



AN ATLAS OF PHYSIOGRAPHY, HYDROLOGY AND LAND USE

VALLEY BRANCH WATERSHED WASHINGTON COUNTY, MN

GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF LANDSCAPE ARCHITECTURE
UNIVERSITY OF MINNESOTA

DATA COMPILED AND MAPPED IN THE DEPARTMENT OF LANDSCAPE ARCHITECTURE AT THE
UNIVERSITY OF MINNESOTA. FUNDING FOR THIS WORK WAS PROVIDED BY A GRANT FROM THE
ST. CROIX WATERSHED RESEARCH STATION OF THE SCIENCE MUSEUM OF MINNESOTA.

SCIENCE
MUSEUM
OF MINNESOTA

An Atlas of Physiography, Hydrology and Land Use

Valley Branch Watershed, Washington County, MN

This atlas was created as part of **Objective 1: Watershed Science in the Field** in furtherance of the Science Museum of Minnesota **Watershed Science: Integrated Research and Education Program**. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota. This funding was approved by the Minnesota Legislature, ML 1997, Chapter 216, Sec. 15, Subd. 13(b) as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Future Resources Fund.

An inter-agency working group assisting the Valley Branch Watershed District Citizen's Advisory Committee provided valuable insight on the organization and usefulness of the information compiled for the atlas. Special thanks are extended especially to Julie Westerlund, Metro Trout Stream Coordinator for the MNDNR and Jason Moeckle, fisheries biologist with the Metropolitan Division of MNDNR.

Jim Almendinger, project coordinator for Objective 1: Watershed Science in the Field also provided insightful commentary on information contained in the atlas.

Geographic Information Systems
Department of Landscape Architecture
University of Minnesota

The geographic information contained in the atlas was compiled by Diane Whited and David G. Pitt. The atlas was written by David G. Pitt. The work of Bart Richardson, currently with the Metropolitan Division of the Minnesota Department of Natural Resources (MNDNR), in preparing the discussion of cultural history, is gratefully acknowledged. His contribution is contained in Appendix B: Timeline of Cultural Development in the St. Croix Valley Landscape. Rhonda Bell and Steve Roos produced the maps, graphics and text layout for the atlas.



Navigating and Printing the Atlas

The following symbols have been added to this virtual version of the *Atlas of Physiography, Hydrology and Land Use: Valley Branch Watershed*. These navigational icons are to assist you, the reader, in finding your way around the Atlas and are only visible on-screen; they will not appear if the atlas is printed. The Atlas has been print-formated at 11" x 17" for best detail, but will also print at 8.5" x 11".



The green watershed appears in the upper left corner of each page; a single click returns you to the Table of Contents.



Map

The red watershed appears next to the text when a map is referenced; a single click takes you to the pertinent map.



Back

The back arrow takes you one page backward.



Previous

The previous diamond returns you to the page you just left; for example, if you use the red watershed to view a map, this key returns you to the text.



Forward

The forward arrow takes you one page forward.

TABLE OF CONTENTS

I. Introduction	1	VI. Cultural History of the St. Croix River Valley	26
A. Purpose of the Atlas		A. History of Native American Occupation of the St. Croix Valley	
B. Geographic Extent of the Atlas		1. Prehistoric Inhabitants	
C. Compilation of the Atlas		2. Impact of Prehistoric Native Americans on Landscape Pattern	
D. Structure of the Atlas		a. Fire	
		b. Hunting	
		c. Agriculture	
		d. Native Plants as Food Sources	
		e. Intentional and Accidental Plant Introduction	
		3. More Recent Native American Communities	
II. Geologic History of the Valley Branch Watershed	4	B. European Exploration of the St. Croix Valley	
A. Development of Bedrock Geologic Formations		1. Expansion of the Fur Trade	
1. Precambrian Upheaval: Creation of the Mid-Continental Rift		2. Cessation of the St. Croix Valley to the United States	
2. Oceanic Inundation and the Sedimentary Rocks of the Watershed		3. Development of the Timber Industry	
3. Late Cambrian St. Croixan Sedimentary Formations		C. Growth and Development of Afton	
4. Ordovician Dolomites		D. Current Land Use in the Valley Branch Watershed	
5. Depth to Bedrock		1. Critical Wildlife Habitats	
B. Glaciation of Surficial Landform		2. Existing Pattern of Cultural Settlement	
1. Landform Development as a Product of Glaciation		3. Existing Patterns of Land Ownership	
2. Glacial Erosional Features			
3. Glacial Depositional Features			
4. Landforms of the Illinoian Glaciation			
5. Landforms of the Wisconsinan Glaciation			
6. River Terraces of the Post-Glacial Period			
III. Surface Drainage Patterns	14	VII. Existing Public Policy Toward Land Development in the Watershed	34
A. Variable Age of Drainage Patterns		A. Existing Zoning Plans	
B. Effects on Presence of Wetlands and Surface Water Bodies		B. Undevelopable Land Under Existing Public Policy	
C. Deranged Versus Well Developed Drainage Systems			
D. Contrasting Drainage Density			
E. Effects of Geologic and Hydrologic Processes on Topographic Elevation and Slope			
IV. Biogeographical History of Vegetation in the Watershed	18	VIII. Valley Branch Watershed: Possible Future Urbanization Patterns	37
A. Revegetation of the Post Glacial Landscape		A. Watershed Development Scenarios	
B. Advancement of the Post-Glacial Forest		1. Extension of Existing Public Policies	
C. Development of the Prairie Community		2. Green Infrastructure Plan for Watershed Development	
D. The Advancing Forest and the Development of the "Tension Zone"		B. Neighborhood Development Scenarios	
E. Presettlement Vegetation of the Watershed			
V. Development of Soils in the Valley Branch Watershed	19	IX. References Cited	48
A. Soil Parent Material Within the Valley Branch Watershed			
B. Effects on Soil Properties		X. Appendices	a1
1. Soil Drainage		A. Appendix A: Dictionary of Basic Mapped Themes Contained Within the Valley Branch Watershed Geographic Information System	
a. Soil Infiltration Capacity		B. Appendix B: Timeline of Cultural Development in the St. Croix River Valley Landscape	
b. Soil Permeability			
2. Soil Erodibility			
3. Soil Fertility			

List of Figures

- Figure 1: Geologic Timeline
- Figure 2: Mid-Continental Rift Zone
- Figure 3: Inland Sea of Hollandale Embayment
- Figure 4: Runoff into Inland Sea of Hollandale Embayment
- Figure 5: Phases of Pleistocene Epoch Glaciation
- Figure 6: Action of Advancing Ice Sheet
- Figure 7: Movement of Materials by Ice Sheet
- Figure 8: Glacial Creation of Landform
- Figure 9: Illinoian Glaciation in the Valley Branch Watershed
- Figure 10: Variability in Landforms and Depth to Bedrock
- Figure 11: St. Croix Moraine
- Figure 12: Pre-glacial St. Croix River
- Figure 13: Glacial Lake Drainage
- Figure 14: Population Trends in Afton Village and Township

List of Maps

- Geographic Extent of Watershed
- Bedrock Geology
- Depth to Bedrock
- Surficial Geology
- Surface Hydrology
- Topographic Elevation
- Topographic Slope
- Soil Parent Material
- Soil Infiltration Capacity
- Soil Permeability
- Highly Erodible Soils
- Soil Fertility for Corn Yields
- Existing Land Cover, 1994
- Forest, Wetland and Trout Habitat
- Cultural Settlement Pattern, 1994
- Land Parcel Size and Development Prospect
- Existing Zoning Plans
- Undevelopable Land Under Existing Public Policy
- Land Development Potential
- High Consolidated Aquifer Contamination Potential
- High Soil Moisture Contamination Potential
- High Soil or Geologic Threat to Consolidated Aquifer Contamination
- Potential Surface Water Quality Contamination
- Development Suitability: Transportation Access
- Development Suitability: Attractors
- Development Suitability: Detractors
- Development Suitability
- Five Acre Watershed Development Scenario
- High Density Watershed Development Scenario
- Cluster Watershed Development Scenario
- Green Infrastructure Watershed Development Scenario
- Prototypical 5 Acre Development Without Stormwater Management
- Prototypical 5 Acre Development With Stormwater Management
- Prototypical High Density Development Without Stormwater Management
- Prototypical High Density Development With Stormwater Management
- Prototypical Cluster Development With Water Quality Management

INTRODUCTION

The landscape that people experience in today's Valley Branch watershed has undergone great change. Many of these changes have occurred as a result of geologic processes, some are attributable to global patterns of climatic change, while others are a product of human occupation of the watershed's landscape. Some changes occurred over hundreds of millions of years, some of the changes occurred over thousands or hundreds of years, while still others have occurred over a period of years or even months. Many of the changes that produced tangible manifestations in the contemporary landscape occurred well over 450 millions of years ago, while other changes directly affecting the present-day landscape are occurring in the contemporary milieu.

The Atlas of Physiography, Hydrology and Land Use in the Valley Branch watershed discusses the physical and cultural characteristics of the watershed. Physiography includes aspects of bedrock and surface geology that contribute to the making of landform and topographic slope. Weathering and erosion of the geologic conditions that comprise physiography, along with the accumulation of organic material, contribute to soil formation. Over time, surface water flowing across the land's surface further refines the sculpting of landform and slope. Together with climatic influences, physiography, soils and hydrology define the physical conditions within which biological conditions and ecological systems in the watershed evolved.

Purpose of the Atlas

In the context of the **Watershed Science: Integrated Research and Education Program**, the Atlas of Physiography, Hydrology and Land Use relates primarily to **Objective 1: Watershed Science in the Field**. In addition to preparing the atlas, Objective 1 also:

- a) developed and implemented a comprehensive hydrologic and water quality monitoring program within the Valley Branch watershed;
- b) compiled hydrogeologic information and developed a model of ground water movement within the watershed;
- c) developed two models to estimate the effects of different patterns of urbanization on surface hydrologic flows and water quality within the watershed.

While the Atlas provided information of value to the ground water modeling activity, the three primary objectives guiding development of the atlas were:

- a) to compile watershed information needed to design and operate the surface hydrologic models;
- b) to compile watershed information needed to develop the alternative patterns of urbanization; and
- c) to display relevant geographic information compiled in the context executing the Watershed Science in the Field objective.

Geographic Extent of the Atlas

When asked to identify the location of Valley Branch, most knowledgeable people would undoubtedly point to a stream and its tributaries that enters the St. Croix River immediately to the north of Afton, Minnesota. Almost all of the stream's tributaries are identified on USGS 7-1/2 minute Topographic Quadrangle maps as being within the political jurisdiction of the City of Afton. The perennially flowing portions of the stream are entirely within the city's boundaries. As defined by the land area over which the Valley Branch Watershed District has management jurisdiction, however, the watershed extends well beyond the political boundaries of Afton. The Watershed District includes large portions of the City of Lake Elmo, and it extends in a northwesterly pattern toward White Bear Lake.

The Valley Branch watershed has an ambiguous definition. This ambiguity is produced by surficial geologic conditions that affect surface drainage patterns within the watershed, and management of the watershed's surface hydrologic resources also affects the watershed's definition. As is discussed in the ground water modeling portion of the **Objective 1: Watershed Science in the Field Final Report**, a large portion of this area is within the ground water basin of Valley Branch. Along with surface runoff from the immediate watershed of the stream, this area apparently contributes to the base flow of the Valley Branch.

Most of the landscape within the Valley Branch Watershed District that is located north of the Interstate 94 highway and a portion of the watershed south of the highway contain poorly developed surface drainage patterns. Within these locales, it is difficult to predict the exact pattern of surface flow since many of the streams, wetlands and ponds in the area have no apparent outlets. In constructing Interstate 94, the Minnesota Department of Transportation (MnDOT) altered surface drainage on the northern side of the highway so that drainage now flows into a detention basin that discharges into the St. Croix River. In the portion of the watershed possessing poorly developed surface drainage on the southern side of I-94 (i.e. the Falstrom Lakes area), MnDOT installed a pipe and valve system. This engineered drainage system allows floodwater accumulating in emergencies to pass under the highway and enter the drainage system on the northern side of the highway.

Taking into account the complexities of natural and human-influenced surface hydrology of the Valley Branch Watershed District, the maps contained in the atlas pertain to those sub-basins defined by the District that are located south of Interstate 94. The combined spatial extent of these basins includes a large portion of the City of Afton, portions of the West Lakeland Township and the northeastern corner of the City of Woodbury.

The map entitled "Geographic Extent of Watershed" illustrates the geographic extent of the Valley Branch watershed as mapped in the atlas.

Compilation of the Atlas

The geographic information contained within the atlas was compiled from a number of sources. The Data Dictionary contained in the appendix to this atlas outlines the sources and procedures used in compiling each of the atlas' map themes.

The compilation, processing and analysis of the themes as well as the preparation of the maps used geographic information system (GIS) software produced by the Earth Systems Research Institute (ESRI) of Redlands, California. The ESRI product known as Arc-Info™ provided the technology for compiling, processing and analyzing spatial information, while ESRI's ArcView™ product provided the technology for producing the map displays contained in the atlas. Both systems operated on a Dell Dimension XPS R400™ platform using a Windows NT™ operating system, and map production occurred on a Hewlett Packard Design Jet 755C™ color drum plotter.

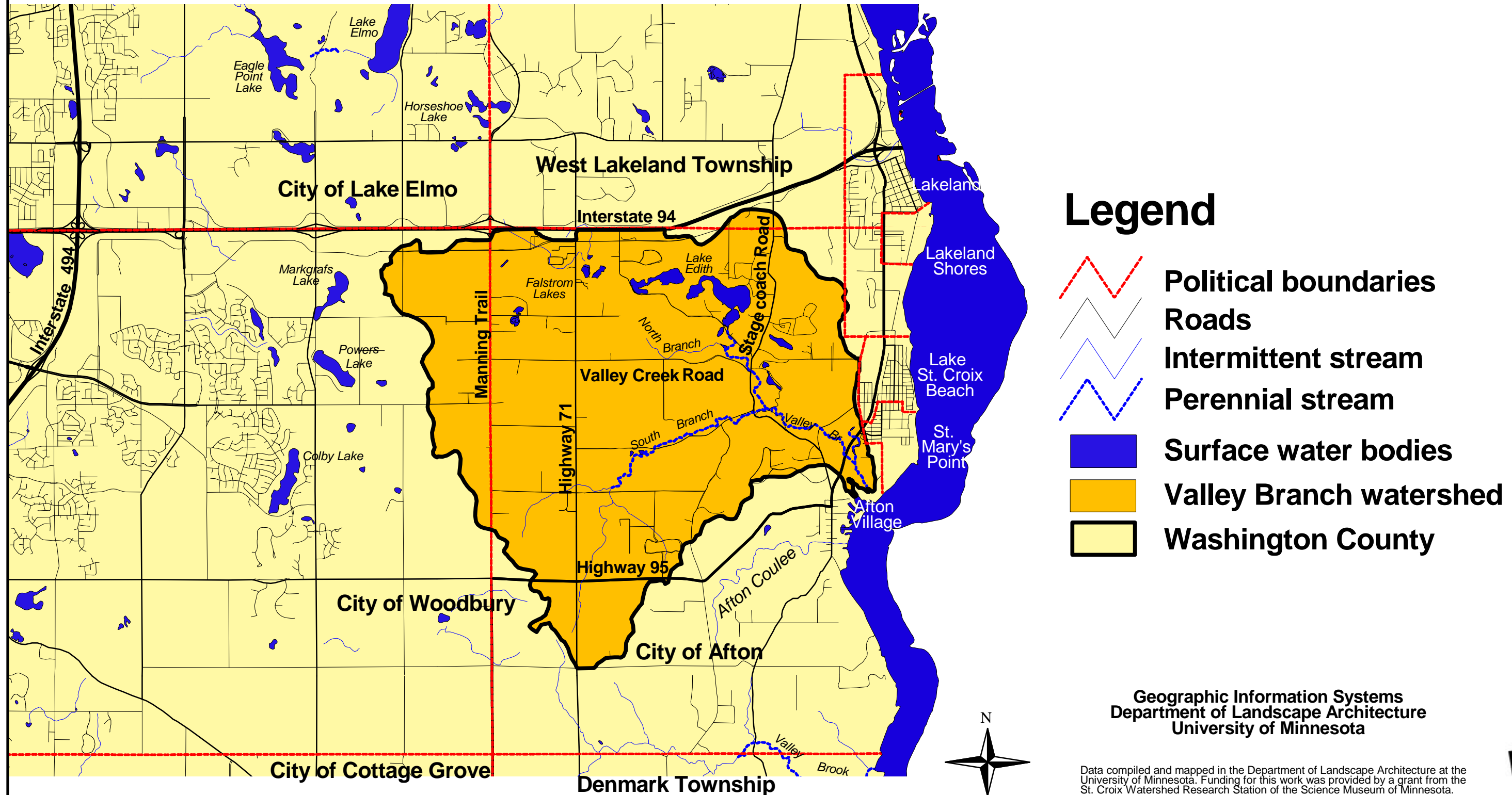
Structure of the Atlas

The atlas presents the physical and cultural characteristics from both a thematic and a historic perspective. Hopefully, the reader will obtain a sense of what is contained within the watershed as well as an understanding of how it came into existence. Material presented in the atlas is organized into the following topical areas:

- a) the evolution of the watershed's bedrock and surface geology;
- b) the development of the watershed's surface drainage patterns that have cut down into the watershed's geology;
- c) the effects of the geologic and hydrologic processes on creating topography within the contemporary landscape of the watershed;
- d) the development of vegetative cover within the watershed;
- e) the evolution of soils in different landscapes of the watershed;
- f) the development of the current pattern of land use, land cover and cultural settlement in the watershed;
- g) existing public policy toward land development within the watershed;
- h) a series of maps presenting alternative urbanization patterns throughout the entire watershed along with neighborhood design strategies that might be used in implementing the watershed-wide development; and finally
- i) a data dictionary explaining the derivation of each mapped themes.

Geographic Extent of Watershed

Valley Branch Watershed - Washington County, MN



Geologic History of the Valley Branch Watershed

Geologists divide time since creation of planet Earth into eras, periods, and epochs. Figure 1 illustrates that the Precambrian Era extends from the Earth's origin (some 4500 to 5000 million years ago) to approximately 600 million years Before Present (BP). The Precambrian Era is divided into three periods: the Early Precambrian spans the time from the Earth's origin to 2700 million years BP; the Middle Precambrian extends to 1700 million years BP and is generally considered the time during which life first emerged on Earth (Ojakangas and Matsch, 1982); and the Late Precambrian spans time from 1700 million years BP to 600 million years BP. The period from 600 million years BP to 225 million years is known as the Paleozoic Era. Of the Paleozoic's seven periods, the Cambrian (600 - 500 million years BP) and the Ordovician (500 - 435 million years BP) are most important to the geologic history of the Valley Branch watershed. The Mesozoic Era extends from 225 million years BP to approximately 70 million years BP. Finally the Cenozoic Era (extending from the present time back some 70 million years) and in particular the Quaternary Period of the Cenozoic are considered the recent past of geologic time.

Five sets of geologic activity shaped the evolution of the watersheds' landforms as they exist today. A series of three events occurring in the Late Precambrian, the Cambrian and the Ordovician Periods, respectively, created the bedrock geology of the watersheds. Two events during the Pleistocene Epoch and one event occurring in the Recent Epoch of the Quaternary Period shaped the watersheds' surficial geology.

Development of Bedrock Geologic Formations

The history of the watershed's bedrock geology involves two sets of activity that were separated from one another by over 600 million years. The first set of activity involved movement of the earth's crust occurring approximately 1.1 to 1.2 billion years BP while the second set involved inundation of the earth's surface by a large inland ocean during periods extending 550 million to 450 million years BP.

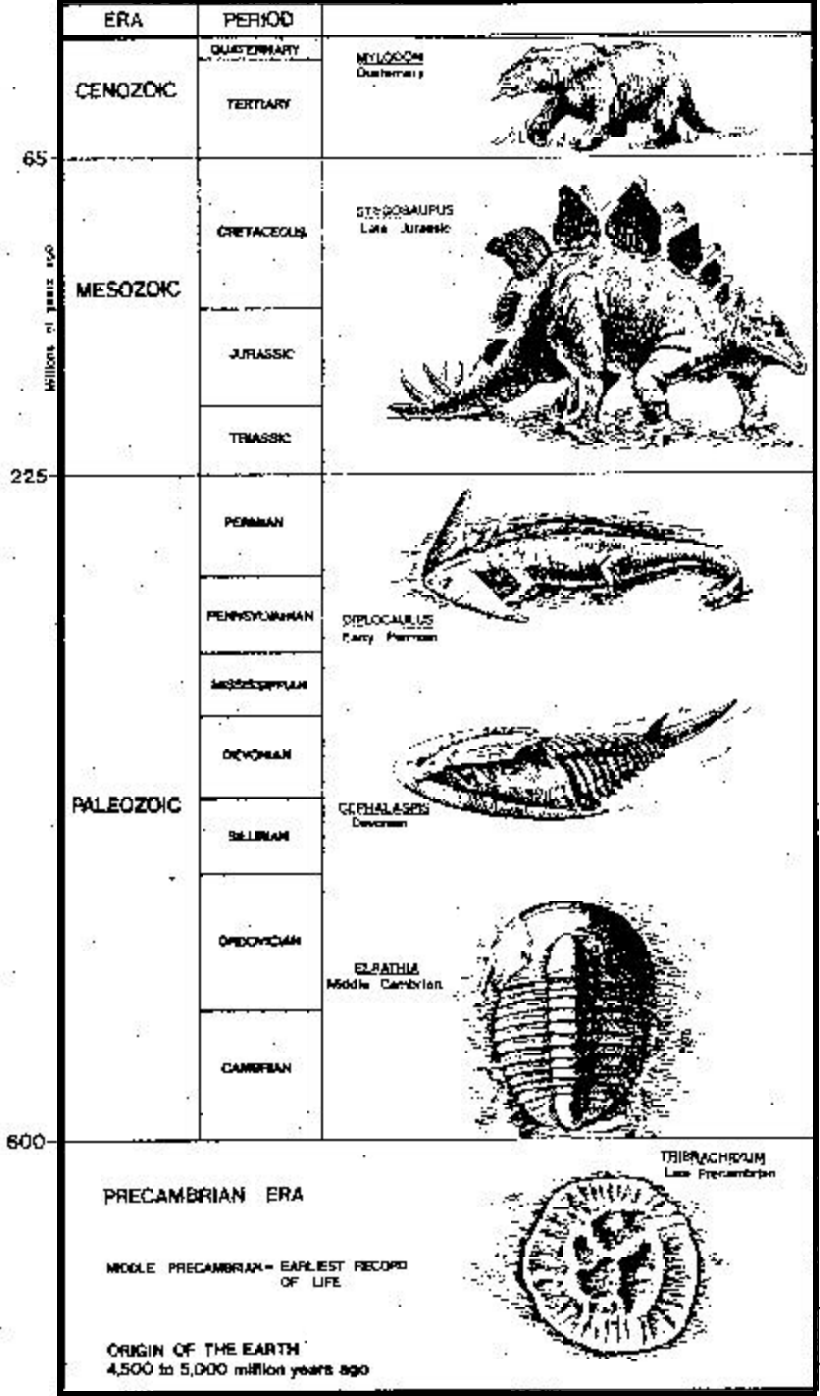


Figure 1. Geologic time is divided into eras, periods and epochs. (Ojakangas and Matsch 1982, p.11)

Precambrian Upheaval: Creation of the Mid-Continental Rift

During the Precambrian Era, Minnesota experienced three periods of substantial volcanism (Ojakangas and Matsch 1982). The most recent of these periods of volcanism, occurring between 1200 and 1100 million years BP, is associated with the development of a mid-continental rift or crack in the earth's surface that extended northeasterly from eastern Kansas through eastern Minnesota and northwestern Wisconsin (see Figure 2). The rift evolved as the North American continent attempted to separate into two plates. This rift separated what is now Hudson, Wisconsin from Wayzata in Hennepin County (Bray 1977). Lava rose up through faults or cracks created by the mid-continental rift and flowed across the surface of the land. The upwelling of lava resulting from the mid-continental rift process produced a geologic feature known as the St. Croix Horst (Morey and Mudrey 1972). Basalt flowing out of cracks in the earth's surface that were created by the up-thrusting action of the St. Croix Horst produced what are now known as the Keeweenaw volcanic rocks. This geologic formation extends from southern Minnesota between Albert Lea and Austin up through Rice County and the St. Croix Valley, into northwestern Wisconsin. It extends into Lake Superior via Minnesota's North Shore and the Keeweenaw Peninsula of Michigan's Upper Peninsula (Morey and Mudrey 1972).

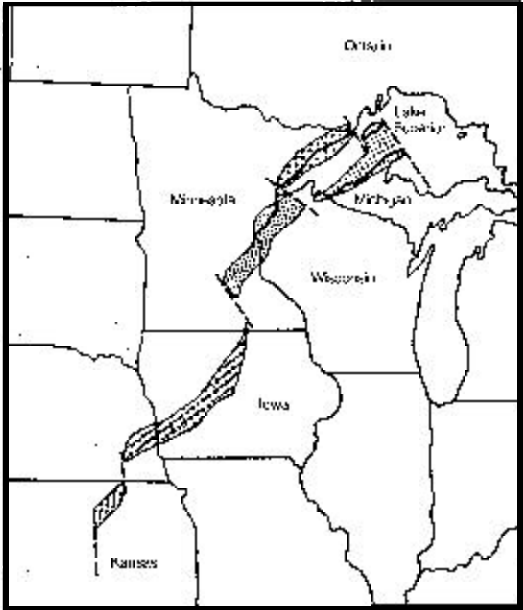


Figure 2. The Mid-Continental Rift zone extended between northeastern Kansas and the north and south shores of Lake Superior. (Ojakangas and Matsch 1982, p.52)

In some areas, this basaltic lava flow was as much as 6100 meters deep (Morey and Mudrey 1972). Throughout Minnesota, it appears at the land surface only in limited areas of the St. Croix River valley and Pine County and along Lake Superior's North Shore. The Dalles at Taylor's Falls and the rock bluffs on the Wisconsin side of the St. Croix just south of Franconia are comprised of Keeweenawan volcanic rocks. These formations were exposed when the St. Croix River incised a new channel after it overtopped an ice dam immediately following the last period of glaciation. In addition, a fault line associated with the Mid-continental Rift is apparent in the Washington County landscape just south of where Trout Brook enters the St. Croix River at Afton State Park.

Oceanic Inundation and the Sedimentary Rocks of the Watershed

Following the volcanic activity of the late Precambrian Period, the middle of the North American Continent began to subside. The subsidence of the St. Croix Horst produced a depression that was eventually filled, in part, by what is today called Lake Superior (Ojakangas and Matsch 1982; Bray 1977).

As the land surface subsided, large continental seas spread inland. By the late Cambrian Period (approximately 550 million years BP), the inland seas reached the Hollandale Embayment, a broad shallow depression existing in southeastern Minnesota, western Wisconsin and northern Iowa (see Figure 3). All of Washington County was inundated by the Hollandale Embayment (Bray 1977, Morey 1994). Within Minnesota, the embayment included all of the southeastern counties within a line running in a northeasterly direction from Martin County through Wantowan, Brown, Sibley, McLeod, Wright, Mille Lacs, Kanabac and Pine Counties, respectively.



Figure 3. An inland sea extended into the Hollandale Embayment in southeastern Minnesota and northwestern Wisconsin during the late Cambrian Period. (Ojakangas and Matsch 1982, p.67)

Late Cambrian St. Croixan Sedimentary Formations. An initial inundation by the continental sea resulted in the deposition of four sedimentary formations. These four deposits and their approximate thickness are: the Mt. Simon Sandstone (as much as 100 meters thick); the Eau Claire Formation (nearly 60m thick); the Galesville Sandstone (30m thick); and the Ironston Sandstone (14m thick) (Ojakangas and Matsch 1982). Following a temporary retreat of water levels, a second inundation during the late Cambrian Period into the Hollandale Embayment produced three additional sedimentary depositions: the Franconia Formation (varying in thickness between 30m and 60m); the St. Lawrence Formation (20m thick); and the Jordan Sandstone (25 to 35m thick). While all of these St. Croixan Formations are expressed as the uppermost bedrock within the Valley Branch watershed, the Jordan Sandstone, the St. Lawrence and Franconia Formations and the Eau Claire Formation have the greatest spatial extent. The Jordan sandstone is white to yellow in color and medium to coarse grained in texture, and its sandstone granular components are round and well-sorted. The St. Lawrence Formation, on the other hand, is a dark colored dolomite that contains clay, silt and sand. The Franconia Formation, like the Jordan formation is fine-grained quartz sandstone. The St. Croixan sedimentary formations are largely silicon in content reflecting the fact that deposition in the Late Cambrian Period was largely a product of surface runoff carrying sand and other fine soil particles from land into the seas of the Hollandale Embayment.

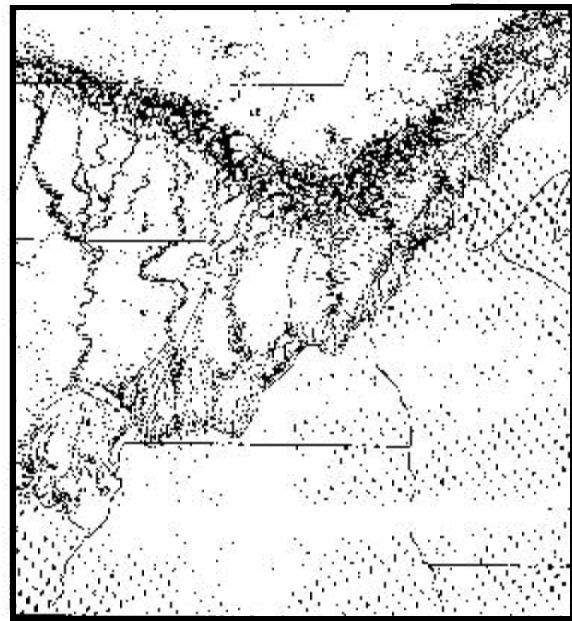


Figure 4. During the late Pre-Cambrian and Cambrian Periods, extensive surface runoff carried sand and other fine particles from the land surface into the inland seas of the Hollandale Embayment. (Ojakangas and Matsch 1982, p.51)

Ordovician Dolomites. In the later portion of the Cambrian Period, the continental sea that filled the Hollandale Embayment retreated, and the land area of the Valley Branch watershed was once again above water. However, in the early portions of the Ordovician Period (approximately 475 million years BP), the continental seas returned to Minnesota, and

the watershed was once again inundated with water. In contrast with the late Cambrian inundation, the continental seas of the Ordovician Period were rich in marine life (Ojakangas and Matsch 1982). The abundance and diversity of marine life in the Ordovician seas produced sedimentary formations that have a higher carbonate content, since accumulation of sediment during much of the Ordovician Period consisted of marine life remnants being deposited on the ocean floor.

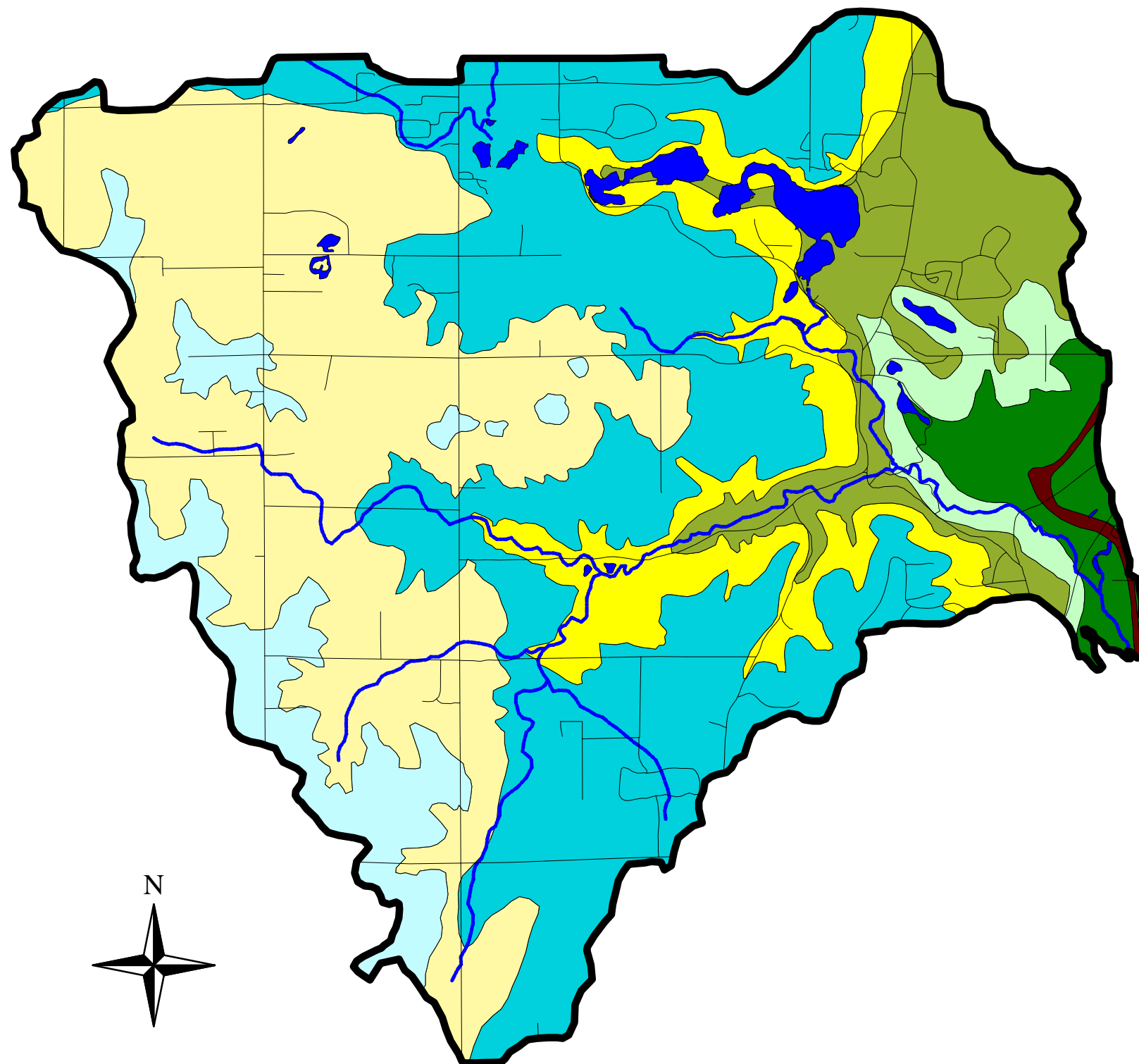
Marine life deposition during the Ordovician Period produced carbonate formations known as dolomite. Most of the Valley Branch watershed is underlain by Ordovician dolomites from the Oneota and Shakopee formations of the Prairie du Chien. These dolomitic formations are tan to gray in color, and they are fine textured (Ojakangas and Matsch 1982). The upper portions of the Prairie du Chien Group are commonly sandy and thin bedded while the lower portions are massive and thickly bedded (Mossler and Bloomgren, 1990). The Oneota and Shakopee Formations of the Prairie du Chien Group are approximately 70 meters thick (Ojakangas and Matsch, 1982). Escarpments of the Prairie du Chien Group are evident along the perennial mainstem of Valley Branch as it flows in a direction parallel to Valley Creek Road.

The western portions of the watershed contain an Ordovician formation known as the St. Peter Sandstone. The St. Peter Sandstone, though not a limestone, was laid down during the Ordovician Period. It is almost pure white in color, and it is the formation that dominates the cliffs of the Mississippi River as it flows through St. Paul. The St. Peter sandstone is rich in silicon, and it is more similar in appearance to the St. Croixan Sandstones (principally the Jordan deposit) than it is to the Ordovician dolomites. The existence of the St. Peter sandstone reflects a brief period of time during which the continental seas of the Ordovician Period receded. During this inter-oceanic interlude, sedimentary deposition was again largely a product of sediment transported by surface runoff. The return of the Ordovician sea is marked by the presence of the Platteville-Glenwood Dolomite in the far western edge of the watershed. The Platteville-Glenwood dolomite is gray to green in color (Ojakangas and Matsch 1982). These formations are especially prominent in the higher elevations of the watershed. County Road 15 (known locally as Manning Trail) traverses much of the Platteville-Glenwood Formation. The road alternates between lower elevations associated with the St. Peter Sandstone and the higher Platteville-Glenwood Formation. The Bissels Mounds are pronounced erosional remnants of the formation sitting on top of the St. Peter Sandstone in the center of the watershed.

The map entitled "Bedrock Geology" illustrates the spatial distribution of the various bedrock geologic formations.

Bedrock Geology

Valley Branch Watershed - Washington County, MN

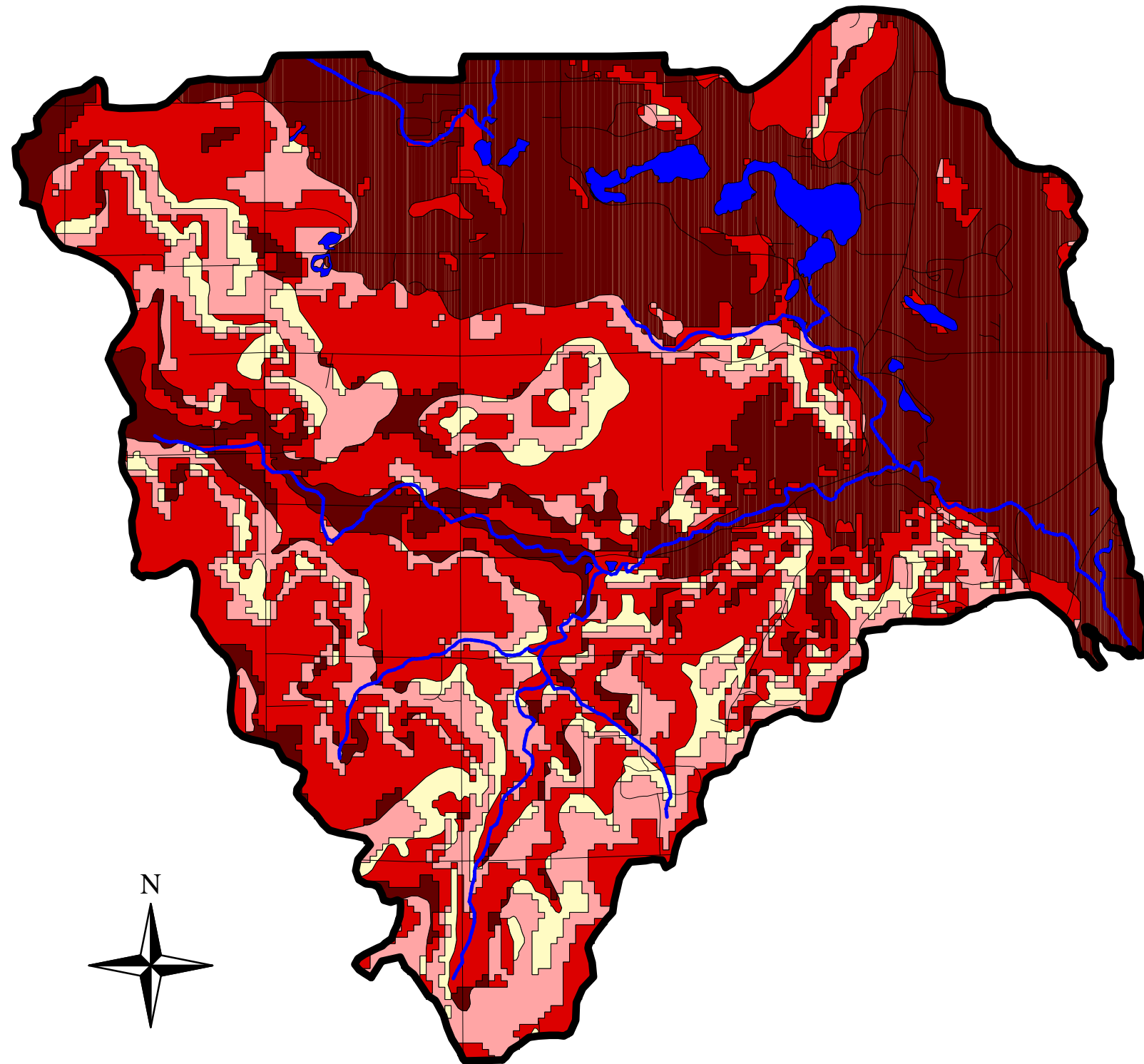


Legend








-  Roads
-  Drainage
-  Water bodies
-  Platteville-Glenwood formations
-  St. Peter sandstone
-  Prairie du Chien group
-  Jordan sandstone
-  Iron-ton-Galesville sandstones
-  Eau Claire formation
-  St. Lawrence and Franconia formations
-  Mt. Simon sandstone

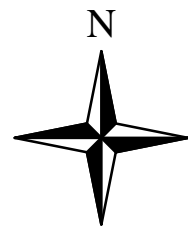
Depth to Bedrock

Valley Branch Watershed - Washington County, MN



Legend

-  Roads
-  Drainage
-  Water bodies
-  10 feet or less
-  11 feet to 30 feet
-  31 feet to 60 feet
-  Greater than 60 feet



Depth to Bedrock

Throughout the watershed, deposits of glacial material produced during the Pleistocene Epoch cover bedrock. These deposits vary in thickness, ranging from areas where bedrock is exposed at the surface to areas containing over 100 meters of glacial drift (Patterson et al. 1990). The areas of bedrock outcropping or extremely shallow bedrock are evident in the landscape as isolated hilltops that are not in agriculture or patches of uncropped areas within agricultural fields. The areas of deepest glacial till are located along the mainstem of Valley Branch near its confluence with the St. Croix River. The present course of Valley Branch, especially the north branch, the Lake Edith area and the landscape to the northwest of Lake Edith extending toward Horseshoe and Sunfish Lakes exists within a pre-glacial river channel. Depths of sediment within this buried river channel range from greater than 100m near the confluence with the St. Croix to 35 to 50m near Horseshoe and Sunfish Lakes, respectively. Similarly, the south branch of Valley Branch also occupies a buried valley containing sediment depths of between 30 to 50m (Patterson et al. 1990). The "Depth to Bedrock" map illustrates a generalized pattern of the distribution of the various depths to bedrock existing in the Valley Branch watershed.

Glaciation of Surficial Landform

The next period in geologic history to produce a lasting influence on the character of the Valley Branch landscape is the Pleistocene Epoch of the Quaternary Period. Known as the "Ice Age", the Pleistocene Epoch actually witnessed four periods of glaciation (see Figure 5). Of these, the last two periods, the Illinoian glaciation (approximately 300,000 to 130,000 years BP) and the Wisconsinan glaciation (35,000 to 10,000 years BP) have directly influenced the character of the watershed's landscape. A short discussion of the influences of glaciation on the landform creation is presented as a prelude to describing the effects of the Illinoian and Wisconsinan glaciation on the watershed's landscape.

Landform Development as a Product of Glaciation

Continental glaciation, as it occurred during the Illinoian and Wisconsinan glaciations, affected surficial landform development through erosional as well as depositional processes. Glacial deposition was more influential than glacial erosion in creating the landscape of the Valley Branch watershed.

Glacial Erosional Features. As continental glaciers moved across the surface of the land, the massive ice sheets and the debris they transport are capable of scratching striations and grooves into the most resistant of bedrock surfaces. Glacial bedrock quarrying may occur wherein bedrock weakened by fractures is plucked out of its original formation and transported to another location. Individual rock fragments carried far from their bedrock origins and deposited on the land surface are known as glacial erratics. The scouring action of the ice sheet and its debris sometimes creates whalebacks or roches moutonnees. These are small mounds of bedrock carved into "whale-like" forms having a blunt and irregular end created by ice approaching the mound and a smooth lee side carved as ice moves over the mound (Strahler and Strahler 1984; and Ojakangas and Matsch 1982).

Glacial Depositional Features. Continental glaciation occurred when global temperatures permitted polar ice packs to form more rapidly than they melted. As ice accumulated in the Polar Regions of the globe, it began to flow away from its sources. As the ice sheet advanced over the land surface, debris in the path of the glacier was plucked, scraped and carried forward (see Figure 6). The plucking, scraping and pushing actions are the result of two forces that operate simultaneously. The leading edges of the ice sheet behaved as if they were giant bulldozers, scraping and carrying debris as they moved. Expansion of the ice sheet from the polar sources kept the under-surface of the sheet in perpetual motion, and this surface behaved as if it were a conveyor belt. The continually moving under-surface plucked and scraped the land, and it carried debris to the leading edges of the ice sheet (see Figure 7).

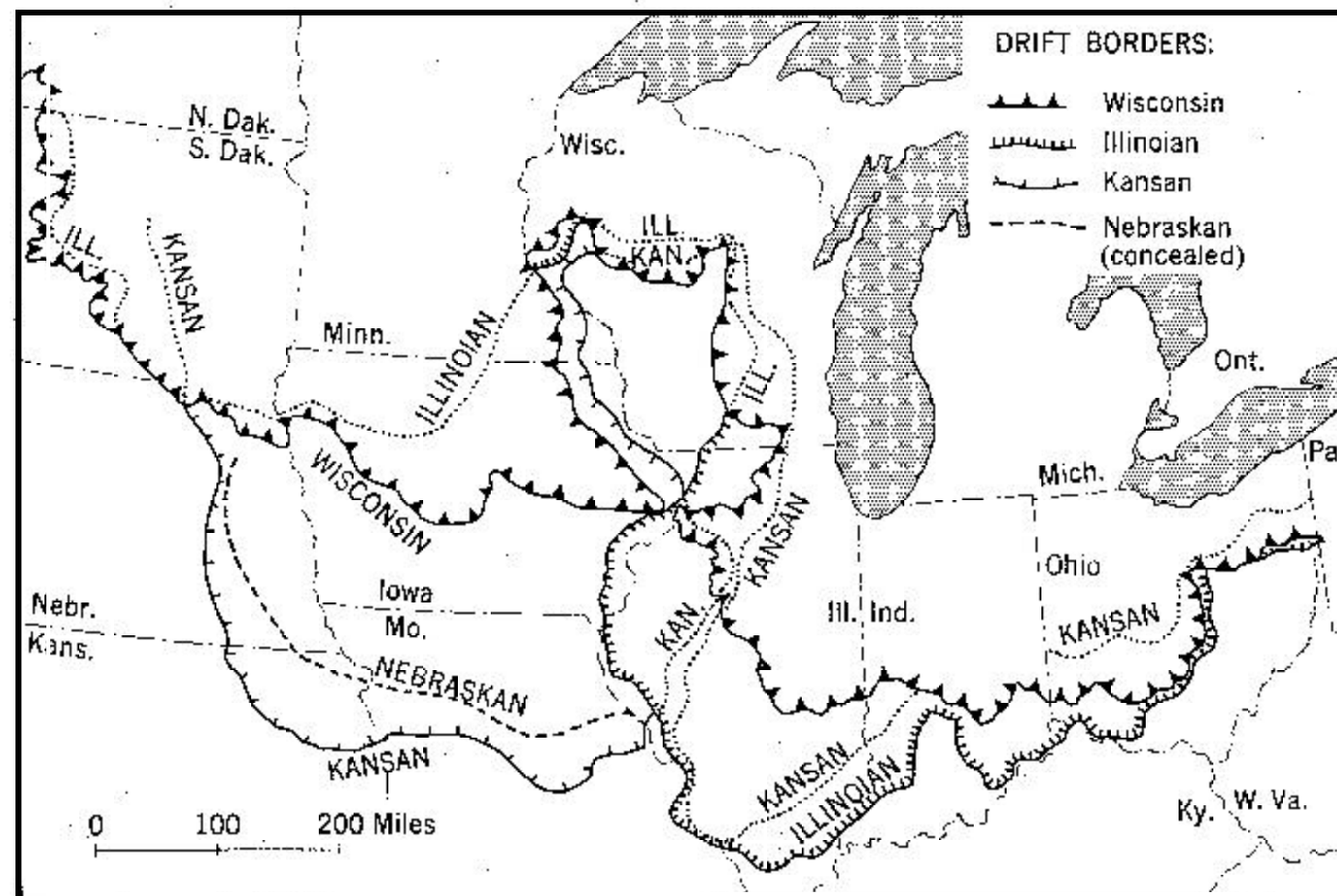


Figure 5. Glaciation of the North American continent during the Pleistocene Epoch involved four advancements of ice sheets. Of these only the last two advancements, the Illinoian and the Wisconsinan affected landform development in the Valley Branch watershed. (Strahler and Strahler 1984, p.362)

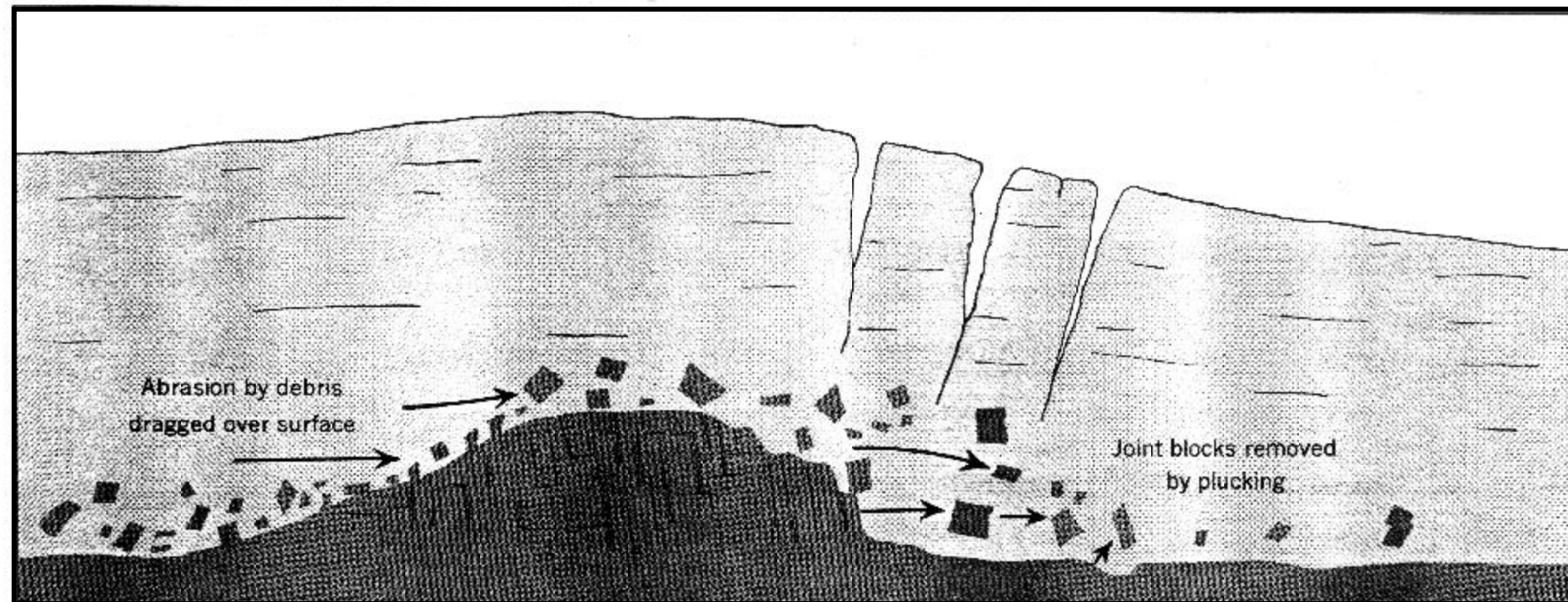


Figure 6. An advancing ice sheet abraded and plucked material from the land surface and transported this material to the leading edges of the ice sheet in a conveyer-belt action. (Trewartha et al. 1977, p. 287)

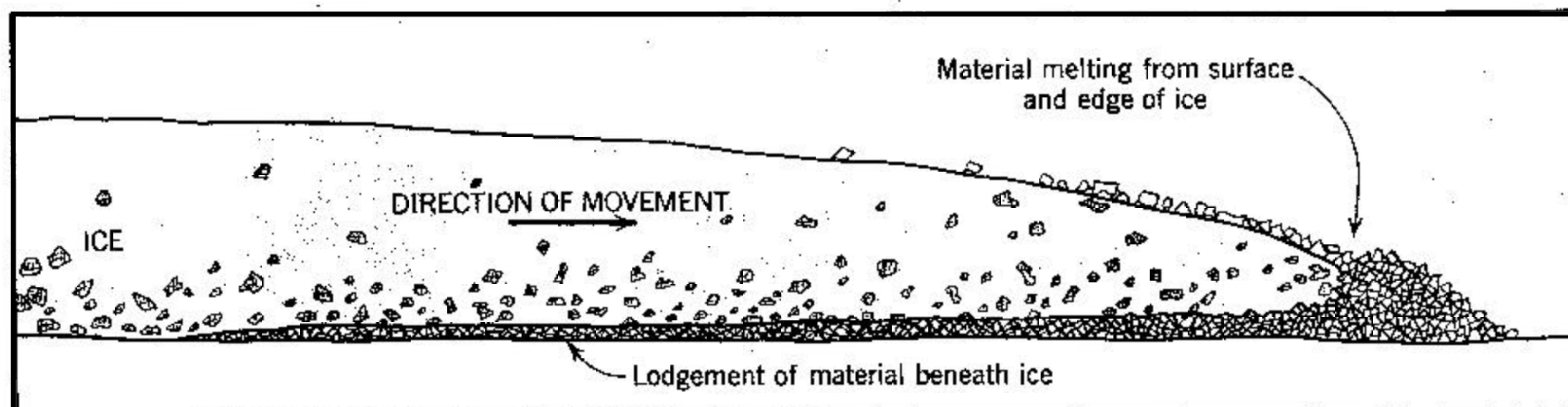


Figure 7. Material plucked and scraped from the under-surface of the ice sheet was transported toward the ice margins. Together with material bulldozed by the leading edges of the sheet, this glacial till was lodged as ground moraine under the ice or as end and lateral moraines at the ice margins. (Trewartha et al. 1977, p. 288).

Glacial drift is a term applied to mineral debris that was transported by and deposited in close association with glaciers. Drift created as a heterogeneous mixture of rock, sand, silt, and clay is known as till. Glacial till was produced by the plucking and scraping of the land surface as the ice sheet moved as well as by the bulldozing effect of the leading edges of the ice sheet.

Till was deposited in many forms by a glacier. As global climatic patterns created conditions where glacial melting equaled ice formation, the ice sheet stopped its forward movement, and the till at its edges was deposited as an end or terminal moraine. The linear hill systems created by deposition of till at the edge of the ice sheet often contain both rises and depressions, and many of the depressions became lakes as they filled

with water melting from the ice sheet. These linear hill systems or morainal ridges are often described as "kettle and knob" landscapes in reference to the multitude of hills and depressions (some of which were lakes or ponds) that they contain. Generally, the topographic contours created in a kettle and knob landscape paralleled the orientation of the ice sheet edge from which they were produced. The orientation of the morainal landscape was also generally perpendicular to the direction of ice sheet advancement.

Similar morainal deposits occur at the lateral edges of ice sheets. Lateral moraines tend not to create as much relief as end moraines since the lateral edges of the ice sheet tend not to contain as much till as do the terminal edges.

Ground moraine resulted when till was deposited as the ice sheet advanced across the land surface. Ground moraine landscapes tended to be flat to gently undulating because the ice sheet scraped the land surface as it advanced. Any material deposited on a ground moraine was therefore subjected to subsequent scraping by successive movement of the ice sheet.

As an ice sheet melted, water flowing over, through and from the melting ice carried debris gathered by the ice sheet during periods of advancement. As the speed of travel for this meltwater slowed down, sediment carried in the flow was deposited on underlying surfaces, much as a stream in the landscape deposits sand and silt into its channel or onto its floodplain when its velocity slows down. As the speed of travel in the meltwater flow continued to decrease, the size of the particle that could carry by the flow also decreased. Thus, layers of sediment having varying particle sizes dropped out of meltwater flow depending on the flow's speed of travel. This type of glacial drift was known as stratified drift, and it usually contained silt, sand or gravel whose particle size varied depending upon the speed at which the meltwater was traveling.

As the speed of meltwater flowing off a melting ice sheet onto an adjacent land area slowed down, a sandy outwash plain was created. If the meltwater flowed through a valley depression either on the surface of the ice, within the ice or on adjacent land surfaces, a meltwater channel formed, and a linear channel of stratified drift was deposited in the landscape.

Occasionally, the melting ice sheet broke into a series of ice blocks, and the flow of meltwater became more localized with respect the location of the ice block. Melting blocks of ice often produced depressions in the land surface, and this pockmarked landscape was known as a pitted outwash plain. Many of the depressions filled with meltwater creating ice block lakes. Figure 8 illustrates the advancement and recession of an ice sheet and the diverse landforms that might have resulted from this activity.

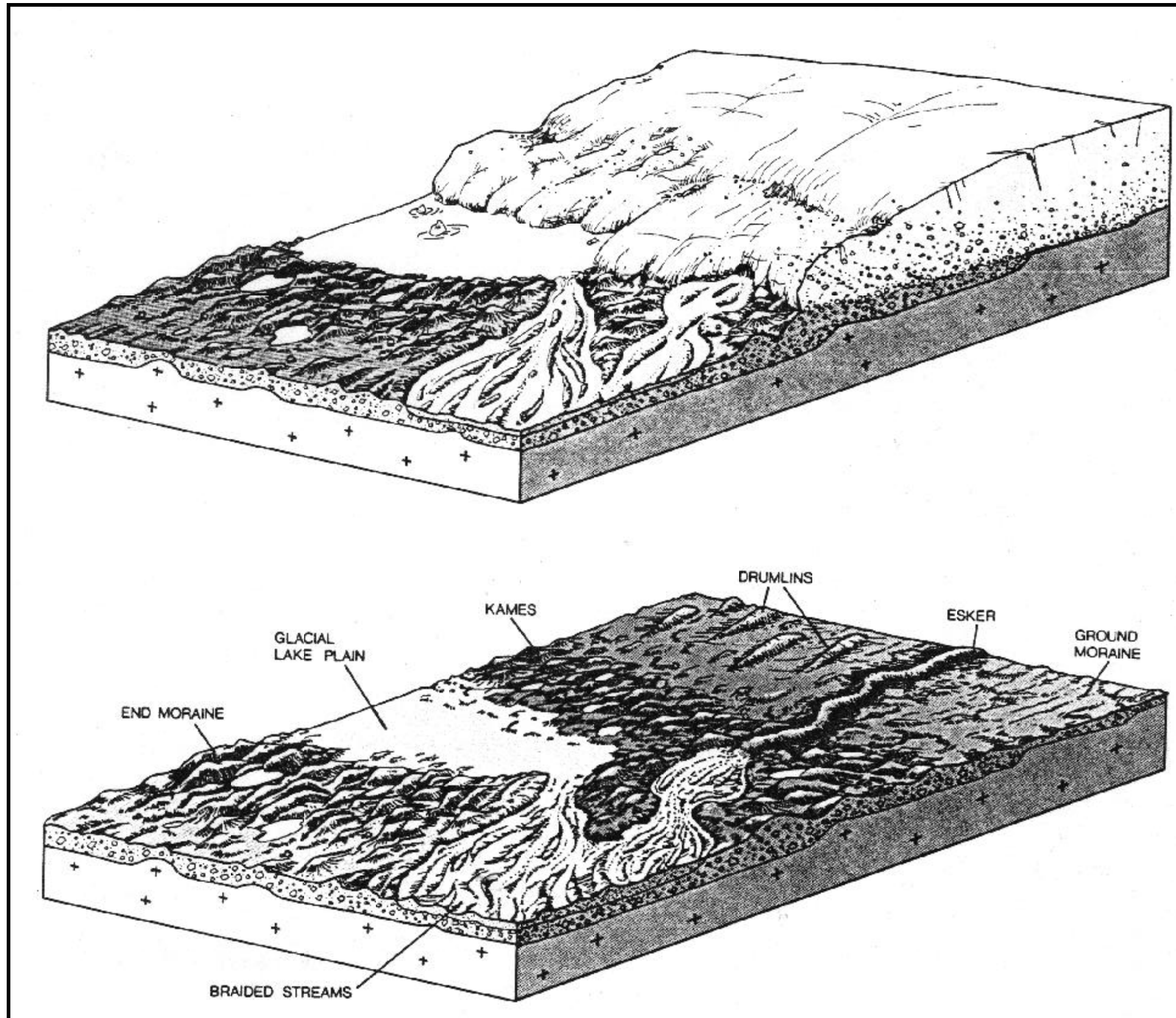


Figure 8. An advancing ice sheet created ground, end and lateral moraine landforms. As the ice melted, stratified drift deposits created outwash plains that often contained braided stream channels, meltwater channels, glacial lake plains, and large areas of sandy conical-shaped hills called kames (Ojakangas and Matsch 1982, p.101).

Landforms of the Illinoian Glaciation

Within the Valley Branch watershed, the area south of the south branch was covered with ice during the Illinoian glaciation but not during the Wisconsin Period (see Figure 9) which occurred at least 100,000 years after the Illinoian ice advancement (Myer et al. 1990, Martin 1965). The older age of the Illinoian landscape means that surface drainage is more strongly developed, and soils and surface geology overburden are considerably thinner than that in the northern half of the watershed (see Figure 10). Continental ice sheets during the Illinoian glaciation originated in two areas of northern Canada. The Labradorean ice center was located to the northeast of Minnesota and Wisconsin while the Keewatin ice center was located in northwestern Canada. Illinoian glaciation advanced from the Labradorean ice source to the northeast as well as the Keewatin ice source to the northwest (Myer et al. 1990). The glacial till remaining in the Illinoian landscape is predominately Keewatin till.

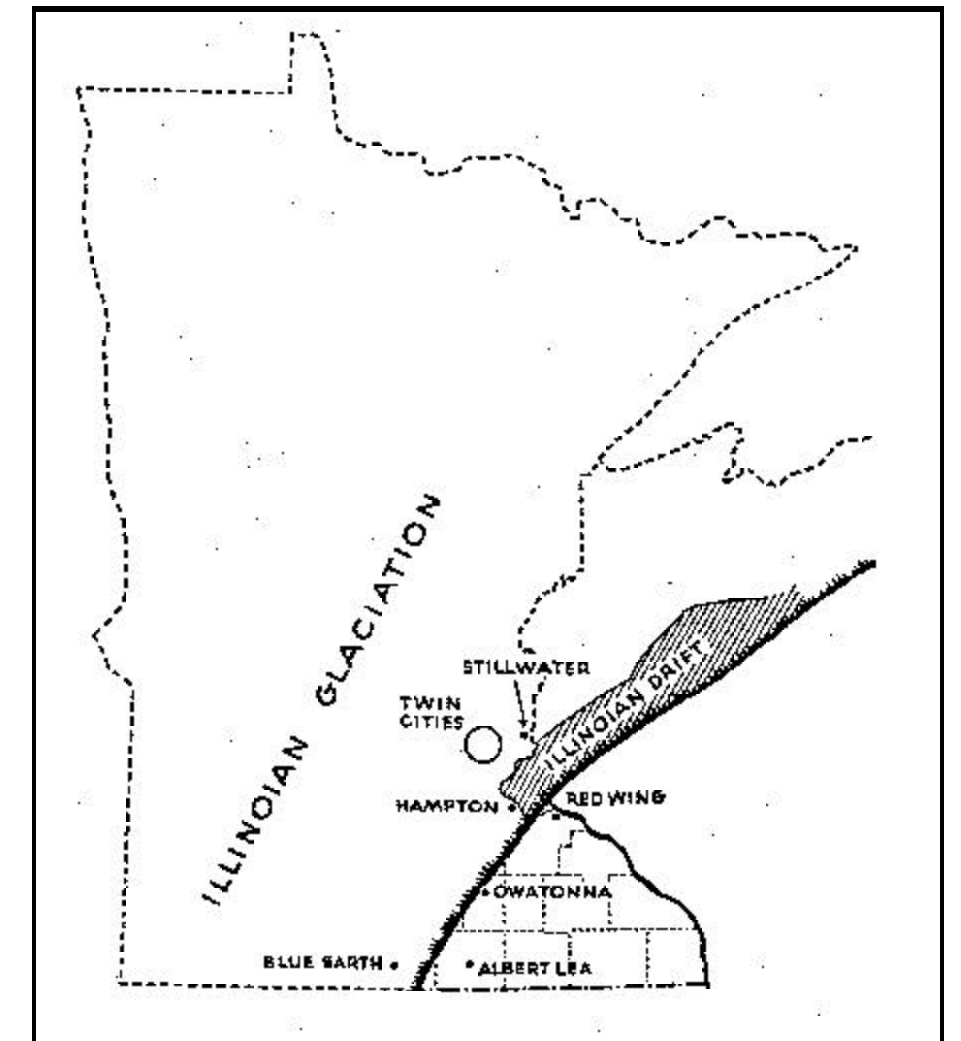


Figure 9. The southern portion of the Valley Branch watershed was covered with ice during the Illinoian glaciation but not during the Wisconsin, and it is at least 100,000 years older than the Wisconsin landscape (Bray 1977, p.34)

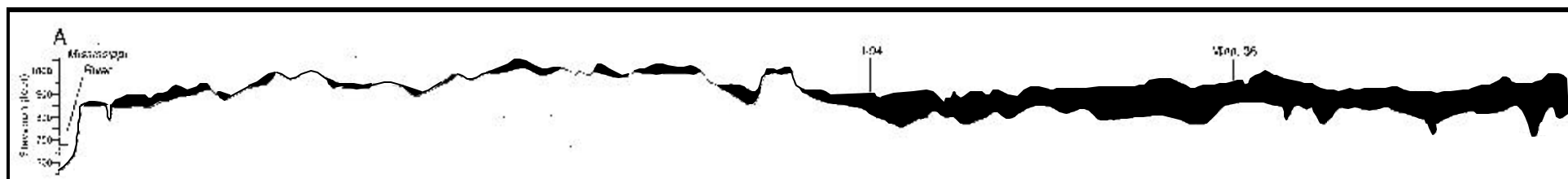


Figure 10. This diagram illustrates the variability in landforms, drainage development and depth of soil and surface geologic overburden in the watershed. The left edge of the diagram represents the Mississippi River while the right edge is located to the north of Highway 36 in Grant Township. Interstate 94 is in the center of the diagram. The well developed drainage and shallow overburden of the Illinoian landscape is typified by the left half of the diagram while the right half exemplifies the poorly developed drainage but deeper overburden of the Wisconsin landscape (Meyer et al. 1990).

Landforms of the Wisconsin Glaciation

During the Wisconsin glaciation, the Superior Lobe advanced over the watershed from its Labradorean source. The Superior Lobe flowed from the northeast directly across the watershed reaching its maximum extent around 20,000 years BP (Bray 1985; Wright 1972). The furthest extent of this lobe is marked by the St. Croix terminal moraine, which extends through Dakota County (see Figure 11). A lateral element of the St. Croix moraine extends throughout the higher elevations of the Valley Branch watershed sitting approximately over top of the Platteville-Glenwood Formation.

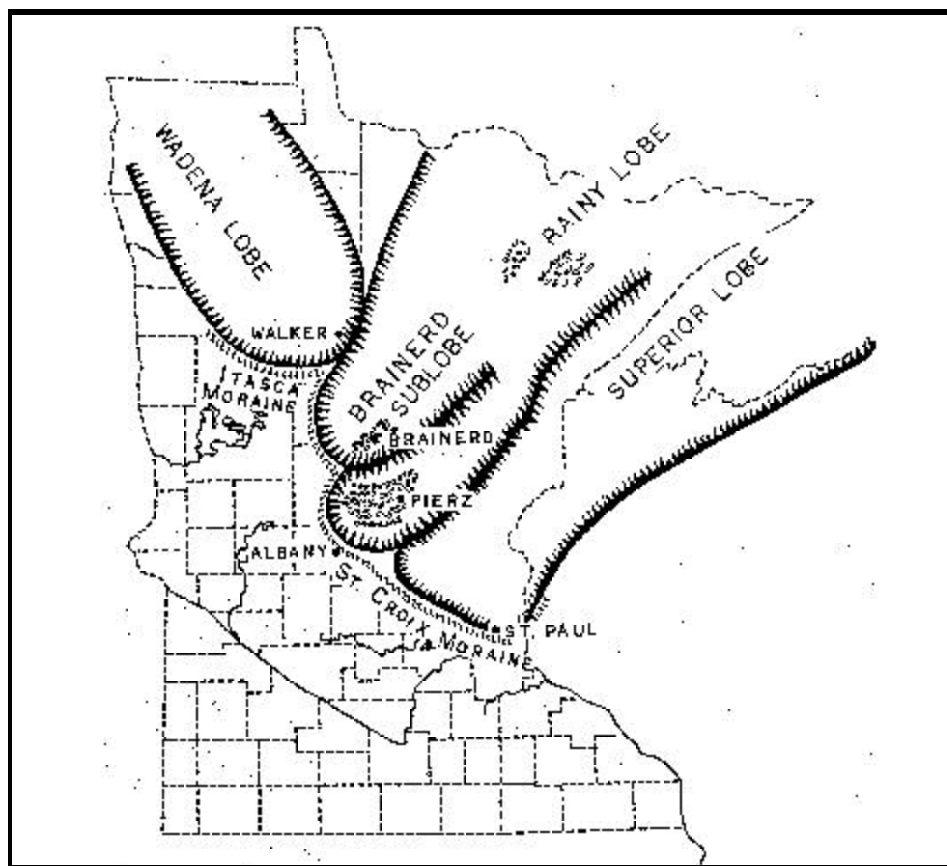


Figure 11. The Superior Lobe reached its maximum extent about 20,000 years BP creating a terminal moraine in Dakota County and a lateral moraine in the western edge of the watershed (Bray 1977, p.41).

As the Superior Lobe began to melt after achieving its maximum advancement, meltwater flowing from the St. Croix moraine in an easterly direction created an extensive outwash plain. This outwash plain occupies an area of relatively flat slopes (i.e. less than six percent) in the vicinity of Bissels Mounds and extending northerly toward Interstate 94. Within that portion of the watershed's north branch residing in the buried river channel, the landscape is pockmarked with kames or sandy conical shaped hills and depressions. This pattern is indicative of localized drainage produced from blocks of ice breaking away from the main ice sheet (Patterson 1990).

River Terraces of the Post-Glacial Period

Prior to advancement of the glacial ice sheets during the Pleistocene Period, the St. Croix River departed from its present course at the Sunrise River, flowing up what is now called the Sunrise valley and connecting to the Mississippi River drainage via the Rice Creek drainage system (Wright 1972). Figure 12 illustrates that the landscape of the lower portion of the St. Croix valley below the confluence of the Apple River is, however, over 100,000 years old, having been the location of the pre-glacial Apple River (Martin 1965, Bray 1985).

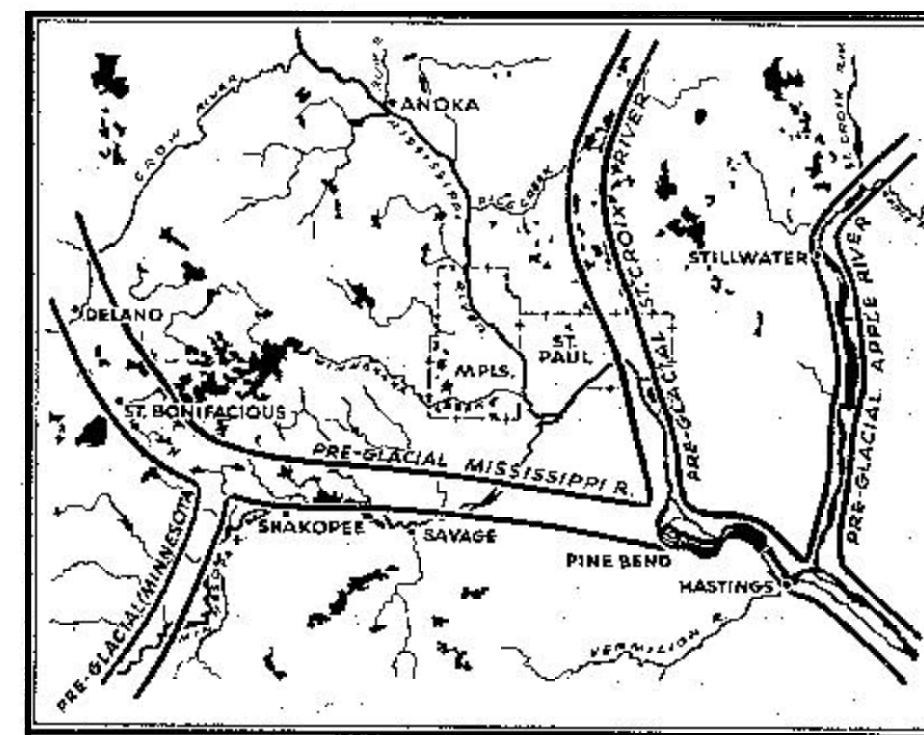


Figure 12. The approximate path of the pre-glacial St. Croix River followed the Rice Creek drainage from the Sunrise River, and it eventually drained down through the current valley of the Phalen Creek drainage system. The pre-glacial Apple River occupied the valley of what is now the St. Croix River below its confluence with the Apple River (Bray 1985, p.52).

The advancing Superior Lobe of the Labradorean Ice Sheet disrupted drainage from the north and west into Glacial Lake Duluth (the precursor of Lake Superior), and created two inland lakes, Aitkin and Upham, respectively. Both lakes drained originally to the south through the Mississippi River drainage. Similarly, Glacial Lake Duluth drained originally to the south and west through the Brule and St. Louis Rivers and eventually into the St. Croix River. However, the Des Moines Lobe, a Keewatin ice sheet advancing from the northwest reached the approximate location of the Twin Cities Metropolitan Area. An offshoot of this sheet, the Grantsburg Sublobe, extended in an east-northeast direction reaching its maximum extent approximately 16,000 years BP (Wright 1972).

The advancing Des Moines Lobe captured Mississippi River drainage flowing out of Lakes Aitkin and Upham, while the Grantsburg Sublobe disrupted surface drainage flowing from Glacial Lake Duluth through the St. Croix drainage system. The capturing of these two drainage systems by the ice lobes resulted in the creation of Glacial Lake Grantsburg, a lake that lasted for 2000 years (Wright 1972). At its greatest extent, Lake Grantsburg covered the landscape in Minnesota from Milaca, Hinkley, Braham and Pine City to Grantsburg, Cloverton and points east in Wisconsin (Bray 1985) (see Figure 13).

Lake Grantsburg finally overtopped the ice dam created by the Grantsburg Sublobe in the vicinity of the present-day Dalles at Taylor's Falls, and it quickly cut a new course that joined with the pre-glacial channel of the Apple River. At this point in time, the St. Croix River was draining Glacial Lake Grantsburg as well as Lakes Aitkin, Upham and Duluth. River stages during this period were more than 60 meters higher than the present 200m pool elevation at Stillwater. Five sets of river terraces were created in the St. Croix Valley as the stage of the river receded from its post-glacial high. The highest terrace is found at an elevation of 250 to 270m while the second highest terrace is 240 to 250m above the river. The third highest terrace exists at elevations of between 230 and 240m feet and the fourth highest terrace is at an elevation between 220 and 230m. The lowest terrace is found at elevations ranging from 210 to 215m.

The map entitled "Surficial Geology" illustrates the distribution of surface geology deposits created by glacial and post-glacial activity within the Valley Branch watershed.

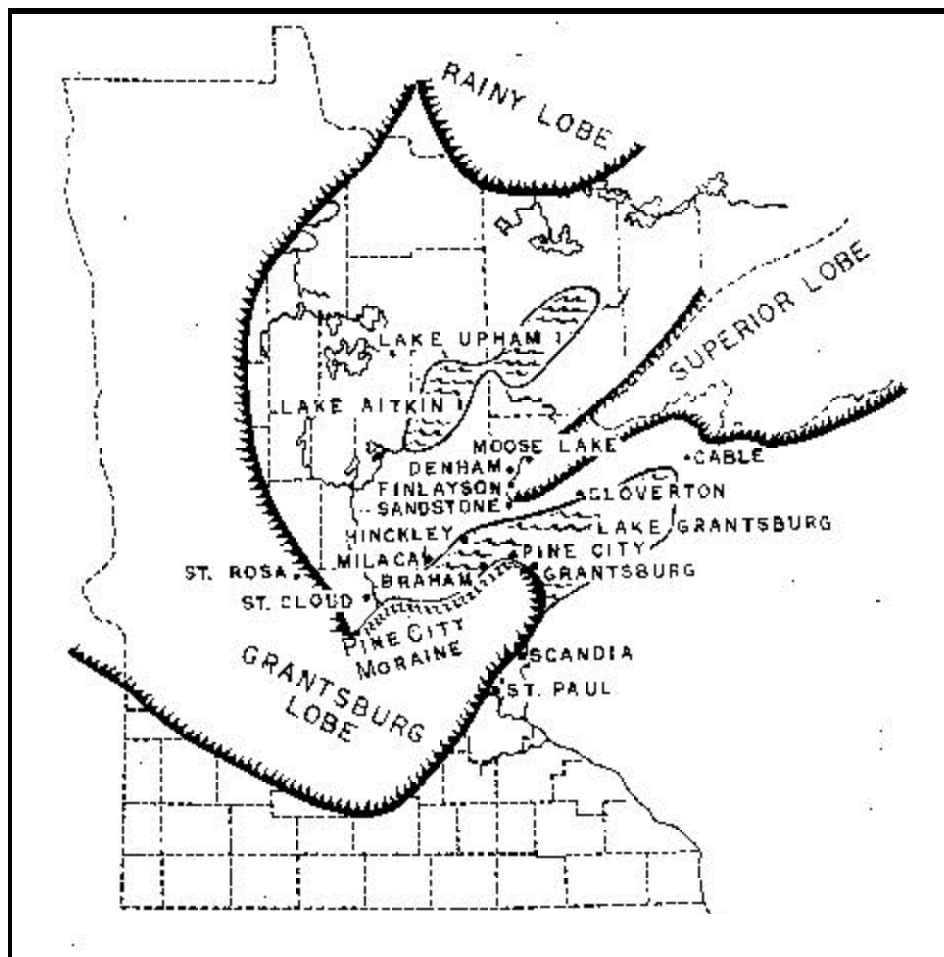
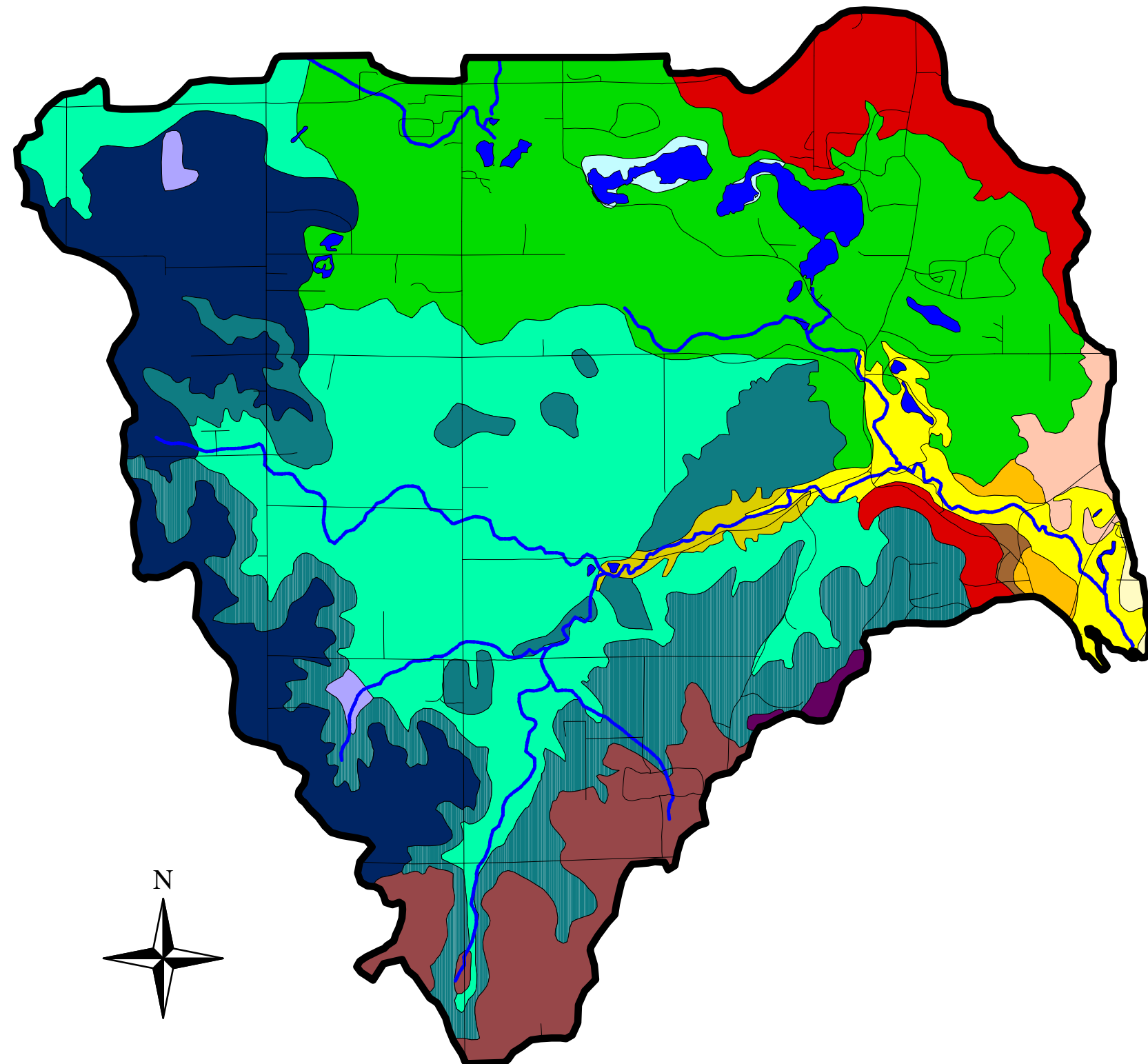


















Figure 13. Drainage from Glacial Lakes Duluth, Upham, Aitkin and Grantsburg resulted in the creation of a series of five river terraces along the course of the post-glacial and present St. Croix River (Bray 1977, p.43).

Surficial Geology

Valley Branch Watershed - Washington County, MN



Legend

-  Roads
-  Drainage
-  Water bodies
-  Loamy floodplain alluvium
-  Sandy floodplain alluvium
-  Lower terrace 1
-  Organic deposits
-  Lower terrace 2
-  Middle terrace 3
-  Middle terrace 4
-  Upper terrace 5
-  Superior smooth outwash
-  Superior pitted outwash
-  Superior lacustrine sand and silt
-  Bedrock within 5 feet of surface
-  Pre-late Wisconsin Keewatin till
-  Pre-late Wisconsin Superior till
-  Wisconsin Superior till

SURFACE DRAINAGE PATTERNS

Variable Age of Drainage Patterns

As noted previously, the southern portion of the watershed below the south branch was glaciated during the Illinoian Period, but this landscape was not covered by ice during the Wisconsinan Period. In contrast, the northern half of the watershed was glaciated during both the Illinoian and the Wisconsinan Periods. The increased age of the Illinoian landscape means that the southern half of the watershed has experienced the dissecting and erosional effects of weathering and surface runoff for a longer period of time (i.e. at least 100,000 years) than has the northern half of the watershed. Thus, the Illinoian landscape has a much better developed surface drainage system, and its soils and surface geology tend to have considerably shallower depths to bedrock than is characteristic of the Wisconsinan landscape (see Figure 10).

Effects on Presence of Wetlands and Surface Water Bodies

The effects of the varying ages of the Illinoian and Wisconsinan landscapes on surface drainage are especially evident in looking at the map entitled "Surface Hydrology". Youthful landscapes, such as the Wisconsinan landscape, are characterized by the presence of extensive systems of wetlands and water bodies. Over time, sediment from the surrounding landscape fills these depressions. The surface hydrology map of the watershed reveals the complete absence of wetlands and water bodies below the south branch, and an extensive system of both wetlands and lakes that runs diagonally from the southeast toward the northwest through the Wisconsinan landscape. This system generally occurs within glacial outwash that filled a river valley in existence prior to the advancement of the Superior Lobe. Blocks of ice sitting in the shifting sediment of the buried valley broke off from the main lobe. As these blocks melted, they created the lakes and wetland systems that characterize this landscape (Patterson et al. 1990).

Deranged Versus Well Developed Drainage Systems

Youthful landscapes are also characterized by having drainage systems that have no apparent direction. Known as deranged drainage, these systems may have single channels that are isolated from other channels. Two or three channels may even begin to form a drainage network that eventually leads into a wetland or a surface water body that has no outlet. In contrast to this youthful pattern, older drainage systems have well-developed networks that drain extensive land areas, providing an outlet for the watershed into a larger stream. The surface hydrology map of the Valley Branch watershed reveals extensive areas of deranged drainage in the Wisconsinan landscape and an extensive branching pattern of drainage in the Illinoian landscape that flows eventual into the St. Croix River. The Illinoian drainage pattern is hierarchical in the sense that many first order streams join together in the upper reaches of the watershed to create second order streams. These streams, in turn join together to create third order streams. By the time the mainstem of Valley Branch flows into the St. Croix River, it is a fifth order stream. None of the sub-basins of Valley Branch in the Wisconsinan landscape contains a stream of the fourth order.

Contrasting Drainage Density

Finally, hydrologists use a term known as drainage density to describe the magnitude of drainage development within a watershed. Within a basin, drainage density is a measure of the total linear feet of channel length for streams of all orders divided by the total basin area. Basins having higher measures of drainage density tend to have better developed drainage systems. Consequently, surface water will drain more rapidly than in basins having lower drainage density. The map of surface hydrology for the Valley Branch watershed reveals that all of the sub-basins in the Illinoian landscape have drainage densities that are within the upper two-thirds of drainage density measurements among all sub-basins in the watershed. In contrast, all of the sub-basins within the lowest one-third of drainage density measurements are located in the Wisconsinan landscape. These figures indicate the advanced state of drainage development in the Illinoian landscape as contrasted with the Wisconsinan landscape.

Effects of Geologic and Hydrologic Processes on Topographic Elevation and Slope

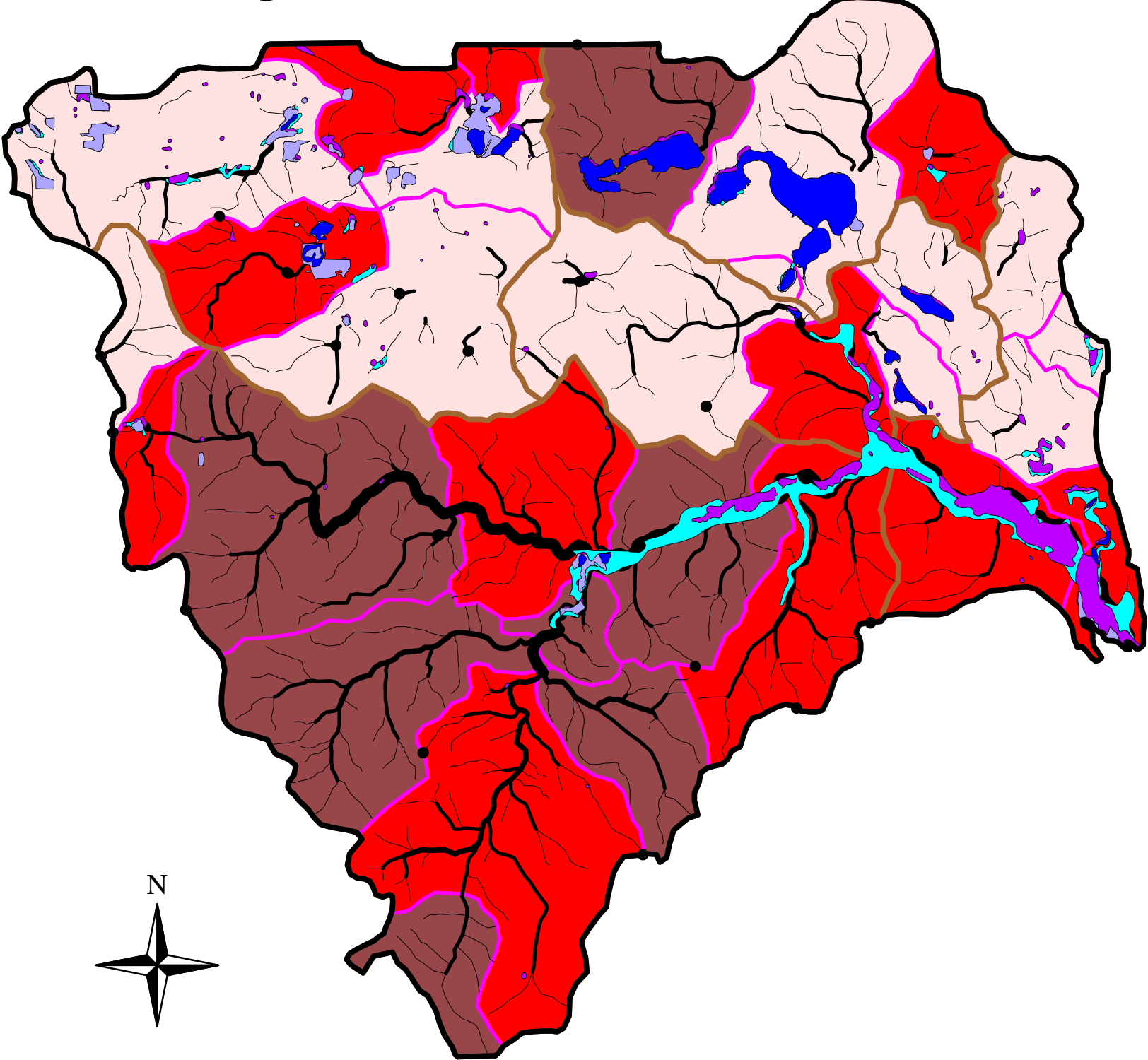
The physical characteristics of the Valley Branch watershed have been subjected to two countervailing forces. On the one hand, processes contributing to the development of bedrock geology have increased the elevation of the land surface. Similarly, the inundation of glacial ice sheets during the Illinoian and Wisconsinan also contributed to the building of the land surface. On the other hand, weathering and erosion have constantly been acting to tear down the land surface and move sediment from the land surface into the St. Croix River.

The actions of the geologic processes in building landform elevation and the weathering and erosional processes in diminishing landform elevation have produced an interesting topography. The "Topographic Elevation" map of the watershed reveals that elevations range from approximately 210 meters at the mouth of Valley Branch to 320m on top of the Platteville-Glenwood Formation in the southwest corner of the watershed. The "Topographic Slope" map reveals that extensive areas containing topographic slopes of less than six percent exist throughout the outwash plain in the central and northern portion of the watershed. Yet, Bissels Mounds, the erosional remnants of the Platteville-Glenwood Formation, rise 30m above this extensive area of level to undulating topography. Along Valley Branch Road, bluffs as high as 60m and steeper than 45% rise upward from a perfectly level valley floor. The pitted outwash landscape of the eastern portion of the watershed represents the only portion of the watershed where the regularity of the rectangular grid created by the Public Land Survey System was altered. The rolling topography and a matrix of wetlands and water bodies proved too formidable for those building the township's original section-line roads, and many of the roads have curvilinear alignments as they move around these natural impediments.

The topographic diversity that characterizes the watershed makes for a picturesque landscape that is highly prized by visitors as well as residents. However, it also creates conditions that could lead to serious degradation of natural resource value and environmental quality. The topography and physical conditions of the watershed mandate a policy of stewarding landscape resource values as policy-makers consider options for the inevitability of future growth and development.

Surface Hydrology






Valley Branch Watershed - Washington County, MN






Legend

-  Water bodies
-  Wetlands
-  National Wetlands Inventory site
-  Floodplain soils
-  Basin boundary

Drainage Order

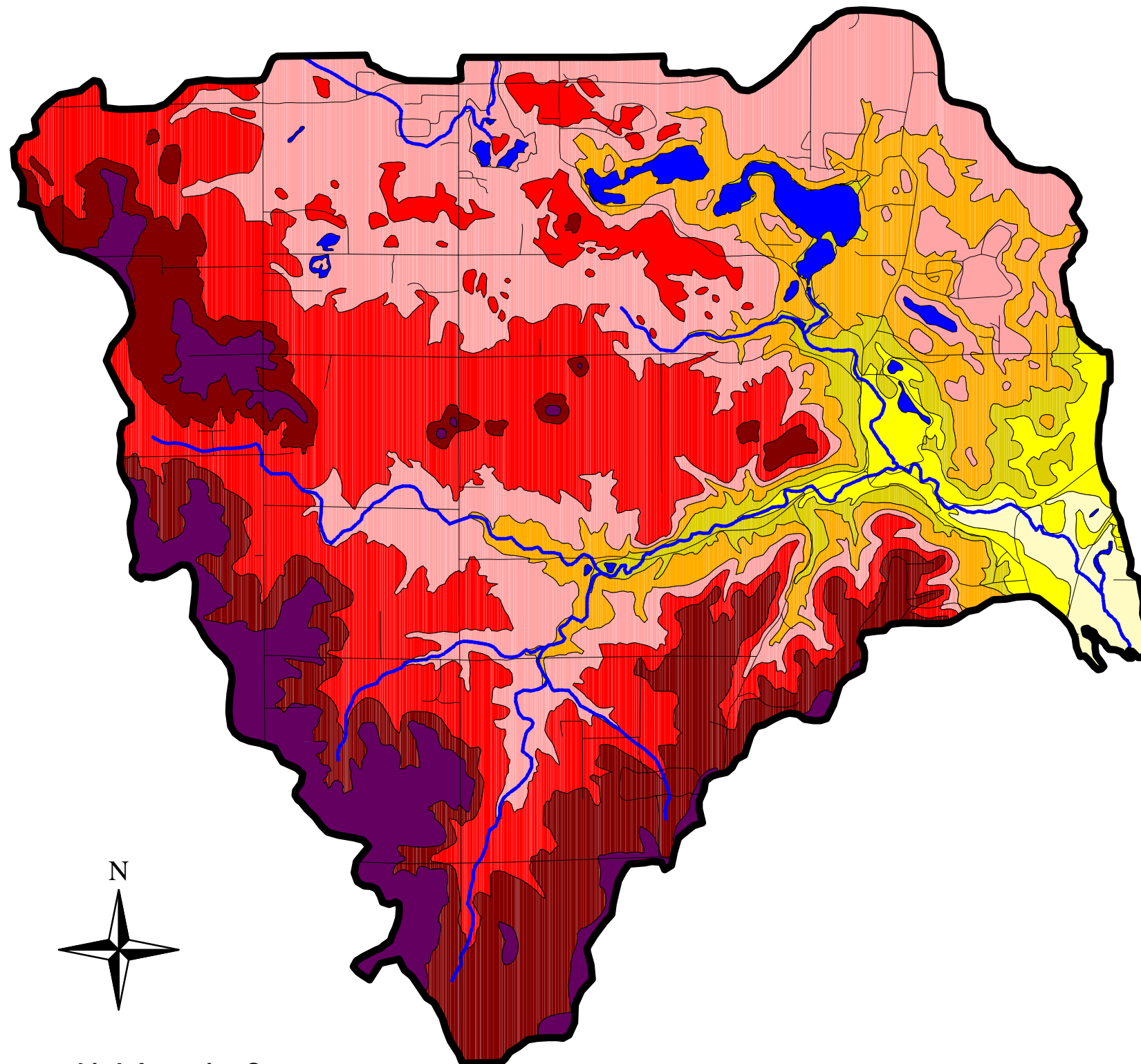
-  1st order drainage
-  2nd order drainage
-  3rd order drainage
-  4th order drainage
-  5th order drainage

Sub-basin Drainage Density

-  Low (<5.61)
-  Moderate (5.61 - 7.68)
-  High (>7.68)









Topographic Elevation

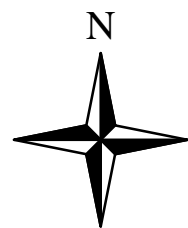
Valley Branch Watershed - Washington County, MN



Legend

-  Roads
-  Drainage
-  Water bodies

-  650 - 700 feet
-  700 - 750 feet
-  750 - 800 feet
-  800 - 850 feet
-  850 - 900 feet
-  900 - 950 feet
-  950 - 1000 feet
-  1000 - 1050 feet



Geographic Information Systems
Department of Landscape Architecture
University of Minnesota

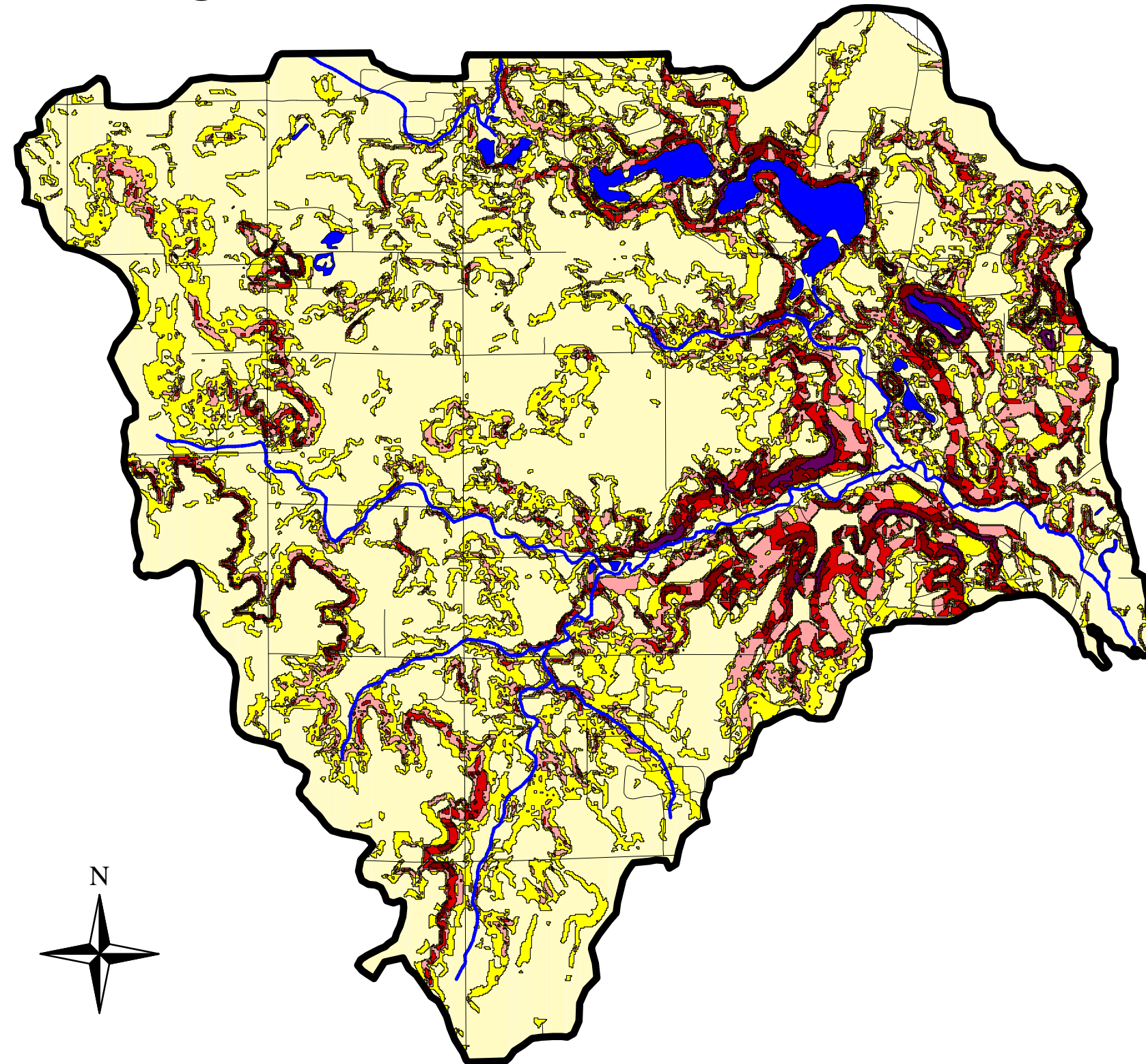


Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.









Topographic Slope

Valley Branch Watershed - Washington County, MN



Legend

-  Roads
-  Drainage
-  Water bodies

-  0 - 6% slope
-  6 - 12% slope
-  12 - 18% slope
-  18 - 25% slope
-  25 - 40% slope
-  greater than 40 % slope



Geographic Information Systems
Department of Landscape Architecture
University of Minnesota



Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.



BIOGEOGRAPHICAL HISTORY OF VEGETATION IN THE WATERSHED

The vegetative history undoubtedly extends far beyond the inundation of the continental ice sheets during the Pleistocene Epoch of the Quaternary Period. However, its recorded effects on the contemporary Valley Branch landscape were all but obliterated by the intervening phases of glaciation.

Revegetation of the Post Glacial Landscape

A rise in the mean annual temperature of the Earth's atmosphere, which occurred at approximately 13,000 years BP (Ojakangas and Matsch, 1982) spelled the end of the Ice Age, and by 10,000 years BP, the Earth's evolution entered Modern Epoch (also known as the Holocene) of the Quaternary Period. The state of Minnesota was free of all ice from the Wisconsin glaciation by 11,500 years BP (Wright 1972).

Advancement of the Post-Glacial Forest

As the ice retreated, the landscape was clothed in tundra vegetation, a herbaceous plant community similar to what exists today in sub-polar regions of the Arctic or above treeline in mountainous landscapes. Continued climatic warming produced a boreal spruce forest in southeastern Minnesota by 11,500 years BP (Wright 1972). Pollen analyses conducted on bog sediments near St. Paul suggest a plant community between 12,000 and 10,000 years BP that may have been as much as 60% spruce. Birch became a component of the community by 11,500 year BP, and Jack Pine, Red Pine, Elm and Oak were part of the community by 11,000 years BP. At 10,000 years BP, the community may have been as much as 30% birch, but the birch quickly yielded to pines, elm and finally oak as the most abundant woody species (Ojakangas and Matsch 1982).

Development of the Prairie Community

A warmer, drier climate continued to prevail, and by 8,000 years BP, prairie vegetation had spread to central Minnesota (Wright 1972). Prairie, perhaps enhanced by hunting practices of humans, reached almost as far north as Duluth by 7200 years BP (Ojakangas and Matsch 1982), and by 7000 years ago, the prairie-forest border was 75 miles northeast of its present position (Wright 1972).

The Advancing Forest and the Development of the "Tension Zone"

At approximately 7000 years BP, the climate once again began to cool, and coniferous forests invaded deciduous forests that had migrated into northern Minnesota. Similarly, deciduous forests invaded prairie vegetation and the prairie-forest boundary or "tension zone" (Curtis 1971) migrated south to its present location (Wright 1972). The previously mentioned analyses of pollen from bog sediments near St. Paul suggest that at 9500 years BP, spruce, pine, birch, elm and oak may have accounted for approximately 85% of the surrounding plant community. By 7000 years ago, the same species may have accounted for less than 40% of the vegetation as prairie species reached their highest levels of abundance. By 5000 years BP, spruce, pine, birch, elm and oak once again may have accounted for over 50% of the plant community. By 2500 years BP, oaks may have accounted for almost 50% of the vegetation, and spruce, pine, birch and elm may have accounted for another 20% of the vegetation (Ojakangas and Matsch 1982).

Presettlement Vegetation of the Watershed

Maps prepared from the field notes of people involved in the Public Land Survey of the St. Croix valley reveal an interesting vegetative pattern in the Valley Branch watershed at approximately 1850. From Prescott to approximately St. Mary's Point, the landscape was predominately "oak openings" and "oak barrens". This cover type contained some white oak and black oak, but it contained predominately bur oak that "had a scattered spacing, growing as individuals or grouped in loose clumps and forming a park like savanna within the open grasslands" (Finley 1976). Marschner (1974) also notes that the oaks tended to have a "scrubby form with some brush and thickets and occasionally with pines". The highest elevations of the watershed contained isolated patches of prairie. Just south of Afton and in the Valley Creek lowland area to the north and west of Afton, a pocket of "Big Woods" existed within the oak openings. Dominant tree species in the Big Woods include sugar maple, basswood, red oak, white oak and black oak (Finley 1976). The river terraces south of Bayport and extending to St. Mary's Point contained a river-bottomland forest of elm, ash, cottonwood, box elder, soft maple and willow (Trygg 1964). Prairie was the dominant vegetation in the areas west of the bottomland river terrace forests in the area between Bayport and Stillwater (Trygg 1964; Marschner 1974; Finley 1976).

DEVELOPMENT OF SOILS IN THE VALLEY BRANCH WATERSHED

Soil consists of mineral granular components of varying sizes, organic material, water and air space. Soils develop in response to a number of factors. The geologic parent material of a soil imparts chemical properties to the soil that may affect such factors as fertility and water holding capacity. The extent and nature of weathering undergone by the parent material affects the size and shape of the granular components of soil. The extent of erosion experienced by the parent material also affects the location of the soil particle relative to its parent material. Topographic position and cardinal orientation or aspect within the landscape will affect the moisture content of the soil, and the steepness of the slope upon which the soil resides affects its propensity for erosion. Surface and subsurface hydrologic regimes will affect soil development by moderating the frequency and duration of conditions during which the soil is saturated with water. Prolonged saturation reduces the amount of oxygen available in the soil and this in turn moderates chemical reactions in the soil. Finally, the amount and type of organic material present in the soil affects conditions related to air and water relationships as well as soil fertility.

Soil Parent Material Within the Valley Branch Watershed

The Soil Survey of Washington and Ramsey Counties in Minnesota (Vinar1980) notes that soils in the Valley Branch watershed formed under numerous landscape conditions. The map entitled "Soil Parent Material" illustrates the parent material conditions from which the various soils in the watershed formed. Soils created principally in glacial outwash plains and terraces are underlain by fine sand to gravelly coarse sands. Soils from outwash tend to be level and well drained to excessively well drained. These soils are found on the outwash plain in the center of the watershed that surrounds Bissels Mounds. These soils extend in a southerly direction following the southern-most branch of Valley Branch, and they also extend throughout the northeastern corner of the watershed.

Soils formed predominately in glacial till were created in upland conditions. Since these soils formed in glacial till, they tend to be loamy in texture (i.e. consisting of sand, silt and clay particles). The loamy nature of this upland soil produces good drainage. These soils are located in the northeast corner of Woodbury and the northwest corner of Afton. They also extend along both the southwestern and the southeastern boundaries of the watershed. Soils formed under ground moraine conditions (i.e. from material deposited beneath the Superior Lobe as opposed to being deposited at the margin of the sheet) are located in the eastern portion of the watershed

Soils formed on glacial lake bottom sediments are found on level to moderately sloping sites. These soils are found most prominently within the watershed near the intersection of Interstate 94 and County Road 15 (Manning Trail).

Many of the steepest slopes within the watershed contain soils formed from fragments of Prairie du Chien or Platteville-Glenwood dolomite that collapsed and moved down-slope. This form of soil parent material exists in the western portion of the watershed along the eastern edges of the Platteville-Glenwood formation as well as in the central portion of the watershed along the bluffs overlooking the south branch of Valley Branch.

Finally, numerous areas exist in the watershed where soils formed in a wind-blown silt mantle with an underlying material of bedrock. These silt-mantled bedrock soils are found predominately in the southern portion of the watershed. Many of the drainage channels extending across the outwash plain in the central and northern portions of the watershed contain soils formed from wind-blown silt. Significant portions of the outwash plain also were covered with wind-blown silt. Soils in these areas tend to found on level to moderately sloping sites, and they are well drained. Silt was blown into the watershed during a period of global warming between 7000 and 3000 years BP. The silt originated in the Dakotas, and it was blown into the watershed by prevailing westerly winds.

Effects on Soil Properties

The variability in soil formation within the watershed produced differences in soil properties that are largely attributable to whether the soil formed in outwash or till.

Soil Drainage

Two soil drainage characteristics are particularly important to urban development.

Soil Infiltration Capacity. Soil infiltration capacity affects the rate at which surface water will move into the soil horizon. Soils having a high infiltration capacity absorb water while soils having a low infiltration capacity shed water. As less surface water is absorbed into the soil, more becomes available to join surface runoff. Infiltration capacity is measured in terms of the number of inches of water a soil will absorb in one hour. The USDA-Natural Resource Conservation Service has established a rating system known as hydrologic soil groups which classifies soils into four categories based on their infiltration capacity. Nearly all of the soils in the Valley Branch watershed are rated as having high or moderate to high infiltration capacity. Areas containing soils with low infiltration capacity are a result principally of shallow depth to bedrock. The spatial variability of infiltration capacity among soils in the watershed is illustrated in the map entitled "Soil Infiltration Capacity."

Soil Permeability. Soil permeability measures the rate at which water will move through the soil horizon once it has entered the soil. Soil permeability is measured as the number of inches of water that will drain vertically in the soil horizon in one hour when the soil is at field capacity. The outwash soils in the watershed generally have higher permeability rates than do the soils formed in glacial till. Thus, the central, northern and eastern portions of the watershed have higher rates of permeability than do the southeastern, southwestern and western parts of the watershed. The spatial variability of permeability among soils in the watershed is illustrated in the map entitled "Soil Permeability."

Soil Erodibility

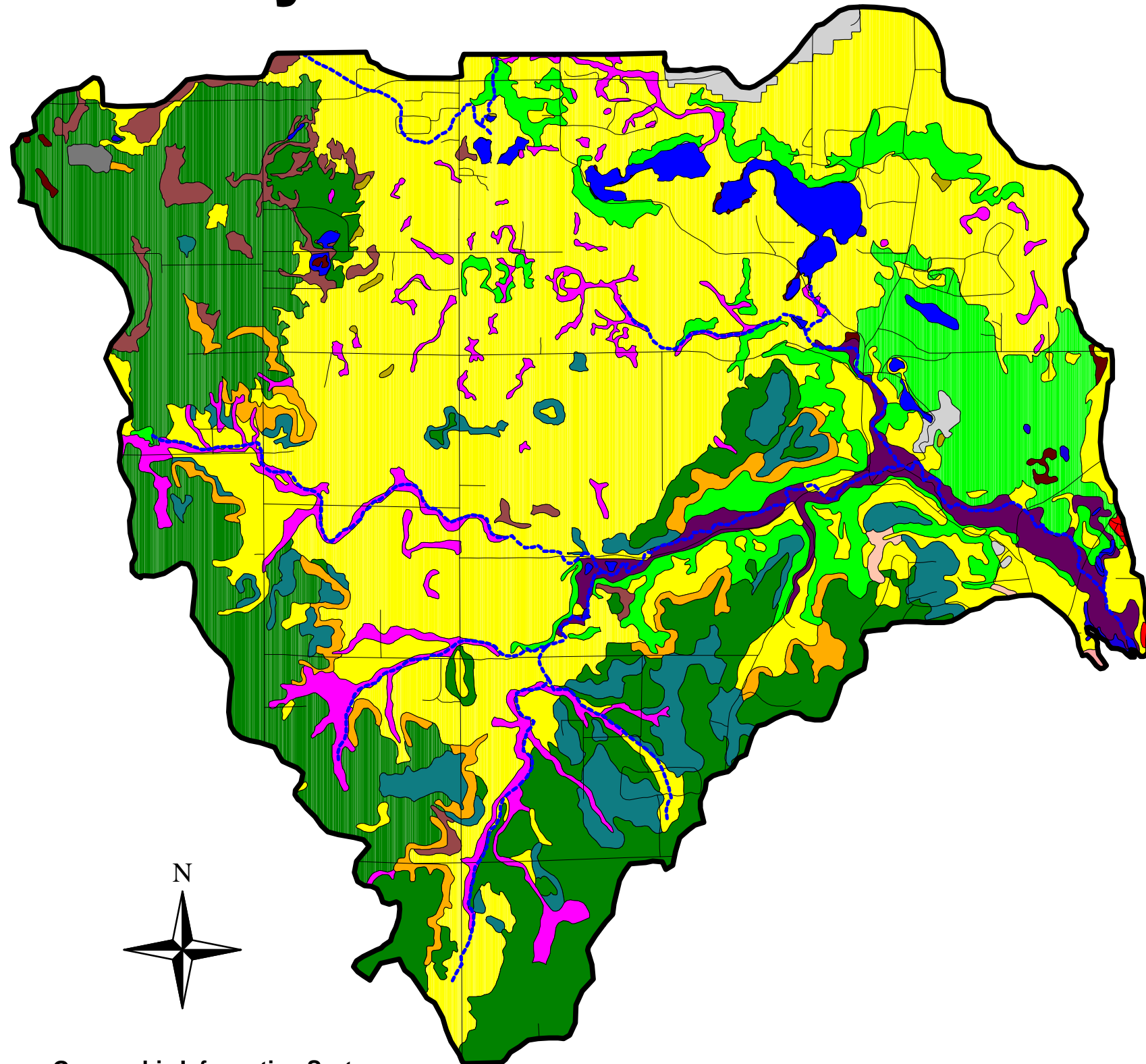
The propensity of soil to erode as a result of surface hydrological processes is affected by several soil properties, including the size and shape of the soil particle, the mixing of soil particle sizes present in the soil matrix and the slope upon which the soil resides. Soils having uniform particle sizes that are relatively small and granular in shape and residing on steep slopes tend to have the greatest propensity for erosion generated by surface runoff. Within the Valley Branch watershed, these conditions are especially prevalent in the upland conditions on the north and south side of the south branch of Valley Branch. The areas adjacent to Lake Edith, in the eastern part of the watershed and the Falstrom Lakes area, and along the more steeply sloping areas where the landscape transitions from the Prairie de Chien dolomite to the Platteville-Glenwood Formation also contain highly erodible soils. The spatial variability of erodibility among soils in the watershed is illustrated in the map entitled "Highly Erodible Soils."

Soil Fertility

Soil formation processes also affect potential fertility of the soil. As measured by the potential yield of soil types in the watershed for corn production under normal management, the soils formed in glacial till tend to have higher fertility levels than do the soils formed in outwash. Both of these conditions, however, have higher fertility levels than do soils formed in wetland conditions, organic soils, soils formed in floodplains, and soils formed on steep slopes. The richest soils in the watershed for corn production are located in the till formations of the southeasterly and western portions of the watershed, while the outwash soils in the central and northern portions have moderate potential productivity. The spatial variability of fertility among soils in the watershed is illustrated in the map entitled "Soil Fertility for Corn Yields."

Soil Parent Material

Valley Branch Watershed - Washington County, MN

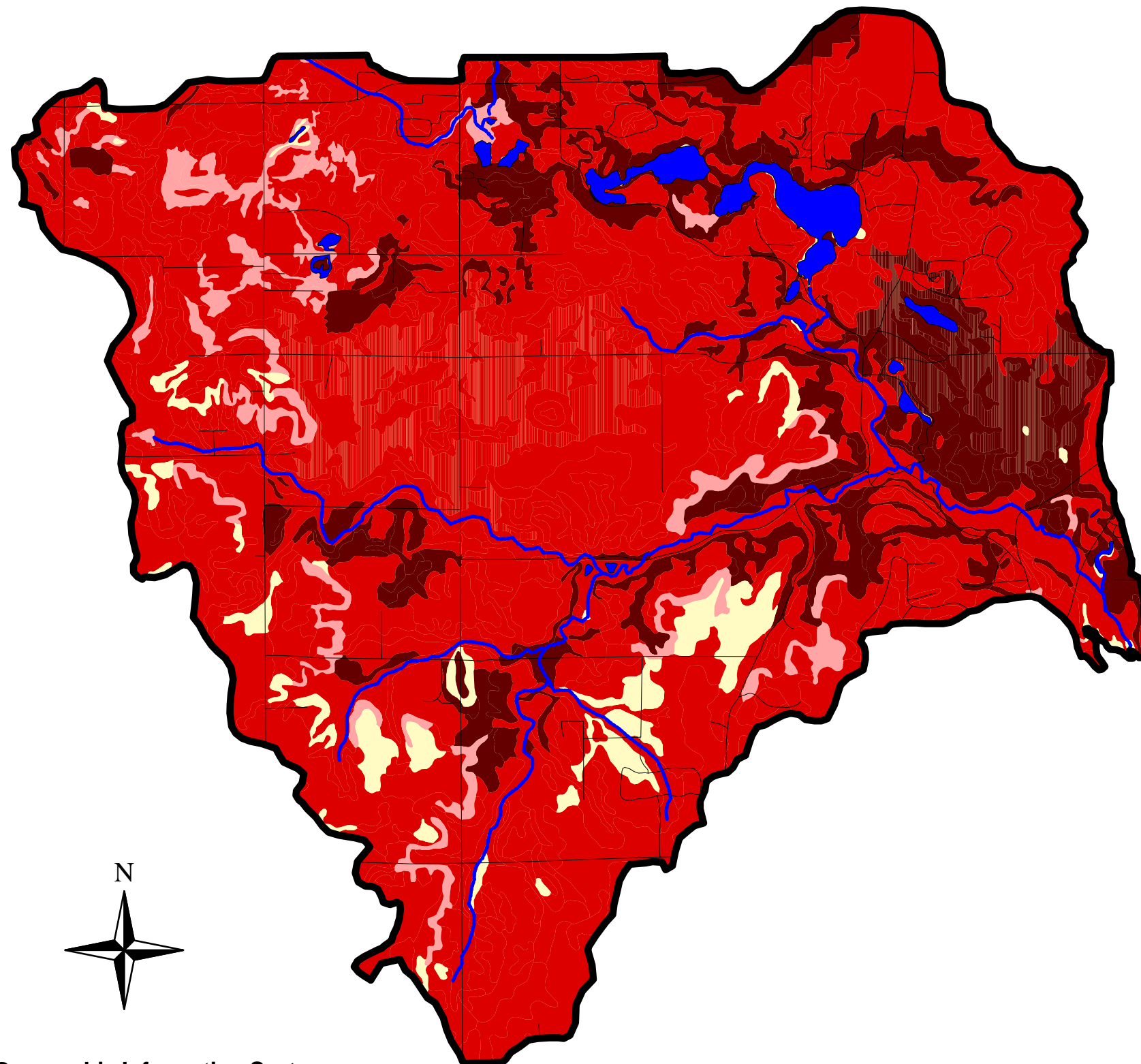


Legend

-  Roads
-  Drainage
-  Water bodies
-  Upland glacial till
-  Ground morainal till
-  Outwash plain
-  Residuum and colluvium from limestone
-  Sandy mantle over sandstone residuum
-  Silty glacial lake plain
-  Slope-washed silt loam
-  Wind blown silt over limestone or sandstone
-  Wind blown silt
-  Floodplain
-  Organic material
-  Wetlands
-  Quarry
-  Gravel pits
-  Human filling of wet areas
-  Urban land



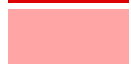
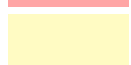
Soil Infiltration Capacity

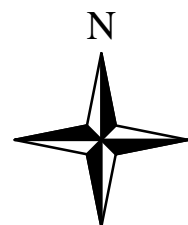
Valley Branch Watershed - Washington County, MN



Legend

-  Roads
-  Drainage
-  Water bodies

-  High
-  High - moderate
-  Low - moderate
-  Low



Geographic Information Systems
Department of Landscape Architecture
University of Minnesota

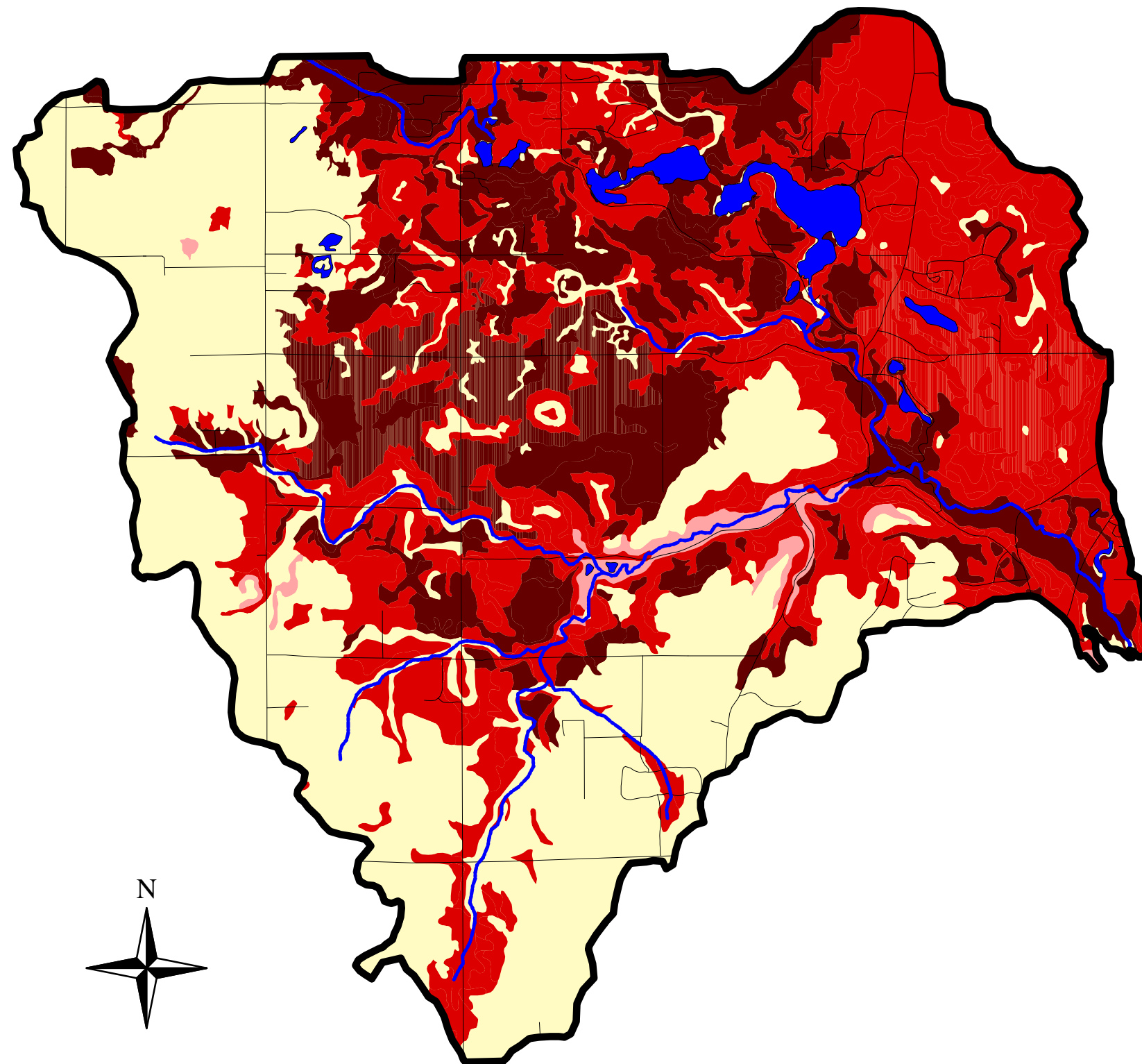


Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.






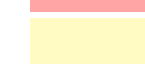
Soil Permeability

Valley Branch Watershed - Washington County, MN



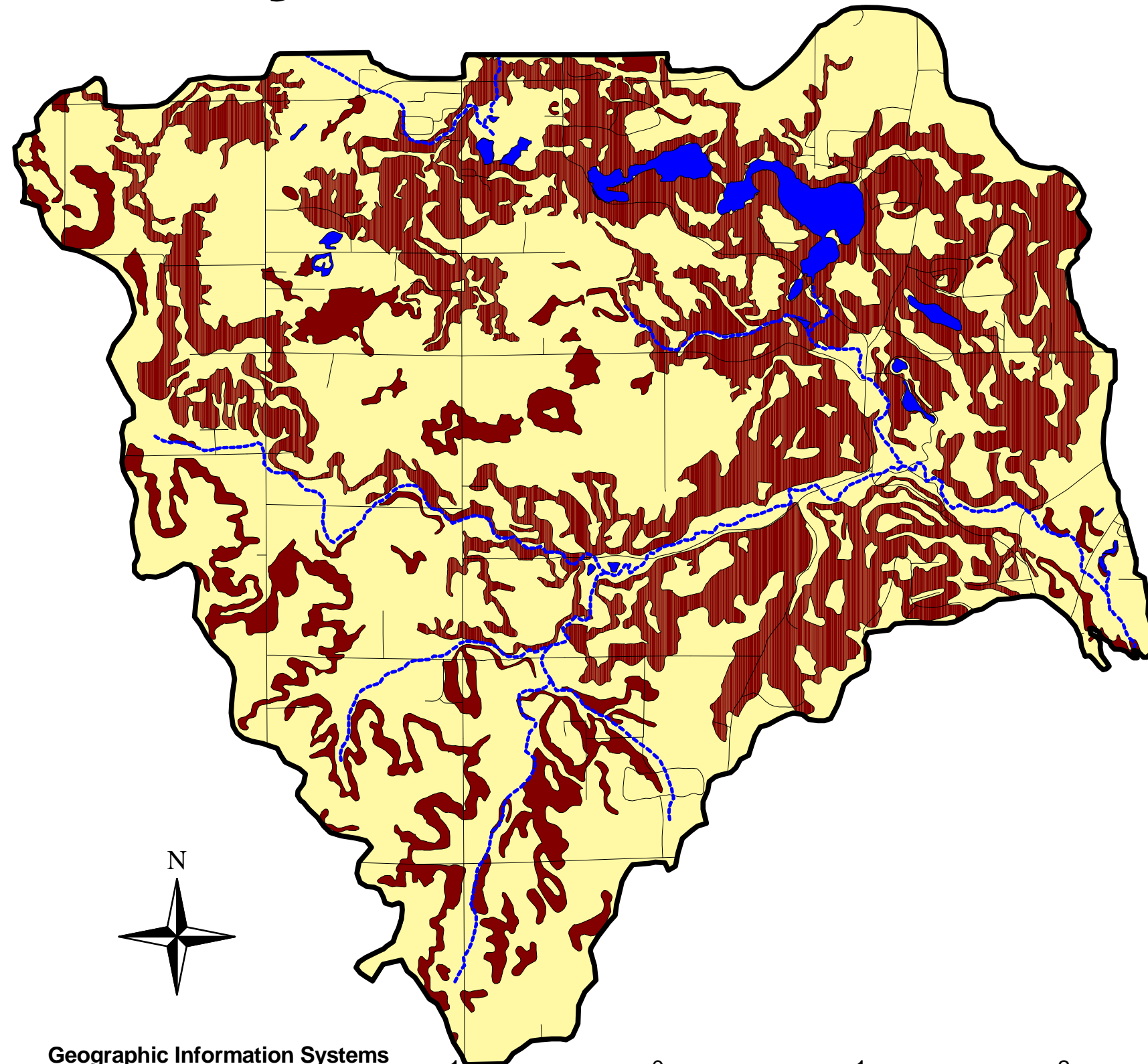
Legend

-  Roads
-  Drainage
-  Water bodies

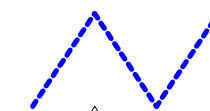
-  High (> 6 inches per hour)
-  High - moderate (2 - 6 inches per hour)
-  Low - moderate (0.2 - 2 inches per hour)
-  Low (< 0.2 inches per hour)

Highly Erodible Soils

Valley Branch Watershed - Washington County, MN



Legend



Drainage



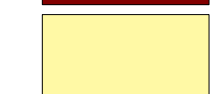
Roads



Water bodies



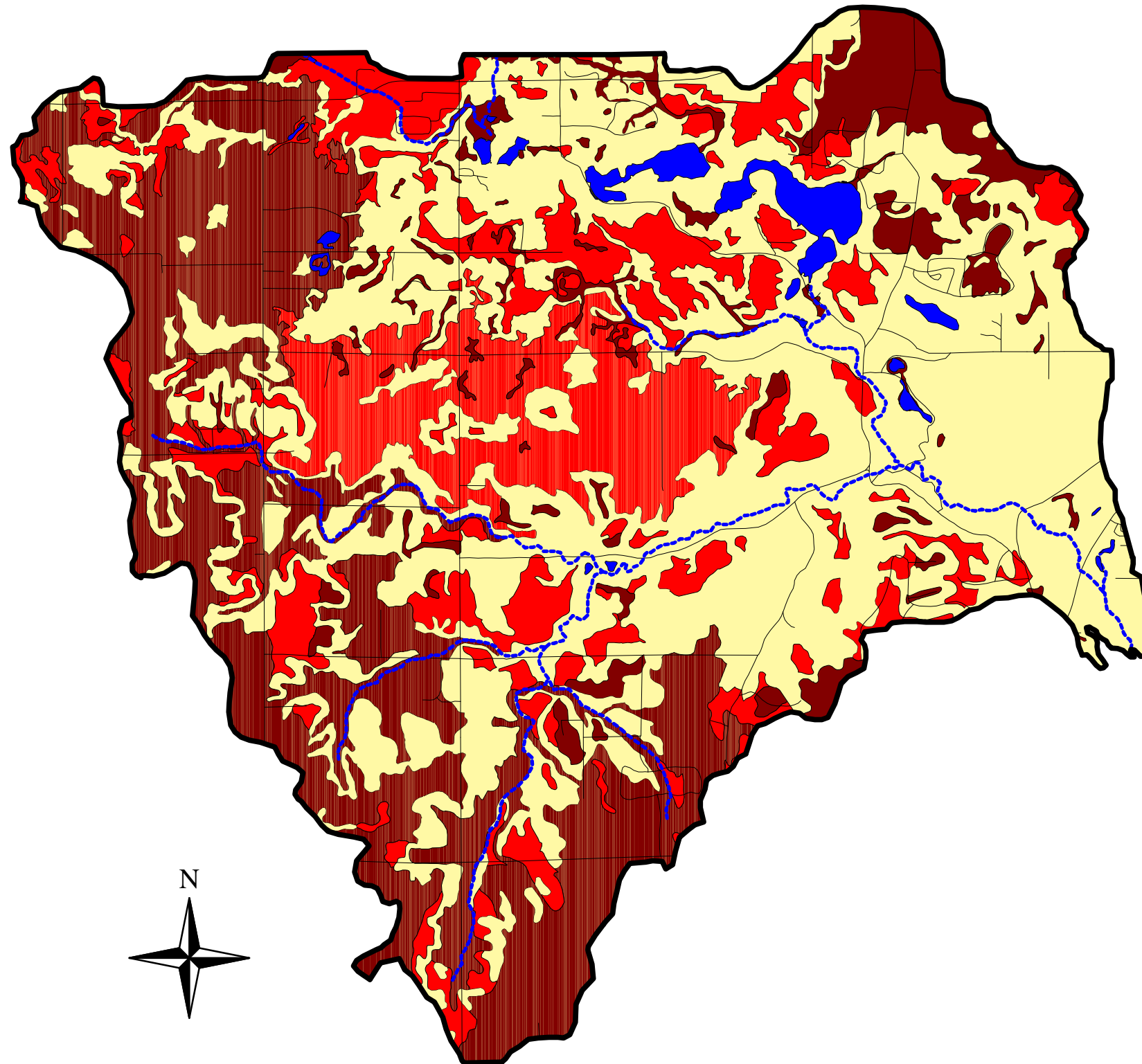
Highly erosive soil or slope



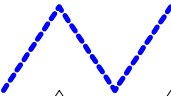





Not highly erosive soil or slope

Soil Fertility for Corn Yields

Valley Branch Watershed - Washington County, MN



Legend

-  Drainage
-  Roads
-  Water bodies
-  Highest corn yields
-  Moderate corn yields
-  Lowest corn yields

Geographic Information Systems
Department of Landscape Architecture
University of Minnesota



Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.



CULTURAL HISTORY OF THE ST. CROIX RIVER VALLEY

The cultural history of the Valley Branch watershed dates back 12,000 years to the period immediately following recession of Grantsburg Sublobe. Evidence of cultural development prior to the period of Early Contact between Native American inhabitants of the St. Croix River valley and European explorers has been investigated using anthropological and archeological methods. Recordation of the valley's history since the Early Contact Period has relied on more traditional methods of historiography.

History of Native American Occupation of the St. Croix Valley

Pre-historic Inhabitants

As early as 12,000 years BP, Paleo-indians hunting mammoths were probably active in the St. Croix valley. During the period 9000 to 2500 years BP, native Americans of the Archaic Period occupied the valley and/or its surrounding landscape. They used copper to make axes, knives, fishhooks, harpoons, spear points, bracelets, and beads. This culture was making complicated metal tools several thousand years before their counterparts in Egypt and the Tigris Valley (Curtis 1971). The Archaic Indians were nomadic hunters.

Between 3500 and 1500 years BP, the Early Woodland Period of Native American occupation emerged. Native communities during this period became more sedentary, and the inhabitants began extensive use of clay pottery.

The Hopewell and Effigy Mound cultures flourished between 1500 and 1000 years BP. The Hopewellians were highly skilled in arts and crafts, making objects in chalcedony, obsidian, and jasper. They raised corn, beans, tobacco, and squash; they understood the art of textile weaving; and they made beads of hammered silver and copper, pearls, and shells. Such a cultural development undoubtedly was based on a highly organized division of labor and could have occurred only under rather high population levels with strong political and religious controls.

The Effigy Mound Builders existed contemporaneously with the Hopewellians. The Mound Builders constructed ceremonial or totem mounds in life-like effigies of birds, turtles, snakes, bison and other animals. This culture attained its acme in Wisconsin. Effigies constructed during this period are apparent on hillcrests overlooking lakes, streams, or springs in southern Wisconsin. The mounds were built from hand-carried basket-loads of earth. The size and internal structure of these mounds indicate that they were probably built in treeless prairie landscapes. The culture combined hunting and agriculture, and it likely migrated with the seasons according to the availability of game and plant foods. The early mound builders abandoned their earthworks at Lac Court Orielles and abandoned the area in approximately 1225 BC (Curtis 1971).

Between 1000 and 1600 AD, the Mississippi period or the last prehistoric period of Native American cultural development emerged. Three cultures occupied this period, the Middle Mississippi, the Upper Mississippi, and the Late Woodland. The Upper Mississippi people were most abundant along the Mississippi and Lake Winnebago. They are thought to have lived in large permanent villages, and they supported themselves by agriculture, hunting, and fishing. They made garden beds of raised mounds of earth, often in intricate curving patterns of parallel rows. Their use of metal was less than that of the Hopewellians and their artistic abilities were also less well developed.

A single village, Aztalan, in Jefferson County reflects the culture of the Middle Mississippi people. This was a large stockaded village, 20 acres in size with numerous homes. Villages of very similar type were seen in the southern portions of the continent by DeSoto in 1541, but they had completely disappeared when Joliet explored the Mississippi, a century later. Some archaeologists are of the opinion that the Spaniards introduced measles and smallpox, which completely wiped out the susceptible Indians in their compact village units. The Woodland Indians, in smaller, isolated bands, escaped. (Curtis 1977)

The Late Woodland culture people made pottery and dug burial mounds. Some mounds along the St. Croix are dated at 1225 AD. A Late Woodland fishing camp site under about 18 inches of accumulated soils in Minnesota's Interstate Park camping/picnic area has been dated at between 1000 and 1300 AD (Crawford undated).

Impact of Pre-historic Native Americans on Landscape Pattern

Occupation of the St. Croix valley by pre-historic Native American cultures had at least five impacts on the pattern of the landscape (Curtis 1971).

Fire. The continued existence of oak openings, prairies, and shrub communities in the St. Croix valley depended on regular pattern fire disturbance. Fire suppressed establishment of woody vegetation that would ordinarily have occupied this landscape, and it allowed the herbaceous grassland and scattered patches of bur oak to predominate. The frequency of lightening strikes does not explain the maintenance of these landscapes. The presence of nomadic hunting tribes throughout the valley in the entire post-glacial period meant that human-made fires were an important if not the sole cause of the fires. A few widely scattered tribes of natives could start enough intentional and accidental fires to keep all but the most protected sites in a fire seral climax condition where prairie and oak openings predominated over woody vegetation.

Hunting. Native American communities affected the diversity, richness and distribution of animal populations through their fire-starting activity and through their influence on the populations of large mammals.

Agriculture. Many of the early sedentary cultures favored floodplain forests sites for food protection. Native woodland vegetation was removed by girdling the trees. However, the total land area affected by agricultural practices was small.

Native Plants as Food Sources. Berries and nuts (e.g. hackberry, walnut, hickory, acorns, and hazelnut) were favorite food sources for many Native American communities. The act of gathering these food stores did not affect the abundance of these species with the possible exception of the Pomme de Prairie (*Psoralea esculenta*), a legume prized by the Indians. This plant may have been gathered to the point of reducing population levels.

Intentional and Accidental Plant Introduction. Circumstantial evidence suggests that introduction of some plant species not normally found in the valley may have occurred as a result of Native American occupation. Species that were possible introduced during this period include Canada plum, white gentian, wild leek, sweetflag, and groundnut and Kentucky coffee tree (Curtis 1971).

More Recent Native American Communities

Ojibwe Indians, displaced from the St. Lawrence River valley by westward movement of Iroquois tribes farther east, begin to move into the Western Lake Superior region in the 1500's. Their movement down into the St. Croix valley during the mid 1600's established a period of conflict with the woodland Dakota that was to last for two centuries (Crawford undated).

In 1745, a major Dakota-Ojibwe battle near Lake Mille Lacs forced the Dakota people out of area around the St. Croix valley. However, war parties continued to enter the valley from villages in the St. Anthony Falls area and along the Mississippi River (Crawford undated). In the 1770's, an Ojibwe war party from Madeleine Island, Wisconsin, encountered Dakota and Fox Indians near today 's NSP hydroelectric dam at St. Croix Falls, Wisconsin. Ojibwe victory in the battle drove the Dakota from the valley. This was the last full-scale Indian battle in the valley (Crawford undated), although skirmishes continued into the mid-nineteenth century. A treaty signed by the Ojibwe and the Dakota at Prairie du Chien, Wisconsin in 1825 established a line of demarcation between the two tribes extending from the present-day location of Eau Claire, Wisconsin through Cedar Bend on the St. Croix River to the present-day location of St. Cloud (Dunn 1979).

The military contests between the Dakota and the Ojibwe caused significant change in the vegetative pattern of the St. Croix Valley landscape. Since political control of the valley remained contested for a period approximately 200 years, neither tribe established permanent settlements. The absence of permanent human occupation resulted in the cessation of human-generated fire. The absence of fire in the landscape transformed many areas that had been described by early European explorers as grassland and oak openings into brush or young forests. The vegetation records provided by the government land survey in the years from 1830 to 1860 reflect changes that had occurred in the preceding 200 years under the influence of unstable and varied Indian populations, but they do not properly indicate the prehistoric conditions (Curtis 1971).

European Exploration of the St. Croix Valley

In 1654, French explorers Radisson and Grosseillers explored southern Minnesota, becoming the first recorded white men in the state. Radisson and Grosseillers explored Lake Superior by canoe between 1658 and 1660. They later explored the Mississippi River, and they may have reached the mouth of the St. Croix (Crawford undated).

Daniel Greysolon, Sieur Dulhut (Daniel Duluth) entered the St. Croix valley in 1680 by way of the Brule River. He traveled the length of the St. Croix, the first European to make this trip. He attempted to make peace among the Indians in anticipation of opening fur trade in this area. Dulhut claimed the St. Croix valley for France.

Expansion of the Fur Trade

During Dulhut's second trip to the St. Croix in 1683, he built a trading post somewhere in the St. Croix area. A fur-trading post was also established near Danbury, Wisconsin in the late 1680's (Crawford undated).

In 1693, Pierre LeSeur established a post near the mouth of the river to keep the St. Croix/Brule River route open for French fur trade. Fort St. Croix, a French fort and fur trade post, was reportedly built and operated near the St. Croix Dalles in 1770 (Crawford undated). French fur traders found themselves in increasing competition with English newcomers in eastern North America. During the late 1700's, two English fur companies, the Northwest Company and the XY Company, were established. The Northwest Fur Company established operations in Minnesota in 1789. The holdings of these two companies were acquired later by John Aster's American Fur Company. Lawrence Booth opened a fur post in the Taylors Falls area in 1793. In 1825, the Indian agent at Fort Snelling licensed the Columbia Fur Company to operate the Fort Barbour fur trading post at St. Croix Falls. In his travels to the St. Croix valley in the mid-1830's, Joseph Nicollet reported finding many fur posts still in operation. Such a post was operating in the Taylors Falls area in 1837. Toward the end of the 1830's the fur industry declined and essentially disappeared from the St. Croix valley (Crawford undated).

Cession of the St. Croix Valley to the United States

In 1763, France was defeated in the French and Indian War. The Treaty of Versailles ceded control of the St. Croix valley to England (Crawford undated). After the American Revolution provided independence for the United States in 1783, the claims of the original 13 colonies to land west

of the Appalachian Mountains were ceded to the newly formed republic. The St. Croix valley was described by the Land Ordinance Survey Act of 1787 as part of the Northwest Territory that extended westward to the Mississippi River. In the early nineteenth century, the valley became part of the Indiana Territory and subsequently part of the Illinois Territory and the Wisconsin Territory (Crawford undated). When the Wisconsin Territory was authorized to begin movement toward statehood in 1846, the federal government used the St. Coix River rather than the Mississippi River to define the potential state's western boundary (Dunn 1979). Despite much debate over the appropriateness of this boundary definition, the St. Croix River remained the western boundary of Wisconsin when it became a state in 1848. Formation of the Minnesota Territory west of the St. Croix River followed, and the territory became a state in 1858.

Development of the Timber Industry

The first reported harvesting of timber by white settlers occurred in 1836 when pine logs were harvested in the Taylor's Falls area with Ojibwe permission but against the wishes of the US government. Most of the 200,000 board feet of pine burned subsequently in a forest fire (Crawford undated). In 1837, Franklin Steele built a cabin on the Wisconsin side of the St. Croix Falls to establish a claim to the water rights for lumber milling. Steele established the St. Louis Lumber Company, and he completed a dam in 1840. The mill was completed in 1842, but it ceased operation in 1845. Jesse Taylor and Benjamin Baker also built a dam and sawmill near the site of the present highway bridge and the upper boat landing in Taylor's Falls. They constructed a log house, the first building within what is now Taylor's Falls. In 1837-38, the logs cut and floated on the St. Croix and its tributaries amounted to 300,000 board feet (Crawford undated).

The first commercial sawmill in Minnesota began operation at Marine Mills, now Marine-on-the-St. Croix, in 1839. Some of the trees being cut at this time were 6 feet in diameter. A commercial mill was established in Stillwater in 1844. Arcola was established and platted in 1846. Early plans reveal never-to-be-realized intentions for a community of sawmills. A second dam was built in the Dalles in 1847, and Caleb Cushing's Boston Lumber Company began operation in St. Croix Falls. The mill burned the subsequent year.

The establishment of government land offices in 1848 and 1849 provided a means for the first legal sale of timberland. The average price for much of this land was \$1.25 per acre, although some sold for as little as 10 cents an acre. Logs cut in St. Croix River watershed between 1847 and 1848 produced 26,000,000 board-feet of lumber. However, a nationwide financial crisis and the depletion of the timber resource brought a significant downturn to the timber industry on the St. Croix River.

Date Event

1803	This part of Minnesota was part of Indiana Territory.
1809	This part of Minnesota became part of Illinois Territory.
1838	Franklin Steele built cabin near what is now St. Croix Falls. Jesse Taylor and Benjamin Baker built cabin near what is now Taylor's Falls.
1839	St. Croix County, Wisconsin was established.
1840	Arcola was platted. Population of St. Croix Falls was 20.
1849	Point Douglas was platted on the western side of the mouth of Lake St. Croix. Named after Stephen D. Douglas.
1849	Lakeland Village was platted.
1850	Scandia was established.
1851	Taylor's Falls was platted.
1852	South Stillwater was platted. Built on part of the former Oak Park site.
1853	Marine Mills was platted.
1855	Afton township was first settled and platted. It was named after the Robert Burns' poem, 'Afton Water' that gives a fine description of the 'neighboring hills, and clear winding rills.'
1857	Oak Park village site platted. Currently in location of Bayport.
1858	Afton Village was incorporated. Taylor's Falls was incorporated, Baytown was founded and later became known as Bayport. It was named after the bay created by Mulvey's Point. Marine Township founded. Lakeland Township is settled and organized Franconia township was organized and platted. Ansel Smith, who came from Franconia, N.H, named the township.
1884	Franconia Village was incorporated.

Growth and Development of Afton

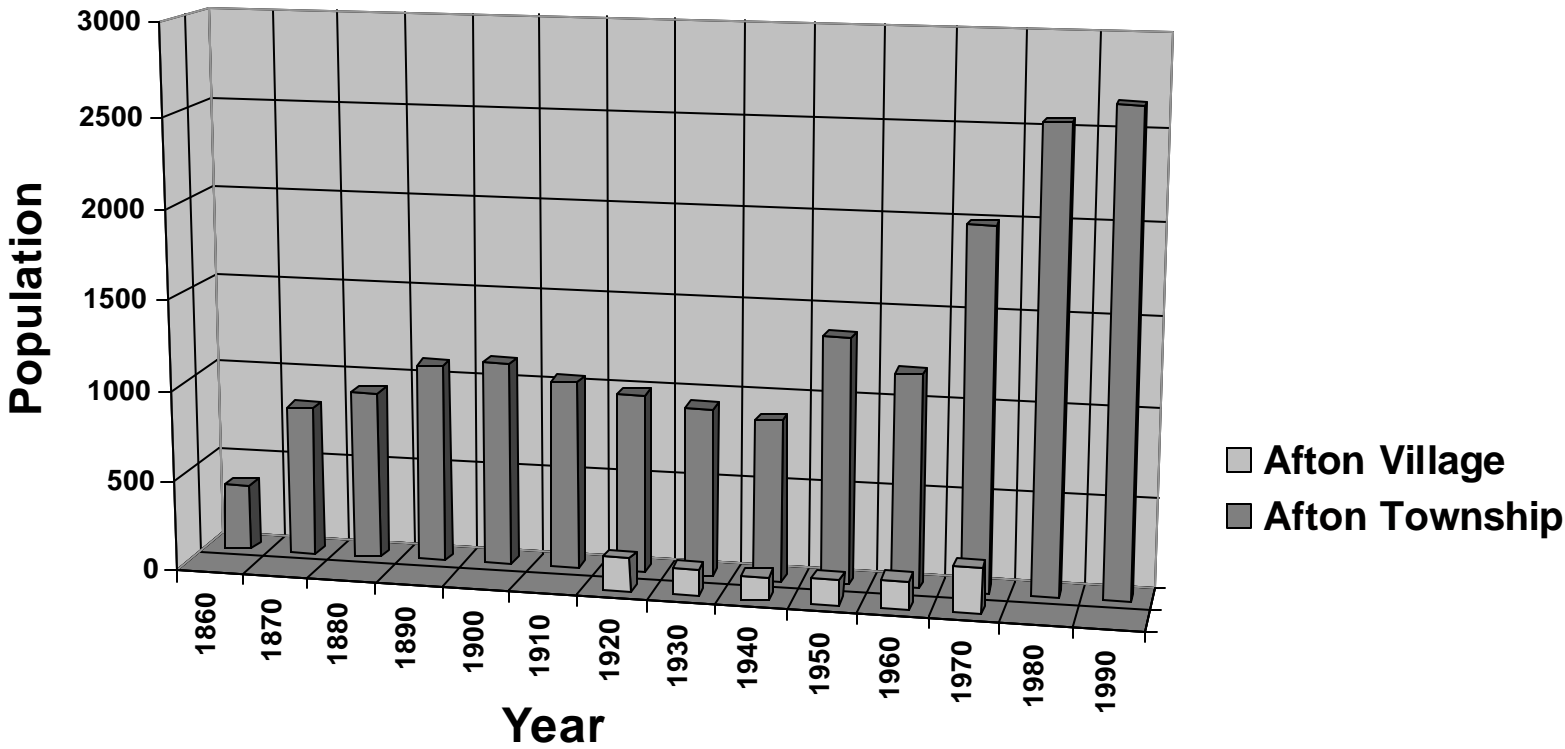
In 1838, following cession of the St. Croix valley by the Dakota and Ojibwe native Americans to the United States, white settlers began to enter the valley. The progression of this settlement pattern in both time and space is evidenced by the following abbreviated timeline of settlement.

Since its founding in 1855, Afton Township, and later the City of Afton, has experienced cyclical patterns of growth. In 1860, the Census of Population enumerated the number of people residing in Afton Township at 360. This number grew steadily during the last half of the nineteenth century, reaching a zenith of 1130 in 1900. The first four decades of the twentieth century saw Afton's population decline to 889 in 1940.

Following World War II the Township's population grew dramatically. In 1960, 1181 people called the township home. By 1970, the population of the township had increased by 69% to 1950. During the 1970's, a 28% increase in population growth occurred and number of the township residents surged to 2550. The leveling-off of population growth continued during the 1980's as the township reached a 1990 population of 2850.

In the 1970's, the Village of Afton and Afton Township incorporated into the City of Afton. This enabled the community to deal more effectively with the benefits and costs of growth and development. A City Building Code was adopted in 1978, and a Zoning Ordinance and Sanitary Sewer Disposal Code were adopted in 1982. A Bluffland and Shoreline Ordinance was passed in 1985, and the city revised its Subdivision Ordinance in 1989. Afton revised its Shoreland Management Ordinance in 1991, and it adopted an Individual Sewage Treatment System Ordinance in 1993 to replace the Sanitary Sewer Disposal Code. A Heritage Preservation Ordinance and revised Floodplain Zoning regulations were adopted in 1994. Finally, in 1998 the City of Afton revised its Comprehensive Plan, reaffirming a desire to retain its status designated by the Metropolitan Council as a Rural Preserve.

Population Trends in Afton Village and Afton Township



Current Land Use in the Valley Branch Watershed

The prehistoric pattern of land cover has changed dramatically in the last 300 years. Prior to the immigration of the Ojibwe into the St. Croix Valley, the upland areas of both the Illinoian and the Wisconsinan landscapes were likely covered with oak savanna and oak openings. The low-lying areas were apparently part of the Big Woods community consisting of Maple, Basswood, Elm and other lowland species. The grassland and Bur Oak communities of the savanna were apparently maintained largely through the fire management efforts of early prehistoric native peoples and subsequently by the Dakota. As the St. Croix became a zone of contention between the Ojibwe and the Dakota, the upland oak savanna and openings began to fill in with brush land, as permanent occupants of the land were no longer present to steward the process of fire succession of the grassland community. Oak forests evolved, similar to the remnant forests found in the contemporary landscape.

Following establishment of Afton in 1855, settlement of the watershed by European cultures ensued, and most of the watershed was in cultivation by 1890. The pattern of cultivation encroached upon the oak savanna community as well as the emerging oak forest. The floodplain bottomlands of Valley Branch and associated hillsides were also brought under cultivation. Rougher portions of the watershed were reserved for woodlots, and these patches undoubtedly contained substantial quantities of oak.

During Afton Township's first 100 years of existence, its population reached a zenith of approximately 1130 in 1900, but it declined to 889 in 1940. During this period, the Village served as a local service center, and most inhabitants of the watershed farmed the land.

Following World War II, and especially in the 1960's, the watershed began to experience a new pressure for land use change. Enhancement of Highway 10 and construction of Interstate 94 at the northern end of the watershed now made it possible for watershed residents to work in St. Paul or Minneapolis. As the political jurisdictions within the watershed organized in the 1970's to manage this growth pressure, zoning and subdivision ordinances were passed that mandated minimum lot sizes of between five acres to less than one acre. The advent of suburban development in the watershed was accompanied by abandonment of agricultural activity on the steeper and wetter soils. Much of the Valley Branch floodplain and its adjacent blufflands reverted to predominately oak forests. Agricultural activity within the watershed became more concentrated with fewer people owning and/or operating larger tracts of land. The concentrated agricultural activity produced a decline in the number of working farmsteads, and some have been abandoned entirely.

The land use pattern that exists today (see map entitled "Existing Land Cover, 1994") reflects yet another transitional point in time. From an original cover of oak savanna uplands and Big Wood bottomlands, land use in the watershed has transitioned into first an agricultural matrix in both the uplands and the bottomlands. More recently, the bottomlands and blufflands have become reforested, and an agricultural matrix containing interspersed patches of suburban development characterizes the uplands.

Critical Wildlife Habitats

Significant transformations in wildlife habitat quality and diversity have accompanied the land use transitions that have occurred in the Valley Branch watershed over last 300 years. Species of the upland oak savanna community have been extirpated as this habitat was removed from the landscape matrix. Similarly, transformations of the bottomland and bluffland forest communities have altered habitat conditions for neo-tropical forest-interior dwelling songbirds. The St. Croix Valley is especially important to this avian guild, as many of its constituent species breed in the large forest expanses of the upper reaches of the St. Croix watershed (Probst et al. 1993). These birds use the St. Croix and Mississippi River valleys as migratory flyways between their breeding grounds and their tropical and sub-tropical over-wintering habitats in the Caribbean. Waterfowl and colonial shorebirds are also impacted by development, which encroaches upon key wetland habitat in the northern portions of the watershed. Finally, the Minnesota Department of Natural Resources recognizes Valley Branch as one of the prime trout habitats in the Twin Cities Metropolitan Area. The Valley Branch Watershed District has established the retention of a naturally reproducing population of brown trout in stream as one of its key management objectives. The spatial extents of these important habitats are located on the map entitled "Forest, Wetland and Trout Habitat".

Existing Pattern of Cultural Settlement

The existing pattern of cultural settlement within the Valley Branch watershed reflects the various eras of land use development in the watershed. The late nineteenth century agricultural era of development is reflected in the political subdivision of the watershed, the transportation infrastructure and pattern of farmstead distribution. Three political subdivisions, the Cities of Afton and Woodbury, respectively, and West Lakeland Township, have jurisdiction over land within the watershed. The Public Land Survey System created by the Land Ordinance Act of

1785 determined the shape of these subdivisions. Their boundaries correspond with township lines surveyed in the watershed in the late 1840's. Similarly, most of the transportation infrastructure within the watershed corresponds to the section roads constructed as a mandate of

the Ordinance Act to facilitate access and egress of settlers to their land and to markets. Farm size within Washington County up until 1950 approximated the 160-acre ideal established as a quarter section of land by the Ordinance Survey. This is reflected in the current distribution of farmsteads throughout the watershed.

The early period of suburban development is reflected in a subdivision located just east of Manning Trail near the northern boundary of the watershed. As is evident on the map entitled "Existing Cultural Settlement Pattern" and on the map entitled "Land Parcel Size and Development Prospect," development density within this subdivision is between one dwelling unit per acre and one dwelling unit per three acres. This development represents a period in time during the 1960's and 1970's before the City of Afton had established its current Rural Residential District density of one dwelling unit per five acres. The current policy is reflected in the configuration of the subdivisions located along the southeastern boundary of the watershed.

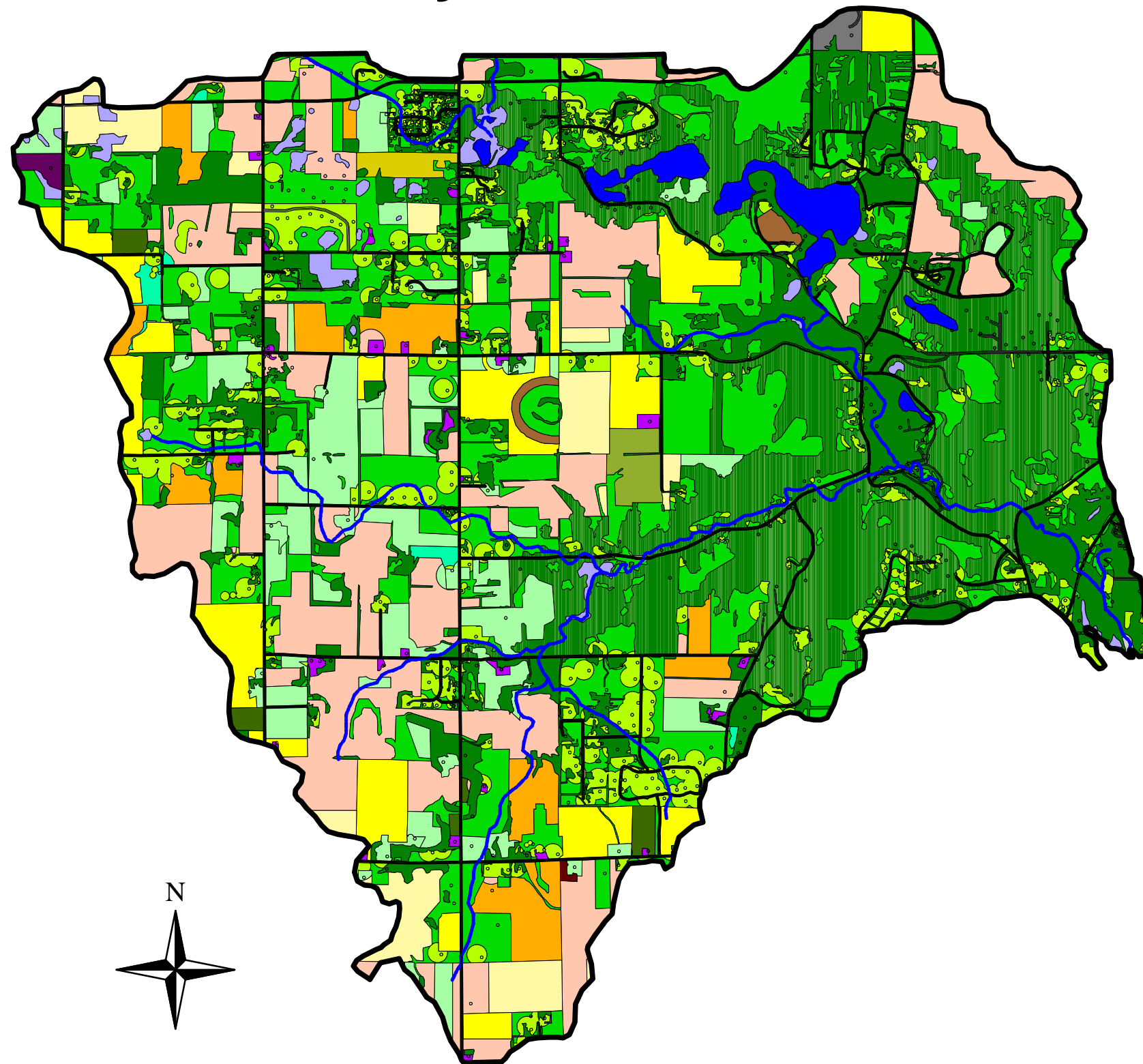
Existing Pattern of Land Ownership

The map entitled "Land Parcel Size and Development Prospect" illustrates that a large majority of the land parcels within the watershed remain in holdings that exceed 20 acres in size. Assuming the presence of willing land sellers, it is likely that future development in the watershed will occur on the parcels larger than 20 acres. The economies of scale afforded to developers seeking to purchase land for development purposes are greater on larger parcels of land. Parcels under 20 acres in size, and especially those under 10 acres, can be considered as being already committed to development.

Some of the parcels exceeding 20 acres in size are in an ownership status that will most likely preclude exercising development options in the near future. For example, the Science Museum of Minnesota owns approximately 127 acres just west of Lake Edith. It is unlikely that this land will be available in the near future for development. Similarly, the State of Minnesota has numerous land holdings throughout the watershed. Land holdings having an ownership status that is unlikely to result in development in the near future are identified on the "Land Parcel Size and Development Prospect" map via a blue stippled pattern.

Existing Land Cover, 1994

Valley Branch Watershed - Washington County, MN

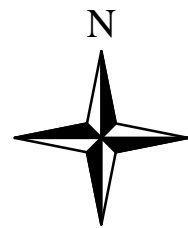


Legend

 Roads

 Drainage

-  Beans, row, cons. till
-  Beans, row, conv. till
-  Beans, row, no till
-  Corn, contour, cov. till
-  Corn, row, cons. till
-  Corn, row, conv. till
-  Hay
-  Pasture
-  Feedlot
-  Sod farm
-  Grassland
-  Farmstead
-  Tree farm
-  Forest
-  Gravel pit
-  Sand pit
-  Water bodies
-  Wetlands
-  Interchange grasses
-  Lawn
-  Hobby farm
-  Trailer park
-  Impervious surface



Geographic Information Systems
Department of Landscape Architecture
University of Minnesota

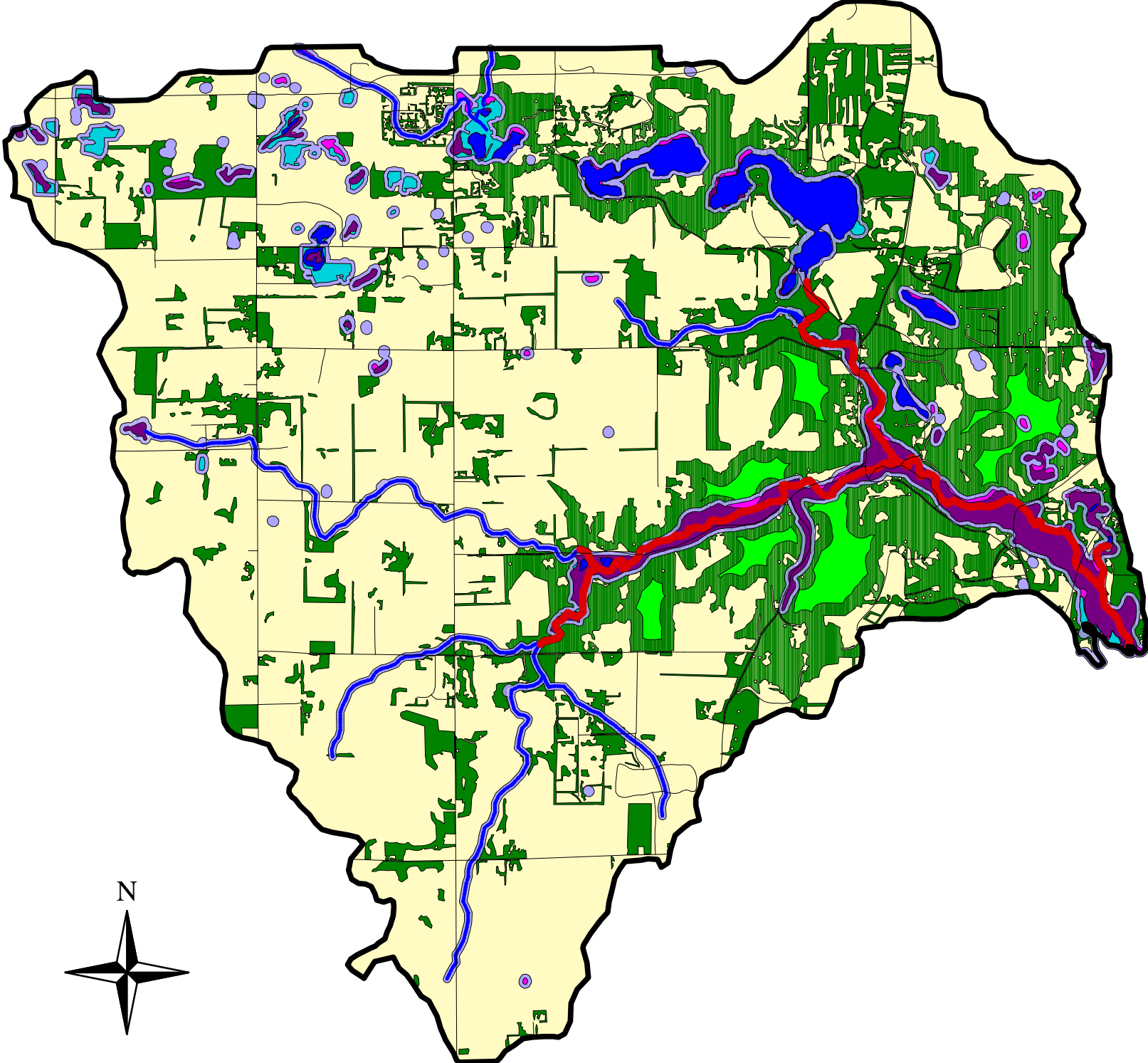


Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.



Forest, Wetland and Trout Habitat

Valley Branch Watershed - Washington County, MN



Legend

- Roads
- Drainage
- Trout habitat
- Water bodies
- Existing wetlands
- Lacustrine NWI sites
- Palustrine NWI sites
- Floodplain areas
- Wet area or drainage with 30 meter buffer
- Existing forest within 100 meters of forest edge
- Forest interior core greater than 100 meters from forest edge
- Not critical forest, wetland or trout habitat



Cultural Settlement Pattern, 1994

Valley Branch Watershed - Washington County, MN







Legend

-  Drainage
-  Water bodies
-  Structure

Transportation Network

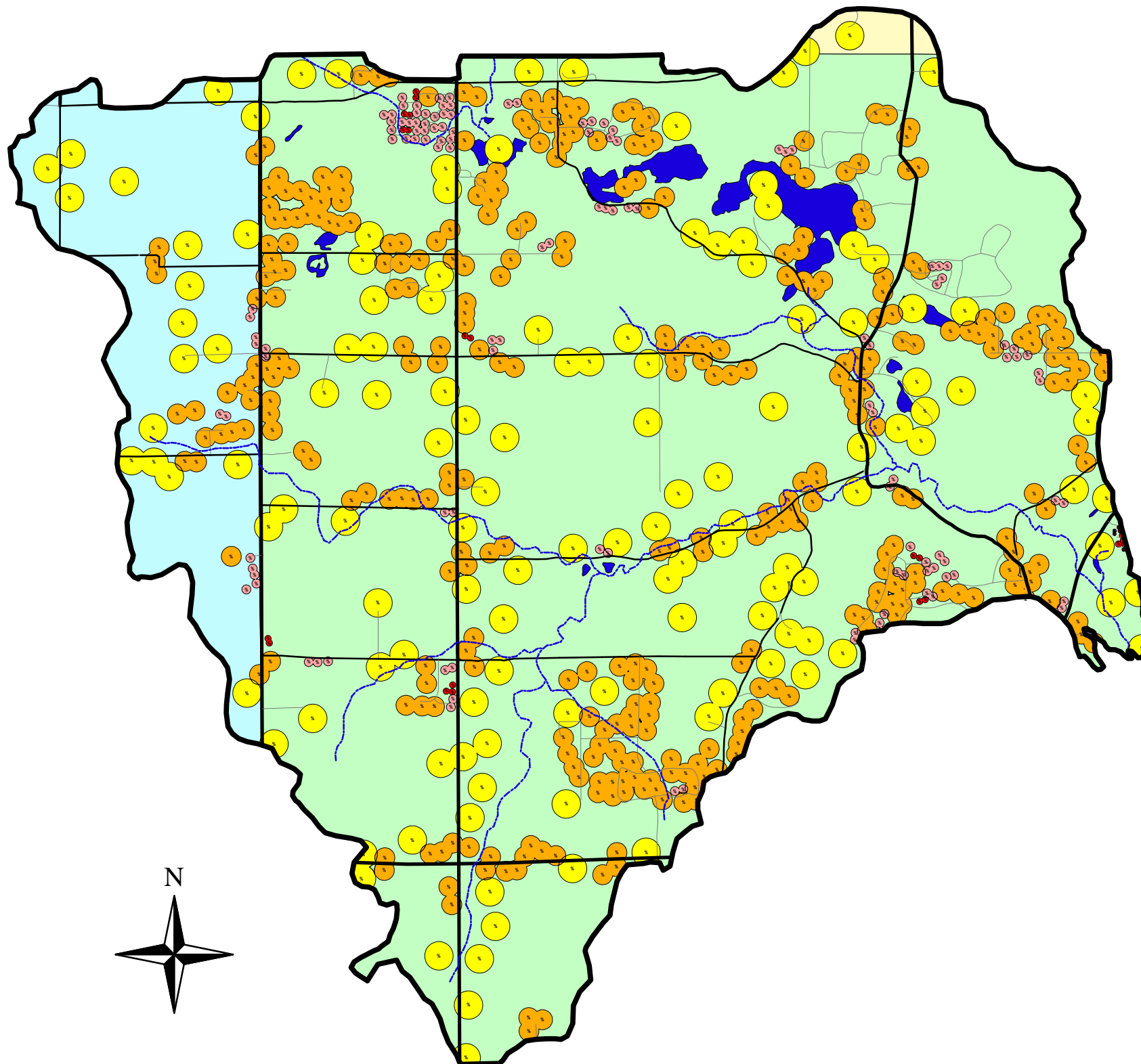
-  State or county highway
-  Township collector road
-  Township or private local access road

Approximate Density of Development

-  One-eighth acre per dwelling unit
-  One-quarter acre per dwelling unit
-  One-half acre per dwelling unit
-  One acre per dwelling unit
-  Five acres per dwelling unit
-  Ten acres or more per dwelling unit

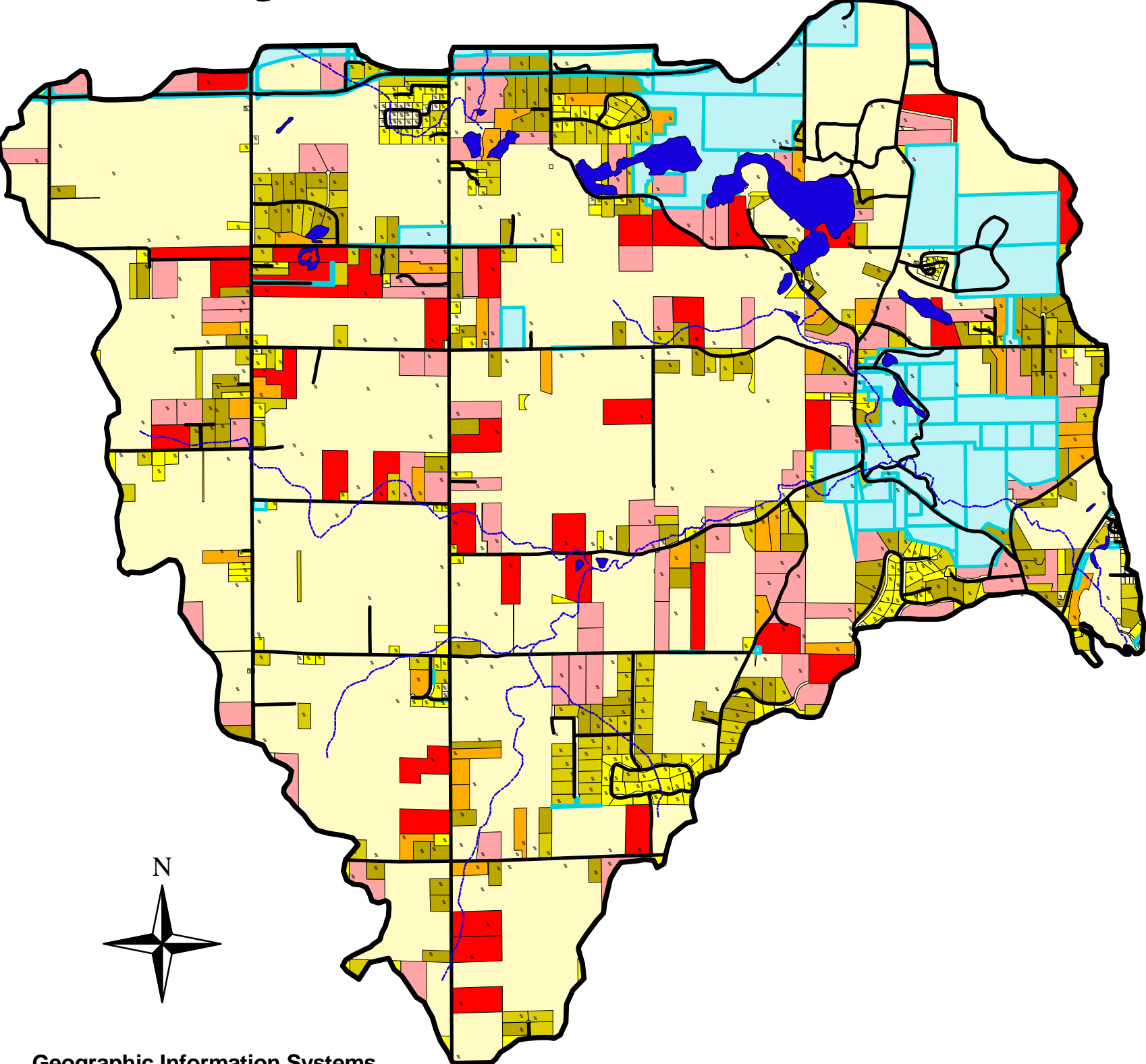
Political Jurisdictions

-  City of Afton
-  West Lakeland Township
-  City of Woodbury



Land Parcel Size and Development Prospect

Valley Branch Watershed - Washington County, MN



Legend

- Structure
- Roads
- Drainage
- Water bodies
- 1 acre or less
- 2 to 3 acres
- 3 to 5 acres
- 5 to 7 acres
- 7 to 10 acres
- 10 to 15 acres
- 15 to 20 acres
- Greater than 20 acres
- Parcels in ownership status unlikely to lead to development

EXISTING PUBLIC POLICY TOWARD LAND DEVELOPMENT IN THE WATERSHED

Existing Zoning Plans

The map entitled "Existing Zoning Plans" displays the current zoning plans for the three political jurisdictions within the Valley Branch watershed. The portion of West Lakeland Township contained within the watershed is currently zoned for residential development at a density of 2-1/2 acres per dwelling unit.

As of the preparation of the atlas, the City of Woodbury was considering adoption of a revised comprehensive land use plan. If adopted, this plan would provide a mixture of land uses and residential densities for that portion of the city contained within the watershed. The plan also calls for a system of development rights transfers that encourages developers to maintain a greenway plan throughout this area. The section of land on the western side of Manning Trail near I-94 will be zoned for retail commercial and commercial office space uses. In the far northwestern corner of the watershed, Woodbury's plan would establish a high-density residential district having a targeted gross density of 12 dwelling units per acre. Immediately to the south of the commercial districts, Woodbury's plan would establish a mixed residential district. This area would contain a mixture of detached and attached single family homes at a targeted gross density of three dwelling units per acre. Developers of land within this district who agree to keep the designated greenways free of development and who agree to build a mixture of attached and detached housing units will be able to increase densities on land actually developed up to 5.5 dwelling units per acre. Similarly, developers of land within the commercial district would be allowed to transfer development rights that would otherwise be exercised in the designated greenways onto adjacent commercial land holdings if they agree not to develop the commercial greenways.

The Metropolitan Council designated that portion of the watershed contained within Afton as part of the Rural Preserve on the Metropolitan Area's East Side. The Council encouraged Afton to main a gross density within this area of one dwelling unit per ten acres. Afton's response was to adopt a land use plan that permits densities of five acres per dwelling unit in Rural Residential Districts of the watershed, three dwelling units

per 40 acres of land in Agriculture Districts and one dwelling unit per 40 acres in Agricultural Preservation Districts. The overall intent of Afton's plan is to comply with the Metropolitan Council's preferred policy. Landowners within the Agricultural Land Preservation Districts have voluntarily enrolled their land in a preserve for an eight-year period of time. During this period, owners are prohibited by easement stipulations from developing their holdings at densities exceeding the prescribed density of one dwelling unit per forty acres. Upon termination of the easement's contract period, owners may apply for rezoning to the Agricultural District density (i.e. three dwelling units per 40 acres). The Afton City Council has generally granted such requests. The Existing Zoning Plan map illustrates the spatial extent of these zoning districts.

Undevelopable Land Under Existing Public Policy

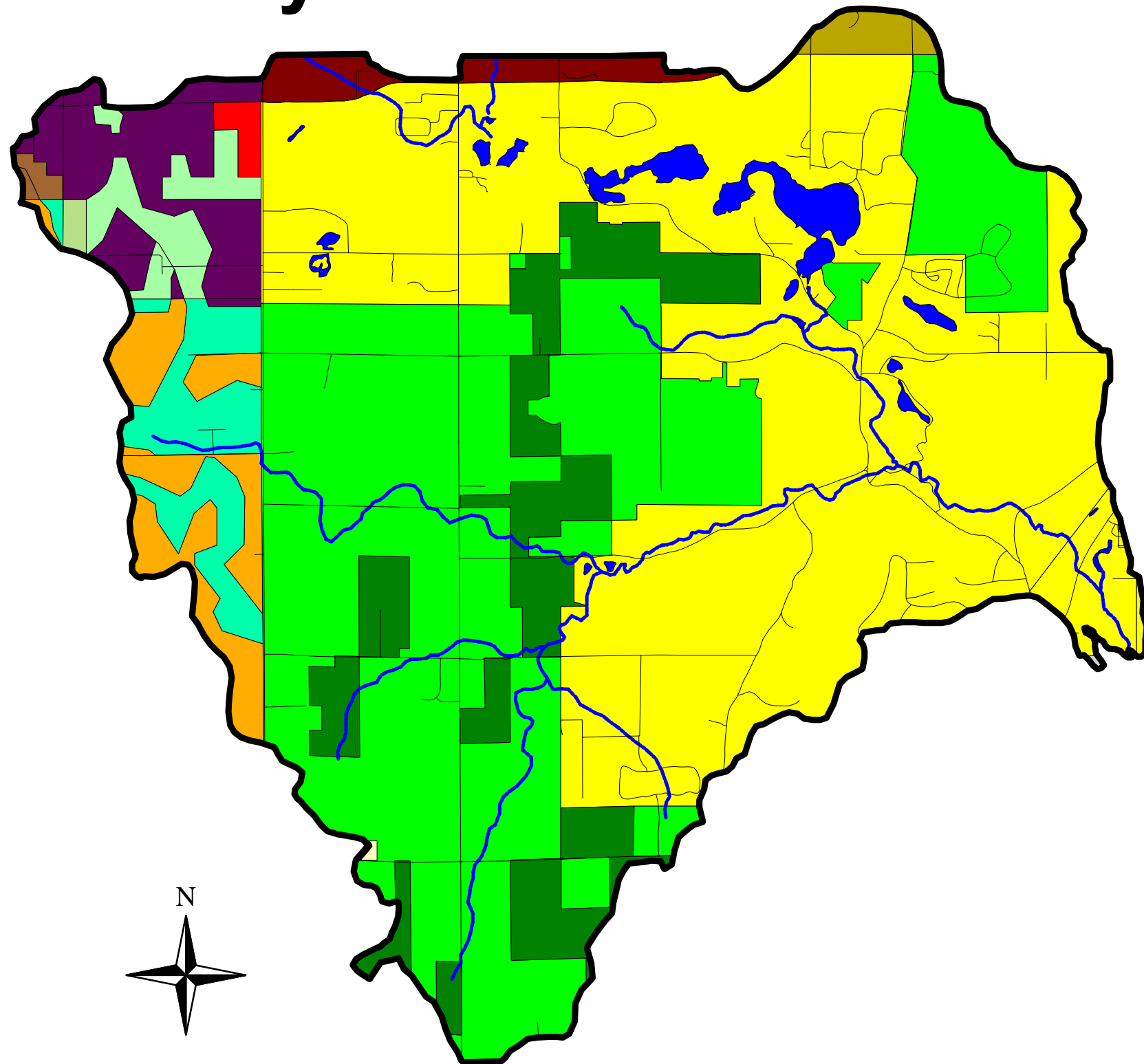
The largest single political jurisdiction within the Valley Branch watershed is the City of Afton. The policies of this jurisdiction were therefore used as a basis for determining land that may be developed under existing public policy. In addition to its Euclidean zoning districts wherein certain land uses and densities are prescribed by zoning regulation, Afton also has a series of "overlay districts" within its zoning ordinance. The regulations of an overlay district become applicable whenever, land meeting a set of defined criteria is proposed for development. The overlay districts address the following issues:

- **Slopes.** The Afton Zoning Ordinance specifies that development occurring in accordance with allowable densities within Agricultural Districts or in Agricultural Preservation Districts must occur on slopes of 13% or less. Development on slopes exceeding 12% requires approval from the Washington County Soil and Water Conservation District. For purposes of defining slopes capable of being developed in this atlas, a criterion of 12% was used. This criterion will likely subsume another requirement that development be setback a minimum of 40 feet from point on a hillside where the slope begins to exceed 18%.







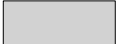



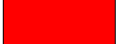





- **Shoreland and Riparian Setbacks.** The Shoreland Zoning Ordinance requires a minimum building setback of 200 feet from the ordinary high water mark of all Natural Environment and Recreational Lakes as well as all trout streams.
- **Wetlands.** Alteration of public water areas in Afton require public water use permits from the Minnesota Department of Natural Resources and the US Army Corps of Engineers and a grading permit from the city. For purposes of defining land that cannot be developed, it was assumed that wetlands would not be disturbed.
- **Floodplains.** New single family homes may be constructed within the 100-year floodplain if their finished floor elevations are above the specified flood elevation and if they are properly flood proofed. However, for purposes of defining land capable of being developed, it was assumed that floodplains would not be disturbed by future development.

Existing Zoning Plans

Valley Branch Watershed - Washington County, MN

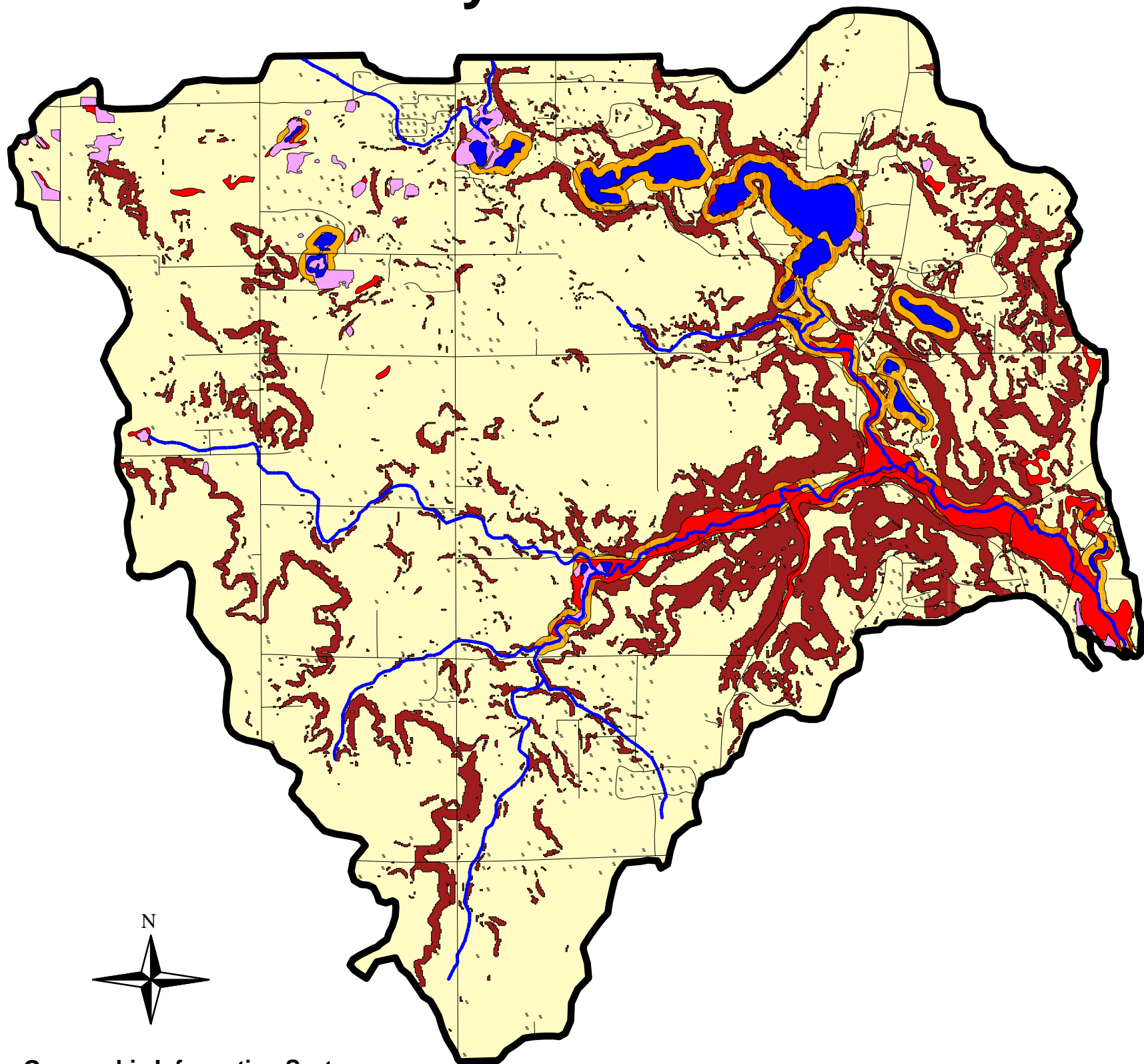


Legend

-  Roads
-  Drainage
-  Water bodies
-  Afton agriculture preserve
-  Afton agriculture
-  Afton industrial
-  Afton residential
-  Afton rural residential
-  West Lakeland - two acre residential
-  Woodbury - commercial greenway
-  Woodbury - commercial shop
-  Woodbury - commercial work
-  Woodbury - high density residential
-  Woodbury - high density residential greenway
-  Woodbury - mixed residential
-  Woodbury - mixed residential greenway

Undevelopable Land Under Existing Public Policy

Valley Branch Watershed - Washington County, MN



Legend

-  Roads
-  Drainage
-  Water bodies
-  Undevelopable wetlands
-  Undevelopable floodplain soils
-  Undevelopable 200 foot lake and stream buffer
-  Undevelopable slopes

Geographic Information Systems
Department of Landscape Architecture
University of Minnesota



Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.



VALLEY BRANCH WATERSHED: POSSIBLE FUTURE URBANIZATION PATTERNS

Major components of the **Watershed Science in the Field** objective involved the modeling of hydrologic and water quality implications of alternative patterns of urbanization within the Valley Branch watershed. This portion of the atlas describes the procedures used in developing the alternative urbanization scenarios, and it presents maps illustrating the scenarios.

The development of the urbanization scenarios proceeded at two geographic scales. A series of watershed-wide development policies were conceived to guide urbanization throughout the watershed. Following implementation of these smaller scale policies, a series of larger scale site design policies were created to simulate alternative patterns of neighborhood development within each of the watershed development strategies.

Watershed Development Scenarios

Two broad policy scenarios were created to characterize overall development patterns within the watershed. One scenario simulated a development pattern that might emanate from an extension or build-out of existing public policies for land development. The second scenario took a very deliberate approach to defining where in watershed development would make most sense.

Extension of Existing Public Policies

In developing a scenario that extends existing public policy for development, the overlay district restrictions on development were presumed to continue into the future. Similarly, the definition of land possessing development potential based on land ownership was presumed to remain constant. Land in a protected ownership status was presumed to not become available for development in the future, and land parcels of less than 20 acres were presumed to be already committed to development. Thus, the land parcels greater than 20 acres in size that were not constrained by any of the overlay development criteria were all presumed to be available for development. The pattern of these parcels within the watershed is illustrated in the map entitled "Land Development Potential."

Green Infrastructure Plan for Watershed Development

In creating a deliberate approach to defining where development might be most appropriately located within the watershed, consideration was given to the following criteria:

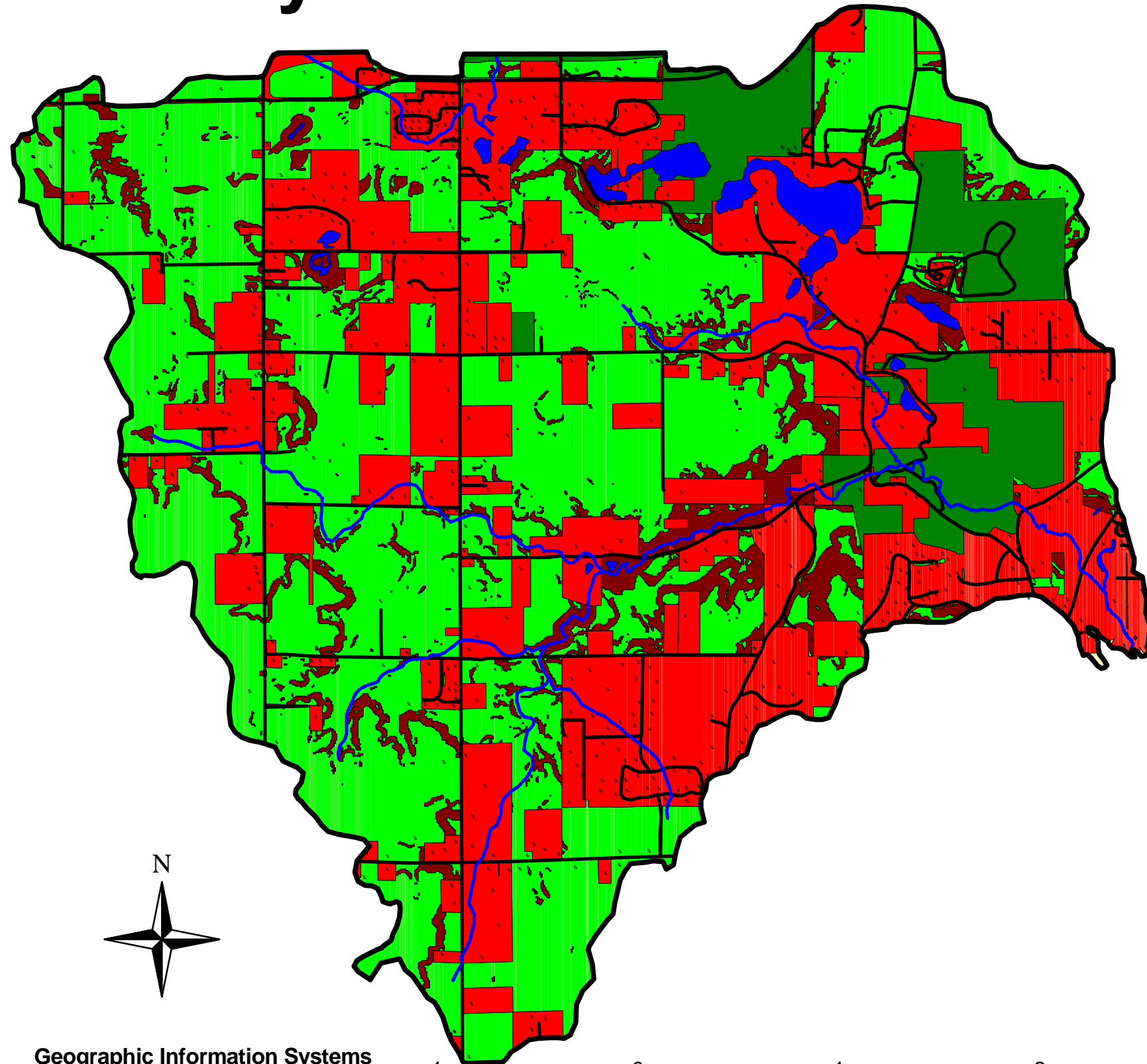
- **Protecting and enhancing the critical habitats** identified on the map of forest, wetland and trout habitat.
- **Protecting ground water quality** within the watershed. Areas of high potential susceptibility for ground water contamination were identified in two phases:
 - Geologic formations having high potential for ground water contamination susceptibility were identified by combining information about bedrock transmissivity with the depth to bedrock map and information pertaining to the permeability of the surface geologic formations overlying the bedrock formations. The location of these formations is illustrated in the map entitled "High Consolidated Aquifer Contamination Potential."
 - Soil formations having high potential for ground water contamination susceptibility were identified by combining the map of Soil Infiltration Capacity with the map of Soil Permeability. The location of these soils is illustrated in the map entitled "Soil Moisture Contamination Potential."
 - A composite assessment of ground water contamination susceptibility potential was defined by combining the geologic formation susceptibility map with the soil formation susceptibility map. The composite contamination susceptibility is illustrated in the map entitled "High Soil or Geologic Threat to Consolidated Aquifer Contamination."

- **Protecting surface water quality** within the watershed. Areas of high potential susceptibility for surface water quality contamination were identified as being within 30 meters of existing water bodies, existing wetlands, National Wetland Inventory sites, and floodplain soils. Areas containing highly erodible soils or steep slopes were also identified as potential sources of surface water quality contamination.
- **Taking maximum advantage of the intrinsic suitabilities** of the landscape to accommodate development. The product of this analysis is reflected in the map entitled "Development Suitability." The analysis focused on identifying:
 - Attractors for development including proximity to existing transportation and development infrastructure and soil suitability for on-site septic system disposal systems. The maps entitled "Development Suitability: Transportation Access" and "Development Suitability: Attractors" illustrate these issues.
 - Detractors for development including agricultural preservation districts, floodplain soils, areas within 30 meters of wetlands, riparian areas or other surface water bodies, critical core forest interior habitat, undevelopable slopes and soils having severe limitations for septic systems. The map entitled "Development Suitability: Detractors" illustrates these constraints.

The Green Infrastructure Watershed Development Scenario presents a strategy for watershed development that attempts to optimize habitat enhancement, ground and surface water quality protection and intrinsic development suitability. The plan identifies nodes wherein higher density development would be concentrated, an agricultural reserve and an environmental infrastructure corridor. The corridor and agricultural reserve focus on stewarding the environmental resources of the watershed's riparian systems and using these resources in the making of new urban fabric within the watershed. The map entitled "Green Infrastructure Watershed Development Scenario" illustrates the Green Infrastructure Plan for the watershed.

Land Development Potential

Valley Branch Watershed - Washington County, MN

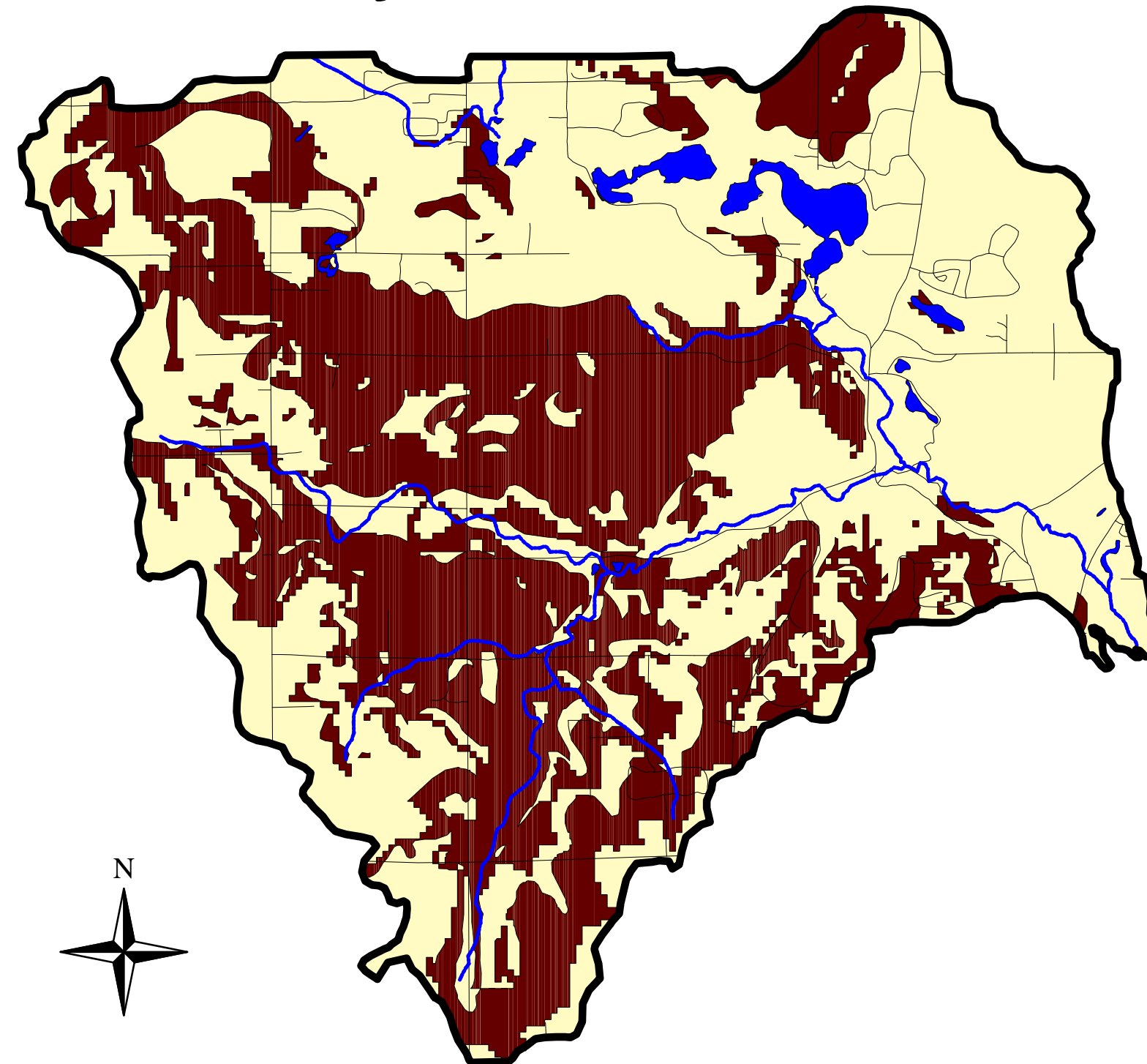


Legend





- Structure
- Drainage
- Road
- Water bodies
- Already developed
- Undeveloped but protected
- Undeveloped and undevelopable
- Undeveloped, not protected but developable

High Consolidated Aquifer Contamination Potential

Valley Branch Watershed - Washington County, MN

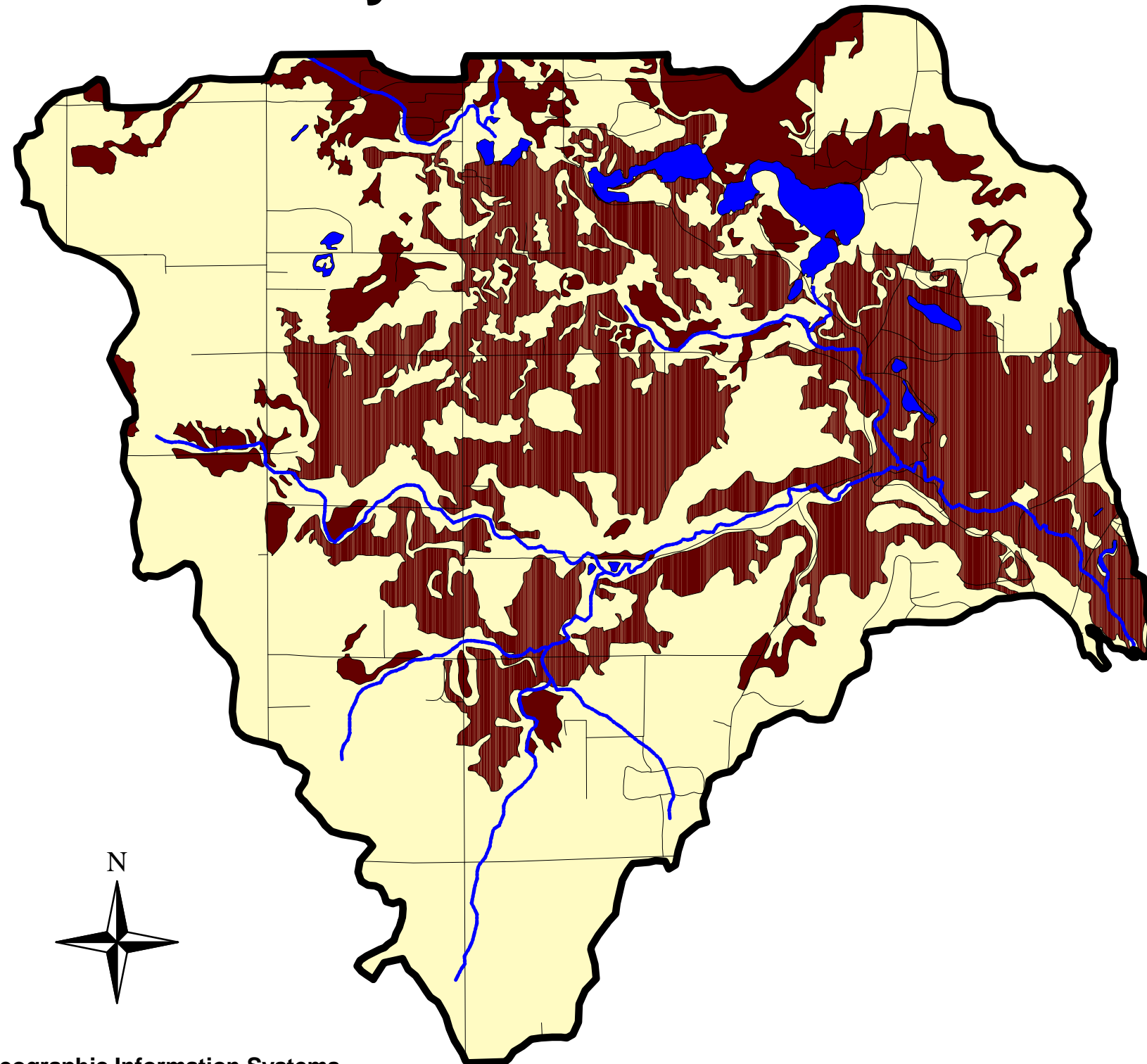


Legend





-  Roads
-  Drainage
-  Water bodies
-  High consolidated aquifer contamination potential

High Soil Moisture Contamination Potential

Valley Branch Watershed - Washington County, MN

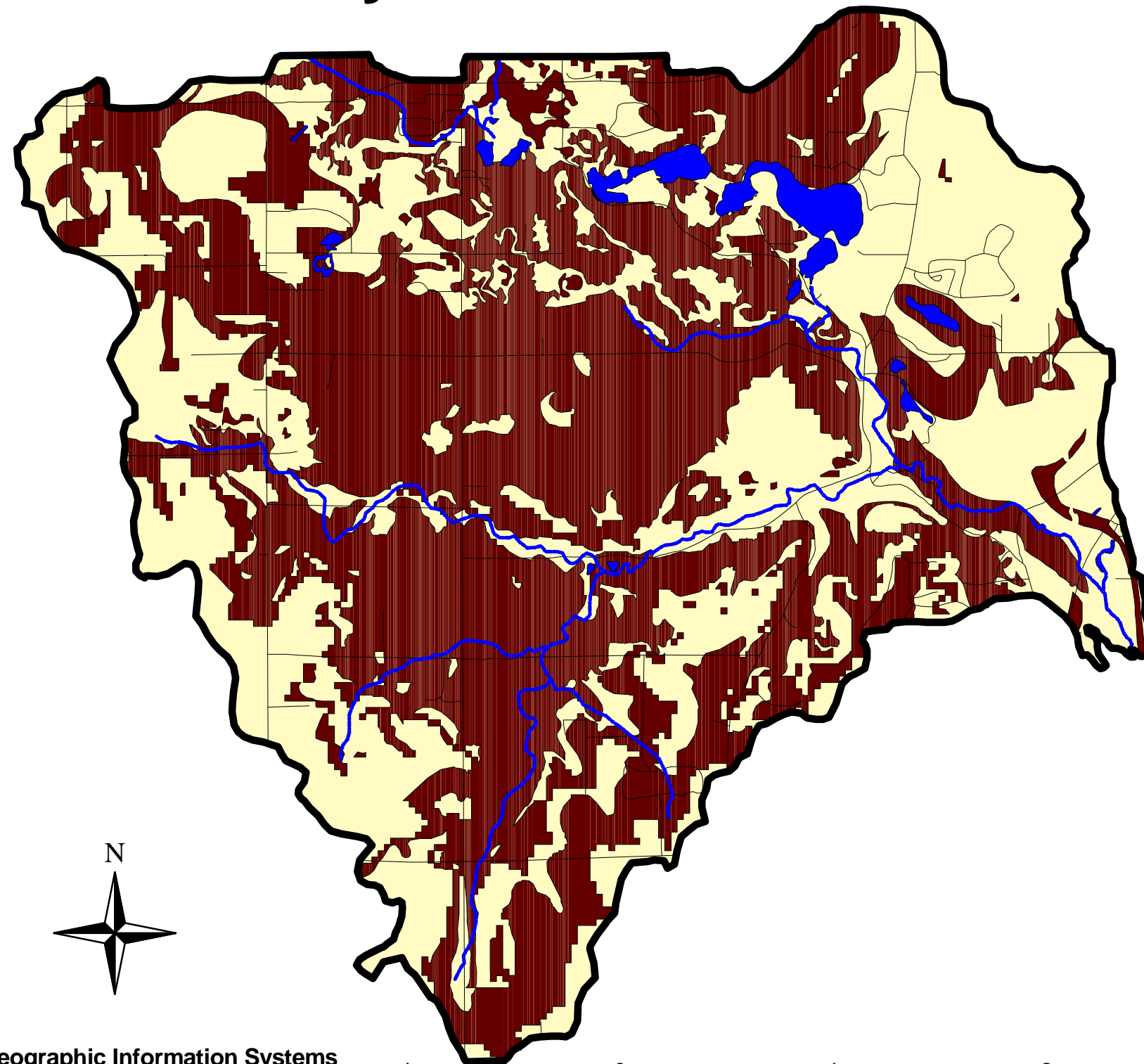


Legend





-  Roads
-  Drainage
-  Water bodies
-  High soil moisture contamination potential

High Soil or Geologic Threat to Consolidated Aquifer Contamination

Valley Branch Watershed - Washington County, MN

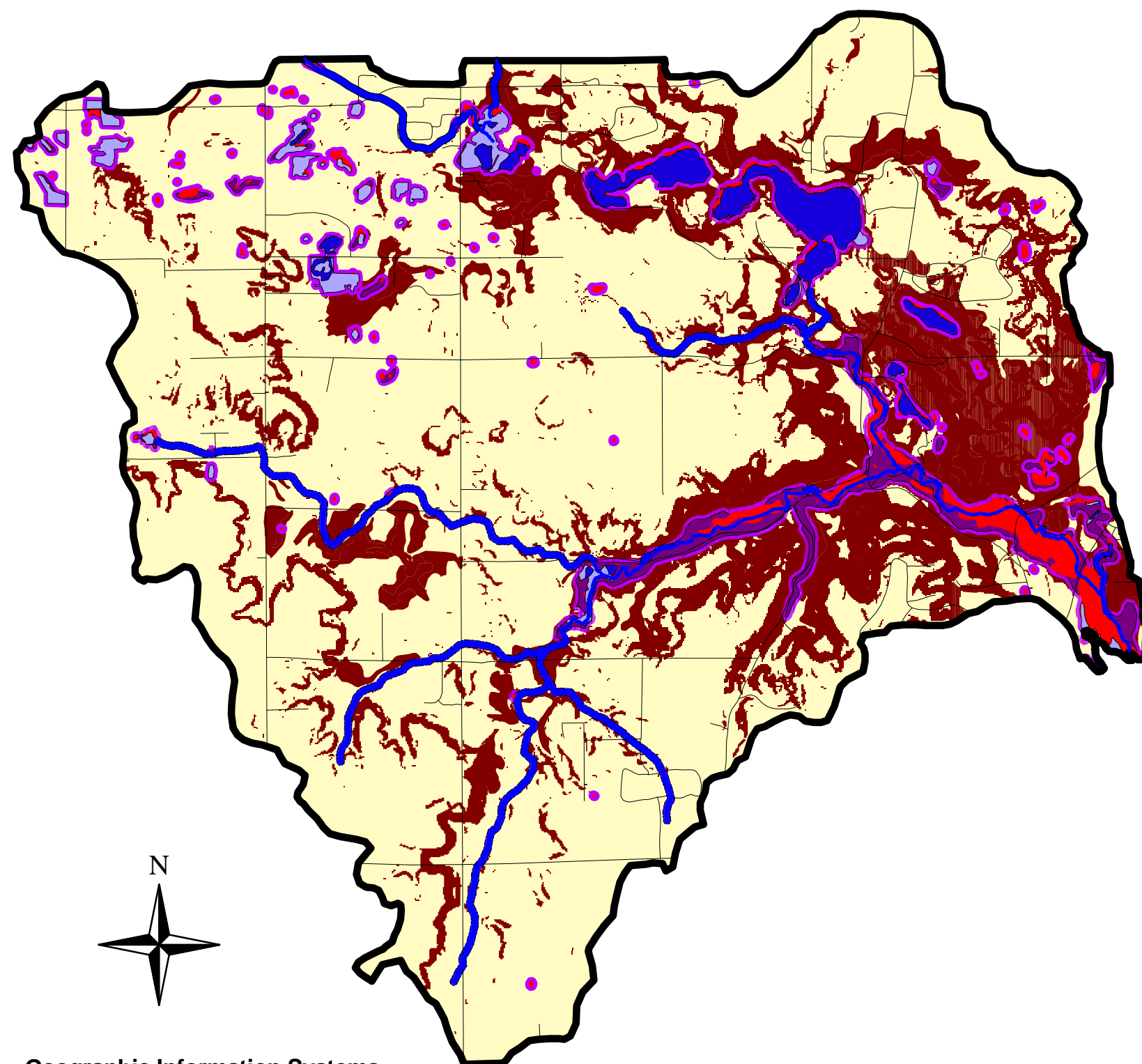


Legend

-  Roads
-  Drainage
-  Water bodies
-  High soil or geologic threat to consolidated aquifer contamination

Potential Surface Water Quality Contamination

Valley Branch Watershed - Washington County, MN

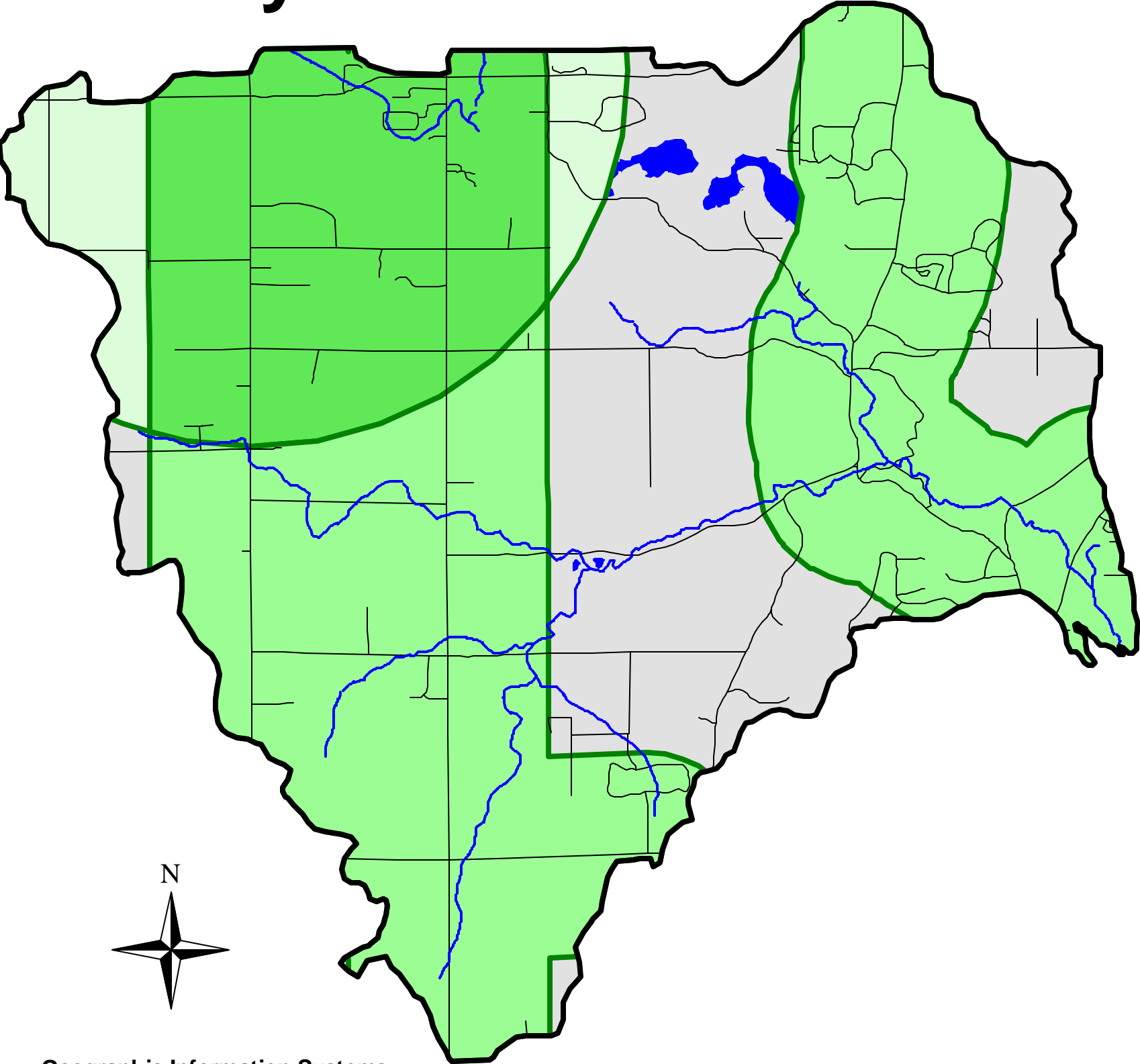


Legend

- Roads
- Drainage
- Water bodies
- Wetlands
- National Wetlands Inventory Site
- Floodplain soils
- Drainage with 30 meter buffer
- Wet area or drainage with 30 meter buffer
- Highly erosive or steeply sloped soils

Development Suitability: Transportation Access




Valley Branch Watershed - Washington County, MN



Legend

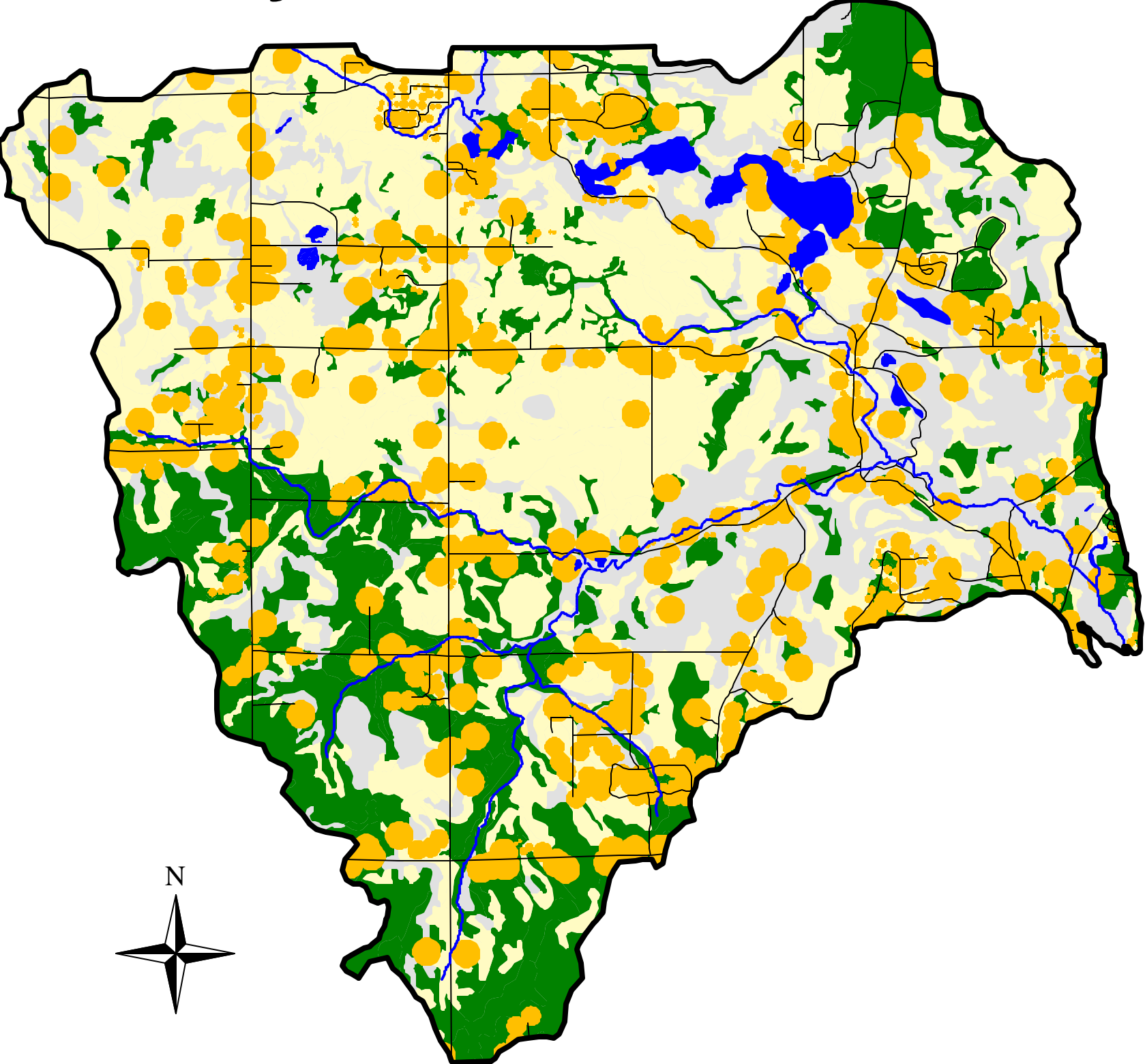
-  Roads
-  Drainage
-  Water bodies

Proximity to Existing Transportation

-  Within 2 miles of I-94 interchange
-  Within half mile of state/county road
-  Within 2 miles of I-94 interchange and half mile of state/county road

Development Suitability: Attractors

Valley Branch Watershed - Washington County, MN



Legend

-  Roads
-  Drainage
-  Water bodies

Attractors for Development

-  Existing Development
-  Moderate soil limitations for septic systems
-  Slight soil limitations for septic systems

Geographic Information Systems
Department of Landscape Architecture
University of Minnesota

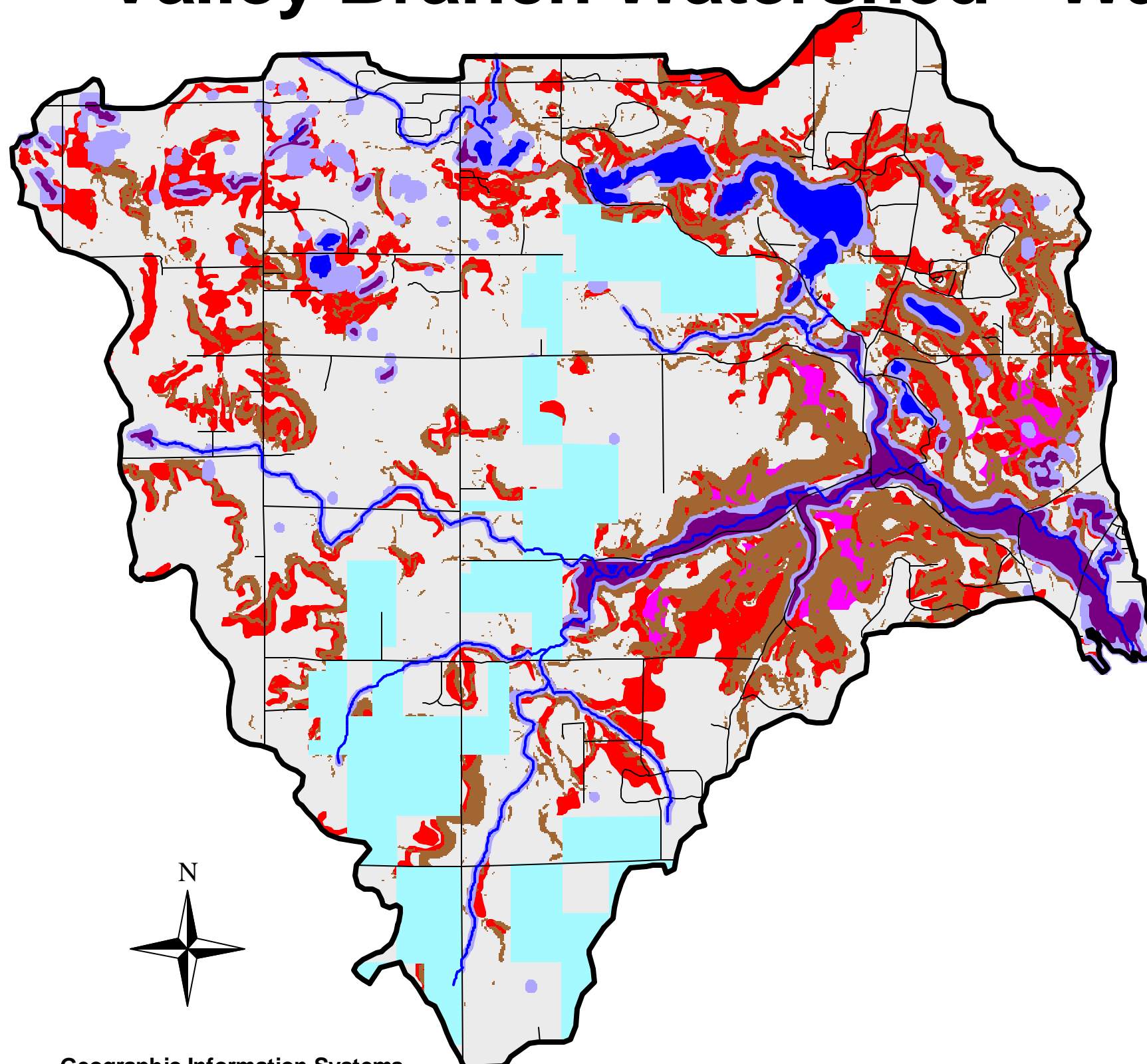


Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.



Development Suitability: Detractors







Valley Branch Watershed - Washington County, MN



Legend

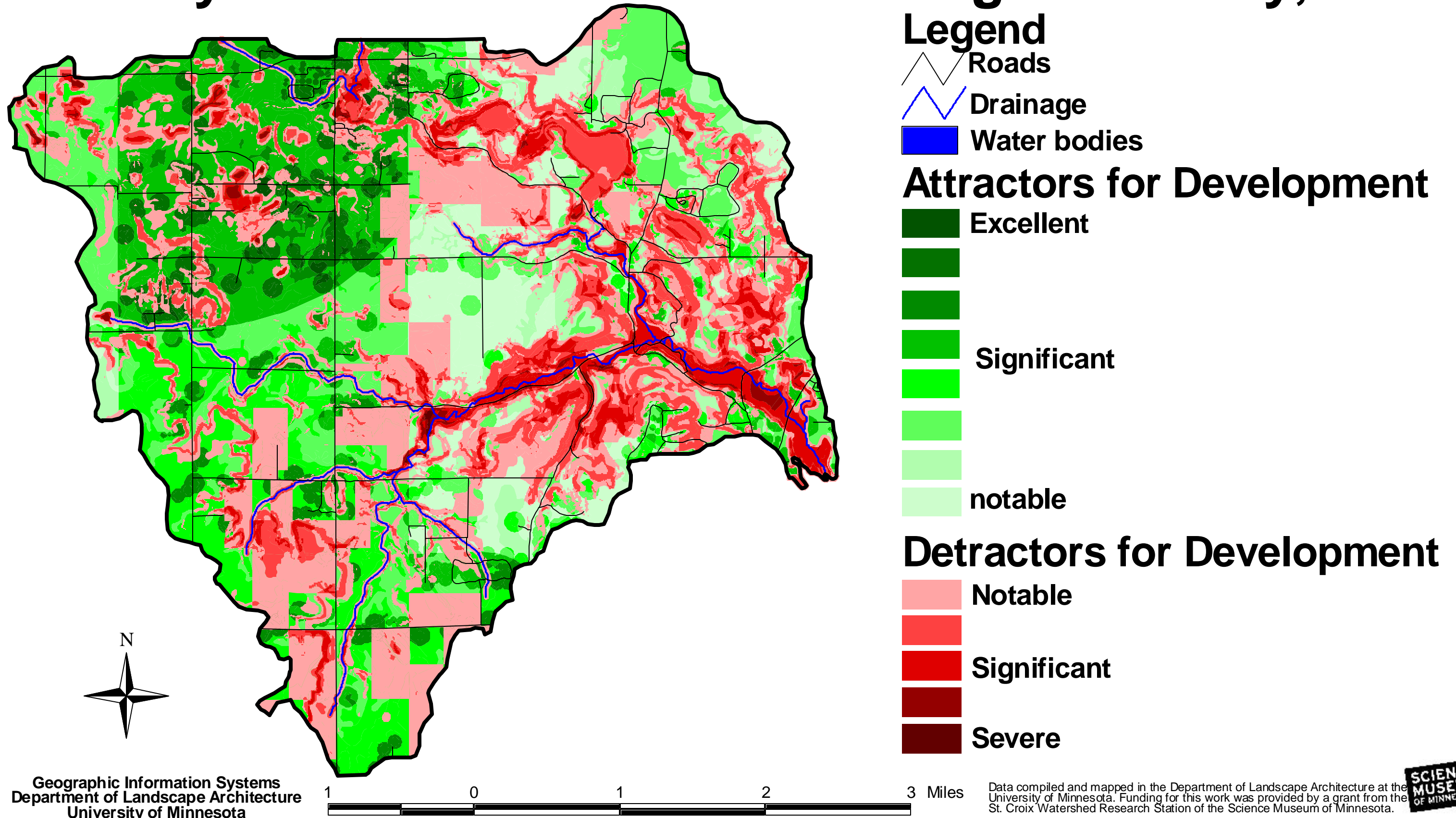
-  Roads
-  Drainage
-  Water bodies

Detractors for Development

-  Agr. preservation district
-  Floodplain soils
-  Wet area or drainage with 30 meter buffer
-  Critical core forest habitat
-  Slopes exceeding 12%
-  Severe soil limitations for septic systems

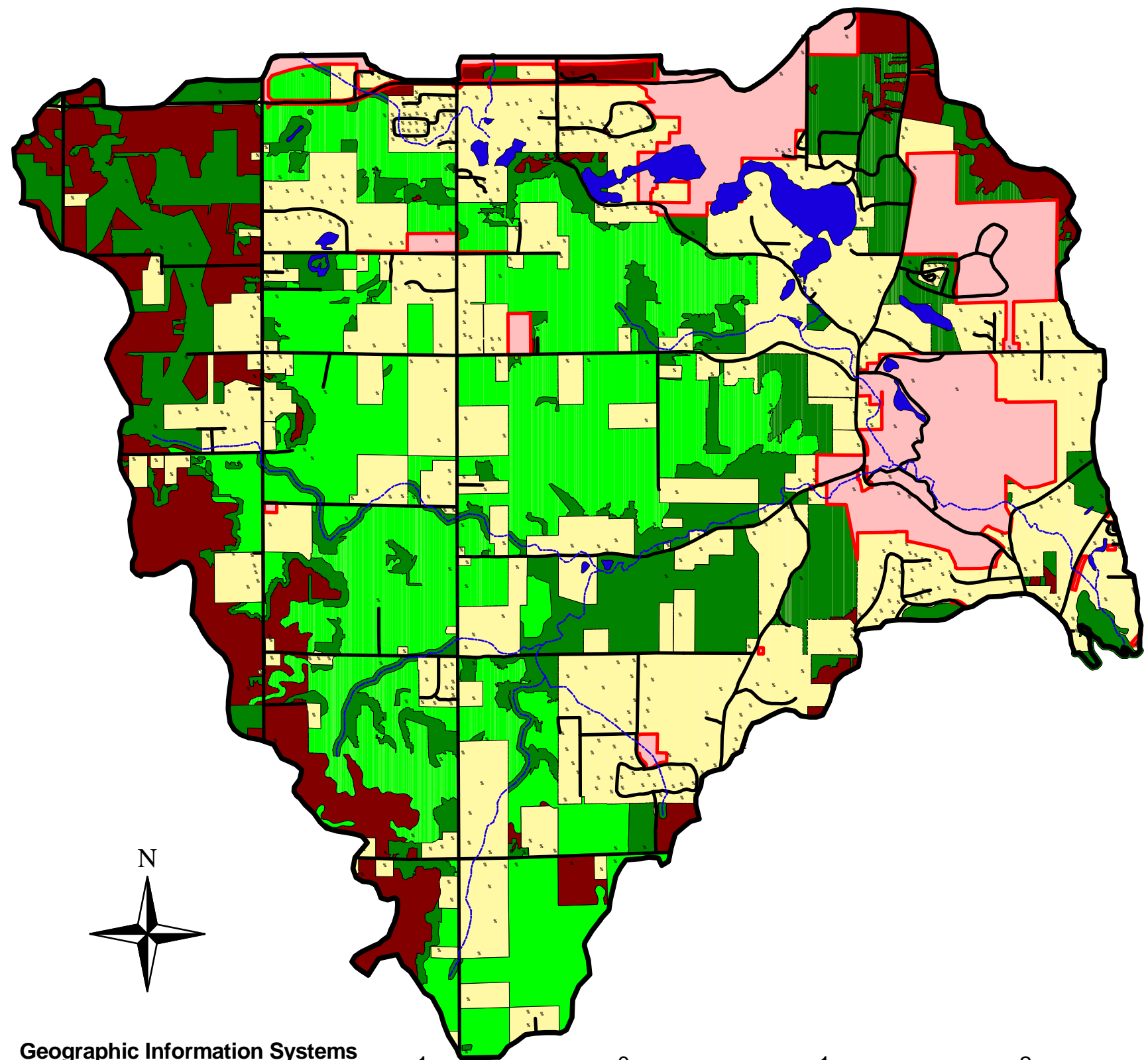
Development Suitability

Valley Branch Watershed - Washington County, MN



Green Infrastructure Watershed Development Scenario

Valley Branch Watershed - Washington County, MN



Legend

- Structure
- Drainage
- Roads
- Water bodies
- Land that is already developed
- Development node with gross development density of three dwelling units per acre
- Protected land to remain undeveloped
- Agriculture with Best Management Practices and Gross Development Density of one dwelling unit per 40 acres
- Green infrastructure corridor with gross development density of three dwelling units per 40 acres

Neighborhood Development Scenarios

The Valley Branch watershed has a somewhat contradictory set of policies regarding neighborhood development patterns. The contradictions center on Manning Trail, a human created political boundary that separates what would otherwise be a continuous landscape pattern. On the west side of Manning Trail sits the City of Woodbury preparing to develop the far upper end of the Valley Branch watershed for commercial uses and residential neighborhoods at densities of between 3 and 12 dwelling units per acres. On the east side of Manning Trail sits the City of Afton seeking to maintain a development density of absolutely not more intensive than one dwelling unit per five acres. On opposite sides of the same street, there are two jurisdictions having completely different notions of how neighborhood is defined. Furthermore, throughout Washington County, there is considerable debate about the idea of cluster development. In the implementation of cluster development strategies, overall gross densities are maintained at a constant level. However, net density is allowed to increase to a higher level. Within the context of Afton's Rural Residential District, for example, a 50-acre parcel might be developed with 10 homes. However, rather than distributing the 10 homes across the entire 50 acres providing 5 acres of privately owned land for each homeowner, the 10 houses might be clustered on three acres at a net density of 3.3 dwelling units per acre. The remaining 46.7 acres is then reserved as open space.

Since each of these three ideas of neighborhood is a viable design concept in the context of existing conditions in the watershed, they were selected as alternative neighborhood designs to be simulated in the Valley Branch watershed. The three neighborhood design concepts (i.e. 3 dwelling units per acre, 1 dwelling unit per five acres, and 1 dwelling unit per five acres clustered at a net density of 3.3 dwelling units per acre) were simulated only in the context of extending existing watershed development policies. The development nodes within the green infrastructure plan are always simulated at a density of three dwelling units per acre. Both the three dwelling units per acre concept and the one dwelling unit per five acres concept were simulated as they would exist with and without application of conventional storm water management technologies.

REFERENCES CITED

Anfinson, S. 1993. The history of the St. Croix Valley. Unpublished lecture presented at a Conference on the Heritage of the Mississippi River. St. Croix Falls, Wisconsin.

Borchert, J. and N.C. Gustavson. 1980. Atlas of Minnesota Resources and Settlements. Minneapolis, MN, Center for Urban and Regional Affairs, University of Minnesota.

Bray, E. C. 1977. Billions of years in Minnesota: The Geological Story of the State. St. Paul, MN, Science Museum of Minnesota.

Bray, E. C. 1985. Ancient Valleys, Modern Rivers: What the Glaciers Did. St. Paul, MN, Minnesota Historical Society Press.

Crawford, D. undated. A Timeline of History in the St. Croix Valley. Unpublished mimeograph furnished by the author, formerly Interpretive Naturalist for Minnesota's Wild River State Park.

Curtis, J. 1971. The Vegetation of Wisconsin; an Ordination of Plant Communities. Madison, WI, University of Wisconsin Press.

Dunn, J. T. 1979. The St. Croix: Midwest Border River. St. Paul, MN, Minnesota Historical Society Press.

Folwell, W.W. 1956. A History of Minnesota. St. Paul, MN, Minnesota Historical Society Press

Martin, L. 1965. The Physical Geography of Wisconsin. Third Edition. Madison, WI, University of Wisconsin Press.

Marschner, F. J. 1974. Original Vegetation of Minnesota. St. Paul, MN, USDA-North Central Forest Experiment Station.

Meyer, G. N., R. W. Baker and C. J. Patterson. 1990. Surficial Geology. Plate 3. In L. Swanson and G. N. Myer. Geologic Atlas of Washington County, Minnesota. County Atlas Series C-5. St. Paul, MN, Minnesota Geological Survey.

Morey, G. B., et al. 1982. Geologic Map of the Lake Superior Region: Bedrock Geology. . St. Paul, MN, Minnesota Geological Survey .

Morey, G. B. and Mudrey, M.G. Jr. 1972. Keweenawan Volacanic Rocks in East-Central Minnesota. In P. K. Sims and G. B. Morey (eds.) Geology of Minnesota: A Centennial Volume. St. Paul, MN, Minnesota Geological Survey, pp. 425-430.

Ojakangas, R. W. and C. L. Matsch. 1982. Minnesota's Geology. Minneapolis, MN, University of Minnesota Press.

Patterson, C. J., J. H. Mossler and B. A. Bloomgren. 1990. Bedrock Topography and Depth to Bedrock. Plate 4. In L. Swanson and G. N. Myer. Geologic Atlas of Washington County, Minnesota. County Atlas Series C-5. St. Paul, MN, Minnesota Geological Survey.

Strahler, A. H. and A. H. Strahler. 1984. Elements of Physical Geography. Third Edition. New York. John Wiley and Sons.

Trewartha, G. T., A. H. Robinson, E. H. Hammond and L. H. Horn. 1977. Fundamentals of Physical Geography. Third Edition. New York, McGraw-Hill.

Trygg, W. 1964. Original Vegetative Cover for the St. Paul Sheet. Ely, MN, Trygg Land Company.

Vinar, K. R. 1980. Soil Survey of Washington and Ramsey Counties, Minnesota. St. Paul, MN, University of Minnesota Agricultural Experiment Station.

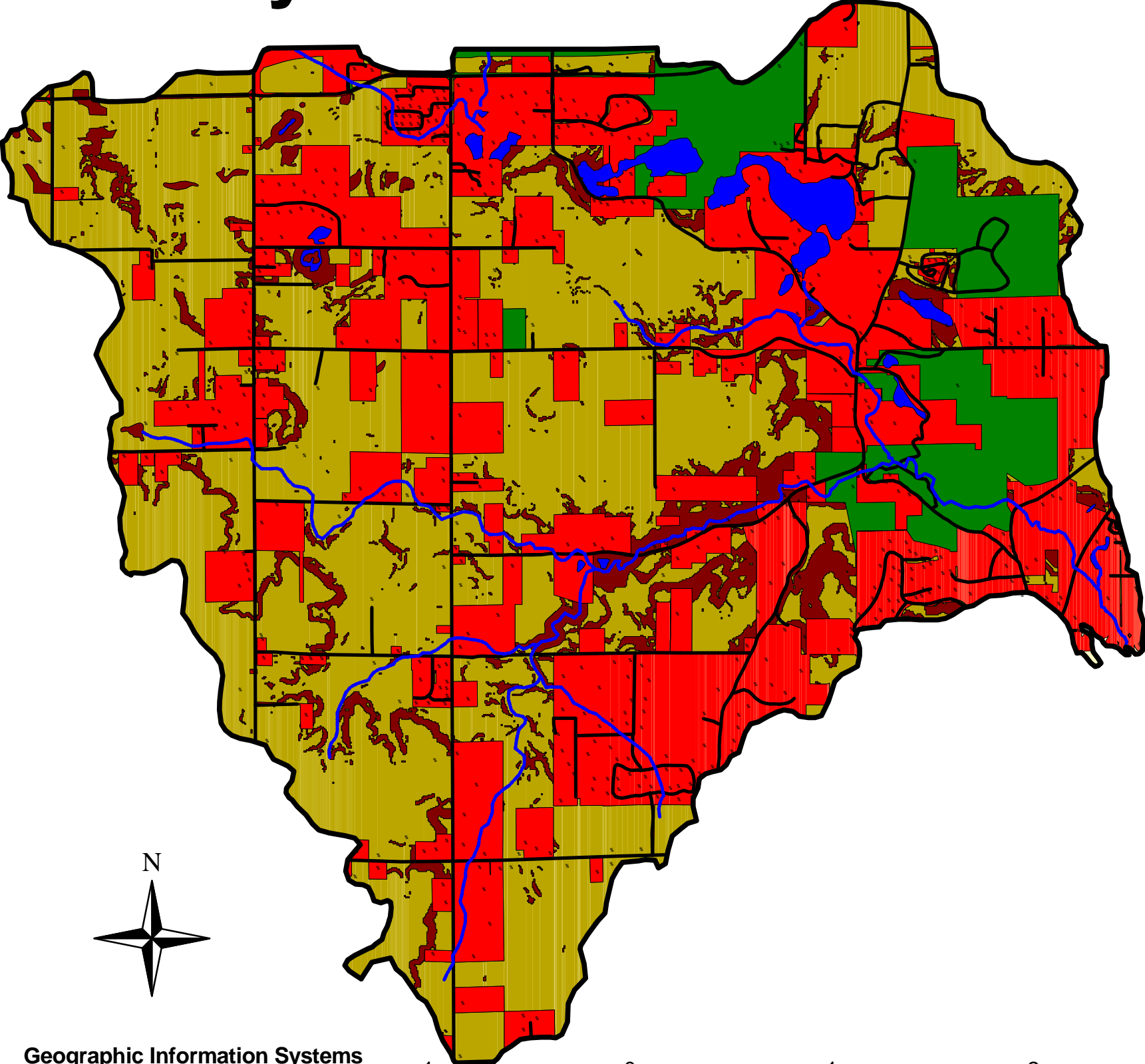
Upham, W. 1969. Minnesota Geographic Names; Their Origin and History. St. Paul, MN, Minnesota Historical Society Press.

Wright, H. E., Jr. 1972. Quaternary history of Minnesota. In P. K. Sims and G. B. Morey (eds.) Geology of Minnesota: A Centennial Volume. St. Paul, MN, Minnesota Geological Survey, pp. 561-580.

Wright, H. E., Jr. 1990. Geologic History of Minnesota Rivers. Educational Series 7. St. Paul, MN, Minnesota Geological Survey.

Five Acre Watershed Development Scenario

Valley Branch Watershed - Washington County, MN

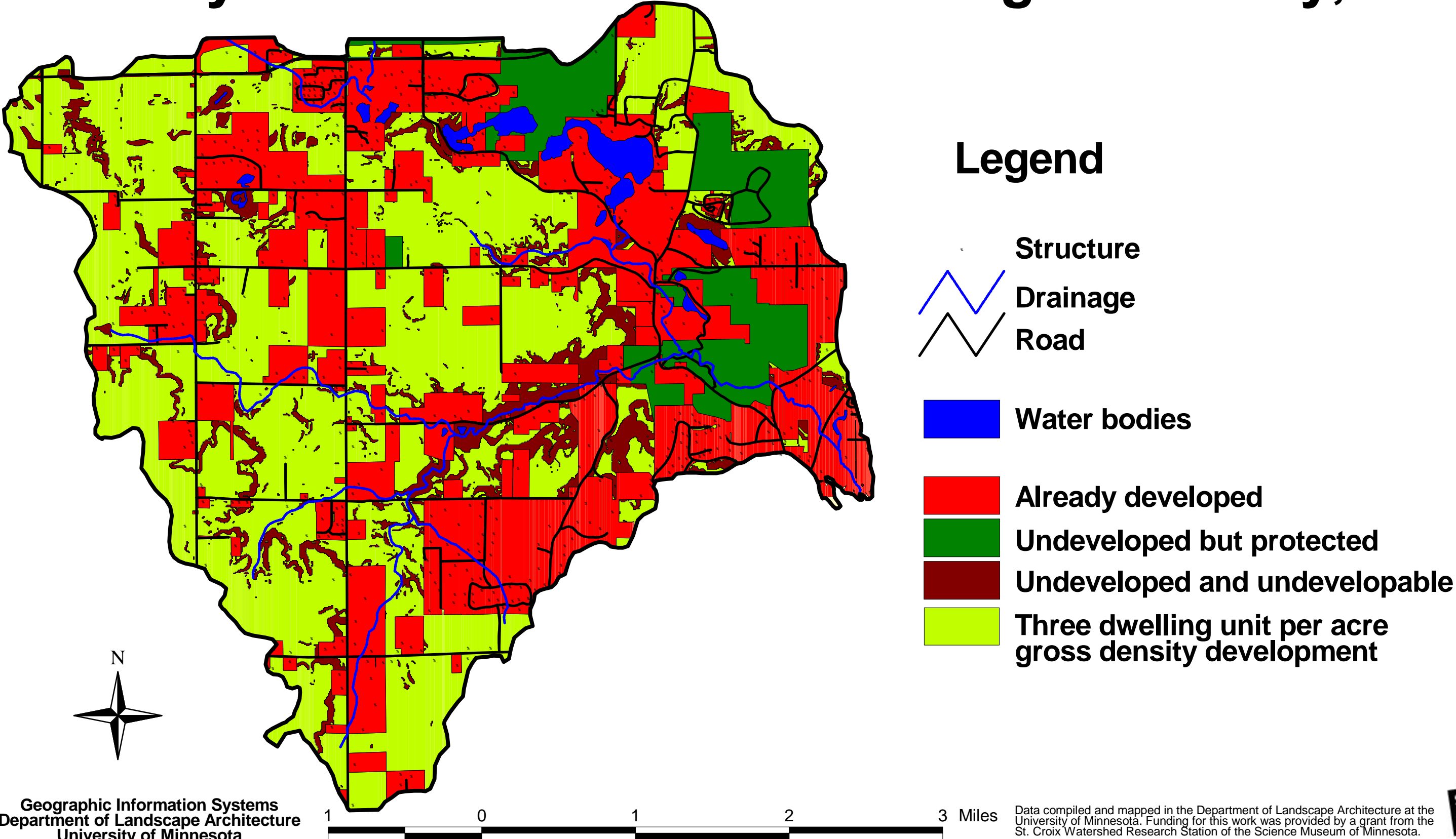


Legend

- Structure
- Drainage
- Road
- Water bodies
- Already developed
- Undeveloped but protected
- Undeveloped and undevelopable
- Five acres per dwelling unit gross density development

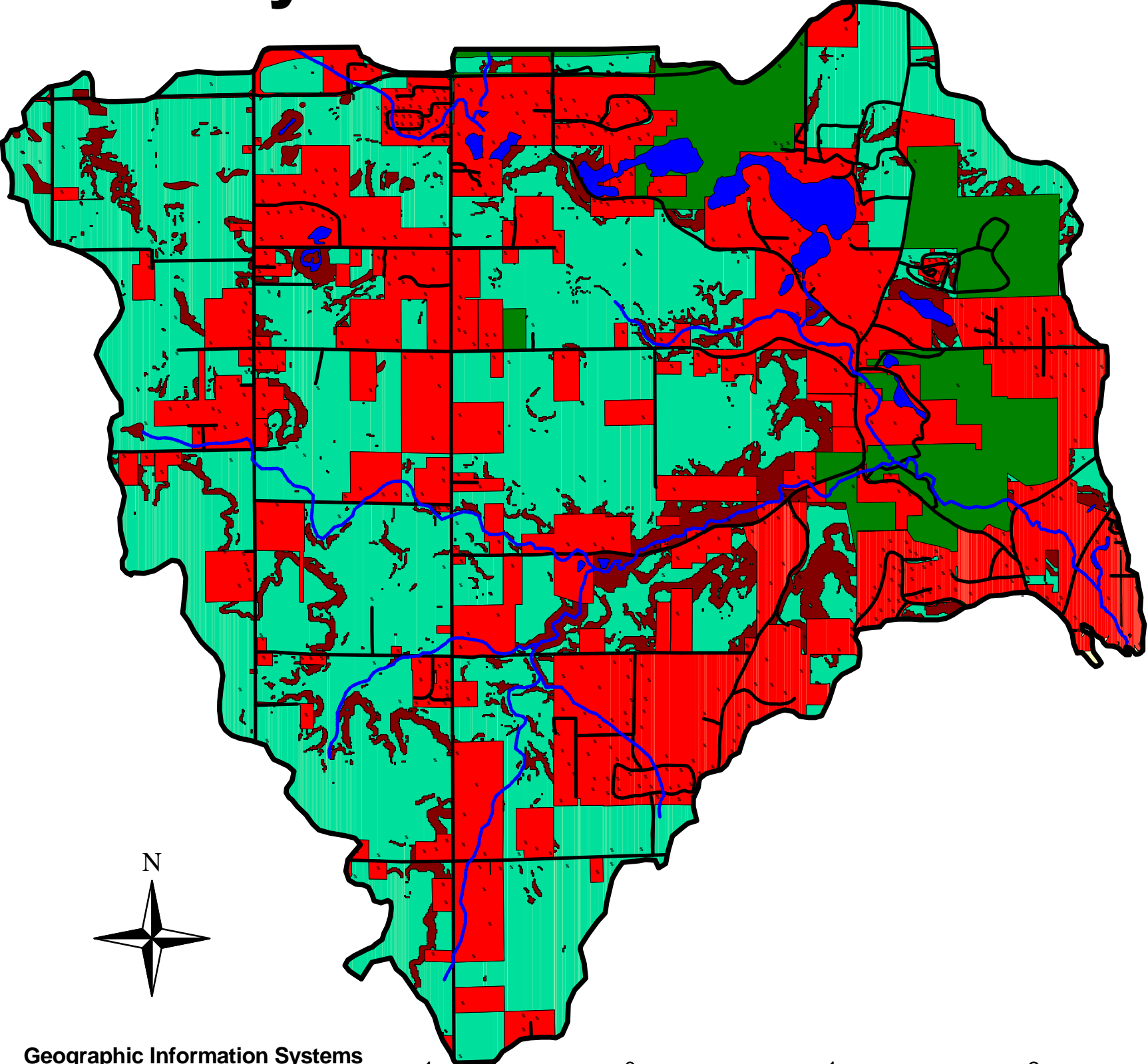
High Density Watershed Development Scenario

Valley Branch Watershed - Washington County, MN



Cluster Watershed Development Scenario

Valley Branch Watershed - Washington County, MN

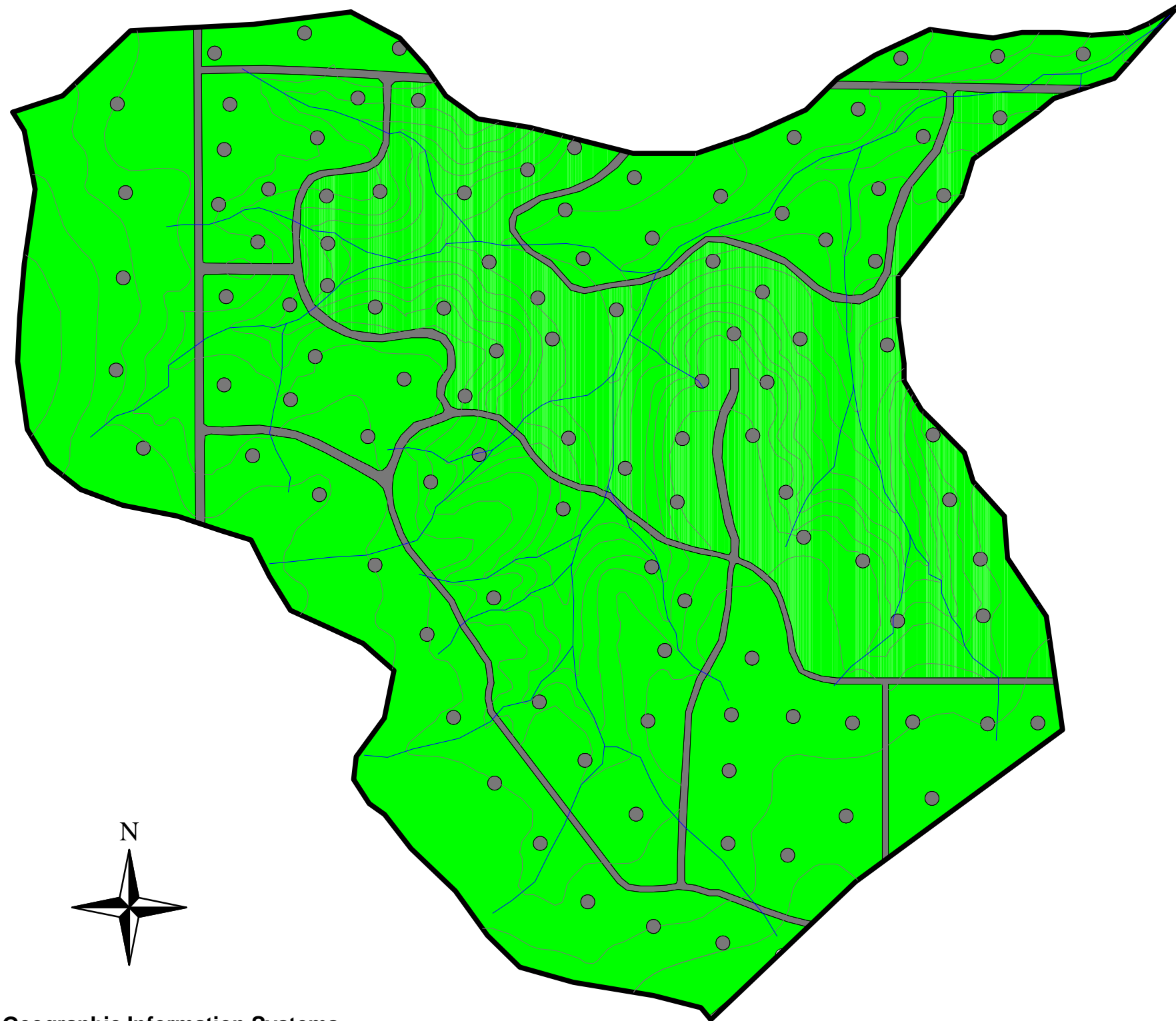


Legend





- Structure
- Drainage
- Road
- Water bodies
- Already developed
- Undeveloped but protected
- Undeveloped and undevelopable
- Five acres per dwelling unit gross density development clustered at three dwelling units per acre net density

Prototypical 5 Acre Development Without Stormwater Management

Valley Branch Watershed - Washington County, MN



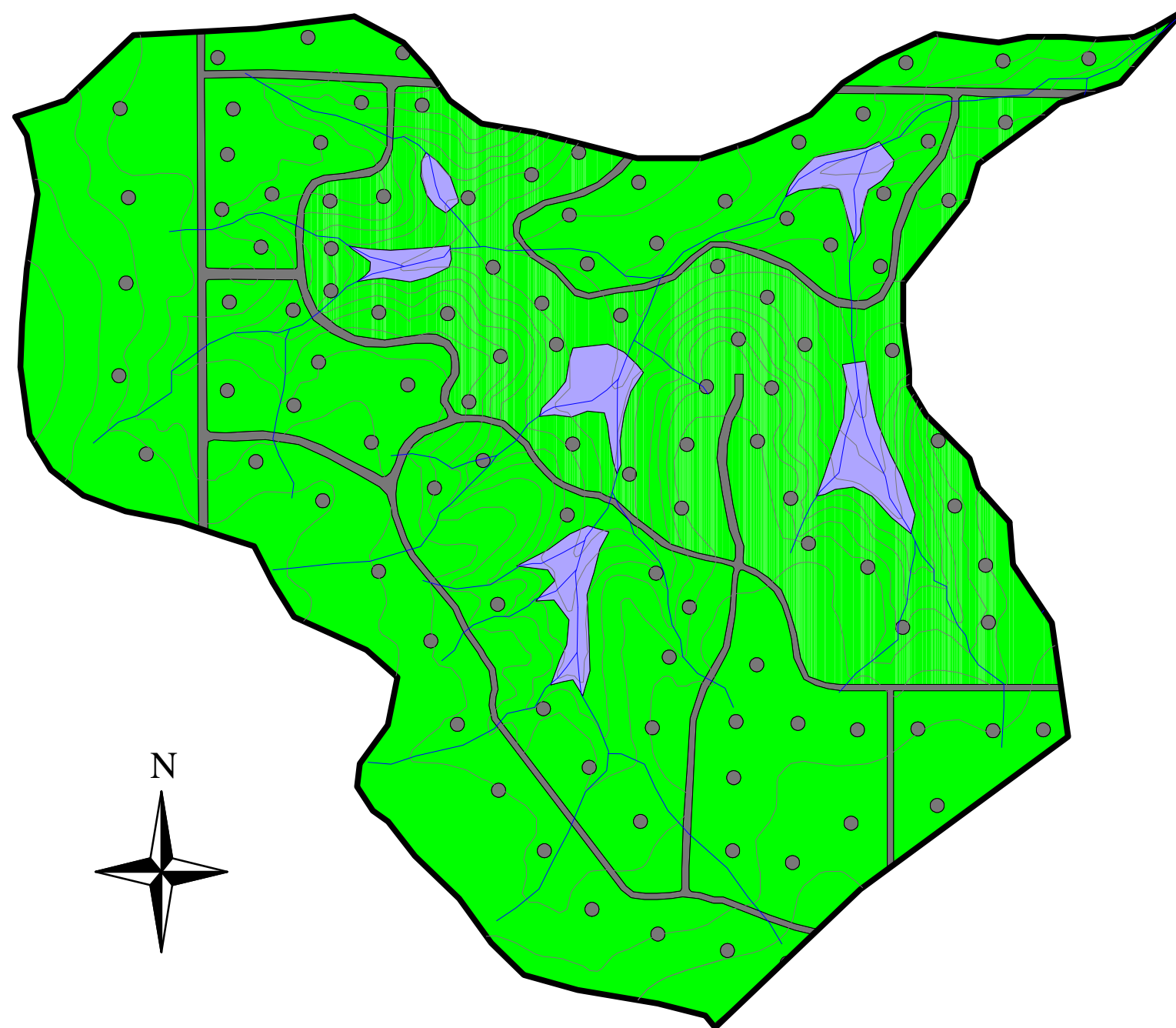
Legend

-  First order drainage
-  Ten foot contour
-  Impervious surface
-  Turf








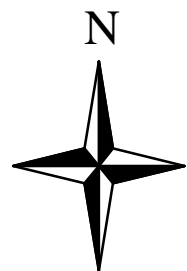
Prototypical 5 Acre Development with Stormwater Management

Valley Branch Watershed - Washington County, MN



Legend

-  First order drainage
-  Ten foot contour
-  Dry detention pond
-  Impervious surface
-  Lawn



Geographic Information Systems
Department of Landscape Architecture¹
University of Minnesota

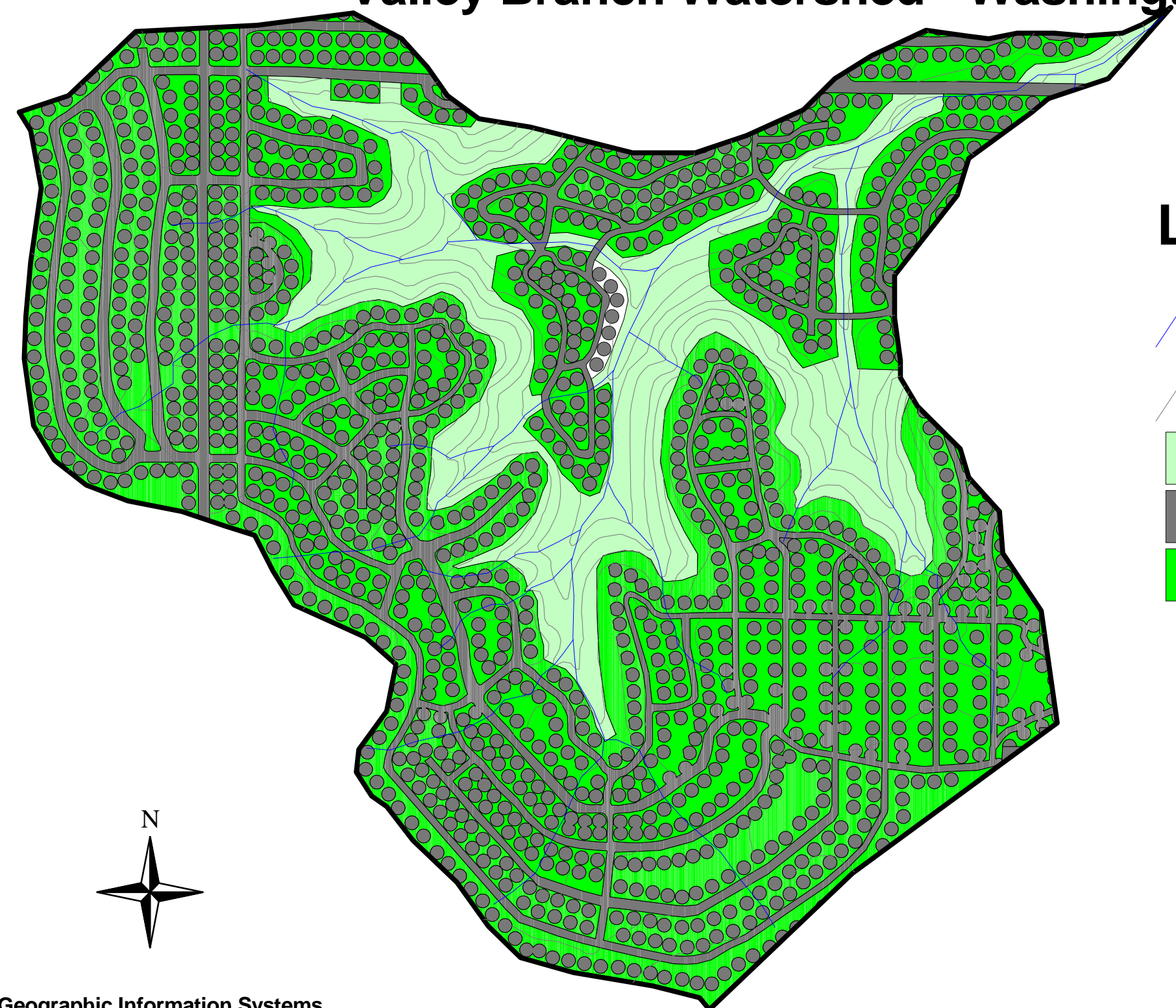


Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.

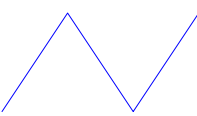

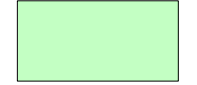


SCIENCE
MUSEUM
OF MINNESOTA

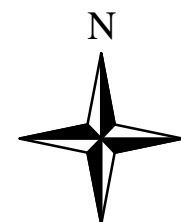
Prototypical High Density Development Without Stormwater Management

Valley Branch Watershed - Washington County, MN



Legend

-  First order drainage
-  Ten foot contour
-  Grassland
-  Impervious surface
-  Lawn



Geographic Information Systems
Department of Landscape Architecture
University of Minnesota



Data compiled and mapped in the Department of Landscape Architecture at the University of Minnesota. Funding for this work was provided by a grant from the St. Croix Watershed Research Station of the Science Museum of Minnesota.










Prototypical High Density Development with Stormwater Management

Valley Branch Watershed - Washington County, MN



Legend

-  First order drainage
-  Ten foot contour
-  Dry detention basin
-  Floodway
-  Grassland
-  Impervious surface
-  Lawn

Prototypical Cluster Development With Water Quality Management

Valley Branch Watershed - Washington County, MN

Legend

-  First order drainage
-  Ten foot contour
-  Impervious surface
-  Forest
-  Grassland
-  Lawn
-  Dry detention pond
-  First flush area
-  Water
-  Wetlands



Appendices

Appendix A - Dictionary of Basic Mapped Themes Contained Within the Valley Branch Watershed Geographic Information System.

Theme name	Theme contents	Type of Theme	Source	Scale	Method of compilation	Relevant attributes	Contents
Vbedrock83	Bedrock geology	polygon	Mossler, J. H. and B. A. Bloomgren. 1990. Bedrock Geology. Plate 2. In L. Swanson and G. N. Myer. Geologic Atlas of Washington County, Minnesota. County Atlas Series C-5. St. Paul, MN, Minnesota Geological Survey.	1:100,000	Polygons from Mossler and Bloomgren 1990 were re-drawn on 1:24,000 USGS Topographic Quadrangles. Re-drawn polygons were digitized.	Bedrocktype	Name of uppermost bedrock formation.
Vbdrdepth83	Depth to first bedrock	polygon	Washington County Well Index.		Well locations were brought into database using UTM northings and eastings contained in the index. Index attribute known as depth to first bedrock used to krieg 10 depth contours within Arc-info. Default parameters were used in the krieging process.	Bedrdepthcode	Depth to first bedrock in four classes: - less than 10 feet. - 10 to 30 feet. - 30 to 60 feet. - greater than 60 feet.
Vsurftype83	Type of surficial geology formation	polygon	Meyer, G. N., R. W. Baker and C. J. Patterson. 1990. Surficial Geology. Plate 3. In L. Swanson and G. N. Myer. Geologic Atlas of Washington County, Minnesota. County Atlas Series C-5. St. Paul, MN, Minnesota Geological Survey.	1:100,000	Polygons from Myer et al. 1990 were re-drawn on 1:24,000 USGS Topographic Quadrangles. Re-drawn polygons were digitized.	Surftype	Name of uppermost surficial geologic formation.
Vdrain83	Perennial and intermittent streams.	line	Hudson and Lake Elmo USGS 7-1/2 minute Quadrangles.	1:24,000	Perennial and intermittent drainage, as indicated symbolically on the quadrangles, were digitized.	Not applicable	Not applicable
Vdrainper83	Perennial streams	line	Hudson and Lake Elmo USGS 7-1/2 minute Quadrangles.	1:24,000	Perennial streams were selected from Vdrain83	Not applicable	Not applicable
Vdrainbasin83	Drainage network	line	Hudson and Lake Elmo USGS 7-1/2 minute Quadrangles. Valley Branch Watershed District Master Plan	1:24,000	Major and minor sub-basins in the Master Plan were digitized.	Vid	Identifies major and minor sub-basins within watershed: EDI = Lake Edith Basin FAL=Falstrom Lakes Basin MVB=Middle Valley Branch NVB=North Valley Branch SVB=South Valley Branch
					Drainage network presented in Vdrain83 was extended to include all first order streams as indicated by crenulations in topographic contour lines.	Streamorder	Identifies order of drainage within watershed: 1=No tributaries enter the channel 2=Two first order channels join together 3=Two second order channels join together 4=Two third order channels join together 5=Two fifth order channels join together
Vcont83	Topographic contours	line	Hudson and Lake Elmo USGS 7-1/2 minute Quadrangles.	1:24,000	Topographic contours provided by USGS on mylar were scanned and attributed.	Elev	Elevation of land surface above mean sea level in 10 foot contour intervals.
Vsurfelev83	50 foot hypsometry	polygon	Hudson and Lake Elmo USGS 7-1/2 minute Quadrangles.	1:24,000	50 foot contours were selected from Vcont83.	Surfelev	Elevation of land surface above mean sea level in 50 foot contour intervals.
Vsloped83	Topographic slope	polygon	Hudson and Lake Elmo USGS 7-1/2 minute Quadrangles.	1:24,000	From the 10 foot contours in Vcont83, a triangulated irregular network (TIN) was constructed in Arc-info depicting slopes in six categories. The TIN was converted to a polygon coverage.	Slope-code	Identifies six classes of topographic slope: 1=0 to 6% slope 2=7 to 12% slope 3=13 to 18% slope 4=19 to 25% slope 5=26 to 40% slope

Theme name	Theme contents	Type of Theme	Source	Scale	Method of compilation	Relevant attributes	Contents
Vsoil83	Soils	polygon	Vinar, K. R. 1980. Soil Survey Manual of Washington and Ramsey Counties, Minnesota. St. Paul, MN, University of Minnesota Agricultural Experiment Station.	1:15,840	Digital soil polygons were imported from data provided by the Washington County Surveyor's Office.	Hydric Perm Kfactor2 Flood Symbol	Identifies four categories that describe Hydrologic Soil Groups or soil infiltration capacity: 1=Group A (high infiltration) 2=Group B (moderate to high infiltration) 3=Group C (moderate to low infiltration) 4=Group D (low infiltration) Identifies four categories that describe soil permeability: 1=greater than 20 inches per hour 2=2 to 20 inches per hour 3=0.2 to 2 inches per hour 4=less than 0.2 inches per hour Identifies seven classes of k factor that describes the erodibility of the soil based on texture and structure. Higher k values indicate greater risk of erodibility. Identifies soils that are occasionally or frequently flooded. Identifies soil mapping units. First number of unit identification refers to soil series, letter refers to slope on which the series resides, and the second number (if present) indicates the amount of erosion that has already occurred on the soil.
Vsoilform83	Parent material of soil.	polygon	Vinar, K. R. 1980. Soil Survey of Washington and Ramsey Counties, Minnesota. St. Paul, MN, University of Minnesota Agricultural Experiment Station.	1:15,840	Data from Vsoil83 were reclassified based on processes of soil formation as described in Vinar 1980.	Formation2	Identifies the mineral material from which each soil mapping unit evolved. Soil mapping units having common soil parent material were grouped together.
Vsoildev83d	Soils with high to moderate suitability for septic tank drain fields.	polygon	Vinar, K. R. 1980. Soil Survey of Washington and Ramsey Counties, Minnesota. St. Paul, MN, University of Minnesota Agricultural Experiment Station.	1:15,840	Data from Vsoil83 were reclassified based on suitability of soil for septic tank drain fields as described in Vinar 1980.	Goodseptic	Identifies soils having slight or moderate limitations for septic tank drain fields.
Vsoilyld83d	Yield of soils for corn under normal management.	polygon	Vinar, K. R. 1980. Soil Survey of Washington and Ramsey Counties, Minnesota. St. Paul, MN, University of Minnesota Agricultural Experiment Station.	1:15,840	Data from Vsoil83 were reclassified based on potential yields of soils in corn production under normal management as described in Vinar 1980. Yields were reclassified to produce three classes of potential yield having approximately equal areas in watershed.	Yieldcat	Identifies soils having three classes of corn yield potential under normal management: 1=Highest corn yields 2=Moderate corn yields 3=Low corn yields
Vagnps83	Land use/cover in 1994	polygon	1991 aerial photographic and 1994 field reconnaissance. Field boundary data maintained by USDA-Farm Service Agency.	1:24,000	1991 aerial photographs were interpreted to identify 23 land use/cover classes. Field boundaries were digitized based on USDA-Farm Service Agency records, and agricultural cover types were adjusted to fit into Farm Service Agency field boundary definition. All agricultural cover types were field checked to identify type of tillage and cropping practices being used.	Ag_code	Identifies 23 land use/cover classes.
Vcore10083	Core forest interior habitat in 1994	polygon	1991 aerial photographic and 1994 field reconnaissance.	1:24,000	Forest cover types from Vagnps83 were buffered inward by 100 meters. Forest area contained within the buffer was attributed as forest edge. Forest area remaining was attributed as interior.	Core	Identifies forest areas that contain core interior habitat.
Vparcel83	Parcel boundary	polygon	Washington County Surveyor's Office.		Data were imported from shapes files provide by Washington County Surveyor's Offices	Acreage2 Protected Development	Identifies acreage of discrete parcels in data base. Identifies parcels whose ownership status is unlikely to result in development in immediate future. Also identifies parcels on which an agricultural land preservation easement exists. Identifies parcels already committed to development and parcels greater than 20 acres that are neither already developed nor in a protected ownership status.
Vnwi83	National Wetlands Inventory sites	polygon	Minnesota Land Management Information Center	1:24,000	NWI polygons were imported from data base obtained from LMIC	Wetland	Identifies multiple classes of wetland types. Attribute labels beginning with P are palustrine (I.e. upland) wetlands while those beginning with L are lacustrine.
Vmuni83	Political subdivision boundaries	polygon	Minnesota Department of Transportation Base Map CD	1:24,000	Municipal and township boundaries were clipped from Base Map CD for watershed	Municipality	Identifies political jurisdictions in the watershed.
Vroad83	Road network	polygon	Minnesota Department of Transportation Base Map CD	1:24,000	Roadways, county highways, county state-aid highways, ramps and township roads and city streets were imported from Base Data CD.	not applicable	not applicable

Theme name	Theme contents	Type of Theme	Source	Scale	Method of compilation	Relevant attributes	Contents
Vzonestruc83	Existing zoning plans	polygon	Cities of Afton and Woodbury, West lakeland Township	1,24,000	Zoning plans from the three jurisdictions were digitized	zone_code	Identifies 13 zoning districts contained among the three jurisdictions.
			Lake Elmo 7-1/2 minute USGS Topographic Quadrangles, updated in 1993.		with structure symbolization on the Topographic Quadrangles and field verified.		
Vshed83	Outline of watershed	polygon	Hudson and Lake Elmo 7-1/2 minute Topographic Quadrangles.	1:24,000	Watershed boundary was delineated on Topographic Quadrangles and digitized.	not applicable	not applicable

Notes:

1. All data compiled in UTM projection with meters as distance units based on NAD83 datum

Appendix B: Timeline of Cultural Development in the St. Croix River Valley Landscape

Two sets of material are presented below to document development of the cultural landscape in the St. Croix River valley. The material is generalized to the entire St. Croix valley since the Valley Branch watershed represents a relatively small spatial extent. In the context of providing an anthropological and historical picture of the landscape’s evolution, a rigorous investigation of the watershed, per se, was beyond the scope of this project. A timeline traces anthropological development of pre-Contact cultures in the Riverway and historical development of the Riverway since the Early Contact Period. Principle sources for the timeline include: A Timeline for Interstate Park, a Timeline of History in the St. Croix Valley developed by David Crawford, formerly Interpretive Naturalist for Minnesota's Wild River State Park; J. Curtis' 1971 book entitled The Vegetation of Wisconsin; an Ordination of Plant Communities published by the University of Wisconsin Press in Madison, Wisconsin; W.W. Folwell's 1956 book entitled A History of Minnesota, published by the Minnesota Historical Society; Minneapolis; J.T. Dunn's 1979 publication, The St. Croix River : Midwest Border River, published by the Minnesota Historical Society; W. Upham's 1969 book entitled Minnesota Geographic Names; Their Origin and Historic published by the Minnesota Historical Press; J. Borchert's and N.C. Gustavson’s 1980 book entitled Atlas of Minnesota Resources and Settlements published by the Center for Urban and Regional Affairs at the University of Minnesota; and a 1993 lecture given by Scott Anfinson of the Minnesota Historical Society at a Conference on the Heritage of the Mississippi River held in St. Croix Falls, Wisconsin.

Timeline of Cultural Development in the St. Croix River Valley Landscape	
12,000 - 9000 BP	Paleo-Indians were probably active in the area during the Cary and Valders glacial sub-stages. The culture is associated with several extinct mammals: mammoths, sloths, camels, and horses. Probably hunted mammoths in the area. (Curtis, <i>Vegetation of Wisconsin</i> , p. 458)
9000 - 2500 BP	Archaic cultural period. The most important culture at this period was the "Old Copper." Used copper to make axes, knives, fishhooks, harpoons, spear points, bracelets, and beads. This culture was making complicated metal tools several thousand years before their counterparts in Egypt and the Tigris Valley. Were hunters and food gatherers. May have hunted caribou, elk, whales, walrus and mammoths. Culture termination corresponds with time of maximum prairie expansion, thus climate and vegetation may have affected the culture. (Curtis, <i>Vegetation of Wisconsin</i> , p. 458)
11,500 BP	Human habitants coexisting with glacial landscape. (lecture by Scott Anfinson, At Mississippi Conference)
9000 BP	Last ice sheets have melted from Minnesota. Pine barrens gradually become pine forests, followed by oaks moving up from south as climate warms. Rivers and streams diminish to precipitation-fed volumes, but climate continues wetter than at present. The landscape is drastically different than it was a million years earlier. Most bedrock has been buried under glacial deposits except where rivers have exposed it, as at Taylor's Falls. Stream patterns have changed, and there are far more lakes and wetlands, creating greater diversity of vegetation and wildlife. "Brown's Valley Man" interred in western Minnesota - one of the earliest human skeletons known from the Western Hemisphere. (Crawford, <i>Timeline for Interstate Park</i>)

7300 BP	Glacial Lake Agassiz drainage basin begins to flow northward.... Beginning of formation of Lake St. Croix by damming effect of delta in Mississippi at head of Lake Pepin. Further siltation of lower St. Croix due to decrease water velocity in lake. (Crawford, <i>Timeline for Interstate Park</i>)
7000 BP	Prairie openings occur on sand plains and dry parts of area as rainfall drops to present-day levels. Prairie advances to about 75 miles northeast of its present extent, then retreats again as rainfall increases slightly. Largest remaining portion of continental glacier, then and today, is an ice cap on Baffin Island. (Crawford)
6000 BP	Nomadic hunters probably enter area for first time. (Crawford)
7000-2000 BP	Archaic Indians present. These are nomadic hunters. Copper tools are made from copper nuggets found in this area. Copper mining villages are established not far away. (Crawford)
3500 - 1500 BP	Early Woodland period. Grassland dominate in southern Wisconsin. A shift from nomadic hunting to more sedentary groups. Use of specially designed clay pottery. (Curtis, <i>Vegetation of Wisconsin</i> , p. 458)

1500 - 1000 BP	Middle Woodland period. Extensive introduction of agriculture. Main cultures are the Hopewell and Effigy Mound Cultures. Hopewellians were highly skilled in arts and crafts, making objects in chalcedony, obsidian, and jasper. They raised corn, beans, tobacco, and squash: they understood the art of textile weaving; and they made beads of hammered silver and copper, pearls, and shells. Such a cultural development undoubtedly was based on a highly organized division of labor and could have occurred only under rather high population levels with strong political and religious controls. The Effigy Mound Builders existed contemporaneously with the Hopewellians. Built ceremonial or totem mounds in lifelike effigies of birds, turtles, snakes, bison and other animals. Culture attained its acme in Wisconsin. Effigies are most common on hill crests overlooking lakes, streams, or springs in the southern Wisconsin counties. The mounds were built from hand-carried basket loads of earth. Their size and their internal structure indicate that they were constructed on open land free of trees. Probably built in prairies, but not known for certain. The culture combined hunting and agriculture; probably migrating back and forth with the seasons according to the availability of game and plant foods. (Curtis, <i>Vegetation of Wisconsin</i> , p. 459)
1225	Early mound builders left their earthworks at Lac Court Orielles and abandoned the area.
1000 - 1600 AD	The last prehistoric period, called the Mississippi period. Three cultures occupied this period, the Middle Mississippi, the Upper Mississippi, and the Late Woodland. The Upper Mississippi people were most abundant along the Mississippi and Lake Winnebago. They are thought to have lived in large permanent villages; they supported themselves by agriculture, hunting, and fishing. They made garden beds of raised mounds of earth, often in intricate curving patterns of parallel rows. Their use of metal was less than that of the Hopewellians and their artistic abilities were also less well developed. A single village, Aztalan, in Jefferson County represents the Middle Mississippi people. This was a large stockaded village, 20 acres in size with numerous homes. Villages of very similar type were seen in the South by DeSoto in 1541 but they had completely disappeared when Joliet explored the Mississippi, a century later. Some archaeologists are of the opinion that the Spaniards introduced measles and smallpox, which completely wiped out the susceptible Indians in their compact village units. The Woodland Indians, in smaller, isolated bands, escaped.(Curtis, <i>Vegetation of Wisconsin</i> , p.460)
1000-1500 AD	Woodland culture Indians present. These people make pottery and dig burial mounds. Some mounds along the St. Croix are dated at 1225 AD. There is a late Woodland fishing camp site under about 18 inches of accumulated soils in Minnesota 's Interstate Park camping/picnic area, dated between 1000 and 1300 BC. (Crawford)

1500 AD	Ojibwe Indians, displaced by westward movement of Iroquois tribes farther east, begin to move into the Lake Superior area, harassing the woodland-dwelling tribes of the Dakota (know to the whitemen by insulting name Sioux) and beginning three centuries of conflict between these tribes. (Crawford) The eastern Algonquian and Iroquoian engaged in tribal wars aided with guns supplied by French and Dutch.(Curtis, <i>Vegetation of Wisconsin</i> , p.460)
mid-1600's	Ojibwe begin entering St. Croix area. (Crawford, <i>Timeline for Interstate Park</i>)
2000 BP - 1830's	Influence of Indians on vegetation. 5 ways the pre-historic and historic changed vegetation 1. Fire - the most important, causing more change than the other 4 combined. Oak openings, prairies, and shrub communities, etc. depend on fire, and the frequency of lightening strikes doesn't explain the maintenance of those landscapes. The presence of nomadic hunting tribes throughout the state in the entire post glacial period means that human-made fires were an important if not the sole cause of the fires. ...A few widely scattered tribes could start enough intentional and accidental fires to keep all but the most protected sites in a retrogressive condition. 2. Hunting - Indirectly affect the plants through their influence on the populations of large mammals. 3. Agriculture - favorite site of cornfields was the floodplain forest. Girdling killed trees. Total land area was quite small. 4. Native plants - berries and nuts were favorite food sources; hackberry, walnut, hickory, acorns, and hazelnut. Act of gathering did not affect the plant population of these species. The Pomme de Prairie (<i>Psoralea esculenta</i>) a legume prized by the Indians may have been gathered to the point of reducing population levels. 5. Plant Introduction (intentional and accidental) - Circumstantial evidence suggests this occurred. Possibly introduced species; Canada plum, white gentian, wild leek, sweetflag, and groundnut. The nuts of Kentucky coffeetree were used in a sort of dice game by various tribes. Many became lost in the vicinity of the villages. In Wisconsin, these trees are located only at site of old indian villages. There is not a way to ascertain what the vegetation would have been had there been no Indians. It is probable that hardwood forests would have occupied the bulk of the land, but this is merely idle guessing. What is important is that a quasi-equilibrium was set up amongst the plants, soil conditions, and topographical conditions in which one community achieved local dominance. (Curtis, <i>Vegetation of Wisconsin</i> , p.461 -464)

1600 - 1800	The shifting tribes of this time probably caused considerable change in impact on various community types. The best evidence for this is seen in the savanna and prairie region, where lands spoken as barren and treeless by the earliest explorers became covered with brush or young forests when the major settlements were made after 1830. The vegetation records provided by the government land survey in the years from 1830 to 1860 reflect the changes that had occurred in the preceding 200 years under the influence of unstable and varied Indian populations, but they do not properly indicate the prehistoric conditions. (Curtis p. 464)
1654	French explorers Radisson and Grosseillers explore southern Minnesota, the first recorded white men in the state (Crawford, <i>Timeline for Interstate Park</i>)
1658-1660	Radisson and Grosseillers explore Lake Superior by canoe. Later, exploring the Mississippi, they may have reached the mouth of the St. Croix. (Crawford, <i>Timeline for Interstate Park</i>)
1680	Daniel Greysolon, Sieur Dulhut (Daniel Duluth) enters the St. Croix valley by way of the Brule River and travels the length of the St. Croix, the first European to make this trip. Attempted to make peace among the Indians in anticipation of opening fur trade with Indians in this area. Claims area for France. Rescues Father Hennepin from Indian captivity on Mississippi River. Santee Dakota still living in Chisago County area. (Crawford, <i>Timeline for Interstate Park</i>)
1683	Dulhut's second trip along the St. Croix. Blegen indicates he built a trading post somewhere in the St. Croix area. (Crawford, <i>Timeline for Interstate Park</i>)
late 1680's	First fur trading post on the St. Croix according to some sources, near present day Danbury, Wisconsin. (Crawford, <i>Timeline for Interstate Park</i>)
1689	Nicolas Perrot refers to the river as the "St. Croix" in a proclamation claiming this and other parts of North America for France. This is the first recorded use of the name "St. Croix" for the river. The name originated after the wreck of a boat belonging to a trader named "Sainte-croix" near the confluence of the St. Croix and Mississippi. The Dakota called it "Hogan Wankaykin" meaning "Place Where the Fish Lies." Father Hennepin names the river "The River of the Tomb" on his map of the area. An alternate story of the naming of the river indicates that it was named after Sieur de la Croix, a companion of Dulhut who was shipwrecked at the confluence. (Crawford, <i>Timeline for Interstate Park</i>)
1693	Pierre LeSeur begins duty assigned by France: to keep the St. Croix/Brule River route open to French trade. Operates a post near the mouth of the St. Croix 1693-1695. (Crawford, <i>Timeline for Interstate Park</i>)
1700-1800	

1700-1703	"Records" (no authoritative source given) indicate that a French fort was built and operated near the St. Croix Dalles, under the name Fort St. Croix. This and a suspected fur trade post, believed to have been built in 1700 based on the evidence of a foundation discovered by H.W.C. Folsom near the south end of the park campground, may be the same installation. One source (O'Neill) gives 1755 as date of establishment.(Crawford, <i>Timeline for Interstate Park</i>)
1700's	French fur traders find themselves in increasing competition with English newcomers in eastern North America (Crawford, <i>Timeline for Interstate Park</i>)
1745	Major Dakota-Ojibwe battle near Lake Mille Lacs forces Dakota out of area. No Dakota villages are located in the Taylors Falls area, but war parties still come from villages in the St. Anthony Falls area. (Crawford, <i>Timeline for Interstate Park</i>)
1754-1763	French and Indian War. France is defeated, and at the Treaty of Versailles cedes control of Canada to England. The St. Croix valley is part of the area included in the settlement. Minnesota west of the Mississippi is ceded to Spain. (Crawford, <i>Timeline for Interstate Park</i>)
1767	Jonathan Carver visits the upper portion of St. Croix, travelling to Lake Superior. (Crawford, <i>Timeline for Interstate Park</i>)
1770's (1771?)	Ojibwe war party from Madeleine Island, WI, encounters Dakota and Fox Indians near today 's NSP hydroelectric dam at St. Croix Falls, Wisconsin. Ojibwe win and the Dakota are driven out of the valley. The last Indian battle in Chisago Cnty.(Crawford, <i>Timeline for Interstate Park</i>)
late 1700's	English fur companies - Northwest and XY companies - come into being. Many French fur traders continue to operate as independents. (Crawford, <i>Timeline for Interstate Park</i>)
1775-1783	American Revolution. United States gains independence, but England retains control of interior of continent. (Crawford, <i>Timeline for Interstate Park</i>)
1793	Lawrence Booth operates a fur post in the Taylors Falls area. (Crawford, <i>Timeline for Interstate Park</i>)
1789-1799	Establishment of Northwest Fur Company in Minnesota. (Crawford, <i>Timeline for Interstate Park</i>)
1803	This part of Minnesota is part of Indiana Territory (Crawford, <i>Timeline for Interstate Park</i>)
1804	Northwest Company Fur Post is established on Lake Pokegama near present-day Pine City. Later operated by American Fur Company. XY Company absorbed by Northwest Company. (Crawford, <i>Timeline for Interstate Park</i>)
1805	Site of Fort Snelling obtained from Dakota Indians by Lt. Zebulon Pike. (Crawford, <i>Timeline for Interstate Park</i>)
1809	This part of Minnesota becomes part of Illinois Territory. (Crawford, <i>Timeline for Interstate Park</i>)

1812-1815	War of 1812. England relinquishes control over interior lands south of Lake Superior. Minnesota west of the Mississippi is ceded to Napoleon Bonaparte by Spain, then to the US by Bonaparte. Established fur trade in formerly English possession is gradually taken over by John Aster's American Fur Company. (Crawford, <i>Timeline for Interstate Park</i>)
1819	This area comes under the jurisdiction of Crawford County. (Crawford, <i>Timeline for Interstate Park</i>)
1820	Fort Snelling is established to oversee this area and the Minnesota and Mississippi Rivers. (Crawford, <i>Timeline for Interstate Park</i>)
1825	Fort Barbour fur trading post is licensed by the Indian agent at Fort Snelling to operate at St. Croix Falls. Operated by the Columbia Fur Company. (Crawford, <i>Timeline for Interstate Park</i>)
1830's	Fur trade mostly dies out due both to depletion of beaver and reduced demand for furs. The beaver hat waned in popularity. (Crawford, <i>Timeline for Interstate Park</i>)
1830 -1860	Time of the government surveys. The vegetation deduced from survey information can be thought of as an intermediate stage in the transition from a prehistoric equilibrium between Indians and the land to the modern balance between white men and the land. (Curtis, <i>Vegetation of Wisconsin</i> , p.465)
1831 (1832?)	Henry Rowe Schoolcraft, husband of Chief Waubojee's grand daughter, visits the upper St. Croix. (Crawford, <i>Timeline for Interstate Park</i>)
1832	"An old trader, Rocque and his son arrived at Fort Snelling from Prairie du Chien, having been 26 days on the journey. Under the influence of whiskey or stupidity, they ascended the St. Croix by mistake and were lost for 15 days." (Crawford, <i>Timeline for Interstate Park</i>) Schoolcraft leads first major American expedition into area, up the Mississippi to its source, then up the St. Croix and down the Brule to Lake Superior. While en route, he camps at present site of Taylors Falls. Burns down 9 buildings of J.R. Brown fur post a few miles above the Dalles because it is there against government regulation. (Brown's post is reported by Nute as occupying the same location as Fort Barbour) Finds Pine City fur post still in operation. Estimates total population of St. Croix Valley, whites and Indians, at 900. (Crawford, <i>Timeline for Interstate Park</i>)
1836	Mr. Pitt and a company of men cut pine logs in Falls area with Ojibwe permission but against the wishes of the US. Government, in a non-commercial operation. Wisconsin Territory organized, including what is now Minnesota east of the Mississippi. Joseph Nicollet travels the St. Croix, finding many fur posts still in operation. Smith reports J.R. Brown cut first logs ever cut on St. Croix in 1836-37. (Crawford, <i>Timeline for Interstate Park</i>)

1837	Dakota Indians cede control of all their land claims east of the Mississippi to the US. in a treaty signed in Washington. Ojibwe cede control of Falls area to US. in a treaty signed at Fort Snelling in exchange for trade goods and money equaling about 7 cents an acre. Major J.R. Brown operates fur post on Minnesota side of Dalles and cuts pine in the area that is now Taylors Falls and the north end of Interstate Park (200,00 board feet, most of which was destroyed by a forest fire)Jesse Taylor claims land along the Minnesota side of the river (Taylors Fall Reporter, v1, 1860 says Ben Baker make the claim and that Taylor worked for Baker) Franklin Steele and /or partners claim water rights to the falls and build a cabin on Wisconsin side to prove claim, having arrived in a bark canoe 1 day after the signing of the treaty at Fort Snelling. Steele says 4 other parties arrived at the falls to make claims during the time the cabin was under construction. (Crawford, <i>Timeline for Interstate Park</i>)
1838	First white settlers move into lower St. Croix valley. First steamboat, the Palmyra, chartered by Steele, reaches Taylors Falls, brings word of the ratification of the treaty by Congress. Steele and company (the St. Louis Lumber Company) start setting up a dam and sawmill, completed in 1840. Jesse Taylor and Benjamin Baker build a dam and sawmill, the dam just above the site of the present highway bridge and the mill in the vicinity of today's upper boat landing, buying part of their claim from Robinet, a French trader. They also construct a log house, the first building within what is now Taylors Falls. In 1837-38 the logs cut and floated on the St. Croix and its tributaries amount to 300,000 board feet. (Crawford, <i>Timeline for Interstate Park</i>)
1830 -1850	In the early years of settlement, the most important vegetation effects were caused by the elimination of fire, the major Indian agent of control. The new occupants accomplished this not only by the removal of the Indians, but by positive efforts at fire prevention. Their small and widely distributed private holdings were guarded against accidental conflagrations and were further protected by the interpolation of roads and plowed fields. Most of the current stands of oak forests and the few remaining white and red pine forests date back to this change in land treatment, with trees remarkably close to one hundred years old on the average. (Curtis, <i>Vegetation of Wisconsin</i> , p. 465)
1839	First commercial sawmill in Minnesota begins operation at Marine Mills, now Marine-on-the-St. Croix. Some of the trees being cut at this time were 6 feet in diameter. St. Croix County established. One of the last Dakota-Ojibwe battle on the river takes place at "Battle Hollow" north of Stillwater. (Crawford, <i>Timeline for Interstate Park</i>)

1840	Neill says steamboat "Tennessee" reaches Taylors Falls. Ben Baker dies, leaving a poorly managed mill complex to Jess Taylor. First grist or flourmill to be built on St. Croix established nearby. First post office established in St. Croix Falls. Population of St. Croix Falls is 20. First known death of white man, Mr. Ryan, drowned in log rafting accident. Two Dakota, sons of Little Crow, killed by Ojibwe near Taylors Falls. (Crawford, <i>Timeline for Interstate Park</i>)
1842	Mill, dam, and millrace of Franklin Steele's company completed and first log sawed in commercial mill at the Dalles. Steele pulls out of company, mill changed owners. (Crawford, <i>Timeline for Interstate Park</i>)
1843	"Arial" is second steamboat to attempt the trip to Taylors Falls, followed by the "Otter" and numerous others. Fall supply boat is stopped by early ice on the river, beginning the "starving time." (Crawford, <i>Timeline for Interstate Park</i>)
1844	During early spring, a fifty-mile road is cut from Taylors Falls to Fort Snelling to transport food to Taylors Falls. First Stillwater sawmill opens, with a small boom to collect logs. Cross Lake boom on the Snake River breaks in spring flood. Logs released from the boom destroy millrace and damage mill at St. Croix Falls. (Crawford, <i>Timeline for Interstate Park</i>)
1845	Steele mill, no longer in operation, changes ownership again, never resumes operation. (Crawford, <i>Timeline for Interstate Park</i>)
1846	Jesse Taylor sells his land holdings to Joshua Taylor (no relation), the first exchange of deeded land in the St. Croix valley. Ben Otis and Jerry Ross begin first farms in what is now Chisago County on Bluff above Taylors Falls. Otis builds first frame house in area. (House is later owned by William Colby) (Crawford, <i>Timeline for Interstate Park</i>) Arcola is founded. Village of sawmills. Named after the ancient town in Italy. (Upham)
1847	A second dam is built in the Dalles. Caleb Cushing's Boston Lumber Company begins operation in St. Croix Falls. Mr. Partridge establishes independent trading post, "Quailtown", about St. Croix Falls. A sketch made at this time, [Lewis, "Cheever's Mill] shows a low falls, about 10 feet high, and mill at the site of today's power dam. (Crawford, <i>Timeline for Interstate Park</i>)
1848	Government land offices open in Taylors Falls (Dunn says 1849) and St. Croix Falls (Dunn says 1847) to handle claims for lumbering. First legal sale of US land to loggers. Some land sells for as little as 10 cents an acre. First commercial mill at St. Anthony Falls established by Franklin Steels. Nation wide financial crisis slows logging industry. Logs cut on St. Croix River and tributaries, 1847-48 yield 26,000,000 feet of lumber. Wisconsin becomes a state. Minnesota officially without government until 1849. Dan Mears establishes first store in Taylors Falls. Boston Lumber Company mill burns. (Crawford, <i>Timeline for Interstate Park</i>)

1849	Government pineland survey establishes legal basis for sale of land to logging companies. All claims by loggers and settlers up to now are technically illegal. No attention was paid to actual ownership of timber. Typical cost for legal purchase was \$1.25 per acre. Much land which was logged was never paid for, even after 1849 survey. Baker Falls townsite officially noted as part of survey. Minnesota Territory established. Government land office moves to Stillwater. Today's Chisago County was part of Washington County at time territory was established. Sawmill in operation at foot of St. Croix rapids with two reciprocating saws. (Crawford, <i>Timeline for Interstate Park</i>) Point Douglas platted. On the west side of the mouth of Lake St. Croix. Named after Stephen D. Douglas. (Upham, p. 570)
1850 - 1900	Agricultural patterns. The first settlers preferred the forest to the prairie because they were suspicious of the treeless lands, were unable to plow them properly with the tools then available, and were generally short of the capital necessary to build the essential buildings with purchased lumber. This situation changed fairly rapidly when the true richness of the prairie began to be realized and the trend then shifted to settlement of prairies and savannas in preference to the heavy forests. There was a nearly complete occupation of the prairies by 1880. In the savanna country there was a tendency to allow the rougher sections of the farm to develop in forest, as source of fuel and building materials. One result was the widespread occurrence of farm wood lots, 10 to 60 acres in size on the average, composed of a dense growth of oaks and associated species on lands that were formerly open brushland or widely spaced savanna. Thus today after more than a century of intense agriculture, there may be more closed forests. The white man introduced a number of weed species. Some crops escaped and flourished in the natural environment. Forage crops like Kentucky bluegrass, redtop, timothy, and other grasses, and white sweet clover, white clover, and other legumes, all adapted to northern climates and continued disturbance . (Curtis, <i>Vegetation of Wisconsin</i> , p. 465 - 466)
1850	Scandia , place of first Swedish settlement in Minnesota. (Upham)
1851	Taylors Falls platted. Incorporated in 1858. (Upham)
1852	South Stillwater platted. Built on part of the former Oak Park site. (Upham)
1853	Marine platted. (Upham)
1855	Minnesota territory population estimated at 40,000 (Vincent) Afton township first settled and platted in 1855, organized in May 1858. Named after "Burns' poem, 'Afton Water' which gives a fine description of the 'neighboring hills, and clear winding rills.'" (Upham, p. 568)
1856	Minnesota territory population estimated at 100,000 (Vincent)
1857	Oak Park village site platted. Currently in location of Bayport. Minnesota territory population census at 150,000. (Vincent)

1858	Baytown founded, later became known as Bayport. Named for the bay created by Mulvey's point. Marine township founded. Lakeland township is settled, organized in 1858. Village platted in 1849. (Upham, p.569) Franconia township organized. Named by Ansel Smith, who came from Franconia, N.H. Village platted 1858, and incorporated in 1884.(Upham, p.108)
1860	Afton township population recorded in Census of Population at 360.
1865	Major log-jam at the Dalles. (unknown)
1870-1890	Much of the Washington County landscape in the vicinity of the Valley Branch watershed is brought into cultivation. (Borchert, 1980)
1870	Afton township population recorded in Census of Population at 825.
1877	Log jam at St. Croix Falls area (unknown)
1880	Afton township population recorded in Census of Population at 925.
1890	Afton township population recorded in Census of Population at 1097.
1900	Average farm size in Washington County., 150 acres. (Borchert) Afton township population recorded in Census of Population at 1130.
1905	60-foot high power dam built at St. Croix Falls. (unknown)
1910	Afton township population recorded in Census of Population at 1047.
1911	St. Croix River Association is formed
1913	End of logging era. (unknown)
1920	Average farm size in Washington County, 150 acres. (Borchert) Afton township population recorded in Census of Population at 990.
1930	Snagging operations begin on the river to clear it for navigation. Lock and dam #3 on the Mississippi River at Hastings affects water levels on the lower 25 miles of the St. Croix River. Afton Village population recorded in Census of Population at 839.
1940	Afton township population recorded in Census of Population at 889.
1947	St. Croix River Association is concerned about sewage in the river.
1950	Average farm size in Washington County, 150 acres. (Borchert) Afton township population recorded in Census of Population at 1361.
1953	Minnesota Board of Health says St. Croix is polluted from Taylors Falls to Prescott.
1960	Sewage treatment plants built at Hudson and Stillwater. Average farm size in Washington County, 200 acres. (Borchert) Afton township population recorded in Census of Population at 1181.
1961	St. Croix River Association suggests zoning along the river to protect scenic qualities.

1965	Alan S. King NSP plant built; Minnesota-Wisconsin Boundary Area Commission formed.
1966	Recreational overcrowding is a concern of the MN-WI Boundary Area Commission.
1968	National Wild and Scenic Rivers Bill passed, including the Upper St. Croix River.
1970	Valley Branch Watershed District identifies zones subject to flooding. Afton township population recorded in Census of Population at 1993.
1970's	Village of Afton and Afton township incorporate as City of Afton.
1972	Lower St. Croix is added as a National Scenic and Recreational Riverway.
1973	Calder Corporation proposes major development in Hudson.
1973	Minnesota passes Lower St. Croix River Act and Critical Areas Act.
1974	Lower St. Croix is designated "a critical area" in Minnesota causing development to be regulated until plans are adopted.
1976	Master Plans are adopted for St. Croix National Scenic Riverway and State zoning regulations are adopted.
1978	City of Afton adopts Building Code.
1980	City of Afton population enumerated by Census of Population as 2550. City of St. Mary's Point population enumerated by Census of Population as 348. City of Lake St. Croix Beach population enumerated by Census of Population as 1176. City of Woodbury population enumerated by Census of Population as 14,726.
1982	City of Afton adopts Zoning Ordinance. City of Afton adopts Sanitary Sewer Disposal Code.
1985	City of Afton adopts Lower St. Croix River Bluffland and Shoreline Ordinance
1986	City of Afton adopts Wastewater Service Charge Ordinance regulating use of community wastewater disposal systems.
1989	City of Afton revises Subdivision Ordinance.
1990	City of Afton population recorded in Census of Population at 2645.
1991	City of Afton revises Shoreland Management Ordinance.
1993	City of Afton adopts Individual Sewage Treatment System Ordinance, supplanting the Sanitary Sewer Disposal Code adopted in 1982.
1994	City of Afton adopts Heritage Preservation Ordinance.
1994	City of Afton revises Floodplain Zoning regulations.
????	City of Afton adopts Mining Regulation Code.
1998	City of Afton revises its Comprehensive Land Use Plan, reaffirming its desire to retain its status designated by the Metropolitan Council as a Rural Preserve.