Regional

Report

Aquatic Resource Assessment

For the Twin Cities Metropolitan Area
Natural Resources Inventory and Assessment

March 2003

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EXECUTIVE SUMMARY

A GIS-based assessment process was used to evaluate selected physical, biological, and cultural indicators for surface water resources in the Twin Cities Metropolitan Area (TCMA). The results from this assessment are relative rankings of the regional importance of the region's surface water resources for various purposes (i.e. water supply, recreation, ecological). This assessment is not intended as a position for any particular management strategy of the region's aquatic resources, but rather it is intended to provide information for planning purposes. The decision of how the water bodies in each of these categories should be managed or protected is a policy decision that involves social, economic, as well as scientific information.

The TCMA has abundant water resources which provide multiple benefits. There are 1,942 open water bodies larger than 3 acres with a total surface area of 108,000 lake acres. There are also 2,784 stream segments with a total length of 5,479 km. The TCMA has five primary water supply lakes and two reserve water supply lakes. The Mississippi River at and above Fridley, Minnesota is also used as a critical water supply source. The region has abundant water-based recreation opportunities. The TCMA has 81 lakes and six rivers that are ranked as outstanding for regional recreational importance. These lakes have a combined surface area of 54,800 acres and the rivers have a combined length of 442 km. The region also has 181 lakes and 514 stream segments ranked as outstanding for regional ecological importance.

The results of this assessment provide an important base of information from which policy and management issues can be discussed. Every effort was made to include the best available regional data; however, there are several areas of this analysis that could be improved upon, if the resources to collect additional input data were made available.

ABOUT THIS REPORT

This report was prepared as part of an inventory and assessment of natural resources for the Twin Cities Metropolitan Area. The report was prepared by Steve Kloiber (651-602-1056) of the Metropolitan Council's Environmental Services Division. Questions about the content of this report can be referred directly to him.

INTRODUCTION

The Twin Cities Metropolitan Area (TCMA) is fortunate to have a large number of lakes (over 900 lakes >10 acres) and thousands of miles of streams and rivers. These lakes, streams and rivers provide recreational opportunities, support ecological habitat, and serve the water supply system. Because these vital resources add to the economic stability and quality of life of the region, protecting the integrity of these water resources is a major public concern. Historically, planning efforts have often dealt with environmental impacts to these sensitive resources as an after-thought. The Metropolitan Council supports efforts to conserve sensitive environmental resources. In a joint effort, the Metropolitan Council and the Department of Natural Resources (DNR) and other partners have teamed up to identify and evaluate natural areas as a guide for land-use decisions that balance growth with conservation through the development of the Natural Resources Inventory and Assessment (NRI/A).

This report describes the component of the NRI/A performed for aquatic resources of the TCMA. This assessment provides a regional comparison of lakes, streams, and rivers according three use categories: water supply, recreation, and ecology. This assessment updates and expands upon an earlier assessment by the Metropolitan Council to prioritize lakes for management purposes based on their water supply and recreational use (Metropolitan Council 1982). In addition, watersheds are assessed according to the level of human hydrologic alteration. A separate analysis of wetland ecological function was performed by the DNR in the terrestrial ecological component of the NRI/A.

METHODS

Key physical, biological, and social characteristics of TCMA aquatic resources were compiled and evaluated to assign a relative ranking of the resource value with regard to water supply, recreational, and ecological use. This assessment was implemented using a geographic information system (GIS) approach. GIS data sets were compiled from various sources for this effort (Table 1). The ranking criteria were developed through an extensive collaborative process involving several interagency groups. Participants in these efforts included a broad cross-section of natural resource experts and other project stakeholders (Appendix A).

Lakes were assessed on a basin level and stream features were grouped into assessment segments based on connectivity, stream order, and minor watershed boundaries. For this assessment, connected stream arcs that have the same stream order (using the Strahler system) were considered an assessment segment; however, long stream segments (>10 km or > 6 miles), excluding the major rivers, were subdivided at minor watershed boundaries.

Table 1
Assessment Input Data

Data Description	Source
Lakes and Major Rivers	Metropolitan Council
Streams	Metropolitan Council and DNR
MCBS Sites of Biological Significance	DNR
Rare Natural Features	DNR
National Wetland Inventory	USFWS
Designated Trout Streams	DNR
Rare and Unusual Fish	DNR
Landcover	UM, Metropolitan Council, DNR
Lake Water Clarity	UM, Metropolitan Council

Water Supply Assessment

The goal of water supply assessment is to categorize surface water features based upon water supply use. This categorization is based on information obtained from local water supply plans for the TCMA (SPWU 1995). Waters are classified based on direct water supply use only. It is important to recognize that many other surface waters are tributary to the lakes and rivers identified here. Management of these tributary areas is required through the source water protection plan requirements of the Safe Drinking Water Act and is not addressed here.

Primary Water Supply (Code = 3)

1) First Tier - Primary Reservoir System (Vadnais, Pleasant, Deep, Sucker, Charley)
2) Mississippi River above the intakes for Minneapolis and St. Paul

Secondary / Reserve Water Supply (Code = 2)

1) Second Tier - Reserve Water Supply - Centerville, Peltier

Recreational Assessment

Surface water features were categorized for regional recreational importance primarily based upon public accessibility as well as basic physical characteristics that relate to the ability to support direct or indirect contact recreation. The indicators used to determine public accessibility include access to the water surface through boat launches or access to the shoreline and scenic views through parks. Physical indicators used for this categorization include surface area for lakes and median summer flow (and/or watershed area) for rivers.

Outstanding Recreational Importance (Code = 3)

1) First Tier Recreational Lakes - This includes lakes with an open water surface area (at OHWL) of more than 100 acres *and* having an adjacent park *and* public water access.

2) Perennial river and stream segments with public access *and* parks *and* sufficient flow to maintain navigation. Stream segments in this category have watershed areas greater than 300 square miles and/or summer median flow greater than 120 cubic feet per second. This includes the Minnesota designated canoe routes such as the Cannon River, Crow River, Rum River, Mississippi River, Minnesota River, and St. Croix River.

High Recreational Importance (Code = 2)

1) Second Tier Recreational Lakes - This includes lakes with an open water surface area (at OHWL) of more than 100 acres *and* having an adjacent park *or* public water access.
2) Perennial rivers and streams with public access *and* parks *and* sufficient flow to maintain navigability most of the time. Stream segments in this category have watershed areas less than 300 square miles, but greater than 150 square miles and/or summer median flow less than 120 cubic feet per second, but greater than 60 cubic feet per second. (e.g. Rice Creek, Minnehaha Creek, Sand Creek, South Fork of the Crow River and the Vermillion River).

Moderate Recreational Importance (Code = 1)

1) Third Tier Recreational Lakes - This includes lakes with an open water surface area (at OHWL) of less than 100 acres, but greater than 10 acres *and* having an adjacent park *or* public water access.
2) Streams with parks *and* insufficient flow to maintain navigability most of the time. Stream segments in this category are third order or higher (using the Strahler stream order method) and they have watershed areas less than 150 square miles and/or summer median flow less than 60 cubic feet per second.

Ecological Assessment

The goal of this section is to categorize surface water features based upon regional ecological importance. This categorization relies on a combination of physical and biological indicators.

Biological assessment techniques are becoming a fairly routine proceedure for evaluating the ecological condition of aquatic resources. Water resource management agencies in most states have either developed or are developing biological assessment programs (Barbour and Burton 2002). The biological indicators used in this assessment primarily relate to the presence of rare, endangered, threatened, or unusual species. There are two reasons for using rare and unusual species as an indicator. First, as a society, we value rare and unusual species and have long established programs to protect them. Second, rare and unusual species are often (not always) rare because they are most sensitive to ecosystem disturbances such as pollution and habitat alteration. Therefore, the presence of these species in a lake, river or stream serves as an indication of better water quality and/or aquatic habitat. For this analysis, only biological survey observations that were last observed within the past 25 years were included in the analysis.

Because information on the presence of rare or unusual species is limited to the resources that have been surveyed, this assessment also incorporates several physical indicators of ecological condition. The physical aquatic habitat is widely recognized as the foundation for the structure of

the biological community. A stream's biological and chemical processes correspond to its physical attributes, and the nature of the biological community changes in a downstream direction as the physical characteristics of the stream change (e.g. width, depth, velocity, and sinuosity) (Vannote et al. 1980). While many indicators have been used for physical habitat assessment of streams and lakes, for this assessment indicators were limited to those for which regionally complete data could be obtained in a GIS format. These indicators include the percent riparian zone covered with natural vegetation, water clarity for lakes, and stream geometry. These indicators are reflective of various components of natural and anthropogenic influences on aquatic systems.

Development and other human acitivities in the riparian zone often results in removal of natural vegetation, which in turn results in several potential adverse impacts for aquatic systems. Decreases in instream habitat quality has been shown to correlate to agricultural and urban land use within the riparian corridor (Diamond and Serveiss 2001). Riparian zones are important interfaces between terrestrial and aquatic communities, providing a complex habitat. Lakes and streams with more natural vegetation in their riparian zones tend to support a more diverse population of flora and fauna (Henderson et al. 1998). Lakes and streams with more natural vegetation in their riparian zones are also buffered from impacts of human development such as stormwater runoff (Schueler 1995).

While lake water clarity can be affected by several factors, such as algae, dissolved organic matter, or inorganic suspended sediment, water clarity in TCMA lakes is usually determined by the abundance of algae, which in turn is usually controlled by the amount of nutrients, particularly phosphorus, present in a lake (Osgood 1988). While phosphorus does occur naturally, elevated levels of phosphorus are usually the result of human activity in the watershed of a lake. As such, water clarity is a good indicator of human induced pollutant loading to TCMA lakes. In addition, water clarity is commonly used as an indicator of trophic state, the amount of organic matter production in a lake. Increases in the trophic state have been shown to result in low oxygen levels, increased stress on native fish populations, fish kills, and shifts in fish species dominance toward more pollution tolerant species such as carp (Heiskary and Wilson 1988).

Stream channel geometry is a function of the landscape as well as direct human alteration. Hundreds of miles of TCMA streams have been channelized, straightened, cleared, dredged, or otherwise modified. In addition, increased stream flow resulting from urban development can also lead to channel straightening (Booth 1990). One way of assessing stream channel geometry is to measure the sinuosity of the stream. Sinuosity is calculated as the ratio of the total stream channel length to the straight-line distance from one segment endpoint to the other segment endpoint. Stream channels having higher sinuosity values are more natural and provide higher habitat value than do straightened channels with low sinuosity (Figure 1). However, many agricultural ditches have right angle turns, sometimes multiple right angle turns, resulting in a high sinuosity value. To avoid classifying these segments improperly the sinuosity analysis was complemented with data on vertex density (the number of vertices per unit length) and stream order. These ditches tend to have a low stream order and low vertex density.

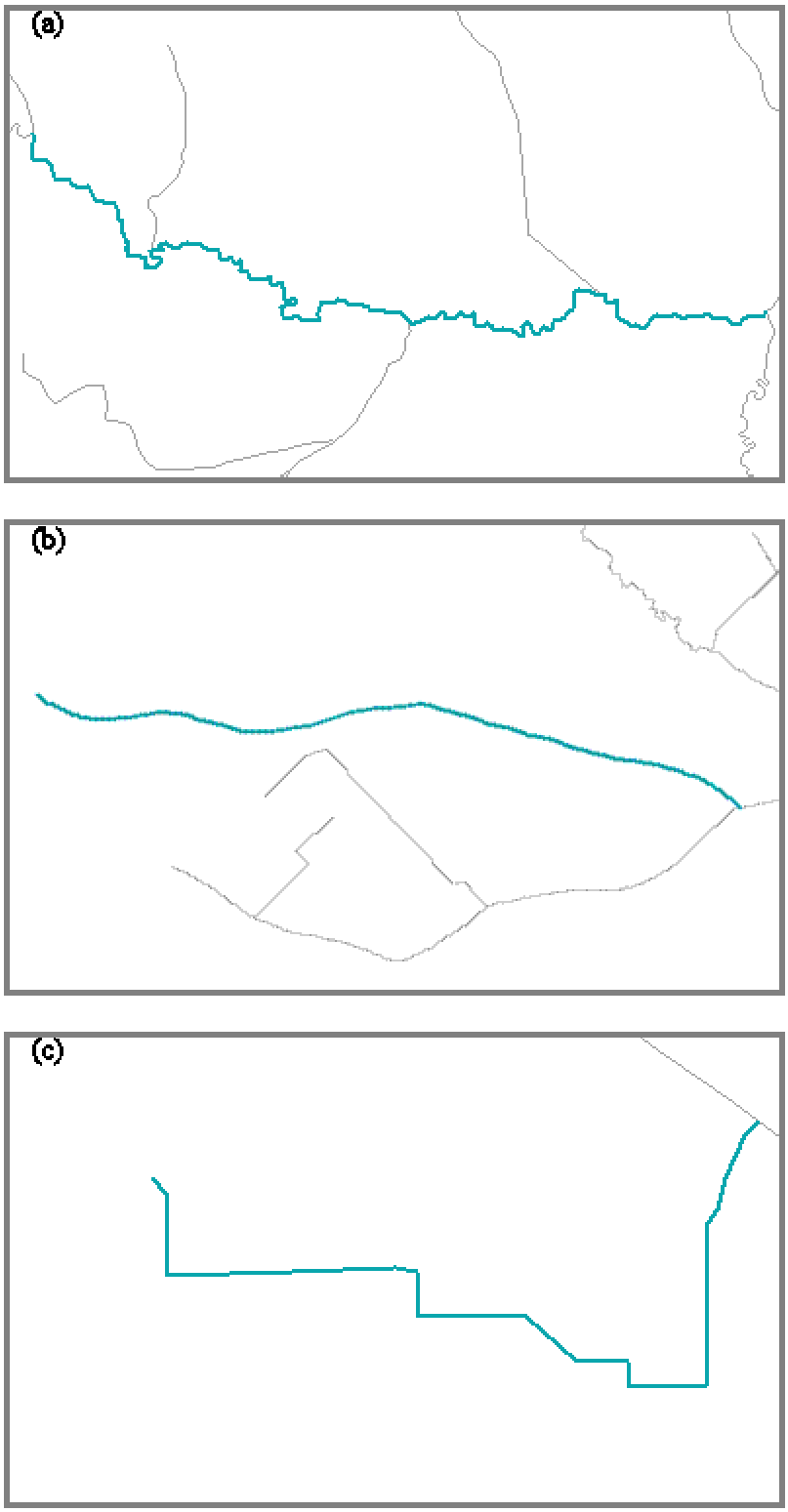


Figure 1: Comparison of stream geometry for natural and human altered channels

a) natural channel with high sinuosity (1.53) and high vertex density (39.0)
b) altered channel with low sinuosity (1.03) and low vertex density (10.8)
c) altered channel with high sinuosity (1.65) and low vertex density (3.9)

The ecological assessment score was calculated as the maximum of the biological score and the physical habitat score. The computations for these components are described below. The composite ecological assessment divides aquatic features into three classes: outstanding ecological value (ecological score = 3), high ecological value (ecological score = 2), and moderate/impacted ecological value (ecological value = 1).

Biological Assessment

1) If any of the following conditions were met, the aquatic feature was assigned a biological score = 3.
   - Lakes, streams, and rivers that intersect CBS sites from the CBS polygon data set with a rank of outstanding biodiversity *or* high biodiversity.
   - DNR designated trout lakes or stream segments that any portion that is a designated trout stream.
   - Lakes that contain at least one CBS point observation within 30 meters (positional error of the data set) of an obligate aquatic species that is not mobile outside of an aquatic environment (e.g. plants, fish, mussels, etc.).
   - Rivers *or* streams that are within 30 meters (positional error of the data sets) of at least one CBS point observation of an obligate aquatic species that is not mobile outside of an aquatic environment (e.g. fish, mussels, etc.).
   - Lakes, rivers, and streams that are within 100 meters of more than one CBS point observation of an obligate aquatic species that can be mobile outside of an aquatic environment (e.g. waterfowl, reptiles, etc.).
   - Lakes, streams, and rivers that contain rare aquatic species from other DNR survey data (e.g. Schmidt and Talmage survey).
2) If any of the following conditions were met, the aquatic feature was assigned a biological score = 2.
   - Lakes, rivers, and streams that are within 100 meters of one CBS point observation of an obligate aquatic species that can be mobile outside of an aquatic environment (e.g. waterfowl, reptiles, etc.).
3) All remaining lakes and streams were assigned a biological score = 1.

Physical Habitat Assessment

For streams, the overall physical habitat score is calculated as the average of the stream geometry score and the riparian vegetation score, rounded up to the nearest integer. For lakes, the overall physical habitat score is calculated as the average of the water clarity score and the riparian vegetation score, rounded up to the nearest integer.

Riparian Vegetation

1) Lakes, rivers, and streams that are surrounded by >65% natural vegetation within 60 meters of the shoreline or bank are given a score = 3.
2) Lakes, rivers, and streams that are surrounded by ≤65%, but >40% natural vegetation within 60 meters of the shoreline or bank are given a score = 2.

3) Lakes, rivers, and streams that are surrounded by ≤40% natural vegetation within 60 meters of the shoreline or bank are given a score = 1.

Lake Water Clarity

1) Lakes with a mean summer Secchi depth > 3.0 meters (using all satellite assessments for the 1990s) were given a score = 3.
2) Lakes with a mean summer Secchi depth > 2.2 meters and Secchi depth ≤ 3.0 meters were given a score = 2.
3) Lakes with a mean summer Secchi depth ≤ 2.2 meters were given a score = 1.

Stream Channel Geometry

1) Streams with Strahler stream order ≥ 3rd order and sinuosity > 1.5 were given a score = 3.
2) Streams with Strahler stream order ≤ 2rd order and sinuosity > 1.5 and vertex density ≥ 13.33 and length ≥ 1 km were given a score = 3.
3) Streams with Strahler stream order ≥3rd order and sinuosity > 1.2 and sinuosity ≤ 1.5 were given a score = 2
4) Streams with Strahler stream order ≤ 2rd order and sinuosity > 1.2 and sinuosity ≤ 1.5 and vertex density ≥ 10 and length ≥ 1 km were given a score = 2.
5) Streams with Strahler stream order ≤ 2rd order and smaller than 1 km were assigned a score = 1.
6) All other streams were given a score = 1.

Watershed Level Summary

The analysis of stream physical condition described above evaluates each stream segment independently of each other. While there are important differences from segment to segment, it is also important to understand the connections between stream segments and how the system operates together. The relationship between watershed landuse, habitat quality, and biotic diversity has been demonstrated by numerous studies (Schueler 1994; Talmage et al. 1999; Wang et al. 2001). As such, a watershed-scale assessment was performed which considers the physical condition of all stream segments within a minor watershed as well as the amount of impervious cover in the watershed.

All stream segments were divided at minor watershed boundaries using an intersect function. The weighted-average physical condition was calculated for each watershed by multiplying each stream segment by its length and then dividing by the total length of all streams in the watershed. Scores for watershed imperviousness were assigned as follows: <10% imperviousness was assigned a score of three, between 10% and 25% a score of two was given, and watersheds with >25% impervious cover were given a score of one. The physical score was averaged with the imperviousness score and then divided into four categories of watershed condition. Watersheds with a condition score between 1 and 2 were considered degraded or impacted, watersheds with condition scores between 2 and 2.5 were considered threatened, and watersheds with scores between 2.5 and 3 were considered in good condition.

RESULTS

Water Supply Use

Lakes

The TCMA has five primary water supply lakes and two reserve water supply lakes (Table 2 and Figure 2). All of these lakes are part of the St. Paul Water Utility (SPWU) supply system. The SPWU draws water from the Mississippi River at Fridley and pumps the water via aqueduct to Charley Lake. From there the water travels through Pleasant Lake and Sucker Lake and the finally to Vadnais Lake. In addition, the SPWU has the ability to draw water from Centerville and Peltier Lakes, but has only done so once in the past 15 years under extreme drought conditions. Assuming that future withdrawals are limited to drought conditions, the lakes and streams above Peltier Lake are unlikely to contribute water and thus were not considered regionally important water supply sources.

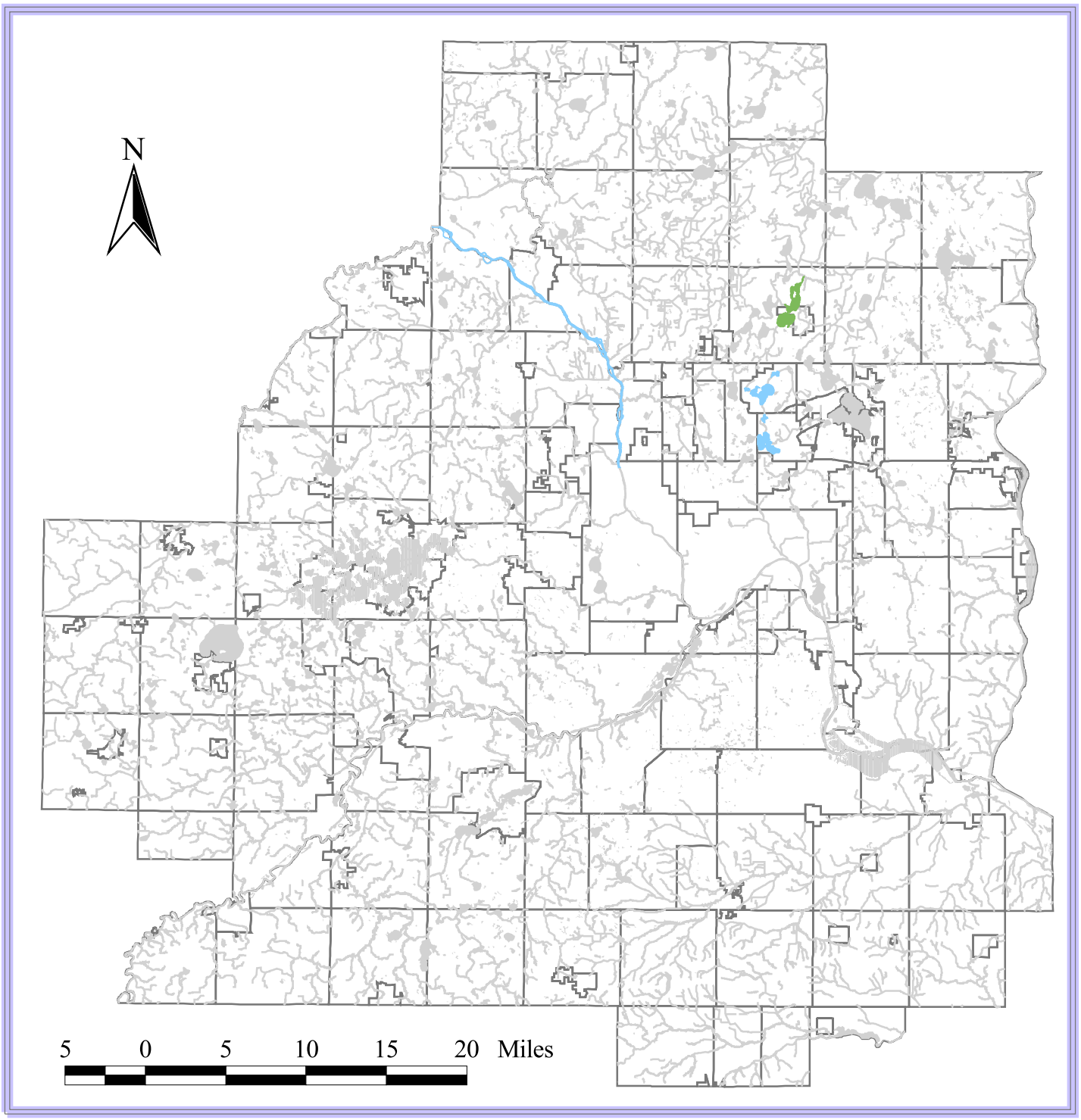
Table 2
Regionally Important Water Supply Lakes

Lake ID	Lake Name	Water Supply Signficance
62001800	Deep	Primary
62002800	Sucker	Primary
62003800	Vadnais	Primary
62004600	Pleasant	Primary
62006200	Charley	Primary
02000400	Peltier	Reserve
02000600	Centerville	Reserve

Rivers/Streams

The Mississippi River is the only river used for water supply in the TCMA (Figure 2). The Minneapolis and St. Paul water utilities both draw water from the Mississippi River at Fridley, therefore the river from Fridley and upstream is considered a regionally important resource for water supply use. It should be noted that all water bodies within the Upper Mississippi River Watershed above Fridley potentially contribute to the drinking water of Minneapolis and St. Paul. Therefore, to ensure the continued use of this resource for drinking water we need to consider appropriate management strategies for the entire watershed. It should also be noted that several communities downstream of the TCMA also rely on the Mississippi River for drinking water. As such, we have an obligation to protect the water quality of the Mississippi for other users.

Figure 2
TCMA Surface Water Supply Use Classification



Regional Water Supply Importance

Lakes and Rivers
- Primary
- Secondary/Reserve
- No Direct Use

Streams
- No Direct Use

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Recreational Use

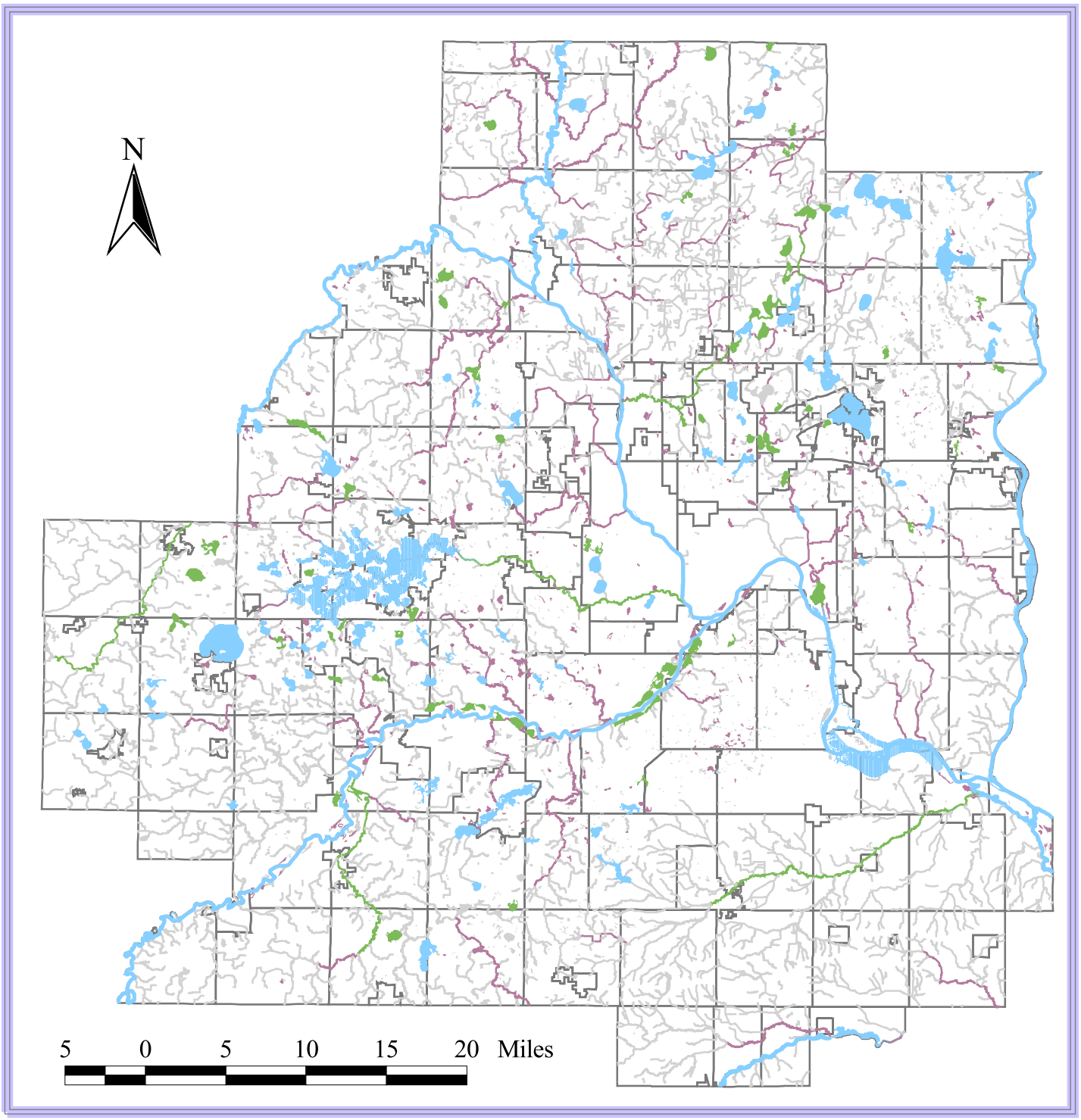
Lakes

The TCMA has 81 lakes that are ranked as outstanding for regional recreational importance (Figure 3). These lakes are larger than 100 acres and have public water access and adjacent parks with a combined surface area of 54,800 acres.. The region also contains 67 lakes with high recreational importance. These are lakes that are larger than 100 acres and that have either a public water access or an adjacent park, but not both. These lakes also represent a potential opportunity to enhance regional water recreation capacity. In addition, the region has 343 lakes with moderate recreational importance. These lakes are smaller than 100 acres and they have either a public water access or an adjacent park. These lakes may also be locally important recreational resources. Table 3 lists the lakes with an outstanding recreational importance classification. For a complete listing of all lake rankings, please refer to the GIS data which can be found at the MetroGIS Datafinder website (www.datafinder.org).

Rivers/Streams

The TCMA has 6 rivers that are ranked as outstanding for regional recreational importance including the Cannon, Crow, Minnesota, Mississippi, Rum, and St. Croix Rivers (Figure 3). These rivers are larger perennial rivers that maintain sufficient flow for navigation with a combined length of 442 km.. They also represent the state designated canoe routes and numerous state and regional parks are located along these rivers as well as public water access sites. The region also contains five streams and rivers with a high recreational importance classification including Minnehaha Creek, Rice Creek, Sand Creek (Scott County), South Fork of the Crow River and the Vermillion River. These streams and rivers also have public water access and adjacent parks. They are intermediate in size and usually maintain sufficient flow for navigation. The region also has numerous other streams with a moderate recreational importance classification. These are at least third order streams that have adjacent parks. For a complete listing of all stream rankings, please refer to the GIS data which can be found at the MetroGIS Datafinder website (www.datafinder.org).

Figure 3
TCMA Surface Water Recreational Use Classification



Regional Recreational Importance

Lakes	Streams
Outstanding	Outstanding
High	High
Moderate	Moderate
Limited	Limited

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Table 3
Lakes with an Outstanding Regional Recreational Importance Classification

Lake ID	Lake Name	Area (acres)	Lake ID	Lake Name	Area (acres)
02000300	Otter	294.6	27007800	Staring	163.2
02000400	Peltier	573.4	27010400	Medicine	922.3
02000600	Centerville	472.8	27011101	Eagle	294.2
02000800	Rice	370.2	27011102	Pike	57.4
02002600	Linwood	570.3	27011700	Weaver	149.2
02003400	Martin	249.4	27011800	Fish	234.8
02004200	Coon	1532.8	27013300	Minnetonka	14185.0
02005300	Ham	180.5	27016000	Long	297.9
02008400	Crooked	118.9	27017600	Independence	834.1
02008900	Round	263.5	27018100	Dutch	173.8
02009100	George	491.5	27018400	Whaletail	518.1
10000200	Riley	295.4	27019200	Rebecca	265.6
10000600	Lotus	242.2	27104500	Nordmyr (Normandale)	108.4
10000900	Minnewashta	686.0	62000200	Bald Eagle	1044.0
10001200	Ann	116.3	62001300	Phalen	197.4
10004100	Zumbra-Sunny	225.4	62005600	Owasso	371.2
10004200	Parley	255.9	62005700	Josephine	114.1
10004401	Auburn West	144.0	62006100	Turtle	439.1
10004402	Auburn East	143.2	62007300	Snail	148.0
10004500	Steiger	169.7	62007800	Johanna	210.6
10004800	Wassermann	166.2	70002200	Cleary	146.4
10005300	Piersons	291.6	70002600	Lower Prior	966.9
10005800	Maria	168.8	70005400	Spring	593.0
10005900	Waconia	3088.1	70006900	Fish	175.9
10007800	Rice	239.3	70007200	Upper Prior	387.4
10008600	Patterson	234.3	70009100	Cedar	793.6
10008800	Hydes	219.4	70009500	O'Dowd	317.9
10010800	Tiger	385.6	70012000	Thole/Schneider	161.3
10012100	Eagle	179.9	82004600	Square	201.9
19000500	U.S. L & D #2 Pool (Baldwin)	5869.8	82004900	Big Carnelian	451.6
19000600	Byllesby	750.4	82005200	Big Marine	1889.6
19002603	Marion West	110.3	82005400	Bone	222.6
19002601	Marion East	462.8	82009100	Battle Creek	105.9
19002700	Crystal	287.1	82010100	DeMontreville	157.0
19003100	Orchard	236.0	82010400	Jane	152.7
27001600	Harriet	338.5	82010600	Elmo	294.3
27001900	Nokomis	200.4	82014000	Oneka	393.3
27003100	Calhoun	414.8	82015900	Forest	2282.9
27004700	Bush	189.0	82016300	Clear	429.2
27006700	Bryant	176.1	82016700	White Bear	2416.7
27007000	Mitchell	114.4			

Ecological Use

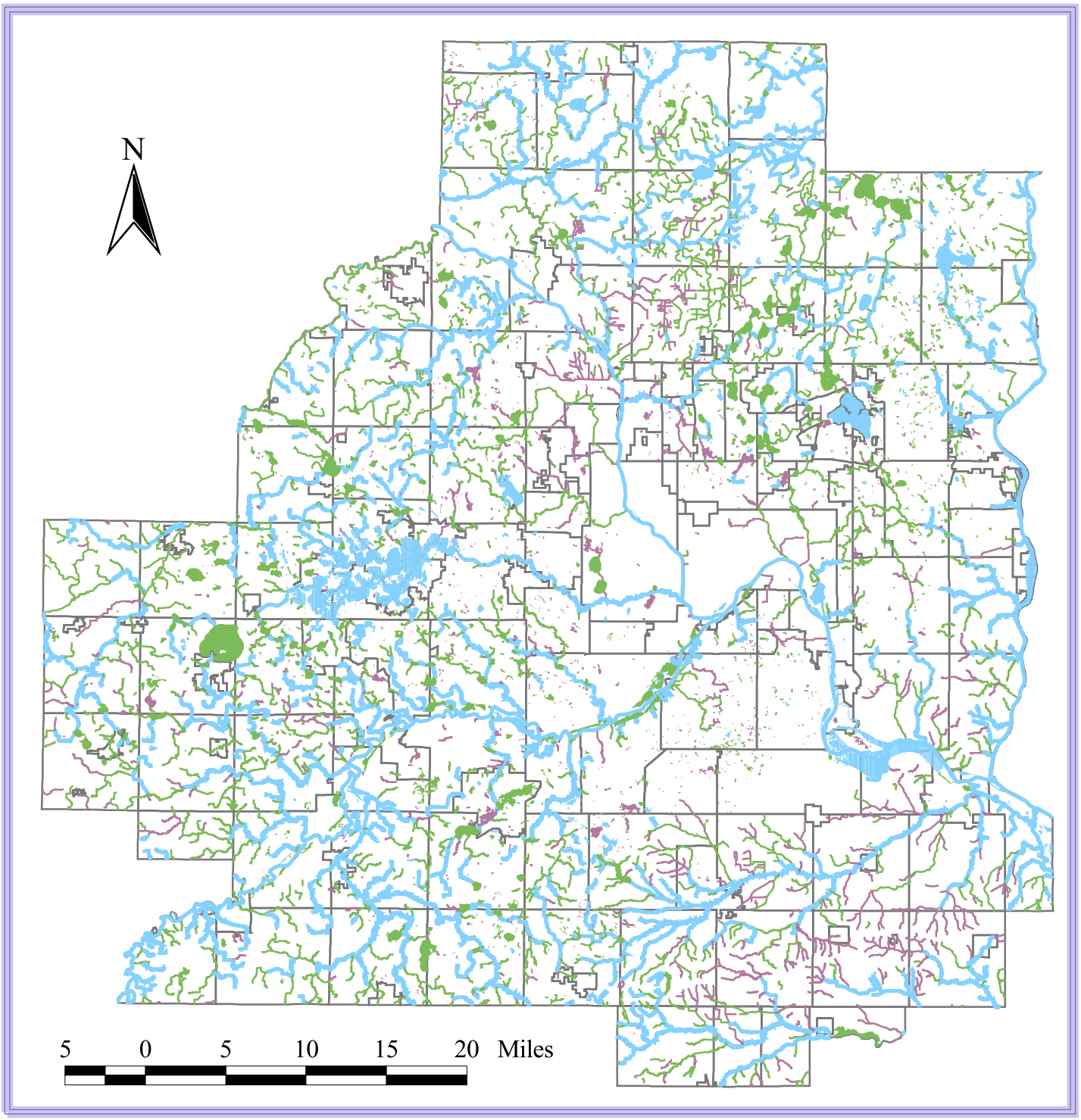
Lakes

The lake GIS data for the TCMA has 1,942 open water bodies larger than 3 acres for a total of 108,000 lake acres. Of these, 181 lakes (9%) are ranked as outstanding for regional ecological importance (Figure 4). The total area of lakes in this category is 41,400 acres (38% of the total lake acres) Lakes with the highest ecological importance include 119 lakes that have a biological score of three - seven trout lakes, 82 lakes that intersect a site of high biological significance, and 121 lakes with one or more observations of rare, endangered, or unusual aquatic species in or near the lake. Lake with the highest ecological importance also include 76 lakes with outstanding physical habitat (i.e. good water clarity and a high percentage of natural riparian vegetation). Fourteen lakes have both high biological and physical scores. There is considerable correlation between lakes that have high quality physical habitat and those that have high biological importance. Most lakes that have a biological score of three have a physical score of two or three (72%). However, there are 56 lakes with a outstanding physical score and a moderate to low biological score (74%). This discrepancy can be explained, at least partially, as the result of the incomplete nature of the biological survey data. For a complete listing of all lake rankings, please refer to the GIS data which can be found at the MetroGIS Datafinder website (www.datafinder.org).

Streams

The stream GIS data for the TCMA has 2,784 stream segments and a total length of 5,479 km. Of these, 514 stream segments (18% of all segments) were ranked as outstanding for regional ecological importance (Figure 4). The total length of stream segments in this category is 2,303 km (42% of total stream length). Two hundred-ten (210) stream segments in this category have a biological score of three (rare, endangered, or unusual species are likely present), 364 stream segments have a physical score of three (high channel sinuosity and natural riparian vegetation), and 60 stream segments have high scores for both biological and physical metrics. As with lakes, most stream segments that have a biological score of three have a physical score of two or three (89%). However, many streams that have a high physical score have low biological scores (81%). Undoubtedly, at least part of this discrepancy can be explained by the limited extent of the biological survey data. If comprehensive biological surveys were performed on more streams, it is likely that more streams would be given a higher biological score. For a complete listing of all stream rankings, please refer to the GIS data which can be found at the MetroGIS Datafinder website (www.datafinder.org).

Figure 4
TCMA Surface Water Ecological Use Classification



Regional Ecological Importance

Lakes	Streams
Outstanding	Outstanding
High	High
Moderate	Moderate

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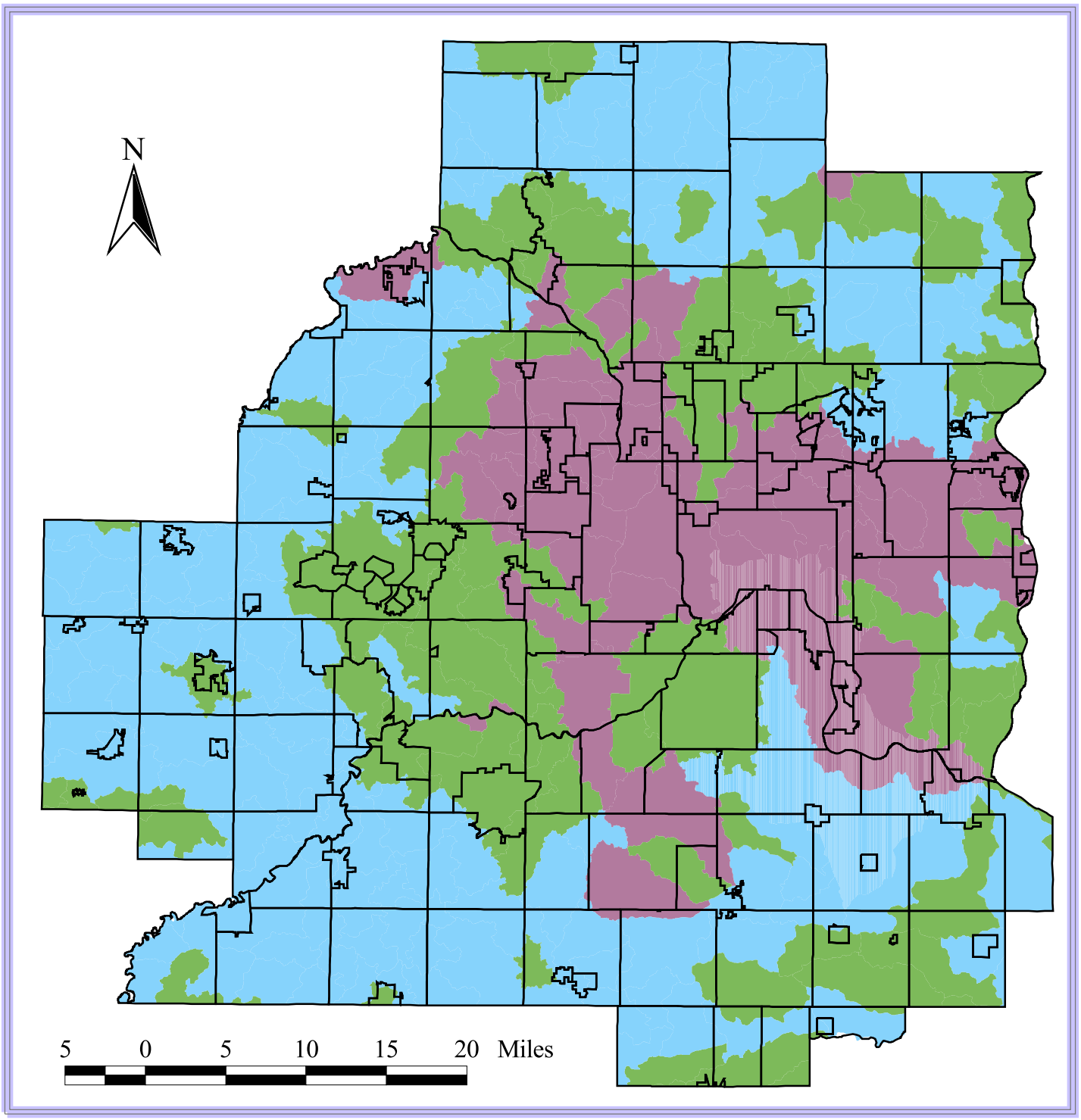
Watershed Level Summary

There are 231 minor watersheds that are at least partially within the seven-county metropolitan area. Of these 125 are considered to be in good condition, 67 are threatened, 39 are impacted or degraded accroding to the measures used in this analysis. The distribution of watershed impacts closely follows the pattern of urban development (Figure 5). However, this analysis considers only riparian vegetation, stream sinuosity, and watershed imperviousness. If watershed agricultural impacts were considered, the number of watersheds considered threatened, impacted or degraded would be considerably higher.

Figure 5
TCMA Watershed Condition Classification



Watershed Condition Class

Watersheds

- Good
- Threatened
- Impacted or Degraded

Metropolitan Council
Building communities that work

March 14, 2003

SUMMARY

The TCMA has abundant water resources which provide multiple benefits. There are 1,942 open water bodies larger than 3 acres with a total surface area of 108,000 lake acres. There are also 2,784 stream segments with a total length of 5,479 km. The TCMA has five primary water supply lakes and two reserve water supply lakes. The Mississippi River at and above Fridley, Minnesota is also used as a critical water supply source. The region has abundant water-based recreation opportunities. The TCMA has 81 lakes and six rivers that are ranked as outstanding for regional recreational importance. These lakes have a combined surface area of 54,800 acres and the rivers have a combined length of 442 km. The region also has 181 lakes and 514 stream segments ranked as outstanding for regional ecological importance.

Data Limitations

This document and the data described in it are not intended as a position for any particular management strategy of the region's aquatic resources, but rather attempts to provide information for planning purposes. These data are a relative ranking of the regional importance of a particular aquatic resource for a specified purpose (i.e. water supply, recreation, ecological). Text labels (such as moderate, high, and outstanding) have been assigned to each of the relative rankings which range from one (lowest) to three (highest) for presentation purposes. The decision of how the water bodies in each of these categories should be managed or protected is a policy decision that involves social, economic, as well as scientific information.

As with all data, the quality of these data are affected by several sources of uncertainty and caution should be exercised in the use of these data. Care was taken to use the best available data; however, the best available data may not be comprehensive, of adequate resolution, or current. Given this uncertainty, especially the ecological data, the ranking should be viewed as probabilities not absolute certainties. Detailed field surveys should be conducted to verify the accuracy of the ecological assessments.

There are several areas of this analysis that can be improved upon, given the resources to collect additional input data. Some specific examples of known issues are listed below.

- As noted in the results section of this report, the biological survey data are incomplete for the TCMA. Only a limited number of streams and lakes have had comprehensive bioligical assessments performed. Conducting comprehensive biological surveys for more streams would undoubtedly reduce the uncertainty in the ecological assessment.

- The quality of the stream digitizing could be updated and improved. Existing stream data doesn't always adequately capture sinuosity and a purely automated analysis is still affected by inflated sinuosity for ditches with right angles. The original data are based upon USGS 7.5-minute quadrangle maps that are now 20 – 30 years old in most cases. Updating the data to align it with the Metropolitan Council's 2000 digital ortho-photos would be a potentially signficant improvement.

- The land cover data is derived from Landsat Thematic Mapper imagery and therefore limited to a 30-meter resolotion. While this resolution is probably sufficient for certain types of analysis, it is uncertain whether this is a appropriate scale for riparian land cover analysis.

- The watershed assessment probably exagerates the quality of the watersheds because it does not account for land use impacts other than urbanization.

- The watershed assessment includes physical condition scores of the major rivers as well as the smaller local tributaries. This may artificially inflate the scores for some urban watersheds given that there is typically good riparian cover along the major rivers. However, the condition of the major rivers is not very reflective of the condition of the local minor watershed.

REFERENCES

Barbour, M.T. and J.L. Burton. 2002. Biological assessment: a necessary tool for state water resource agencies. In Advances in Water Monitoring Research. Tamim Younos Ed. Water Resource Publications, LLC. Highlands Ranch Colorado. 105-123.

Booth, D.B. 1990. Stream-channel incision following drainage basin urbanization. *Water Res. Bull.* 26: 407-417.

Diamond, J.M., and V.B. Serveiss. 2001. Identifying sources of stress to native aquatic fauna using a watershed ecological risk assessment framework. *Environ. Sci. Technol.* 35: 4711-4718.

Heiskary, S.A., and C.B. Wilson. 1988. Minnesota Lake Water Quality Assessment Report. Minnesota Pollution Control Agency. St. Paul, MN. 144pp.

Henderson, C.L., C.J. Dindorf, and F.J. Rozumalski. 1998. Lakescaping for Wildlife & Water Quality, St. Paul, MN: Minnesota Department of Natural Resources, Section of Wildlife, Nongame Wildlife Program. 180pp.

Metropolitan Council. 1982. Water Resources Management, Part 2: Surface Water Management - Nonpoint Source Pollution and Stormwater Runoff. Metropolitan Council. St. Paul, MN. 103-166.

Osgood, R.A. 1988. The Limnology, Ecology, and Management of Twin Cities Metropolitan Area Lakes. Metropolitan Council. St. Paul, MN. 119pp.

Schueler, T.R. 1995.The architecture of urban stream buffers. Watershed Protection Techniques. 1: 155-163.

Schueler, T.R. 1994.The importance of imperviousness. Watershed Protection Techniques. 1: 100-111.

SPWU. 1995. Water Conservation and Emergency Response Plan. St. Paul Water Utility. St. Paul, MN. 62pp.

Talmage, P.J., K.E. Lee, R.M. Goldstein, J.P. Anderson, and J.D. Fallon. 1999. Water Quality, Physical Habitat, and Fish-Community Composition in Streams in the Twin Cities Metropolitan Area, Minnesota 1997-98. Water Resource Investigation Report 99-4247. U.S. Geological Survey. 18pp.

Vannote, R.L., GW Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. *Can. J. Fish. Aquat. Sci.* 37:130-137.

Wang, L., J. Lyons, P. Kanehl, and R. Banneran. 2001. Impacts of urbanization on stream habitat and fish across multiple spatial scales. Environmental Management. 28: 255-266.

APPENDIX A

Participation in the Development of the Aquatic Resource Assessment

Metropolitan Council NRI Lakes Sub-Team

Participation Level:

- Three half-day meetings held on July 19, August 15, and September 19, 2001
- Technical input
- Advanced material provided electronically
- Comments received at meetings and outside of meetings via electronic correspondence

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Metropolitan Council NRI Rivers and Streams Sub-Team

Participation Level:

- Three half-day meetings held on July 17, August 15, and September 19, 2001
- Technical input
- Advanced material provided electronically
- Comments received at meetings and outside of meetings via electronic correspondence

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Metropolitan Council - DNR Natural Resource Inventory Coordination Team

Participation Level:

- Series of meetings held between October, 2001 and January, 2002
- Working sessions discussing and developed detailed criteria

Participants:

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* Other participants invited as needed.

APPENDIX B

Aquatic Resource Assessment Data Development Details

Lakes and Wide Rivers

Area - The Area field is the area of the polygon representing the extent of open water in square meters. It was calculated using the ArcView 3.2 request "*Shape.ReturnArea"*.

Lake_id - The Lake_id field is a unique 8-digit identifier for each lake polygon in string format. The value of this field is the DNR Division of Water lake identification number (Dowlknum) if one has been assigned. If Dowlknum is null, then Lake_id is a unique sequential number (Autonumber).

Autonumber - The Autonumber field is a unique sequential number generated using the ArcView 3.2 request "99000000 + (rec + 1)". A value of 99000000 was added to each record number to make an 8-digit number, similar to, but distinguishable from the Dowlknum.

System - The system field is used to distinguish lacustrine open water features (lakes) from riverine open water features (rivers). Larger rivers were digitized as part of the open water class of the Metropolitan Council's 2000 land use data. These features were selected manually and the ArcView field calculator was then used to assign the System value of "River" for these features. All remaining open water features were assigned the System value of "Lake".

Dowlknum - The Dowlknum field contains a unique lake identification number assigned by the DNR Division of Waters. The field was obtained, along with coordinates for the lake center from the DNR's Lakes database. A point file was created using the coordinates and this file was spatially joined the Council's Hydro2k data layer. The accuracy of the ID assignment was checked by staff from Metropolitan Council's GIS department as well as staff from the Metropolitan Council's Environmental Quality Assurance department.

Pwiclass - The Pwiclass field indicates whether a lake is listed as a protected water (P) or protected wetland (W) by the DNR. This field was derived from the DNR's Lakes DB.

Rname - The Rname field is the DNR registered name of the lake from Lakes DB.

Alt_name - The Alt_name field is the alternative name of the lake from Lakes DB.

Prod_date - The Prod_date field contains the date that the feature geometry was either initially created or the date it was most recently modified. The date format is yyyymmdd.

Prod_grp - The Prod_grp field contains an identifier of the Metropolitan Council department that either created or last modified a feature.

Lineage - The Lineage field is used to track whether a feature was initially digitized as part of the original Metropolitan Council 2000 land use data, if it was modified from the original land use data, or if it was added afterwards.

Area_ac - The Area_ac field is the area of the polygon representing the extent of open water in acres. It was calculated using the ArcView 3.2 request "*Shape.ReturnArea/4047*".

Biodiv_sig - The Biodiv_sig field indicates whether an open water feature intersects a site of high biodiversity as identified in the Minnesota County Biological Survey (MCBS). GIS data for the MCBS sites of biological significance was obtained from the DNR. Sites that had a biodiversity rank equal to high were selected from the set. The ArcView select by theme command was used to find all open water polygons that intersect selected polygons of the MCBS sites of biological significance. The ArcView field calculator was then used to set the Biodiv_sig value for all selected records to "Y". The field calculator was also used to set the Biodiv_sig value to "N" for all other records.

Trout - The Trout field indicates whether a lake is a DNR designated trout lake. A list of metro area designated trout lakes was obtained from the DNR. The data was manually entered into this Hydro2K data layer.

Nonmobile - The Nonmobile field specifies the number of observations within the past 25 years of rare, endangered, threatened or unusual aquatic species (heretofore referred to as R&E species) that are not mobile outside of an aquatic environment (e.g. fish, mollusks, etc.) associated with an open water feature. An observation of a non-mobile R&E species was considered to be associated with a water feature if it was within a distance of 30 meters, which is the approximate combined spatial accuracy of the data. Point observation data for R&E species were provided by the Natural Heritage and Nongame Research Program of the DNR and were current as of the date delivered (4/23/01). The point observation data were classified according to their water requirement and their mobility outside an aquatic environment. A data layer of open water plus a 30 meter buffer was created using the buffer wizard in ArcMap 8.2. The open water features were spatially joined to the point data using ArcView 3.2. R&E species with a last observed date greater than 1977, requiring water, and not mobile outside of an aquatic environment were selected. The number of R&E species within each 30-m buffered water feature were summarized using the summarize field command in ArcView 3.2, summarizing on the Lake_id field. This results in a table of the number of R&E species by the unique Lake ID. This table was then joined to the Hydro2K data layer and the Nonmobile field was calculated using the field calculator (Nonmobile = JoinedTable.Count).

Mobile - The Mobile field specifies the number of observations within the past 25 years of R&E species that are mobile outside of an aquatic environment (e.g. reptiles, birds, etc.) associated with an open water feature. An observation of a mobile R&E species was considered to be associated with a water feature if it was within a distance of 100 meters, which is an assumed average travel distance from water. Point observation data for R&E

species were provided by the Natural Heritage and Nongame Research Program of the DNR and were current as of the date delivered (4/23/01). The point observation data were classified according to their water requirement and their mobility outside an aquatic environment. A data layer of open water plus a 100 meter buffer was created using the buffer wizard in ArcMap 8.2. The open water features were spatially joined to the point data using ArcView 3.2. R&E species with a last observed date greater than 1977, requiring water, and mobile outside of an aquatic environment were selected. The number of R&E species within each 100-m buffered water feature were summarized using the summarize field command in ArcView 3.2, summarizing on the Lake_id field. This results in a table of the number of R&E species by the unique Lake ID. This table was then joined to the Hydro2K data layer and the Mobile field was calculated using the field calculator (Mobile = JoinedTable.Count).

Bio_class - The Bio_class field contains a relative score summarizing the known biologically significant sites based on the Biodiv_sig, Trout, Nonmobile, and Mobile fields. The value is a 1, 2, or 3, with a value of three having the highest probability of important biological features. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Clarity - The Clarity field contains the average of the satellite-estimated, summer-mean, water clarity depth (equivalent to the Secchi disk transparency depth). Details of the satellite water clarity estimation procedure can be found in Kloiber et al. (2002).

Clar_class - The Clar_class field contains a relative water clarity rank based on the Clarity field. The value is a 1, 2, or 3, with a value of three being the best water clarity condition. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Rip_veg - The Rip_veg field contains the fraction of the land area within 60 meters of the shoreline that is covered by natural vegetation. A natural vegetation layer was created by reclassifying the modified Landsat land cover data provided by DNR. Forest and and herbaceous land cover classes were assigned a value of one, all other land cover classes were assigned a value of zero. A 60-meter buffer data layer (outside the water polygon only) was created using the buffer wizard in ArcMap 8.2. The ArcView summarize zones command was used to calculate summary statistics on natural vegetation. The resulting summary table was then joined by Lake_ID to the Hydro2K data table and the field calculator was used to assign the Rip_veg value (i.e. Rip_veg = JoinedTable.Mean).

Rip_class - The Rip_class field contains a relative rank based on the amount of natural vegetation in the riparian zone based on the Rip_veg field. The value is a 1, 2, or 3, with a value of three being the best natural vegetation cover. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Phys_class - The Phys_class field contains a relative rank of the physical condition of the lake for ecological habitat. The value is a 1, 2, or 3, with a value of three being the best habitat condition. The physical class is the average of the water clarity class and the

riparian vegetation class rounded up to the nearest whole number. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Eco_class - The Eco_class field contains a relative rank of the overall ecological condition of the lake based on the physical habitat condition and the known probability of significant biological features. The value is a 1, 2, or 3, with a value of three being the best overall ecological condition. The ecological class is the maximum of the physical class and the biological class. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Park - The Park field indicates whether or not there is a public park adjacent to a water feature. Data for park locations was extracted from the Metropolitan Council's 2000 land use data set. The ArcView select by theme command was used to find all open water polygons that where within a distance of 0 meters of a park polygon. The ArcView field calculator was then used to set the Park value for all selected records to "Y". The field calculator was also used to set the Park value to "N" for all other records.

Pwa - The Pwa field indicates whether or not there is a public water access (PWA) site for a water feature. Data for PWA locations was obtained from the DNR. The ArcView select by theme command was used to find all open water polygons that where within a distance of 30 meters of a PWA point. The selection was visually checked against the PWA points and the Hydro2K data set. Manual adjustments to PWA locations were made were necessary. The ArcView field calculator was then used to set the Park value for all selected records to "Y". The field calculator was also used to set the Park value to "N" for all other records.

Rec_class - The Rec_class field contains a relative score summarizing the regional recreational significance based on the Area_ac, Park, and Pwa fields. The value is a 1, 2, or 3, with a value of three being more regionally important for recreational use. These values were assigned according to the Regional Aquatic Assessment Procedures document.

WS_class - The WS_class field contains a relative score summarizing the regional water supply significance based on the criteria presented in the Regional Aquatic Assessment Procedures document. Data were obtained through a review of regional and local water supply plans on file at the Metropolitan Council. The value is a 1, 2, or 3, with a value of three being more regionally important for water supply use.

HU_class - The HU_class field contains a relative rank of the overall human use significance of the lake based on the recreational and water supply significance. The value is a 1, 2, or 3, with a value of three being the most significant for overall human use. The human use class is the maximum of the recreational class and the water supply class. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Streams

Stream_ID - The Stream_ID field contains a unique numeric identifier for each stream segment. Stream segments were aggregated from the digitized features of the original source data layer. Stream features were aggregated according to Strahler stream order and connectivity. Initially, all stream features that had the same stream order and were connected in an upstream-downstream relationship were aggregated using an ArcInfo dissolve process. Stream segements longer than 10,000 meters were then manually split at DNR minor watershed boundaries.

Count - The Count field contains the number of features from the original data that were aggregated to create the stream segment.

Old_ID - The Old_ID field contains the stream identification number from the first draft of the aquatic assessment.

Strahler - The Strahler field contains the stream order number for each segment based on the Strahler stream order system.

Length - The Length field contains the length of the stream segment in meters.

Split - The Split field contains a boolean variable (Y/N) that indicates if the segment was manually split from a longer segment at the DNR minor watershed boundary.

Sinuosity - The Sinuosity field contains a measure of the channel sinuosity. This is defined as the actual stream length divided by the straight line distance from one end of the segment to the other end. This was calculated using a ArcView script obtained from staff at the Iowa Rivers Information System (IRIS) program at Iowa State University (pers. comm. Robin McNeely 2002).

Vert_Dens - The Vert_Dens field contains the vertex density for each segment expressed as the number of vertices per kilometer. This was calculated by using an ArcView script to convert polylines to points. The resulting point file was summarized by Stream_ID with the summarize field command in ArcView. This resulted in a table having the number of vertices for each segment. This table was joined to the stream data layer and the Vert_Dens field was calculated using the field calculator (Vert_Dens = JoinedTable.Count/(Length/1000)).

Geom_score - The Geom_score field contains a relative rank of the natural character of the stream geometry. The value is a 1, 2, or 3, with a value of three being the most natural geometry. The geometric score is derived from a rule-based classification using the channel sinuosity and the vertex density. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Rip_Veg - The Rip_veg field contains the fraction of the land area within 60 meters of the stream that is covered by natural vegetation. A natural vegetation layer was created

by reclassifying the modified Landsat land cover data provided by DNR. Forest and and herbaceous land cover classes were assigned a value of one, all other land cover classes were assigned a value of zero. A 60-meter buffer data layer (outside the stream line) was created using the buffer wizard in ArcMap 8.2. The ArcView summarize zones command was used to calculate summary statistics on natural vegetation. The resulting summary table was then joined by Stream_ID to the MetroStream data table and the field calculator was used to assign the Rip_veg value (i.e. Rip_veg = JoinedTable.Mean).

Rip_score - The Rip_class field contains a relative rank based on the amount of natural vegetation in the riparian zone based on the Rip_veg field. The value is a 1, 2, or 3, with a value of three being the best natural vegetation cover. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Phys_score - The Phys_score field contains a relative rank of the physical condition of the stream for ecological habitat. The value is a 1, 2, or 3, with a value of three being the best habitat condition. The physical class is the average of the geometric score class and the riparian vegetation score rounded up to the nearest whole number. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Bio_Div - The Biodiv field indicates whether a stream feature intersects a site of high biodiversity as identified in the Minnesota County Biological Survey (MCBS). GIS data for the MCBS sites of biological significance was obtained from the DNR. Sites that had a biodiversity rank equal to high were selected from the set. The ArcView select by theme command was used to find all stream segments that intersect selected polygons of the MCBS sites of biological significance. The ArcView field calculator was then used to set the Biodiv value for all selected records to "Y". The field calculator was also used to set the Biodiv value to "N" for all other records.

Trout - The Trout field indicates whether any portion of a stream segment is a DNR designated trout stream. A GIS data layer of designated trout streams was obtained from the DNR. The ArcView select by theme command was used to find all the stream segments that were within a distance of 10 meters of a DNR designated trout stream. The field calculator was used to set the Trout value for all selected records to "Y". The field calculator was also used to set the Trout value to "N" for all other records.

Nonmobl_re - The Nonmobl_re field specifies the number of observations within the past 25 years of rare, endangered, threatened or unusual aquatic species (heretofore referred to as R&E species) that are not mobile outside of an aquatic environment (e.g. fish, mollusks, etc.) associated with a stream segment. An observation of a non-mobile R&E species was considered to be associated with a stream segment if it was within a distance of 30 meters, which is the approximate combined spatial accuracy of the data. Point observation data for R&E species were provided by the Natural Heritage and Nongame Research Program of the DNR and were current as of the date delivered (4/23/01). The point observation data were classified according to their water requirement and their mobility outside an aquatic environment. A 30-meter stream buffer data layer was created using the buffer wizard in ArcMap 8.2. The buffered stream segments were spatially

joined to the point data using ArcView 3.2. R&E species with a last observed date greater than 1977, requiring water, and not mobile outside of an aquatic environment were selected. The number of R&E species within each 30-m buffered stream segment were summarized using the summarize field command in ArcView 3.2, summarizing on the Stream_ID field. This results in a table of the number of R&E species by the unique Stream ID. This table was then joined to the MetroStreams data layer and the Nonmobl_re field was calculated using the field calculator (Nonmobl_re = JoinedTable.Count).

Mbl_re - The Mbl_re field specifies the number of observations within the past 25 years of R&E species that are mobile outside of an aquatic environment (e.g. reptiles, birds, etc.) associated with stream segment feature. An observation of a mobile R&E species was considered to be associated with a stream segment if it was within a distance of 100 meters, which is an assumed average travel distance from water. Point observation data for R&E species were provided by the Natural Heritage and Nongame Research Program of the DNR and were current as of the date delivered (4/23/01). The point observation data were classified according to their water requirement and their mobility outside an aquatic environment. A 100-meter stream buffer data layer was created using the buffer wizard in ArcMap 8.2. The buffered stream segments were spatially joined to the point data using ArcView 3.2. R&E species with a last observed date greater than 1977, requiring water, and mobile outside of an aquatic environment were selected. The number of R&E species within each 100-m buffered stream segments were summarized using the summarize field command in ArcView 3.2, summarizing on the Stream_ID field. This results in a table of the number of R&E species by the unique Stream ID. This table was then joined to the MetroStreams data layer and the Mbl_re field was calculated using the field calculator (Mbl_re = JoinedTable.Count).

Bio_score - The Bio_score field contains a relative score summarizing the known biologically significant sites based on the Bio_div, Trout, Nonmbl_re, and Mble_re fields. The value is a 1, 2, or 3, with a value of three having the highest probability of important biological features. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Eco_score - The Eco_score field contains a relative rank of the overall ecological condition of the stream segment based on the physical habitat condition and the known probability of significant biological features. The value is a 1, 2, or 3, with a value of three being the best overall ecological condition. The ecological class is the maximum of the physical class and the biological class. These values were assigned according to the Regional Aquatic Assessment Procedures document.

Adj_park - The Adj_park field indicates whether or not there is a public park adjacent to a water feature. Data for park locations was extracted from the Metropolitan Council's 2000 land use data set. The ArcView select by theme command was used to find all stream segments that where within a distance of 10 meters of a park polygon. The ArcView field calculator was then used to set the Adj_park value for all selected records

to "Y". The field calculator was also used to set the Park value to "N" for all other records.

Canoe_rt - The Canoe_rt field indicates whether a stream segment is a State designated canoe route. A GIS data layer of metro area designated canoe routes was obtained from the DNR. The data was manually entered into this stream data layer.

Flow_score - The Flow_score field contains a categorical flow rank (3, 2, or 1) based on the estimated median summer flow. Median summer flow is taken as an indicator of the ability of a stream or river to support contact recreation. Rivers that are listed as a designated canoe route have watersheds that are larger than 300 square miles and have median summer flows greater than 120 cubic feet per second. These rivers/streams were selected and the ArcView field calculator was used to assign a flow rank of 3. Mainstem streams from medium sized watersheds (300 square mile > Watershed Area > 150 square miles) have median summer flows less than 120 cfs, but greater than 60 cfs. These rivers/streams were selected and the ArcView field calculator was used to assign a flow rank of 2. Remaining stream segments were selected and assigned a flow rank of 1.

Rec_score - The Rec_score field contains a relative score summarizing the regional recreational significance based on the Flow_score and Adj_park fields. The value is a 1, 2, or 3, with a value of three being more regionally important for recreational use. These values were assigned according to the Regional Aquatic Assessment Procedures document.