Brook	Rock River (Mainstem)
Oliver Creek	Stony Creek	Rock River (East Branch)
Plum Creek		Schultz Creek
Silver Creek		Spring Brook
Waterloo Creek		Wildcat Creek
		Woodland Creek

8.0 REFERENCES

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